The World Class Tool Shop and its Prospects in Michigan

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Executive Summary

Automotive companies are trying to buy their tools, dies, and molds (TDM) at the lowest possible price. With the recent emergence of tooling capacity in “low-cost countries” (LCCs), that low price is getting even lower. Domestic TDM sources are being pressed to meet the “world price” for tools or risk losing their bids to suppliers who can provide TDM at this lower price. This paper examines how this new environment affects domestic TDM builders.

- In a survey of 43 Michigan TDM shops, we found that their automotive customers value price above all else.
- Many TDM shops report that they only win work by bidding low on initial price with the hope to make up their margin on engineering changes or by providing additional services—a strategy that is not sustainable as the industry trends toward making fewer engineering changes.
- LCCs are not necessarily the lowest-cost producers from a total lifecycle cost perspective. This is difficult to determine in an industry where the quoted price often bears little resemblance to the true cost of making tools and the ancillary costs for program management, engineering changes, launch support and tool maintenance are often not compiled.
- On paper, the price advantage of outsourcing tools to LCCs can be 20 to 35 percent lower than prices offered by Michigan TDM shops. (This result is highly sensitive to the assumption that LCC productivity is one-half the domestic level; if the productivity differential is larger—as some analysts believe—the LCC price advantage would be even smaller.)
- Domestic TDM shops have several available strategies to compete with the “world price” for tooling:
    1. They can buy some or all of their tooling or inputs from LCCs
        - There are cost-saving opportunities for TDM shops that adopt an international business model.
        - But this model is also economically and technically risky because of the possibility of:
            - Late tools
            - Inferior quality
            - Loss of intellectual property
            - Even further loss of orders as the competition learns how to make automotive TDM
            - Shifts in the exchange rate that reduced the advantage of offshore production

        - Many of these risks can be mitigated by only sending simple tools or small details to LCCs.
    - May require the TDM shop to learn new business skills
    - Can be done by the TDM shops themselves, or by utilizing a tooling integrator to place work offshore
2. They can specialize in only certain aspects of TDM work:
    - Complex tooling
    - Tryout and launch
    - Management of engineering changes
    - Management of offshore tool purchasing and support of the tool once it reaches this country
    - Design and engineering
3. They can implement cost-saving actions that can complement or offset international price advantages:
    - Implementing lean
    - Improving mastery of advanced engineering (better CAD/CAE design)
    - Developing niche capabilities (e.g., tools for high strength steels or tools targeting low-volume manufacturing applications)
    - Maintaining close customer relationships via high levels of customer service—so that the TDM shop and the customer can collaborate, and learn from making previous tools how to make the customers' current and future tools most efficiently

These strategies are not mutually exclusive. Indeed, pursued properly, they can be mutually reinforcing, as domestic TDM shops improve their performance and market share in their specialties while minimizing the long-term competitive risk of losing high-end work to their offshore collaborators. Many of Michigan's leading tool shops are currently pursuing some or all of these initiatives.

Introduction

Buyers for many automotive OEMs—and, in fact for other large companies beyond that industry—are focused on getting the lowest price for their tool, die, and mold (TDM) purchases. The frequent message to TDM sources is that they must meet or beat the "world price" for tools or risk losing their bids to suppliers who can provide TDM at this lower price. Winning bids often include tools made in "low-cost countries" (LCCs). LCCs are thought to be lower cost because they employ a lower-wage workforce, do not pay benefits, have fewer worker health and safety protections, and sometimes utilize inferior engineering and sub-standard materials. When you combine LCC cost advantages with state-of-the-art engineering systems and manufacturing resources, the potential for significant cost savings is obvious. There are other critical factors affecting overall costs, however, especially those that pertain to technical capabilities and logistical costs for managing offshore sources. This paper examines how the cost advantages and systemic disadvantages affect a domestic TDM.

TDM builders, especially the smaller shops among them, are unsure how to comply with their customers' demands for lower-cost tooling. The use of LCC shops offers one alternative. However, developing TDM relationships with LCCs poses new challenges. TDMs are still run, in many cases, by journeyman toolmakers rather than finance-oriented dealmakers; utilizing LCC tool sources would force these companies to move out of their comfort zone into potentially risky ventures that could put the fate of their family businesses on the line. In addition, LCC sourcing may not be the only (or even the best) way to satisfy their customers' desires for lower-cost tools.

In our survey of forty-three Michigan TDM shops, we found that most are heavily dependent on the automotive industry, and most serve suppliers rather than the OEMs directly. The shops' report that their primary customer values price above all else, followed by delivery performance (on-time), lead-time performance (order-to-delivery), and quality/durability. A large proportion of shops surveyed is seeking to grow the processes related to building complex tooling, which suggests a move toward specialization. Shops in the survey report that, in addition to falling prices for tooling, tolerances are getting tighter, lead times are shrinking, and engineering changes are becoming fewer. Finally, over half of our respondents report that their customers only pay for tooling once it is in production, which stands in marked contrast to the more immediate payment terms offered to many offshore suppliers.

Customers recognize the technical capabilities of domestic TDM shops as superior, especially in relation to many foreign sources. If foreign tools arrive in the United States requiring significant rework, who will repair them, implement recent engineering changes, and support them in production? The ***international business model***, encouraged by many U.S. customers, must recognize cost advantages versus system disadvantages, which include:

- Engineering design feedback to the customers' product design engineers
- Technical learning curve of offshore shops (engineering, manufacturing and tryout)
- Logistics of managing and tracking offshore tools
- Cost disadvantages for shipping and import duties
- Management of the implementation of engineering changes
- Domestic tryout and maintenance of tools once in production

We do not know for certain if LCCs are actually the lowest-cost producers. The tooling industry—both in the United States and in LCCs—employs quoting strategies that often bear little resemblance to the true cost of the tool itself. It is not unusual to see a 100 percent spread from the lowest to the highest bidder on tools from TDMs with similar cost structures. So called "mood" factors affect prices based on shop utilization, customer reputation, and long-term relationship potential. Suppliers may significantly underbid on TDM jobs—focused instead on landing the work, filling their capacity, making up their margin on engineering changes, or (in the case of many LCC TDM shops) learning how to make the tools, and building their own internal capabilities. ***Our research shows that (on paper) the price advantage of outsourcing tools can be in the often-reported range of 20 to 35 percent lower than prices offered by Michigan tool shops.***

Recently, a Tier 1 customer commented, "I know I can buy cheap tools from LCCs. I just don't know where to buy cheap tools that *work*." One aspect of the ***international business model*** is for the domestic shops to help make sure that the offshore TDMs work before sending them to the customer. Several large domestic TDMs and an emerging group of international tooling "integrators" have developed service networks that can support smaller shops working internationally, thus mitigating economic and technical risk. Smaller, simpler tools can be sent offshore, and by managing these for a customer, a domestic shop might obtain additional higher-value-added work (complex tools) for domestic construction. Small shops might also benefit by offshoring only tool details that can be machined abroad at lower cost and then sent back for assembly into a larger tool, thus resulting in overall lower tool cost.

The conclusion of this paper is that every TDM shop needs to consider the role that it wishes to play in the ***international business model***. There are clearly cost-saving opportunities in working internationally, but these savings require new business skills and entail additional risks. Risks include program management (e.g., late tools), inferior quality, unusual business practices and loss of intellectual property that can lead to future work loss. There are degrees of offshoring that may include program management, engineering, construction, assembly, and tryout. In addition, there are a number of cost-savings actions that can complement international advantages, or even offset the international benefits. These include lean manufacturing methods, developing advanced engineering (better CAD/CAE design), developing niche capabilities into areas that are not well known (e.g., tools for high strength steels, or targeting low volume manufacturing applications), and maintaining close customer relationships via high levels of customer service. There is a stronger argument for larger, more complex

tools staying domestic because of the need for communication between the customer and supplier. Smaller, simpler tools are more prone to be competitively produced offshore. The near-term future result will likely be a hybrid international business model with a great proportion of large, complex tools remaining domestic, smaller and simple tools being sent offshore, and certain specialty niche tools (or tooling services) staying domestic. The principal issue is the distribution of offshore versus domestic market share. If the domestic TDMs are able to introduce cost-saving methods, a greater proportion of TDM supply will remain domestic.

Background

Tooling procurement has become a global activity, and with the recent entry of low-cost producers in Eastern Europe and Asia, the competition is becoming increasingly fierce. Domestic customers are experimenting with using suppliers in these low-cost countries[1] (LCCs) in an effort to save time and money, leverage lower prices from their domestic suppliers, expand their market, and to improve their own competitiveness. Auto OEMs want lower prices, which may mean that even small, family-owned suppliers must become more global, with the goal of getting "U.S. quality (or better) at Asian (or lower) prices."[2]

There is a commonly held belief among tool shops that, while tools sourced from suppliers in LCCs may be lower cost initially, in practice these tools may be fraught with technical problems. The industry abounds with anecdotes about tools made in an LCC that must be repaired by local tooling companies who have superior technical expertise, technology, and equipment, as well as close geographic proximity to North American production locations. One Michigan tool shop owner reports, "We get calls every week to fix the work of low-cost competitors. It can be pretty lucrative."[3] Another tool shop owner stated that, "Many times, the cost to fix the problem goes well beyond the original price the client thought it would save."[4] Several shop owners have indicated that a major portion of today's domestic tool industry is being used to correct tools from LCCs. On the flip side, some customers have indicated that, even after paying for the local fixes, LCC tools are still cheaper than if they were produced entirely in the United States. Furthermore, they feel that the current problems are temporary—we are simply experiencing the growth pains for developing fully capable LCCs.

Most North American tool suppliers envision themselves in the business of making tools, not merely brokering or servicing them. Since it is viewed as a higher-cost producer vis-à-vis the LCC shops, what can a North American TDM shop do?

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[1] By Low Cost Country, we mean China, India, much of Southeast Asia, Eastern Europe, Mexico and Central and South America. Admittedly, producers in some of these countries are lower cost than those in other countries (most notably, costs are reported to be lower in China, Korea, and Thailand). The price advantage of working with Eastern European TDM sources is less than many Asian TDM shops, and therefore, Eastern Europe makes more economic sense for customers in closer geographic proximity.
[2] "GM in Asia: Automaker's influence over suppliers and sourcing sends ripples from China to Macomb Township," *Detroit Free Press*, December 23, 2004.
[3] "Ailing toolmakers turn to outsourcing," *Detroit News*, April 4, 2005.
[4] Ibid.

- Shift focus to become strictly a service business?
- Make incremental shop floor improvements to become even leaner?
- Buy some or all of their tooling or details from LCCs?
- Move engineering or production work to an LCC?
- Identify and develop core competencies to find a niche?
- Search for new customers, new industrial markets or new exporting opportunities?
- Invest in new equipment and technologies to stay at the cutting edge?
- Try to find ways to convert fixed costs into variable costs to minimize losses during downturns?
- Standardize tool designs and tool manufacturing (standardized work)?
- Dedicate resources to R & D in an effort to find a better (cheaper/faster) way to make tools?

These questions illustrate that North America's tool, die, and mold makers are currently at a strategic crossroads.

The catalyst behind the drive for lower tool prices stems from OEM pressure to reduce investment cost. The pressure to reduce investment cost is due largely to the extreme competition in the automotive market where there is more capacity than demand, resulting is a fierce battle for market share. Market share is gained (or retained) by introducing new models which have shorter life-cycles and lower production volumes. The total investment cost for the dies and molds for an entirely new car model can range between $50 million and $100 million dollars. DaimlerChrysler, Ford and GM have targeted tool cost reduction as a priority, and reductions of 5 percent to 10 percent are no longer sufficient. The new cost reduction targets are approaching **50 percent**[5], which cannot be readily obtained with minor operational improvements. There are two recognized strategies for achieving cost savings of this magnitude. One is for the captive tool sources (either resident in-house at the auto company or from outside suppliers with a close, and often committed/dedicated, relationship with the customer) to develop a ***standardized work*** strategy. Both product and tool construction processes are standardized and closely coordinated to achieve high productivity. The second strategy is to seek tools from LCCs, principally taking advantage of low cost labor. The approach to implement a general lean strategy at a domestic tool shop will help competitiveness, but cannot reach 50 percent. The lean strategy will, however, help to retain some marginal tools that might otherwise go offshore. Generally, the TDMs would like to work on both strategies to permit a closer customer relationship while implementing lean methods to reduce costs. The challenge here has been for the OEM customers to commit to developing these long-term supplier relationships.

Tooling customers' demands are driving much of the need for suppliers to consider a different strategic course. Full-service shops are often running at less than capacity. This low resource utilization puts pressure on these shops to specialize. Customers, however, still seek one-stop shopping. Customers also want "world prices" for their

[5] DaimlerChrysler presentation by Frank Ewasyshyn (Executive Vice President, Manufacturing) at the 2005 Management Briefing Seminars in Traverse City, Michigan.

tooling buys—a code phrase for LCC pricing. Some look to their tooling suppliers to manage the relationships with LCC shops and to go beyond just being a supplier to being an integrator—a business requiring substantial expertise in program management. Even if a TDM shop resists the push to move work to LCCs, the increased competition is going to force prices down. These significant customer pressures have North American tool shops wrestling with competitiveness questions such as:

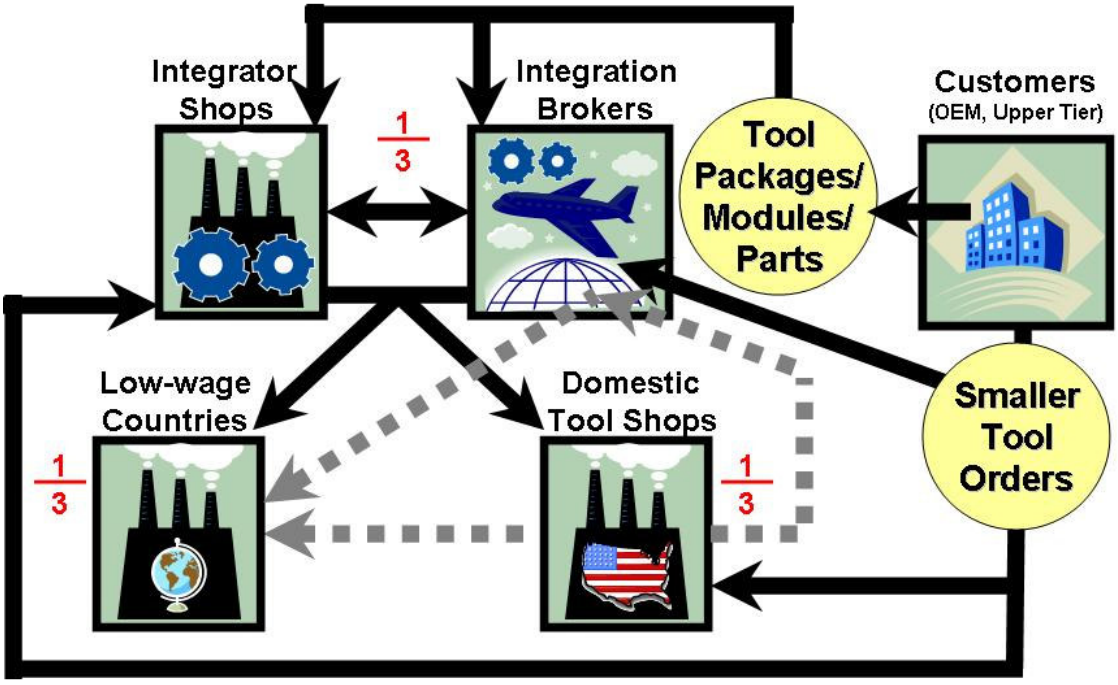
- What level of performance (cost and lead time) will be required?
- What types of personnel are needed (e.g., engineer, tool maker, tryout, sales)?
- What levels of engineering capabilities/resources are necessary?
- What capital equipment is needed (e.g., machine tools, tryout presses)?
- What business relationships should be developed (domestic and/or international)?

Many small tool shops are (or were recently) “full-service shops”—housing a wide range of in-house capabilities and outsourcing a few tasks (such as engineering) if any at all. Tooling customers helped create this industry structure by seeking to have a wealth of qualified shops capable of competing for their tool work so that they could extract lower prices. Major consequences of this industry organization are that that there is—by definition—excess capacity and that prices have been driven down to a point where small shops can no longer afford to bankroll such inefficiency.

To compete in this evolving industry, a domestic tool shop may be forced to choose one of two paths: become a full-service integrator capable of supplying full tooling programs through its network of domestic and off-shore tool shops or become a more efficient niche tooling specialist. Larger shops (those employing 100+ people) and those already developing off-shore tooling supply relationships are most likely to become integrators. The considerable investment necessary to go offshore may be cost prohibitive for a smaller shop that does not control entire packages of tools. These shops will usually retain some in-house capabilities, and outsource portions of their work to lower-cost producers, both domestic and in LCCs. There may be 4-5 of these available in Michigan.

Tooling shops are not the only businesses capable of supplying automotive tooling. In recent years, a number of tooling “integration brokers” have entered the market. These “integration brokers” are manufacturing-hollow companies that can supply large tooling packages by leveraging their relationships with domestic and/or off-shore tooling suppliers. At present, the market is fairly evenly divided, with about a third of the total domestic TDM purchases being made through integrator shops, another third directly from domestic shops, and the final third from LCC producers (through integrator shops, integrator brokers and domestic shops). The diagram below shows the current structure of the TDM industry:

Figure 1: Current TDM Industry Organization



Note that, in this model, both integrator shops and integration brokers will bid on tool packages or modules. These “integrators” will then parcel out the work to try to achieve the highest quality tool at the lowest possible cost. Either type of integrator may contract with other integrators to do work, or more likely, they will look to domestic specialty shops for more complex tools and to low-wage producers to do the more labor-intensive work and simple tools. The domestic specialty shops may also contract with other tool producers (domestic or in low-wage countries) to do some or all of the contracted work. They may work directly with low-wage tool shops or, more likely, these smaller shops will contract their offshore work using an integration broker.

Generally, customers feel most comfortable working with integrator shops because of historical relationships and because they have demonstrated capabilities in producing high quality tools. The challenge is to aggressively offshore tools to less capable LCC tool shops and then manage their development and guarantee their operation to the customer. The integrator broker, a fairly new phenomenon, offers more aggressive cost savings because of extensive ties to LCCs, but they possess less tooling knowledge and technical credibility. Some integrator brokers have developed a domestic relationship with domestic tool shops to overcome this shortcoming. The customer’s dilemma is to weigh cost-saving opportunity with risk tradeoff between these two alternatives.

Domestic TDM suppliers (the integrator shops and the domestic tool shops) have competitive strengths due to their:

- Extensive engineering and technical capabilities
- Established reputations for meeting customer needs
- Proximity to customers and horizontal/vertical supply chain providers
- Extensive range of manufacturing resources
- Strong, established business relationships among themselves and their customers
- New (largely undeveloped) business opportunities with the emergence of foreign auto makers in North America
- Relative immunity from foreign currency exchange fluctuations

In this paper, we set out to establish what it is that automotive tooling customers actually want from their suppliers, and what it is that North American automotive tooling suppliers are providing. We then used this information to develop alternative business scenarios that can lead a tooling company in a direction toward increased competitiveness and long-term viability. We then examined each scenario to validate its economic soundness and made recommendations for domestic tool shops to consider for future success.

Methodology

CAR has met with over fifteen automotive OEM and Tier 1 tooling customers over the past three years to ascertain their priorities and expectations of the domestic tooling industry. The discussions have typically involved a combination of purchasing, engineering and manufacturing management. We asked about their outsourcing and make/buy decisions and strategies, their own internal capabilities, technology, design and engineering, and purchasing practices. Knowing the priority given to tooling cost, we asked how cost is measured and explored how to reduce these costs. The tooling coalitions in Michigan posed one strategy for reducing cost, and we asked if they would collaborate with the coalitions to jointly seek lower costs. We also asked, if we were not already told, what role they envision LCCs play in reducing cost. Finally, we attempted to identify any perceived risks with the consolidation of the domestic industry, as tooling capabilities are moved to LCCs.

In early 2005, CAR surveyed tooling suppliers to learn what it is they are doing to help move their companies toward increased competitiveness and long-term viability. Forty-three tooling suppliers responded to the extensive survey regarding respondents' customers, supplier relationships, internal capabilities, technology, design & engineering, strategies, and finances.

Tooling Customers Perceptions

The dominant business model for Michigan TDM shops is established by DaimlerChrysler, Ford and General Motors because they constitute the largest market share for the local shops. Practices by the domestic OEMs tend to extend to their Tier 1 part suppliers and ultimately to the tool suppliers. The aggressive cost reductions being

sought by the industry begin at the OEMs where they have their own strategies for reducing internal tool costs as well as externally sourced tools. One can argue that the OEM internal tool shops have never been as competitive as the external shops; however, their cost reduction progress has been dramatic. Taking 1997 as a benchmark, one OEM indicated that their internally produced tools are now made 57 percent cheaper! Their goal for next year is two-thirds cheaper (about 10 additional percentage points). Hence, tooling cost reductions of one-half to two-thirds are being realized. Another domestic OEM has indicated that their cost goal is to produce (or purchase) tools that are one-third less than Honda's tools which have been recognized as the lowest in the industry, at less than 50 percent of typical domestic tooling costs. These companies believe that the projected costs savings are necessary to remain competitive, and they are deploying various strategies to achieve them. One company has implemented a "13-point" strategy employing the following techniques:

- Standardized Work
- Rigid Z height control
- Parallel processing of long lead dies
- Synchronous/pull systems
- Main Datum—0,0,0 at base of die
- Metal clearance standard
- Automated change-over
- Surface relief (non-working)
- Parametrics
- Cost & hours differential
- Drill on machine
- Small details/inserts (standardize process)
- Automation—build to data/early

In the "13-point" strategy, the single most important activity, by far, is developing a ***standardized work*** flow for tool making. This strategy is often met with resistance at independent tool shops that believe that every tool is an individual, complex, engineered product, while the customer is attempting to "commoditize" the tool. The customer, however, believes that many aspects of tool design and construction can be commonized.

An important strategy for standardized work—which is a major factor at Honda—is to design lean tools with consistent design attributes. Lean tools have less content (they are smaller, lighter, and have fewer tool components) and when they are consistent (similar) over time, the construction process can become lean also. These factors are largely controlled by the customer and would be out of the independent tool maker's control. However, if a customer (OEM) chose to develop this strategy collaboratively with an outside tool source, they could jointly work toward this goal together. The general sentiment with the Michigan customers is that the independent tool shops must pursue getting lean along with outsourcing to LCCs in order to meet 50 percent cost reductions. There have been isolated cases with Michigan customers developing long-term, collaborative supplier relationships to help reduce costs, but only on a very limited basis. Given the current over-capacity situation in the tooling industry, customers can readily obtain low prices through competitive bidding.

Another important performance metric for tool sourcing is lead-time. Speed to <u>design and build</u> tools is increasingly critical as product development times are shortened. Also,

in order to reduce engineering changes (and associated costs), customers like to hold back on tooling releases, which places added emphasis on supplier lead-time. An assessment of lead-time performance based on one OEM is:

Figure 2: Lead-Time Performance Assessment

	Current Benchmark	Current Performance	Near-Term Goal
Dies	20 weeks	20 to 26 weeks	18 weeks
Molds	8 weeks (occasionally)	8 to 12 weeks	8 weeks (consistently)

One factor influencing the offshoring of tools is the lead-time to ship the tools to the United States. As lead-times shorten, the transportation time from LCCs becomes more critical. The transportation time can vary from two to four weeks, thus making LCC sourcing infeasible. However, LCCs benefiting from low cost labor and minimal work rules are more receptive to working 24 hours per day and 7 days a week, so the overall lead-time schedule needs to be evaluated on a case-by-case basis.

Tooling Supplier Survey

Supplier Demographics

The forty-three tool, die & mold makers who responded to the World Class Tool Shop survey represent a diverse sampling of companies in this industry in Michigan. While a large share (two in five) are located in the Metro Detroit region, the remainder of the state is well represented—in particular, the Grand Rapids, Saginaw, and Flint areas. The size range is diverse, as well, with the smallest shop in the survey reporting just $1.2 million in 2004 sales; the largest $45.0 million, and the average shop just over $9.8 million.

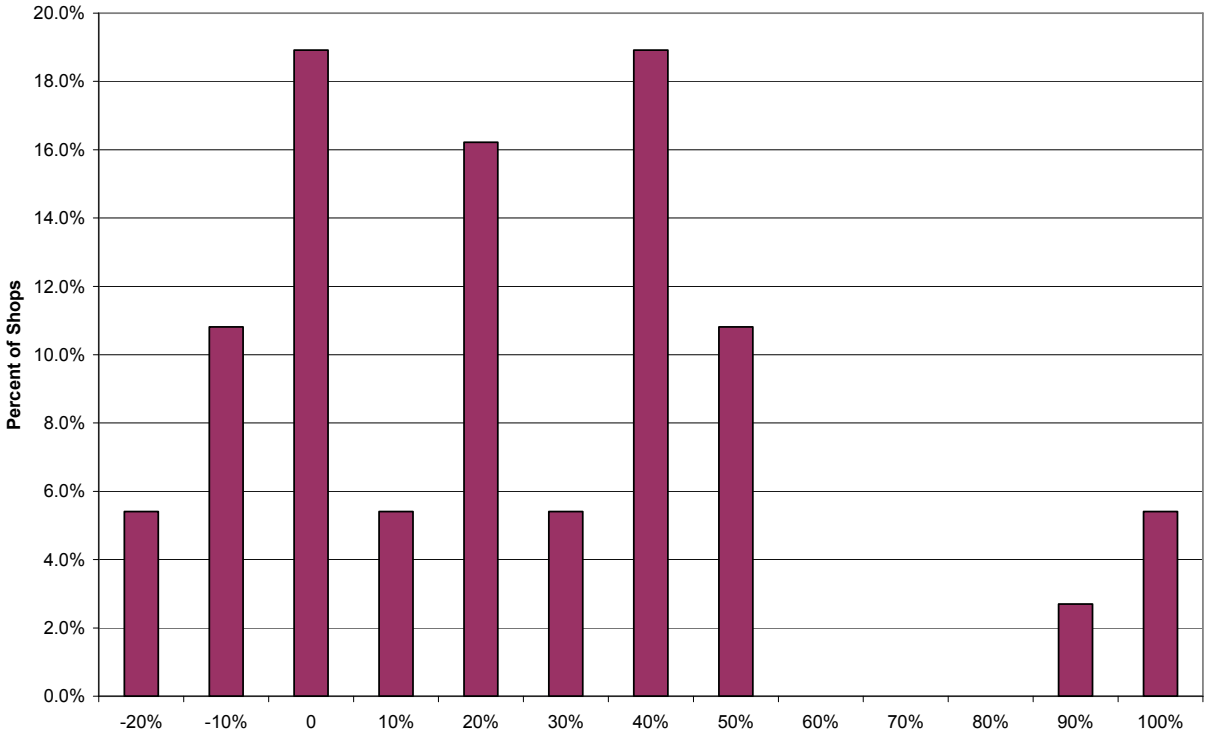
Looking only at those products considered “core”, the respondent group is fairly evenly divided among special purpose equipment makers, progressive dies shops, and mold makers. In addition, most respondents report having broad capabilities in all areas of tool, die and mold making, with the four main current “core” areas being tool engineering, CNC programming, CNC machining, and tool construction/assembly.

All of the tool shops in the survey supply the automotive industry in some way. For the average firm, automotive sales constitute two-thirds of their overall business. In fact, 86 percent of survey respondents report being dependent upon the auto industry for 50 percent or more of their total sales.

For the most part, tooling suppliers who responded to this survey serve the automotive Tier 1 and Mid-Tier suppliers, rather than the OEMs directly. However, the Big Three auto OEMs are ultimately the consumers of the tools/dies/molds for a vast majority of respondents with 95 percent of respondents reporting that their tools/dies/molds are made for GM, 91 percent for Ford, and 78 percent for DaimlerChrysler. Over 50 percent of respondents report supplying the largest of the “new domestics”—Toyota and Honda.

As smaller suppliers to an industry that experiences an amplified business cycle, it is understandable why tool shops frequently complain that their business is either "feast or famine." This volatility in the industry is apparent in examining the two-year change in sales reported by respondents, which ranges from -23.8 percent to +98.1 percent. While eight shops posted greater than 40 percent sales gains, the average shop in the survey reported an 18.8 percent sales gain in the 2002-2004 timeframe. Despite the recent broader economic recovery, it is clear that the recovery in the tool sector has not reached all players.

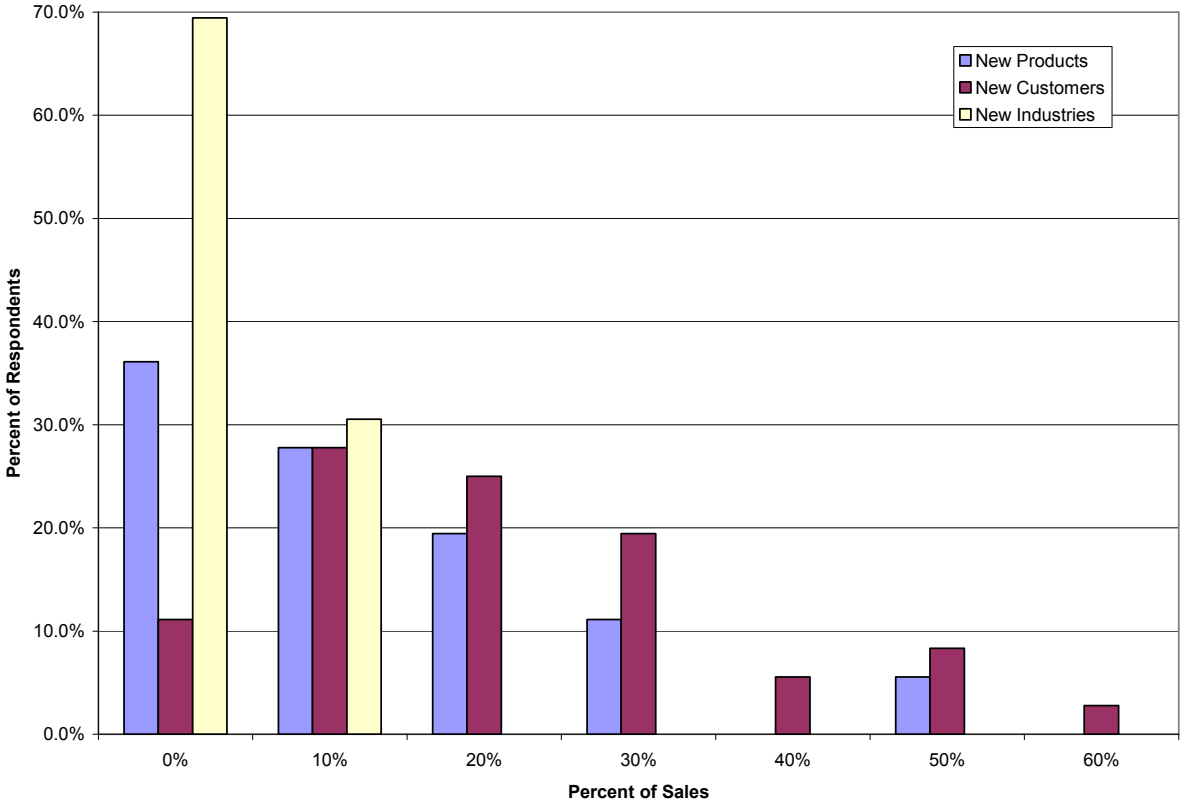
Figure 3: Two-Year Change in Sales



Plastics News reports that "a lot of big names in the tool making business from a decade ago aren't around anymore—but many of the names haven't changed."[6] In their first annual survey of mold makers, the publication found 20 firms with sales greater than $22.5 million, 15 of which are still in the top 20 in the 2005 survey. The National Tooling and Machining Association (NTMA) had 3,000 member companies in 2001; in 2004, membership had dwindled to just 1,800.[7]In the face of such instability, one might expect tool/die/mold shops to be actively seeking alternative ways to fill their existing capacity. Surprisingly, 69 percent report that they are not trying to break into new industries, 35 percent are not pursuing new products, and 11 percent are not pursuing new customers. Since most shops in this survey are planning to remain automotive suppliers, an investigation of how best to respond to automakers' demands for lower pricing is indeed relevant.

[6] "Tooling industry still a rocky endeavor," *Plastics News*, June 6, 2005.
[7] "Tooling industry feels pain of outsourcing," *Automotive News*, August 2, 2004.

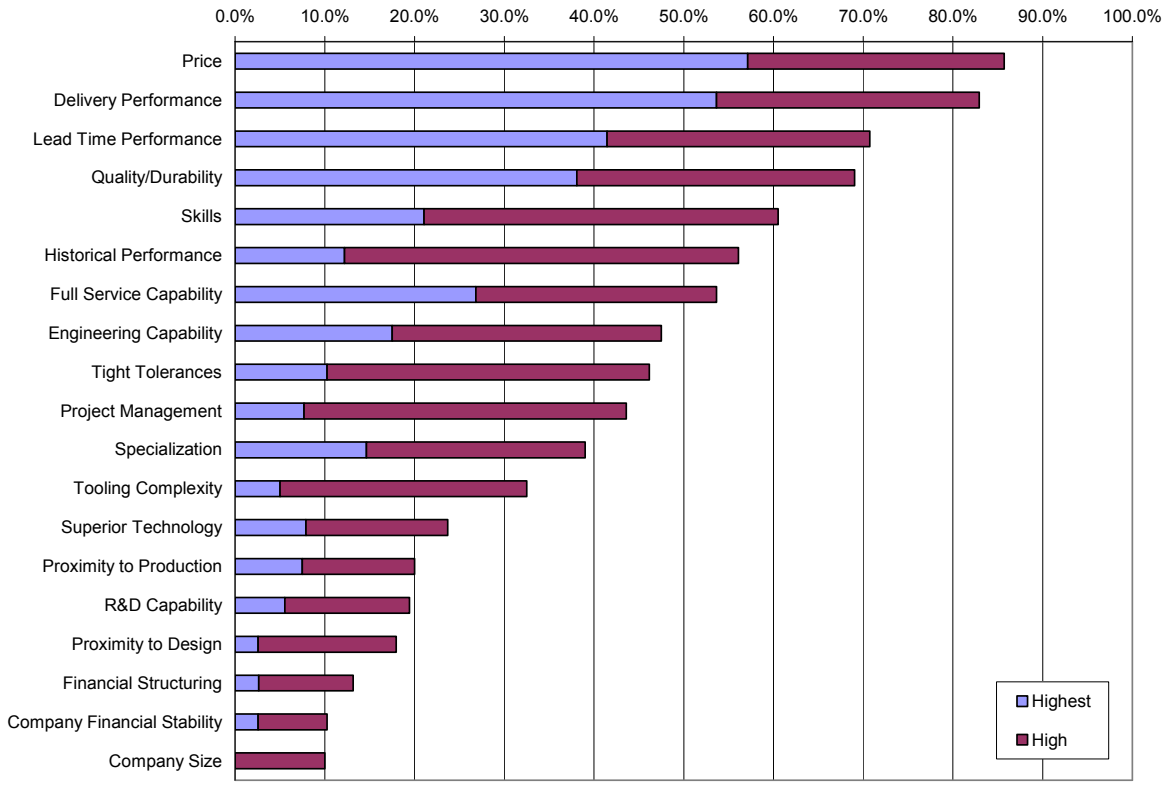
Figure 4: Percent of Sales from New Products, Customers, and Industries



Customer Expectations

To no one's surprise, our supplier respondents report that price is the top factor their primary customer values. Delivery performance (on-time, every time) comes in second, with order-to-delivery lead time performance ranked third. While many respondents report that many other factors are "valued," pursuit of lower prices is the factor that has been getting the most attention recently.

Figure 5: Top Factors Suppliers Report Their Primary Customer Values



So, customers want low prices and reliable, fast delivery. What about the expectations for the tool itself? We asked respondents to tell us how expectations for tool performance are changing. Respondents reported on the level of performance their customers expected five years ago, what they currently expect, and what they think their customers will want five years from now on a number of tool performance metrics. As one might expect, respondents expect their customers' demands for tighter tolerances and shorter lead times will continue. The only other statistically significant result is that, on average, customers expect engineering change orders to be less frequent than they are currently or were just five years ago. This result might reflect the move toward standardization in tool design and construction, and has implications for those tool shops that place low initial bids for tooling with the hope of making up their margin on the engineering changes. The table below presents the average results for this set of questions.

Figure 6: Average Expectations for Tool Performance

	5 Years Ago	Current	5 Years From Now
Typical Tolerances	0.70 mm	0.34 mm (51% tighter than 5 years ago)	0.18 mm (47% tighter than current)
Lead Time/Dies (days)	415 days	323 days (22% improvement over 5 years ago)	247 days (24% improvement over current)
Lead Time/Molds (days)	192 days	148 days (23% improvement over 5 years ago)	113 days (24% improvement over current)
Frequency of Engineering Change Orders (1=low, 3=high)	2.0	2.12* (6% more frequent than 5 years ago)	1.79 (16% less frequent than current)
Complexity of Engineering Change Orders (1=low, 3=high)	1.83	2.12* (16% more complex than 5 years ago)	1.97* (7% less complex than current)
Tool Design Standards (1=lean, 3=over-engineered)	2.12	2.16* (2% more over-engineered than 5 years ago)	1.94* (10% leaner than current)

**These results are not statistically significant.*

Sourcing

We hypothesized that tool sourcing decisions may vary depending on the complexity of the tool being designed/fabricated, and so we asked suppliers to provide information on how they would source a representative "simple" tool versus a representative "complex" tool. We began our investigation by first asking what respondents thought were the characteristics of such "simple" and "complex" tools:

- Characteristics of "simple" tools
  - Smaller
  - Light engineering
  - Flat parts
  - 90° bends
  - Open tolerances
  - Minimal details
  - Build to customer-supplied prints —no development required
- Characteristics of "complex" tools
  - Larger
  - Complex engineering
  - 3D shapes
  - Deep draws
  - Developed edges
  - Multi-step grinding/finishing/coating
  - Use with higher-strength materials
  - Tight tolerances
  - Many/complex details
  - Extensive development required

The survey results show that the characteristics of a "simple" and a "complex" tool are pretty universally understood. As you can see in Figures 7 and 8, "simple" tools—those that one might reasonably expect to be the first to be made offshore—comprise less than 25 percent of the business for a majority of survey respondents.

Figure 7: Distribution of Sales for "Simple" Tools

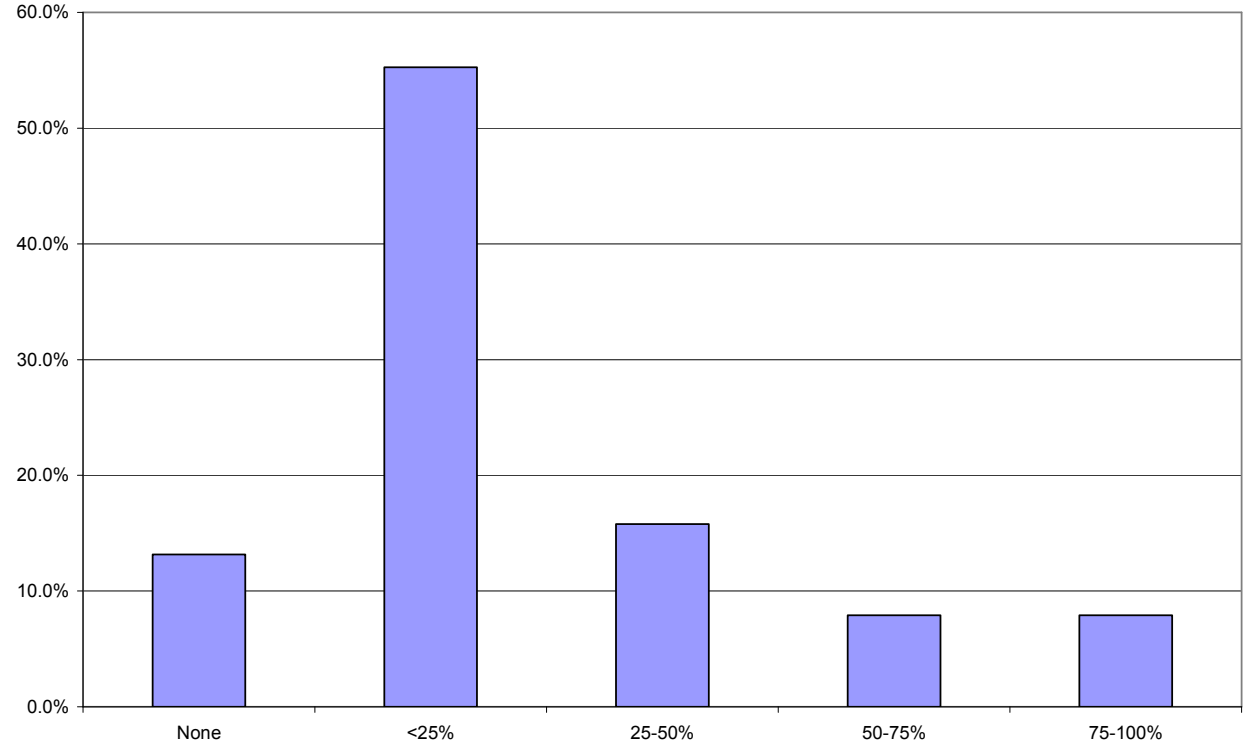
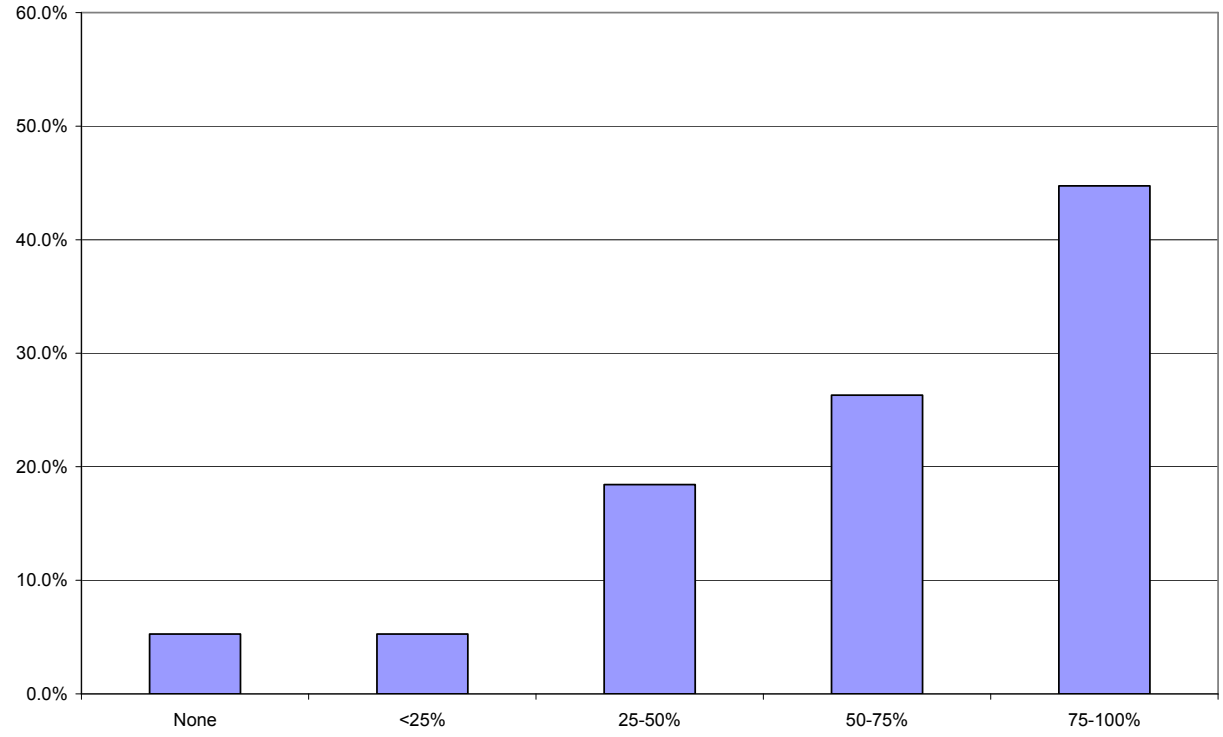


Figure 8: Distribution of Sales for "Complex" Tools



Thinking of representative “simple” and “complex” tools, we asked respondents to tell us how they themselves would source various aspects of tooling by function. While one might expect these representative types of tools to be sourced differently, the data show that respondents tend to keep roughly the same percent of work inside for “simple” and “complex” tools, and that when work is outsourced, there is very little variation in where that work is done. With the exception of patterns/castings, an overwhelming majority of survey respondents plan to do all aspects of tool engineering, construction, tryout, changes, launch and maintenance internally for both “simple” and “complex” tool types. This practice differs somewhat from many prevailing customers’ objectives for specialization and seeking more outsourcing (especially to LCCs) of non-core activities. Core activities for domestic shops would generally be in the higher value-added areas of program management, engineering and tryout for simple tools, and most other aspects (excluding castings) of complex tools.

Figure 9: Sourcing for “Simple” Tools

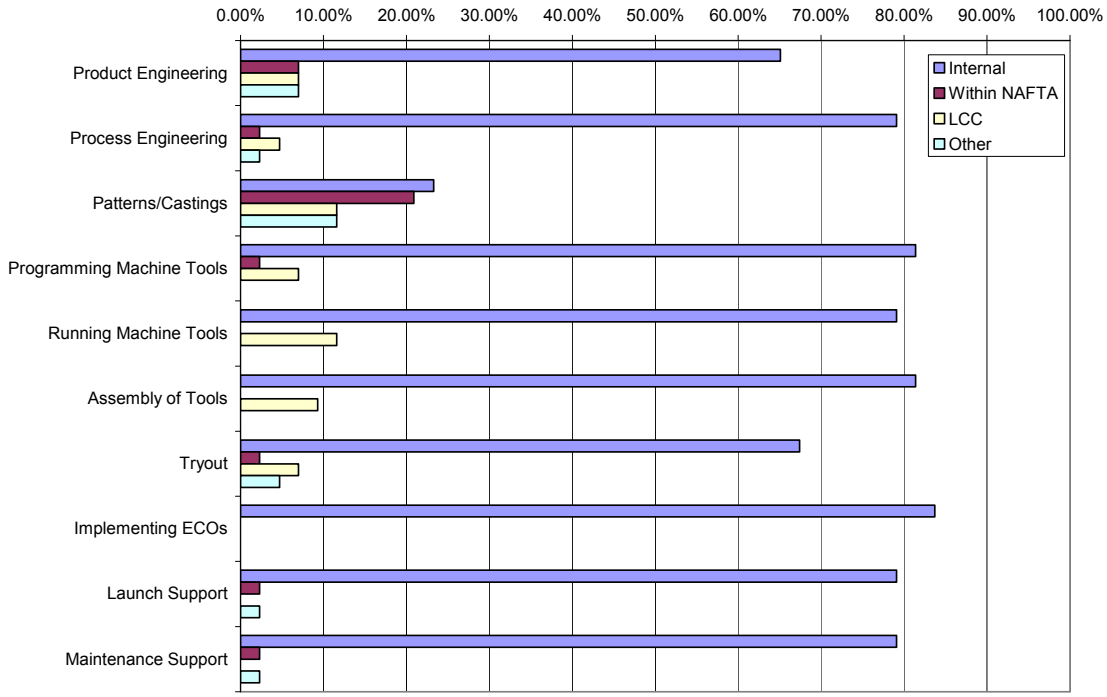
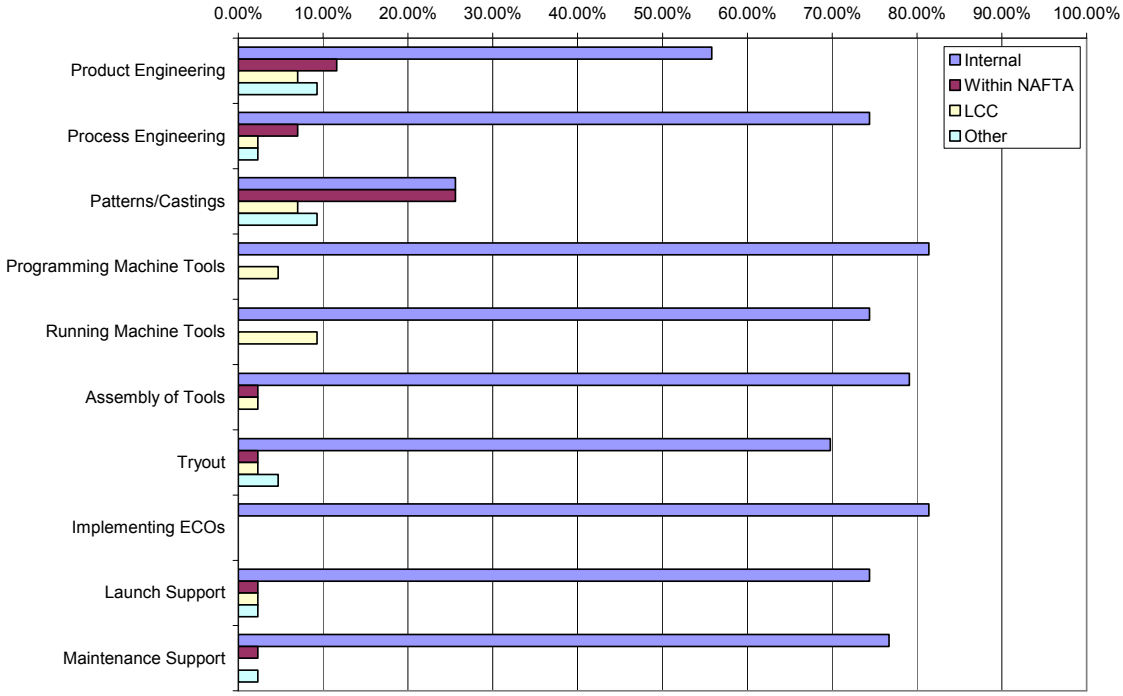


Figure 10: Sourcing for "Complex" Tools

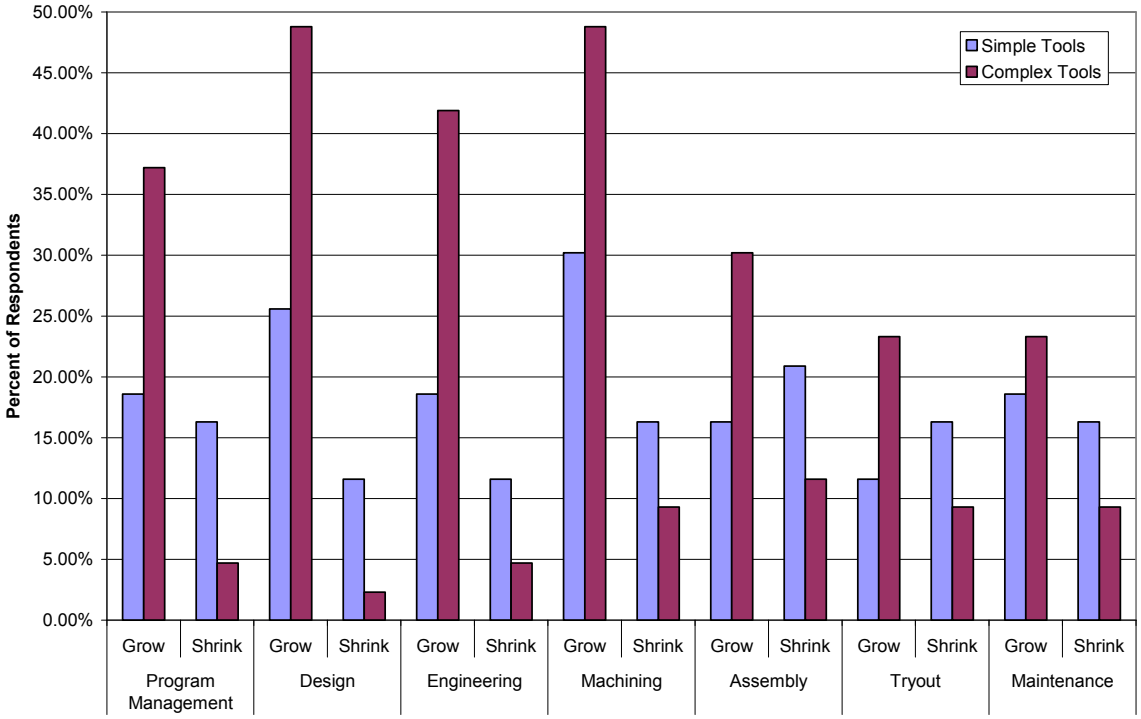


Surely, it might make sense to do more work internally—no matter how complex the tool—if the tool shop has underutilized internal resources for which it is already paying. To better understand the make/buy tooling decisions, we asked respondents to tell us about their internal capacity constraints. Over 20 percent reported labor, design and machine time as capacity constraints in making "simple" tools/dies/molds, and just under 35 percent reported labor, design, wire EDM and machine capacity as their constraints for "complex" tools. Of course, the converse is true—most tools shops are not currently constrained by their own capacity.

Growth Plans

Since some Michigan tool shops are facing capacity constraints, while at the same time most are implementing strategies to increase their global competitiveness, we asked respondents to tell us which areas of their business they plan to grow and which they are planning to shrink in the coming years.

Figure 11: Growth Plans for "Simple" and "Complex" Tools



For both "simple" and "complex" tooling, machining, design, engineering and program management are cited as the top areas for growth. Interestingly, while the growth areas are the same, we found considerably more respondents wanting to grow in these areas to make "complex" tooling rather than "simple" tools.

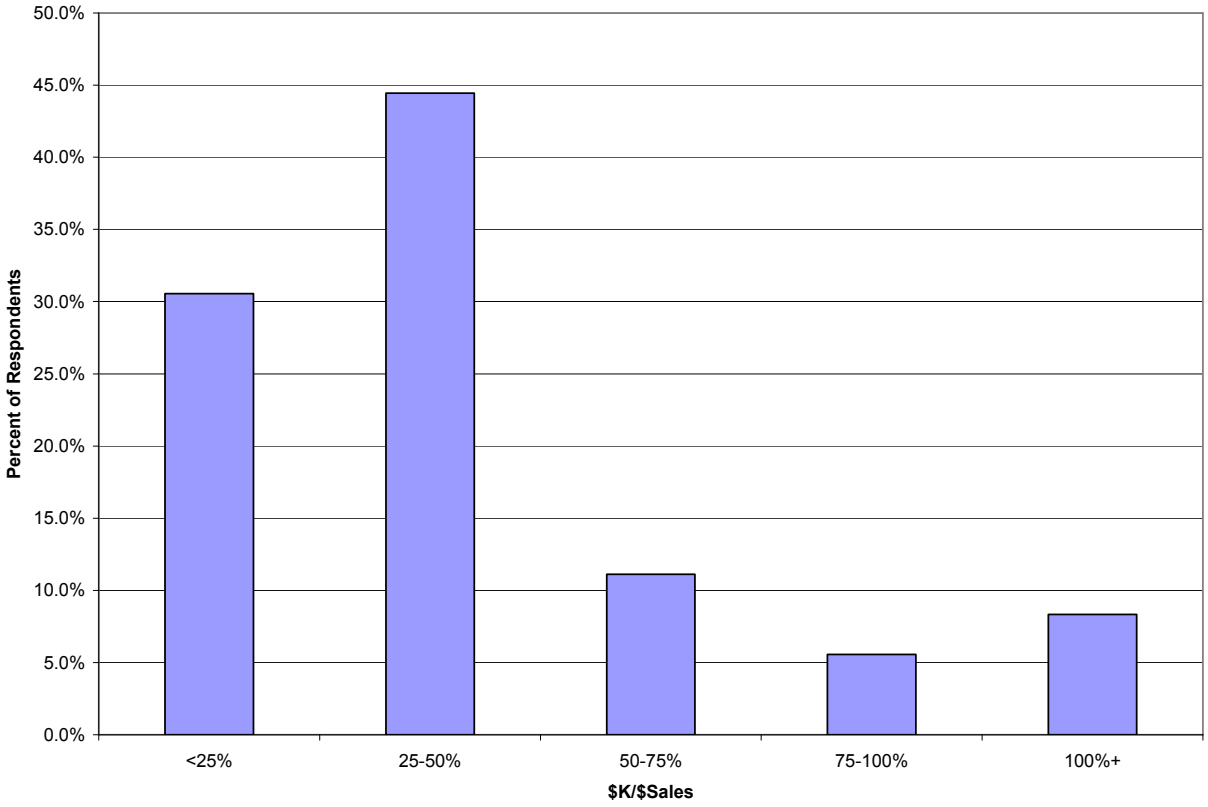
When taken together with the data on the sales distributions by type of tool and the respondents' sourcing plans by type of tool, we found that while the different types of tools are not managed differently, tool shops clearly see more opportunities in making "complex" tooling than they see in making "simple" tools. This implies that there are training—and perhaps collaboration—opportunities in helping shops better manage more complexity in their work. The shops likely see expansion into these core activities for complex tools as an area of the market where they can compete with LCCs, and therefore retain this work in the United States.

Technology, Design and Engineering

Respondents report that a vast majority of their sales—over 77 percent—are accounted for by design and build jobs, and that an additional 4 percent of sales are design-only. Design is clearly integral to a large chunk of Michigan tool businesses, with just about three-quarters of that design work being done by in-house design staff. The remaining 25-percent of design that is outsourced may provide opportunities for collaboration among shops.

While tooling is widely considered a very capital-intensive business, the valuation of the capital stock reported by survey respondents shows that fully three-quarters have a replacement value of capital that is less than or equal to half of their annual sales volume. This distribution of capital intensity is remarkably similar to that of a sample of plastic and metal-working shops that produce intermediate goods and parts where 66 percent of shops reported capital valuation at less than or equal to half of their annual sales volume.[8] This result implies a surprising modest fixed capital cost, meaning that high capital utilization may not be as important to tool shops as it was when the value of their capital was higher than other manufacturing industries.

Figure 12: Capital Valuation



As for the type of capital stock, the average respondent reported having 25 core metal removing machines. Just under 30 percent of the respondents' machines are less than five years old, but two in five of the older machines have been substantially upgraded in the last five years. Most of these machines (55.2 percent) are NC/CNC including EDM, and a large portion (41.6 percent) are 3+ axis. Just under 15 percent of the respondents' machines were high RPM (25K+). Nearly 30 percent of the machines are CNC with built-in measurement devices. On average, respondents report that 53.0 percent of their cutting tools are in quick change holders and 31.1 percent are pre-set.

[8] Source: Michigan Manufacturing Technology Center's Performance Benchmarking Service, 2004 data.

The average tool shop in our survey is open for production 4,551 hours per year (2 shifts), and on average, the machines are actually running (removing metal) 72.7 percent of the hours the shop is open.

We asked respondents to tell us what percent of the work currently done at their location was likely to be done elsewhere in three to five years, and for them to indicate whether that "elsewhere" would be an LCC or not. While the estimates ranged from zero to 100 percent of current work that will be done elsewhere, most shops told us that they anticipate about a fifth (20 percent) of their current work would be done elsewhere, and that "elsewhere" almost universally meant the work would be done in an LCC. This implies that a reasonable goal might be to curb the offshoring of tools to about 20 percent of current tool purchases, based on supplier expectations.

Finances

Companies that utilize LCC tool shops have found they have to offer very attractive financing terms to their partners, particularly those in Asia. It is not uncommon to find customers making progressive payments to their LCC tool source, and paying 100 percent of the tooling costs before the tool, die or mold can be shipped to the United States. These financing practices are in sharp contrast with those being offered to domestic tool shops. Over half of our respondents report that their customer only pays them when the tool is in production—well past the ship date—and just under 30 percent of tool shops report having any sales where progressive payments are made.

Figure 13: Payment Terms

	Current	3-5 Years
100% at PPAP	51.2%	46.5%
Other*	27.9%	20.9%
1/3, 1/3, 1/3	20.9%	18.6%
Amortize With Production	4.7%	14.0%

(PPAP = production part approval process, typically the phase where the finished tool is run at the customer's site and validated for future production.)
**Others mentioned: Net 30, Net 45, and Net 60; 90 days after PPAP; 30%-30%-30%-10% @ PPAP; 90% @ shipping, 10% upon customer approval.*

Many financial institutions have pulled away from financing this work-in-progress because of the high level of risk associated with such investments. With customers pressuring domestic tool shops to achieve LCC pricing, it seems there is room for suppliers to push back and demand LCC financing terms, as well.

We asked survey respondents to tell us how the total cost of tooling breaks down into broad categories of labor, raw material, components, engineering services, capital expense, duty/taxes and freight. For survey respondents, labor—which includes design, engineering, assembly/construction, tryout, engineering changes, rework, launch support and maintenance, and is a hybrid of domestic and local labor rates—comprises over 52 percent of the average cost of a tool. This leads us to the core question of our analysis: do the lower labor rates and levels of quality and productivity found in LCCs

more than make up for the additional costs (and risks) incurred in sourcing a tool offshore?

Figure 14: Factors Contributing to Tooling Cost

Contributing Factors	Average Priority Ranking (1=highest)
Short Lead Times	2.8
GD&T/Quality Requirements	3.3
OEM/Tier 1 Tooling Standards	3.4
Stamper Tooling Standards	4.3
PPAP/APQP Processes	4.5
Engineering Change Orders	4.9
Financing	5.1

Modeling Domestic Tooling Shops' Costs

To assess the opportunity posed by sourcing to LCC shops, the CAR-MMTC team began by building a set of cost models for representative Michigan tool shops. We started with detailed proprietary cost data from eight shops that range in size from less than $2 million to more than $20 million, producing the full range of products from simple, $15,000 four-cavity molds to highly complex $200,000 progressive dies and $1 million line dies. These shops' product lines cover the full waterfront of automotive and non-automotive tooling for stampers and molders, including molds, progressive dies, line dies, transfer dies, prototypes, and custom fixturing. In order to conceal the identities of the actual company data underlying these models, we scaled them to create four stylized shops: a $3 million die builder, a $3 million mold builder, a $30 million die builder, and a $30 million mold builder.

Using data collected in mid-2004, we carefully measured costs and, using an activity-based costing template, allocated all overhead costs to the most appropriate activity bucket. Employing additional data culled from MMTC's Performance Benchmarking Service database, we estimated the proportion of labor and overhead expense in the engineering, machining, and construction buckets that was associated with engineering change orders (ECOs). These new ECO-related cost buckets are needed, because even its most ardent promoters readily concede that offshore manufacturing impacts how U.S. tool shops execute ECOs. According to these data:

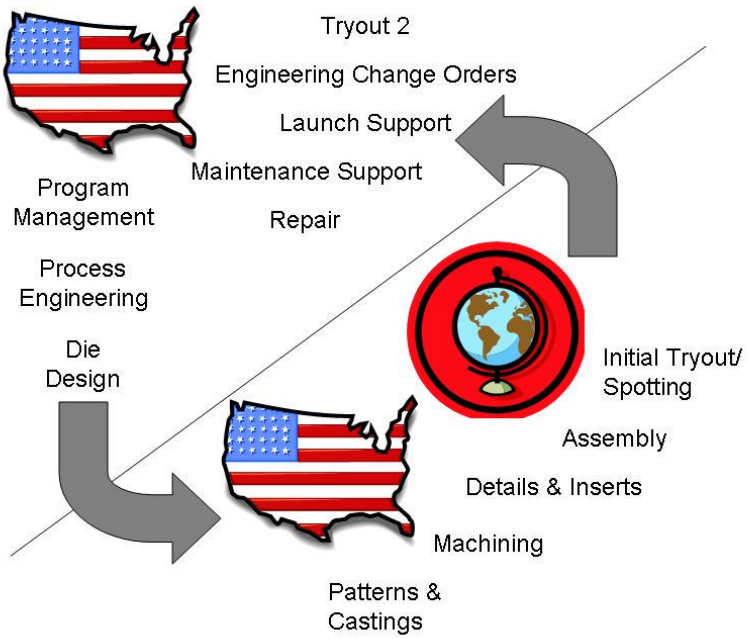
- Between 9 percent and 15 percent of engineering labor and overhead expense is typically consumed by the execution of ECOs.
- On the order of 7 percent of machining and construction labor and overhead expense is consumed by ECO execution.
- Roughly 5 percent of labor and overhead expense is tied up in launch support and monitoring (and, as necessary, correcting) the performance of the tool at the customer's site(s).
- About 3 percent of manufacturing cost (labor, overhead, and material) cannot be assigned to any activity bucket, but must be considered unallocated overhead. This includes the SG&A portion of building, tax, and utility expense.

These rule-of-thumb figures were vetted with a variety of owner-managers and sector experts. While they do not necessarily represent the precise economics of any of the underlying eight shops, they are useful as models. Note that, while these rules are applied the same way, because engineering, machining, and construction expenses have different weights for each of the shops, the results are quite different across the model companies.

Assessing Offshore Benefits and Costs

With these cost models in hand, the project team assessed the savings of offshoring the most commonly outsourced elements of a TDM order to an LCC. In contrast to the base case (where all work is done domestically), the LCC model keeps the "front end" (program management, process engineering and die design) and the "back end" (tryout 2, engineering change orders, launch, maintenance and repair) domestic and sends the rest of the work (patterns & castings, machining, details & inserts, assembly and initial tryout/spotting) to an LCC shop. Of course, no shop will outsource 100 percent of their tools; instead, they would likely follow the strategy described by our survey respondents—specializing in more complex TDM work, and offshoring simple tools, details, inserts and possibly 2-D machining. However, our cost data did not provide enough detail to replicate this real-world model of making complex tooling domestically, and so we modeled all manufacturing being outsourced to an LCC. Furthermore, it is assumed that the smaller domestic shops (the $3M die and mold shops we present) will utilize an integration broker to source TDM work to an LCC shop and will pay a fee to that broker, while larger shops may hire a person located in the LCC to manage the logistics of their much larger tool or mold buy.

Figure 15: TDM Sourcing Model



While there are a myriad of different offshoring strategies—including those that move program management, process engineering, and die design offshore—the project team chose to consider only the most commonly utilized offshoring strategy outlined above.

Based on actual financial data, survey responses, and expert interviews, we applied the following assumptions to the LCC strategy model (a table detailing the cost categories and model results can be found in Appendix III):

- Labor & overhead costs include work done both domestically and offshore.
- Offshore labor is assumed to be 20 percent of the domestic labor cost, and takes into account the lower wage rate (one-tenth the domestic rate), lower productivity (one-half the domestic level[9]), as well as fewer worker benefits and health and safety protections. We have not considered the more or less fixed-cost pension and healthcare obligations, or the unemployment insurance experience rating impacts, on domestic tool shops that downsize here as they move work abroad.
- The cost of raw materials and components is about 10 percent lower in LCC shops because, while the price of steel may not be significantly different in these countries, many of the components used are locally produced and therefore cost less.
- The cost of capital is assumed to be 25 percent lower in an LCC—even though the capital stock is younger—due to government subsidies of capital expenditures.
- Offshore tax, duty, and freight combined are assumed to be 8 percent of total cost. While figures are different for different countries, they are all in a tight range (from roughly 7 to 15 percent.)
- Moving the manufacturing activities of a TDM build to an LCC necessitates roughly 15 percent additional domestically performed machining, assembly, and tryout at domestic labor rates.
- Offshore logistics for a small shop are assumed to be $15K in travel plus 10 percent of the LCC TDM purchase as a broker fee paid to an integrator or other intermediary to manage the buy located in the LCC. (Larger shops would require a program or project manager—typically an engineer—more or less dedicated to monitoring the offshore source. Depending on the volume of business being placed offshore, and the extent to which the major offshore source(s) are themselves using subcontractors, this may require week-long overseas trips—at least four to six times each year, and often, monthly. We modeled this cost as $150K plus travel costs.

[9] Overall results are highly sensitive to this assumption. The authors note that, while experts in TDM source management generally agreed with this 50 percent relative productivity figure, other analysts think that the gap is larger. While published government data obviously vary tremendously by country and industry, they do not suggest productivity differentials as small as 50 percent. For example, China's $800 billion in manufacturing output—just under $600 for each of its 1.3 billion citizens (Morgan Stanley, *Singapore Lessons for China*, 5/6/05)—was produced by 83 million workers (Judith Banister, "Manufacturing Employment in China," *Monthly Labor Review* 128:7 [July 2005]). The United States' $1.5 trillion (Bureau of Economic Analysis) was produced by 14.3 million (Bureau of Labor Statistics). Those national-level figures put the U.S. productivity advantage at 10.88-to-1.

- "On the water" time (the time cost of money) is assumed to be 28 days, which allows two weeks for travel and two weeks for customs clearance to enter the country.
- Outside services and profits are held at a consistent proportion of total costs for both the domestic and the LCC strategy model, since we have no information to suggest that these costs differ with the domestic or LCC strategy selection.

Under the aforementioned assumptions, and across the four model shops, the LCC sourcing strategy is shown to be 25 to 28 percent lower-cost than the all-domestic strategy.[10] The table below shows our results.

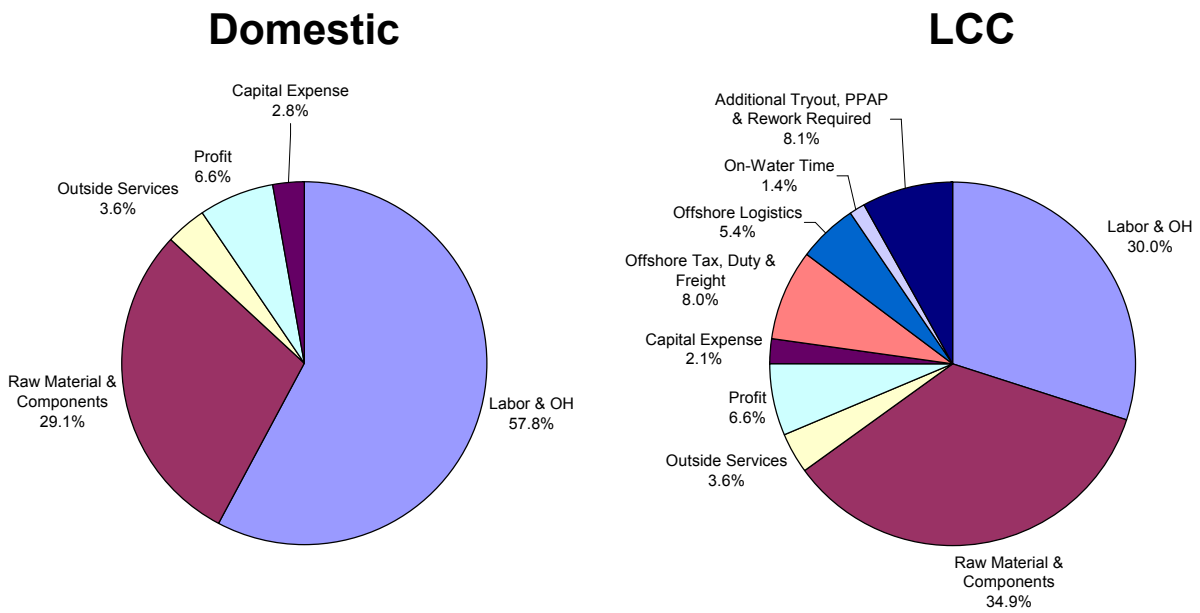
Figure 16: Representative Cost Savings in Domestic vs. LCC Strategy

	Shop Size	Strategy	Total Cost	LCC Cost Savings
Dies	$3 Million	Domestic	$2,943,722	25.0%
		LCC	$2,207,791	
	$30 Million	Domestic	$29,312,817	28.4%
		LCC	$20,984,612	
Molds	$3 Million	Domestic	$2,838,896	25.9%
		LCC	$2,103,404	
	$30 Million	Domestic	$29,357,419	26.9%
		LCC	$21,455,987	

For the small die shop ($3 Million), the LCC strategy provides a 25 percent cost advantage. The labor share of total costs shrinks from 57.8 percent using the domestic strategy to just 30 percent when the machining, manufacturing, and initial tryout/spotting are done in an LCC shop. The additional costs associated with offshoring (tax, duty & freight, logistics, on-water time, and additional tryout, PPAP and rework required) total 22.9 percent of total costs under the LCC strategy, and the raw materials and components share of total costs inches up slightly from 29.1 percent to 34.9 percent (although the dollar value of these purchases is assumed to be 10 percent lower in the LCC).

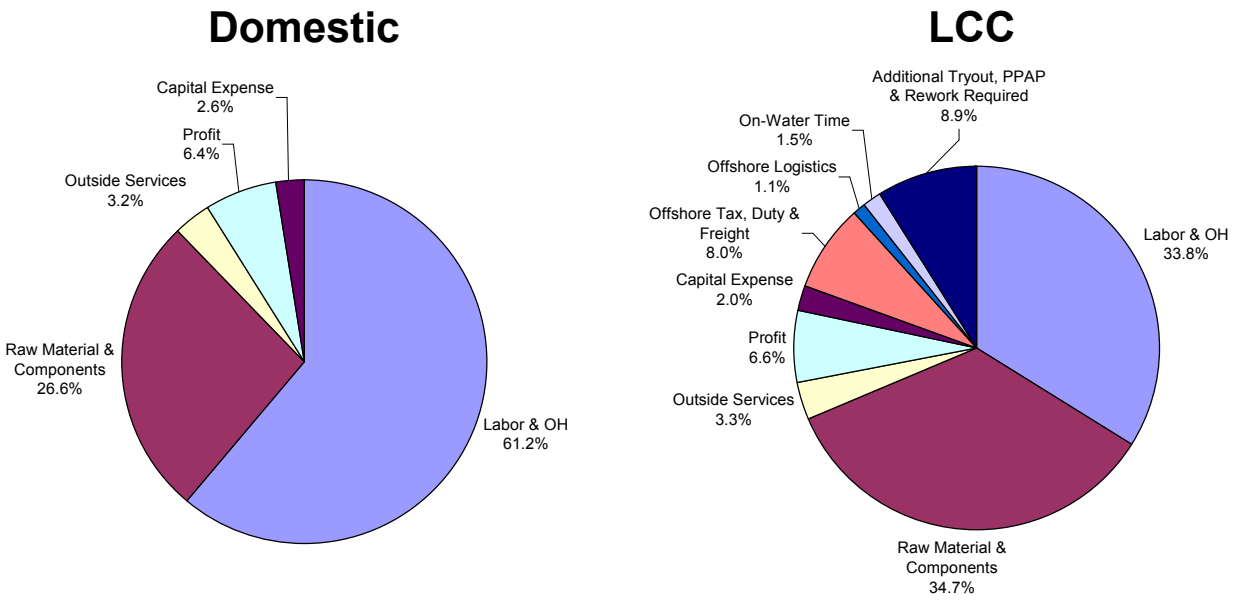
[10] Again, results are highly sensitive to our assumption that offshore sources require only half as much labor per comparable unit of output. If they are only one-fifth as productive, for example, the 25 to 28 percent landed cost advantage would drop to the 7 to 15 percent range.

Figure 17: Small Die Shop Domestic vs. LCC Strategy



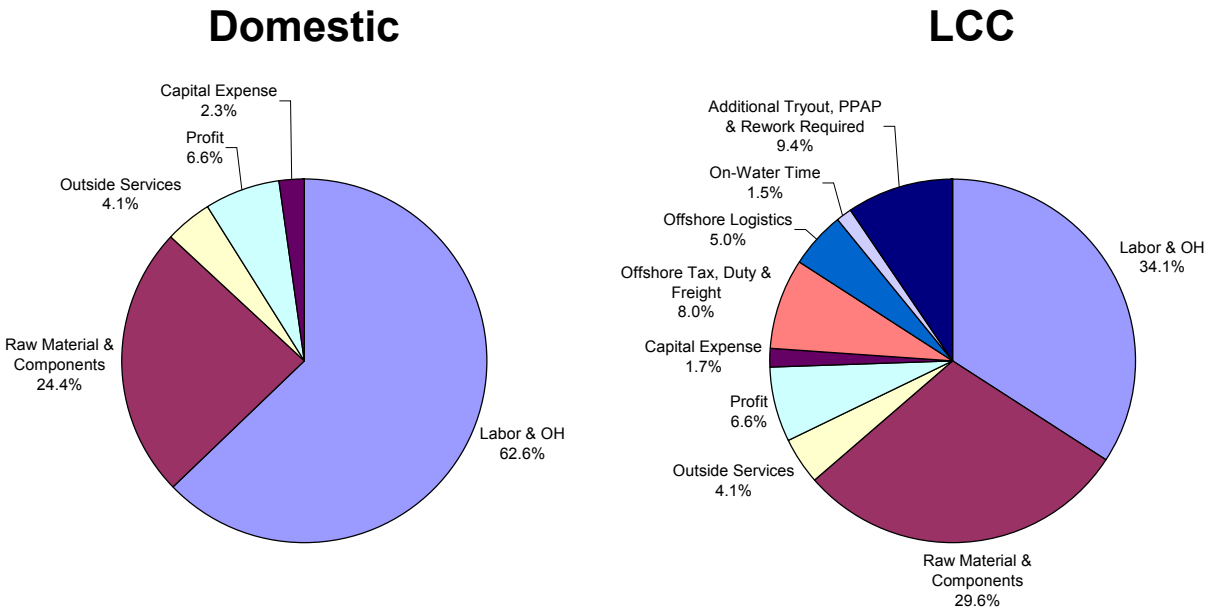
For the large die shop ($30 Million), the LCC strategy provides a 28.4 percent cost advantage. The labor share of total costs shrinks from 61.2 percent using the domestic strategy to just 33.8 percent when the machining, manufacturing, and initial tryout/spotting are done in an LCC shop. The additional costs associated with offshoring (tax, duty & freight, logistics, on-water time, and additional tryout, PPAP and rework required) total 19.5 percent of total costs under the LCC strategy, and the raw materials and components share of total costs inches up slightly from 26.6 percent to 34.7 percent (although the dollar value of these purchases is assumed to be 10 percent lower in the LCC).

Figure 18: Large Die Shop Domestic vs. LCC Strategy



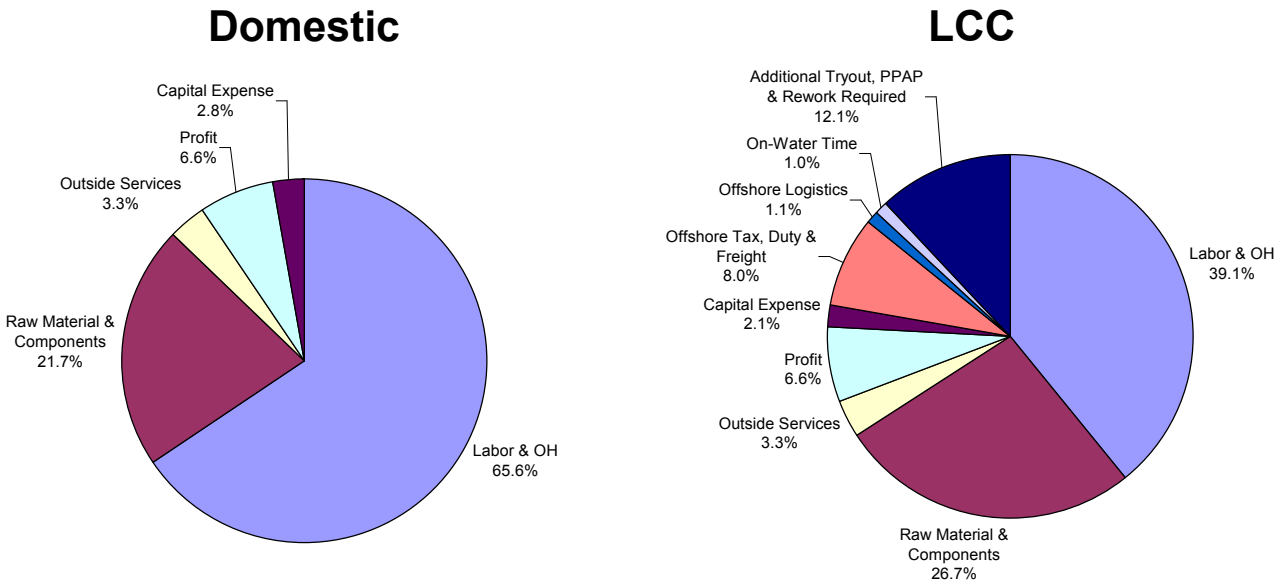
For the small mold shop ($3 Million), the LCC strategy provides a 25.9 percent cost advantage. The labor share of total costs shrinks from 62.6 percent using the domestic strategy to just 34.1 percent when the machining, manufacturing, and initial tryout/spotting are done in an LCC shop. The additional costs associated with offshoring (tax, duty & freight, logistics, on-water time, and additional tryout, PPAP and rework required) total 23.9 percent of total costs under the LCC strategy, and the raw materials and components share of total costs inches up slightly from 24.4 percent to 29.6 percent (although the dollar value of these purchases is assumed to be 10 percent lower in the LCC).

Figure 19: Small Mold Shop Domestic vs. LCC Strategy



For the large mold shop ($30 Million), the LCC strategy provides a 26.9 percent cost advantage. The labor share of total costs shrinks from 65.6 percent using the domestic strategy to just 39.1 percent when the machining, manufacturing, and initial tryout/spotting are done in an LCC shop. The additional costs associated with offshoring (tax, duty & freight, logistics, on-water time, and additional tryout, PPAP and rework required) total 22.2 percent of total costs under the LCC strategy, and the raw materials and components share of total costs inches up slightly from 21.7 percent to 26.7 percent (although the dollar value of these purchases is assumed to be 10 percent lower in the LCC).

Figure 20: Large Mold Shop Domestic vs. LCC Strategy



Implications for Tool Shop Sourcing and Strategy

Not surprisingly, the smallest shops appear to have the least to gain from moving tools offshore. What's more, LCC shops that are large enough to deal with U.S. companies are looking to build partnerships that will help them secure future work and eventually their own ties to the customers. This partnership is less attractive for the LCC shop when struck with a small U.S. TDM supplier that does not have the ability to bring them large amounts of future work or direct ties to the ultimate tooling customer. This is also the motivating factor for large LCC shops who seek partnerships with large domestic tool shops or coalitions of shops.

Nor is it obvious that even mid-size and larger shops should conclude that CAR's analysis vindicates their plans (and/or their customers' implied directives) to move more and more tools offshore. A landed cost advantage of 25 to 28 percent is indeed a daunting edge to try to overcome when price is your customer's top priority, but offshoring is only one among several means to reduce costs by that magnitude. There are some outside factors that would negate the LCC's cost advantage. The first is a major shift in the relative value of the dollar vis-à-vis the currency of the LCC. Our model shows that roughly a 50 percent shift in the relative value of the currencies would be necessary to overshadow the cost savings achieved by the modeled LCC. In addition, we calculated the productivity increase necessary to make up for the LCC cost advantage and found that domestic TDM productivity would have to increase by 41 to 44.7 percent to make up for the LCC cost advantage.

Figure 21: What Would Negate the LCC Cost Advantage?

	Shop Size	LCC Cost Savings	Currency Shift	Productivity Increase
Dies	$3 Million	25.0%	49.5%	43.2%
	$30 Million	28.4%	54.9%	41.0%
Molds	$3 Million	25.9%	53.4%	41.4%
	$30 Million	26.9%	56.7%	44.7%

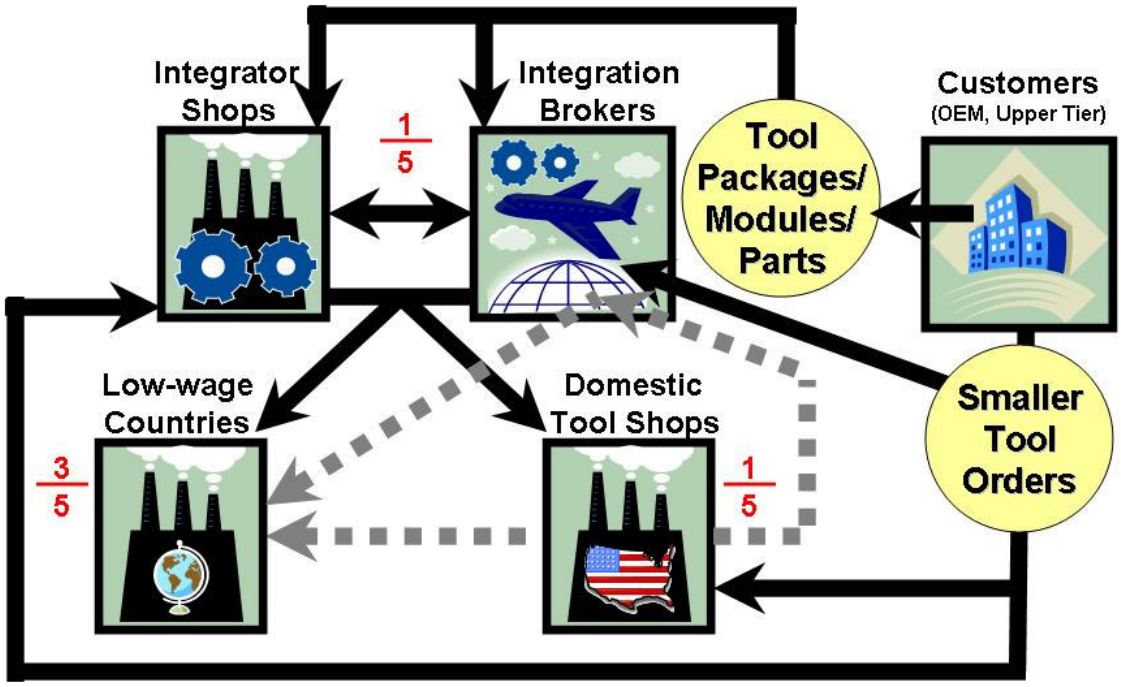
CAR has produced a significant body of work in recent years that suggests that a different business model in the tooling sector—emphasizing customer collaboration, tool shop collaboration and lean practices (e.g., lean manufacturing and functional build) could cut customer costs by 45 percent or more.

MMTC's Performance Benchmarking dataset also makes clear that a 25 to 28 percent landed cost advantage for the international business model does not imply that nearly every builder of smaller, simpler tools needs to source aggressively offshore. Some 10 to 15 percent of TDM builders in the United States already have productivity that is enough above the domestic average that they are already cost-competitive. Another 10 to 15 percent could get there with three to five years of strong (7 percent or more) annual productivity gains.[11]

In Figure 1 (page 8) we described the general structure of the TDM industry. The current structure estimates that the volume of work split between the three industry suppliers (integrator shops/brokers, domestic tool shops and LCCs) is approximately equal, at one-third each. In looking forward three to seven years, we see no change in the architecture of the industrial organization. What will likely change is the share of TDM work being done by each of the various types of TDM suppliers—with roughly 60 percent of the work being done in LCC shops, and the remaining 40 percent being split between the integrators (shops and brokers) and the smaller domestic TDM shops. The erosion of the domestic market will likely continue unless steps are taken or events occur that change the current path. Integrator shops will likely retain in-house capabilities in program management, engineering, specialized tooling, tryout, launch, and maintenance/repair. The domestic TDM shops will become more and more specialized in the areas of complex tooling and tryout, launch, maintenance and repair, and the TDM work (with high labor content and simple tools) will likely be sourced to LCC suppliers.

[11] Note that if the onshore-offshore productivity ratio were, as previously suggested, 5-to-1 rather than 2-to-1, then on the order of one-third of U.S. TDM makers would already be competitive, and another one-third could be competitive with three to five years of 7 percent-plus productivity gains.

Figure 22: Future (3-7 years) TDM Industry Organization



Strategies

Domestic TDMs have a variety of options to respond to the changing industry. Figure 4 illustrates that the top three performance criteria are price, delivery (lead time and on-time), and quality, respectively. Other factors are also important, but price is consistently the leading factor within the automotive industry today. A TDM that does not directly consider price as part of their future business strategy is on shaky ground as auto customers are trying to make all other factors less distinguishing across the supply base—worldwide.

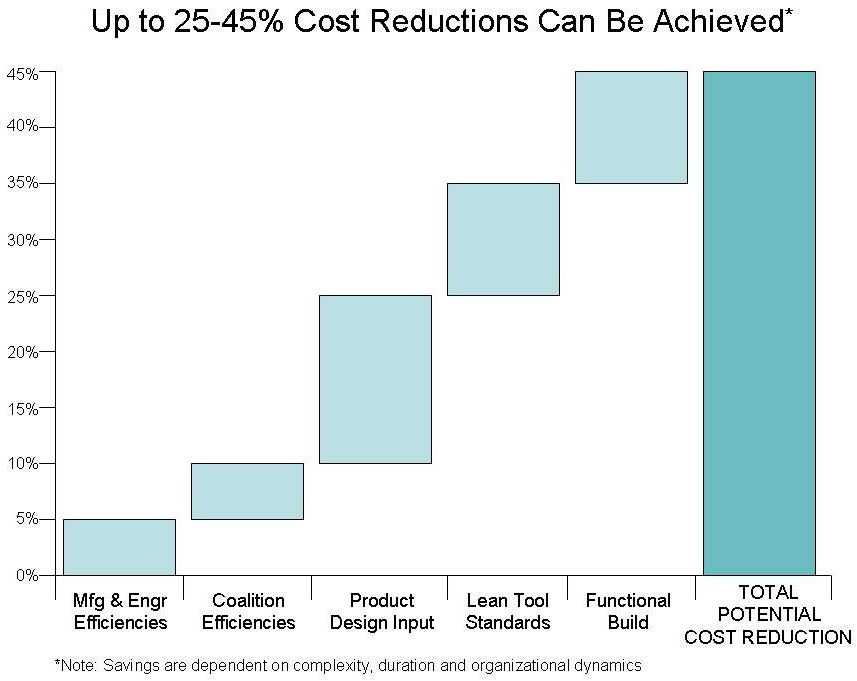
A group of automotive die and mold shops identified five key factors that, if employed, could achieve a cost savings of up to 45 percent. Although some of these activities could also be employed by LCCs, they would principally benefit the domestic TDMs. These activities are:

- Introducing lean manufacturing techniques in engineering, manufacturing, assembly and tryout. There are well-established lean principles that can be used, although since most are designed for high-volume operations, adjustments are needed for TDMs. General tools for visual management, reducing inventory and increasing order speed to delivery are effective strategies with a cost-saving potential of at least five percent.
- Coalition efficiencies that pool together coordinated resources (e.g., shared engineering, workload balancing, etc.) and group purchasing for a tooling coalition collaborative can achieve another three percent.
- Product design collaboration with tool customers can reduce engineering changes, tryout time, and other costs that drive up the total tool price. The

potential savings is significant (10 percent to 15 percent); however, this assumes that the customer is willing to entertain the effort. Many of the domestic TDMs possess the necessary knowledge. But, many customers resist early involvement (commitment) and too much influence by the tool source in product design.

- Lean tool standards can provide another five percent to 10 percent cost savings. Many TDM suppliers believe that tool design standards are overly stringent and over-engineer certain areas of tools, while under-engineering other areas. The TDM shops, in many cases, have greater knowledge about appropriate tool standards than their customers do. This savings opportunity is also customer-dependent if it is to be realized.
- Functional build (tooling tryout methodology) can save an additional five percent to 10 percent. Rather than trying to meet unnecessary Cpk buyoff requirements, functional build allows you to accept the tool when a quality assembly can be made. Again, this benefit requires the customer to accept a new methodology for trying out tools and validating them for production.

Figure 23: Possible Cost Reductions



We asked survey respondents to tell us in what areas they plan to concentrate their resources in the next five years. The highest ranked priorities were implementing a hybrid offshore sourcing model and attempting to broaden sales—both outside the United States and by diversifying their U.S. customer base.

Figure 24: Resource Priorities for the Next Five Years

Area	Priority (1=low, 3=high)
Hybrid offshore sourcing/design	3.00
Broaden sales outside United States	3.00
Diversify customer base	2.80
Build technical competencies (engineering & production)	2.54
Become more efficient by specializing in fewer process steps	2.40
Cut costs by implementing lean	2.33
Develop international partnerships to access lower-cost resources	1.83

The domestic TDMs, for the most part, do not see themselves wandering too far from the auto industry. As we saw in Figure 4 (page 13), most shops are introducing new products (65 percent) and seeking new customers (89 percent), but few are trying to break into new industries (31 percent). Having a more diverse customer base insulates shops from the directives of just a few customers and makes it possible for a shop to "fire" a customer if necessary. The most common customer diversification strategy with domestic TDMs has been to seek work from foreign automakers that have a domestic presence, as well as their suppliers. These include, for example, Toyota, Honda, Nissan, BMW, Daimler and Hyundai.

Most tool shops strive for close, collaborative relationships with their customers because it improves overall effectiveness and mutual profitability. Other surveys have shown that most domestic shops believe that domestic customers avoid close relationships and seek lower costs through competitive bidding rather than jointly working to reduce costs together. Although the foreign automakers in the United States tend to have more collaborative customer-supplier relationships, the urgency to reduce costs still prevails. Implementing lean techniques and visual workplace standards is a strategy that goes hand-in-hand with pursuit of new markets. Many of the "new domestic" automakers will only work with shops that have shown mastery of lean and full and open communication with the shop floor. It is difficult to ascertain the competitiveness of a tool maker, even after competitive bidding, since prices are often not correlated with costs. In lieu of selecting TDMs based on an absolute competitiveness scale, visual evidence of continuous improvement may be an overriding requirement.

On the other hand, those shops that serve just one or a few customers do become very good at responding to their customer needs. Such specialization is sometimes rewarded by the customer allowing priority consideration on new programs or more attractive financing terms. One domestic OEM has a tool vendor certification program whereby they work closely with "certified" shops on die design and standards, and shops are guaranteed payment on a specific date. The collaboration on design and standards means the tool is often made right the first time (or at least requires fewer changes), and the favorable payment terms make cash flow easier to manage for the small supplier shop. All participants in this program also meet regularly as a group with the customer to discuss the work being done, customer designs, and ways to make things

better. While the competitors are asked to share best practices with each other in these meetings, the participating shops do so knowing that in the long run the information may be shared by the customer anyway. This particular OEM takes a "total cost" view of its tooling program, and weighs the local support and service they receive as critical to the success of their operations. This OEM partnership includes an informal agreement among certified shops to share "best practices" in regular meetings with the customer.

Another strategy is to collaborate with other TDM shops directly—outside of the customer relationship. These tooling coalitions allow smaller shops to take part in bids on larger packages of tools, share best practices with each other, and pool resources to acquire new technology or other outside assistance. The bigger shops gain access to the specialization (and lower cost structure) of the smaller shops. The combined coalition also develops an economy-of-scale that shares costs, pools purchasing power, and obtains critical mass that helps gain the attention of large customers.

Some shops—either alone, or in cooperation with other shops—are finding it makes financial sense to send out small portions of their work to LCC suppliers. Sending our smaller parts of the work saves on engineering travel, as well as on-site management and shipping costs. One shop in the survey reports they are piloting sending their design work overseas to India (saving close to 50 percent), on this portion of their work, while another is offshoring their details and other smaller castings and tool components to Korea and Mexico, and a third is sending fabrication to a lower-wage country. The savings from these strategies vary from five to 10 percent of the total tool cost for offshoring design or details to 20 percent for contracting an LCC shop to do just fabrication. These strategies all move smaller suppliers into what is mostly unfamiliar territory with associated risks. A senior manager at the company that is offshoring design summed it up this way: "I don't think I could have imagined this kind of partnership even five years ago."[12] To the TDM shops' credit, they are exploring the feasibility of LCC savings in a controlled manner. Without question, the competitiveness and ease of offshoring will continue to increase over the next few years.

Another area of opportunity for the domestic tool industry is to stay at the cutting edge of tool technology. The quality and technical capability of domestic tool shops has seldom been questioned; the recent challenge has focused on cost reduction. Advancing technologies will only work to the domestic tooling shops' advantage. Technologies that are advancing so rapidly that they require the tool shops' focus include:

- New fabrication technologies (rapid tooling, sprayforming, etc.)
- Advanced materials (advanced high strength steels, aluminum, etc.)
- Digital engineering tools that help predict formability and springback (or shrinkage) characteristics of steel (or plastic)
- Rapid prototyping technologies for producing very low volumes of components used to validate product or tooling design

[12] "Ailing toolmakers turn to outsourcing," Detroit News, April 4, 2005

- Low volume tools that can produce quality components at lower production volumes and lower tooling investment costs

It has been a trend in the automotive industry for customers to source tools by packages (or a collection of tools that may or may not be related to each other). Respondents report that more and more, they are being asked to bid on packages of tools/dies/molds, rather than individual tools. Tools that are related in a package provide an opportunity to perform functional build, if the supplier will allow it. Again, functional build permits the "buyoff" of tools at the assembly level if they produce a dimensionally acceptable assembly. The individual parts may or may not meet individual requirements (often expressed as Cpk targets). This requires the tool supplier to develop the knowledge and systems necessary to perform a functional build, something that adds to the intellectual capability that supports their customer. (Normally, the customer has to perform some analogous activity anyway.) Remember that functional build saves, on the average, 10 percent of the tool cost.

Another critical skill that supports tooling packages is program management. One of the customers' objectives of sourcing tool packages is to outsource the management (expediting, administration, tryout, etc.) of tools, as well, since the tool supplier may not have the capability to produce some of the tools in the package. Just under half of the respondents reported that they only bid on tool packages if they can do a majority of the work inside their own shop—which means the other half plan to be program managers, subcontracting at least some of the work out to other shops. As program managers, these suppliers have an opportunity to present their customers with cost savings by subcontracting some (or even all) of the package to either domestic tooling specialists and/or LCCs. Several customers indicated that they would like the supplier to determine where the tools can be made most cheaply, recognizing that the supplier would bear the risk if tools were sent to an LCC and a tool failed. If LCCs are not used, the tool cost would not be competitive. The customer wants the domestic supplier to source tools to an LLC and still guarantee delivery and quality at an LCC price.

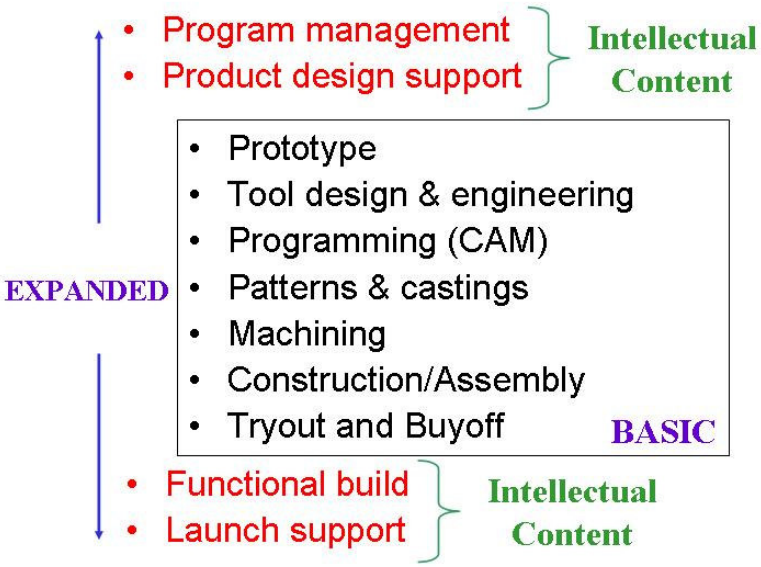
Conclusion

The major forces driving changes in the tooling industry stem largely from an excess in worldwide tooling supply and falling automotive market share, particularly by the domestic auto companies. The pressure will continue to reduce tool costs by significant amounts (40 percent to 50 percent). Some tools may not have to realize these cost reductions if the international capabilities do not exist (e.g., very large specialized tools that form new materials). By and large, world-class tool making capabilities will continue to reside in North America, Western Europe and Japan; but the capability gap with Southeast Asia (and other developing countries) will close faster than the increase in their labor rates. Automakers will also continue to reduce their dependency on specialized tools so that a greater percentage of them can be readily produced by lower skilled suppliers. Consequently, there will be more pressure to send additional domestic offshore to lower cost suppliers.

The international business model depicted earlier will continue to evolve with the following industry structure:

- Tooling Integrators
  - Tool and die integrators will continue to offer a broad range of tooling services to support the OEMs (particularly DaimlerChrysler, Ford and General Motors). This group of select companies has already consolidated, but will probably stabilize at about four or five die shops based in the mid-west (predominately Michigan), and about the same number of mold shops. These shops possess resources to address a broad range of tooling services involving program management (to coordinate internal, international and domestic outsourcing of tooling packages), engineering, machining and construction, assembly, tryout and low-volume production. Although their overall cost structures will be perceived as high, the service that they provide as the "go to" company for any tooling problem will give them a critical position in the industry.
  - Tooling integrators have been developing with extensive international networks of LCC suppliers. Tooling integrators are attempting to seek the lowest-cost solution to every aspect of tool building. The principal domestic presence is a sales office with limited technical capabilities, that provides the interface with customers and the rest of the integrator's network of LCC engineers, tool shops, and production sources. They may have relationships with domestic shops for the purpose of implementing engineering changes, providing limited production, and offering launch support and ongoing maintenance. These organizations target OEMs (particularly DaimlerChrysler, Ford and General Motors) and Tier 1 suppliers for tooling packages necessary to support the network of companies.
- LCC Tool & Engineering Shops
  These shops exist throughout developing countries, most notably in Southeast Asia (China, India, Taiwan, and Korea) and in Eastern Europe (Czechoslovakia, Romania, Hungary, etc). The capability of these shops to provide tooling and related services to the domestic industry varies today, but can be very good. Given the strong push by the domestic customers to encourage LCC development and use for tooling sources, the capability gap will continue to diminish. The cost-benefit tradeoff will continue to weigh foreign cost savings, inferior quality and risk from LCCs with higher cost, superior quality and minimal risk from domestic suppliers. Pricing for tooling in LCCs today and in the future will reflect market forces (more so than actual costs) and the perceived cost-benefit tradeoff. For example, engineering in India today is about one-half the cost of domestic engineering, but the perceived quality is perhaps 80 percent of the domestic quality in terms of errors and completeness to domestic standards. Over time, this quality differential may disappear or be reduced, but the cost advantage may also decrease. The labor-intensive aspects of tooling will likely be outsourced in significant quantities, such as engineering, machining (two-dimensional and three dimensional), assembly and preliminary tryout (e.g., spotting and nesting of dies). The more intellectually challenging and critical aspect of tool making (such as program management, design engineering, final tryout and implementation of engineering changes) will continue to be done more from local sources because of technical skills and proximity advantages.

Figure 25: Expanded Set of Products and Services Strategy



- Domestic Tool Shops
  These shops will continue to support both the domestic and foreign OEMs in North America in providing specialized services. Due to the cost pressures of LCCs, it will be difficult for the local shops to offer broad competitive services. In other words, they will become more niche providers. They will tend to offer a subset of tool operations, such as: engineering, tryout, prototype parts or tools, low volume production parts, and select machining operations (two or three dimensional machining, EDM, etc.). These shops will support the tooling integrators (providing their niche capability) and their traditional Tier 1 customers. On a limited basis, they will also source tooling, tooling details, engineering, etc. from LCCs. The strategic direction and scope of these shops' services will include, for example:
  - Technical knowledge regarding new, ever-advancing materials such as advanced high strength steels, aluminum, and composites. The challenges posed by new materials and coordination with the customer will justify the cost for close collaboration on tooling development.
  - General tooling design for lean tools or tools for creative part designs.
  - Digital advances in engineering for improved tool design that reduces problem solving on the shop floor and in tryout. Advances in mold design (e.g., stack molds), mold flow analysis and cooling (molds), and springback prediction, feasibility analysis, and trim development (dies) are critical areas today that are being developed domestically.

These “small” specialty shops will continue to compete by offering specialized services at competitive prices. Their ability to increase the value of these services while reducing prices will dictate how much tooling market share remains in North America. An estimate for the approximate tooling distribution today is one-third by the integrators (tooling and die integrators, and tooling integrators), one-third by the LCCs and one-third by the niche domestic shops.

Figure 26: Expanded Set of Products and Services Strategy Distribution

	LCC TDM Sources	TDM Integrators	Niche TDM Shops
Old	0%	50%	50%
Today	33%	33%	33%
In 5 Years - No Domestic Progress	60%	20%	20%
- Aggressive Domestic Progress	33%	33%	33%

Given the current trend and feedback by the customer base, additional significant cost reductions are required by the local tooling industry if work is to stay domestic. So an estimate for the future tooling market, in light of the current direction to increase offshore outsourcing, is 20 percent Integrators, 60 percent LCC, and 20 percent niche shops. The key strategies for the tool and die integrators and the niche shops to maintain market share locally is to increase technical competence and decrease costs (as described earlier) by:

- Continue aggressive implementation of lean practices. Practice continuous improvement, eliminate waste, and eliminate non-core activities. (Avoid the temptation to offer broad services because this drives up cost.) Experts from tooling facilities have continued to emphasize the need for the domestic shops to use all the resources at their facilities more efficiently. Tool shops must move away from the craftsmanship model toward the *synchronous* model with standardized design and processing.
- Seek outside support for aspects of niche tooling—consider as appropriate outsourcing to other niche shops or even LCCs: engineering, tool details, special machining/processing, tryout, etc.
- Work collaboratively with other tool shops to reduce costs (group purchasing, workload balancing to increase resource utilization, etc.)
- Continue technical advances in engineering, digital technologies, special tools for advanced materials, etc.

Managing today’s tool shop has become more sophisticated with complex international and financial considerations. Most domestic customers will tolerate a marginal premium (about five percent) for domestically made tools, but the 25 percent cost disadvantage is too much to endure. As the tooling industry would point out, the system cost perspective would further reduce the 25 percent advantage, but most customers choose to dismiss this theory. System costs (looking at costs out of different accounts) would consider risks from poor quality or late tools, launch delays, increased maintenance costs, reduced production rates, etc. While there is clearly some merit to these concerns

today, these problem situations will slowly diminish as the LCCs gain experience which is being encouraged by the domestic customers. The domestic shops wish to continue to emphasize their relationship advantage due to historical experience and close-communication, but at the same time the customers are trying to discount this experience base. Significant costs could be eliminated through better customer-supplier collaboration, but many customers have shown little desire to modify their practices (for example, introducing more consistent product/tool designs, working for a functional build buyoff, etc.). In some ways, the international prices are being used as leverage by the customers to motivate the domestic tooling industry to cut costs. There will be very small demand for shops that are not lean as the LCCs slowly gain experience.

As many analysts have pointed out, a procurement approach dominated by looking at short-term cost differentials exposes customers to high levels of risk. Should the dollar move lower, as large fiscal and trade deficits suggest it yet may, the economics would change drastically. While large OEMs are hedged against such events, most small (and some large) tool shops are not.

Should global geopolitics change, OEMs may come to rue decisions that—however well-intentioned and focused on bringing products to market at lower cost they may have been—also had the effect of reducing onshore capacity to produce the tools on which their consumer products depend.

At the very least, we believe that our analysis should cause the auto industry—and, by extension, other industries in which the allure of offshoring is gaining strength—to keep more options on the table. Offshore tool buys may have a place in OEM strategy, but there are ample grounds for avoiding placing too many eggs in that one basket. We invite serious people across the industry to join in the developing dialogue about the future of the tooling sector in our industry and our economy.

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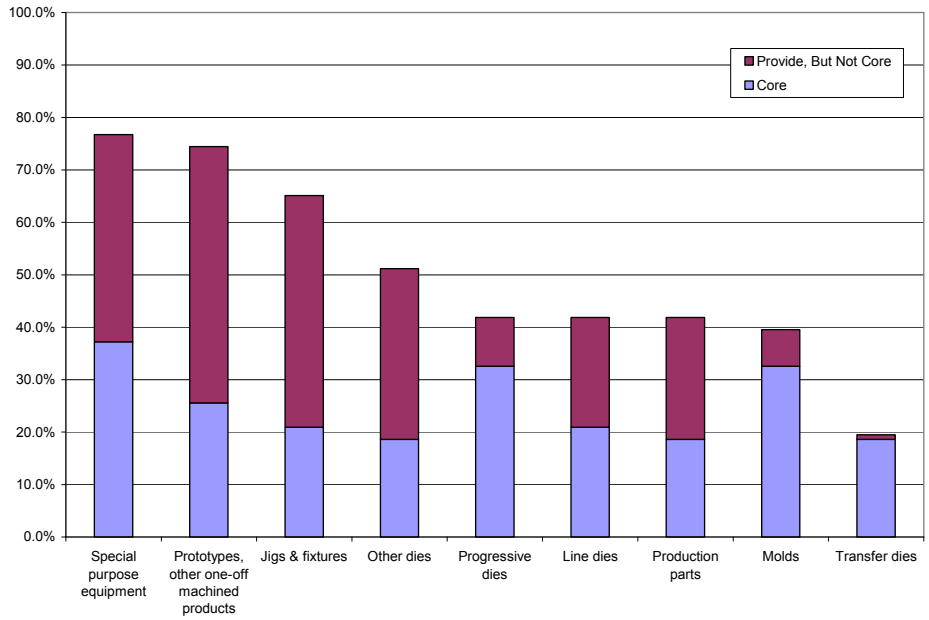
Appendix I: Additional Survey Findings

Demographics

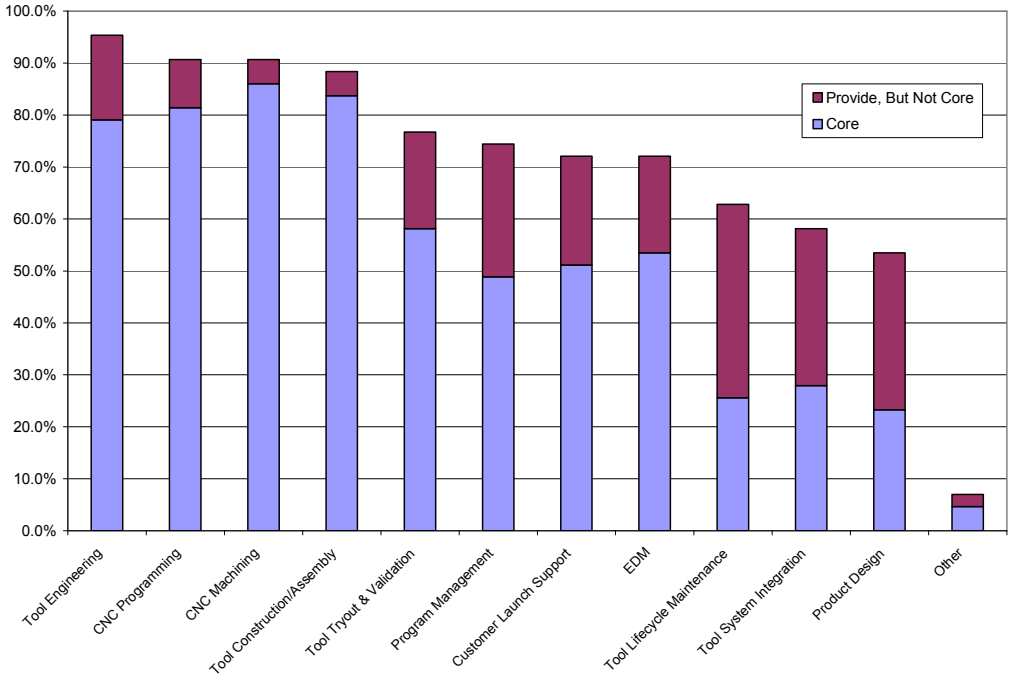
By and large, respondents report that they make special purpose equipment, prototypes/other one-off machined products, and jigs & fixtures. However, looking only at those products considered "core", the group is fairly evenly divided among special purpose equipment makers, progressive die shops, and mold makers.

Figure I: Core Products



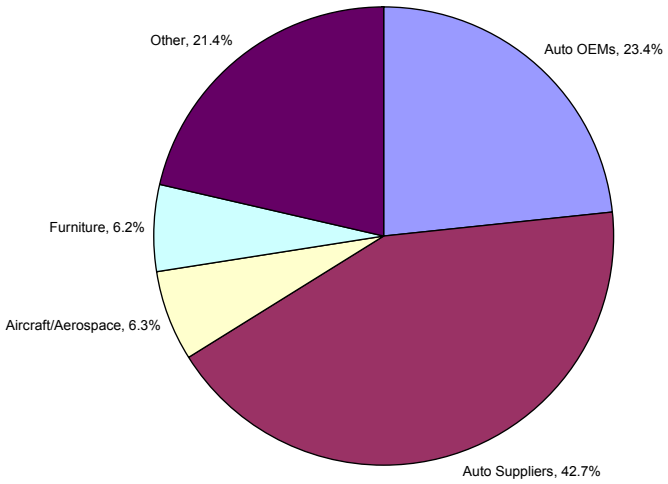
As a group, the tooling survey respondents report that they have broad capabilities in all areas of tool, die and mold making, with the four main current "core" areas being tool engineering, CNC programming, CNC machining, and tool construction/assembly. Nearly all of the respondents have capabilities in design of both 2-D (93 percent) and 3-D solids (86 percent), and over half of those who have the capability consider it a core offering. Program management is also very prevalent (69.8 percent), and feasibility analysis software seems to be taking hold (48.8 percent).

Figure II: Core Processes



All of the tool shops in the survey supply the automotive industry in some fashion. The following chart shows the average shop in the survey's percent of sales by industry. Note that, for the average firm, automotive sales constitute two-thirds of their overall business. In fact, 86 percent of survey respondents report being dependent upon the auto industry for 50 percent or more of their total sales.

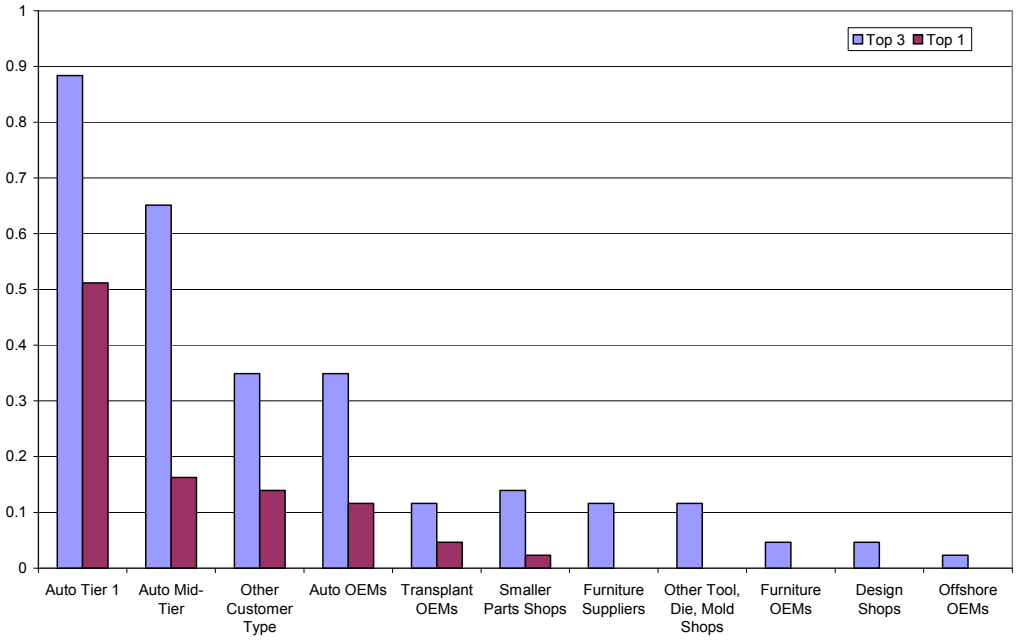
Figure III: Average Tool Shop Sales Breakdown



Customers

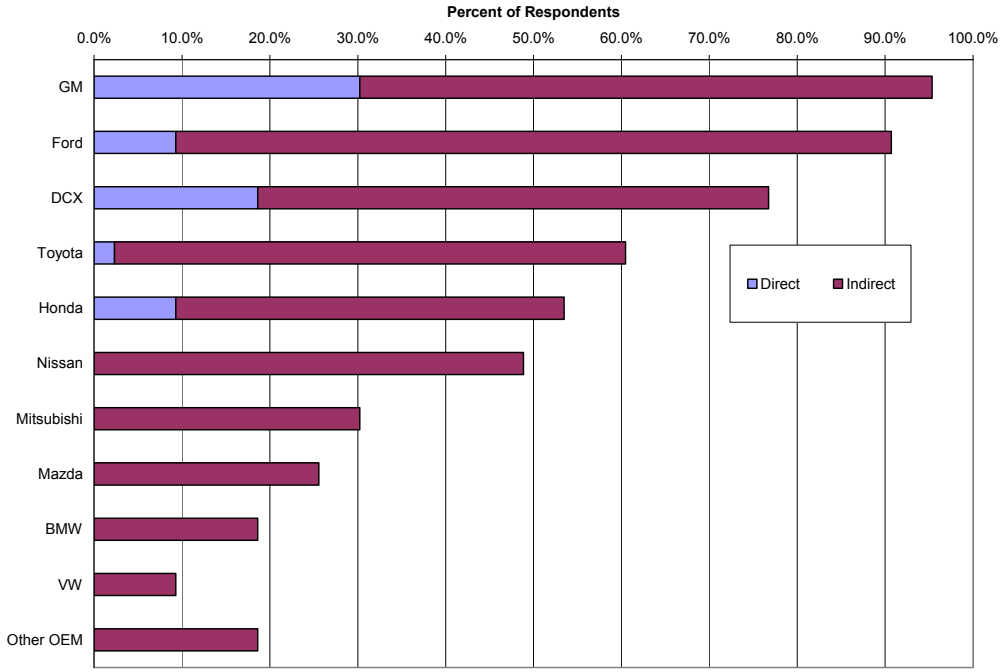
For the most part, tooling suppliers who responded to this survey serve the automotive Tier 1 and Mid-Tier suppliers, although nearly half (46.5 percent) report that the Big Three automotive OEMs are among their top three customers in terms of sales. Aerospace was the most frequently mentioned “other” primary customer.

Figure IV: Largest Primary Customers



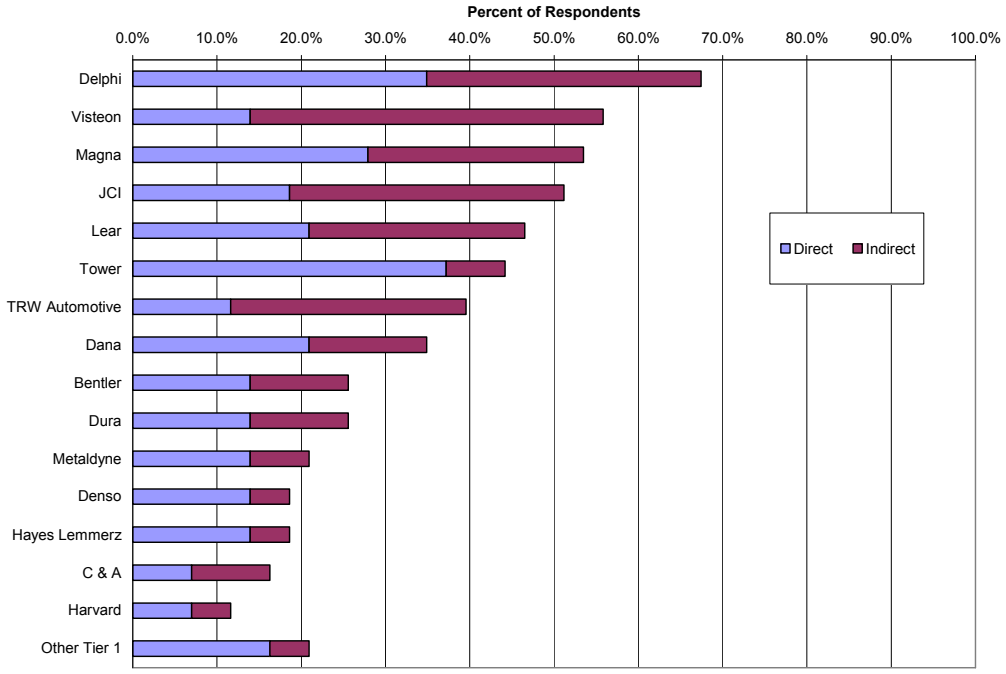
Not surprisingly, most of the Michigan tool shops in our survey supply the Big Three. In fact, over 95 percent of the survey respondents supply General Motors, either directly or indirectly. Over 50 percent of respondents report supplying the largest of the "new domestics"—Toyota and Honda. OEMs mentioned in the "other" category include Mercedes (n=3), Hyundai (n=2), and Subaru (n=1).

Figure V: Which Automotive OEMs?



Also not surprisingly, more Michigan tool shops in our survey supply the Tier 1 suppliers directly than those that sell directly to the OEMs. Over 50 percent of respondents report supplying Delphi, Visteon, Magna and JCI. Sixteen Tier 1 suppliers mentioned in the "other" category, among them: Budd, American Axle, and Bosch.

Figure VI: Which Automotive Tier 1's?



Suppliers

The trend toward buying more from offshore suppliers and service providers is evident in the survey results. Most tool shops expect to reduce the percent of design & engineering, raw materials, supplies, components and machining (or details) purchased from suppliers within 250 miles, and at the same time increase their purchases of these same items from offshore suppliers. While offshore purchases of raw material, supplies and components is expected to increase 151 percent in the next five years, and design & engineering 183 percent—offshore outsourcing of machining (or details) is expected to increase 3,500 percent in the next five years.

Figure VII: Percent of Purchases by Geographic Location

	Purchased From Suppliers Within 250 Miles		Purchased From Suppliers Located Outside North America	
	Past Year	5 Years From Now	Past Year	5 Years From Now
Design & Engineering	87.6%	75.4%	4.2%	11.9%
Raw Material, Supplies, Components	87.1%	74.8%	7.1%	17.8%
Outsourced Machining or Details	95.1%	76.6%	0.4%	14.4%

Many tooling customers have special purchasing programs for minority-owned and women-owned suppliers, and while tool shops in this survey expect to increase their work with these supplier groups, the gains do not come close to the over 100 percent increase in the number of respondents who plan to work with LCC suppliers in the next 3-5 years.

Figure VIII: Percent of Respondents Who Work With Minority-Owned, Women-Owned or LCC Suppliers

	Currently Work With	Plan to Work With in Next 3-5 Years	Our Shop is Classified in This Category
Minority-owned	37.2%	46.5%	7.0%
Women-owned	37.2%	41.9%	11.6%
LCC	20.9%	41.9%	2.3%

Capabilities

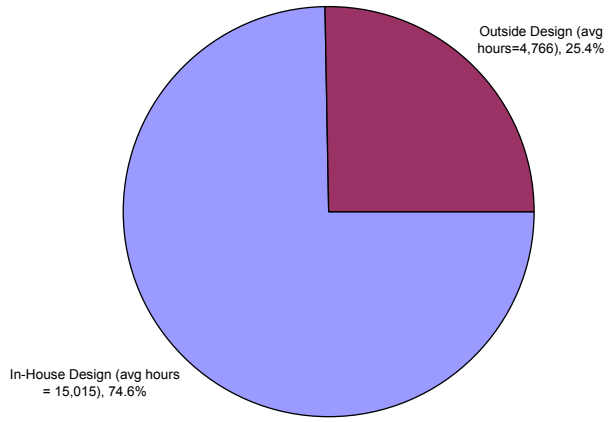
Respondents are clearly looking to upgrade their capabilities. On average, the highest priority areas targeted for growth were sales, tool design, 3-D solids design software and quoting accuracy.

Figure IX: Upgrade Priorities

	Mean Upgrade Priority (1=Lower, 5=Higher)
Sales	4.00
Tool Design	4.00
3-D Solids Design Software	3.70
Quoting Accuracy	3.59
Program Management	3.27
Engineering Change Management	3.11
High-Speed (RPM=25K+) 5-Axis Machine Tools	2.92
5-Axis Machine Tools	2.89
Feasibility Analysis Software	2.78
Process Design Standardization	2.78
Product Engineering	2.22
Tryout Presses	2.03

Tool, die and mold shops in this survey report that they outsource design on over one-in-four jobs.

Figure X: Design Outsourcing



While most respondents have invested in new or upgraded software and machinery, fewer have looked to outsourcing as a competitiveness strategy, and even fewer still have changed the materials they use or the materials their tools form. With high-strength steel, composites, and other new materials gaining in usage, looking to add capabilities in materials may provide a future competitive edge.

Figure XI: Competitiveness Strategies, Past Three Years

	Percent of Respondents
Bought new/upgraded software	90.7%
Bought new/upgraded machinery	86.0%
Outsourced machining/build work we used to do internally	44.2%
Changed the types of materials we use	44.2%
Outsourced design work we used to do internally	34.9%
Changed the types of materials our tools/dies/molds can be used to form	18.6%

We know that North American tooling suppliers are often asked to support tools that they did not build. We asked respondents to tell us what types of support they provide for these tools, and how many of the tools that they are asked to support were built offshore. Maintenance and engineering change orders were the most common types of support provided by survey respondents, and roughly 15 to 20 percent of the tools supported were built offshore.

Figure XII: Supporting Tools the Supplier Did Not Build

	Support	For Those Who Support Tools They Did Not Build, Average % Built Offshore
Implementing Engineering Changes	42.9%	20.5%
Tryout	28.6%	14.5%
Launch Support	32.4%	14.5%
Maintenance Support	47.1%	16.1%

Many shops report they make their margins on current tooling work by getting paid for engineering change orders (ECOs). We asked respondents to tell us if they negotiate a fee for all ECOs or if they negotiate a pre-incident rate. It is interesting to note that most tooling suppliers negotiate their payment for ECOs after the job has been completed, rather than in advance.

Figure XIII: Engineering Change Order Costs

Payment Method	% Yes	Of those who do, % who negotiate in advance
Total Engineering Change Orders	62.8%	29.6%
Rate Per Incident Engineering Change Orders	53.5%	17.4%

Most survey respondents report that they calculate direct material, tooling, and engineering/design labor separately for each job, and factory indirect labor, order processing and inventory holding costs are rolled into these shops' hourly (usually) billing rates.

Figure XIV: Approaches to Cost Estimation

	Calculate Separately For Each Job	Sometimes Adjust Usual Rates or Add Special Mark-Up	Included in Usual Hourly Billing Rates	NA
Direct Material	83.7%	11.6%	0.0%	0.0%
Tooling	58.1%	11.6%	18.6%	4.7%
Engineering/Design Labor	83.7%	4.7%	7.0%	0.0%
Factory Indirect Labor	32.6%	4.7%	51.2%	7.0%
Order Processing	18.6%	7.0%	60.5%	9.3%
Inventory Holding Costs	9.3%	11.6%	53.5%	20.9%

We asked respondents to tell us what types of information they are required to report to their largest customer. The tooling invoice is required for over 70 percent of tool shops in this survey. Other types of information are required less frequently by tooling customers.

Figure XV: Cost Reporting to Largest Customer

Information	Percent of Respondents Whose Largest Customer Requires This Info
Tooling Invoice	72.1%
Log of ECOs	48.8%
Construction Standard	46.5%
Hourly Rates	37.2%
Other	20.9%
Labor Reports	11.6%

CENTER FOR AUTOMOTIVE RESEARCH

Appendix II

World Class Tool Shop Supplier Survey

We understand that those who are in the business of supplying tools/dies/molds to industry are facing fierce competition from off-shore suppliers, and significant pressures from customers to change the way you do business. In this changing business environment, many domestic tool shops are wrestling with identifying and developing their core competencies, trying to understand what types of business relationships they should be developing to best serve their customers, and learning what will be required to be competitive in terms of cost, lead time, personnel, engineering capabilities and resources, and capital investments.

Through this study, we are surveying your customers to learn their views on the future direction of the domestic tool/die/mold industry. At the same time, we would like you to tell us what it is you are doing internally to help move your company toward increased competitiveness and long-term viability. This research is supported by the State of Michigan, through the Michigan Economic Development Corporation. Individual company answers will not be disclosed outside of the research team unless you specifically grant permission to do so to the Center for Automotive Research.

To receive a copy of the research results, please check here: ☐

If you have any questions, please contact Kristin Dziczek (kdz@cargroup.org or 734-929-0469) or Dr. Jay Baron (jbaron@cargroup.org or 734-929-0470) Please return the survey to:

When completed, please return the survey to:

World Class Tool Shop Survey
Center for Automotive Research
1000 Victors Way, Suite 200
Ann Arbor, MI 48108
FAX: 734-662-5736

Name:		
Company:		
Address:		
City:	*ST:*	*ZIP:*
Phone:	*Email:*	

Thank you for your participation.

SECTION 1: YOUR CUSTOMERS

During the past year, approximately what percent of sales were to:

	Percent of Sales
1101. Automakers	%
1102. Auto suppliers	%
1103. Aircraft/aerospace companies & suppliers	%
1104. Makers of computer, communications, or electronic equipment and their suppliers	%
1105. Furniture makers and their suppliers	%
1106. Medical	%
1107. Companies in other industries	%
1108. The public—final consumers, wholesalers, or retailers (as opposed to other manufacturers)	%
TOTAL	100%

What are the top three types of customers to whom you **primarily** sell? (Rank the top three where 1=largest percent of sales)

	Rank Top Three
1109. Domestic Automotive OEMs	
1110. Transplant Automotive OEMs	
1111. Off-shore Automotive OEMs	
1112. Automotive Tier 1 suppliers	
1113. Automotive Mid-Tier suppliers	
1114. Furniture OEMs	
1115. Furniture suppliers	
1116. Design shops	
1117. Smaller parts stamping/molding shops	
1118. Other tool/die/mold shops	
1119. Other customer type: _____	

What factors do you think your primary type of customer (the one you ranked as #1 in Q1109-19 above) value in their tool/die/mold purchases?

Factors	*Lower ← Importance → Higher*
1120. Price	1 2 3 4 5
1121. Quality/durability	1 2 3 4 5
1122. Tooling complexity	1 2 3 4 5
1123. Tight tolerances	1 2 3 4 5
1124. Company size	1 2 3 4 5
1125. Company financial stability	1 2 3 4 5
1126. Historical performance	1 2 3 4 5
1127. R & D capability	1 2 3 4 5
1128. Engineering capability	1 2 3 4 5
1129. Project management	1 2 3 4 5
1130. Delivery performance	1 2 3 4 5
1131. Skills	1 2 3 4 5
1132. Specialization	1 2 3 4 5
1133. Financial structuring	1 2 3 4 5
1134. Superior technology	1 2 3 4 5
1135. Proximity to design	1 2 3 4 5
1136. Proximity to production	1 2 3 4 5
1137. Lead time performance	1 2 3 4 5
1138. Full service capability	1 2 3 4 5

Which automotive OEMs are the customers of your tools/dies/molds Indicate if you supply each OEM directly, indirectly, or not at all. (if you do not serve automotive OEMs, please skip to Q1150

	Direct	*Indirect*	*Do not supply*
1139. GM	☐	☐	☐
1140. Ford	☐	☐	☐
1141. DCX (for Chrysler)	☐	☐	☐
1142. Toyota	☐	☐	☐
1143. Honda	☐	☐	☐
1144. Nissan	☐	☐	☐
1145. Mazda	☐	☐	☐
1146. Mitsubishi	☐	☐	☐
1147. BMW	☐	☐	☐
1148. VW	☐	☐	☐
1149 Other: _____	☐	☐	☐

Which automotive Tier 1's are the customers of your tools/dies/molds? Indicate if you supply each Tier 1 directly, indirectly, or not at all. (if you do not serve automotive Tier 1's, please skip to Q1166)

	Direct	*Indirect*	*Do not supply*
1150. Bentler	☐	☐	☐
1151. Collins & Aikman	☐	☐	☐
1152. Dana	☐	☐	☐
1153. Delphi	☐	☐	☐
1154. Denso	☐	☐	☐
1155. Dura	☐	☐	☐
1156. Harvard	☐	☐	☐
1157. Hayes Lemmerz	☐	☐	☐
1158. JCI	☐	☐	☐
1159. Lear	☐	☐	☐
1160. Magna	☐	☐	☐
1161. Metaldyne	☐	☐	☐
1162. Tower	☐	☐	☐
1163. TRW Automotive	☐	☐	☐
1164. Visteon	☐	☐	☐
1165. Other: _____	☐	☐	☐

Which furniture OEMs are the customers of your tools/dies/molds? Indicate if you supply each OEM directly, indirectly, or not at all. (if you do not serve furniture OEMs, please skip to Section 2, Q2101)

	Direct	*Indirect*	*Do not supply*
1166. Haworth	☐	☐	☐
1167. Herman Miller	☐	☐	☐
1168. Steelcase	☐	☐	☐
1169. Other: _____	☐	☐	☐

SECTION 2: YOUR SUPPLIER RELATIONSHIPS

In the past year, approximately what percent of your purchases were from supplier locations within 250 miles (400km) of your plant? What do you estimate this percentage to be five years from now? How much from outside North America (U.S., Canada, Mexico)? What do you estimate this percentage to be five years from now?

	Purchased from suppliers within 250 miles (400km)		*Purchased from suppliers located outside North America*	
	Past Year	*5 Years From Now*	*Past Year*	*5 Years From Now*
Design & engineering	2101.	2102.	2103.	2104.
Raw material, supplies, components	2105.	2106.	2107.	2108.
Outsourced machining or details	2109.	2110.	2111.	2112.

SECTION 3: YOUR CAPABILITIES

Which of the following do you consider your core product(s)?

Type of tool/die/mold	*Core*	*Provide, but not core*	*Do not provide*
3101. Progressive dies	☐	☐	☐
3102. Transfer dies	☐	☐	☐
3103. Line dies	☐	☐	☐
3104. Other dies	☐	☐	☐
3105. Molds	☐	☐	☐
3106. Prototypes, other one-off machined products	☐	☐	☐
3107. Jigs & fixtures	☐	☐	☐
3108. Special purpose equipment	☐	☐	☐
3109. Production parts	☐	☐	☐

What processes do you consider your core expertise?

Core	*Core*	*Provide, but not core*	*Do not provide*
3110. Product design	☐	☐	☐
3111. Tool engineering	☐	☐	☐
3112. Program management	☐	☐	☐
3113. CNC machining	☐	☐	☐
3114. CNC programming	☐	☐	☐
3115. EDM	☐	☐	☐
3116. Tool construction/assembly	☐	☐	☐
3117. Tool tryout & validation	☐	☐	☐
3118. Tool system integration	☐	☐	☐
3119. Customer launch support	☐	☐	☐
3120. Tool lifecycle maintenance	☐	☐	☐
3121. Other: _____	☐	☐	☐

Which of the following engineering tools/software packages does your shop have, and which are considered among your shop's core capabilities?

Core	*Have*	*Core capability*	*Do not have*
3122. Program management	☐	☐	☐
3123. 2-D design	☐	☐	☐
3124. 3-D solids design	☐	☐	☐
3125. Feasibility analysis	☐	☐	☐
3126. Other: _____	☐	☐	☐

Next, we'd like to know how expectations for tool performance are changing. Please answer the following questions with data representing expectations 5 years ago, current, and what you expect it to be 5 years from now.

	5 Years Ago	*Current*	*5 Years From Now*
3127-29. Typical tolerances Check one: ☐ in ☐ mm			
3130-32. Production part approval Check one: ☐ PPAP ☐ Cpk			
3133-35. Production part approval: number of checkpoints			
3136-38. Frequency of engineering change orders: low/med/high			
3139-41. Complexity of engineering change orders: low/med/high			
3142-44. Tool design standards: lean/ moderate/over-engineered			
3145-47. Lead time: number of months			

Thinking about the tools/dies/molds your company has built in the past year, please describe the characteristics (e.g. amount of engineering, geometry, number of details, etc.) of the following general tooling types:

3148. "Simple" tools/dies/molds (requires basic tool making knowledge):

_____
_____
_____
_____
_____
_____
_____

3149. What percent of your sales are represented by these "simple" tools/dies/molds? _____%

3150. "Complex" tools/dies/molds (requires extensive tool making experience and technical expertise):

_____
_____
_____
_____
_____
_____
_____

3151. What percent of your sales are represented by these "complex" tools/dies/molds? _____%

For a typical "simple" tool/die/mold (reference your answer to Q3148) going into production in the NAFTA zone, please identity how your company would propose sourcing the tooling by function:

	Do Internally	*Within NAFTA*	*Low-Cost Country**	*Other*
3152. Product engineering	☐	☐	☐	☐
3153. Process engineering	☐	☐	☐	☐
3154. Patterns/castings	☐	☐	☐	☐
3155. Programming machine tools	☐	☐	☐	☐
3156. Running machine tools	☐	☐	☐	☐
3157. Assembly of tool	☐	☐	☐	☐
3158. Tryout	☐	☐	☐	☐
3159. Implementing engineering change orders	☐	☐	☐	☐
3160. Launch support	☐	☐	☐	☐
3161. Maintenance support	☐	☐	☐	☐

* By Low Cost Country, we mean China, India, much of Southeast Asia, Eastern Europe, Mexico and Central and South America.

For a typical "complex" tool/die/mold (reference your answer to Q3150) going into production in the NAFTA zone, please identity how your company would propose sourcing the tooling by function:

	Do Internally	*Within NAFTA*	*Low-Cost Country*	*Other*
3162. Product engineering	☐	☐	☐	☐
3163. Process engineering	☐	☐	☐	☐
3164. Patterns/castings	☐	☐	☐	☐
3165. Programming machine tools	☐	☐	☐	☐
3166. Running machine tools	☐	☐	☐	☐
3167. Assembly of tool	☐	☐	☐	☐
3168. Tryout	☐	☐	☐	☐
3169. Implementing ECOs	☐	☐	☐	☐
3170. Launch support	☐	☐	☐	☐
3171. Maintenance support	☐	☐	☐	☐

Do your customers hire you to provide pre-production support for tools/dies/molds you did not build? If so, what percent of the tools/dies/molds that you support were built offshore?

	Support	*% Tools/Dies/Molds You Support That Were Built Offshore*
Implement engineering changes	3172. ☐ Yes ☐ No	3173. %
Tryout	3174. ☐ Yes ☐ No	3175. %
Launch support	3176. ☐ Yes ☐ No	3177. %
Maintenance support	3178. ☐ Yes ☐ No	3179. %

Do your customers typically ask you to bid on individual tools/dies/molds separately, or do you quote packages of tools/dies/molds at one time? Do you see this practice changing in the next 3-5 years?

	Currently	*In 3-5 Years*
3180-81: We are asked to bid on each individual tool/die/mold separately	☐ Yes ☐ No	☐ Yes ☐ No
3182-83: We are asked to bid on packages of tools/dies/molds	☐ Yes ☐ No	☐ Yes ☐ No

If you are currently being asked to bid on packages of tools/dies/molds, do you only bid on those jobs where you could do a majority of the work inside your own shop, or do you bid on jobs planning to manage a group of shops (including your own) to complete the entire job?

3184. ☐ Only bid where can do majority of work inside

☐ Bid & plan to manage a group of shops to do the work

Do your customers buy off on the tools/dies/molds you make individually, or do they instead consider whether or not the entire assembly meets all functional requirements (including those parts you may not have had a role in producing)? [This process is also known as "functional build."]

3185. ☐ Customers buy-off each tool/die/mold individually

☐ Customers buy-off on entire assembly

3186. What total tool savings do you estimate your customers might realize by using functional build? _____%

SECTION 4: YOUR TECHNOLOGY, DESIGN & ENGINEERING

Are you currently constrained by your internal capacity, and therefore must outsource some of your tooling and mold making in the short term? (Refer to Section 3, Q3146 & 3148 for the definitions of "simple" and "complex" tooling)

	Constrained (Please identify constraint)	*Not Constrained*
4101. Simple Tools/ Dies/Molds	☐ _____ _____	☐
4102. Complex Tools/ Dies/Molds	☐ _____ _____	☐

In the next 3-5 years, in which in-house tool/die/mold-making areas are you planning to grow? Stay the same? Shrink?

Area	*Simple Tools/ Dies/Molds*			*Complex Tools/ Dies/Molds*		
	+	=	-	+	=	-
Program Management	4103. ☐	☐	☐	4104. ☐	☐	☐
Design	4105. ☐	☐	☐	4106. ☐	☐	☐
Engineering	4107. ☐	☐	☐	4108. ☐	☐	☐
Machining	4109. ☐	☐	☐	4110. ☐	☐	☐
Assembly	4111. ☐	☐	☐	4112. ☐	☐	☐
Tryout	4113. ☐	☐	☐	4114. ☐	☐	☐
Maintenance	4115. ☐	☐	☐	4116. ☐	☐	☐
Other: _____ _____	4117. ☐	☐	☐	4118. ☐	☐	☐

In your opinion, what areas of technology, design and engineering are your company's highest priorities to upgrade? (1=low priority, 5=high priority, circle one per line)

Area	*Lower ← Priority → Higher*
4119. Program management	1 2 3 4 5
4120. Engineering change management	1 2 3 4 5
4121. Quoting accuracy	1 2 3 4 5
4122. 5-axis machine tools	1 2 3 4 5
4123. High-speed (RPM=25K+) 5-axis machine tools	1 2 3 4 5
4124. Tryout presses	1 2 3 4 5
4125. 3-D solids design software	1 2 3 4 5
4126. Feasibility analysis software	1 2 3 4 5
4127. Product engineering	1 2 3 4 5
4128. Process design standardization	1 2 3 4 5
4129. Other: _____ _____	1 2 3 4 5

Of your "one-to-an-order" sales—dies, molds, prototypes, etc.—about what percent were:

	Percent one-to-an-order sales
4130. Design only	%
4131. Design & build	%
4132. Build only	%
4133. Tryout only	%
TOTAL	100%

How much of your design work do you perform in-house? How much do you contract out?

	Percent of Jobs	*Approximate Total Hours*
4134-35. In-house	%	
4136-37. Outside design	%	

Did you do any solid modeling at this location in the past year?

4138. ☐ Yes ☐ No

Did you do any computer-aided engineering (CAE) analyses such as finite element analysis, circle grid analysis, mold flow analysis, kinematics, etc., at this location in the past year?

4139. ☐ Yes ☐ No

Roughly what is the replacement value of all the machines and equipment you use? Please include the value of machines that you lease as well as those you own. By replacement value, we mean that if you have a 20-year-old machine, how much it would cost to replace it with a roughly identical 20-year-old machine. (Please do NOT include the value of your building or land, and do NOT report book value.)

Replacement value: 4140. $_____

The following questions ask about your core metal-removal equipment—your lathes, mills, EDMs, etc. Do NOT include any presses or other non-metal removal equipment. Also, do NOT include machines used mainly for tryout.

How many such core metal removal machines do you have? 4141._____

How many of these are:

	Number of Machines
4142. Less than 5 years old?	
4143. 5 or more years old, but substantially upgraded in the last 5 years?	
4144. More than 20 years old?	

How many have the following features?

	Number of Machines
4145. NC or CNC, including EDM	
4146. 3 or more axis	
4147. High RPM (25K+)	

How many of your NC or CNC machines—if you have any—have built-in measurement devices such as touch-probes?

	Number of Machines
4148. Built-in measurement devices	
No CNC	☐

Next, enter the approximate:

	Percent of Cutting Tools
4149. Percent of cutting tools that are in quick-change holders	%
4150. Percent of cutting tools that are pre-set	%

How many hours in the past year were your shop doors open for production? [*Example*: Open for two 8-hour shifts per day, 5 days per week, 50 weeks per year. Answer = 4000 hours]

Hours Open: 4151. _____ hours

How many hours in the past year were machines actually running? (By "running," we mean actual metal-removal time.) DO NOT include any hours that the machines were idle or waiting, such as setup time, maintenance time, idle time due to the operator being on break or unavailable, time waiting for material, time waiting for resolution of quality problems, etc.

Hours Running: 4152. _____ hours

Is your answer based on data you track, or is it an estimate? (Check one.) 4153. ☐ Data ☐ Estimate

SECTION 5: STRATEGIES

During the past year, what proportion of your sales was of products you didn't make 3 years ago? What proportion of your sales was to customers not served 3 years ago? What proportion to industries not served 3 years ago?

Percent of Sales from:		
New Products	*New Customers*	*New Industries*
5101. %	5102. %	5103. %

Do you currently work with other shops that are minority-owned, women-owned, or located in a low-cost country (LCC)? Do you plan to develop any such relationships in the next 3-5 years?

Type of Shop	*Currently Work With*	*Plan to Work With in Next 3-5 Years*	*Our Shop is Classified in This Category*
5104-6. Minority-owned	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
5107-9. Woman-owned	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
5110-2. LCC	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No

In the past 3 years, what changes have you made in order to try to remain competitive?

Area	*Made This Change*
5113. Bought new/upgraded machinery	☐ Yes ☐ No
5114. Bought new/upgraded software	☐ Yes ☐ No
5115. Outsourced design work we used to do internally	☐ Yes ☐ No
5116. Outsourced machining/build work we used to do internally	☐ Yes ☐ No
5117. Changed the types of materials we use	☐ Yes ☐ No
5118. Changed the types of materials our tools/dies/molds can be used to form	☐ Yes ☐ No

Thinking about the next 5 years, what are your priorities in distributing your resources in order to build your competencies?

	Priority		
	Low	*Medium*	*High*
5119. Diversify customer base	☐	☐	☐
5120. Build technical competencies (engineering & production)	☐	☐	☐
5121. Cut costs by implementing lean	☐	☐	☐
5122. Develop international partnerships to access lower-cost resources	☐	☐	☐
5123. Become more efficient by specializing in fewer process steps	☐	☐	☐
5124. Other:_____	☐	☐	☐

Do you have an active program to standardize product and process design?

5125. ☐ Yes ☐ No

SECTION 6: FINANCES

During the past year, what were your sales? How about 2 years before that?

	Most Recent Year (e.g., calendar 2004)	*2 Years Before That (e.g., calendar 2002)*
Total sales	6101. $	6102. $

In your opinion, what percent of the work now done at this location do you estimate is likely to be done elsewhere 3-5 years from now (regardless of by whom)?

6103. Percent elsewhere 3-5 years from now: %

In your opinion, what percent of the work now done at this location do you estimate is likely to be done in low-cost countries 3-5 years from now?

6104. Percent in low-cost countries 3-5 years from now: %

What was your total spending on payroll and benefits in the past year? (*Include* payments for Social Security, Medicare, bonuses, overtime, healthcare, pension plans, and other fringe benefits. *Exclude* any payments made to people who are not your employees.)

6105. Total payroll and benefits:	$

What was your total spending out outside services, material, and supplies in the past year?

	Total Spending
Design & engineering	6106. $
Raw material & supplies	6107. $
Outsourced machining or details	6108. $

On average during the past year, what were your receivables—the amount that your customers owed you?

6109. Total receivables:	$

Do any of your customers only pay you for tooling after they start using it in production mode?

6110. ☐ Yes ☐ No

Roughly what percent of your sales were to customers with whom you have an arrangement for "progressive payments"? That is, on what percent of your sales, did you receive some payment after the initial down payment but before shipment?

6111. Percent of sales with "progressive payments":	%

How detailed is your approach to cost estimation? Specifically, which cost components do you calculate separately for each new job? Which costs do you typically NOT calculate separately, but sometimes adjust for unusual jobs? Please check one box per row. Check "NA" for any costs that do not apply to your business, or for items that are bought and owned directly by your customers ("consigned").

	Calculate Separately for Each Job	*Sometimes Adjust Usual Rates or Add Special Mark-up*	*Included in Usual Hourly Billing Rates*	*NA*
6112. Direct material	☐	☐	☐	☐
6113. Tooling	☐	☐	☐	☐
6114. Engineering/ design labor	☐	☐	☐	☐
6115. Factory indirect labor	☐	☐	☐	☐
6116. Order processing	☐	☐	☐	☐
6117. Inventory holding costs	☐	☐	☐	☐

We are interested in the general distribution of your cost of tooling across the following categories. Please indicate what percent of your tool/die/mold cost is spent on the following elements:

Cost Element	*% of Total Tool/Die/Mold Cost*	*Not Applicable*
6118. Labor	%	☐
6119. Raw material	%	☐
6120. Components	%	☐
6121. Capital expense	%	☐
6122. Engineering services	%	☐
6123. Freight	%	☐
6124. Duty/taxes	%	☐
6125. Sales representative	%	☐
6126. Launch support	%	☐
6127. Maintenance	%	☐
6128. Reworking	%	☐
6129. Engineering change orders	%	☐
6130. Profit	%	☐
TOTAL:	100%	

Please rate the following factors in order of their overall contribution to the cost of tools/dies/molds (where 1=largest factor contributing to cost and 9=smallest factor contributing to cost)

Factor Contributing to Tooling Cost	*Priority (Rank all, where 1=largest and 9=smallest factor contributing to cost)*
6131. Financing	
6132. Short lead times	
6133. OEM/Tier 1 tooling standards	
6134. Stamper tooling standards	
6135. GD&T/Quality requirements	
6136. PPAP/APQP processes	
6137. Engineering change orders	
6138. Other:_____	

How do you are currently paid for engineering change orders?

Payment Method	*Currently Paid This Way*	*In Advance or After Delivery*
6139-40. Negotiate fee for total engineering change orders	☐ Yes ☐ No	☐ Advance ☐ > Delivery
6141-42. Negotiate rate per incident engineering change order	☐ Yes ☐ No	☐ Advance ☐ > Delivery
6143. Don't do ECOs	☐	

What payment terms does your largest customer currently use? What do you think your largest customer will use in the next 3-5 years?

Payment terms	*Currently Uses*	*Will Use in 3-5 Years*
6144-45. 1/3 on order, 1/3 on shipment, 1/3 at buy-off	☐ Yes ☐ No	☐ Yes ☐ No
6146-47. 100% at PPAP	☐ Yes ☐ No	☐ Yes ☐ No
6148-49. Amortize with production	☐ Yes ☐ No	☐ Yes ☐ No
6150-51. Other:_____ _____	☐ Yes ☐ No	☐ Yes ☐ No

What information/reporting are you required to report to your largest customer?

Information	*Required*
6152. Tooling Invoice	☐ Yes ☐ No
6153. Construction standard	☐ Yes ☐ No
6154. Log of engineering change orders	☐ Yes ☐ No
6155. Labor reports	☐ Yes ☐ No
6156. Hourly rates	☐ Yes ☐ No
6157. Other: _____ _____	☐ Yes ☐ No

Thank you for your participation!

Appendix III—Model Results

The “All Domestic” models are built using data collected in mid-2004 based on proprietary cost data from eight shops that range in size from less than $2 million to more than $20 million—producing the full range of products from simple, $15,000 four-cavity molds to highly complex $200,000 progressive dies. These shops’ product lines cover the full waterfront of automotive and non-automotive tooling for stampers and molders, including molds, progressive dies, line dies, transfer dies, prototypes, and custom fixturing. In order to conceal the identities of the actual company data underlying these models, we scaled them to create four stylized shops: a $3 million die builder, a $3 million mold builder, a $30 million die builder and a $30 million mold builder.

LCC Strategy keeps the following elements domestic:

- Program Management
- Process Engineering
- Die Design
- Tryout 2 (homeline)
- Engineering Change Orders
- Launch Support
- Maintenance
- Repair

The following elements would be outsourced to an LCC TDM producer:

- Patterns & Castings
- Machining
- Details & Inserts
- Assembly
- Initial Tryout/Spotting

	$3M Die Shop		$30M Die Shop		$3M Mold Shop		$30M Mold Shop	
	All Domestic	LCC**	All Domestic	LCC**	All Domestic	LCC**	All Domestic	LCC**
Labor & Overhead*	$1,702,231	$661,926	$18,612,508	$7,085,015	$1,778,532	$717,438	$19,254,015	$8,399,346
Raw Material & Components	856,668	771,002	8,101,870	7,291,683	691,624	622,462	6,363,451	5,727,106
Outside Services	106,455	79,480	979,581	692,492	115,258	86,240	979,581	708,048
Capital Expense	83,421	46,364	791,446	424,938	66,494	36,284	822,782	450,576
Profit	194,946	145,714	1,934,646	1,384,984	186,988	138,825	1,937,590	1,416,095
Offshore Tax, Duty & Freight		176,623		1,678,769		168,272		1,716,479
Offshore Logisitcs		118,156		240,000		104,771		240,000
Time Cost of Money for Days “On-Water”		30,790		314,769		30,859		210,885
Additional Tryout, PPAP & Rework		177,736		1,871,961		198,253		2,587,452
TOTAL	$2,943,722	$2,207,791	$29,312,817	$20,984,612	$2,838,896	$2,103,404	$29,357,419	$21,455,987
Percent Cost Advantage		25.0%		28.4%		25.9%		26.9%
Currency Shift Necessary to Negate Cost Advantage		49.5%		54.9%		53.4%		54.7%
Productivity Increase Necessary to Negate Cost Advantage		43.2%		41.0%		41.4%		41.0%

* Labor & Overhead Cost represents a blend of domestic and LCC labor rates for the LCC model.

**LCC model assumptions: Raw materials and components are 10% cheaper in LCC, capital expense is 25% cheaper in LCC, offshore tax, duty & freight assumed to be 8% of total cost, offshore logistics are assumed to be $15K in travel plus 10% of the offshore purchase for smaller shops and $150K plus travel costs for larger shops, on-water time assumed to be 28 days, additional tryout/PPAP/rework assumed to be 15% at domestic labor rates. See report page 24 for more detailed description of the model assumptions.