Leveraging Global Operations Innovation to Create Sustainable Competitive Advantage

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ABSTRACT

High fixed costs and the emergence of globalization have forced traditional domestic automotive mass producers to the brink of bankruptcy. This thesis focuses on the global growth strategy of a Tier 1 automotive supplier and examines causal relationships between that strategy and the system stakeholders who execute and support it. The literature review examines current research to illustrate the benefit of approaching globalization with a process-driven, systems-based mindset. Current literature offers insight into improved financial measures that traditional mass producing firms can employ to streamline decision making and shift the mindset of leaders to engage employees, suppliers, and customers around a long-term systems based operating strategy.

The thesis is based upon three core experiences the author had at American Axle to illustrate the importance of systems-based operations innovation. The literature review in conjunction with the internship experience is used to illustrate opportunities for American Axle to improve its operating strategy. The paper highlights traditional approaches currently used inside the company and offers solutions to change employee behavior throughout American Axle's global manufacturing system. The thesis examines behaviors, metrics, and results often seen in an absorption cost environment where there are weak operational controls and non-standard corporate scorecards. Using current research and professional industry experience, I will argue robust operational controls and metrics, aligned with an overarching systems approach that considers the long term implications of today's decisions, are essential components to the viable, long term success of any global enterprise.

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I would like to thank my parents Phillip and Mary Storm for the many sacrifices they made in their life to raise 9 children. It does not seem like it was very long ago when as a young boy I would sit with mom and read out loud to her in the living room of our childhood home. I also recall the many mornings I spent with dad listening to his business advice while delivering morning papers throughout the neighborhood or the many evenings we spent huddled around a radio listening to State of the Union speeches at home. I will always cherish and appreciate the values and character traits they instilled in me from my childhood which provided the foundation upon which I built my life and ultimately pursued my life's dreams.

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Note on Proprietary Information

The data presented throughout this thesis has been altered to protect the confidentiality of American Axle & Manufacturing. The values contained herein do not represent actual values used by the company. The values have been disguised to preserve confidentiality of competitive data.

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1.0 Introduction

American Axle & Manufacturing (AAM) is a premier, Tier One, automotive supplier headquartered in Detroit, Michigan. AAM has built a strong global reputation providing world class design, engineering, testing, validation, and manufacturing to produce driveline and drivetrain systems for the automobile industry. [AAM Annual Report, 2006] The company derives its profits from three operating divisions: the Driveline Division, the Metal Formed Products Division, and the Driveshaft & Half Shaft Division.

With annual sales of $3.25 billion in 2007, AAM is one of the most profitable Tier One auto suppliers in the industry. To realize profits, AAM continues to grow its global footprint and diversify its customer base. Over the last 24 months AAM expanded manufacturing operations in South America, Europe, and Asia. With 76% of revenue coming from sales to General Motors in 2006 [AAM Annual Report, 2006] the company continues to follow their primary customer into emerging markets outside of the United States while at the same time looking for ways to grow in non-automotive global markets. Some of AAM's most recent non-automotive growth has come from customers like CAT and Harley Davidson.

As the automotive OEMs become less vertically integrated, pressure will increase on Tier One automotive suppliers like AAM to speed their product life cycles up to meet the ever changing demands of customers. To meet these demands profitably, AAM needs to focus on three core areas of improvement: 1) Developing a Consistent Global Operating Strategy, 2) Aligning Processes and Systems, and 3) Institutionalizing Systems Thinking. In the following thesis, the author will present case examples from 6.5 months working in the AAM Corporate Materials department. Recommendations will be provided using frameworks derived from current research to show the impact systems thinking could have on AAM's overall ability to compete profitably in global markets around the world.

1.1 Thesis Motivation

Facing unprecedented challenges that include escalating energy, material, and labor costs, AAM is in the midst of building a global footprint to compete outside of the United States. In pursuit of global expansion through recently constructed plants in Poland, Brazil, and China along with a recently announced joint venture in India and new plant construction in Thailand, AAM is in the midst of a global blitz. The growth has stretched the capability and reliability of the AAM operating system to deliver consistent financial performance across business units. As a result, gross profits have declined from $475 million in 2004 to -$129 million in 2006. Gross margins decreased from 13.2% to -4% during the same periods. [AAM Annual Report, 2006] Most telling, inventory levels increased 25% from the end of fiscal 2006 to the end of the third quarter in 2007 while comparable revenues declined. These business realities help illustrate the enormous opportunity to help AAM develop a systems based operations strategy. Senior management's desire to reexamine AAM's global growth strategy and framework initiated this thesis project.

The objective of the project was to analyze the current manufacturing footprint to develop a framework that would support implementation of an overarching AAM Global Operating System. By visiting suppliers and literally walking the value stream of key assemblies from finished good back up through the supply chain to raw material provider, the thought process was to discover and analyze how business was getting done so an effective corporate operating system could be developed.

1.2 Thesis Overview

The thesis is based on process/value stream mapping, global supply chain theory, global operations management theory, activity based cost accounting theory, disruptive technology theory, and an overarching systems approach utilizing fundamental principles of the Toyota Production System. Process/value stream mapping was used to document current state material flow in AAM's Buffalo plant and to develop an understanding of AAM's manufacturing operations. The technique was also applied during supplier visits to Tier 2 forging facilities, component manufacturers, and steel producers. Global supply chain theory was used to identify opportunities in the AAM material and procurement systems. Global operations theory was applied to the systems and processes used amongst cross-functional departments at both the corporate and plant levels of the organization. Activity based cost accounting theory helped demonstrate the irregular standards used from one plant to the other and also highlighted the need for an overarching financial tracking system to measure the financial health of AAM's global business. Disruptive technology theory was applied to AAM's current strategic vision in an effort to help the company think about the long-term implications of their growth plans and to consider areas of the market where their strategy may be most vulnerable.

The thesis project focused on three core areas of AAM's business. The author first visited the Buffalo Gear & Axle facility in Buffalo, New York to help AAM reduce the total number of containers and increase material velocity on all productive systems prior to the equipment being transferred to Detroit Gear & Axle. For the next phase of the project, the author examined AAM's global supply chain process by focusing on one specific aspect of their global business, Guanajuato Gear & Axle. During the last portion of the project, the author identified opportunities to improve the AAM Driveshaft business by visiting both driveshaft assembly plants and also major Tier 1 and Tier 2 suppliers.

Key observations of the thesis project used to frame this thesis include:

- Companies competing in global markets need educated leaders who understand the complexities of globalization. The Toyota Production System is the global benchmark that encourages companies to commit to training, teaching and developing leaders who understand operations and the value of sharing information.

- As companies grow globally, financial incentives must be aligned with the operational objectives of the firm. ABC and Time-Driven Activity-Based Costing help companies manage operational costs. Successful companies using these systems have managers whose knowledge and attitude toward cost management is based on long term performance.

- Operations innovation occurs when company leadership reinvents new ways for work to get done. This enables lasting change that generates measurable year over year improvement.

- Companies often fail to recognize how manufacturing impacts their corporate strategy. The companies view the relationship as high efficiency and low cost overlooking the long range impact their shortsightedness has on the company. An important job of company leaders is to teach others in the organization about strategy.

- Manufacturing system design must be strategy driven versus product design driven due to the rapid rate of innovation and flexibility required to meet changing customer needs and demand. The structural advantages generated by the reinforcing loops of innovation and speed will enable a company to outperform its competitors.

- Many firms today focus on a very high level corporate strategy that overlooks the precise way work is performed at the operating level and the methods and processes that link inter-dependent groups to each other in an unambiguous way. Leaders need to build their organization and strategy around the operations that are the basis of the organization's real work.

- To build an innovative and continuously improving organization, companies need to focus on creating built-in tests in their global operations that signal an activity, connection, or flow path problem automatically.

1.3 Thesis Outline

The thesis is organized into eight chapters. They are as follows:

Chapter 1: An explanation of the company and rationale for pursuing research in the selected field is provided. The approach used to conduct research as well as key observations gained from the project are included.

Chapter 2: Summarizes the research host company's history and the specific areas of the company the author was exposed to during the course of the project. Provides an overview of the host company's competitive landscape and identifies a specific problem statement used to frame this paper.

Chapter 3: Reviews current literature related to the Toyota Production System, ABC and Time-Driven Activity-Based Costing systems, establishing operational controls to promote long term growth, operations based innovation, the role of leaders, the dynamics of innovation and change, the rules of innovation and continuous improvement, and the foundation of a successfully implemented global operating strategy.

Chapter 4: Provides a current state overview of American Axle's operations including corporate materials, supply chain management, and the AAM driveshaft division. Each section is intended to provide the reader with an overview of current state observations related to the authors work.

Chapter 5: Current research is applied to specific case examples to reinforce the framework presented in the literature review. The intent is to show the theory presented in Chapter 3 can be applied at American Axle and create significant value for the company.

Chapter 6: Recommendations are offered for implementing solutions based on global strategic vision, aligning processes and systems, and institutionalizing systems thinking at AAM.

Chapter 7: Cost and benefits associated with implementing operations based innovation are provided in the context of an alternative industry, healthcare, to illustrate the challenges, costs, and benefits of implementation are related.

Chapter 8: Lessons learned and suggestions for future work are included in this chapter.

2.0 Company Background

This chapter provides an overview of American Axle and the interactions the thesis author had inside and outside of the company. A review of the company's history and founding is provided to help the reader understand and appreciate the challenges American Axle and Dick Dauch (Founder, Chairman, and Chief Executive Officer of AAM) in particular, have overcome to get to where they are today. The chapter describes the AAM Corporate Materials Department and offers a glimpse of how cross-functional areas of the company interact to develop and execute the current corporate strategies that are in place. The chapter concludes with a synopsis of the industry and competitive landscape providing specific reasons why American Axle should consider reexamining their global strategy and the systems used to support it.

2.1 History of American Axle & Manufacturing

American Axle & Manufacturing's (AAM) roots date back to the early 1900's. In 1917 General Motors started construction on what would later become AAM's Detroit Gear & Axle manufacturing plants. For the next 77 years General Motors produced driveline products for their Chevrolet Division. On March 1, 1994 Richard E. Dauch (Co-Founder, Chairman, and Chief Executive Officer of AAM), along with another investor, purchased five manufacturing plants from General Motors to create a stand-alone independent Tier 1 automotive supplier. [AAM homepage, www.aam.com]

On January 29, 1999 American Axle & Manufacturing went public on the New York Stock Exchange trading under the symbol "AXL". Since its first initial public offering AAM has grown globally. Today AAM has a global automotive presence in the United States of America, Brazil, China, England, Germany, India, Japan, Mexico, Poland, Scotland and South Korea. In February of 2008 the company announced plans to construct a new plant in Thailand. The company currently employs approximately 12,000 associates and had revenues of $3.3 billion in 2007.

2.2 Corporate Materials Department

The AAM Corporate Materials department is led by the Vice-President of Procurement and Supply Chain Logistics. The Vice-President is supported by a Director who coordinates and leads all of the day to day activities of the department. Reporting to the Director are five managers from the following functional areas: lean/cost estimating, material scheduling, logistics, material systems, and in-direct material management. Below each manager there are full-time associates.

The materials team is specialty oriented in that specific people do specific tasks. There is very little cross-training across the different functions of the department. One person specializes in material container procurement while another specializes in processing cost requests for the Cost Estimating department. A great illustration of the degree of specialization is the way in which AAM manages their material management system Oracle. From the author's perspective it appeared AAM only had two people in their corporate materials department who were Oracle experts.

The void of expertise was also very vivid inside AAM factories. While AAM associates and salaried employees knew and understood how to execute specific functions in Oracle, very few understood how the system worked for the benefit of the factory and company.
As an entire department, the materials team did not review on a regular (weekly) basis, the material performance of each individual AAM facility. There were no "Top 10" lists to attack the cost drivers in AAM factories or to monitor the effectiveness of management and plant systems at each individual facility.

The AAM Materials Director and Managers held weekly meetings with the Vice-President. Salaried associates (non-managers) did not hold regular meetings with their respective manager. The lean improvement team held weekly meetings with the Director, but other functional groups in the department did not hold weekly meetings as a team nor did the entire department ever meet on a regular basis as a team to review or track plant/corporate performance. During the 6.5 months the author spent at AAM, the Materials Department met in its entirety on two occasions.

2.3 Corporate Materials Strategy and Execution

Cross-functionally, one great source of leverage for the corporate materials department is the Sourcing Steering Committee. Each week Directors from Finance, Purchasing, Supplier Quality & Development, and Materials meet to evaluate existing new business and/or cost saving proposals. In these meetings the financial analysts report results from a Total Landed Cost model that considers an agreed upon list of criteria upon which to compare different sourcing alternatives. Part of the criteria used includes costs associated with the material department such as logistics costs, broker fees, container expenditures, inventory holding costs, etc.

While the Sourcing Steering Committee meetings are excellent in that they bring together different corporate groups to align positions and interests, it was very interesting to observe the group dynamics with regard to AAM's overarching corporate strategy and execution. During one of the early meetings the author attended, one of the Directors exclaimed, "I don't know what the 'Big Boys' upstairs are doing. They're suggesting we source components for a new program that will launch in Mexico from Thailand and Brazil." In many meetings the topic of localizing the supply base closer to AAM assembly centers was often discussed. Rarely in these meetings or any other related meetings were charts reviewed regularly to monitor and report out on performance attainment relative to localizing components by a specific date. The plans and charts that were shown often used vague timeframes and did not spell out specific details of when, how, and by whom a specific component would be localized. To this point a Director commented, "We've had a plant in Mexico since 1998. It's now 2007 and we're still sourcing 70+% of our components from outside of Mexico."

2.4 Sharing Ideas in Corporate Materials

At the corporate level, a lot of pressure is placed on the team to "fire fight". Urgent daily issues crop up that consume valuable time and resources. An example of being in the "fire fight" mode is the production ramp up of the China Gear & Axle plant. As China began to ramp up volume throughout 2007 the plant began to experience difficulty managing their inventory pipeline of material supplies. This drove expedited deliveries up and in some instances required parts to be air-lifted from the United States. The AAM corporate office decided to send a team of AAM material experts to China. Their goal: to reduce premium transportation and production interruptions in China. A very similar problem developed in Brazil. As in the China example, a corporate material team also flew to Brazil to help them address material issues in an effort to reduce transportation and procurement costs.

Considering the context of each example provided above, it is worth noting that in neither situation did any of the material team members openly share lessons learned with all members of the corporate materials team.

2.5 Corporate Operating Strategy

At a senior level, AAM corporate vice-presidents meet every week in the Operating Committee meeting to review the operating strategy and operating performance of the company. In this meeting the future strategic initiatives of the company are discussed along with financial targets and objectives related to the five year business plan of the company. Inside and outside of AAM this committee meeting is regarded as the most powerful decision making body the corporation has. All major initiatives and programs begin here.

One observation is that the company and its senior leadership have difficulty filtering information released in this meeting down through their respective organizations. Although many of the topics are confidential, there are certain important business initiatives, measures, and priorities which should reach the associates who actually execute and use them in their day to day jobs. The other important aspect of information/knowledge sharing comes from the associates themselves. Through information sharing, senior leadership could gain valuable insight and feedback from the associates in their respective areas and use the feedback to shape the decisions made at the Operating Committee level, which ultimately impact the company and its future. Related to this, a Director remarked in the summer of 2007, "I've heard rumors we may be building a plant in Thailand and that the company is looking to source parts for the Thailand plant from our China facility. I don't think they've thought about the tariffs involved or the hostile relationship China has with Thailand." In February of 2008, AAM publicly announced plans to build a plant in Thailand.

2.6 Industry Competitive Analysis

The global automotive industry is one of the most competitive industries in the world. Consider in 1955 four out of every five cars in the world were manufactured in the United States, half of which by General Motors. Toyota produced 23,000 vehicles, all in Japan. Today General Motors and Toyota are virtually tied for the top global sales position both reporting sales of over 9.3 million units. [BBC, 2007] Interestingly, GM now reports over 60% of their sales outside of what has become Toyota's largest market, the United States. In 2007 General Motors reported one of the largest losses in the history of the automotive industry, reporting losses in excess of $38 billion while Toyota is projected to report profits in excess of $16 billion.

Figure 1 and **Figure 2** illustrate the significant structural changes occurring in the global automotive industry. As expected, the changes are impacting the entire automotive supply chain.

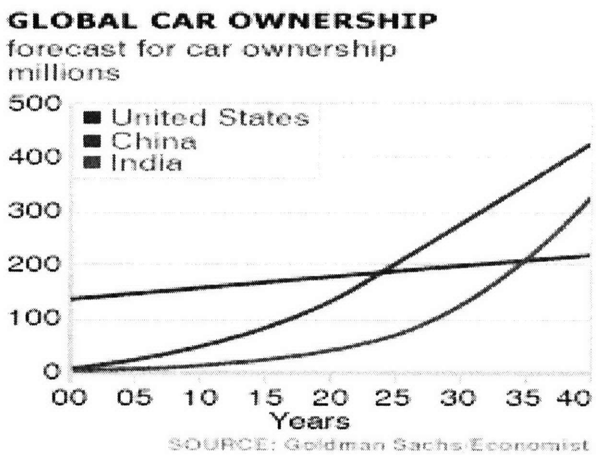


Figure 1: Global Car Ownership [BBC, 2007]

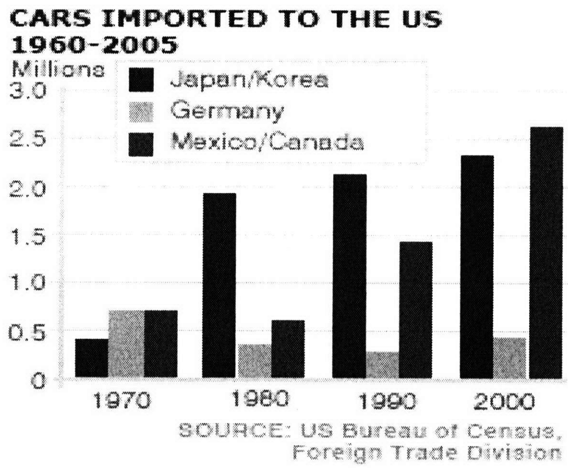


Figure 2: Cars Imported to the U.S. [BBC, 2007]

The impact of this change has been felt by all suppliers. All of American Axle's direct competitors are in bankruptcy or are emerging from bankruptcy. Due to favorable pricing agreements, warranty claim protection, and strong leadership execution following the asset-sale in 1994 AAM successfully turned dilapidated factories into profitable manufacturing operations. Nine out of the last ten years AAM has been profitable. Moving forward the company is working to diversify its customer base and expand its global operations. To date it has a manufacturing presence in every major automotive market with the exception of Russia. To maintain its competitive edge AAM is counting on a competitive national agreement with their largest union, the United Auto Workers (UAW), in 2008. Near term objectives for AAM include growing their non-GM book of business, growing/differentiating their product portfolio, and rationalizing existing domestic manufacturing capacity and costs.

2.7 Problem Statement

"Lean Production: It is easy to say you will do it, but harder to actually implement it."
James Womack, author, Machine that changed the World

"In a knowledge economy, a key source of competitive advantage and superior profitability within an industry is how a company creates and shares knowledge"
The New Economy: A Primer, Cambridge Technology Partners, 1999

With unprecedented industry challenges facing American Axle and the prospects of growing a global manufacturing footprint in emerging markets around the world, AAM is at a cross-road. On one hand the company, compared to industry peers, is positioned on solid ground. Their balance sheet and liquidity is strong. Their product portfolio is growing. And they have a strong book of future business. On the other, AAM is faced with unforgiving industry competitors, requiring the company to execute with laser like precision. As the lucrative pricing and warranty agreements with General Motors fade, AAM will face pressure to put processes and procedures in place that will enable the company to execute on a global scale, profitably.

The objective of this thesis is to improve the operating system AAM employees use to design, engineer, test, validate, and build finished products for end customers. The paper develops a systems framework built upon the principles of the Toyota Production System to help AAM better understand the impact misaligned incentives have on the current corporate operating system and attempts to explain how the company can implement corrective action. [Womack, 1991]

3.0 Literature Review

As the automotive industry's focus shifts from a saturated North American market to emerging economies like Brazil, Russia, India, and China there is strong demand for workers who can help companies mitigate the risk of managing a global supply chain. With an expanding list of countries from which automotive suppliers procure and manufacture parts, the need to understand country regulations, tariffs, government relations, and infrastructure capabilities is increasing. To cope with increasing complexity in supply chains, product life cycles, and technological advancement, workers are required to possess an ever increasing amount of knowledge and flexibility. For "old" industries like auto and steel, the shift has not been easy. While labor regulations and lines of demarcation have been adjusted to increase competitiveness among hourly workers, salaried employees are now encouraged to work in foreign countries and develop a broad base of skills to better understand the intricacies of competing in global markets.

Current research helps us understand the complexities of this challenge. The following literature review focuses on Toyota and the success it has realized building a company which grew from a small Japanese manufacturer in the 1950's to become the most successful automotive company in the world in terms of both profit and unit sales. The literature examines the fundamental principles that define Toyota and helps to build a framework to understand how and why American automotive companies struggled to replicate their model. The review focuses on the importance of capturing and using costs effectively to make decisions, track performance, and develop strategies. It examines how ambiguity and workarounds build reinforcing loops of confusion and chaos in critical processes and procedures. The rate of innovation and technological change also plays a large role in automotive strategy. The author examines the work of Clayton Christensen in the context of competing in a mature industry and offers insight into disruptive technologies impact on global systems strategy.

3.1 Globalization & The Knowledge Economy

Before examining specific details related to the automotive industry, it is important to consider education's impact on an employment base. Data from the United States Bureau of Labor Statistics (See **Figures 2, 3, 4** below) show educational attainment is directly proportional to the level of employment in three distinct labor groups: high school drop-outs, high school graduates without college degrees, and college graduates. [U.S. Bureau of Labor Statistics, 2008]

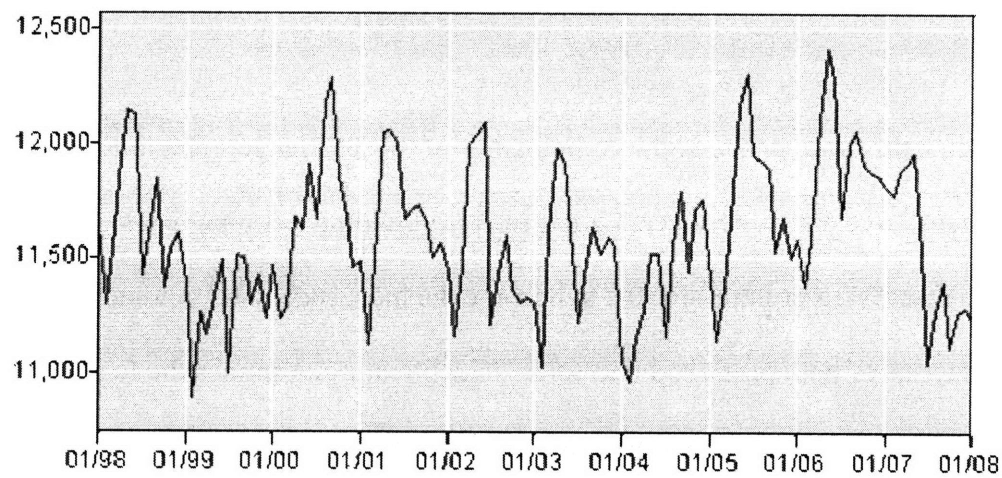


Figure 3: U.S. Employment Level (in 000's): Less than High School Diploma

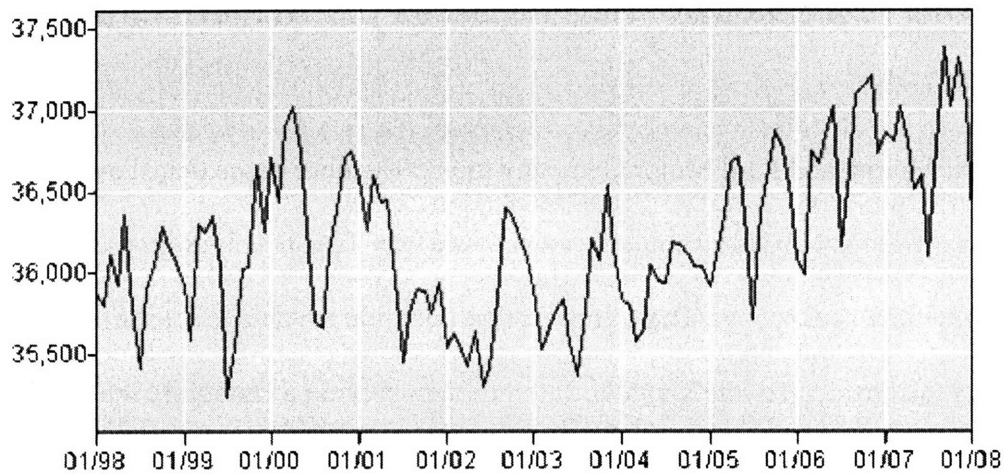


Figure 4: U.S. Employment Level (in 000's): High School Graduates

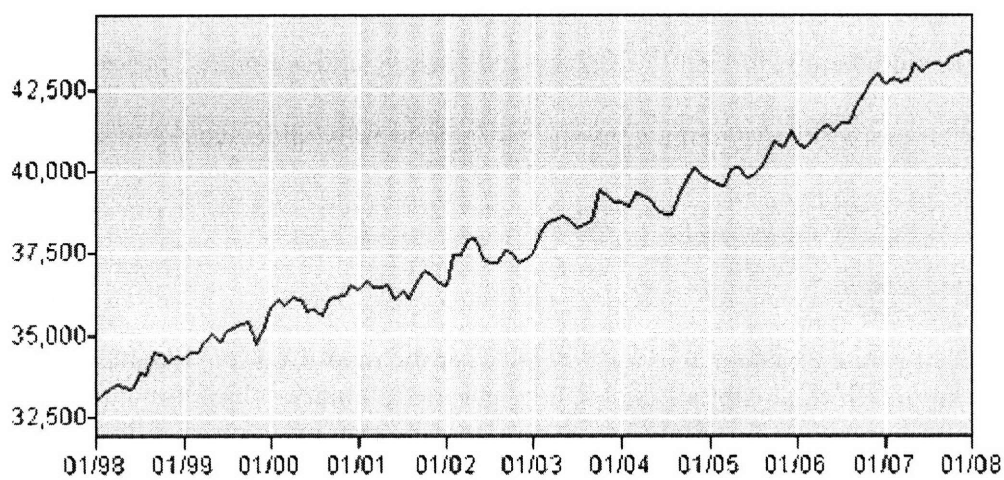


Figure 5: U.S. Employment Rate (in 000's): College Graduates

The charts are intended to illustrate the significant difference between each educational group in an effort to demonstrate there is demand in the U.S. market for educated labor. The intent is also to show the demand for educated "knowledge" workers is increasing substantially more than uneducated. As globalization and the development of emerging markets continue, global companies will depend even more upon higher educated, more specialized, pools of labor.

3. 2 The Toyota Production System's Impact on U.S. Manufacturing

In 1998 General Motors and Ford Motor Company took 50% more hours than Toyota to build an automobile. Many auto analysts attribute this gap to the way Toyota solves problems in all functional areas of their company. The significant competitive advantage forced many domestic auto companies to consider Toyota's approach to problem solving even before the 1990's. In 1984 Toyota and General Motor's formed the first automotive join venture in the United States. Located in Fremont, California the NUMMI plant demonstrated to the world that the Toyota Production System could be successfully replicated outside of Japan. Following Japanese culture, Toyota opened the doors of the factory to the world. They invited leaders from all walks of life, industry, and business to visit the factory and observe and learn their process. Interestingly, a large majority of companies still struggle to fully understand and implement the Toyota Production System. As Tom Stewart [Stewart, 2002] writes in *The Case Against Knowledge Management*:

> "Knowledge management activities are all over the map: Building databases, measuring intellectual capital, establishing corporate libraries, building intranets, sharing best practices, installing groupware, leading training programs, leading cultural change, fostering collaboration, creating virtual organizations – all of these are knowledge management, and every functional and staff leader can lay claim to it. But no one claims the big question: Why?"

Why is it that in 1998, after fourteen years of working jointly with Toyota, General Motors still took 50% more hours to build an automobile? [BBC, 2007] Perhaps it is the result of Toyota's deep rooted commitment to simple knowledge management processes. As Steve Spear and Kent Bowen show in *Decoding the DNA of the Toyota Production System*, Toyota commits to training, teaching, and developing simple knowledge sharing as close to the production process as possible. [Spear, Bowen, 1999] Whether an employee is a new executive or hourly technician, the training process focuses very heavily on developing practical knowledge and teaching the employee how to contribute effectively using the scientific method.

3.3 Allocating Cost: Activity Based Cost Accounting

One challenge all firms face in developing an efficient operating system is a costing process that facilitates the efficient measurement of cost and performance. In high fixed cost environments, like those found in the domestic auto industry, firms are often tempted to overproduce. Producing more of something helps to rapidly decrease per unit costs when fixed costs are distributed over more output. As a result long production runs and an emphasis on capacity utilization are very common. Due to the amount of companies pursuing these incentives in the auto industry, overproduction and price suppression have undermined profitability. [Ikenson, 2006]

In most businesses, activity based cost (ABC) accounting is the method firms use to match or realize their costs with sales. Because product costs are capitalized in an ABC system, companies can manipulate their income by capitalizing fixed costs. This creates short term incentives for managers who may be motivated by bonus payouts tied to profit. Changing the incentive bonus payout calculations for managers is one way to prevent overproduction. An internal carrying charge for inventory could be figured into the payout formula. Another suggestion would be to include non-financial variables in the measure to evaluate performance very similar to metrics one would find on a balanced scorecard. [Horngren, Datar, Foster, 2006]

3.3.1 The Profit Fallacy

Why are non-financial variables so important? Because in ABC costing, fixed overhead is assigned to units of inventory and as a result the costs do not impact COGS on the income statement until the units are sold. Put plainly, when units are produced (not sold) fixed overhead stays in finished goods inventory. [Das, 2006] If companies fail to establish a strong operations system with the right incentives and internal controls, managers will be misled into thinking the more they produce the more the company will make, when in fact it is quite the opposite. Buying raw materials consumes cash. Because the auto industry is very capital intensive and because margins are small, cash is a scarce commodity. Helping managers develop an operating system that reduces managers' incentives to divert cash from useful business purposes versus tying it up in inventory is essential to surviving in today's global marketplace. [Najarian, 2007]

Developing a new incentive payout formula requires leaders who understand the implications of absorption costing and who have the ability to accurately identify costs and allocate the appropriate level to variable or fixed accounts. Experience and breath are important because current research shows ABC costing is by no means the only alternative available. The Theory of Constraints and Variable Costing are other methods considered and used by many. [Watson, Blackstone, Gardiner, 2007] One of the early proponents of ABC cost accounting recently published an improved method that helps to simplify the process for field practitioners. The process is called Time-Driven Activity-Based Costing.

3.3.2 Time-Driven Activity-Based Costing

When ABC costing was first rolled out many managers and the academic community applauded its ability to provide companies with more accurate cost information. Soon though companies began to complain about the difficulty and expense they incurred trying to gather minute details from which to allocate costs. Costing soon became very complex and the willingness of managers to use the process effectively eroded. Responding to this criticism Robert Kaplan developed an easier alternative called Time-Driven Activity-Based Costing (TDABC). [Kaplan, Anderson, 2007]

Time-Driven Activity-Based Costing enables managers to estimate resource demands imposed by each transaction, product, or customer. This relieves them of time-consuming and costly employee surveys often used in an ABC environment to appropriately allocate costs to a given product or production center. The basis of the new approach encourages companies to focus on two parameters. One is the cost per unit of time to supply resources to a business activity. (The total overhead expenditure of a department divided by the total number of minutes of employee time available) The other is the time it takes to carry out one unit of each activity. Using this approach managers can focus on deficiencies the model reveals: inefficient processes, unprofitable products and customers, and excess capacity. [Kaplan, Anderson, 2007] In their book it is interesting to note, Kaplan and Anderson show that TDABC can help companies link strategic planning to operational budgeting, drive continuous lean improvements, and improve competitive benchmarking.

3.3.3 Abandoning Short Term Non-Cash Gains

As noted above, absent of an operations strategy with strong operational controls, companies and managers are often tempted to overproduce. Many fail to realize how the system they operate in impedes their ability to free working capital and generate tangible long term gains for the company. Lean manufacturing and systems thinking are often associated with business "buzz words" or a "current trend". What many fail to realize is the major tangible financial benefit of lean manufacturing is the conservation of cash through high inventory turns. [Najarian, 2007] Often managers in traditional manufacturing companies are encouraged to maximize labor efficiency. At American Axle labor and capacity utilization are primary metrics used in the plant. The metrics highlight another misunderstanding that labor varies in direct proportion to production volume. In reality, direct labor typically increases or decreases in plateaus. If labor is measured by the accounting convention using a labor efficiency variance, the difference between earned hours and actual clock hours is taken. In reality, if labor is not variable with increases in production, the same phenomenon occurs. Managers overproduce to avoid the labor efficiency variance. [Najarian, 2007]

How then can firms respond to costing systems that increase paper profits at the expense of real ones? The answer is they should focus on developing an operating system that emphasizes the real long-term financial health of the company and abandons short-term non-cash gains. One way to do this is to develop new metrics built upon lean principles. Examples include inventory turns, on time ship performance, customer fill rate, and safety near-miss and recordable rates.

3.3.4 Changing the Mindset

Activity or Time-Based costing enables companies to identify which products, services, and resources generate the most profit or loss in their firm. It is important to note that, as with any data, unless management uses the data and acts upon it, the system does not serve any useful purpose regardless of how accurate it is. At American Axle there is an opportunity for executive leadership to work with the hourly technicians on the shop floor to build knowledge and awareness around systemic controls. Management's knowledge and attitude toward cost information will need to undergo a substantial change such that they learn to draw upon a mental model built up through coaching, teaching, and knowledge sharing and be directed towards a course of action that truly benefits the organization. [Hicks, 1999]

3.4 Reinventing How Work Is Performed

Based on current academic papers and available literature shown in previous sections, it is clear globalization has had a profound effect on the automotive industry and businesses across the globe. Each of the reviewed topics thus far serves as a key pillar of operational innovation that no more than 10% of large enterprises have successfully tried and implemented. [Hammer, 2004] According to Hammer, operational innovation shouldn't be confused with operational improvement or operational excellence. Most firms do in fact focus on reducing costs, errors, and delays to improve and provide excellence to customers. Few though actually change the way work gets done to implement lasting change that generates measurable year over year performance improvement. Hammer believes companies need to fundamentally change how work gets done and to do it he says firms need to innovate. Using Wal-Mart as an example he explains the Wal-Mart culture drove daily improvements in cost, inventory turns, and sales per square foot, but it was operational innovation in cross-docking, goods distribution, and purchasing that enabled the company to go from $44 million in sales in 1972 to $44 billion in 1992.

One unique characteristic of operational innovation is that it is proven to increase reliability with minimal capital investment. To reinvent the way work is performed in a company, Hammer suggests firms should do the following:

- Look for role models outside your industry.
- Identify and defy a constraining assumption.
- Make the special case into the norm.
- Rethink critical dimensions of work.

Developing operational innovation and integrating it into the strategic framework of a company is not easy. Companies often fail to recognize how manufacturing impacts their corporate strategy. The companies view the relationship as high efficiency and low cost, and often overlook the long range impact their short sighted focus on efficiency and cost has on the overall performance of the company. Failing to recognize this relationship can straddle companies with noncompetitive production systems which are expensive and time-consuming to change. [Skinner, 1969] Considering the trade-offs implicit in any innovative process, Hammer's framework gives companies an integrative tool to link corporate strategy to operational innovation. The question is, why do so many companies fail to successfully implement it?

3.5 Operations as a Corporate Strategic Enabler

Porter argues managers can get caught up in the pursuits of operational excellence at the expense of their company's strategy. [Porter, 1996] Because managers often feel seduced into pursuing operational effectiveness, and get caught up in concrete and actionable pursuits, they lose the big-picture vision and perspective necessary to recognize trade-offs that significantly impact the competitive strength of the firm. According to Porter general managers should define and communicate the unique position from which the firm generates a strategic competitive advantage and at the same time consider the important trade-offs resulting from such a position. The leaders should be the people who instill discipline and decide which industry changes the company will respond to. While Porter seems to take issue with Hammer's position that a firm can use operational innovation as a corporate strategy, it seems Porter fails to realize operational innovation has been shown to be a sustaining and profitable corporate strategy as exemplified by Wal-Mart and Toyota, two of the most profitable firms in the history of business. Clearly both firms competitive advantage lies in the heart of their operating system.

Porter's contention though illustrates why so many businesses have failed to learn from the Toyota and Wal-Marts of the world. While corporate executives craft nifty strategies based on "operational effectiveness" and "operational excellence", few invest the time and energy needed to truly understand how operational *innovation* enables corporate strategy and generates competitive advantage. Porter states "one of the leader's jobs is to teach others in the organization about strategy – and to say no." [Porter, 1996]

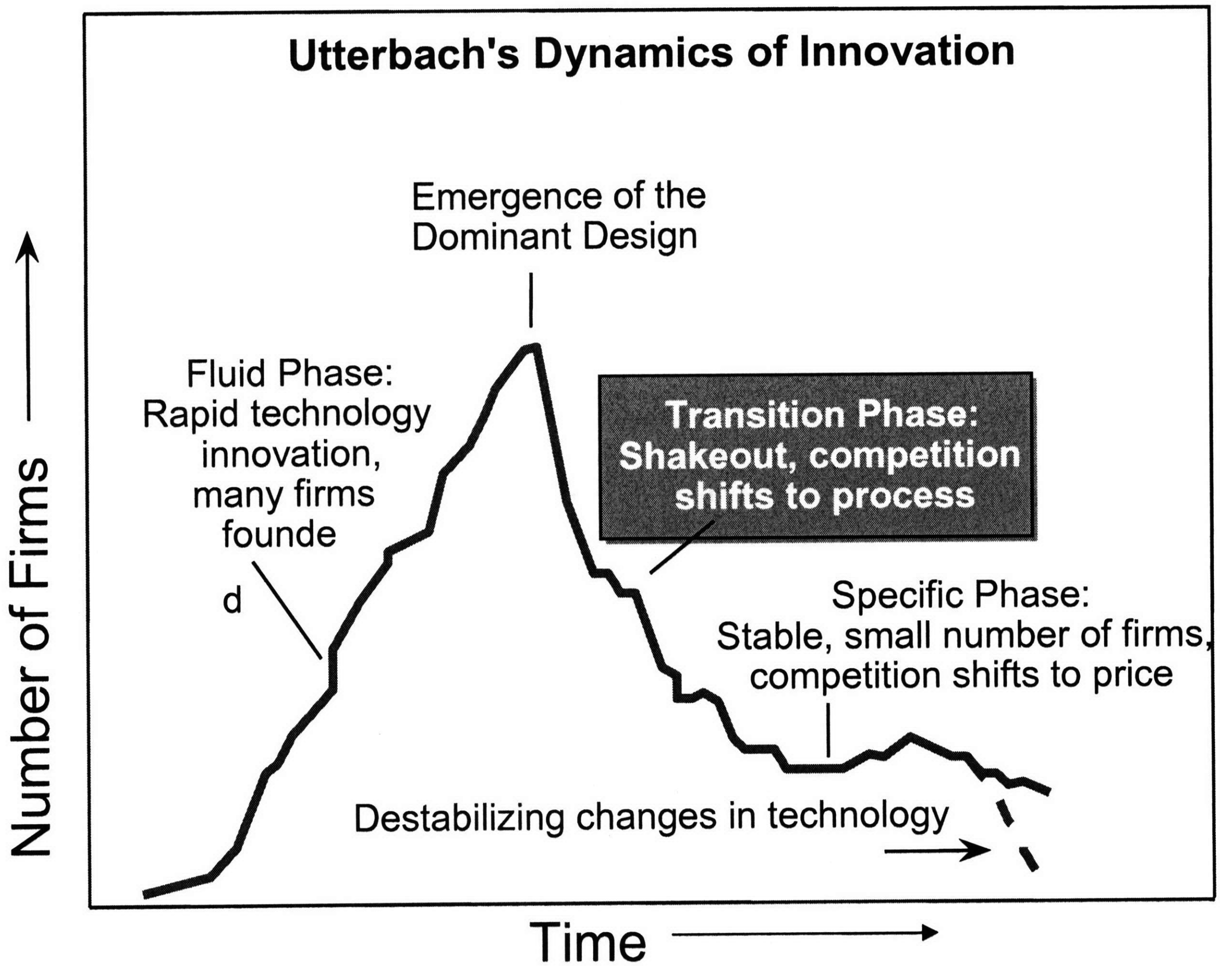
3.6 Dynamics of Innovation

It has been shown in business the rate of product innovation is highest during formative years, but as the product matures, the rate of process innovation overtakes the rate of product innovation. Very mature products usually have very low levels of product and process innovation. [Utterback, Abernathy, 1978]

Innovation from both a product and process standpoint is an essential ingredient of any sound strategy. Many mature industries have been caught off guard by disruptive firms who enter the incumbents market by targeting a portion of the market the incumbent does not strategically serve due to size and scale. Toyota in the auto industry and mini-mills in the steel industry are both examples of disruptive firms who entered their respective industries and steadily grew until finally they disrupted the industry incumbents and forced them to change. [Christensen, 1997]

Competing in this type of dynamic environment requires a corporate strategy or system that gives weight to manufacturing inputs. An emphasis on process innovation and a firm's core competencies must match the maturity of the industry in which the firm competes. Manufacturing system design must be strategy driven vs. product design driven due to the rapid rate of change and the dependence on flexibility and speed required by rapidly changing customer needs and demand. [Nightingale, 2006]

The graph below illustrates the dynamic impact of innovation on firms over time.



Source: [Utterback, Abernathy, 1978], [Nightingale, 2006]

Figure 6: The Dynamics of Innovation

The structural advantages generated by the reinforcing loops of innovation and speed will enable a company to outperform its competitors. With more flexibility, capability, productivity, quality, customer satisfaction, and employee empowerment the company will realize long-term competitive success. [Nightingale, 2006]

3.7 Linking Inter-dependent Groups to Real Work

One reason why companies fail to truly understand and embrace operational innovation is because they are consumed with the competitive dynamics of today's global business climate. Many companies are faced with low growth, low margin business environments where the only real way to grow is by winning market share from a competitor. The way firms do this successfully is by developing lower operating costs and thus outbidding competitors by offering lower prices to customers. Product quality and service are also usually a big part of the customer value proposition. [Hammer, 2004] The problem is most firms today focus on a very high level corporate strategy that overlooks the precise way work is performed at the operating level and the methods and processes that link inter-dependent groups to each other in an unambiguous way. Company executives and operations leaders often view their role as one of supervision, resource allocation, and direction, all of which are vital to the company's success. But as Hammer states, "all are perched precariously on a foundation not grounded in the bedrock of the organizations real work". [Hammer, 2004]

Examining Toyota, the world benchmark for operational innovation, helps practitioners better understand rules that can enable real work to be examined and improved in any company. According to Steve Spear and Kent Bowen there are four rules Toyota employs to build a foundation of innovation and continuous improvement. Each rule requires activities, connections, and flow paths to have built-in tests that signal problems automatically. [Spear, Bowen, 1999]

The rules are as follows:

- All work shall be highly specified as to content, sequence, timing, and outcome.
- Every customer-supplier connection must be direct, and there must be an unambiguous yes-or-no way to send requests and receive responses.
- The pathway for every product and service must be simple and direct.
- Any improvement must be made in accordance with the scientific method, under the guidance of a teacher, at the lowest possible level in the organization.

In their Harvard Business Review article Spear and Bowen state Toyota's managers recognize the devil is in the details as shown by all work being highly specified as to content, sequence, timing, and outcome. This supports Hammer and Skinner's assertion that to successfully implement a strategy based on operational innovation, executives and leaders must immerse themselves in the detail of operations.

3.8 Literature Review Summary

The current literature and academic papers referenced illustrate the challenges firms face competing in today's global economy. Emerging market growth has placed new demands on companies to seek out highly educated workers trained to manage on a global scale. Literature shows Toyota's commitment to training, teaching and developing operations leaders and their practice of sharing knowledge as close to the source as possible can help firms overcome this leadership transition challenge. [Spear, Bowen, 1999]

The research also shows in high fixed cost environments firms are often tempted to overproduce if financial incentives and operational objectives are not aligned. ABC and Time-Driven

Activity-Based Costing are two accounting systems that have helped companies manage operational costs. Knowledge and attitude toward cost management should be based on lean principles that consider long term growth. [Hicks, 1999] A renewed focus will help managers reinvent new ways for work to get done and enable them to implement lasting change that generates measurable year over year improvement. [Hammer, 2004] Improvement can be realized if leaders create built-in tests for activities, connections, and flow paths that signal problems automatically. [Spear, Bowen, 1999] Instead of being product-design driven, firms should focus on creating a global strategy that enables the firm to compete in a dynamic, rapidly changing, innovative operating environment. [Nightingale, 2006]

The following thesis examines causal relationships at a Tier 1 global automotive supplier to illustrate challenges firms face implementing operations based innovation. The paper offers a framework for the supplier to overcome these challenges and suggests methods for implementing a global operating system that will deliver significant structural competitive advantages to the firm.

4.0 Overview of American Axle's Current State

Like many start-up companies, American Axle struggled to develop standardized processes and procedures to govern the development and use of capital equipment in AAM factories following its creation in the early 1990's. Engineering, purchasing, and material management processes lacked standardization and although many inside the company did a remarkable job strengthening financials, significant opportunities remained to develop and implement innovative processes based on the Toyota Production System.

4.1 Corporate Material Standards

As many companies who attempt to implement lean systems do, American Axle hired an outside consultant to come in and help the company develop a lean culture. Each month consultants would visit the corporate office and meet with members of the corporate materials team in Detroit. On occasion the visits would include a scheduled appointment with functional departments or leaders, but on most visits the majority of time was spent with corporate materials staff.

In June of 2007, the company was in the midst of major change. One of their oldest facilities, Buffalo Gear and Axle, was scheduled to be idled by the end of the calendar year, and much of the capital equipment related to steering linkages was expected to be transferred to Detroit. The problem was, no one in Detroit knew what the material requirements were to support the transfer. Material associates in Detroit would state "I have no idea what they use in Buffalo; all I can do is retrieve the information out of our Oracle system. Whatever Buffalo has in the system is what I plug into our spreadsheets."

Using existing excel spreadsheets created to capture material requirements, an analysis was performed by cross-referencing the spreadsheet information with proposed equipment layouts developed by industrial engineers in Detroit. The layouts showed how the capital equipment would be installed, the material flow, and the number of employees used to run each machine. Using the data on the spreadsheet it was discovered the current state material requirements (containers, quantity, transport) did not align with the future state layouts proposed by the team in Detroit.

4.1.1 Material Containers

Non-standard terms used to describe specific types of containers made communication difficult. Each plant had different names for identical types of containers. It was very noticeable on conference calls when associates from one plant would inquire about container availability at another and try to explain what an "Evans Gon" or "Blue 40 by 40" was to the other party. Each was describing the same container using local terminology versus a corporate standard.

One big area where standards impact the material process is in the development of standard packs. Using the standards rolled out by hired consultants, AAM was challenged with creating a PFEP, or plan for every part, across the entire company. The corporate office and plants lacked a process to validate adherence to the established PFEP standard. The Oracle database that stored container information was not updated regularly and thus was not trusted as a source for PFEP related information. When it was time to plan for the equipment transition from Buffalo to Detroit, no one in material could accurately identify the standard pack quantities, the container dimensions, the container weights, or the piece weights of affected parts.

4.1.2 Material Transportation

A big part of the equipment relocation from Buffalo to Detroit included changes in material flow. The industrial engineers did an excellent job of thinking about how to rearrange capital equipment such that non-value added steps could be reduced and cost could be taken out of the system. The team made extra effort to include cross-functional groups from the corporate office, Detroit, and Buffalo. As a result the team did implement improved layouts which helped reduce non-value added steps in the Detroit facility.

One area the team struggled with was identifying how to improve the transport of material in Detroit. Because very few people working on the industrial engineering team understood the intricacies of the floor processes in Buffalo, it was difficult for them to suggest meaningful change. As a result "WIP" or work in process banks were incorporated into layouts and in fact were implemented and used once the equipment arrived in Detroit. The author asked one of the corporate material leaders why WIP banks were added to the new layouts and questioned how the WIP bank sizes were calculated. The material leader responded "Once you work enough years in this industry, you realize machines never run. I just take what they expect to use in a shift and multiply that by three to give me a nice buffer between each of the machines."

4.1.3 Material Performance Tracking

Rigorous inventory analysis and central reporting controls were not observed at American Axle's corporate office. During the 6.5 months of research, there were no occasions where meetings were held with corporate material associates to review, track, and report out on the corporation's inventory management progress. The analysts who did perform logistics analysis used excel spreadsheets for individual third party providers but had no standard logistics software or program from which to extract meaningful cost data.

4.2 Global Supply Chain Management

Due to the unique company history mentioned earlier in this paper, AAM's global growth has demanded increased levels of understanding and specialized knowledge with regards to global supply chain management. The company's talent base, especially in supply chain and material management, has not kept pace with its rapid global expansion. Many of the procurement, inventory management, and financial reporting systems are outdated. The new systems that are used, namely Oracle, do not function as effectively as they could due to the limited ability of most employees to enter, use, and extract meaningful data from it. To illustrate the point, two international locations, which were struggling to reduce expedited shipping costs, contacted global headquarters to inquire about whether the Oracle system experts at headquarters could visit their facilities to help train and develop the level of skill required to appropriately manage their facilities.

In another instance, while working in one of the plants on the Detroit campus, the author met with a scheduler who was coming in at 2 a.m. everyday to do inventory audits of material on-hand in the plant. He would walk around the factory and up and down production aisles to tally what material was consumed the previous day, what was on-hand, and compare that to scheduled production to place orders such that material never starved the production line. Because material was not located in one common area, it was very difficult to identify how much of what part was on-hand. The scheduler would make assumptions and once back in his office used an 8.5x11" sheet of paper to document which "pull" requests in the Oracle system he manually turned off and on such that the automated pull signals Oracle generated when a fork truck driver transferred parts to a line could be manipulated. In addition, he mentioned the company was paying him overtime to come in to work early to perform these tasks.

4.2.1 Global Supply Chain Strategy

The behavior outlined in the previous section was not isolated. It was and continues to be a part of every single supply chain employee's work experience. The root cause of this behavior is poor execution of supply chain strategy from the senior ranks of the company down to the shop floor. As a senior officer in the company explained when asked, "Our strategy is value stream mapping. This is essentially our strategy. We use these maps to reduce our in-transit inventory and lean out our supply chain." While value stream maps are one tool that will help a company do this, of more importance is how the value stream maps are used inside the organization to reduce inventory, track performance, optimize logistic lanes, communicate with suppliers, and increase material velocity. To these questions there were no clear answers, proposals, or plans on paper that could be shared with any member of the team or other functional department. As a result global supply chain management is a big and pressing issue at the company.

4.2.2 The Scan Empty Process

The AAM Scan Empty Process is Oracle based and is designed to automate the material processes the company uses to both procure and ship materials. To set the process up an employee needs to identify how many standard packs of a specific part a plant needs, based on daily production volumes, such that the total amount of shipped parts from the supplier is enough to keep the plant running without part shortage considering the frequency of part shipment from the respective supplier and the lead time. A standard pack quantity is assigned a unique pull number. When an AAM material driver moves a standard pack of material from a holding bank to the production line, the driver scans the container pull number. Automatically the Oracle system generates an electronic pull to the supplier that tells them AAM consumed one standard pack. The pull is a request for the supplier to fill and ship another standard pack during the next regularly scheduled shipment to AAM.

4.2.3 Carter Logistics: The AAM Milk Run

Carter Logistics is one of the primary logistics companies AAM uses to pick up material from suppliers via a milk-run. A milk-run limits the number of individual trucks that pick up material from suppliers. One truck usually travels on a milk-run route to numerous suppliers. Often the route and suppliers visited are for more than one customer; in other words AAM may not be the only company Carter is picking up material for from a given supplier. The milk-run process allows companies to reduce the complexity of their logistics system, to share and distribute logistics costs with multiple Carter customers, and also to increase the velocity of material flow by picking up material on a more frequent basis.

In August of 2007 the author traveled on a Carter milk-run and observed how AAM's suppliers help manage AAM's global supply chain. Speaking with and listening to AAM suppliers, insight was gained with regards to AAM's material processes. At E&E Engineering in Plymouth, MI a scheduler at the dock greeted the milk-run truck when it arrived. When asked if E&E receives electronic pulls from AAM's manufacturing centers the scheduler chuckled, "The releases AAM sends us do not agree with the pulls. I know what they use daily. Plant 2 (an AAM plant in Detroit) releases are garbage. One week they are very low and the next they are very high! I know they're running so I sort of massage the numbers by manually updating releases in the portal with the scheduler at AAM." Asked how he can prepare a production schedule at E&E based on this type of system he stated, "For production scheduling here, I manually enter requests in MRP based on what I know GGA's needs are in reality vs. what gets sent through their system."

4.3 The Global Driveshaft Business

As mentioned in the earlier portion of this paper, American Axle is organized into three divisions, of which one is the Driveshaft & Halfshaft Division. Historically this division has not been as profitable as the other two divisions because of numerous factors that include a commoditized product, rigid labor rules, and high material costs. The company's forging facilities in Guanajuato, Mexico and Tonawanda, New York produce forgings for this business of which some go to outside processors for machining before being shipped back to AAM's assembly centers. The basic Bill of Material for a driveshaft includes a slip-yoke, weld-yoke, tube, and spider. Driveshafts are assembled in Guanajuato, Mexico and Three Rivers, Michigan.

4.3.1 Leadership Perspective

A large majority of the driveshaft business is tied to General Motors full size truck and sport utility programs. The driveshaft links the power generated from the engine to the axle and they are usually sold in the form of a bundled contract with the axle.

Because it is difficult for American Axle to increase component prices in bundled contracts, company leaders felt emphasis should be placed on reducing costs. From their perspective there are only two types of cost that significantly impact the driveshaft business: labor and material costs. Since a majority of labor costs are fixed due to union contracts, senior managers suggested this may not be a good research area for the author. Material prices are also fixed due to long-term contracts and leadership suggested it is very uncommon to renegotiate material contracts.

4.3.2 Driveshaft Supplier Communications

The limited trust between automotive OEMs and automotive suppliers directly impacts AAM's ability to realize cost savings and continuous improvement in the driveshaft business. In October of 2007 AAM leaders discussed one of the Big Three OEMs interest in a joint cost savings project to be held at one of the AAM plants that produced products for them. An AAM sales executive in attendance at this meeting stated, "We want to be very careful about what we share. Do not put any cycle time information on any of the value stream maps we give them." When the possibility of developing a letter of understanding or some type of legal framework from which to start building a productive relationship was raised, the executive said it would not be an option.

The author participated in a supplier workshop with the AAM Lean Team. The intent of the visit was to investigate a continuous improvement item related to AAM's plant operations in Detroit. Specifically, the issue dealt with the supplier reducing the piece count in each of the standard packs sent to AAM such that the total amount of inventory stored at the line and also in the holding bank could be reduced.

The meeting began with the General Manager of the supplier stating, "Your purchasing organization agreed to pay for $25,000 in tooling and we agreed to not increase piece price. The current 100% inspection operation was put in place at no cost to AAM." He went on to describe the inefficiencies he has to deal with daily as a result of racks that come back to his factory with old shipping labels his people need to remove, quality scores internal to AAM that don't reflect defects from AAM forging facilities to intermediate customers, and AAM buyers who only care about price. To drive his point home he stated, "I am hard pressed to believe your management time is well spent here. This is not part of the AAM low hanging fruit. I don't need AAM to come in here and teach me how to brain-storm. Not sure you all gave this much thought before coming here…how logical of an idea was this?" Convening after leaving the supplier, the AAM team agreed a standard process should be created to manage supplier relationships.

4.4 Rethinking the AAM Operating System

The examples mentioned in the sections above intentionally highlight current opportunities for AAM to improve their operating processes and systems. By confronting the brutal facts and performing a candid assessment of reality "on the ground" it is hoped this paper will provide AAM with a firm foundation from which to begin evaluating where and how to apply operations innovation to their global operating system. Focusing on core areas related to the author's 6.5 months of research; material standards, supply chain management, and driveshaft profitability, the following chapter highlights specific case examples where operations innovation could significantly impact the performance of the entire company, its suppliers and customers.

5.0 Strengths and Weaknesses of AAM's Global Operating System

With American Axle's largest customer General Motors generating over 50% of its revenue in markets outside of the United States, AAM faces immediate pressure to globalize. The company is responding. Within the last ten years new facilities have been built in Mexico, Brazil, Poland, and China. Recent announcements include a new joint venture in India and new plant construction in Thailand. The rapid rate of growth and global expansion presents an opportune time to leverage the power of a strong process and operations based global strategy to build sustainable competitive advantage for the long-term. This chapter examines AAM's global strategic vision, cost accounting, and scan empty system using current research to suggest how the company can improve the performance of operations.

5.1 Global Strategic Vision

Hammer states one unique characteristic of operational innovation is its ability to increase the reliable performance of companies with minimal capital investment. To do this he suggests firms look for role models outside of their industry to benchmark. By identifying and defying a constraining assumption, firms can realize innovative solutions to difficult problems that once hindered performance. He suggests rethinking critical dimensions of work and making the special case the norm. [Hammer, 2004] The big question is, does AAM's current operating system encourage this type of thinking and behavior?

5.1.1 Benchmarking Role Models Outside the Auto Industry

Based on my interactions, discussions, and observations with hourly, salary, and executive employees at AAM, the company does not actively benchmark role models outside of the automotive industry. During the time I spent at AAM I realized a significant number of employees (greater than 90%) had never worked outside of the domestic automotive industry or visited non-automotive plants. Over 95% of the senior officers have spent their entire career with domestic auto companies in the United States. During the six and a half months I spent at AAM, I spoke to ten company officers in one-on-one interviews about benchmarking. None had visited an OEM assembly plant or toured a non-automotive factory to perform competitive benchmarking in the last five years. Following this discovery, I interviewed twenty-seven salary associates at four different manufacturing centers. None had visited a non-automotive factory to perform competitive benchmarking in the last five years. In October of 2007, I met with the UAW leadership representing hourly workers in the Detroit plant and during this discussion I learned none of the UAW leadership had participated in joint benchmarking trips to non-automotive factories with management during the last five years.

To demonstrate the learning and insight that can be gained from benchmarking role models outside of the auto industry, I leveraged relationships built through the Leaders for Manufacturing program to arrange benchmarking trips for executive leaders from American Axle to visit Boeing and Dell in the fall of 2007. The trips included executive and non-executive employees and at both companies AAM leaders had the opportunity to evaluate world class lean operating systems in action. I also organized a benchmarking trip to Toyota's Lexus factory in

London, Ontario Canada. There remains a significant opportunity at AAM to increase the awareness and knowledge needed to compete in today's global economy by benchmarking role models outside of the auto industry. This is one suggested way AAM can develop leadership's ability to coach, teach, and share knowledge across the organization. [Hicks, 1999] Recently the company committed to moving key leaders between global regions to develop the international experience and cultural understanding that will improve AAM's ability to successfully execute global strategic initiatives. By benchmarking the operations of non-automotive role models and developing global talent the company will begin building the foundation required to build sustainable competitive advantages using operations innovation.

5.1.2 Identify and Defy a Constraining Assumption

Instead of company Directors proclaiming the "Big Boys upstairs" are responsible for keeping a bad process bad, Hammer suggests operations innovation requires leaders to identify and defy constraining assumptions. [Hammer, 2004] I believe one big assumption that impacts the entire company's ability to develop innovative solutions is the fear people have for the Operating Committee decision making body. From observation and participation in executive level meetings I learned there is a significant deference to authority with the AAM culture, often at the expense of the company's performance. Directors need to realize they in fact are the "Big Boys" senior officers are depending on to execute the strategy of the company. Collectively they need to work with each other to push-back against the Operating Committee decisions that they believe are not in the best interest of the long-term performance of the company. Instead of viewing their role as one of supervision, resource allocation, and direction, company leaders need to ground themselves and their senior officers in the bedrock of the organizations real work. [Hammer, 2004] According to Porter one of the most important parts of a leader's real work is to teach others in the organization about strategy and to say no. [Porter, 1996]

5.1.3 Make the Special Case into the Norm

Since 2000, the Guanajuato factory has been expanded four times. The central versus line-side location of material receiving docks prevent tractor trailers from delivering components as close to the point of use as possible. This drives value wasting transport equipment, more in-plant containers, more labor, and more coordination among plant and corporate management. It also creates special "fires" or crisis. During July of 2007, a material analyst I worked with at AAM traveled to Mexico to help resolve a transport problem involving the movement of material from the central inventory holding area to a line side operation.

The mobile vehicle transporting the carts to the operating line felt unsafe. During transport, especially while climbing elevation grades on the shop floor, the carts would begin to careen out of control and into on-coming traffic in the plant. To correct this problem a material analyst from the corporate office in Detroit flew down to Mexico. A third party firm was hired to assist with developing a solution to the cart problem. While the safety issue of the cart losing control during transport was solved, the root cause of the problem was not. All of the cost associated with the problem (potential for serious safety incident, flight/hotel/food for corporate employee, hiring of 3rd party, labor of materials staff and equipment in Mexico) was not enough to raise a red flag and draw attention to a special problem. The root of the problem was related to the need of the factory to transport the material from the central inventory holding area to the operating line in the first place. Could a new receiving dock be installed closer to the line such that components could be pushed from the tractor trailer to the line? Instead of spending significant sums of money to work around the root cause, could a cross functional team of employees develop a cheaper, safer solution with a simple and direct path to the line? [Spear, Bowen, 1999] Developing new innovative solutions when confronted with special challenges like this enables operations-based innovation to take hold in an organization. Due to the rapid rate of change and the demonstrated need for flexibility and speed, AAM's manufacturing system design must be based on a strategy that considers the future growth of the factory and eliminates the need for non-value added material movements due to expansion. [Nightingale, 2006]

5.1.4 Rethink Critical Dimensions of Work

During a visit to AAM's factory in Guanajuato, Mexico operators were observed performing numerous tasks that did not add any customer value to the part being produced. Operators on the line were observed walking to pick up gears and pinions from containers that did not place the parts at the "fingertips" of operators. The containers from which the operators picked the parts were not labeled or positioned to any visible standard. At the station there were no standardized worksheets that explained to the operator how to load the part into the machine and what to do with it when the machine was done cycling. After the machine completed its cycle the operator placed the parts into a push rack.

Interestingly, there was a conveyance system at the work station to transport the machined component to the next machining station, but the operator did not use it. When questioned why she didn't use the available conveyance system the operator stated it had been broken for months and that she and the operator at the next station had developed a method by which they could run their machines without using the broken conveyor. In essence, the workers created a work-around. (See **Figure 7** below)

Figure 7: Operator Station in Guanajuato Factory (Operator picks part from machine near yellow arrow. The operator is supposed to place part on conveyor for next operation near red arrow.)

Observing this I spoke with the manager of industrial engineering. He stated the machines were installed less than five months prior to my visit. When questioned why the machines were laid out the way they were on the shop floor, the manager stated the industrial engineering talent in the factory was not as strong as he would have liked.

This situation highlights one of the key ingredients or components necessary for a robust culture of operations innovation. In the automotive industry, designing manufacturing systems and installing capital equipment are critical dimensions of work. This example demonstrates the system to deliver this critical dimension of work at AAM is broken. The corporate engineering team that is responsible for designing production systems first of all needs to work towards a global standard that defines how common systems are designed and installed in different regions of the world. Local industrial engineers need to be challenged by the senior staff members managing the plant when system layouts are presented. Following the model presented earlier in this section, if managers possessed the knowledge and understood the fundamental work of the factory employees, questions about non-value added work and non-value added part transportation between operations should be part of the project screening process. It goes back to fundamentally changing the way work gets done to implement lasting change that generates year over year measurable performance improvement. [Hammer, 2004] Without a clearly defined global operating strategy that defines standard operating procedures and control, small ambiguous discrepancies will grow into large problems. [Spear, Bowen, 1999]

5.2 Cost Accounting Observations

With gas and commodity prices as volatile as they are, decisions should not be based solely on who is cheapest or fastest to market; rather it should be realized that supply chain design strategically impacts the survival, profitability, and power of the company and industry it competes in. [Fine, 1998] In the first section of this paper we examined AAM's overarching operating system in the context of Michael Hammer's operations innovation model. Section two uses current research to validate observed opportunities to align important engineering, financial, and material systems with the global operating vision described earlier in this chapter.

5.2.1 Highly Specified Outcomes

Most manufacturing processes at AAM factories require steel. The Guanajuato factory is no different. To develop an understanding of how steel suppliers impact the commodity costs at AAM's Mexico factories, I examined AAM's six largest steel suppliers. The range of annual steel consumption by supplier ranged from 4%-36%. Interestingly, the steel supplier providing 4% of annual steel consumed was responsible for over 1/3 of the annual logistics costs AAM incurred for steel to be transported to Mexico. Price wise, this supplier had the highest cost per metric ton.

With high logistics costs AAM made concerted efforts to work with suppliers to localize production. In June of 2007, the purchasing department gave a presentation to the senior executives of AAM. In the presentation the purchasing team showed tracking charts of when suppliers would be localized and what annual savings the company could expect. While the charts showed expected dates when supplier quality development teams expected the supplier to produce localized production, the charts did not state what the status of each individual localization effort was or who specifically owned the process. The purchasing team also noted it was very difficult to localize steel due to lack of available supply in Mexico.

These problems reinforce manufacturing's impact on corporate strategy. While it often appears attractive to locate plants and work in low cost countries due to efficiency and cost gains, the long range impact can easily be overlooked if the process used to develop the corporate operating strategy is not robust. [Skinner, 1969] The long range impact of short sighted focus on efficiency and cost can be detrimental to the overall performance of the company without strong leadership holding the localization team accountable for highly specified content, sequence, timing, and outcome. [Spear, Bowen, 1999]

5.2.2 Variable Costs and Skewed Contributions

To strengthen the localization strategy AAM needs good financial information. Managers need to know which products' cost the most to produce and why. [Kulmala, Paranko, Uusi-Rauva, 2002] To evaluate the robustness of AAM's product costs, I examined AAM's cost accounting system because it can ultimately hide competitive advantages, bias decision making, and cause managers to discard key processes that may be a source of competitive advantage. [Brassard, 2004]

According to Harvard Professor Robert Kaplan, companies are usually at one of four cost management stages. [Kaplan, 1999] Based on research conducted at AAM I believe the company is at stage 2 since a large majority of people do believe the company's cost systems produce reliable financial statements; however, the systems have limitations that impact the ability of managers to exercise operational control, perform accurate product costing, and conduct profitability analysis.

To evaluate this assumption, I met with the finance director of a major division to better understand how AAM uses information systems to perform financial analysis. I explained I was looking for historical financial data to perform a competitive analysis of his division's products to determine what factors contributed to the overall performance of the division he managed. The director explained AAM had no system from which to retrieve historical data. He stated the Oracle system currently used by AAM was not an efficient system from which to gather data and perform financial analysis. Probing further, the director explained many of the AAM plants use their own method of allocating costs and there is no specific direction given from World Headquarters to the plants regarding how to allocate or report standard costs. He stated the Oracle system has unique pay points programmed in and to change the pay points would require massive amounts of dedicated resources. For my analysis he suggested I use a high level report that showed the part number, annual sales, material costs, sale price, and contribution margin of a given product. The report, he stated, would demonstrate labor and material costs were the big drivers contributing to the underperformance of the division whose finances he managed.

In each plant, financial analysts made journal entries and managed cost reporting for their respective AAM factories. The analysts explained that they work with leaders in various departments of their plant to come up with the appropriate percentage of a line item cost to absorb in the respective departments. When asked how often this allocation percentage is updated to reflect equipment that gets moved, altered, or idled, the analysts explained many of the allocation models they use have not been updated for years.

During my visit to the AAM factories, I learned that the plants distribute or allocate their costs very differently. For example, the international factory I examined allocated 80% of direct labor to variable cost and 20% to fixed. The domestic location allocated 100% of direct labor as fixed cost. Likewise for expense tools-material, the international factory allocated 90% to variable cost while the domestic factory allocated 75% to variable. Why is this important? The financial data generated at World Headquarters to compare the factories' performance would not be an "apples to apples" comparison. Because one factory allocates a greater portion of the same line item cost (labor/materials/sundry) to variable, the contribution margin generated by Oracle would be skewed. In effect this would hide competitive advantages, bias decision making, and cause managers to discard key processes that may be a source of competitive advantage for the company. [Brassard, 2004]

5.2.3 Contribution Margin Considerations

One financial metric all of the executives use and talk about is contribution margin. Contribution margin is a financial measure that is used to measure how individual products contribute profit after subtracting variable costs. It is important to note contribution margin analysis ignores the relevance of fixed costs. It is a metric for small short-run decisions, but if the product or process is small enough for the contribution margin to matter, one must ask how much of an impact it will have on the company. Depending too heavily on contribution margin for pricing can impact make-buy decisions inside a company. It can lead companies to always make parts instead of sourcing them from outside of the company. [Robinson, 1990]

Considering the role the cost system plays as a management decision making enabler, I performed a cost analysis at one of AAM's plants to validate the hypothesis of senior managers that the problem in the driveshaft business was related to fixed costs. Using historical financial data I examined line item costs over a period of four years and compared them to unit sales. I discovered that the local plant could skew the contribution margin of the product, depending on the percentage of labor allocated as fixed or variable.

Figure 8 below shows total over time labor and its trend relative to sales over the time period. The graph is important because it shows variable costs were not only contributing significantly to the overall costs of the factory from which the data was taken, but that the variable costs increased significantly while units produced fell. I believe this graph illustrates leadership's lack of accountability in managing variable costs

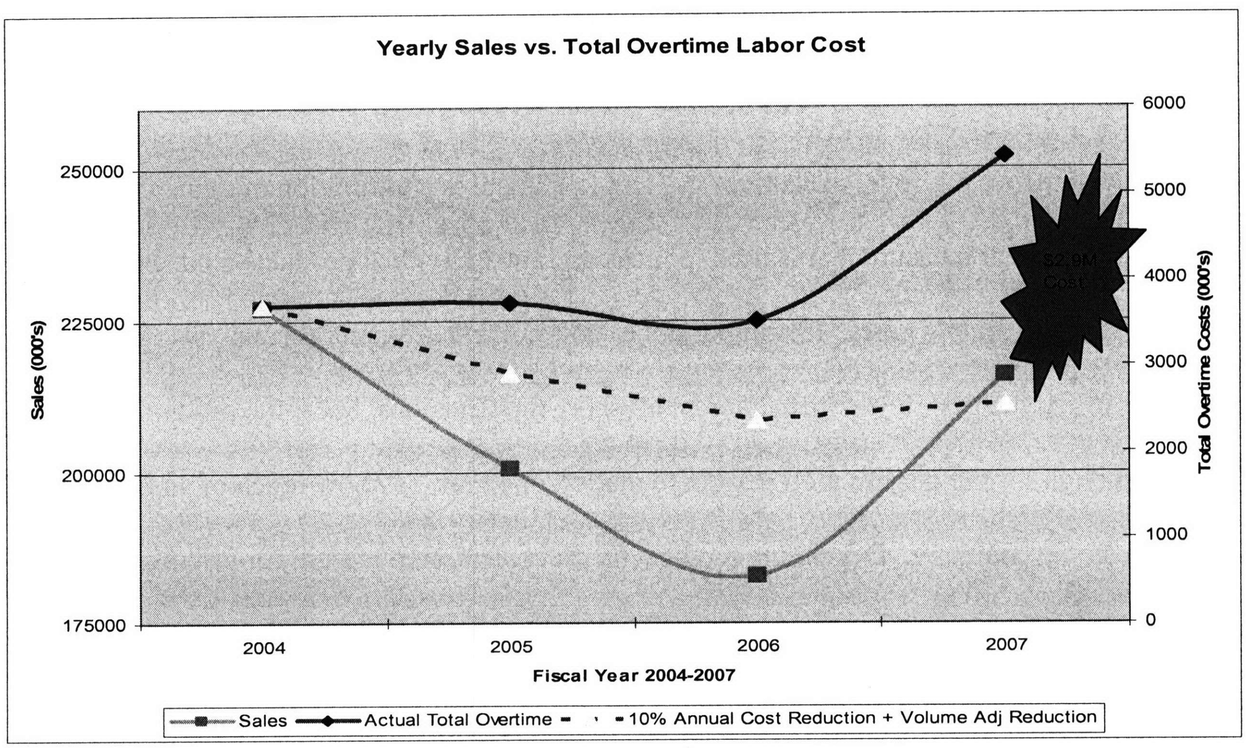


Figure 8: Driveshaft Yearly Sales vs. Total Overtime Labor Cost

While a significant majority of managers believed fixed costs contributed to poor profitability, their inability to see or to manage variable costs due to inefficient financial reporting systems contributed to the poor profitability of the product produced. In fact, assuming management demanded 10% annual reductions in overtime, and assuming overtime consumed varied perfectly with the units produced, the graph shows the company could have saved $2.9 million.

In addition to overtime labor costs **Figure 9** shows the same trend for cutting tools. Over the time period examined, cutting tool costs did not vary according to the units produced. As sales decreased, cutting tool costs increased, illustrating again the impact management's perception that fixed costs were actually contributing to unprofitable plant performance was not true. It was uncontrolled variable costs.

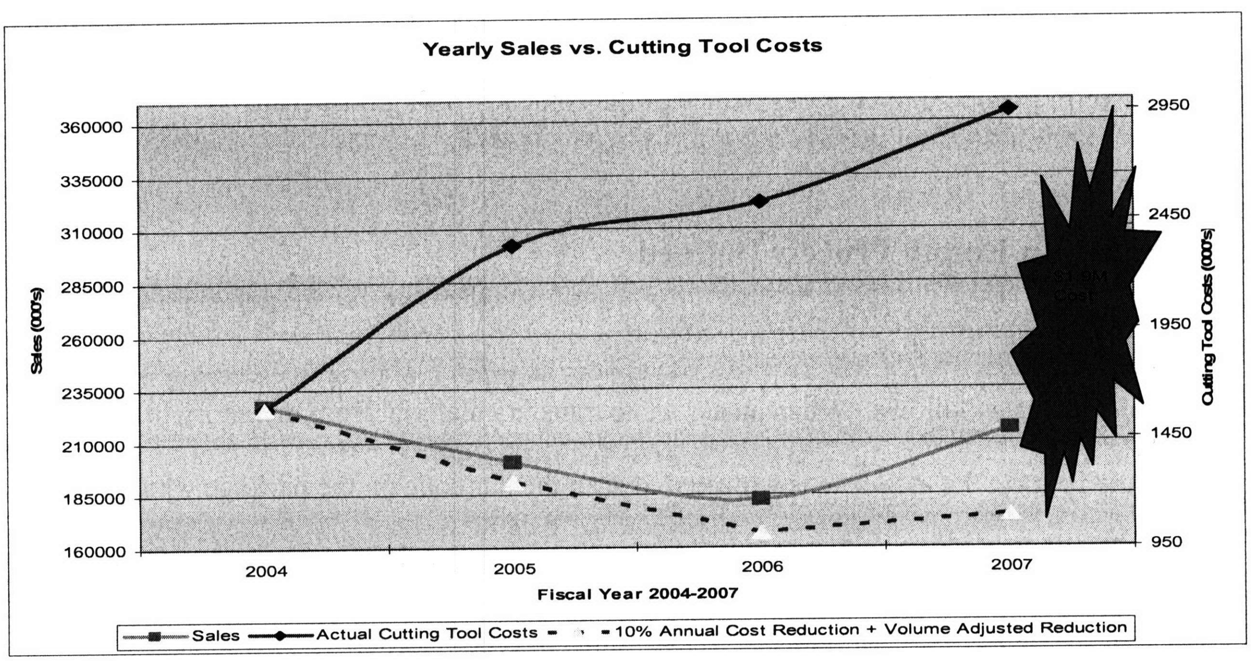


Figure 9: Driveshaft Yearly Sales vs. Cutting Tool Costs

It is important for AAM to realize that most if not all of the traditional fixed costs in manufacturing are actually variable. There are situations where many overhead resources are not consumed in proportion to the number of units produced, but rather they are consumed by product related activities. [Robinson, 1990]

5.3 Scan Empty Process Observations

Up to this point this chapter has highlighted areas to improve AAM's engineering and financial systems. Following the order laid out at the start of the chapter, I will conclude by discussing in detail a process mentioned briefly in Chapter 4, the scan empty process. It is an electronic materials system that integrates AAM factories with an online supplier portal and the corporate Oracle system. The system is intended to help AAM manage their supply chain and the replenishment of goods consumed in factories around the world and I believe it is a system that could transform the operational performance of the company on a global scale.

5.3.1 The Scan Empty Process Defined

The process works as follows. When an associate transfers material from inventory to its point of use in the factory, the associate is expected to scan the bar code on the package which houses the material. The scanner then generates an electronic pull signal in Oracle which shows up on the online portal signaling the supplier to replenish the consumed parts. The pull signal has a unique pull number assigned to it. Usually a unique pull number corresponds to one standard pack of a certain part.

In order for an AAM supplier to replenish orders at an AAM factory, the supplier must have a pull signal with a unique pull number. When the material is shipped following receipt of the pull signal, the AAM receiving dock verifies the material received by cross-checking the pull numbers on the packages received with those assigned in the Oracle system. Once approval of the order is received, AAM receiving dock transfers the material electronically into AAM inventory, and closes out the order. If the material received does not match the pull in the portal or Oracle system, the associate is expected to write a discrepancy report.

5.3.2 Observed Ambiguity

Observing the process I realized there are significant problems. The first and most important problem is that very few managers or executives understand how the system works and very few understand the significant impact the system has on plant and company performance. In both domestic and international plants, most employees I spoke with had a very limited understanding of how the scan empty process worked or how to make changes in the system when problems were identified with specific part numbers or material.

In one plant I trailed a material scheduler and observed how he counted inventory manually on the shop floor, and then used the Oracle system to verify scheduled material arrivals for that particular day. In his office, I watched as he manually overrode automated pull signals and used an 8.5x11" sheet of paper to keep track of pull signals he had turned on or off in the system. In some instances he proceeded to call suppliers and explain which pulls he needed when and what pulls in the system the supplier should ignore or pay attention to. Following this experience I went out into the field and visited suppliers. I traveled with a third party logistics company to observe how the scan empty process impacted suppliers and logistics companies. At one Midwest supplier I asked the material manager to explain how the scan empty process helps her company manage AAM inventory. She shared the following chart. **(See Figure 10)**

GGA & 3 Rivers Requirements Week of 10/30/07									
3 Rivers	GGA	Part #	Pulls Requested	Pulls Shipped	Pulls Left	Over Pulled	Under Pulled	Total Pcs Over	Total Pcs Under
X		5723	7	25	3	21		73,500	
X		6456	10	17	0	7		21,000	
	X	5723	0	0	0	0	0	0	0
	X	6456	3	0	0		3		9,000
	X	570	12	2	0		10		20,000
	X	6457	4	12	3	11		22,000	
							TOTALS	116,500	29,000

Figure 10: Scan Empty Inventory Example

NOTE: Pulls requested are the actual number of electronic material orders in the AAM supplier portal for a specific week. If seven pull quantities of material are consumed at an AAM factory from a specific supplier, the supplier should see seven new pull quantity orders on their status screen in the AAM supplier portal. Pulls shipped are the actual number of pull quantity orders shipped to AAM in a given week. Pulls left identify the amount of pull quantity orders that were in the system at the start of a week which were technically supposed to ship to AAM, but did not ship at AAM's request. The differences that account for pulls being over/under are the direct result of AAM schedulers manually overriding the electronic system. Schedulers will often call a supplier and issue a pull number manually thus enabling the supplier to ship new material. A scheduler may also call to request that a pull quantity already in the electronic system not be shipped.

The chart shows for the week of October 30th, AAM plants had 36 pulls requested in the supplier portal, but actually had the supplier ship 56 pulls. For one part number AAM over pulled by 21 pulls which equaled 73,500 pieces of material. In another instance, AAM requested 12 pulls of another part number but only requested 2 pulls for shipment. This resulted in the supplier getting left with 20,000 pieces of material. In total the supplier shipped 116,500 pieces of material it did not plan to ship. During the same week the supplier did not ship 29,000 pieces of material it had planned to ship.

Making the problem worse, I discovered the company has not developed standard definitions for material. Many plants define their standard packs differently. One plant may define a standard pack as the standard quantity of material a supplier ships on a pallet. Thus if the supplier ships a pallet of material and there are 25 boxes of material on that pallet and in each box there are 10 bolts, the standard pack quantity in Oracle shows up as 250 pieces. On the pallet is one unique pull number and the same number appears on the shipping label of each individual box on the pallet.

At the other extreme, a plant may define a standard pack as the individual boxes that make up the standard shipment of material a supplier ships on the pallet. So in this instance a standard pack is one box containing 10 bolts. Each box has a unique pull number that is different from box to box. In Oracle the material associate would see 25 different pull numbers assigned to the pallet of material the supplier sent in.

Both the ambiguous workarounds embedded in the scan empty process and the lack of clearly defined standard pack sizes impact the volatile material shipments. As an example of this volatility, **Figure 11** illustrates material schedules in Detroit and shows the gross weight of material received by day, by supplier in Detroit as noted by the color codes.

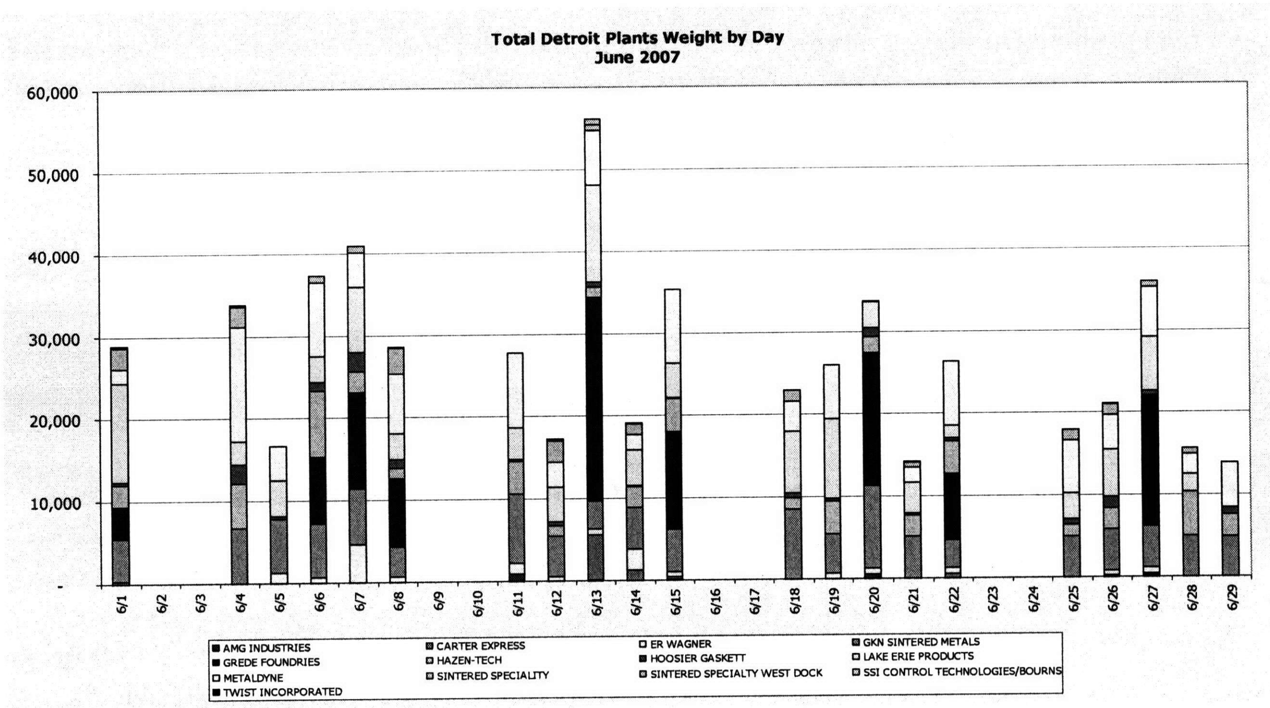


Figure 11: Total Detroit Plants Weight by Day

5.3.3 Factors Contributing to Ambiguity

A lack of training, process discipline, and clearly defined packaging standards contributes to AAM material schedulers overriding the scan empty system. Because schedulers do not fully understand the system, or have the perspective to see what the root cause of the variation in the system really is, they create workarounds. [Hicks, 1999] As Michael Hammer states, "When work is handed off from person to person and unit to unit, delays and errors are inevitable.

Accountability blurs, and critical issues fall between the cracks. Moreover, no one sees enough of the big picture to be able to respond quickly to new situations." [Hammer, 1990]

5.4 Summary of Observations

This chapter provided specific examples of operational challenges documented during the course of the thesis project at American Axle. Due to the rapid rate of change and the dependence on flexibility and speed required to compete in today's global market, manufacturing system design must be strategy driven. [Nightingale, 2006] The strategy must consider the precise way work is performed at the operating level and the methods and processes that link inter-dependent groups to each other in an unambiguous way. [Hammer, 2004] Connections and flow-paths with built-in tests that signal problems automatically reduce ambiguity and workarounds. [Spear, Bowen, 1999] Developing robust financial systems will allow management to focus on inefficient processes, unprofitable products and customers, and excess capacity. [Kaplan, Anderson, 2007] Committing to training, teaching, and developing simple knowledge sharing will grow a culture that embraces a systems view of operations and appreciate the contribution of every single employee. [Spear, Bowen, 1999] The mental model resulting from this behavior will allow management to direct their efforts and attention towards a course of action that will benefit the organization and enable the company to implement a world class global operating system. [Hicks, 1999]

6.0 From Observing to Implementing

Many auto companies who have been in emerging markets like China and India for lengthy periods of time still struggle to realize the efficiency and cost savings they hoped for prior to making the overseas investment. [Amend, 2008] Based on the observations provided in Chapter 5 and the available research, I would argue it is because the companies lack a global strategy that is built around their operations. In the following chapter of the thesis, I will lay out a proposed plan for American Axle to develop a consistent global operating strategy that aligns their processes and systems and supports the institutionalization of systems thinking in the organization.

6.1 Develop a Consistent Global Operating Strategy

In order to develop a common global operating strategy and hold people accountable for implementing it, American Axle employees must first know and understand what the strategy of the CEO and senior team is. Instead of getting caught in the trap of rolling out multiple change initiatives, senior leadership needs to clearly communicate a simple strategy from the top of the organization to the bottom. This will strengthen the morale of the team and clarify individual roles and responsibilities within the organization.

Specific application of this framework will require AAM's senior team to define and prioritize processes that have a significant impact on the performance of their business. For each process they must identify a senior level manager who will have end-to-end responsibility for the individual process and be the living embodiment of AAM's commitment to its processes. As Michael Hammer states, "To succeed a process owner must have real responsibility for and authority over designing the process, measuring its performance, and training the front-line workers who perform it." [Hammer, 1999] A process owner "can't serve on an interim basis, active only while the new process design is being developed and put in place." According to Hammer, to succeed a process owner must have a permanent role because business conditions change and evolve over time. If process owners do not have a permanent role or staying power, old organizational structures will reassert themselves.

Without repeating details laid out in previous chapters, three critical areas of the business AAM should consider as core pieces of their global operating strategy include developing global talent, establishing effective systems to manage and measure global operating performance, and building trust based relationships with suppliers.

6.2 Align Corporate Processes and Systems

During the course of my research I realized it is essential for AAM to organize around outcomes instead of tasks. Because of AAM's unique history and recent transformation from private company to public corporation, job designs, work flows, control mechanisms, and organizational structures must be reevaluated. [Hammer, 1990]

One mechanism that may help AAM transition to a more outcome based operating system is the creation and implementation of a global balanced scorecard. Currently there is need inside the company for a scorecard that sends a common message to all divisions, business units, and stakeholders in the organization. The scorecard system should impact the behavior of managers and empower them with meaningful data that can be quickly communicated to their organizations and teams. Operations based measures drive exceptional financial performance. Think Toyota, Wal-Mart, Southwest Airlines, and Vanguard. Each of the companies leverage operations based innovation and measurement systems to drive exceptional performance.

According to Kaplan and Norton, balanced scorecard advantages include:

1. Integrating disparate elements of the customer perspective, short response times, improving quality, emphasizing teamwork, reducing product launch times, and managing for the long term.

   Four categories to measure and track include lead time, customer quality, part defect level, and on-time delivery.

2. Guarding against sub-optimization by illustrating causal relationships. They show how improvement in one area may be achieved at the expense of another area of company.

The balanced scorecard framework Kaplan and Norton write about consider multiple perspectives each focused on outcomes versus specific tasks. [Kaplan, Norton, 1992] The internal business perspective considers business process outcomes that impact customer satisfaction: cycle time, quality, employee skill levels, and productivity. The innovation and learning perspective involves goals and measurements related to continuous improvement. This perspective identifies the company's ability to innovate, learn, and improve which ultimately enables faster product launches, increased operating efficiency, and more value creation for customers. The financial perspective is a tool to help AAM evaluate how the company's implementation and execution of the organization's strategy affects the bottom line. Cash flow, sales growth, market share, operating income, and return on equity are all important elements they site.

One of the significant strengths of the balanced scorecard is that it does not have a control bias. The balanced scorecard is enabled by sound corporate strategy and long-term vision instead of the traditional control based systems. The framework emphasizes "cross-functional integration, customer supplier partnerships, global scale, continuous improvement, and team accountability." [Kaplan, Norton, 1992]

To start, I suggest AAM follow Michael Hammer's approach. Eliminate existing job definitions and departmental boundaries and create new positions where specific people have specific responsibility for performing work in a specific period of time. Instead of permitting the handing off of work or responsibility to another group or person, give power to someone who never relinquishes control. And make sure that someone is a leader who has the training and perspective necessary to compete in the global operating environment of the company. [Hammer, 1990]

6.3 Institutionalize Systems Thinking

During the reevaluation process AAM's leaders should maintain a systems focus. The team should consider processes generating positive outcomes and create reporting mechanisms that enable senior executives to track performance encouraging continuous improvement and learning. [Kaplan, 1990]

To help illustrate how AAM can institutionalize systems thinking and create a process driven enterprise, I will share my experience visiting one of the AAM third party logistics providers, Carter Logistics (Carter). Carter, based in Anderson, Indiana, is responsible for conducting milk-runs to AAM suppliers in the Midwest.

During my visit to the company I participated in a four state milk-run to various American Axle suppliers in the Midwest. The driver I rode with was very polite and spoke sincerely about the company's safety program and the bonuses it provides for safe drivers. The office areas were laid out to maximize team interaction and quick communication. The cross-dock was spotless. (See **Figure 12** below) I did not find any material out of place; everything was stored in marked, dedicated locations. One thing that stood out is process simplicity. It was very easy to walk the Carter value stream starting with the "driver board" right through the dispatch office out on to the cross-dock.

Figure 12: Carter Logistics Cross Dock

During the Carter milk-run we (the driver and I) stopped at one of American Axle's key suppliers. While waiting for the shipping dock to load our truck, I spoke to the material manager responsible for

AAM's account. I asked very pointed questions about processes to discover what happens when a problem is identified. How is the problem passed along to American Axle and who at American Axle takes responsibility to make sure it gets resolved in a timely manner? What problems are you currently working on with American Axle? Which have you resolved? For each question the individual I was speaking to often expressed a real need for true ownership of specific issues at both American Axle and the milk-run suppliers. Many of the people I spoke with could provide names of people they "call" when there is a problem. When I asked them to provide me with specific examples of problems they have identified and resolved working with American Axle, they had no substantial data or sheet of workable issues resolved. It would be very beneficial for all 3 parties: AAM, Carter, and Suppliers to create a continuous improvement process that clearly defines how problems will be identified, reported, tracked, and resolved by all parties. A vision or strategy supported by effective management and measurement techniques to drive positive outcomes would be very helpful.

To drive continuous improvement American Axle might consider a quality process that identifies material shipping discrepancies. An example of a current discrepancy is Carter receiving material without appropriate labeling. Without master labels on inbound containers, Carter has to devote extra resources to investigate where the material skid's final destination is. If Carter "guesses" wrong, the AAM or supplier location that needs the containers call AAM's corporate office and tie up valuable resources to track down missing containers.

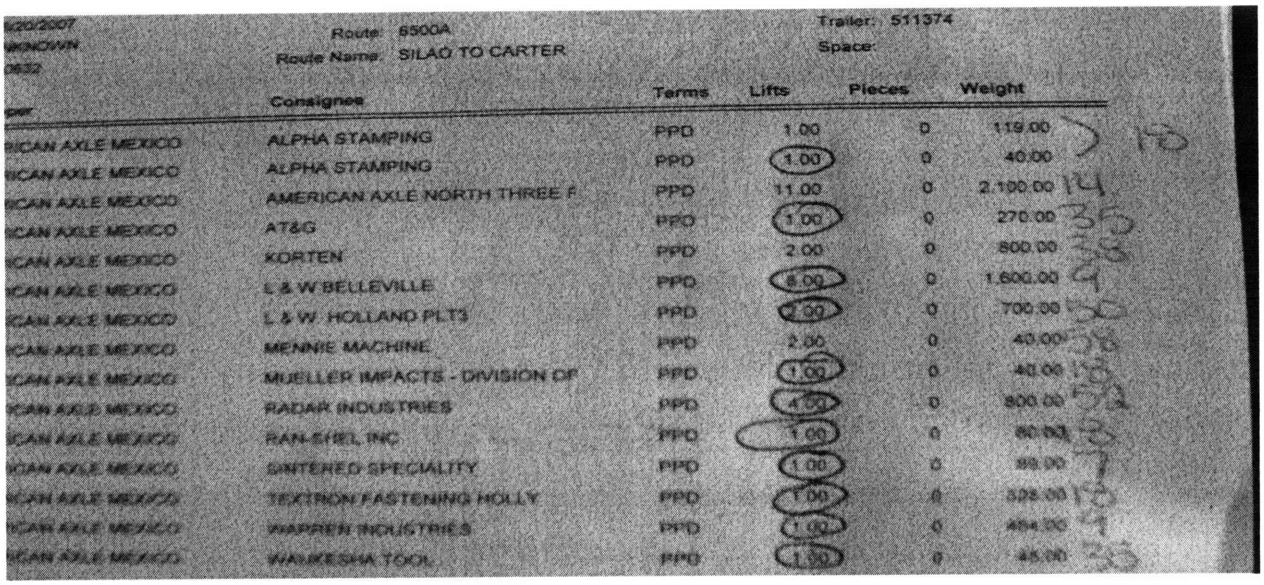
More important is the Corporation's inability to track these discrepancies to monitor supply chain inefficiencies and drive continuous improvement. A suggestion would be for the entire Corporate Materials group to employ the same quality standards as manufacturing. When a problem is identified by AAM, Carter, or Suppliers, a quality alert bulletin is issued. This can be tracked with a bulletin that includes a description and picture of the problem, the date of occurrence, and a case number that can be logged into the same tracking database currently used in Quality. Aligning the processes and systems used in different functional areas of the company would be beneficial to everyone including outside suppliers.

6.3.1 Specific Opportunities to Institutionalize Systems Thinking

Over 90% of all empty containers I saw during my visit to Carter Logistics had old shipping labels on them. When parts are consumed in AAM plants, American Axle should mandate all labels be removed to clearly identify full versus empty containers. This simple step would support the desired outcome of containers being shipped to AAM and returned to AAM suppliers without interruption.

AAM's Guanajuato, Detroit, and Three River plants need to create accurate Bills of Lading (BOL). All three plants are currently shipping empty containers using one line item to call out bulk empties on the BOL. The plants assign Carter as the consignee when in fact they are only the carrier. The destination supplier should be the consignee. The AAM facilities need to spell out what quantity of empties go to what supplier Carter picks up from. This has a direct impact on Duty Free Goods shipped across borders. While I was at Carter I observed an inbound truck arrive at Carter's dock from Guanajuato. The truck had components and empties. When I went over to ask the hourly fork truck operator if I could see the BOL for the empties he said there were none. He stated Guanajuato often ships empties with no paperwork…none. When I asked how this can happen he said it is what they call a "ghost transaction".

Applying Master Labels is very sporadic. There were many skids I examined which were marked very well yet others had no labels besides the painted "Property of AAM" on the side. This forces many delays in the unloading and loading of trucks at Carter. A related area where AAM could help is making sure skids are loaded with Master Labels that face the back of the trailer. This prevents fork truck drivers from having to get off of their truck to see what skid they are pulling and referencing where its destination staging area is on their dispatch sheet. (Please see **Figure 13**.)



Route: 6500A
Route Name: SILAO TO CARTER
Trailer: 511374
Space:

Consignee	Terms	Lifts	Pieces	Weight
ALPHA STAMPING	PPD	1.00	0	119.00
ALPHA STAMPING	PPD	1.00	0	40.00
AMERICAN AXLE NORTH THREE F	PPD	11.00	0	2,100.00
AT&G	PPD	1.00	0	270.00
KORTEN	PPD	2.00	0	800.00
L & W BELLEVILLE	PPD	8.00	0	1,600.00
L & W HOLLAND PLT3	PPD	2.00	0	700.00
MENNIE MACHINE	PPD	2.00	0	40.00
MUELLER IMPACTS - DIVISION OF	PPD	1.00	0	40.00
RADAR INDUSTRIES	PPD	4.00	0	800.00
RAN-SHEL INC	PPD	1.00	0	[illegible]
SINTERED SPECIALTY	PPD	1.00	0	[illegible]
TEXTRON FASTENING HOLLY	PPD	1.00	0	[illegible]
WARREN INDUSTRIES	PPD	1.00	0	[illegible]
WAUKESHA TOOL	PPD	1.00	0	[illegible]

Figure 13: Carter Logistics Dispatch Sheet (Fork truck driver dispatch sheet on Carter cross-dock, written numbers identify the storage bay the skid is to be transported to. The drivers can not identify the line item on the BOL from their fork truck if there is no Master Label.)

For material with Master Labels (See **Figure 14** below), there is ambiguity in the way Guanajuato identifies who the material is shipping to on the BOL and the actual skid itself. The below example shows a skid Master Label with J&R Engineering (supplier) and B&C (supplier) in parenthesis. The BOL will often show only B&C. B&C is the parent of J&R. Each is located in the same town but at a different mailing address.

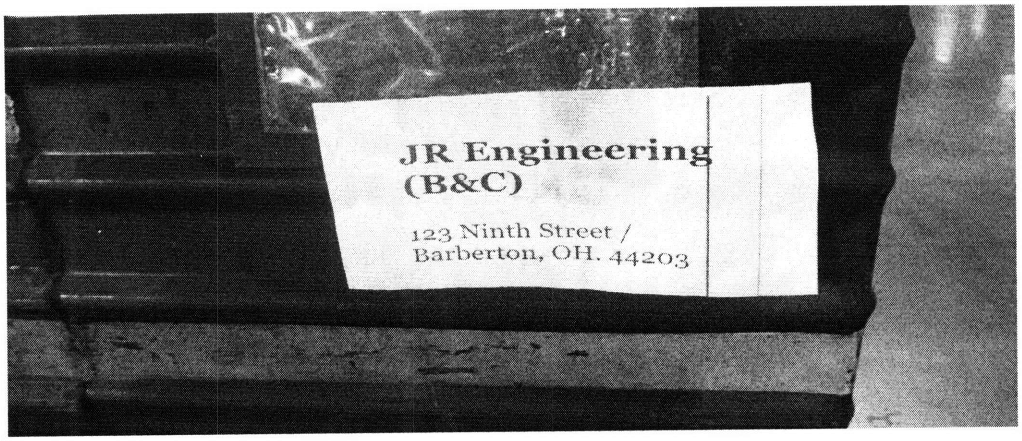


Figure 14: Master Label Example

At Carter I asked to see pull sheets, which are formal requests from AAM and AAM suppliers that send a "signal" to Carter requesting material be picked up on a given day. As of my visit Carter had not received regular pull information from either AAM or AAM suppliers and as a result Carter drivers go into pick-up destinations blind. They do not have an accurate skid count or weight estimate ahead of time. One way to resolve this is to use the sheet Carter has provided (See "Shipping/Origin-Destination Notice" in **Figure 15**). The milk-run process states this sheet should be faxed or emailed daily regardless of whether or not AAM or suppliers are shipping any freight. It allows Carter to better utilize trucks and reduce costs for AAM.

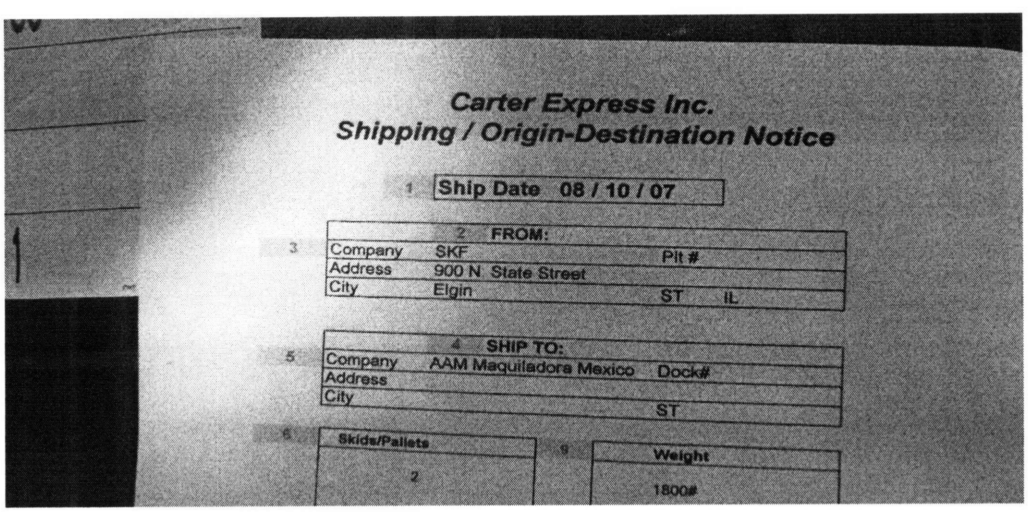


Figure 15: Shipping/Origin-Destination Notice

6.4 Summary

AAM could realize significant performance improvement by creating a common global operating strategy, aligning global processes and systems, and incorporating systems thinking into the fabric of their global operations. The corporate materials group could realize significant improvement by placing an emphasis on common processes that supports problem identification, resolution, and tracking. Clarifying who has responsibility to manage the processes which ultimately resolve open issues and drive corrective action and holding those individuals accountable would drive outcome based management into the life-blood of the organization. Embracing process improvement and thinking about how each process contributes to an even larger extended system will enable AAM to realize significant improvement in their supply chain and build a world class global operating system. Instead of an AAM material manager in Buffalo, NY maintaining a service level that is less than 55% to an intermediate bottleneck outside processor and blaming the performance on his position in the value chain, the material manager might consider communicating with peers at AAM assembly plants to address why material schedulers change production plans so frequently. [Lee, Billington, 1992] Examining processes in a systems context will help identify root causes, and attacking the root cause by applying operations based innovation will empower all stakeholders to take personal ownership for solving problems at the point where they occur.

7.0 Benefits and Costs Related to Implementation

Implementing recommendations provided in Chapter Six will not be easy. Trying to align the leadership of a large multi-national corporation will require leaders who may be used to traditional business processes or domains to sacrifice or give up established "territory" obtained over years of being with the company. Instituting processes and systems based on outcomes and holding people accountable for their performance relative to measured outcomes may cause some employees to leave the company. The departure of senior executives or employees in critical areas may hinder the development of a new product launch or customer deliverable. It is important for senior management (C-level Officers) to consider the impact a new strategic vision may have on key personnel and develop an appropriate reaction plan to ensure smooth implementation if leaders do depart. This chapter evaluates the costs and benefits associated with implementing the recommendations, and to provide an alternative perspective, namely to consider the challenge within the context of the healthcare industry.

7.1 Preserving Spirit of Innovation

As mentioned in earlier sections, defining a global operating strategy and aligning processes and systems around outcomes will strengthen an organization's sustained competitive advantage by enabling all employees to continuously improve processes that deliver value to customers. I also noted the way organizations tightly couple the process of doing work with the process of learning to do it better as it's being done defines an organization's ability to deliver consistent high quality performance to its customers. [Spear, Fixing Healthcare from the Inside, Today] In healthcare, hospitals often grapple with this challenge. Trying to develop an overarching operating strategy and vision for what is very often a non-profit enterprise with multiple stakeholders extending beyond the hospital and into the community/provider space is not easy. The challenges, costs, and benefits are very similar to those of American Axle.

To overcome the stated challenges hospitals need to build strong coalitions of stakeholders including policy makers and politicians. To reduce the high fixed costs, many large hospitals are considering new specialized healthcare centers. These will require capital outlays and perhaps regulatory/legislative changes. The needs and interests of key stakeholders will need to be realigned. By breaking down the complex problems found in healthcare and examining how an individual's work is performed relative to the needs of the whole system, there is a lot of potential for America to realize significant immediate gains in the effectiveness, cost, and quality of care. Like American Axle, hospital operations-based innovation can create immediate value for all stakeholders, provided that leadership develops and sticks to one "global" strategy.

In healthcare, like auto, the set of cause-and-effect factors that determine the linkage between strategic and productive operations is often elusive. The strategic plans and processes by which a company intends to gain advantage over its competitors often do not include operations design and management. [Skinner, Manufacturing – Missing link in corporate strategy] From medical errors to central-line infections, hospital patients' odds for survival are now similar to parachuting out of an airplane. To address this problem research shows healthcare managers must transform themselves from rescuers arriving with ready-made solutions into problem solvers helping colleagues learn Toyota's famed lean process improvement techniques. [Spear, Fixing Healthcare from the Inside, Today]

Before problems can be solved though, leaders must understand operations and processes. As leaders begin to immerse themselves in the operations of the organization, the strategic role of the organization's operations builds external support. Leaders start to understand their role managing the flow of inter-dependent parts and learn to appreciate the relationships needed to strengthen the health and performance of the whole system. Applying Toyota's lean principles teams of employees work with leaders to eliminate ambiguity and define exactly who is responsible for what, when, and how. When mistakes occur, those closest to the problem avoid working around it, and instead work with one another to identify the root cause, develop an idea to fix it, and then test and verify a new innovative solution.

7.2 Focusing on the Details

The exceptional level of determination required to focus on what many view as minor details is not uncommon in organizations that leverage operational innovation as a competitive advantage. It provides a structured way for organizations to examine detailed product design, unit processes, and the logistics and coordination of a system delivering sophisticated care to patients. [Fine, Clockspeed] Benefits of this mindset include the removal of ambiguity and an increase in the level of specificity by improving four levels of system design: output, responsibility, connection, and method. Testing each as quickly and inexpensively as possible in a real simulation provides instant feedback to employees and builds trust in the effectiveness of suggested solutions.

Examples of realized success in healthcare using this technique include improved rates of accurately filling prescription medication in hospital pharmacies, reduced rates of patient falls, and an increase in the amount of time nurses spend with patients providing care versus reacting to non-value added events imposed by an inefficient system. [Spear, Fixing Healthcare from the Inside, Today]

Although operations-based process innovation requires very little capital and generates immediate gains, many firms still struggle with the concept. Powerful stakeholders inside and outside of the organization often disrupt the alignment needed to forge productive relationships which enable innovation to take place. Because resources are often an essential ingredient when making operational changes, strong relationships with players who have the power to influence outcomes and implement change are important. The players help navigate the organizational complexities and facilitate the breakdown of rigid organizational barriers. It is imperative that employees working on operations innovation consider their own specific value chain dynamics and be mindful of the trade-offs that most certainly will impact the overall performance of the healthcare system. [Fine, Clockspeed]

7.3 Leaders Must Challenge the Status Quo

Implementing operational and process innovation requires organizational leadership that is willing to challenge the status quo. Stakeholders must be willing to relinquish power and control, embrace change, and sacrifice individual resources for the benefit of the whole. Overcoming the functional cost silos in healthcare is an important first step to build a culture of operations based innovation. [Herzlinger, Why Innovation in Health Care is So Hard] The automotive industry and American Axle are no different. Inexperienced innovators may advocate for investments in expensive technology to align information systems or boost productivity. Applying Toyota's simulation framework, employees should limit expensive technology investment and employ the "bolt don't weld, tape don't bolt, hold don't tape" implementation methodology.

The operations based innovations that deliver the greatest "bang for the buck" are usually the simple ones. Defining color codes for drug delivery in a patient room or hospital pharmacy is not very sophisticated, but when taken in aggregate, not making the simple change contributes to a system that would not be capable of delivering consistent high quality care to patients. The same holds for the English entrepreneur who developed a new system for customizing eyeglasses quicker and more efficiently. In a fraction of the time for a fraction of the cost, a customer can receive custom eye-glasses due to someone devising a simple, easy to use innovative process. [Christensen, Will Disruptive Innovations Cure Health Care] The key is creating an organization of process innovators. From the top of the organization to the bottom all stakeholders must develop an appreciation for the role they play contributing to an overarching operating enterprise. Working together to diagnose problems, identify solutions, align players, and implement corrective actions will ensure success is realized for providers, insurers, and patients alike.

The innovators who devote themselves to improving operations in this way can expect immediate results. Industry practitioners have already reduced rates of hospital-acquired infections, falls, medication errors, and other complications by up to 90%. Pressure ulcer rates and birth injury rates have been reduced by applying operations innovation at the largest Catholic healthcare system in the United States. Each are proof that if leaders do step up and consider the role they play developing an operations-based problem solving culture they can improve the reliability of their processes and the coordination of care provided to their patients. [Spear & Berwick, A new design for healthcare delivery]

8.0 Conclusions

The project and thesis covered in this work helped me develop a broader perspective and appreciation for the challenges firms face in today's very complex and rapidly changing business environment. After being immersed in the company culture, visiting manufacturing sites, talking to customers, and observing the interdependent links between different stakeholders in the AAM system I developed a renewed appreciation for the impact globalization has had on business and the need for companies to embrace operations-based innovation.

Meeting face to face with employees and observing how they perform their work, I learned when the people closest to the process perform the process, there is no need to have large amounts of overhead to manage it. From supplier localization to material scheduling, incorporating information processing work into the real work that produces the information is an essential part of developing an operating system that delivers results. [Hammer, 1990]

8.1 Lessons Learned

Lessons learned during this research project can be summarized into six distinct categories:

1. In all facets of the project the author learned it is easy to talk about people, talent, and skill as an essential ingredient to successful business, but quite another to actually develop the people and leaders required to compete in today's global world.

2. A global operating strategy that prioritizes and specifies the processes and systems vital to the company's future success must be communicated throughout all levels of the organization. The company and its leaders can not waiver from the course they commit to; rather they need to focus on sending a clear and consistent message to all employees that lets each know how they can contribute, add value, and participate in the future success of the company.

3. Strengthening supplier relationships and building trust with them is very important for long term growth potential of the company.

4. Developing a process to manage and track the effectiveness of systems like the scan empty process will ensure processes add value to organizations, their customers, and their suppliers. Establishing clear process owners and clear timelines for localizing suppliers and working to reduce third party logistics inefficiencies will make the AAM supply chain more profitable and robust.

5. Balanced scorecards provide a valuable and useful alternative to conventional ABC cost models. Instead of focusing organizations on contribution margins that measure short run performance, balanced score cards encourage companies to use actual costs and actual performance as a daily measure of satisfying the customer. Balanced scorecards help people see and understand the operating system performance drivers, and encourage changing the way people think about problems inside the organization. Shifting from a task-oriented to a process-oriented mindset helps the organization identify problems and resolve them much more effectively; this is because the work is not concentrated on one specific task, but on interdependent tasks that support a process and system that delivers true value to customers.

6. Business units should be encouraged to challenge the status quo. When leadership states material and labor costs are driving unprofitable business unit performance, employees should be willing to question their superiors and provide other perspectives from which to derive possible solutions. Eliminating bureaucracy and driving information gathering down to the process that actually generates the information will save cost and eliminate unnecessary paperwork and reports that hide true performance.

8.2 Suggestions for Future Work

This thesis project helped American Axle to consider the value of systems thinking. Working with cross-functional departments at both the corporate and plant level helped stimulate dialogue between the author and company employees. The ideas shared challenged established mental models and encouraged each of us to think and act differently while searching for new ways to add value to the company, suppliers, and customers.

During the course of the project, a few key areas were noted for future student projects.

1. Inventory Optimization.

    a. American Axle plants and suppliers would benefit from a student who has an interest in sizing raw, work in process, and finished inventory banks. The Guanajuato factory appears to be the one plant that would benefit most from such an analysis.

2. The Scan Empty Process

    a. The corporation would benefit from a student who could perform a detailed analysis of the current-state process and provide management with an illustration of how the system is impacting current inventory management performance. A key deliverable would be developing a future-state vision and plan providing concrete steps the company should take to improve the effectiveness of this system.

3. Develop a Balanced Scorecard

    a. The financial systems in use at American Axle are based on very traditional aggregated reporting systems. A project that focuses on developing a balanced scorecard at one manufacturing site and linking that scorecard to a new corporate reporting system may help the company evaluate the effectiveness and benefit of changing their current reporting systems.

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