A Collaborative Business Model for the Tool and Die Industry

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Manufacturing Systems Group
Center for Automotive Research – Altarum

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Glossary of Terms

Term	Meaning
ABC	Activity Based Costing.
Activity Based Costing	Accounting method for allocating overhead charges based on leasing equipment / space / overhead resources per unit time.
CAD	Computer Aided Design.
Captive shops	Tooling shops that are owned by the customer.
CAR	Center for Automotive Research.
CNC	Computer Numerically Controlled.
Die Design Standard	A standard that states how dies will be manufactured, for example, how many wear plates will be used, whether standardized screws will be used, etc. These standards can be generic for all dies or specific to particular part families, such as fenders. In the US, customers often dictate the standard to ensure dies are made that will run in the customer's presses.
Functional build	A method for determining when a die is acceptable for production based on its ability to produce a part that will result in an acceptable assembly.
Lean manufacturing	Practices and techniques designed to reduce waste in all its forms (e.g., cost, time, space, labor), including work-in-process inventory through single part production flow; wasted motion, space, and labor through more efficient work space layouts; fluctuating resource demands through leveling work flow, etc.
OEM	Original Equipment Manufacturer.
Setup	Task of placing a die in a precise position on a machine or press prior to operation.
SUV	Sport Utility Vehicle.

Term	**Meaning**
Synchronous Process Flow	A production line flow of materials through serial processes with all resources needed at every point in the process as the job arrives.
T&D	Tool and Die.
The Big 3	DaimlerChrysler, Ford, and General Motors.
Tryout	The trial and error process of making a part, checking a part versus its specifications, making changes to the die, and making the next part.
Unibody	Car design strategy where the car body provides the structure for the engine and transmission, as opposed to having a separate frame and chassis.
Value stream mapping	Technique to identify bottlenecks in the product process flow.
CAM	Computer Aided Manufacturing.
Patterns	Styrofoam shape of the die from which the casting is formed.
Castings	The cast block of metal from which dies are made.
2-D machining	Process of rough machining the two-dimensional part shape in the casting.
3-D machining	Process of fine machining the final three-dimensional part shape.
PPAP	Production Part Approval Process. The process by which the contracted dies are proven to be capable of producing parts that meet specifications.
Die lineup	Number and order of dies required to produce a particular part
Draw die	First die in a die lineup, which determines the part shape and does the greatest amount of forming.
Blank	Flat piece of metal that is placed in a draw die.
Blank die	Die that forms the blank.
Bearing surface	A metal supporting surface in a die.

Wear plate	A plate that allows the upper and lower die to move against each other.
Die insert	A separate metal piece that is inserted into the main die, usually to perform a special function, such a piercing a hole, or to create an especially hard area in the die.
Show panel dies	Dies that make parts that are externally visible to the customer on a car, such as a hood, fender, or door outer panel. Examples of non-showing parts are reinforcements, rails, engine compartments, safety belt anchors, etc.
Cpk	Process capability index that relates the tolerance of a dimension to the process mean and variance. If the process is centered 4 standard deviations from the closest tolerance limit, the Cpk is 1.33.
BIW	Body In White, the assembled car body including doors, decklids, and hoods prior to painting.

I. Executive Summary

The current economic problems facing the tool and die industry are significant:

- 30% - 50% overcapacity,
- increased foreign competition,
- technology improvements that lower the barrier for others to enter the market,
- lower demand from the automotive companies due to reduced number of new vehicles, greater part integration, and increased part carryover,
- increased customer demands to provide more services and lower price by 5% annually.

Although some of these factors have come and gone before, this economic downturn is considered to be different from previous downturns, because there has been a fundamental change in the manner in which the automotive industry operates. Both OEMs and their suppliers are under intense foreign competition and must cut costs and change the way they do business, both internally as well as between one another. The above factors are permanent and not going to disappear as the automotives compete; hence the industry needs to restructure and develop new business models, such as the coalition approach.

Benchmark data shows the foreign competition can make dies at one-third the cost in approximately one-half the time. These differences can be attributed to three basic reasons: lean operations, simpler part designs from their customers, and closer supplier-customer relationships. This latter factor is particularly important as it drives, in part, the simpler part designs, and because it enables both parties to identify system level cost reduction opportunities, such as functional build.

It is imperative that T&D shops adopt lean practices. These practices have been shown to result in lower cost and improved manufacturing performance. The benchmark data clearly shows that lean practices lower time and cost in the manufacturing functions, i.e., die machining, assembly, and tryout. The state-funded Michigan Manufacturing Technology Center (www.mmtc.org) offers numerous training classes and implementation support for lean practices.

The T&D shops must learn to collaborate with one another and with their customers. For example, they can form coalitions that offer a broader range of services to their customers including project management and functional build. Collaborative efforts can drive tooling costs down by 40% through the following:

- Manufacturing and Engineering Efficiencies – 10%
- Coalition Efficiencies – 5%
- Product Design Input – 10%
- Lean Tool Standards – 5%
- Functional Build – 10%

The OEMs must entertain such coalitions as viable options. They can only succeed if the OEMs learn to work with the coalitions to reap the benefit of the system cost savings. These cost savings will require early design input, the creation of lean die standards, changing the part approval process (PPAP), and the implementation functional build processes at the supplier's and potentially at the customer's site.

The local, state, and federal government can support the coalition model by

- Funding the creation of coalitions or initial development into the structure of coalitions for various industries or customers (automotive, furniture, etc.),
- Creating investment tax credits and faster depreciation schedules to enable T&D shops to keep pace with the changes in technology,
- Changing laws to allow coalitions to purchase group healthcare coverage,
- Providing more funds for the education and adoption of lean manufacturing methods,
- Providing funds to support coalition cost reduction initiatives.

II. The Tool and Die Industry

Many tool and die makers have gone bankrupt during the first years of the new millennia. This study was commissioned to better understand the underlying causes for the demise of these shops, including a benchmarking study comparing selected Japanese (2) and US die shops (4). The results from the benchmarking study are presented in various places in the report.

The information presented in the report was derived from the literature, interviews with industry experts, working with different organizations in the industry, the results of the benchmarking study, and CAR's extensive knowledge of the world automotive industry.

A. Challenges for the Tool and Die Industry Sector

The tool and die (T&D) industry, particularly in Michigan, has always experienced large fluctuations in demand with high and low cycles lasting several years. In Michigan, where nearly 50% of the tool and die industry is automotive related, the cycles are a way of life, and companies have learned to expand and contract over time. Figure 1 illustrates the employment cycle for Michigan's tooling companies since 1970. These cycles are largely related to the introduction of major vehicle programs in the automobile companies. The questions being asked by T&D companies now is when will the next up-tic begin, will the demand return to full-employment levels, and will the demand support prices that allow T&D companies to make a profit?

Two factors contributing to the down turn are overcapacity and foreign competition. Most T&D manufacturers believe that there is a significant over-capacity in the world and domestic market (by 30% to 50%), with developing countries (mostly in Asia) continuing to build new capacity with the intent of supplying North America.

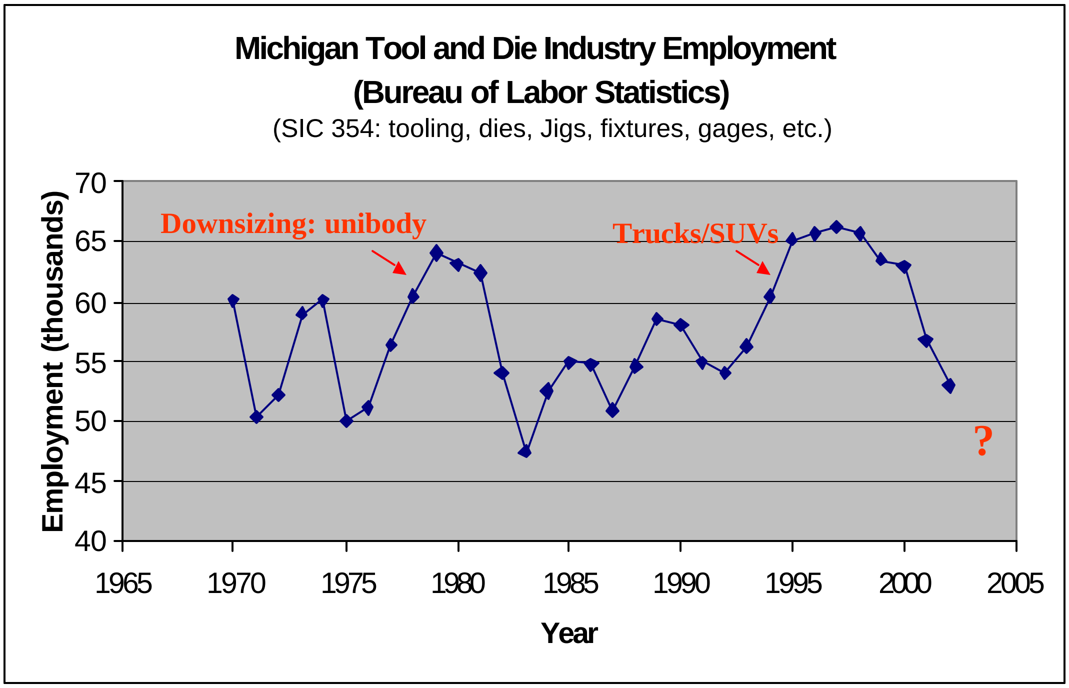

Figure 1 – Michigan Tool and Die Employment Cycle.

On the surface, it would appear from the cycles in Figure that all the industry has to do is wait for the next upturn, and business will continue as usual. In fact, when you compare the concerns of T&D companies back in 1975 with those of today, not much has changed (see Figure 2). Dominant concerns in 1975 included: foreign competition, increasing productivity (at the T&D shops), over supply, and low profit margins. All these issues are with us today. All these factors continue to put pressure on the industry today. So what has changed?

The concern that the downturn is, in fact, a re-structuring of the industry stems from the competitive changes at the automobile OEM level. The T&D industry sector is a microcosm of the automobile industry. International competition is intense with over-capacity, particularly in the major developed countries (North America, Europe and Japan). This has led to falling market share by the Big-3 – the principal customers of the domestic T&D industry. A primary mechanism to re-gain market share is to introduce new vehicle models that generate increased sales. The major bottleneck of introducing new programs is funding, which in turns places pressure on lowering tooling costs.

	1975 (1)	2002
Capacity Increase		
Increased foreign competition	X	X
Productivity gains	X	X
Shortage of Skilled Help	X (die maker)	○ (engineer)
Unfair Competition		
Excess capacity	X	X
Pricing below costs	X	X
Reduced Demand		
Foreign competition	X	X
Captive shops	X	X
Customer technology		Ⓧ
Unsupportive Government Policies		
Exchange rates		Ⓧ
Taxes	X	X

Figure 2 – Comparison of Issues Critical to Tool and Die Companies in 1975 Versus 2002.

Company	Relative Die Costs
Honda	X
Big-3 A	2.6 X
Big-3 B	2.8 X
Big-3-C	3.1 X

Figure 3 – Big-3 Relative Die Costs With Honda.

The cost efficiencies of many of the Asian companies are well recognized, which affords them a competitive advantage at gaining market share. A recent industry study, for example, shows the Big-3 OEMs have a significant tool and die cost disadvantage with respect to Honda in the car body (see Figure 3). The Big-3 die costs are over 2.5 times greater than Honda's die costs. Honda's timing is also considerably faster at tooling construction and tryout, although not to the same magnitude as the die cost differential (see section II.C Competitive Observations). The Big-3 recognize the need to reduce this competitive disadvantage, and that a significant transformation of the domestic tooling industry may be necessary.

One of the mechanisms the Big-3 is using to push down prices is on-line auctions. In spite of the negative reaction by long-term suppliers, the OEMs have managed to reduce prices with auctions, particularly during times of over-capacity. It was recently reported that DaimlerChrysler has been purchasing dies at 30% to 40% below conventional prices from just a couple of years ago. Although providing short-term cost relief and sending a message to the T&D industry, the auction approach is counter to the Asian (including Honda) collaborative supplier model. For example, suppliers to Honda see their relationships as open, collaborative, and long-term. The reward for this relationship includes less volatile demand cycles and cost-reducing cooperation (such as two-way sharing of product/process design knowledge), albeit with lower overall operating profit margins.

Other changes by the automotive companies are forcing suppliers to assume a greater portion of the OEM's financial liability and investment risk. The percent of annual capital expenditures by the supplier base has increased steadily for the past several years reaching approximately 66% in 1999 (IRN, 2002). No part of the supply industry is affected more than tool and die where the manufacturing lead times are long and the expenditures are high. Previous payment schemes were progress-based, for example, providing 30% at contract signing, 30% upon final design approval, 30% upon shipment, and 10% upon final validation at the customer facility. Under such a plan, the supplier could generally finance work-in-process through local banks when necessary. The new payment proposals, which are replacing the traditional progressive payments, at best, pay 100% upon shipment to the customer. Other proposals defer payment until final validation at the customer, or later. One proposal is to pay for dies on a production part basis, by amortizing the investment over the projected life of production on a piece-part basis. This pushes final payment out even further and adds additional payment risk. A further complexity has occurred from sourcing dies to tier-1 stamping companies (thus pushing the tool and die supplier back to a tier-2 supplier). The tool and die supplier must negotiate payment from a smaller, tier-1 company. Under these payment conditions and with the instability in the market, many banks have avoided tool and die financing, because of the higher risk in receiving payment altogether.

Although a traditionally cyclical business, there is strong evidence that the industry is re-structuring in a substantial, long-term way. The outlook for small (under 10-15 employees), independent and entrepreneurial tool and die shops is very grim. These small shops will likely need to identify their niche and then team up with larger companies that pool together resources to supply a greater variety of bundled products and services. The cost pressures on the larger shops will also force them to continuously evaluate their strengths and maintain a technical edge. Foreign competition is forcing the domestic auto companies to "share the pain" with the suppliers. Although many see the foreign tool and supply companies as the cause of the domestic problem, the true cause is the competitive pressures being experienced by the auto companies.

B. State and Federal Involvement

The difficulties experienced by the tool and die industry, particularly in Michigan, have been recognized by state and federal agencies. In addition to commissioning this study, the Michigan Economic Development Corporation (MEDC) has been supporting the industry through several initiatives including support to the Michigan Manufacturing Technology Center (MMTC). The MMTC (www.mmtc.org) provides services to the industry in the form of training and consulting for small manufacturers throughout the state. The MMTC leverages funds from state and federal sources to support the needs of Michigan manufacturers.

The federal government recently became actively involved with the tool and die industry when the International Trade Commission (ITC) began an investigation into the competitive conditions vis-à-vis foreign competition. They wish to ascertain whether or not other countries are competing fairly in their pricing of tools and dies to North American customers. The ITC report is expected in October 2002.

Representing Michigan's tooling industry to the federal and state government is the Coalition for the Advancement of Michigan Tooling Industries (CAMTI).

> *"CAMTI's mission is to direct federal and state government attention to the issues facing Michigan's tooling companies and affected communities. It will also advocate for legislative and regulatory initiatives that will advance their interests."*

The CAMTI website (www.camti.org) contains information on pending legislation, ITC committee transcripts, and dates of upcoming events that would be of interest to the tooling industry.

A report written in spring 2002 by IRN, Inc. for The Right Place Program (a regional economic development organization serving west Michigan) provides an overview of the industry issues and ongoing initiatives. The report, "*A Competitive Assessment of the Die and Mold Building Sector – A West Michigan Perspective*," provides a summary of issues based on research and broad perspectives gleaned from interviews with tool and die companies and industry experts.

C. Competitive Observations

A number of benchmarking studies have been conducted showing the cost and lead-time advantages Asian automakers have over the domestic companies. All the major Japanese automakers are recognized as having competitive or superior performance, and have had this advantage for many years. The Japanese companies are known for their efficiency and lean production methods, and better implementation of these practices will undoubtedly improve the competitive performance of North America companies (see section III.B Lean Practices). Lean design and manufacturing practices, along with new technologies in engineering and high-speed milling have greatly increased tool and die production capacity without any increase in labor hours or facility space.

These lean methods can be applied in North America. One North American tool and die operation indicated that they increased their capacity from the early 1990s to 2002 by 50% without any increase in additional resources, and that they expect a 25% increase to continue over the next few years. This result was largely attributed to implementing lean techniques, focusing on core competencies, and setting up the business as a production-oriented facility, rather than treating each job as a project.

There are several key distinctions between the Asian and North American markets that are important to understand. The Japanese customer-supplier model is different, and simply saying North American suppliers are not competitive is incomplete. A key aspect of the Asian relationships is that it evolves over the long-term as a formal partnership, and includes fine-tuning manufacturing and engineering around product expectations (we might refer to this as product design standards). The North American business model has evolved with suppliers competing against each other on every program, and any program could be very different from any past one. Although tools and dies could be taken by a North American supplier and produced by a Japanese source, it is not clear that it could be done more cheaply. In other words, because the Japanese OEMs and their supply network have fine-tuned their processes to be cost efficient for a specific product design standard, a Japanese supplier might not be able to generate Honda prices for tools from a domestic company's part design, since their processes are not fined tuned to the domestic company's design standards.

	Tool & Die Suppliers	
	North America	**Asia**
Product Design	Complex	Simpler
Tryout	Many presses and extensive experiences	Few presses and limited tryout
Functional Build	Organizational difficulties	Natural process
Engineering Changes	Many (complex designs)	Few (simpler designs and early manufacturing input)
Die Standards	Unique to OEM	Unique to supplier

Figure 4 – Comparison of Asian and North American Companies.

Some of the key differences that help account for the performance differences between Asian and North American suppliers are shown in Figure 4. As illustrated in Figure 3, there can be significant tooling cost advantages under the Asian model, and particularly in the case of Honda, that model was developed for the purpose of minimizing cost. However, in North America, the customer-supplier business model evolved differently with more complex objectives than focusing primarily on cost. Few would argue that in North America product design complexity for styling advantages tends to be a priority over developing simpler designs for the purpose of manufacturing simplicity. Consequently, more engineering changes tend to occur, and more extensive tryout is required. In general, the Asian supply model is not robust to implementing a large number of engineering changes during die construction, whereas the North American suppliers have had to learn to accommodate these disruptions. The streamlined Asian process has also been developed around dies with a single die design standard. All die construction processes (engineering, patterns, castings, machining, assembly and tryout) can be developed assuming a single standard, thus greatly reducing costs. Finally, the functional build method of accepting a die (dimensionally) provides a significant advantage over companies trying to make every measured dimension on the part conform to statistical criteria, e.g., Cpk > 1.33. Functional build is described later in this report (see section IV.D Functional Build).

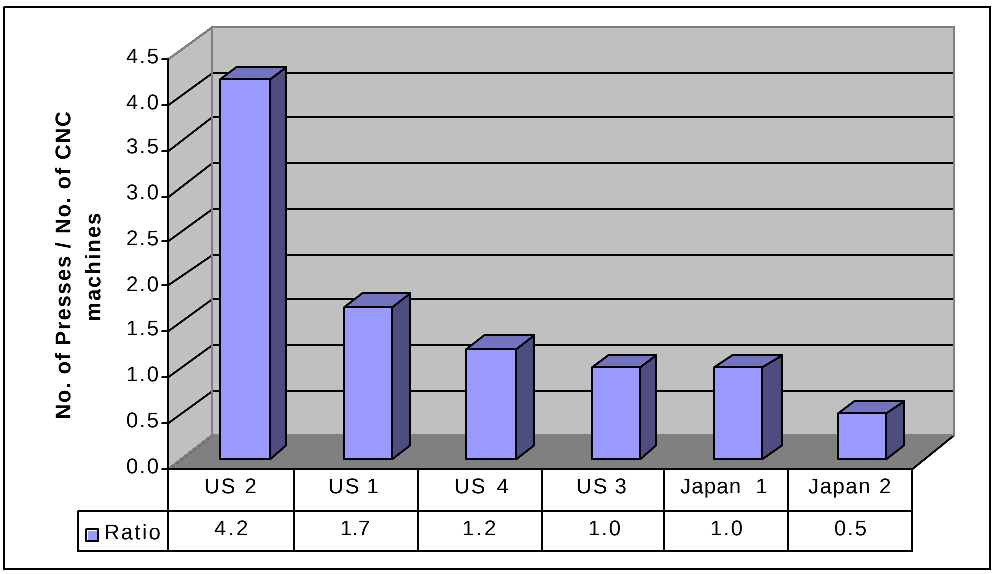

Figure 5 - Tryout Presses per CNC Machine Tool.

Benchmarking data collected for this report illustrates the difference in tryout between Asian and North American shops. Figure 5 shows for the four North American suppliers, the ratio of tryout presses per CNC machine tool varied from 4.2 to 1.0. For the two Japanese companies the range was from 1.0 to 0.5. Japanese die suppliers generally have less equipment to tryout at the die construction source because:

- Less tryout is needed (lower complexity parts and fewer engineering changes require implementation at the end of the process).

- More tryout is performed at the customer's location in the production press where more accurate re-work decisions can be made, and where other related parts can be compared for assembly using functional build.
- Tryout is not seen as a core business practice.

Related to cost is the amount of time the shops spend on creating dies (see Figure 6). Analysis of the benchmark data shows that the time it takes to complete a set of dies differs dramatically between the Japanese and the US companies. The Japanese take approximately 20 weeks to complete a die, whereas the US companies take approximately 35 weeks to complete a die (44%) difference. The Japanese take about the same amount of time to design dies and to procure castings (patterns and castings are 100% outsourced by everyone). The major differences are in the machining and assembly and in die tryout. The Japanese suppliers are approximately 60% faster than the US shops. The assembly speed is largely due to: elimination of assembly through die simplification (reduction in inserts and cams), design simplification, standardized processes, prepackaged assembly part kits (standard parts such as screws, hoses, etc. are prepared for the specific job elsewhere and ready when the assembly process is started). The tryout speed difference is largely due to the factors mentioned previously: lower part complexity and functional build.

timing (weeks)	US avg	Japan avg	% of US
Die design	4.6	5.3	-14%
patterns and castings	5.8	5.1	11%
machining and assembly	16.4	6.4	61%
tryout	7.6	2.8	64%
total	34.4	19.5	44%

Figure 6. Comparative Timing of Die Construction Steps.

There is no reason to believe that the North American tool and die technical capability is second to general Asian or European capabilities. There is also little question that lower cost dies can be sourced either by using the Asian model, or by sourcing dies to countries with very low labor costs. The challenge of sourcing complex tools and dies to low labor countries, e.g. China, is that they are just beginning to develop the necessary technical expertise, and the risk of failure would be high. An allegiance between a domestic supplier for difficult dies, and a low cost supplier in a developing country for simpler dies certainly has potential. Or similarly, a relationship where engineering is performed domestically and machining and assembly performed in low-wage countries has merit. A major concern, however, with both of these options is that over time the foreign partners will develop their own technical expertise at the expense of the domestic company. An alternative collaborative model proposed later in this report largely replicates the strengths of the Asian model within the constraints found in North America.

The domestic auto companies recognize the value of sourcing tools and dies to local companies. Cost related advantages of local suppliers include:

- Lower logistical costs (shipping, travel, communication, etc.).
- Better communication, which is especially important for complex tools and dies.
- More familiarity by the local companies with domestic requirements (design, tryout, die standards, etc.).
- Better able to implement engineering changes.
- Shorter lead and response time due to improved communications and shorter shipping times.

The domestic automakers, although pressed to reduce their costs, see both a technical and cost advantage to sourcing tools and dies locally. One industry manager indicated that the value, or premium associated with sourcing dies overseas in Asia could be up to 30%. In other words, everything else being equal, an automaker might be willing to pay up to 30% more to source a tool or die domestically rather than in Asia.

III. What the Tool and Die Suppliers Need to Consider

A. Business Practices of "Best" Shops

A recent study in Europe (see section VIII.C) surveyed approximately 50 T&D shops in Europe and South America to identify the characteristics associated with high performing shops. High performing T&D shops had a long-term record of steady workflow of profitable work. The five factors that had a high degree of correlation with high performing shops were:

- Companies had focused processes – they had clearly defined core competencies, out-sourced non-core services, and developed niche specialties. This extended to equipment selection, strategic sourcing partners, and careful commitment to strategic customers.
- A higher than average effort was extended to new jobs early in the production cycle. A higher level of project planning and engineering attention was applied before work made it to the shop floor.
- Companies practiced continuous improvement in planning and operations, with an emphasis on their chosen core competencies.
- Machine tool planning (setup and machining) and programming was rigorously developed using centralized resources. The attempt was to minimize reliance on shop floor personnel for this activity during periods when the CNC machines could be cutting metal (thereby increasing machine utilization).
- Highly motivated workforce – employees that enjoyed their work and cared about company performance.

The study found that companies that excelled at these practices experienced superior performance and efficiency. The performance of these companies averaged 25% shorter lead time, 35% lower labor content, up to 60% less time on the machine tools for dies, and a much higher percent of spindle cutting time. Hence, the dies are only on the machines while they are being cut instead of waiting on the machines while the machines are being programmed.

B. Lean Practices

Most T&D shops outside of Asia do not have close, dedicated, and collaborative relationships with their principal customers. T&D shops tend to be small, independent, and very entrepreneurial, either serving a broad customer base with multiple services, or providing a small niche product. Since the mid-70s, the North American T&D shops have evolved and become more sophisticated. The sophistication extends beyond technology; however technology still plays an important role.

Positive Attributes	**Negative Attributes**
• Effective project management • "Synchronous" process flow • Process specialization • Understanding of costs • Reduced need for paper (use of math-based tools) • High machine tool utilization • Blend of older and newer technology (e.g., machine centers and engineering) • Effective management of engineering change implementation • Identification and development of core competencies • Effective, centralized engineering function	• One or more operators assigned to one machine • High employee turnover • Too much time spent in final tooling tryout • Operators programming or re-programming machine tools when the machines should be running

Figure 7 - Factors Associated With Tool and Die Shop Performance.

The factors associated with T&D shop performance listed in Figure 7 were part of the benchmarking effort and derived from several sources including Big-3 interviews, Japanese and US T&D shop owner interviews, and industry research. The specific observations noted in the sections to follow are based on actual implementations and strategies seen at the most successful shops. Given the dynamic nature of the industry, T&D shops today have made progress with the positive performance factors mentioned in section III.A, or probably have not survived the current market pressures. All shops, however, need to continuously work toward the implementation of these lean practices.

1. **Project Management –** Effective project management has been recognized as one of the most significant developments at today's world-class tool and die shops, because it requires disciplines that instill a standardized managed workflow. The role of tool and die project management is to schedule resources (engineering, machine tools, assembly personnel, tryout presses, etc.) and plan for the timely execution of many tasks (including purchasing parts and outsourcing services). Many companies use software such as Microsoft Project Manager. The key to effective project management is having predictable events that can be planned. Reducing the uncertainty of events, like tryout or the unplanned engineering change is important, as well as having a system that is flexible enough (robust) to adapt to unplanned situations. Two measures of effective project management are efficient use of company resources and reliable prediction of completion dates. A part of project management is to effectively anticipate and manage engineering changes. The system must be able to process engineering changes without significantly deteriorating performance. Decisions about when to implement changes (immediately or batch until later) are key considerations.
2. **Synchronous Process Flow –** Synchronous process flow is consistent with effective project management. The term synchronous is used to suggest production-line style manufacturing for tools and dies. Tools and dies move through the shop in a production line fashion with all resources needed at every point in the process ready for the job when it gets to the downstream operation. Synchronous production requires standardized work, e.g., standardized bill of materials and resource demand at each work center. Certain design and production aspects of construction are standardized so that "bundles" of components are pre-packaged and ready for the tool. This maximizes off-the-shelf supply rather than re-engineering or special ordering parts when needed and, thereby, lowers cost. Although unplanned events, such as machine tool breakdown, engineering change, sick employee, etc., can disrupt synchronous flow, the manufacturing process needs to be designed to be robust to these events, which will occur, even though their frequency and timing is uncertain.

Value stream mapping is one technique that can help identify and eliminate bottlenecks in the process flow. One technique to move an operation toward a production orientation is to begin measuring and managing the shop floor based on throughput of dies. The unit of production measurement is, "dies produced," rather than the more traditional perspective of selling hours of capacity. This significant distinction requires die design/production standardization and will help maximize capacity. For example, one US shop has doubled their capacity in terms of dies produced without increasing their available labor hours. They implemented lean practices that targeted the number of dies produced.

3. **Process Specialization** – Process specialization is also consistent with synchronous flow in that different individuals in the shop become specialists in their job function. This is again analogous to the production line where each operator has a specifically assigned task. The old model with a craftsman toolmaker, which often was the project manager for his/her die, is obsolete. The toolmaker skills, while still very valuable, should be focused toward the engineering and problem solving part of the process. Other individuals should focus on their respective specialties, such as project management (which includes scheduling), engineering design, machining, machine tool programming, setup, tryout, etc.
4. **Understanding of Costs** – Several OEMs indicated that they believe that the T&D shops do not recognize their cost structure, leading to sub-optimal business decisions and non-competitive quotes. A typical approach taken by a shop is to develop an hourly rate for a collection of services and use the rate to quote a job. This rate might, for example, aggregate several costs (including machine tools, computer software, etc.), and assign an hourly rate based on the labor hours involved, irrespective of the capital equipment involved. Suppliers with a broad range of capabilities (e.g., full-service supplier) have a complex cost structure that demands closer scrutiny. The activity-based costing (ABC) approach has been recommended for businesses with a complex range of equipment and services. ABC is an accounting method for allocating overhead charges based on an equipment / space / overhead resource leasing per unit time concept. This also supports lean initiatives, as ABC is much simpler to implement if there are standard work times and the

infrastructure is in place to monitor the time of each operation. With ABC, the company can better evaluate the economic viability of certain assets and make better decisions regarding:

- developing quotes,
- upgrading capital equipment and technology,
- expanding capabilities (e.g., into engineering, tooling repair, prototype development, tryout, etc.), and
- focusing on cost reduction opportunities.

5. **Reduced Paper** - The trend toward the paperless factory is prevalent in the T&D business. Few, if any, shops have totally eliminated paper on the shop floor, but all competitive shops have eliminated much of it. State-of-the art today is to have 100% electronic data beginning from process design through cutter path generation, and similarly for all die processes through CNC machining. Various technologies such as SMIRT software (www.smirtware.com) have helped, which allow personnel to interrogate design files or CNC programs directly through a computer. Perhaps more important than eliminating paper itself, the paperless shop floor is indicative of a lean, synchronous shop floor without the need for chronic problem solving.
6. **Machine Tool Utilization** – Overall manufacturing efficiency is heavily correlated with percent of spindle cutting time on the machine tools. Unfortunately, most U. S. T&D shops do not formally measure their machine utilization. Some companies measure machine tool utilization by including setup, run time, etc. Estimated machine times ranged from 60% to 85%. However, "lean" companies rigorously measure their machine utilization emphasizing spindle cutting time. High performing shops strive for spindle cutting time in excess of 90% of machine time (less preventive maintenance). One Japanese shop had an average annual uptime of 87.9% on their 3-D milling machines and 79% on their 2-D milling machines. Factors contributing to a high spindle cutting time include standardized locators for quick load and unload of the work piece/jig, debugged CNC machine programs prior to changeover (e.g., using simulation or other methods for validation), preset tooling, and load/unload pallet automation. Average die changeover times in the US range from 0.5 to 4 hours. In lean shops they range from 18 minutes to 1 hour.

7. **Technology –** Companies need to stay current of the latest manufacturing and engineering technologies as appropriate. This includes the judicious use of such manufacturing technologies as high-speed cutting tools, laser welding, CAD/CAM technology, and engineering design and simulation tools. When effectively applied, machining centers can achieve 24-hour operations with an operator to machine ratio from 1:2 to 1:3. The US companies typically have 1 person per machine and are moving towards 0.5 operators per machine. The lean shops have fewer than 1 per machine and operate some machinery unmanned at night. Engineering design tools are evolving where excellent product feasibility analysis is becoming standard, and spring back prediction is improving. Simulations are extending to manufacturing simulations of dies in the production press, taking into account material handling automation and scrap metal removal. Automakers use this information to maximize production speeds, and they are beginning to expect tool and die suppliers to share in this responsibility.
8. **Development of Core Competencies –** Many tool and die shops actually provide a subset of products and services from a broad range of possible ones, for example:
    - Tools
    - Dies
    - Fixtures
    - Patterns (for castings)
    - Engineering design (tools and dies)
    - Feasibility engineering (product design)
    - Tooling tryout
    - Prototype development
    - Production launch support

    Some "full service" suppliers provide many or all of these services along with many more. Although the full service supplier offers many advantages in some circumstances, particularly when fast turnaround is required or when a customer lacks industry knowledge or ability to manage many subtasks, the concern that is raised is whether or not a supplier can be competitive with all these services at the same time. Without specialization, some of these capabilities may come at high costs because of sporadic utilization and experience – a further reason to consider activity based costing analysis so as to determine the cost of non-fully utilized assets. Some suppliers can become more competitive by developing “niche” capabilities from a subset of this list. Although there is a clear need at times for a full service supplier, many world class companies specialize in fewer areas so that they will always be recognized as an industry leader with a few critical capabilities, rather than a generally good supplier of many capabilities. Process specialization includes having strategic suppliers that can execute operations either more efficiently than the primary shop (perhaps with lower labor costs, etc.), or can readily handle simpler operations, like 2-D machining, reserving the more critical operations/capacity, like 3-D machining, where there may be a competitive advantage at the primary shop.

9. **Centralized Engineering –** It would be difficult today to compete in complex tool and die construction without a major emphasis in a central engineering function. Centralized engineering is consistent with reducing (or eliminating) the craftsmanship approach of tool and die making on the shop floor. Although most auto companies would like to see the need for sophisticated engineering design to decrease and let die sourcing compete as a commodity from labor costs, the intellectual content in tool and die is one of the unique attributes of this product; so developing this capability is important. For example, one Japanese shop has the strategic goal to minimize the assembly function by reducing the number of steel inserts, eliminating cams, and utilizing standard part kits. These latter steps are all a function of the specific die design. Hence, the strategic goal can only be accomplished by having a strong die engineering function.

IV. What the Tool and Die Customers Need to Consider

The domestic auto companies wish to reduce the tooling cost disadvantage they experience with their Asian competition (e.g., refer to Figure 3). A significant reduction in costs will require a joint effort between the T&D shops and the auto companies. Granted, the T&D shops can more broadly implement cost reduction initiatives that will contribute to reducing total costs as outlined previously, but many opportunities require joint cooperation. The requirements in terms of die standards and die components, quality certifications (ISO and QS standards) and performance requirements including dimensional objectives and the production validation process (such as the production part approval process or PPAP) all contribute to higher costs, leading some to argue their value.

Most industry experts do not refute the assertion that the product designs of the domestic automakers are inherently more difficult to produce than those for the Asian auto companies. Consequently, there is less carryover of design and manufacturing knowledge, and the sourcing relationships have not encouraged the development of standardized practices or recognized the "total system cost" in launching a new vehicle. Total system costs in this case include tooling related performance factors such as:

- Capital tooling cost (for all dies, fixtures, assembly tools, etc.)
- Tooling design and engineering
- Tooling tryout and production validation
- Implementation of engineering changes
- Product launch effectiveness (ramp up speed and quality)

Past practices have emphasized reducing tooling costs by focusing on individual tooling quotes (typically by bidding one supplier against another), which likely shifted costs to other areas in the total system. There are several areas of collaborative opportunity (between the auto companies and tool and die shops) where improvements can greatly reduce the total system costs associated with tooling.

A. Collaborative Product and Process Engineering

Closer communication between product design and the tooling suppliers can significantly reduce complex problems that do not affect the product design features important to the final customer. Tool and die engineers have in-depth knowledge about tooling design that can be brought to bear early in the development process. Closer communication and earlier involvement would allow tooling engineers to identify manufacturing concerns related to part interface features (e.g., flanges) and forming issues that affect die lineup (number and complexity of die operations, blank die design, and material utilization) without changing the exterior part appearance. This level of involvement will help offset later engineering changes from process design, and help prevent program delays.

B. Development of Analytical Design Methods

The auto companies and all major tool and die suppliers have a significant investment in software and technology to support die design. Forming software to analyze feasibility and draw die development is very effective. Many more advances are needed in the rapidly changing field of spring back prediction, particularly given the rapid introduction of new materials (e.g., numerous high strength steel varieties and aluminum), which often have a higher degree of spring back compared to standard mild steels. Most companies, both auto and supplier, consider their knowledge in these fields proprietary and often do little to support co-development. A closer collaboration in developing these analytical methods, and then supporting their use early in the product development process will reduce downstream engineering changes due to product complexities, and accelerate the tool build and tryout process, resulting in higher manufacturing productivity.

C. Lean Die Standards

There are a number of die construction standards used by the domestic automakers. Some standards are unique to the facility where the tools will be put into production. Many standards are also developed that "over engineer" the dies to compensate for manufacturing negligence, e.g., poor press maintenance or process control discipline such as loading two blanks in the draw die. There are also aspects of the die standards, which differ between auto companies that are not designed to provide anything unique, but help contribute to higher costs. Auto companies and tool and die suppliers have agreed that a coordinated effort could produce substantial savings by re-evaluating the multiple die standards and rationalizing an approach to reduce the number of standards. The number of variations of die components could be reduced, and building dies to the required standards could be simplified. Some of the Asian lean die standards have included:

- Reduced bearing surfaces
- Fewer wear plates
- Using smaller dies as appropriate for the part rather than for the press
- Using fewer die inserts and flame hardening surfaces
- Less finishing on non-show panel dies

Some of the lean die standards require significant internal advancements by the automakers first. For example, lighter dies will require well-maintained presses. "Right-sizing" dies (e.g., making the size of the die match the size of the part rather than a press) requires an internal press replacement / adjustment / maintenance strategy that can be expensive and long-term before implementation.

D. Functional Build

Numerous studies have been conducted at tooling tryout sources (die shops) and stamping facilities that have shown that very few parts throughout the industry meet all of their initial dimensional specifications set by design (see Auto/Steel Partnership for reference reports). Larger, more complex parts tend to experience this problem more, and the same observation is true for European and Asian auto companies as well. Researchers at the University of Michigan have estimated that 50% of stamped parts at domestic automakers have never passed the production part approval process (PPAP). Further, it has been shown that most of the parts that have not passed PPAP, and therefore are out of specification, still result in assembled bodies that are within specification. This is an indication that the assembly process is insensitive to the incoming part variation, and that many part tolerances are tighter than necessary.

In North America, the conventional process to buyoff dies has required the suppliers to continually rework dies to get the dies as close to design intent as possible (Cpk > 1.33). Then when the deadline to ship the dies approaches, engineering evaluates what else must be changed with the time that is left. In effect, the full development time is used in an attempt to create "perfect" parts. Then the process is repeated when the assembly process is validated (see left hand side of Figure 8). However, studies have shown that 50% of parts are accepted as less than perfect due to deadlines. This imprecise process is deadline driven (forcing many dies to be late) and results in the tooling supplier making many die changes during tryout to create a perfect part that will not necessarily improve the final quality of the assembly.

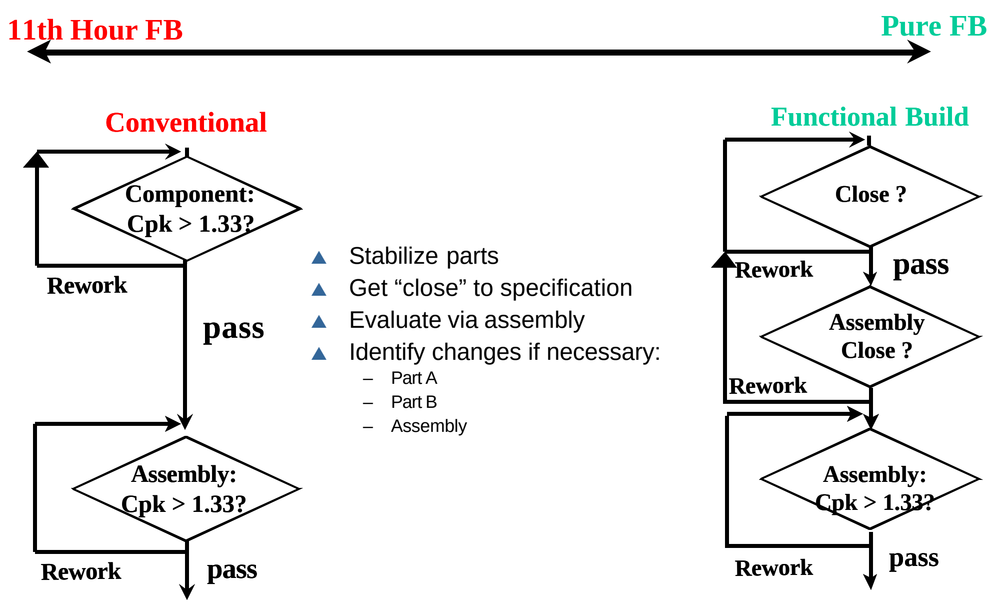

Figure 8 – The Functional Build Continuum.

The functional build process acknowledges that stamped parts do not have to be dimensionally "perfect," yet can still assemble into an acceptable assembly. A development process that recognizes this early during tryout does not wait until time runs out to make the final buyoff decisions. Instead it creates assemblies during the pre-launch phase to evaluate whether parts result in acceptable assemblies, even if they are not within specification. These pre-launch assemblies are usually built on special functional build fixtures, since the production assembly tooling is often not yet available. Hence, there is a two phase approval process. First, the parts are checked to determine whether they are close enough to specifications (often 2x or 3x the specified tolerance) that they will result in a good assembly. If not, then the dies are reworked. Then the functional build assembly is evaluated to determine whether the assembly is close enough that it will result in an acceptable assembly in production.

If the functional evaluation assemblies indicate a potential problem, then a decision must be made between the following options:

A. Rework the die of the part that is not within specification
B. Rework the die of the mating part (that may or may not be within specification)
C. Adjust the assembly tooling

Traditionally, option A would be the only choice possible, since the part is not within specification. Functional build argues to do that which is most expedient in terms of time and cost. Often this is option C. In this manner, only those features that affect the assembly quality are reworked, even if other features do not meet specification. Generally, there are rigorous and statistically based acceptance criteria to ensure a justifiable level of risk.

Since either strategy (conventional or functional build) ultimately relies on evaluating the build-up of the assembly instead of the individual parts, both are considered a form of functional build. However, the conventional strategy is called 11th-hour functional build, and the former strategy just functional build or pure functional build (see Figure 8). The 11th-hour functional build process suggests that when die makers meet their timing deadlines (which they almost always do because achieving Cpk is so difficult), then they revert to functional build in a desperate attempt to get things to work (i.e., do "whatever it takes") at the factory.

The strategy to implement functional build has been pursued to some extent by all of the domestic auto companies, but with limited success. The major barriers to its successful implementation tend to be more organizational than technical. The tooling suppliers, in general, strongly support implementation of functional build. Regardless of whether the execution is controlled by the auto companies or by the tooling suppliers, substantial lead time and quality savings could accrue if it were more widely practiced.

V. The Collaborative Business Model

A. Objective

The objective of the collaborative business model approach is to provide a more competitive selection of tools, dies, and related services than any single tool and die supplier could offer individually. Through collaboration, the capabilities of the suppliers will continue to improve, perhaps evolving such that certain suppliers will develop specialty areas of expertise where they will become recognized as world leaders. The intent of the collaborative model is to encourage long-term relationships between a range of suppliers (with both overlapping as well as unique capabilities) and their customers. The principal benefits of the collaborative approach are:

- It is consistent with recent trends by the domestic automakers to outsource large "chunks" of the body structure; an approach already used when dealing with foreign tooling sources. A coalition of collaborating companies can manage the full range of products and services for a new vehicle including project management, engineering, prototype development, tooling construction and tryout, and launch support. A tooling coalition can be designed to manage the volume of work associated with an entire body structure or substructure.
- The collaborative model supports the total systems approach, thus avoiding shifting costs and problems from one part of the process to another.
- It promotes the development of niche specialties by suppliers. There are many small shops with narrow, but deep knowledge on various aspects of tool construction. These small suppliers have difficulty competing on large programs where broad capabilities are needed. These niche shops can better compete in their technical area if they are a part of a larger coalition of companies.
- It better supports the implementation of functional build. The nature of functional build is to identify the lowest-cost solution to quickly fix problems.

Many times the best solution is in another area of the process (e.g., change a simple part to correct a difficult problem in a complex part).

The size of the domestic tool and die supply base is likely to continue to contract as the worldwide capacity continues to increase from new shops in developing countries and significant productivity gains at existing shops. The collaborative coalition model provides a mechanism where the most capable shops have a better chance of competing. A competitive domestic tool and die supply base will enhance the competitive position of the domestic auto companies, which is the key to sustaining the domestic business.

Since the collaborative business model advocates a total systems approach for engineering, construction, and customer support for new tooling programs, the performance metrics should be adjusted to recognize this broader perspective. The old metrics were heavily skewed toward initial tooling cost, which is still understandably important. However, companies operating under a collaborative approach should be evaluated for additional performance measures such as:

1. **Total tooling cost achievement relative to budget**. The total tooling cost should include costs due to engineering changes since the collaborative approach should help reduce the number of required changes and manage how they get implemented.
2. **Percent of parts that pass production validation (PPAP) according to schedule** (100% goal).
3. **Launch rate**, particularly for measures about body quality, such as time required to achieve six-sigma quality for the body-in-white.

Two levels for the collaborative business model are presented below. The first level, <u>Tool and Die Coalition</u>, combines the resources of several tool and die shops and builds a collaborative model amongst the shops along with their customers. The second model is the <u>Integrator Coalition</u>. The integrator approach further broadens the scope from the tool and die shops to include complementary businesses, such as product engineering and assembly weld tools.

B. Description of Tool and Die Coalition

The range of products and services offered by tool and die shops is widely variable. Most shops offer a basic range of capabilities including prototype development, prototype fabrication, die design engineering, die construction and assembly, and preliminary tryout. On one end of the spectrum there are shops specializing in one or more of these activities; and on the other end exist "full service shops" offering all these capabilities and sometimes more.

The scope of capabilities of the tool and die collaborative business model exceeds what is typically offered today, even by a single full service company. For example, providing program management to support the development of multiple tooling projects across several suppliers. Another critical activity is early product design support, especially checking for product feasibility issues and identifying part design alternatives that do not affect part appearance in the body, but improve manufacturability, can be very important to reduce costs and head off future engineering changes. Additional services at the end of the tool making process include support for functional build evaluation and process launch support at the customer's facility. Figure 9 shows this range of possible supplier services from which a customer may choose for a given program.

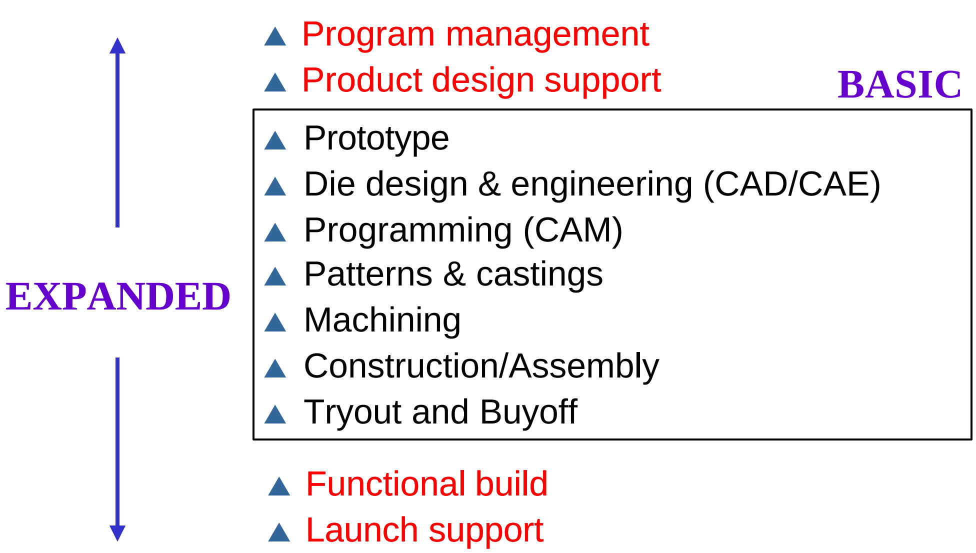

Figure 9– Basic and Full Service Coalition Capabilities.

The expanded capabilities that are not typically handled by full service shops are coordinated program management responsibility and functional build. Coordinated program management extends the shops' reach both upstream and downstream from tooling construction, and can often include services and tools from other tool shops. Program management improves communication and scheduling coordination. Modular functional build (FB) involves sourcing groups of components (e.g., all panels that go into a single subassembly like a door or body side) and allowing the supplier to make tryout rework decisions based on how well the panels fit together (rather than making independent, isolated decisions panel by panel). The value of these services increases as the coalition responsibility increases to multiple modules, and the coalition approach expands the breadth of the group to handle multiple subassemblies on a program.

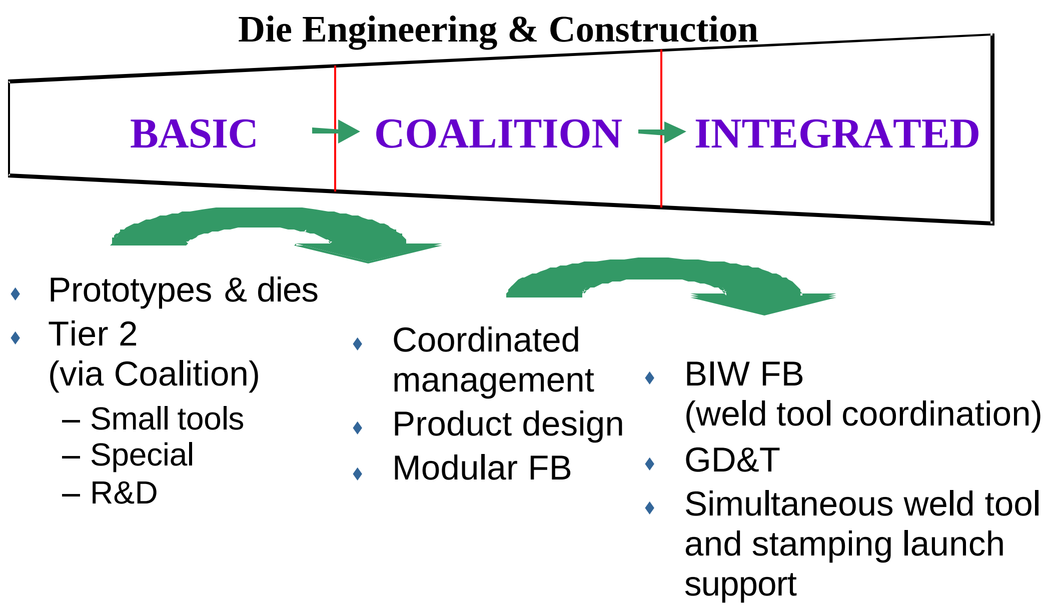

Figure 10 – Evolution and Expanding Role for Tooling Coalition.

Figure 10 illustrates the evolution toward expanded collaboration beginning with the basic tool and die supplier. The basic supplier provides dies and generally outsources other related activities. The expanded, collaborative supplier provides dies, but also provides coordinated management, early product design, and executes modular functional build. The highest level of collaboration extends the tool and die supplier into body-in-white functional build (beyond just the modular level), gets involved with product design (geometric dimensioning and tolerances), and provides simultaneous launch support for assembly processes and stamping. These capabilities are not resident at the tool and die shops, but require an approach involving additional expertise as described in the integrator model.

Very few, if any, single suppliers have the capacity to offer the expanded range of products and services in Figure 9 for a major portion of a vehicle body. However, a coalition of tool and die shops can be formed that, in aggregate, does have the capability and capacity to handle large sections (if not an entire) vehicle. The conceptual organization shown in Figure 11 illustrates one approach for assembling the tool and die shops.

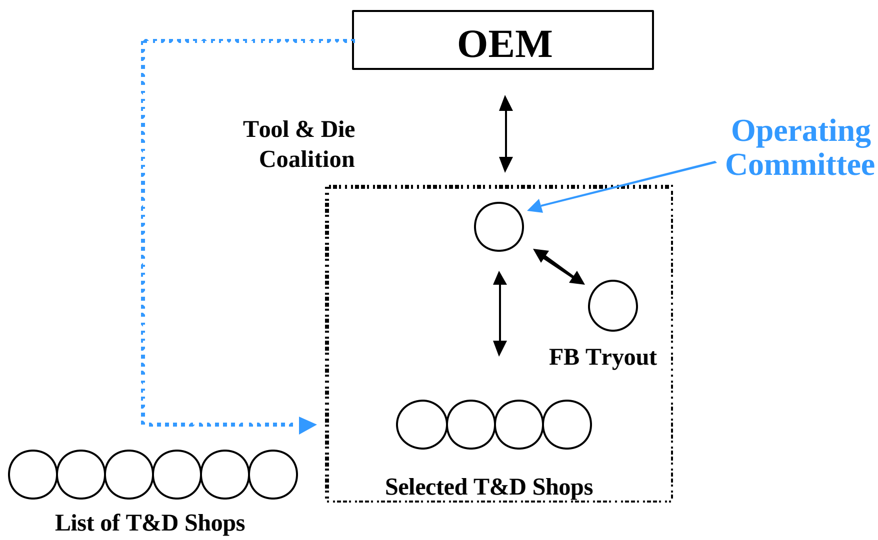

Figure 11– Tooling Coalition Organization.

The schematic in Figure 11 shows one possible collaborative model to support a broad range of products and services for a major vehicle program. Although a coalition might assemble the multiple organizations into a coalition before bidding on a project, the customer (OEM in this case) may wish to select the specific suppliers they wish to have included or excluded based on their past experiences or other motivations. The coalition has to allow for the flexible entry and exit of T&D suppliers. Figure 11 shows a candidate list of loosely aligned suppliers outside of the dotted box. From this list, the customer chooses the specific suppliers to include in the program. The coalition may also include a functional build tryout group that evaluates panel buyoff decisions affecting everyone in the coalition. This may be part of or separate from the coalition, depending upon the customer's wishes.

The "operating committee" serves as the principal interface with the customer, i.e., the single point of contact. This is viewed as one of the great advantages to the customer, as the customer no longer has to manage multiple T&D shops with multiple points of contact; the management function is handled by the operating committee. Generally, the organization of the operating committee would include a senior program manager that integrates program schedule information from the supplier shops, and coordinates activities across the group of companies. The senior program manager may also be involved in negotiating engineering changes that affect dies at the various shops. Another potential member of the operating committee is an independent monitor that helps to facilitate the coalition, monitor it for competitiveness (including benchmarking the competition), and provide a mechanism for recommending system improvements both to the customer and to the tool and die shops. Figure 12 summarizes the key roles embedded in the operating committee.

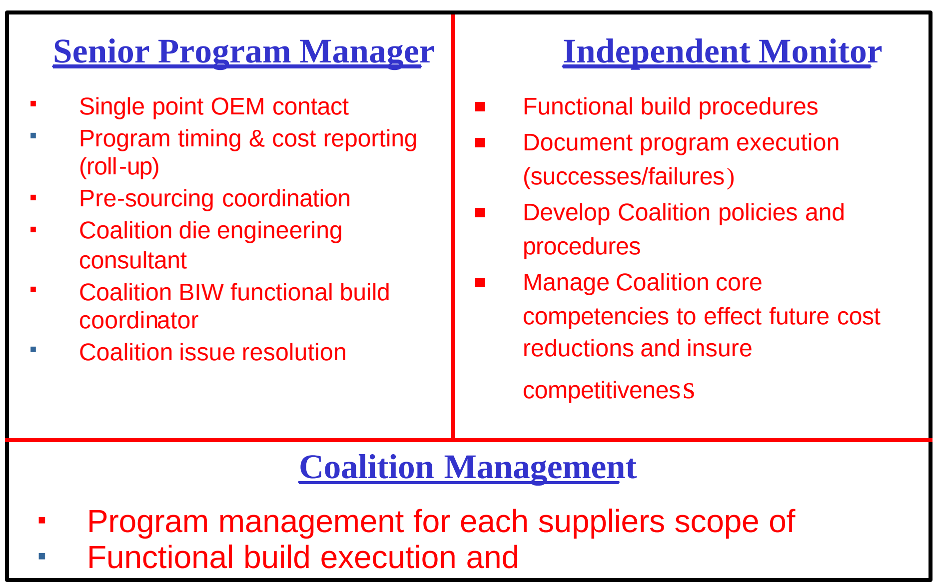

Figure 12 – Organization for Tooling Coalition Operating Committee.

C. Integrator Coalition

The integrator coalition model expands on the tooling coalition model to include other complementary functions, and offers the highest collaborative capabilities shown in

Figure 10. These activities are often associated with Japanese techniques that focus more attention on the manufacturability of the part designs and assessing the manufacturing process capability during the development process, rather than relying on initial engineering assumptions. The three key activities that the integrator model is intended to address are:

- **Body-in-white functional build**. The coalition model described above addressed the functional build benefit of evaluating parts at the subassembly or module level. For example, the coalition would be able to make decisions regarding changing a door inner panel, door outer panel, or reinforcement to guarantee an acceptable door assembly. A higher level of functional build can be achieved through the integration of modules. For example, the integrated coalition would be able to make decisions regarding changing a door assembly (and all its associated parts), body side, or the assembly process to guarantee that a door fits correctly the body side opening.

  The integrator model would be involved in a program pre-launch phase further "upstream" in the development process than tool and die shops normally participate. A product development process (timing and schedule of events) can be designed to include body-in-white functional build with significant improvements in lead-time, quality, and cost avoidance by eliminating unnecessary tooling rework often performed early in the process "just in case" it could cause a problem later downstream (see section IV.D Functional Build).
- **Product design**. The traditional North American design approach assigns numerous dimensional requirements to reduce the risk that a part meeting those requirements will fail. The extension of this approach is to tighten these requirements (reduce the tolerances) to further reduce the risk. Unfortunately, as the requirements increase, the manufacturing cost and lead-time for the associated tooling also increases. Incorporating more manufacturing understanding into the product design phase (i.e., with T&D shop and assembly tooling process knowledge) would improve the manufacturability of

the tooling and reducing cost and lead-time without any sacrifice in product quality.

- **Simultaneous tool and die and assembly tooling process validation**. Just as applying functional build at the module level reduces overall tool and die costs, incorporating the assembly tooling into the decision process further reduces cost and lead-time. Although it is feasible to validate the dies first and then move on to validate the assembly tools, the process would be faster and lower-cost (avoiding die rework) if the two processes were validated together.

Tool and die shops would need to team with other industry partners to assemble the collaborative integrator business model. An engineering company with product design capability and knowledge of product launch issues and management is needed. This company would likely be assigned as the lead organization for a program, helping to manage the tooling suppliers (dies and assembly weld tools). The tool and die shops would collaborate using the tool and die collaboration model described earlier. Another coalition of companies would include one or more assembly tool shops. Similar to the tool and die coalition, the assembly tool shops would likely form a partnership or coalition to provide the tooling for the body shop (see Figure 13).

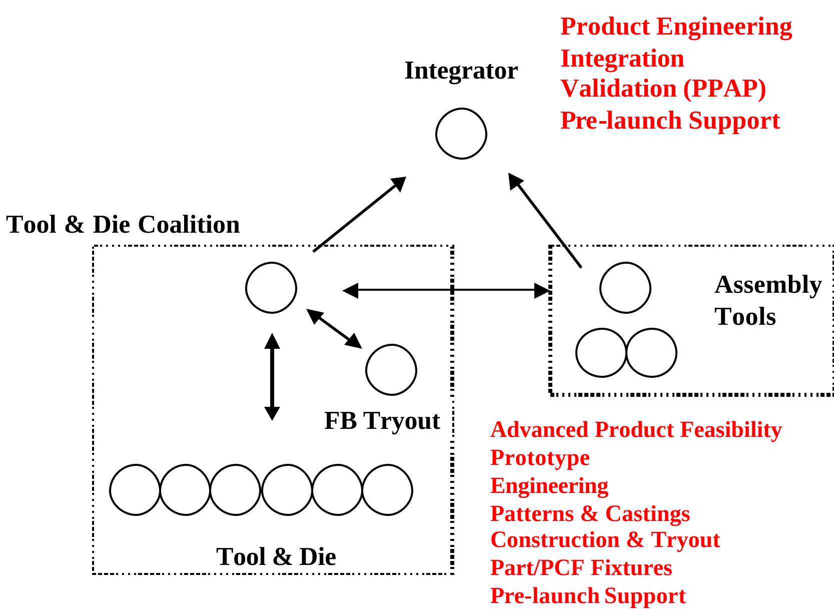

Figure 13 – Integrator Collaborative Model.

D. Synergistic Benefits and Cost Impact of Collaborative Model

The general collaborative model, whether for just the tool and die shops or for the integrator participants (engineering company and assembly tool shops), is shown in Figure 14. This figure illustrates a "pool" of companies with complementary products and services that can be drawn into a particular project based on the project demands and/or based on customer requests. In this fashion, the model does not discriminate as to who can join the coalition membership. Potential candidate companies include the die builders, mold builders, assembly weld tool companies, part checking fixture shops, and engineering integrators. In the event of an automaker wanting to source production as well, a stamping company may also wish to be included in the coalition. The organizational makeup and composition of each project team would depend on the customer.

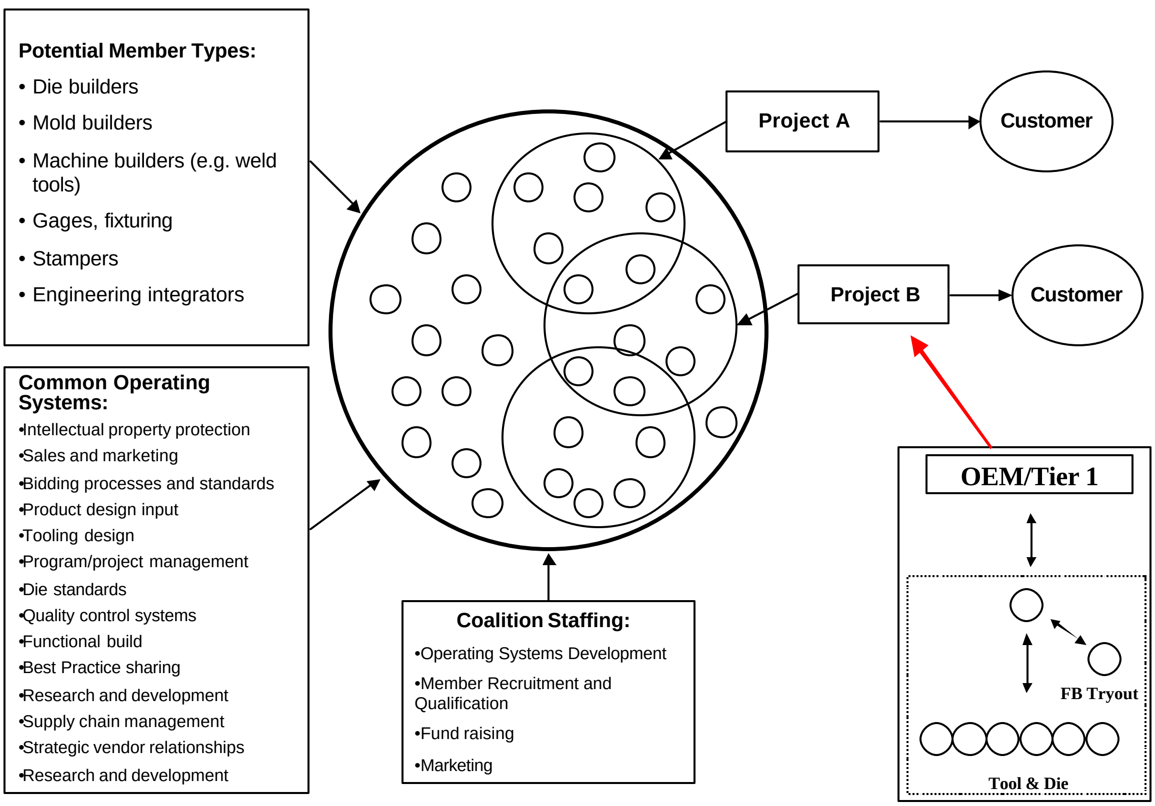

Figure 14 – General Collaborative Coalition Model.

The cost-saving benefits of the collaborative model are significant. The immediate short-term savings on tools approach 40%! The savings are shown graphically in Figure 15. These savings are accrued from the following areas.

A. **Manufacturing and Engineering Efficiencies – 10%**

Discussions with tooling companies have indicated that efficiency savings by implementing lean practices (discussed earlier) can save 10% (this number varies by shop). Implementation is not necessarily tied to the collaborative model, but implementation by working with a coalition would greatly improve the efficiency and effectiveness of implementation through the sharing of lessons learned and simply the understanding of how quickly others are moving on their adoption of lean practices.

B. **Coalition Efficiencies – 5%**

The efficiency of coordinating work amongst the coalition of companies, sourcing work to more efficient companies within the coalition, and balancing workload where capacity is available will save another 5%.

C. Product Design Input – 10%

Identifying early design issues that could complicate manufacturing later on, and proposing design changes will result in reducing die engineering effort, tryout, and possibly engineering changes. The costs associated with these efforts are estimated to be 10% of the tooling cost.

D. **Lean Tool Standards – 5%**

Current tool design standards are not as cost efficient as they could be. Identifying tool design standards that drive up cost, and recommending alternative approaches will reduce tooling costs by 5%.

E. **Functional Build – 10%**

Effective implementation of functional build will reduce tryout time and tooling rework, thereby reducing tooling costs by about 10%. The savings increase on larger more complex parts and is less on smaller, simpler parts.

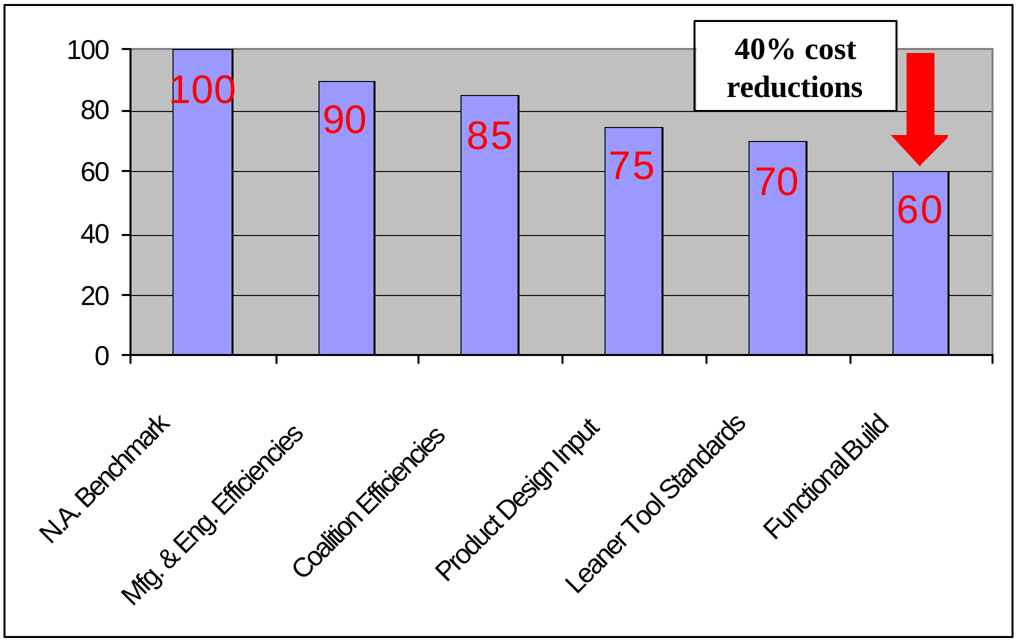

Figure 15 – Cost Reduction Opportunity Through Collaboration.

In addition to the purpose and benefits of the coalition discussed earlier, there are a number of synergistic opportunities, including:

- Sales and marketing efforts.
- Development of standardized processes for bidding and resource deployment including functional build procedures and methods.
- Development of tooling standards.
- Standardized project management methods and software.
- Improved utilization of coalition resources (e.g., engineering workstations and personnel, machining equipment, pattern shops, tryout presses, etc.).
- Improved ability for small, niche shops to develop their expertise and still compete successfully on larger programs that would otherwise be beyond their ability.
- Financing resources and leverage for volume purchasing of standard components.

E. Implementation Issues of the Collaborative Model

There are a number of implementation steps to the collaborative business model, some with many possible solutions. The list below, although far from exhaustive, identifies some of the key issues in assembling the collaborative model.

- **Tool and Die Collaboration** - Building trust and open communication between companies, who are otherwise industry competitors, is difficult and requires the involvement of a neutral third party. The coalition of companies needs to agree on a common mission, vision and operating principles. Further, the coalition needs to develop a business plan that outlines current capabilities, needed capabilities and growth areas, research and development, marketing, etc.
- **Operational Decision Making –** Many sensitive business decisions are required including ownership structure, governance, staffing, and membership (the process of how companies are allowed to join). The bidding process when multiple coalition companies desire the same piece of work needs to be managed within anti-trust regulations.
- **Internal Sourcing –** The process of sourcing tools and services within the coalition is critically important to be fair, avoid anti-trust guidelines, and still promote the development of niche players (recognizing that some companies are superior to others in some areas.) Ideally, certain suppliers would be identified as the preferred supplier because of their technical capability, but this is difficult and can violate anti-trust laws. One approach is to use an independent facilitator that can help identify appropriate sourcing, perhaps using customer input. A heuristic (formula) that achieves the desired result fairly (strives for the lowest cost while maintaining a profitable coalition enterprise) is one approach.
- **Anti-Trust –** Companies have to be concerned about sharing cost and pricing information with companies that are otherwise competitors. The coalition can demonstrate that their collective businesses offer a competitive product that justifies the collaboration, but the communication of certain information must be managed. (See Appendix for a sample Anti-trust Guideline for the coalition.) Individual companies still retain the right to intellectual property in their field of services.

- **Finance (internal and external) –** Internal financing decisions and identifying the control and flow of capital is important. Many shops would prefer to have a purchase order directly with the customer. But this would result in multiple purchase orders and tend to weaken the single-point-of-contact management. A mechanism is needed that allows for coalition-level decision making when a decision is best for the whole, but perhaps not for an individual company. One such possibility is a central pool of funds to support cost and revenue sharing. Lastly, most companies have their own external financing relationships, but the coalition might consider developing a coalition-specific source for capital.

F. Recent Experiences with the Collaborative Model

The Center for Automotive Research (CAR) at Altarum has been working on the collaborative model for the past year. Many of the observations in this report were developed through experiences gained in developing the model in close cooperation with several die shops and with the input of the domestic OEMs. CAR was chosen as the independent facilitator because of its knowledge of the industry, its reputation in the industry, and its access to OEM management for seeking guidance.

The coalition calls itself the US Tooling Coalition (USTC), and the member companies are:

- American Tooling Center
- Atlas Tool, Inc.
- Autodie International
- Hercules
- QMC Die Tech.
- Riviera Tool Company
- Ronart Industries, Inc.
- Sekely Industries
- Thunder Bay

Besides the comments made in previous sections, the basic necessary elements for creating a collaborative organization were present amongst this group from the beginning. First, the die shops had already communicated with one another prior to approaching CAR for help in forming the coalition. Hence, they had the understanding that cooperation was necessary for survival, and the desire to cooperate. Second, with the addition of CAR to the group, the intellectual capital necessary for the coalition to work, i.e., functional build, digital technologies, lean manufacturing, tooling know-how, etc. fell into place. Third, the coalition concept was consistent with the customers' business direction of working with fewer companies and developing the so-called tier 0.5: engineering through turn-key startup (launch support). Lastly, the coalition was able to identify the initiatives necessary to reduce costs and make the coalition cost competitive (see section V.D. Synergistic Benefits and Cost Impact of Collaborative Model).

Once the coalition had developed a workable plan, several other companies, such as product engineering and assembly tooling suppliers, approached the USTC indicating that they were willing and eager to work with the coalition in preparing competitive bids to the OEMs.

CAR's primary role has been to act as a neutral, independent participant, helping to create a dialog between competitors, technology partners, and their customers. Through interviews with the OEMs and the die shops, CAR identified several critical areas for improvement, including communication between the customers and the suppliers, antagonistic relationships that had developed, in part, due to the poor communication, and cost reduction opportunities.

Another major responsibility for CAR was the creation of the quote to a customer. The reason was the sensitive nature of individual shop quotes used to create the coalition quote revealing the cost structure of the companies. Hence, CAR was the neutral entity to collect the various cost information and develop a heuristic on how the overall coalition quote would be established, and how the various dies would be distributed amongst the various coalition members. The process did raise concerns over the members' varied pricing strategies, and the heuristic was adjusted several times to accommodate those differences.

The response by the OEMs has been varied, but generally positive. One of the OEMs is very supportive, entertaining a coalition bid on a vehicle program, and working with the coalition on developing a program of long term cost reduction initiatives. Another OEM is very interested in the coalition concept, especially if the coalition can demonstrate immediate cost reductions, as opposed to long term cost reductions. They are also willing to consider the broader integrator coalition approach. The third OEM is supportive of any new strategic concepts and has shared various experiences and suggested new business opportunities it would be willing to entertain, if presented by the coalition. Hence, each OEM sees the benefits of the coalition and is willing to enter into a collaborative relationship, albeit of a varied nature, to reduce costs. This is an indication that the coalition can provide the lower tooling cost of the Asian model, while maintaining the flexibility of US model, namely the ability to work with the different engineering and business systems of the US OEMs.

There are still challenges remaining. For example, it takes extra time and effort to coordinate and balance the multiple priorities of the coalition. This becomes especially critical near the submission deadline of a quote, because the OEM can add or change demands on the format and content of the quote. Under such tight time restrictions it becomes difficult to communicate with everyone and obtain a consensus decision.

The ultimate question will be: was it worth it? In the coalitions view, there are not many other options. The business climate is changing, and the industry is consolidating. Customers expect a lower-cost supply chain, which can only occur through cooperation both up and down the supply chain as well as across the supply chain. In other words, suppliers must cooperate with their customers, suppliers, and competitors. The impact of this effort will be long term and will change the way automobiles are built.

VI. Conclusions and Recommendations

The current economic problems facing the tool and die industry are significant, and are considered to be different from previous economic downturns, because there is a fundamental change in the manner in which the automotive industry operates. Some of the causes of the downturn are overcapacity, foreign competition, lower demand for dies, technology improvements, and an increased demand for a greater variety of services. These factors are permanent and not going to disappear; hence the restructuring of the industry.

Benchmark data shows the foreign competition can make dies at one-third the cost in approximately one-half the time. These differences can be attributed to three basic reasons: lean operations, simpler part designs from their customers, and closer supplier-customer relationships. This latter factor is particularly important as it drives, in part, the simpler part designs, and because it enables both parties to identify system level cost reduction opportunities, such as functional build.

There are three basic recommendations: T&D shops must adopt lean practices, T&D shops must form strategic partnerships / coalitions between T&D shops as well as their customers, and government must support the industry during this transition period.

A. Adopting Lean Practices

It is imperative that T&D shops adopt lean practices. These practices have been shown to result in lower cost and improved manufacturing performance. The benchmark data clearly shows lower time and cost in manufacturing, assembly, and tryout, which are all manufacturing functions, as opposed to die design and castings. Further, the data show greater efficiencies in machine utilization, fewer labor hours per machine, and shorter machine setup times. Lastly, the data show that the lean shops have not only synchronous production, but also the infrastructure and internal metrics that enable further identification of bottlenecks and cost reduction opportunities. This is driven by a measure of production capacity other than number of labor hours, namely: number of dies produced. Other related initiatives include adoption of ABC accounting, improving CAD/CAM systems to move towards the paperless T&D shop, investing in high speed milling machines to eliminate benchwork, standardizing workflow, standardizing common parts, and prepackaging parts in quantities and types needed to assemble a single die.

Although these are specific suggestions, each T&D shop should conduct an analysis to determine the most cost effective method to transition to a lean manufacturing system. Within Michigan, the state funded Michigan Manufacturing Technology Center (www.mmtc.org) offers numerous training classes and implementation support for lean.

B. Creating Collaborative Relationships

A significant opportunity exists for the domestic tool and die (and related industry sectors, such as product engineering and assembly tool companies) if they can pool their resources and work to the competitive benefit of their principal customers – the auto companies. The current competitive bid process is antagonistic, short-term and non-collaborative. The complexities in launching a new vehicle require collaboration between the customer and the many suppliers providing products and services that all interact with each other. The bidding process and physical demands expected of the suppliers to support their customers are not compatible.

The collaborative model outlined in this study is an attempt to overcome this incongruence. There are many challenges in the development and implementation of the collaborative model. The facilitation effort to bring many suppliers together is significant. One of the keys to keeping the effort together is finding a customer (e.g., automotive OEM or Tier One) that is willing to entertain the concept. Of course the customer's fear is that they will experience higher costs without competitive bidding, so attention to cost is critical. This places a significant burden on achieving success with the coalition quickly – beginning with the first job. The lead-time and costs to develop a basic operating structure for the coalition, negotiating and marketing the coalition with potential customers, and identifying appropriate member companies is a significant undertaking. Support from industry (both customers and suppliers) and government organizations would greatly increase the likelihood of success. For example, the following actions will help the collaborative model develop and succeed:

1. **Tool and Die and Related Industry Companies**

   Entertain cooperating together and pursuing joint initiatives to improve individual and industry competitiveness. This requires consideration of core competencies and the movement toward niche specialization. The coalition approach allows one to offer a greater range of services to the customer, as well as the opportunity to practice functional build at the modular or BIW level; a practice that the benchmark data clearly showed reduced tryout time and cost.

   The coalition approach also requires a progressive mindset to look beyond lean manufacturing techniques into innovative ways to increase customer value through adding, subtracting, or changing processes and technologies on a continual basis. Simply adapting once will not suffice. A mindset of continuous improvement in both everyday business and the collaborative model will be essential to become a state-of-the art T&D shop. Meanwhile, being able to maintain other parts of the business separate from the coalition initiatives to protect the business from anti-trust concerns will also be paramount. The collaborative efforts may drive major shifts in the business, but they cannot drive competitive interactions outside of the collaborative context.

2. **Automotive OEMs and Tier One Customers**

   Entertain the coalition as a viable option – perhaps allowing it to compete against other competitive options and recognize that the potential of the collaborative model will increase in its competitive performance over time. Provide direction to the coalition in terms of cost reducing initiatives that are priority to the customer. Make the internal organizational changes required to support a collaborative model. Along those same lines, recognizing that the most powerful cost saving and quality-improvement activities require collaboration between the OEM and the suppliers. For example, the benchmark data showed a significant cost reduction from more efficient die standards and the right sizing of dies, which both require stronger communication between the customer and the supplier. Therefore, allowing the coalition access to critical resources (personnel, design, facilities) to enable true implementation of cost saving initiatives is a crucial step. Tool and die suppliers equipped with in-depth knowledge about their tools can be invaluable to the customer experiencing integration issues related to other parts of the vehicle assembly.

C. Government Support

Financial and intellectual support is required to move the collaboration development forward. A more in-depth model needs to be developed to serve as a framework to guide companies in forming collaborative relationships. Academic and research & development organizations can work together to refine the collaborative relationships, and facilitation is needed to negotiate operating issues between organizations. It is also likely that the coalition model could be generalized for use in other industries.

Local, state, and federal economic development organizations can assist in the implementation and adaptation of the coalition model to fit specific group needs. In addition, state and federal institutions could provide financial support in the form of

- Investment tax credits and faster depreciation schedules to enable T&D shops to keep pace with the changes in technology,
- Change laws to allow coalitions to purchase group healthcare coverage,
- Provide more funds for the education and adoption of lean manufacturing methods, and
- Provide funds to help the initiation of coalitions and support coalition cost reduction initiatives.

Ultimately, without government support, current market forces and social and organizational obstacles to collaboration will drive the industry overseas.

VII. References

1. The Right Place Program, "A competitive Assessment of the Die and Mold Building Sector, A West Michigan Perspective," by IRN, Inc., 550 Three Mile Road, Suite A, Grand Rapids, MI., May 2002.
2. Coalition for the Advancement of Michigan Tooling Industries, www.camti.org.
3. Eversheim, W., and Deckert, C., "Future Strategies for the Tool and Die Industry", 2nd Annual Conference with International Participation on Rapid Technologies, Global Alliance of Rapid Prototyping Associations (GARPA), Frankfurt, Germany, November 30, 2001.
4. Auto/Steel Partnership, www.a-sp.org.

VIII. Coalition Appendix

A. Coalition for the Advancement of Michigan Tooling Industries (CAMTI)

B. Michigan Tooling Act (from www.camti.org)

C. Fraunhofer Tool and Die Paper on Performance

D. U.S. Tooling Coalition (USTC) Antitrust Policy (Draft Guidelines)

APPENDIX A

Coalition for the Advancement of Michigan's Tooling industries

Acrobat Document

APPENDIX B

Special Tools Lien Act

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APPENDIX C

Fraunhofer Tool and Die Paper on Performance

Acrobat Documen

APPENDIX D

U.S. Tooling Coalition (USTC)

Antitrust Policy (Draft Guidelines)

State and Federal antitrust laws are intended to protect the public from agreements between competitors that affect the price or distribution of products. USTC member companies are competitors in the market and it is understood that they will always act in their individual and competitive best interests.

USTC member companies and the Center for Automotive Research (CAR) shall comply with the letter and spirit of antitrust laws on all activities that are within the scope of their participation in the USTC. The general requirements of the antitrust laws prohibit any agreement that restrains trade. Specifically, USTC members and CAR shall strictly avoid any of the following activities or discussions relating to them:

1. agreeing to establish geographic trading areas, allocate markets or customers, or classify certain customers as being entitled to preferential treatment;
2. participating in any plan designed to induce any manufacturer or distributor to sell or refrain from selling, or discriminate in favor of or against any particular customer or class of customers;
3. agreeing to limit or restrict the quantity of supplier products;
4. participating in any plan that has the purpose or effect of discriminating against or excluding competitors;
5. agreeing or participating in any plan to refuse to deal with potential customers or suppliers without a sound business justification.

USTC member companies have agreed to cooperate as a group to provide tools, dies, fixtures, and related services (USTC Product) that no one individual company in USTC could provide alone. CAR and USTC member companies will collectively assemble a single, combined proposal for USTC Product. CAR will act independently from the USTC member companies, and collect and manage individual member quotes for the purpose of developing an aggregate quotation. The following steps will be followed.

1. The USTC and CAR will collectively define the specific scope of tools, dies, fixtures, and related services (USTC Product) that will be offered to a potential customer for a single, USTC price. The USTC Product will be partitioned into Product components.
2. USTC member companies will develop independent and individual quotations for Product components. All USTC members are invited to develop a quotation for the Product components that they wish to pursue for their business.
3. Individual component quotes from USTC member companies will be submitted directly to CAR for consideration in developing an aggregated USTC quote.
4. A heuristic will be developed by CAR and USTC that interprets individual USTC member quotes and generates an aggregate quotation. Individual USTC member

quotes are not disclosed to the USTC member companies. (See attachment describing heuristic methodology.)

At USTC meetings and functions, members are generally free to discuss collective USTC capabilities, marketing strategies, and general approaches for improving engineering and manufacturing efficiencies.

At USTC meetings and functions, members shall stay within the formal agenda, including any additions to that agenda, and avoid any informal or formal discussion relating to specific company plans.