Collaboration in the Automotive Supply Chain - Realizing the Full Potential of a Powerful Tool

PREPARED FOR
ANXeBusiness, Inc.

BY
Bernard Swiecki
Economics and Business Group

and

Richard J. Gerth
Manufacturing, Engineering, and Technology Group

CENTER FOR AUTOMOTIVE RESEARCH

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Bernard Swiecki
Senior Project Manager

Dr. Richard J. Gerth
Senior Research Scientist

Center for Automotive Research
1000 Victors Way, Suite 200
Ann Arbor, MI 48108
734.662.1287
www.cargroup.org

Introduction

The automotive industry has undergone a transformational evolution over the last two decades. Compared to just twenty years ago, the industry is now building different, more complex products and using changing corporate structure to deliver more content to consumers while actually decreasing prices. The increases in efficiency necessary to accomplish these changes have come about as a result of painful structural change that has significantly increased collaboration between automakers and suppliers. The industry is therefore functioning under a different operational structure for which the business practices and corporate departments of both automakers and suppliers were not conceived. To take maximum advantage of the benefits offered by collaboration, and to advance the implementation of collaborative business practices even further in the future, automotive manufacturers and suppliers need to structure their companies in a way that will maximize collaboration while freeing employees and departments to do the tasks for which they are most appropriate.

Many stakeholders in the North American automotive industry, from automakers to lower tier suppliers, find themselves under unprecedented financial pressure. The U.S. market has begun a transition to smaller, passenger-car based vehicles while undergoing a drastic contraction of sales volume. Consumers have signaled a desire for smaller vehicles that generally cost less than those they purchased in the past. Decreasing transaction prices, when coupled with a decreased sales volume, create a revenue threat that is being felt in the entire automotive industry.

Thus, the industry finds itself in a time of shrinking market size and shrinking margins, while the resources available to address these developments are also shrinking. Globalization and the flight to source from low cost countries have resulted in some savings, but it has not been the panacea some had expected. Globalization, along with increasingly complex collaborative relationships in automakers' home markets, has made it necessary for the automotive industry to reevaluate and change the way it manages collaboration.

As a response to these changes, automakers and suppliers have begun to integrate their global operations into seamless companies in a pursuit of increased synergies and economies of scale. This integration, however, brings with it a multitude of challenges. Many automotive suppliers have assets around the world but have not integrated those assets into a cohesive whole. *International* operations are therefore achieved, but truly *global* scope is elusive. In order to achieve it, automakers and suppliers will have to revise both their internal and collaborative business practices. Increasingly global scope brings with it both risk and reward: in order to realize the true benefits of global operations, companies have to relinquish a degree of central control to their overseas operations. Those companies who are able to do so, while maintaining transparency and cohesiveness, will be able to take advantage of the benefits of global operations without suffering the possible negative consequences.

Recent Trends

Many developments, both internal and external, have made the automotive industry an increasingly complex business. The vehicle itself has grown in complexity and sophistication. Government regulations regarding safety, emissions, and fuel economy have added considerable cost to each new generation of vehicles and powertrain components. At the same time, the consumer is, on an inflation-adjusted basis, paying less for the average new vehicle than in the past. The cost of inputs, ranging from commodities like steel and plastics to employee health care, has been rising rapidly (see Table 1).

Table 1. Automotive Industry Financial Environment

Industry PPI/CPI/ECI	1998-2008 YTD % Change
New Cars and Trucks CPI	-6.18%
Motor Vehicles Manufacturing Price Index PPI	-3.95%
Motor Vehicle Parts PPI-Commodities	+3.66%
Rolled Steel PPI	+95.81%
Primary Aluminum PPI	+90.04%
Plastic Materials & Resins PPI	+85.27%
Refinery Gases (Feedstock) PPI	+567.38%
Petroleum Refineries PPI	+542.70%
Health Insurance ECI	+97.74%

Source: BLS-July 2008

Several product trends are emerging in the North American automotive industry that will ultimately increase the complexity and workload faced by automakers and suppliers. The number of nameplates has grown much faster than the overall market, resulting in declining sales per nameplate (see Figure 1). The trend of increasing number of nameplates, coupled with decreasing sales per nameplate, is a clear indication that the U.S. market is becoming more fractured and specialized than it had been in the past.

Trends in model proliferation and platform consolidation indicate that a product dichotomy is emerging in North America (it is also forecast to continue in the foreseeable future). While the decreasing number of platforms on the market points to an increase in commonality, the rising number of nameplates is an indicator of increasing specialization. The industry will therefore be challenged to develop a wider array of products using fewer common platforms and "parts bin" components. At the same time, product lifecycles are decreasing, which will multiply the number of projects suppliers are working on at any given time – further increasing workload and complexity.

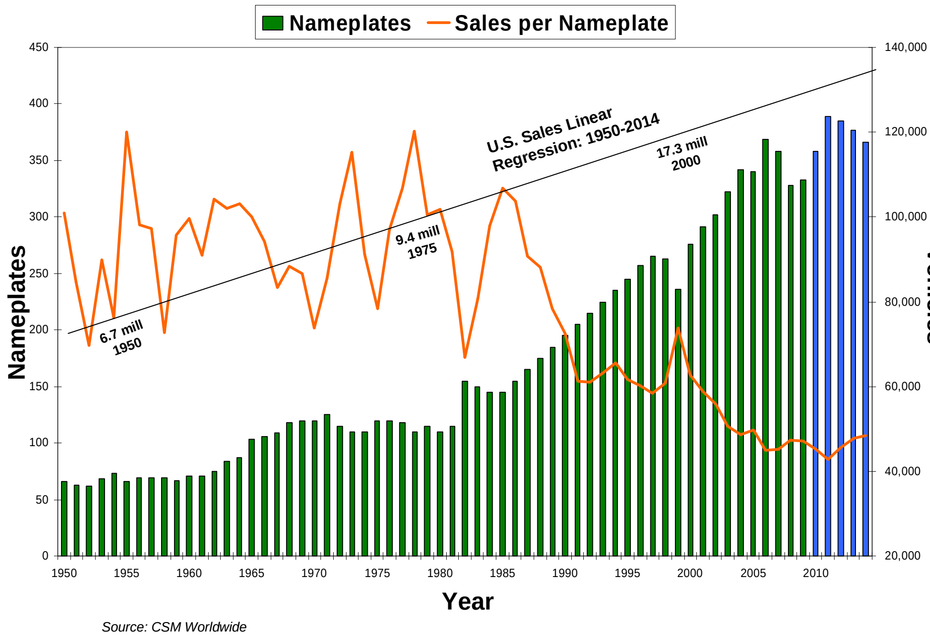

Figure 1. U.S. Market Nameplate Proliferation 1950-2014.

The automotive industry as a whole employs about 670,000 employees in the United States, as illustrated in Figure 2. The industry has experienced a decrease in employment levels, with current employment representing virtually half of the peak employment levels experienced only ten years ago. While a portion of the employment reductions can be attributed to increased production efficiency, the increased outsourcing of automotive jobs has also contributed to this trend. The industry is therefore challenged to use fewer employees and more expensive inputs to build a more sophisticated and expensive product while receiving less revenue to cover the costs and still produce a profit. It is not surprising, therefore, that automakers and suppliers are scrambling to find cost reductions wherever they may exist. These reductions, however, often add their own complexity and necessitate the need to actively manage the relationships they bring about.

In response to these fiscal and market challenges, the automotive Industry has undergone structural changes that have made automakers' and suppliers' responsibilities more challenging to fulfill. Suppliers have taken on increased engineering responsibility. The OEMs have therefore relinquished a degree of control over their intellectual property. Problems that were at one time internal to OEMs have now become external and more challenging to address. The industry-wide employment decrease described above has decreased the number of people who strive to address these problems at both OEMs and suppliers. Globalization has made formerly domestic collaboration global, thereby increasing complexity while decreasing control and visibility. In many ways, however, the industry is approaching these developments with a corporate structure and a set of business practices carried over from previous eras that may not be sophisticated enough to resolve the issues of today's challenging collaborative environment.

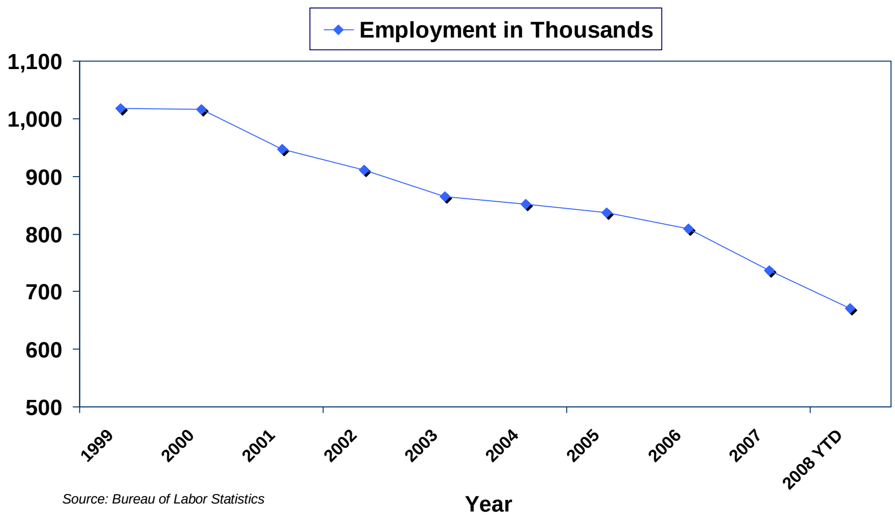

Figure 2. U.S. Employment Directly Related to Automobile and Automobile Parts Manufacturing 1999-2008 YTD

The industry has addressed the increasingly complex collaborative environment through the application of a wide array of increasingly capable computer applications. These applications increase capability but often require increased support. They also have to cope with emerging challenges such as enabling collaboration in a global setting rife with security and IP risks.

As both automotive industry structure and the products built by the industry become more complex, the collaboration required to engineer these products also grows in complexity. Legal and procedural problems remain even if new collaborative software emerges and legacy mindsets of OEM and supplier staff make it difficult to maximize collaboration in an industry structured to put up walls and defend home turf. Collaboration is potentially a powerful tool to address the technical and financial problems faced by the industry but, unless a more structured and optimized approach to collaboration is adopted, the automotive industry faces the threat of not being able to maximize its benefits.

A Simple Transaction Model

It is instructive to evaluate the trends of the past two decades on the complexity of the OEM and supply chain and their associated links. A common systems approach to quantifying complexity is to model OEMS and suppliers as nodes and evaluate the links between the nodes. Basically each link between an OEM and a supplier is a connection. In order for the supplier and the OEM to collaborate they need to share information in a timely manner along these connections. Each time they share some kind of information, be it design information or payment information, there is an electronic transaction. This timely sharing of information through transactions is at the heart of electronic collaboration. Thus, the more transactions, the greater the complexity.

Of course, establishing the connections and managing and conducting the transactions in a timely, secure, and reliable manner requires significant resources. Further, as technology has progressed, so have the demands on the transaction system in terms of bandwidth, speed, interoperability, application and business process support, and security.

In order to understand the impact of the various developments described previously on the number of transactions, we developed 3 simple transaction models from an OEM's point of view (see Figures 3 through 5). The models, assumptions, and responses are primarily based on the experience of the domestic North American OEMS.

The transaction models attempt to characterize the increase in collaboration complexity simply by tracking the number of transactions between organizations, i.e., the number of communication exchanges required for collaboration. This model is extremely simple in that it ignores the communication exchanges within a company, and it assumes only one connection between a customer and a supplier. It also assumes that two suppliers never have to communicate with each other, and there are only Tier 1 suppliers.

Table 2. Assumptions Underlying the Three Scenarios

ASUMPTIONS	**Variable**	**1980s**	**1990s**	**2000s**
# of Vehicles Sold	V	1,000,000	1,000,000	1,000,000
# of Platforms (architectures)	A	3	4	3
# of Models per Platform (architecture)	MPA	1	3	4
Average # of Parts per Vehicle	PPV	100	100	100
% of Carryover Parts	%CO	0%	80%	80%
Average # of Parts per Supplier	PPS	1	1	1
Average # of Connections per Part	CPP	1	1	1
Average # of Transactions per Connection	TPC	100	1,000	1,500

There are three transaction models or scenarios that represent the typical automotive system in the mid 1980s, mid 1990s, and current or near future 2000s. The basic structures of the three scenarios are shown in Figure 3, Figure 4, and Figure 5. The numerical assumptions underlying the scenarios are given in Table 2. Common assumptions to all three scenarios are that 1 million vehicles are produced, every vehicle consists of 100 parts, and every part is supplied by a different supplier. Any parts produced in-house are not considered to be part of this model, as internal communications are not considered. Clearly, the model complexity could be increased to consider internal linkages as well.

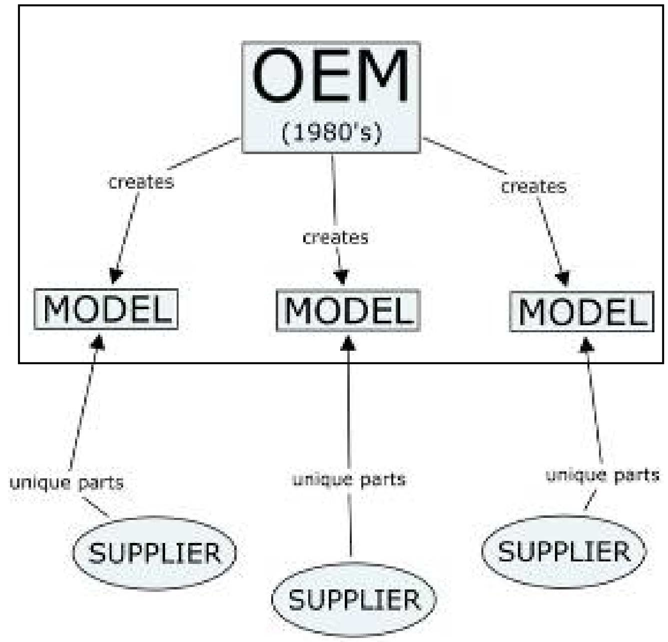

Figure 3. Model of OEM Structure of the 1980s

In the 1980s, the typical NA OEM produced a limited number of models (see Figure 3. These models were generally quite distinct from each other and had very few parts in common. While they also produced very similar variants of the same model with minor cosmetic differences for their different vehicle brands, it was not considered to be comparable to what is being done now on a platform level. The minor differences between brands of the same model are not at the level that develops later in the 1990s. Thus, this scenario has no platforms and 3 models. It assumes, therefore, that there are no carryover parts between models. The OEM designed and produced many of the parts in-house, and the other parts were produced by a variety of suppliers. In general, OEMs preferred to have many suppliers which they could bid against each other for cost savings.

Table 3 shows the results and conclusions for each model. The equation for computing the various Table 3 values are given in equations [1] through [10]. For example, our 1980s model assumes that an OEM is producing 3 different vehicle models. These models were so complex that they each had their own platform. Thus, one can argue they produced 3 platforms and one model of each platform. The model assumes that every model consists of 100 unique parts. If each part is supplied by a different supplier, then there are a total of 300 suppliers. It also assumes a total production volume of 1 million vehicles. Under these assumptions, there are 333,333 vehicles sold / model, 100 suppliers /

model, a total of 300 suppliers, and 300 total connections. With 100 transactions per connection, there are 30,000 transactions in the system.

Table 3. Numerical Characteristics of the Three System Scenarios

Characteristic	Variable	1980s	1990s	2000s
# of Models	M	3	12	12
# of Shared Platform Parts	P_{shared}	-	320	240
# of Unique Parts	P_{unique}	300	240	240
# of Total Parts	P_{total}	300	560	480
# of Suppliers to platforms	S_A	-	320	240
# of Suppliers to models	S_M	300	240	240
# of Total Suppliers	S_{total}	300	560	480
# of Suppliers per Model	SPM	100	47	40
Volume per Model	VPM	333,333	83,333	83,333
# of Total Connections	C_{total}	300	560	480
# of Transactions	T_{total}	30,000	560,000	720,000

$$M = A * MPA \qquad [1]$$
$$P_{Shared} = A * PPV * \%CO \qquad [2]$$
$$P_{Unique} = M * PPV * (1 - \%CO) \qquad [3]$$
$$P_{Total} = P_{Shared} + P_{Unique} \qquad [4]$$
$$S_A = \frac{P_{Shared}}{PPS} \qquad [5]$$
$$S_M = \frac{P_{Unique}}{PPS} \qquad [6]$$
$$S_{Total} = S_A + S_M \qquad [7]$$
$$SPM = \frac{S_{Total}}{M} \qquad [8]$$
$$C_{Total} = P_{Total} * CPP \qquad [9]$$
$$T_{Total} = C_{Total} * TPC \qquad [10]$$

Over the next two decades the industry experienced a number of developments:

1. Industry consolidation through the purchasing, merging, or partnering of OEMs
2. The rise of platforms with a large amount of commonization of parts between highly differentiated model variants produced on flexible manufacturing lines.
3. Increased use of the internet for business transactions and sharing of data.

Figure 4 shows how some of these developments have changed the system by the 1990s. The first impression is that this system is much more complex than that of 1980s. Many of the OEMs that had merged initially kept different parts of the functional organizations and products separate, thereby increasing the number of platforms and models. While they may have gained some organizational efficiency by consolidating certain functions, for the most part they

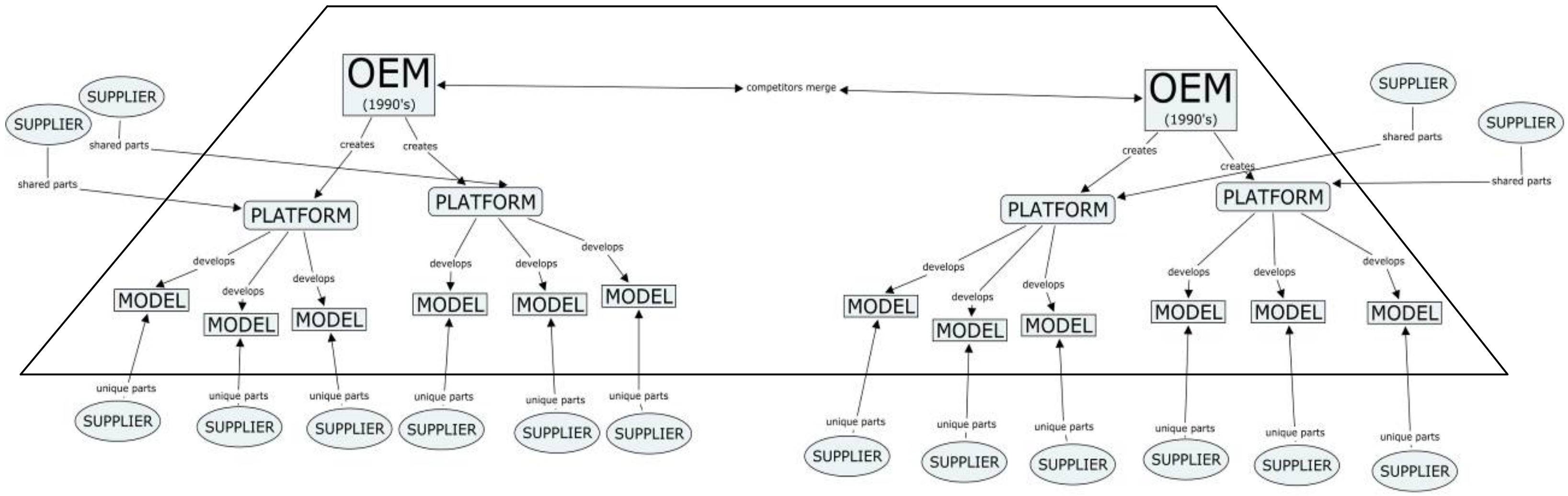

Figure 4. Model of OEM Structure of the 1990s

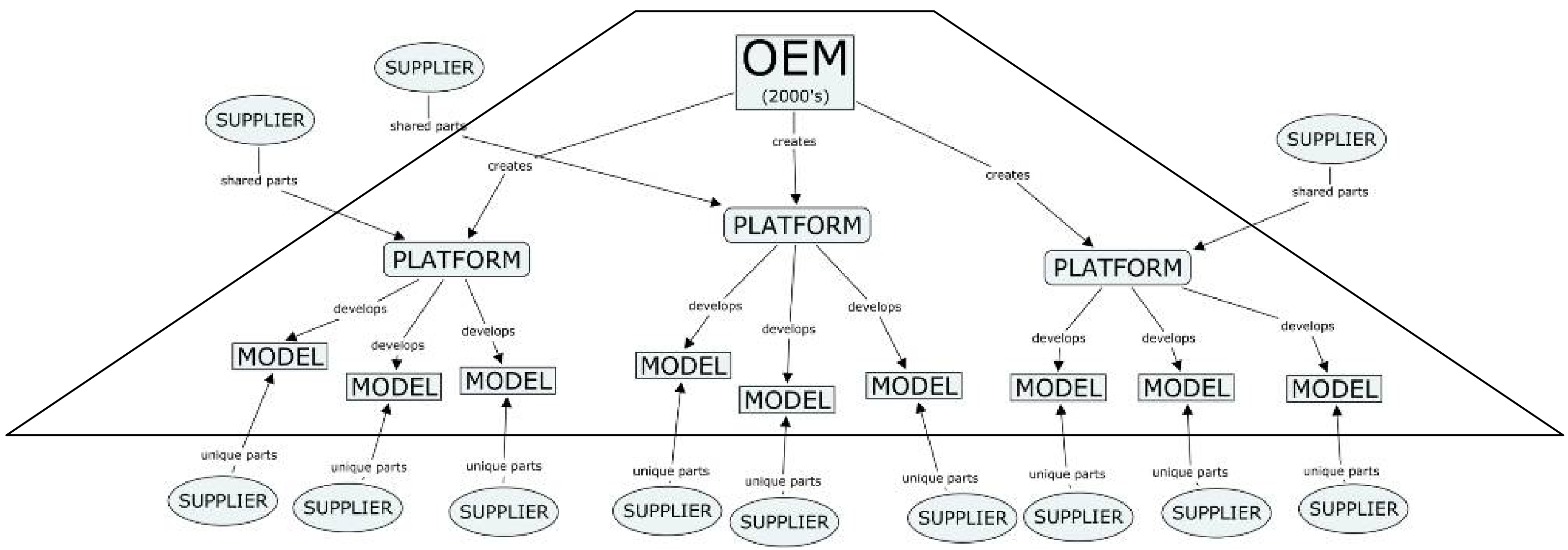

Figure 5. Model of OEM Structure of the 2000s

kept their models and supply chains intact. Consolidation of platforms, supply chains and other developments came later and are discussed below.

The trends mentioned above are captured in the assumptions (see Table 2). We assume two platforms per pre-merged OEM and three models per platform. This increases the overall number of models, which the market demanded, but at a lower volume/model (assuming 1 million total vehicles). Only the platform strategy coupled with flexible assembly manufacturing allows this type of model differentiation without significant capital expenditure. Assuming 80 percent part commonality, and again that every part is produced by a different supplier; there are only 47 suppliers per model. This is a dramatic reduction compared to the 1980's system. However, because there are so many more models which results in more total parts, there are more total suppliers (560) in the system. This leads to a dramatic increase in the number of connections by a factor of 1.87. In addition, due to the increased use of the internet, the number of transactions per connection is assumed to have increased from 100 per connection to 1,000 per connection. This results in 560,000 transactions, an 18.7 fold increase in the total number of transactions relative to the 1980s.

The many developments of the 1990s accelerated and led to some of the changes we see today and anticipate to continue to see into the future (2000s):

1. Dramatic increase in cost pressures: shifts in markets, energy prices, government regulations, and changes in technology (electronics and powertrain).
2. Globalization of markets and developing new production facilities in emerging markets
3. Globalization of the supply base to lower costs.
4. Commonization of processes and products to lower costs and gain efficiencies
5. Maturity of the internet for global high speed communication
6. Increased use of simulation and solid model based engineering tools and processes.

For the model we only focus on the commonization of processes and products and the increased maturity of the internet. The new system structure is shown in Figure 5. In this case we are showing fewer platforms – 3 for a single unified, global OEM – but more models per platform (4 models/ platform). In order to keep the numeric example comparable to 1995, we have kept the total number of models offered the same at 12. Again, assuming 80% commonality, 100 parts per model, every part produced by a different supplier, and 1 million total vehicles, we get 40 suppliers / model and 83,333 vehicles / model. Therefore, the total number of suppliers decreases to 480, decreasing the total number of connections (see Table 3). However, the maturity of the internet and the increased use of software in design have increased both the number of transactions per connection (from 1,000 to 1,500) as well as the number of functional groups that interact. Thus, despite the 15% reduction in the number of suppliers we still see a 29% increase in the total number of transactions.

What is not shown, but is perhaps even a greater factor of system complexity is the nature of the connections. Vehicle models are now produced in multiple countries, have simultaneous launches, globally distributed suppliers, and so on. These factors complicate the system beyond our simple transaction model's ability to illustrate.

This example was presented primarily from an OEM's perspective. From a supplier's perspective the situation may be even worse for two primary reasons. First, they are often required to maintain different systems and processes for different major OEM customers, thus increasing their overall burden. Second, the increased outsourcing of modules and other components from the OEMs has resulted in many Tier 1 suppliers increasing their supply chain depth and breadth, thereby adding to the Tier 1's connection complexity.

Thus, while by many measures that are based on a per vehicle model statistic, the system is getting more efficient, it should be equally clear that from a total systems perspective, the system is getting much more complex, as measured by number of connections and transactions between external organizations.

Conclusions

Because collaboration is growing increasing more complex and potentially risky (because it entails a relinquishing of control), it must be properly executed and monitored in order for automakers and suppliers to realize its potential benefits without suffering offsetting negative consequences. The vast majority of today's automakers and suppliers hail from a time when collaboration was either non-existent or much simpler. A portion of their *internal* corporate structure and business practices are therefore holdovers from a time when they did not *externally* participate in truly collaborative projects. The externality of multi-firm collaboration has been brought upon the automotive industry out of necessity – if the industry is to continue to reap its rewards, however, industry stakeholders may have to adjust their *internal* structure and business practices to fit, control, optimize, and grow the *external* collaborative activities in which they're engaged.

Several strategies may prove useful in addressing these developments, including the centralization of collaboration responsibility within one company department, instead of distributing it between purchasing, engineering, manufacturing, and IT. Likewise, a realignment of an OEM's purchasing, engineering, manufacturing, and IT departments to focus on their core duties (while optimizing their structure and business practices for a collaborative business environment) would likely be very effective.

It is likely that, if they have not already, automakers and suppliers will soon have realized the maximum benefit that can be achieved from practicing collaboration with the corporate structure and business practices that date from decades ago. In order to implement the next level of improvements in sophistication, quality, cost control, and time-effectiveness promised by collaboration, companies themselves will have to change to reflect the industry's modern business environment. Reorganization to meet the objectives listed above would be the centerpiece of such evolution and would have to be adapted to meet the specific characteristics of each firm. Just as the vehicles it builds have changed tremendously in the recent past, the automotive industry is rapidly evolving and bringing success to those best prepared to deal with and take advantage of its changes. The future, along with the full benefits of the collaborative environment by which it will be defined, will belong to the companies who continue to evolve to meet this challenge.