BEYOND THE BIG LEAVE

The Future of U.S. Automotive Human Resources

Program for Automotive Labor and Education





A report to the Charles Stewart Mott Foundation and the Mid-Michigan Innovation Team/U.S. Department of Labor Workforce Innovation for Regional Economic Development (WIRED) Initiative

CAR
CENTER FOR AUTOMOTIVE RESEARCH

BEYOND THE BIG LEAVE

The Future of U.S. Automotive Human Resources

A Report to the Charles Stewart Mott Foundation and the Mid-Michigan Innovation Team/U.S. Department of Labor Workforce Innovation for Regional Economic Development (WIRED) Initiative

And with the participation of the following companies:

Chrysler LLC
Ford Motor Company
General Motors Corporation
Honda of America
Toyota Motor Engineering & Manufacturing North America, Inc.
Toyota Motor North America, Inc.
Continental AG
Cooper-Standard Automotive
Denso International America Inc.
Johnson Controls, Inc.
Robert Bosch LLC
Siemens VDO Automotive Corporation
Valeo, Inc.
Yazaki North America Inc.

Table of Contents

SECTION III *(continued)*

SECTION IV

SECTION V

SECTION V *(continued)*

List of Figures

List of Tables

Acknowledgements

The authors wish to acknowledge the generous support of the Charles Stewart Mott Foundation and the Mid-Michigan Innovation Team/U.S. Department of Labor Workforce Innovation for Regional Economic Development (WIRED) initiative. We would also like to recognize the efforts and contributions of several CAR staff. Diana Douglass played a key role in coordinating the overall project, organizing the interview material, and producing this report. Wendy Barhydt provided her expert document review and proofreading assistance. Mark Birmingham, Robert Kahn, Samantha Lehto, and Richard Li provided able research assistance. We would also like to express our strong appreciation for the data and time provided by the interview respondents at the participating companies: Chrysler LLC, Ford Motor Company, General Motors Corporation, Honda of America, Toyota Motor Engineering & Manufacturing North America, Inc., Toyota Motor North America, Inc., Robert Bosch LLC, Continental AG, Cooper-Standard Automotive, Denso International America Inc., Johnson Controls, Inc., Siemens VDO Automotive Corporation, Valeo Inc., and Yazaki North America Inc. We would like to recognize Paul Ryan and Kim Custer from the Association of International Automobile Manufacturers (AIAM) for providing key data necessary to produce CAR's forecast of international employment. Finally, we would like to thank the facultys and staffs of Delta College, Lansing Community College, Mott Community College and Saginaw Valley State University for their guidance and early input on construction of the interview instrument. Tom Crampton and the faculty and staff of the M-Tec at Mott Community College have been especially helpful to our research team. Of course, any errors that remain are our own.

Authors

Kristin Dziczek, Director, Program for Automotive Labor and Education

Sean McAlinden, Vice President of Research and Chief Economist

Yen Chen, Industry Analyst

Bernard Swiecki, Senior Project Manager

Executive Summary

Michigan's current automotive labor challenge and opportunity is the subject of this study, the first automotive labor market report produced by CAR's Program for Automotive Labor and Education (PALE). This program was launched in 2006 with support from the Charles Stewart Mott Foundation and the Mid-Michigan Innovation Team (MMIT)/U.S. Department of Labor Workforce Innovation for Regional Economic Development (WIRED) initiative. PALE's mission is to connect major automotive firms to educational institutions for the purpose of effectively transmitting labor market information on future employment, occupations, training and educational requirements of the U.S. automotive labor force.

Motor vehicle manufacturing firms participating in this study include Chrysler LLC, Ford Motor Company, General Motors Corporation, Honda of America, Toyota Motor Engineering & Manufacturing North America, Inc., Toyota Motor North America, Inc., as well as some of the largest auto suppliers in North America including Robert Bosch LLC, Continental AG, Cooper-Standard Automotive, Denso International America Inc., Johnson Controls, Inc., Siemens VDO Automotive Corporation, Valeo Inc., and Yazaki North America Inc. These companies have agreed to advise PALE and share information on the labor and education topics that are of greatest concern to automotive communities in Michigan and the rest of the United States. This information will be disseminated by CAR for at least one year after the completion of this study. It is hoped that PALE will be able to update this study on an annual basis, through the cooperation of its corporate participants.

This study approaches the future challenges in the U.S. and Michigan automotive labor market in two ways. In section II, a forecast of Detroit Three employment, attrition and hiring in the United States and Michigan is presented. This forecast was completed by CAR with the assistance of the human resource planning departments of Michigan's three major vehicle companies. The Detroit Three supplied basic information on employment and company forecasts of the expected attrition of their employees in Michigan and the United States. CAR developed estimates of expected employment in 2011 and 2016 to complete the forecast of job openings. In addition, CAR prepared a forecast of international automaker employment in the United States for 2011 and 2016. CAR's forecast of automotive job openings sets the stage for a compilation of direct industry input on auto human resource issues presented in sections III, IV and V. These sections contain the approved responses of PALE's participating automotive firms on such issues as technical labor needs, hiring criteria, the performance of educational institutions, and recommendations for future training and education programs including suggested curricula. The stated

opinions and positions in sections III, IV and V reflect the direct input from over thirty company human resource executives at five major motor vehicle firms and eight major automotive suppliers.

The purpose of this report and PALE's subsequent dissemination activities is to provide economic development officials and educational institution administrators in Michigan and the upper Midwest with direct input and information from the U.S. auto industry that no other region in North America can and will receive. The receipt of this information should be the right of the undisputed home of the North American motor vehicle industry.

The forecast of Detroit Three employment and hiring through 2016

In section II of this study, CAR presents a forecast of Detroit Three employment, attrition and hiring by occupation (production, skilled trades, engineering/technical and other salaried workers) for the United States and for Michigan, as well as an employment forecast for the international automakers producing vehicles in the United States. To produce the forecast, CAR examined recent employment trends in the U.S. and Michigan automotive sectors, as well as U.S. sales, production and market share history, and detailed demographic information (provided by the participating automakers) on the current and projected workforce. Our forecast is heavily influenced by three major industry human resource trends:

1. High productivity growth in U.S. automotive manufacturing and engineering
2. The rapid retirement of the "baby boomer" automotive employees and their replacement by younger generation workers
3. The replacement (in the United States) of traditional domestic automotive employment by international automotive employment.

Two central conclusions of our 2007–2016 forecast are: there will be considerable hiring in the U.S. and Michigan automotive industries and total U.S. automaker employment will not decrease.

Since a model is a representation of a complex system, a number of explanatory variables must be used in order to define the model. In the case of CAR's model of Detroit Three employment, these variables include U.S. light vehicle output, the companies' labor productivity levels and trends, the performance of a key competitor, projected employee attrition, possible changes in occupational structure, and the impact of labor contracts. A key driver in the CAR Detroit Three employment and hiring model is the constraint on future desired labor productivity levels at the Detroit Three. CAR makes the reasonable competitive assumption that the Detroit companies must match the best practice labor productivity and unit labor cost levels of the industry leader in North America.

Tables E.1 and E.2 present the estimates for Detroit Three employment in the United States and in Michigan for 2007, 2011, and 2016. The tables also include the change in employment through 2011, and overall through 2016. The Detroit Three's U.S. employment dropped to 241,189 in the United

Table E.1: Detroit Three U.S. Automotive Employment 2007 and Forecast for 2011 and 2016

U.S. Employment	2007 Preliminary	2011 Forecast	2016 Forecast	Change Thru 2011	Change Thru 2016
Total Employment	241,189	210,542	203,219	-30,647	-37,969
Hourly	166,575	145,148	136,488	-21,427	-30,087
Skilled Trades	39,775	25,128	21,869	-14,647	-17,906
Production	126,800	120,020	114,619	-6,780	-12,181
Salaried	74,614	65,394	66,731	-9,220	-7,883
Engineering/Technical	24,707	21,731	22,266	-2,977	-2,441
Other Salaried	49,907	43,664	44,465	-6,243	-5,442

Source: Center for Automotive Research

States and 129,037 in Michigan by the end of 2007. During the forecast period, these downward trends will continue, with the Detroit Three expected to shed 30,647 jobs in the United States and 14,782 jobs in Michigan by 2011, and a total of 37,969 jobs in the United States and 20,607 in Michigan by 2016. By 2016, Detroit Three employment levels are forecast to fall to 203,219 in the United States and 108,430 in Michigan. The forecast decline in Detroit Three employment is largely the result of an anticipated decrease in Detroit Three domestic vehicle production and CAR's model constraint that the Detroit Three must match the ever-increasing labor productivity performance of the North American leader in order to keep the unit labor cost competitive. Total automaker employment in the United States is expected to stay level at roughly 355,000 due to a projected increase of over 38,600 in international automaker employment. This rise in international automaker employment is driven primarily by production increases at these companies.

In addition to employment levels, CAR forecasts new hires by the Detroit Three in the United States and Michigan during the forecast period 2008–2016. These new hires are necessary because the Detroit Three are projecting large-scale employee attrition through "baby boomer" retirements. These results are shown in Tables E.3 and

Table E.2: Detroit Three Michigan Automotive Employment 2007 and Forecast for 2011 and 2016

MI Employment	2007 Preliminary	2011 Forecast	2016 Forecast	Change Thru 2011	Change Thru 2016
Total Employment	129,037	114,254	108,430	-14,782	-20,607
Hourly	73,439	68,364	65,209	-5,075	-8,231
Skilled Trades	20,179	12,097	10,722	-8,082	-9,457
Production	53,260	56,268	54,487	3,007	1,226
Salaried	55,597	45,890	43,221	-9,707	-12,376
Engineering/Technical	22,844	18,813	17,580	-4,031	-5,264
Other Salaried	32,753	27,077	25,642	-5,676	-7,111

Source: Center for Automotive Research

Table E.3: Hiring Forecast for Detroit Three U.S. Automotive Employment 2011 and 2016

U.S. New Hires	Through 2011	Through 2016
Total New Hires**	56,673	77,209
Hourly**	38,390	38,848
Skilled Trades*	2,000	2,000
Production	38,390	38,848
Salaried	18,282	38,361
Engineering/Technical	6,078	12,890
Other Salaried	12,204	25,470

Source: Center for Automotive Research
**Transfer from production.*
***Sums do not include the number of workers transferred from production to skilled trades.*

Table E.4: Hiring Forecast for Detroit Three MI Automotive Employment 2011 and 2016

MI New Hires	Through 2011	Through 2016
Total New Hires**	36,250	45,955
Hourly**	24,154	24,154
Skilled Trades*	1,205	1,205
Production	24,154	24,154
Salaried	12,095	21,800
Engineering/Technical	4,927	8,846
Other Salaried	7,168	12,955

Source: Center for Automotive Research
**Transfer from production.*
***Sums do not include the number of workers transferred from production to skilled trades.*

E.4. Over 115,000 workers will leave the Detroit Three in the United States during the forecast period; over 54.2 percent of them will be in Michigan. In the United States, the Detroit Three are expected to hire 56,673 new workers during 2008–2011, and an additional 20,536 employees—primarily salaried workers—by 2016. In Michigan, CAR projects that the Detroit Three will hire 36,250 employees by 2011. Between 2011 and 2016, the Detroit Three are projected to hire 9,705 new workers in Michigan. CAR estimates that the Detroit Three will hire roughly 21,800 salaried workers in the forecast period—nearly 8,900 of these new hires will be for engineering and technical positions. All of the hourly new hires are expected to occur over the next four years (2008–2011), when tens of thousands of hourly employees are expected to retire from the Detroit Three. The Detroit Three granted only 2,000 apprenticeships nationwide under the 2007 UAW agreements, and CAR estimates that a total of 1,205 of those skilled trades apprenticeships will be granted in Michigan. These skilled trade positions will be filled by current production workers. Retirement and early retirement will be used by the Detroit Three to cut the number of current skilled trades workers by as much as 45 to 47 percent by 2016. By 2011, 31 percent of Michigan hourly workers are projected to receive second tier wages, compared to 27 percent of U.S. hourly workers.

A recession in 2008 moves CAR's Detroit Three hiring forecast forward into at least 2009. The available labor supply in Michigan could become a critical constraint. Potential Detroit Three employees now face lower starting wages and benefits (negotiated by the Detroit Three and the UAW in the 2007 labor agreements), as well as an indefinite wait in the plant until they have the opportunity to earn full Detroit Three automaker wages.[1] Historically, high wages and generous benefits have attracted many workers to this industry; without them, the Detroit Three may face challenges finding enough people willing to work in their plants. This means the Detroit Three will now compete directly with their suppliers and other sectors for new hires, and might force these companies to hire more new labor market entrants and less experienced workers. In the next sections of this study, CAR presents the results of our automaker and supplier interviews regarding future hiring, education and training requirements. Given the rapid pace of workforce turnover predicted in CAR's forecast, it is reasonable to express concern that there may not be enough time to train the new workers to meet the companies' stringent hiring requirements.

Hiring the new autoworker of 2010: production and skilled hourly workers

The five automakers interviewed for this section of the study (GM, Ford, Chrysler, Toyota and Honda) responded to questions regarding hiring and training their production/team members and skilled trades/maintenance associate workforces, the nature of future automotive work beyond 2010, and the performance of the U.S. education system.

For the most part, the automakers interviewed for this study reached general consensus on many of the topics related to hiring and training production workers/team members. In the area of skilled trades/maintenance associates, there was a marked division between the domestic (unionized) firms and the international automakers, but agreement among the representatives of each group as to how skilled trades work will be organized and the future needs for this category of worker. CAR believes that general consensus was reached in the following areas:

- The nature of production work is becoming more and more complex as the product—and the technology used to build it—become more and more advanced. This production complexity necessitates employing workers who may not have higher levels of formal academic preparation beyond high school or a GED, but nevertheless can demonstrate higher literacy and numeracy levels and more advanced communication and team skills than were previously required of automotive manufacturing workers. Computer literacy was cited as a critical skill by three companies.

[1] *According to the 2007 agreements between the Detroit Three and the UAW, new hires will earn a second-tier of wages and benefits until they move into a "core" job (at GM and Chrysler) or they are no longer in the lowest 20 percent in terms of seniority (at Ford). When a "non-core" worker moves into a higher wage job, he or she will earn the traditional wage, but will retain the second tier benefits package.*

- The physical demands of automotive work have lessened and injuries have declined, as a result of advances in ergonomics. Many ergonomic solutions bring with them higher levels of technological content and require a more advanced workforce to master their proper use.
- The automakers agreed that they currently face a surplus of applicants for their positions. All of the companies interviewed for this study employ temporary or contract workers to some degree, and most use this temporary workforce as a source of permanent hires. The ability to "get to know" a temporary worker on the job eliminates much of the guesswork about how the worker will perform once hired. All of the respondents expressed concern about the adequacy of the future labor supply—for production work, as well as for skilled trades/maintenance associates. They cited common misconceptions about the nature of modern manufacturing work as a major barrier to students becoming interested in a career in automotive manufacturing.
- All of the study participants have extensive corporate training resources and standardized curricula for production workers. The length of initial training varies from a few weeks to three months. Annual refresher training is provided in the areas of health and safety, quality, environmental compliance and legal issues (e.g., EEO, diversity and sexual harassment). Additional training is available to workers who volunteer for it, at all of the companies. Vendors are usually called upon to provide equipment-specific training, which is generally bundled as part of a new equipment purchase.
- Skilled trades or maintenance associates are a critical part of the manufacturing workforce at each of the automakers interviewed for this study. There is a wide range of experience with workers in the trades (as mentioned in the introduction to this section): the Detroit Three, who have represented workforces, and the internationals whose workers are not represented by a union. The Detroit Three have a large number of skilled trades classifications, with the goal of getting down to fewer than ten, and the international firms have just two to three maintenance classifications. The proportion of the workforce that is comprised of tradespersons varies across the two groups as well, with the domestic companies having greater than 20 percent of their workforce in the trades and the internationals with fewer than 15 percent of their workforce in these classifications.
- The vast majority of skilled trades/maintenance associate apprentices come from within the ranks of the production workforce at all firms interviewed for this study. Workers who seek to transition into a skilled job classification must demonstrate not only a desire, but a demonstrated aptitude (through testing) for high level math, computer skills and technical work.
- Math ability, technical reading skills and computer literacy were generally agreed to be the most important specific skills required for entering the skilled trades/maintenance associate workforce. Technical problem-solving and analytical skills were also cited as important.
- While the domestic manufacturers struggle with a current oversupply of trades workers in nearly all classifications, all of the automakers interviewed for this study expressed concern about the future pipeline of skilled workers. The participants believe there are problems attracting people to skilled trades because the common perception is that the work is dirty and not very challenging or well paid.
- The skilled trades training requirements are governed by union agreements at the Detroit Three companies. Those interviewed stated that much of the education and training curriculum has not changed in a very long time, including the required 8,000 hours of on-the-job training coupled with 650–700 hours of classroom training. All three believed that technological changes will drive alterations to the program to prepare journeyperson skilled trades workers, and all three either have in place or have endorsed the concept of a shared curriculum between the trades for the first year. The Detroit Three companies are also seeking more teamwork within skilled trades, more flexibility in assignments, and higher utilization of the skilled trades

workforce. Higher utilization is achieved through cross-skilling and a team approach to maintenance projects—the norm at the international automakers. At the two international firms that participated in this study, maintenance associates undergo two to three years of training that is almost exclusively on-the-job at one firm and a combination of job rotations and classroom training at the other. All five automakers offer ongoing training for journeyperson skilled trades/maintenance associates; the training is more intense when new equipment is being purchased or a new process is introduced into the manufacturing environment. Technical and community colleges play a key role in delivering both initial and ongoing training to this workforce at all of the respondent companies.

- In general, all five automakers reported that they do not see major changes coming in the nature of future automotive work.
  - The Detroit Three respondents expect there will be less supervision and less specific direction in the future, but no such change is expected at the international firms.
  - All of the respondents commented that teams will be integral to the functioning of their companies going forward.
  - In terms of automation, the companies see that, as manufacturing hardware becomes more flexible, the need for workers who can interact with and troubleshoot software problems will be critical.
  - All companies interviewed for this study see the physical demands of automotive work declining.
  - The Detroit Three will seek to outsource "non-core" trades that are not directly related to building vehicles as well as highly-specialized skills that are infrequently required. The international firms will utilize their in-house trades as much as possible, and only hire contractors where their internal staffs do not have the skills to manage a project.
  - All of the firms interviewed either have or are in the process of outsourcing most custodial, grounds and housekeeping work.
  - All of the respondents recognized that, to the extent that work can be common around the globe, it will be. However, regional labor markets may mean it makes better business sense to use less automation in lower wage areas of the world. Any skills gaps that may exist between workers in the U.S. and other regions are closing quickly.
  - All of the participants stressed the need for very high skills standards in the education system, and affirmed that the basics—reading, writing, math and computer literacy—will continue to be key to preparing the workforce of the future.

Hiring the new autoworker of 2010: engineers and technicians

The CAR research team interviewed five major motor vehicle manufacturers (GM, Ford, Chrysler, Toyota, and Honda) on the subject of future engineers and technicians at their companies in the United States and Michigan. The interview respondents were all senior level human resource (HR) executives responsible for the hiring and training of vehicle and manufacturing engineers at their companies. Future hiring of engineers is a critical necessity at each firm. The respondents were asked to discuss specific engineering needs by types, in the future, and the sources that will be used to find this labor. The companies were also asked to describe their hiring criteria and processes, currently and in the future. The respondents were also interviewed on the subject of what will constitute "core" and "non-core" fields of engineering at their firms in the future, and on technical and market changes that will affect their use of and types of engineering. Finally, the respondents were asked to describe engineering training at their firms and as well as their recommendations to educators on appropriate and necessary curricula for future automotive engineers.

Disagreements between the firms' responses were outweighed by general consensus on many of the topics. General accord, CAR believes, was reached on the following conclusions:

- Mechatronic engineering, a combination of mechanical, electronic and software engineering, will dominate future hiring at motor vehicle firms—not only for vehicle design

and engineering, but also manufacturing engineering. The use of electrical engineers will also increase as electronic content greatly increases in the vehicle. Knowledge of specific powertrain technologies will also become critical.

- Future engineers must be well-versed in computer design and CAE techniques before arriving at the firm for employment. Future engineers must learn to work in teams, possess business acumen and project management skills, and be culturally aware.
- New engineers will be hired from other companies, on referral, and straight out of educational institutions. Relevant experience is highly valued. The hiring of engineering graduates who have participated in cooperative engineering programs (often company-based) will expand dramatically. Required education levels for both engineering and technician applicants will rise in the future. Technicians will need a four-year diploma; even auto service technicians at dealerships will require an associates degree.
- Outside screening firms are used by several of the companies to look for specific skills and the right experience. Further screening is done internally through interviews and various group exercises. Several firms are also increasing their hiring from a variety of global educational institutions participating in the company cooperative education program.
- "Core" fields identified by the companies certainly include vehicle integration and powertrain engineering, as well as CAE. Also, several firms that have outsourced significant engineering responsibilities to suppliers expect to reverse this trend in the future, on the grounds of efficiency. The use of contract engineers is expected to decline in the future at all of the firms; the same is not true in the case of technicians. Fewer technicians will be used in the future by a number of the companies. The CAD drawing work in particular will be contracted out.

The companies are generally comfortable about the adequacy of the supply of engineers in the future. However, there were worries by at least one firm about not being the first choice of graduates. All of the firms had worries about the skills imparted to students by educational institutions in terms of practical hands-on knowledge, business skills, and attitudes toward employment.

- All of the responding firms offer and conduct extensive internal training programs on a wide variety of subjects for newly hired and experienced engineers. Many of the subject areas were non-technical and were related to other work skills needed on the job for working with other engineers around the world.
- The respondents had many recommendations for educational institutions. In general, the following types of programs were recommended:
  - Training in the use of CAD drawing and CAE connected to actual subject material
  - Education in the areas of fuel economy technologies and alternative fuels
  - Training in quality analysis methods such as Six Sigma
  - Education in project management and other business skills
  - The development and maintenance of cooperative education programs connected to motor vehicle firms.

Hiring the new autoworker of 2010: automotive suppliers

The CAR research team interviewed HR managers from eight Tier 1 automotive suppliers for this study. The questionnaire used for these interviews was the same as the one used for the automaker production, skilled trades, engineering and technical labor interviews. The respondents were encouraged to depart from the questions asked when they believed additional discussion might be beneficial.

All of the firms interviewed for this study expect that the nature of the work done by both engineering/technical staff as well as their production employees will become more demanding over time and will require more skilled workers throughout the industry.

Among engineers and technicians, both groups are expected to grow in importance. The majority of the respondents do not expect the proportion of engineers to technicians to change. While all engineering disciplines will likely become more impor-

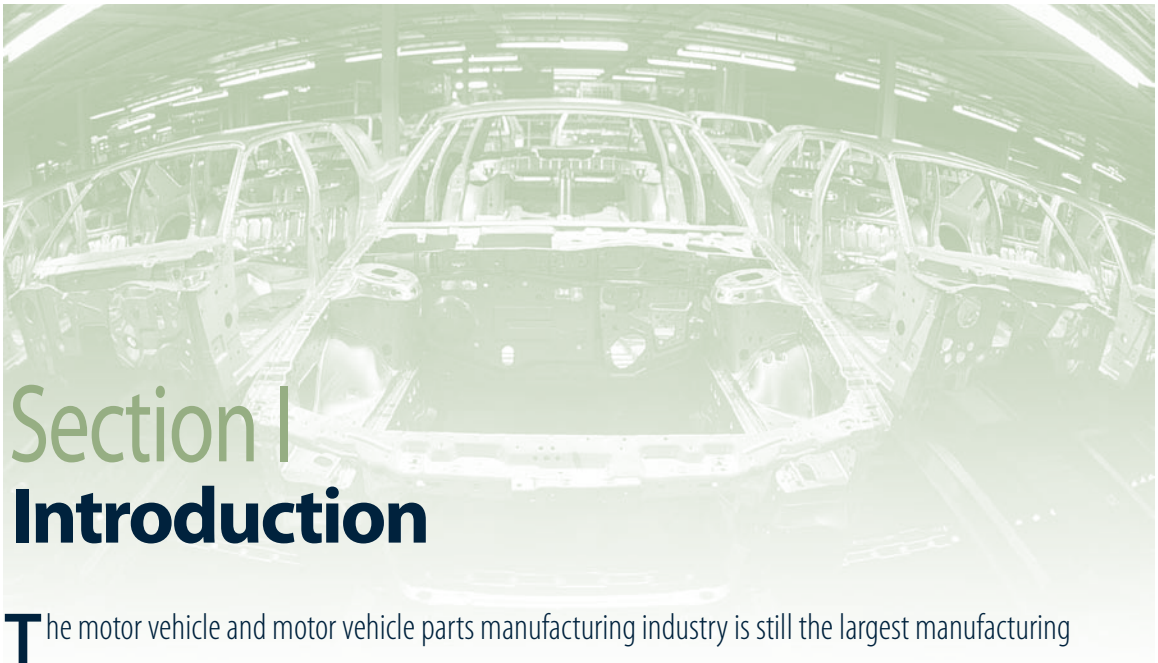
tant over time, specialized fields such as materials, environment, and wireless communication engineers are expected to see the largest growth.

The hiring process for all employees has become more thorough as firms require more qualified staff and as they work to reduce employee-related problems in the workplace by employing more exacting screening processes. When hiring engineers and technical staff, the respondents stated that they achieve the best results by conducting a group interview that includes employees with whom the candidate would be working. Interviews conducted by HR staff are deemed sufficient when hiring manufacturing workers.

When training production workers on how to perform their duties, the respondents' firms largely prefer to conduct the training in-house. When providing skilled trades employees with the technical training they need, however, the respondents indicated a heavy use of local community colleges and vocational schools. Respondents indicated that their firms engage in training manufacturing employees in a wide variety of subjects. In addition to instructional training on how to perform their job, all manufacturing employees receive training in health and safety, quality, environmental training, ethics, sexual harassment, diversity, working in teams, hazardous materials handling, and interpersonal skills.

The respondents made numerous recommendations for improvements at educational institutions. For all employee categories, an increased focus on math, science, and problem-solving is considered critical. The respondents also asked for more influence on "soft skills," including respect for others, respect for property, work ethic, positive attitude, an appreciation of diversity and attendance. The respondents recommended that colleges fortify their engineering programs with a greater emphasis on business aptitude. They also recommended an increased focus on CAD skill—one that would go beyond the basic capabilities of most graduates.

In the future, the respondents expect all of their employees to face a more challenging workplace—whether they are engineers, technicians, production workers, or skilled trades workers. The vehicles the industry will produce will continue to become more complex and the industry's manufacturing facilities, whether they produce vehicles or vehicle parts, will continue to become more technologically advanced. The capability to work in this complex environment, calling for greater cooperation with a wide array of coworkers (both human and robotic), will be critical.



Section I
Introduction

The motor vehicle and motor vehicle parts manufacturing industry is still the largest manufacturing industry in the United States in terms of both employment and output. The industry is also still the largest single export income-producing industry in the state of Michigan. Yet, clearly, the industry has experienced a period of stagnation and decline—in the United States and especially in Michigan in the last seven years. For example, as shown in Figure I.1, employment in the U.S. auto industry achieved an all-time historical peak of 1,128,400 in 1999. However, by 2007, U.S. employment had fallen to 820,000, or a decline of about 27 percent. The decline in Michigan was even more pronounced.

Michigan automotive manufacturing employment fell from 316,300 in 1999 to 173,600 in 2007—or a decline of about 45 percent. The reasons for this decline in employment are many. Vehicle production in the United States remained level during 1994–2006, at the same time the industry experienced a record growth in productivity. The dollar value of imported automotive parts tripled between 1992 and 2006. And, of course, Michigan's relatively larger decline is also partly attributable to the loss of market share and sales by the state's largest automotive firms.

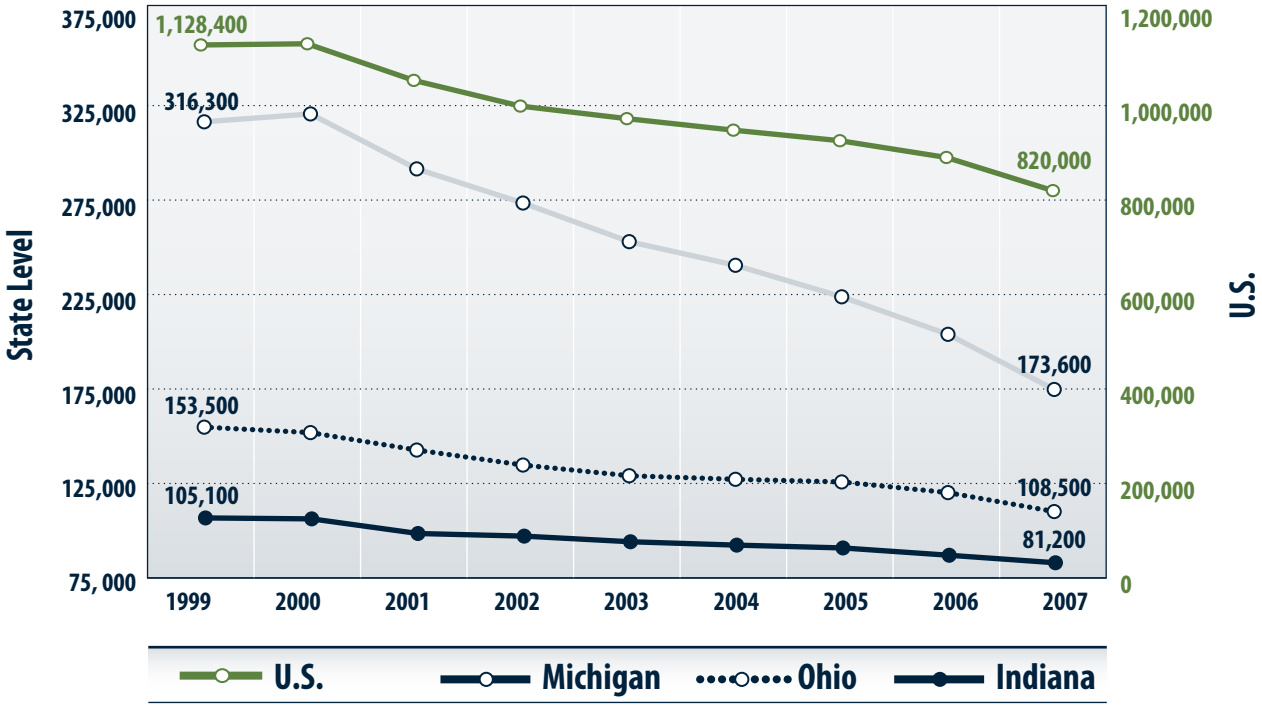
Michigan's auto industry produced over 3.4 million vehicles in 1994, or about 31 percent of U.S. vehicle production. In contrast, the state's auto industry produced only 2.2 million vehicles in 2006, or about 21 percent of national production. Michigan's share of 1994 world production of 52 million vehicles was seven percent. In 2006, the state's global share of production had fallen to three percent of almost 69 million vehicles produced globally. The world auto industry is not only the largest manufacturing industry on the planet, but also the fastest growing. This growing international market occurring in many countries that have never seen significant auto sales before represents the state and the country's most significant automotive challenge and opportunity.

This report, however, is about a different challenge and an opportunity for the state of Michigan: the challenge of future automotive human resources. The massive restructuring of the Detroit Three and many large suppliers, in recent years, not only represents the downsizing of the traditional auto industry in the United States but also the retirement of an entire generation of automotive employees. A critical finding of this study is that "Baby boomer" production and salaried employees are leaving (and will leave) in such numbers that the companies such as the Detroit Three must still hire many thousands of new employees in the years ahead. This massive replacement of auto labor represents an opportunity for many in Michigan and other Midwest states. Yet the old

jobs will, indeed, not come back. Instead, they will be replaced by different jobs involving different tasks and requiring different qualifications and experience. It is vitally important, then, that Michigan and other traditional automotive regions be fully informed as to the scale and timing of this replacement hiring and the specific criteria that will be used to select the new autoworkers of the 21st Century. It should also be emphasized that the international sector of the U.S. auto industry has steadily grown in employment at a rate of 4.5 percent a year since 1992. This sector will continue to grow in the future. Over 38 percent of vehicles produced in the United States were built by international automakers; this percentage will rise to 50 percent with many of the vehicles designed and developed in the United States, within a few years.

Michigan's current automotive labor challenge and opportunity is the subject of this study, the first automotive labor market report produced by CAR's Program for Automotive Labor and Education (PALE). This program was launched in 2006 with support from the Charles Stewart Mott Foundation and the Mid-Michigan Innovation Team (MMIT)/U.S. Department of Labor Workforce Innovation for Regional Economic Development (WIRED) initiative. PALE's mission is to connect major automotive firms to educational institutions for the purpose of effectively transmitting labor market information on future employment, occupations, training and educational requirements of the U.S. automotive labor force. Motor vehicle manufacturing firms participating in this study include Chrysler LLC, Ford Motor Company, General Motors Corporation, Honda of America, Toyota Motor Engineering & Manufacturing North America, Inc., Toyota Motor North America, Inc., as well as some of the largest auto suppliers in North America including Robert Bosch LLC, Continental AG, Cooper-Standard Automotive, Denso International America Inc., Johnson Controls, Inc., Siemens VDO Automotive Corporation, Valeo Inc., and Yazaki North America Inc. These companies have agreed to advise PALE and share information on the labor and education topics that are of greatest concern to automotive communities in Michigan and the rest of the United States. This information will be disseminated by CAR for

Figure I.1: Motor Vehicle and Parts Manufacturing Employment, 1999 – 2007



Source: U.S. Department of Labor, Bureau of Labor Statistics

PALE's mission is to connect major automotive firms to educational institutions for the purpose of effectively transmitting labor market information on future employment, occupations, training and educational requirements of the U.S. automotive labor force.

at least one year after the completion of this study. It is hoped that PALE will be able to update this study on an annual basis, through the cooperation of its corporate participants.

This study approaches the future challenges in the U.S. and Michigan automotive labor market in two ways. In section II, a forecast of Detroit Three employment, attrition and hiring in the United States and Michigan is presented. This forecast was completed by CAR with the assistance of the human resource planning departments of Michigan's three major vehicle companies. The Detroit Three supplied basic information on employment and company forecasts of the expected attrition of their employees in Michigan and the United States. CAR developed estimates of expected employment in 2011 and 2016 to complete the forecast of job openings. In addition, CAR prepared a forecast of international automaker employment in the United States for 2011 and 2016. CAR's forecast of automotive job openings sets the stage for a compilation of direct industry input on auto human resource issues presented in sections III, IV and V. These sections contain the approved responses of PALE's participating automotive firms on such issues as technical labor needs, hiring criteria, the performance of educational institutions, and recommendations for future training and education programs including suggested curricula. The stated opinions and positions in sections III, IV and V reflect the direct input from over thirty company human resource executives at five major motor vehicle firms and eight major automotive suppliers.

The purpose of this report and PALE's subsequent dissemination activities is to provide economic development officials and educational institution administrators in Michigan and the upper Midwest with direct input and information from the U.S. auto industry that no other region in North America can and will receive. The receipt of this information should be the right of the undisputed home of the North American motor vehicle industry.

Section II
A Forecast of Detroit Three Employment and Hiring Through 2016

Introduction

The automotive manufacturing industry has dominated U.S. manufacturing and the Michigan economy in terms of high wage employment, export income, and spin-off employment for many decades. However, the structural decline of this industry within the United States and Michigan currently represents the greatest economic challenge facing U.S. manufacturing, the state of Michigan and its communities. It is important, therefore, to estimate the extent of this decline and its relevance to other important industries in the United States and Michigan (e.g., automotive parts manufacturing and automotive research and development activity).

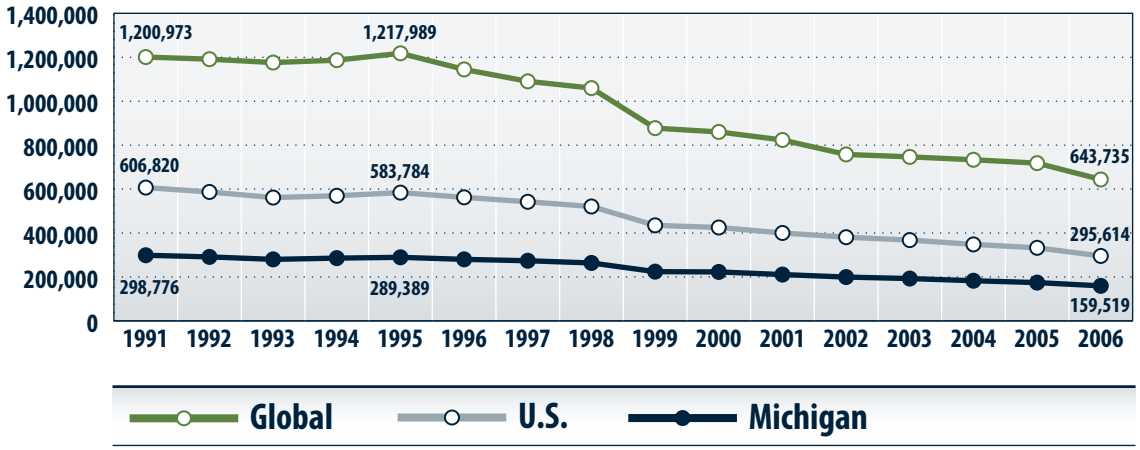
It is also important to forecast the possibility of new hiring in the auto industry, even if such hiring represents only a partial replacement of retiring automotive workers.

This section does not examine the reasons for the rapid decline in the U.S. auto industry in recent years.[2] However, a forecast of a major component of United States and Michigan's automotive employment (The Detroit Three: GM, Ford, and Chrysler, LLC)[3] will be shown, as well as an accompanying forecast of hiring activity over the period 2008–2016. The reasoning behind this forecast will be discussed and the relevant data underlying CAR's estimation will be shown as well. The ratification of a new labor agreement between the UAW and the Detroit Three in October 2007 is an important development for this forecast. This labor agreement must be recognized as the most significant in at least 40 years of negotiations between the

[2] For a discussion of the reasons for the decline in the U.S. and Michigan automotive industry, see "Driving in Reverse? The Future of the Automotive Sector in the United States", by Sean P. McAlinden and Steven Szakaly in The ***Economic Outlook for 2007, Fifty-Third Annual Conference on the Economic Outlook****, University of Michigan, Ann Arbor, November 16 and 17, 2006.*

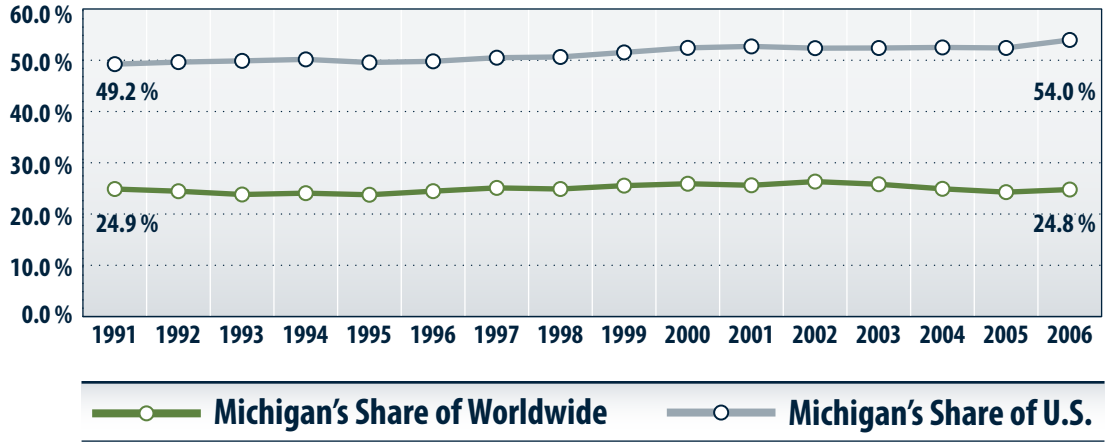
[3] The practice of referring to the former "Big Three" as the "Detroit Three" will be used in the remainder of this study. The phrase is not common practice with many industry observers and may reflect the Detroit Three's current market share position in the United States.

Figure II.1: Detroit Three Total Employment (including wholly owned automotive subsidiaries), 1991–2006



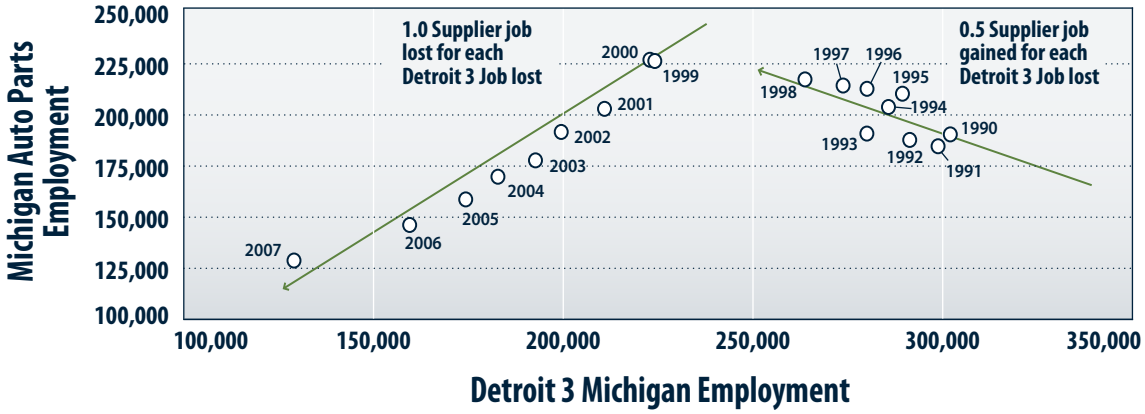
Source: Company 10-Ks, 20-Fs

Figure II.2: Michigan's Share of Detroit Three Employment, 1991–2006



Source: Company 10-Ks, 20-Fs

Figure II.3: Detroit Three Michigan Employment vs. Michigan Auto Parts Employment, 1990–2007



Source: U.S. Department of Labor, Bureau of Labor Statistics, Center for Automotive Research

companies and the union. The agreement should pave the way for a better future for the United States and Michigan auto industry in the years ahead, and is an integral factor in the CAR forecast.

In this section of the study, CAR presents a forecast of Detroit Three employment, attrition and hiring—as well as an employment forecast for the international automakers producing vehicles in the United States—by examining recent employment trends in the United States and Michigan automotive sectors. We also examine U.S. sales, production and market share history, and offer detailed demographic information (provided by the participating automakers) on the current and projected workforce. Our forecast is heavily influenced by three major industry human resource trends:

1. High productivity growth in U.S. automotive manufacturing and engineering
2. The rapid retirement of the "baby boomer" automotive employees and their replacement by younger generation workers
3. The replacement (in the United States) of traditional domestic automotive employment by international automotive employment.

Two central conclusions of our 2007–2016 forecast are: there will be considerable hiring in the United States and Michigan automotive industries and total U.S. automaker employment will not decrease.

United States and Michigan Detroit Three employment trends

The "Big Three" earned that moniker for good reason—in the '70s and '80s, these three companies employed as many as one million people in the United States; over half of those workers were located in the state of Michigan. At the 1979 peak, workers at the Detroit Three comprised more than two-fifths of Michigan's total manufacturing employment. The Detroit Three are no longer as big as they once were. However, at the end of 2006, they still employed more than 295,600 people in the United States: Fifty-four percent of those workers were in Michigan, and one in four Michigan manufacturing employees worked for GM, Ford, or Chrysler.

Figure II.1 presents the trend of global, United States and Michigan Detroit Three employment between 1991 and 2006, and includes employees at all wholly owned automotive subsidiaries. Detroit Three employment reached its most recent peak in 1995, when more than 1.2 million people worked for these three companies globally. Since this recent peak, Detroit Three global employment has fallen nearly 50 percent: due in part to increased labor productivity, the loss of North American market share and the resulting corporate restructuring efforts. Detroit Three employment levels fell by 50 percent in the United States between 1995 and 2006, and by 45 percent in the state of Michigan.

Figure II.2 presents Michigan's share of Detroit Three global and U.S. employment between 1991 and 2006. Michigan's share of Detroit Three global employment has held steady at roughly 25 percent through this time period, while Michigan's share of U.S. employment has gradually increased over the past 16 years, to nearly 55 percent.

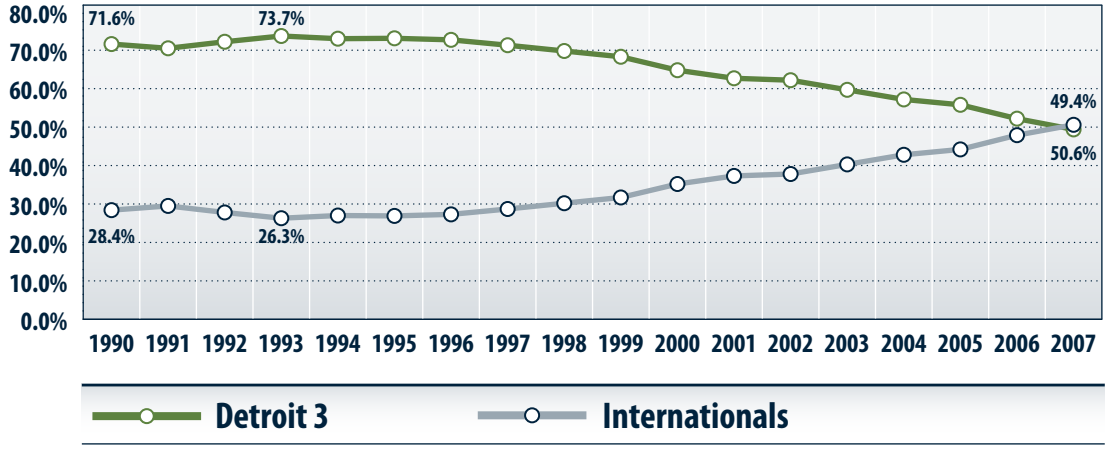
The Detroit Three have reduced employment in almost every year since 1990. The current job reductions in Michigan show a very different pattern than has been seen previously. Prior to 1999, when the Detroit Three cut jobs in Michigan, automotive parts suppliers in the state gained employment—indicating that Detroit Three work was being outsourced to the local supplier sector.

The break in this pattern is evident in Figure II.3, which shows the coefficient of Detroit Three Michigan employment versus Michigan automotive parts industry employment for the period 1990 to 2006. The data clusters into two distinct groups: 1990 to 1998 (on the right), where the loss of a Detroit Three job was partially offset by the gain of 0.5 job in the supplier sector, and the period 1999 to 2007 (on the left), where the loss of a Michigan job at the Detroit Three was correlated with the one-to-one loss of a Michigan automotive supplier job.

U.S. market share and production history

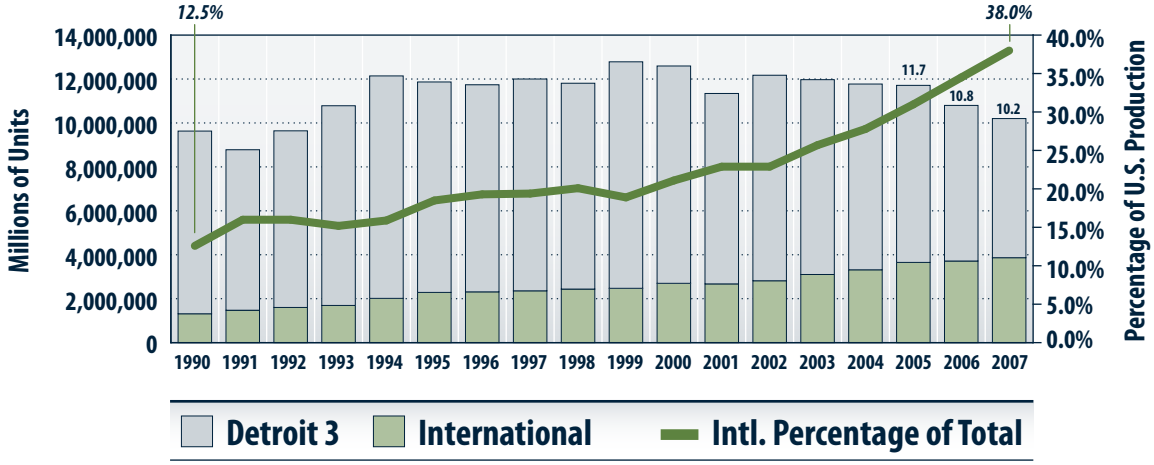
Stiff competition from international automakers has resulted in serious erosion of the domestic automakers' collective domestically produced U.S. market share. At the end of 2007, the international share of U.S. sales surpassed the Detroit Three's domestically produced vehicle sales share for the

Figure II.4: Detroit Three Domestically Produced and International Automaker U.S. Market Share, 1990–2007



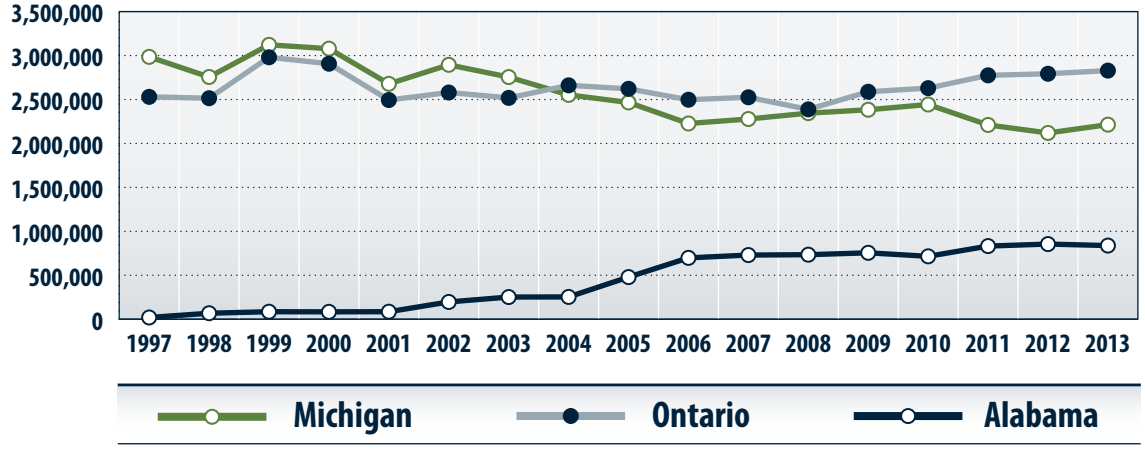
Source: Center for Automotive Research.

Figure II.5: U.S. Light Vehicle Production and International Share of Domestic Production, 1990–2007



Source: Automotive News, Center for Automotive Research

Figure II.6: Michigan, Ontario, and Alabama Light Vehicle Production, 1997–2013



Source: csm|worldwide North American Light Vehicle Production Forecast, December 2, 2007.

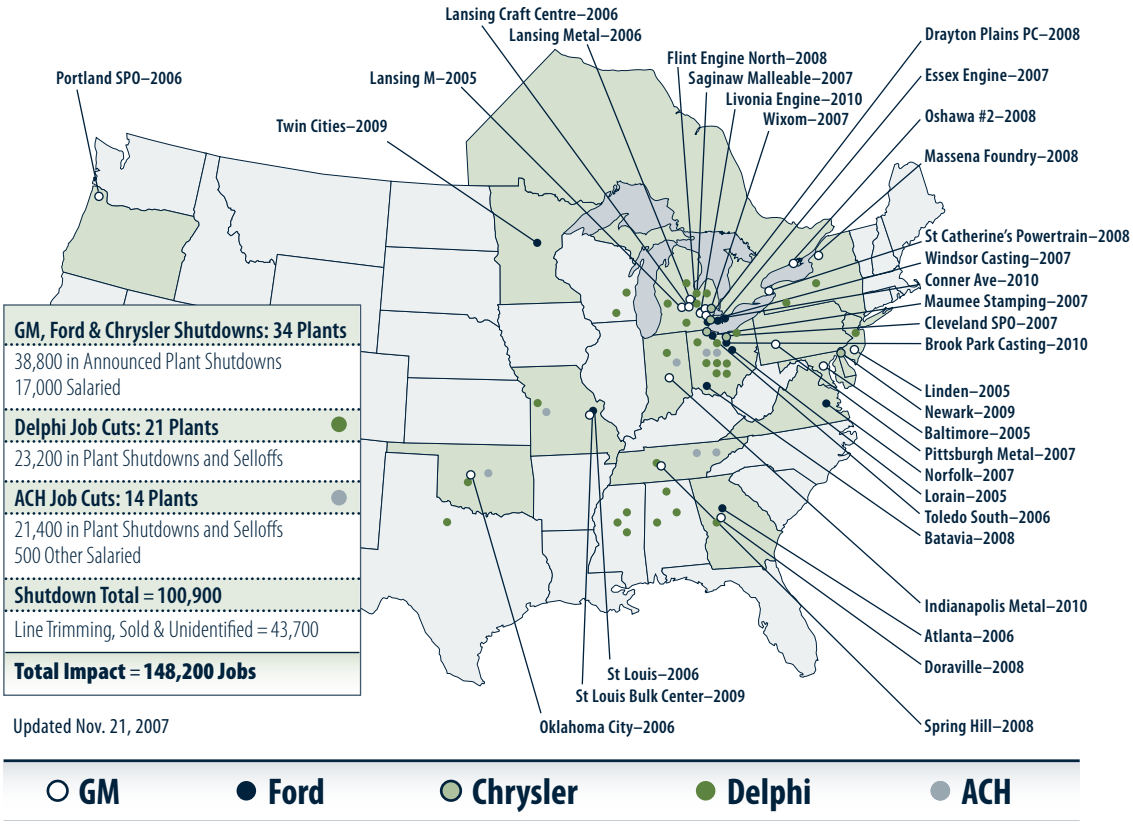
first time, climbing to 50.6 percent (as shown in Figure II.4).

In the face of stagnant U.S. demand, production trends have also fallen off from a high of 12.8 million vehicles produced in the United States in 1999 to just 10.2 million in 2007 (as shown in Figure II.5). The overall decline in U.S. production is dominated by the precipitous drop in Detroit Three production. International producers have added capacity and boosted their domestic production figures to nearly 38.0 percent of the total vehicles produced in this country in 2007.

The rise of international vehicle production is rapidly creating an automotive industry outside of the traditional automotive region of North America. Figure II.6 illustrates the shift from north to south by examining recent vehicle production trends for Michigan, Ontario and Alabama. In 1997, Alabama produced no motor vehicles, but just ten years later, the state produced roughly 750,000 vehicles a year in Daimler, Honda and Hyundai facilities. Production in both Michigan and Ontario—traditional automotive production centers—fell dramatically during this same period.

The Detroit Three's market share slide and subsequent fall in production have resulted in a critical problem of overcapacity. The companies have responded by undertaking massive restructuring efforts beginning in 2005, including plant shutdowns, line trimmings, employee buyouts, layoffs and early and standard retirement incentives. The Detroit Three plan to eliminate 4.0 million units of North American light vehicle capacity by 2010[4] and have already reduced U.S. employment by more than 107,000 people between 2005 and 2007[5]. The map in Figure II.7 below shows the announced and

Figure II.7: GM, Ford, Chrysler, Delphi and ACH United States and Canadian Plant Shutdowns, Announced and Executed, 2005–2011



Source: Company Announcements, Press Reports, and Center for Automotive Research

[4] Light Vehicle Production Forecast: North America, *csm|worldwide, Volume 16, Number 4, 4Q 2007*

[5] *Center for Automotive Research based on company announcements and media reports.*

executed United States and Canadian plant shutdowns at GM, Ford, Chrysler and at GM and Ford's former parts operations, Delphi and ACH. The total impact from these 69 plant closures and line trimmings is the gross reduction of 148,200 jobs in the United States and Canada. The announced employment reductions at the Detroit Three are a major factor in CAR's hiring and employment forecast detailed in the following sections.

Detailed Detroit Three workforce demographics

The Detroit Three provided CAR with detailed information on their current workforce by age and years of service, historical trends and projected attrition for the forecast period 2007–2016. The automakers were asked to provide this employment information for the United States as a whole, as well as a breakdown for the state of Michigan. The companies provided the following information:

1. Seniority and age distributions of the 2006 workforce.
2. Historical employment levels from 1999 to 2006.
3. Historical attrition from 1999 to 2006.
4. Projected attrition through 2015.

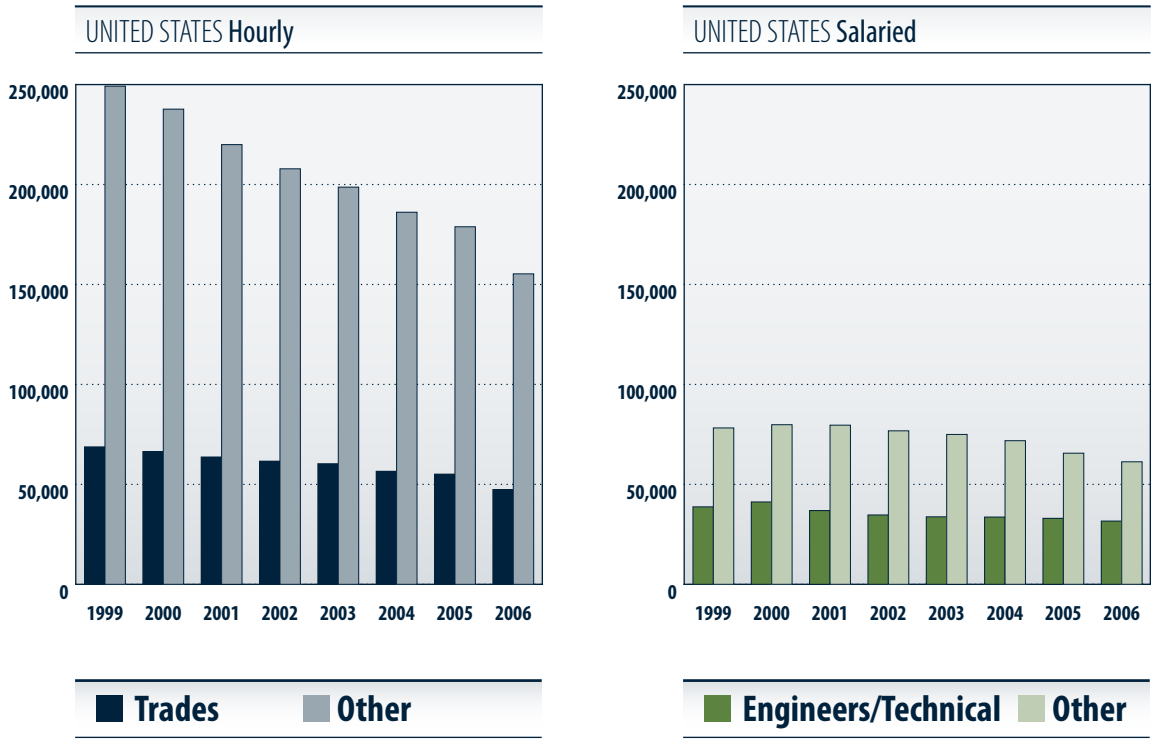
For each category of employment information, the automakers provided further information concerning the following attributes:

1. Geographical area: United States and Michigan.
2. Type of worker: salaried or hourly.
3. Occupational categories: Salaried worker data was broken out between engineering/technical employees and other salaried employees, including administrative employees. Hourly worker data was broken out between skilled trades workers and production workers.

Demographic distributions of Detroit Three employment by seniority and age were provided. However, two companies did not provide historical or projected salaried worker attrition for either geographic area.

The aggregate survey data provided by the Detroit Three is presented in Tables II.1a through II.5b. This detailed employment data is not only a valuable input to projecting employment levels by

Table II.1a: Detroit Three United States Employment, 1999–2006



Source: Proprietary Company Data, Center for Automotive Research

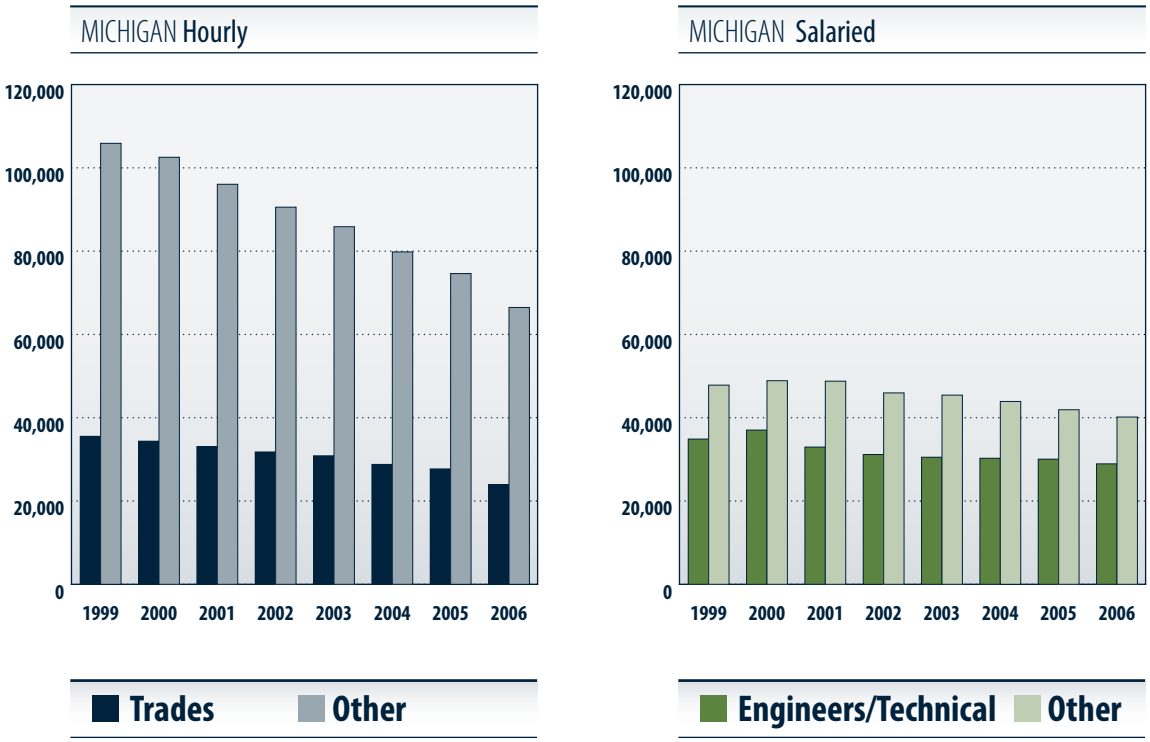
The Detroit Three provided CAR with detailed information on their current workforce by age and years of service, historical trends and projected attrition for the forecast period 2007–2016. The automakers were asked to provide this employment information for the United States as a whole, as well as a breakdown for the state of Michigan.

occupation and geographical area, but also permits CAR to estimate projected attrition—and therefore new hires—ten years out. See Appendix for data tables for Tables II.1a–II.5b

Historical employment

Table II.1 represents Detroit Three total employment in the United States and Michigan between 1999 and 2006. The figures presented include employment at all fully-owned company subsidiaries, and show the Detroit Three lost 32.0 percent of total employment in the United States and employment fell 28.8 percent in Michigan; in the same time period. The largest job reductions were in the hourly production labor force, which fell by 36.3 percent in the United States and 36.1 percent in Michigan between 1999 and 2006. The salaried workers experienced a smaller decline of only 20.6 percent job loss in the United States and 16.4 percent in Michigan.

Table II.1b: Detroit Three Michigan Employment, 1999–2006



Source: Proprietary Company Data, Center for Automotive Research

Demographics

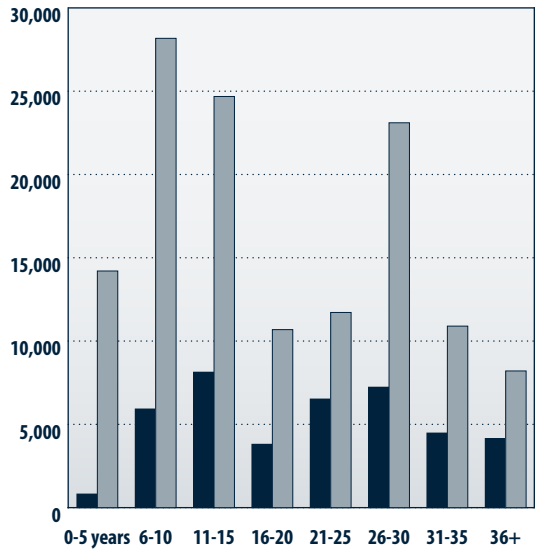
Tables II.2 and II.3 (page 20 through 23) show the distribution of Detroit Three employment by service years (5-year cohorts) and age (10-year cohorts). Descriptive statistics show no significant difference between the service and age distributions of the United States and Michigan Detroit Three workforces. On average in 2006, Detroit Three employees have nearly 18 years of seniority and are roughly 46 years old. Hourly workers are generally older and more senior than salaried workers in both geographic areas, averaging closer to 47 years old with roughly 19 years of seniority. At an average age of between 50 and 51 and having between 21–22 years of seniority, the skilled trades workforce is the oldest and most senior of all of the four job categories. The data presented here is aggregated across the Detroit Three companies, and does not show the considerable variation in workforce composition between the firms. Generally, workers at GM are older and more senior than their counterparts at Ford and Chrysler.

Historical attrition

Table II.4 (page 24) shows historical employee attrition at the Detroit Three in the United States and Michigan, from 2000 through 2006. The pattern of normal attrition between 2000 and 2005 was broken in 2006. Hourly attrition in 2006 surpassed attrition by nearly double the number

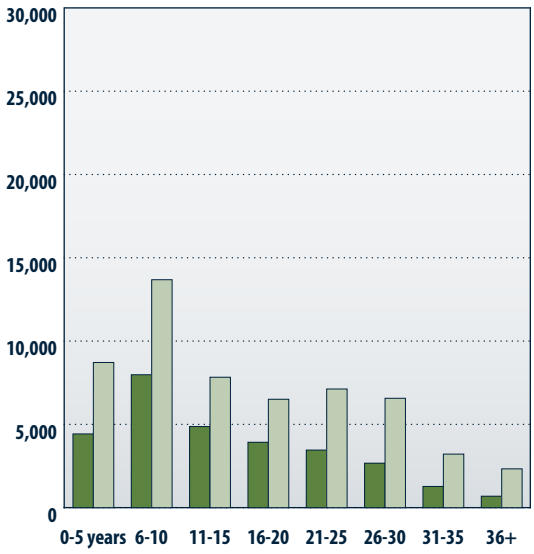
Table II.2a: Detroit Three Distribution of United States Employees by Service Years, 2006

UNITED STATES **Hourly**



Service Years	Mean	Median
All US Workers	17.70	14.95
Hourly	18.78	16.53
Trades	21.47	21.41
Other	17.94	14.75
Total Hourly Trades		41,042
Total Hourly Other		131,671

UNITED STATES **Salaried**



Service Years	Mean	Median
All US Workers	17.70	14.95
Salaried	15.52	13.08
Engineers/Technical	14.72	12.29
Other	15.95	13.57
Total Salaried Engineers/Technical		29,282
Total Salaried Other		55,962

Source: Proprietary Company Data, Center for Automotive Research

Data as of Q1 2007

of workers who left the Detroit Three in the most recent years. Detroit Three attrition in the United States for this time period totaled nearly 225,000 workers; Michigan represented 48.5 percent of the total. It is important to note that only two of the companies provided historical salaried attrition figures. Therefore, actual salaried attrition is certainly higher than shown in the table.

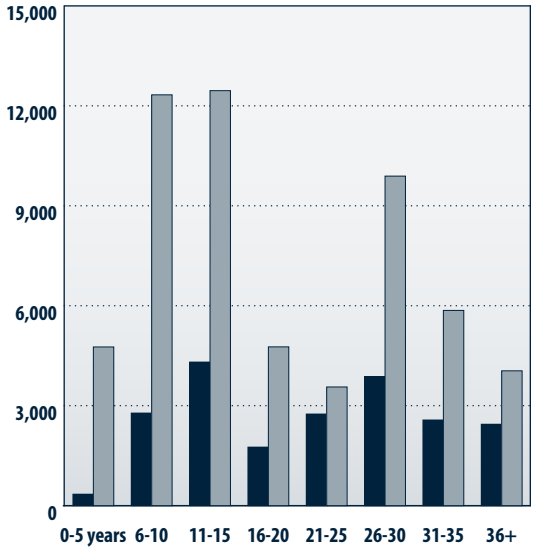
The Detroit Three also provided a forecast of projected attrition by geographical region (United States and Michigan) as well as by occupational split (production vs. skilled trades and engineering/technical vs. other salaried). It must be remembered that this data was provided prior to the conclusion of the UAW negotiations with the Detroit Three. There are several provisions in the new contracts which CAR believes will have a major impact—not only on the number of attritions but also on the timing of the exit of much of the workforce. Since CAR adjusted the data provided by the Detroit Three on future permanent leaves, the discussion of projected attrition has been moved to the model assumptions section of this report.

Forecast of Detroit Three employment, attrition and hiring, 2007–2016

CAR's Detroit Three employment model was constructed to provide forecast estimates in three areas: the Detroit Three's long term employment levels, attrition, and projected new hires—for both

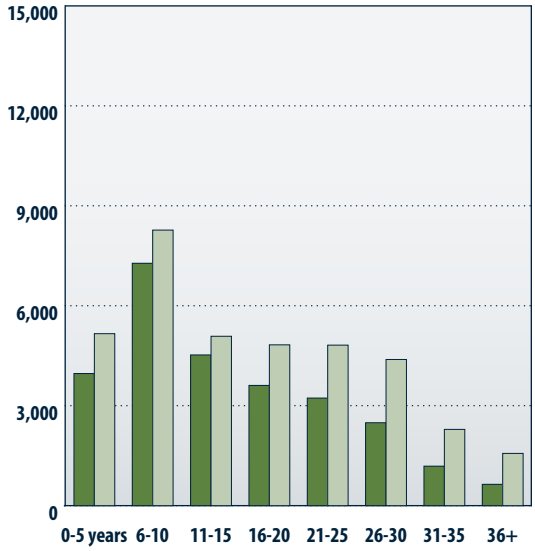
Table II.2b: Detroit Three Distribution of Michigan Employees by Service Years, 2006

MICHIGAN **Hourly**



Service Years	Mean	Median
All Michigan Workers	17.80	14.93
Hourly	19.42	16.74
Trades	22.09	17.26
Other	18.45	14.71
Total Hourly Trades		20,824
Total Hourly Other		57,676

MICHIGAN **Salaried**



Service Years	Mean	Median
All Michigan Workers	17.80	14.93
Salaried	15.79	13.64
Engineers/Technical	14.83	12.45
Other	16.50	14.69
Total Salaried Engineers/Technical		26,916
Total Salaried Other		36,406

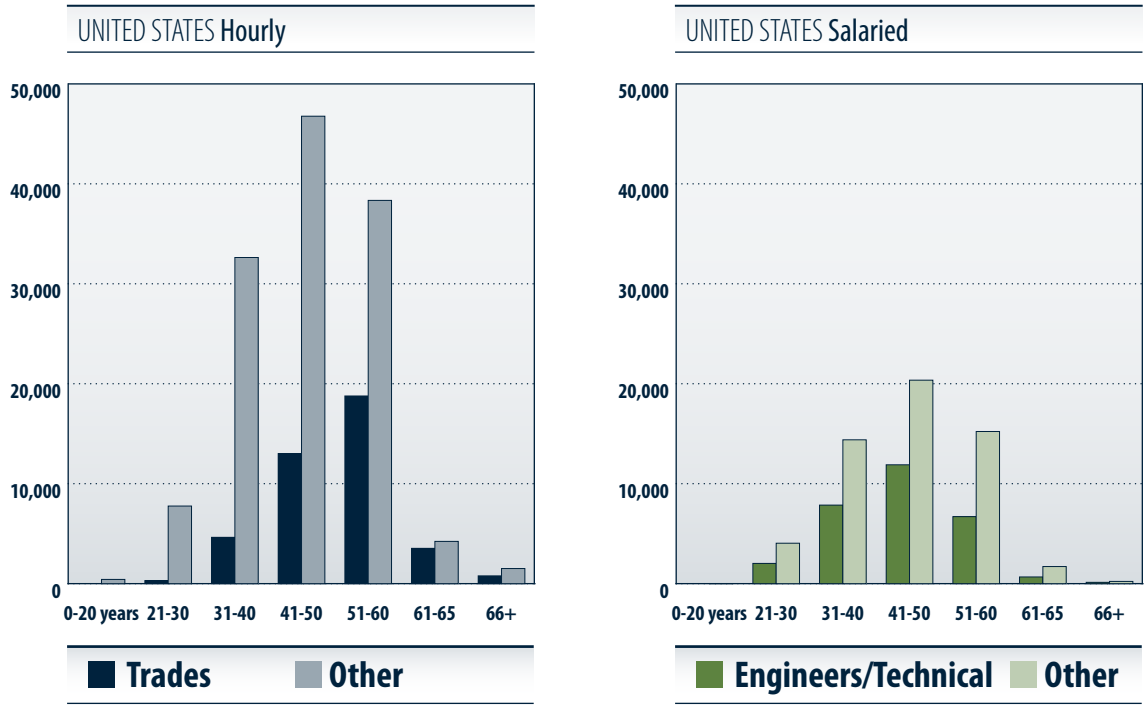
Source: Proprietary Company Data, Center for Automotive Research *Data as of Q1 2007*

the United States and Michigan, as well as for production, skilled trades, engineering/technical and other salaried workers—though 2016. As a model is a representation of a complex system, a number of explanatory variables must be used in order to define the model. In the case CAR's model of Detroit Three employment, these variables include U.S. light vehicle output, the companies' labor productivity levels and trends, the performance of a key competitor, projected employee attrition, possible changes in occupational structure, and the impact of labor contracts. Since CAR intends to provide a transparent forecasting methodology that can be modified to accommodate readers' potentially different hypotheses, we will discuss each major variable in the model in detail.

U.S. Detroit Three light vehicle output

The model uses a U.S. Detroit Three light vehicle production forecast provided by CSM Worldwide. This forecast covers all passenger cars and light trucks up to 3.5 metric tons gross vehicle weight or a Class 3 gross vehicle weight rating in North America. In the introduction section of *csm|worldwide Light Vehicle Production Forecast: North America*[6] it is noted that:

Table II.3a: Detroit Three Distribution of United States Employees by Age, 2006



Service Years	Mean	Median
All US Workers	46.02	45.96
Hourly	46.71	46.79
Trades	50.73	51.37
Other	45.46	45.35
Total Trades		41,042
Total Other		131,671

Service Years	Mean	Median
All US Workers	46.02	45.96
Salaried	44.62	44.43
Engineers/Technical	44.22	44.00
Other	44.82	44.68
Total Salaried Engineers/Technical		29,282
Total Salaried Other		55,962

Source: Proprietary Company Data, Center for Automotive Research *Data as of Q1 2007*

[6] Light Vehicle Production Forecast: North America, *csm|worldwide, Volume 16, Number 4, 4Q 2007*

"CSM's global forecast is driven by detailed regional economic and sales analysis that offers a clear understanding of consumer dynamics and trends. CSM Worldwide exhaustively examines all facets of the vehicle manufacturing environment. This includes competitive positioning, manufacturing strategies, consumer and demographic trends, export potential and global product interaction."

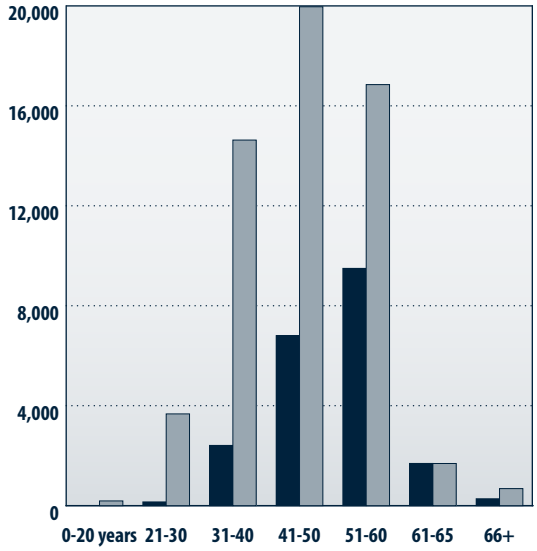
The CSM U.S. vehicle production forecast is one of the most important variables in CAR's estimate of the Detroit Three's future employment levels. This variable is important for the following reasons:

1. Related forecasts concerning market share, sales and sourcing are included in the forecast of these companies' production in the United States.
2. Vehicle production is used as a proxy for output in determining the Detroit Three's future labor productivity for the U.S. labor force. Productivity and production levels are used to determine future U.S. employment levels for the Detroit Three.

At the time this model was constructed in late 2007, CSM's U.S. production forecast extended through 2013. In order to forecast Detroit Three's

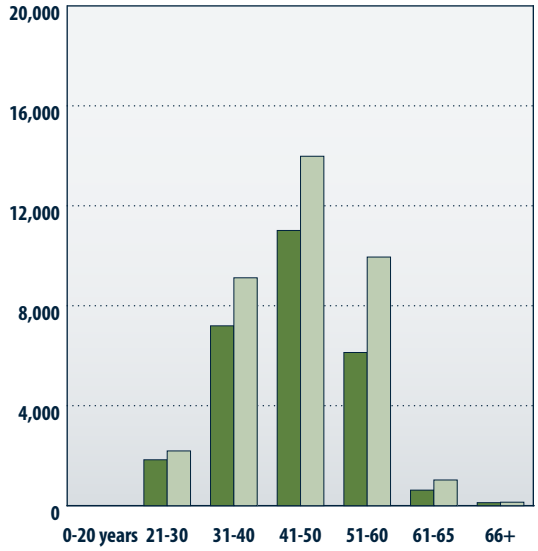
Table II.3b: Detroit Three Distribution of Michigan Employees by Age, 2006

MICHIGAN **Hourly**



Service Years	Mean	Median
All Michigan Workers	45.80	45.70
Hourly	46.65	46.80
Trades	50.48	51.10
Other	45.27	45.18
Total Trades		20,824
Total Other		57,676

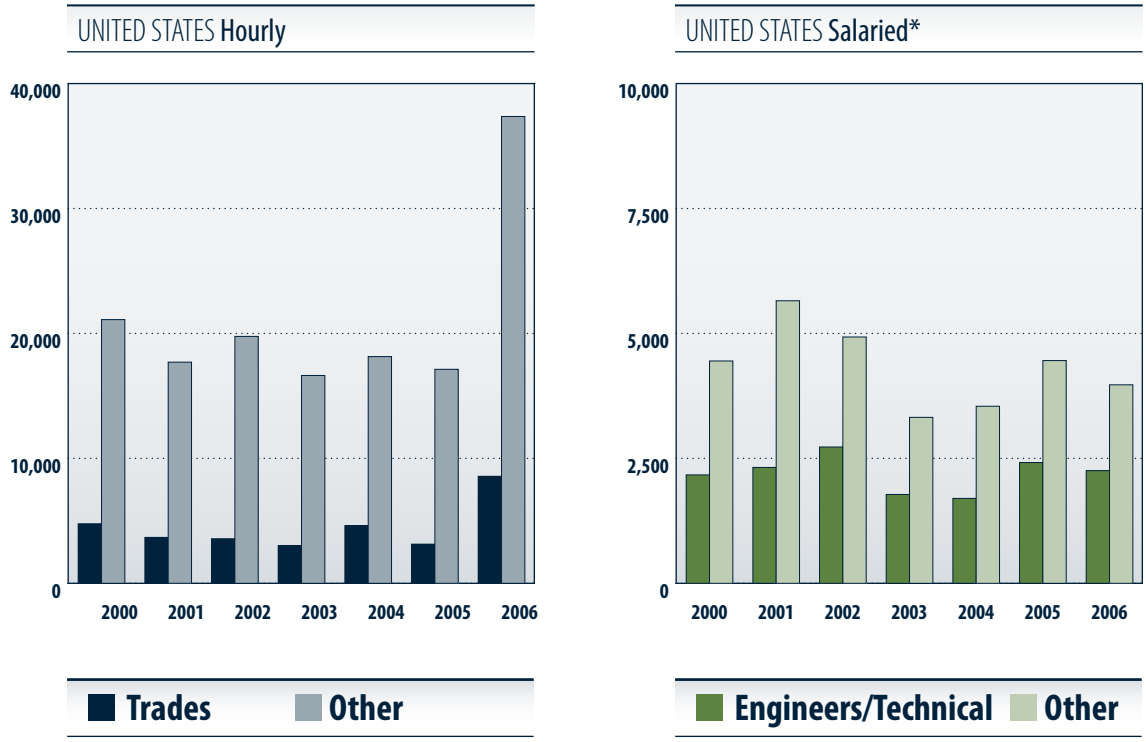
MICHIGAN **Salaried**



Service Years	Mean	Median
All Michigan Workers	45.80	45.70
Salaried	44.74	44.53
Engineers/Technical	44.24	44.02
Other	45.10	44.93
Total Salaried Engineers/Technical		26,916
Total Salaried Other		36,406

Source: Proprietary Company Data, Center for Automotive Research *Data as of Q1 2007*

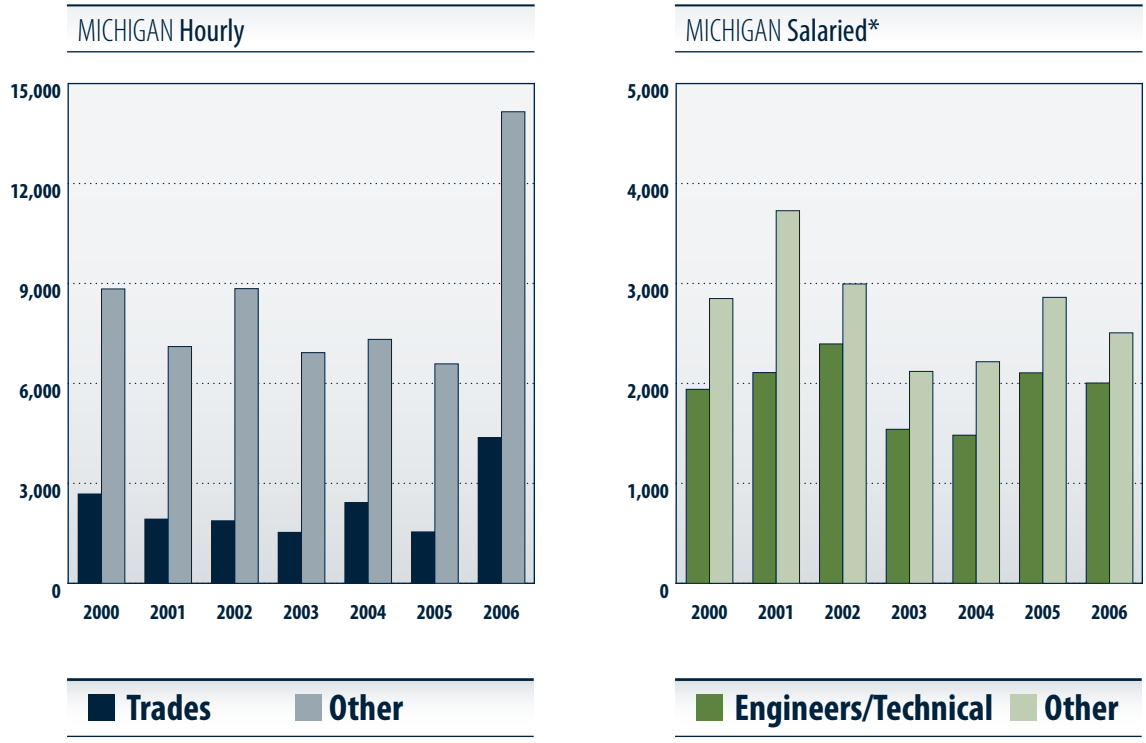
Table II.4a: Detroit Three United States Employee Attrition, 2000–2006



Source: Proprietary Company Data, Center for Automotive Research

** Exclude GM due to missing data*

Table II.4b: Detroit Three Michigan Employee Attrition, 2000–2006



Source: Proprietary Company Data, Center for Automotive Research

** Exclude GM due to missing data*

employment through 2016, CAR utilized two methodologies for two different geographic areas to extend CSM's forecast through 2016:

1. To estimate the Detroit Three's U.S. production from 2013–2016, an estimate was produced using linear regression techniques with the last three years of CSM's original forecasted production as inputs. The reason for using just the last three years of CSM's forecast is that the U.S. production estimates of 2011–2013 do not show the dramatic volatility that the company is forecasting for the 2008–2011 period. It is therefore reasonable to project U.S. light vehicle production as a steady trend from 2011–2013 through 2016.
2. To estimate the Detroit Three's Michigan output from 2013–2016, a three-year lagged autoregressive estimate was constructed using CSM estimates of vehicle output from 2001–2013. This method was chosen because Michigan's vehicle output is more volatile during the entire forecast period. Therefore, CAR sought to construct a vehicle production estimate for 2013–2016 allowing for cyclical changes, which use of lagged autoregressive models can accomplish.

Labor productivity

In CAR's model, productivity is defined as annual vehicles produced per hourly "core" worker. "Core" work is any work that cannot be easily outsourced to a supplier. This definition of "core" and "non-core" work will be explained in greater detail in the section of this report dedicated to the assumptions regarding the UAW labor agreements. When productivity increases, vehicles produced also increases (given the same number of workers). On the other hand, when labor productivity increases and vehicle production remains the same or falls, the number of workers required will decrease.

Productivity is a key factor in CAR's estimates of employment based on vehicle production. A small change in the productivity assumption could result in very large changes in employment levels. Due to the sensitivity of this assumption, estimates of future productivity are a critical input.

Competition and industry best practices

A key driver in the CAR Detroit Three employment and hiring model is the constraint on future desired labor productivity levels at the Detroit Three. CAR makes the reasonable competitive assumption that the Detroit companies must match the best practice labor productivity and unit labor cost levels of the industry leader in North America.

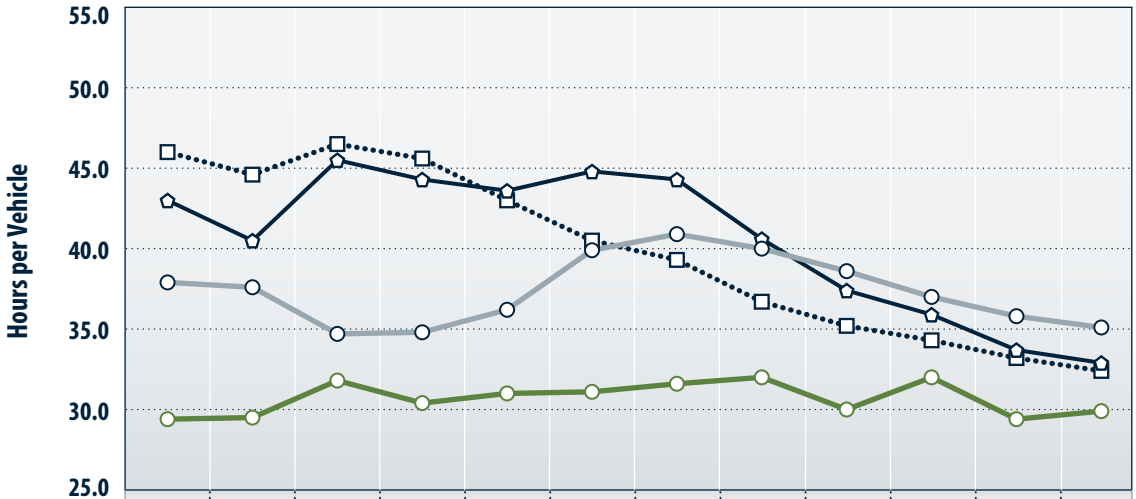
The annual The Harbour Report™ North America[7] has compiled and documented automotive industry productivity in North America since 1992. The Harbour Report™ documents the progress that carmakers have made in the area of labor productivity. In Figure II.8 (page 26), CAR presents recent productivity trends of four major OEMs in North America—the Detroit Three and the industry's productivity leader, Toyota. The trends since 1995 tell a clear story: the Detroit Three are committed to closing in on the industry leader in terms of labor productivity in order to become competitive.

CAR's assumption is that each of the Detroit Three will match the industry leader's North American labor productivity levels in both hourly and salaried employment by 2016. It also assumes that the industry's leader will not stand still and, instead, that automotive best practice will improve by one percent per year. An illustration of this is contained in Figure II.9 (page 26).

The model also addresses geographical differences in productivity. Historical data show that the Detroit Three's Michigan operations have significantly lower productivity overall than that of the United States. This is not a surprising finding. The Detroit Three have their global headquarters and basic engineering research facilities in Michigan, and therefore have a higher ratio of non-manufacturing hourly employees resulting in lower productivity rates in the state. Also, a higher proportion of Michigan's production consists of major component plants, such as engines, transmissions and major stampings. Applying the national trend of productivity growth to the model for Michigan would result in an underestimate of future Michigan automaker employment.

[7] The Harbour Report™ North America 2007, *Harbour Consulting.*

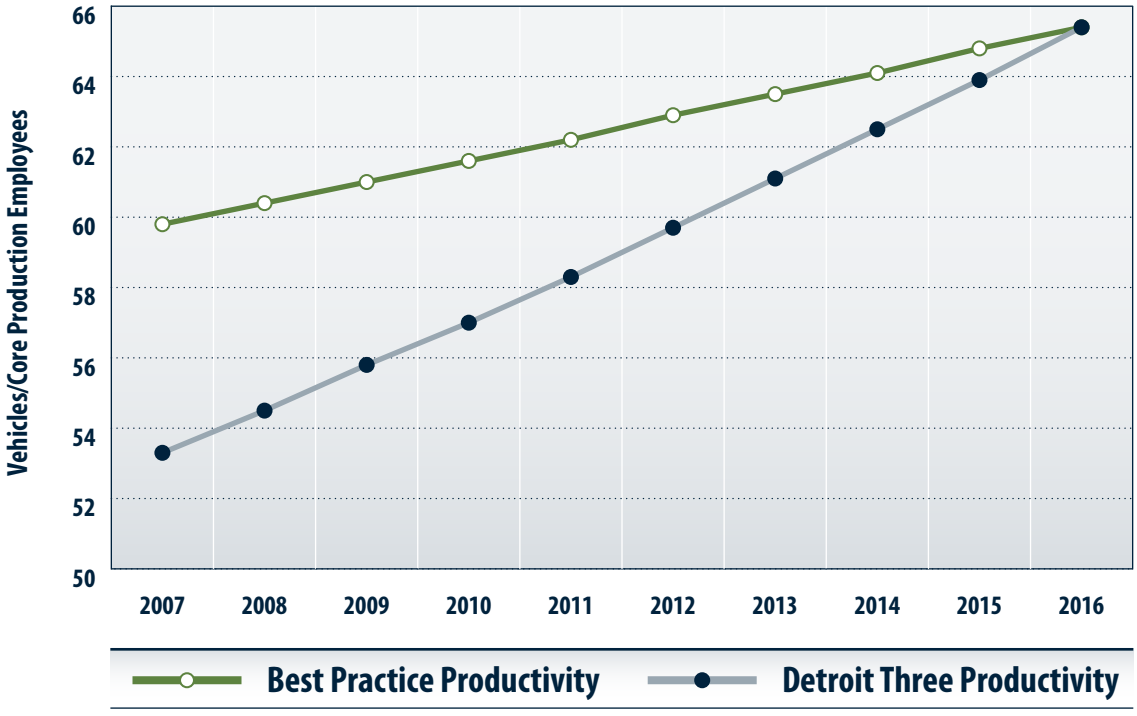
Figure II.8: The Harbour Report™ Productivity, Hours per Vehicle in Major Operations, 1995–2006



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
GM	46.0	44.6	46.5	45.6	43.0	40.5	39.3	36.7	35.2	34.3	33.2	32.4
Chrysler	43.0	40.5	45.5	44.3	43.6	44.8	44.3	40.6	37.4	35.9	33.7	32.9
Ford	37.9	37.6	34.7	34.8	36.2	39.9	40.9	40.0	38.6	37.0	35.8	35.1
Toyota	29.4	29.5	31.8	30.4	31.0	31.1	31.6	32.0	30.0	32.0	29.4	29.9

Source: The Harbour Report™ North America 1996–2007.

Figure II.9: Detroit Three and International Productivity Trends, Vehicles per "Core" Production Worker, 2007–2016



Source: The Harbour Report™ North America, csm|worldwide, Center for Automotive Research

Forecast employee attrition

Table II.5 (page 28) shows the Detroit Three's projected attrition (permanent leaves) in the United States and Michigan for 2007–2016. This information is based on data provided by the companies during the first quarter of 2007, which did not account for impacts of the new UAW contract, completed in the fourth quarter of 2007. An anticipated result of the new UAW contract with the Detroit Three is that the provision for a second-tier labor force will provide incentive for the companies to expedite their planned attrition in order to achieve lower labor costs. In addition, CAR expects the Detroit Three's combined attrition number will increase significantly in the next ten years as the companies reduce capacity, eliminate models, trim production, and cut jobs. CAR took these factors into consideration, along with the original responses from the companies, and projected Detroit Three attrition as shown below.

Between 2007 and 2016, CAR estimates that nearly 115,500 workers will leave the Detroit Three nationally, with 54.2 percent of those in Michigan. In the United States, nearly two-thirds of the workers leaving the company will be hourly workers, and just short of three-quarters of those will be production workers. Of the salaried workers who will leave the Detroit Three nationally, roughly one-third will be engineering and technical employees. In Michigan, of the 90,700 workers who will leave the Detroit Three, over 55.7 percent of them will be hourly workers, and 71.5 percent of those will be production workers. On the salaried side in Michigan, a slightly higher proportion than nationally—over 41.1 percent—of those workers leaving the company will be engineering and technical employees.

Occupational structure

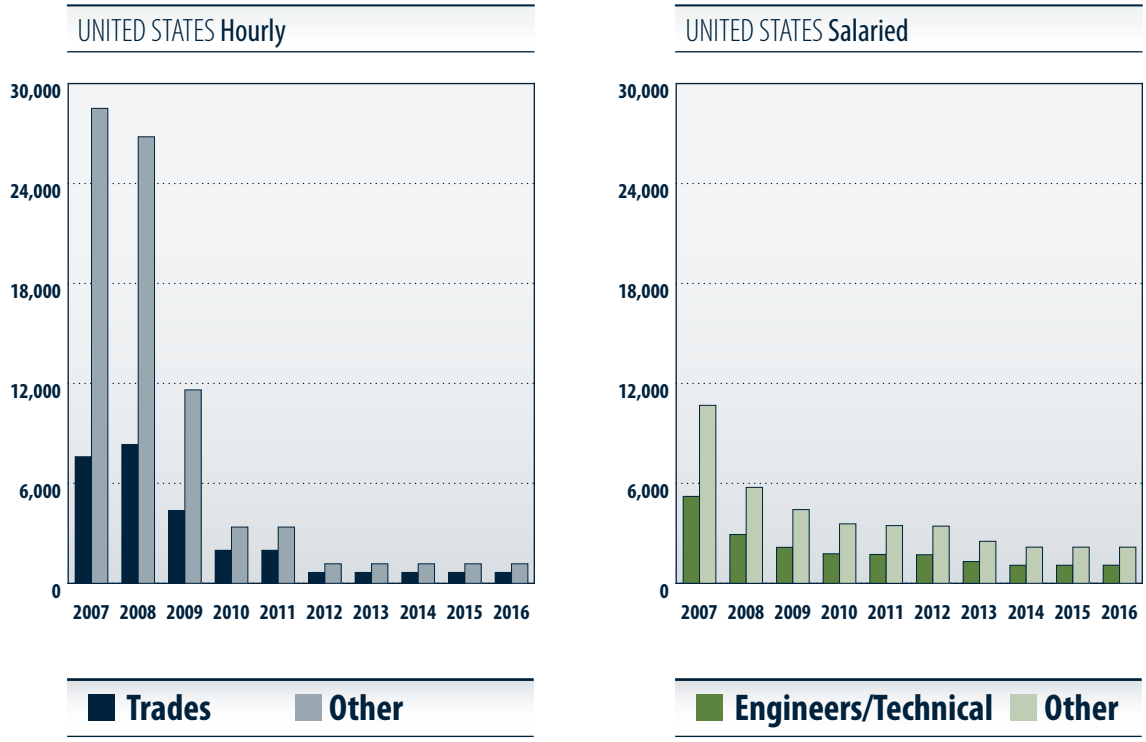
The model directly estimates the number of hourly workers using vehicle production and labor productivity as inputs. However, the same data and methodology cannot be used to directly estimate the occupational split between production and skilled trades or engineering/technical workers and other salaried employees or the overall proportion of salaried employees. Estimating the number and occupational split of the salaried workforce presents a unique challenge, because unlike hourly workers whose number is closely tied to production volumes, the number of salaried workers is associated with company size and with the location of their research and development activities. These factors vary across the companies, making it necessary to consider individual company variations when projecting the salaried labor staffing levels and characteristics.

CAR estimated the number of salaried workers and the occupational splits within the hourly and salaried ranks based on the historical data provided to CAR by the companies. CAR used the historical employment data provided by the companies to produce a data series on the historical ratio of hourly-to-salaried employment, the ratio of production-to-skilled trades workers, and the ratio of engineering and technical employees-to-other salaried workers.

Since the ratio of hourly-to-salaried workers varied widely across companies, CAR used linear regression techniques based on the companies' historical data to project each individual company's future split between hourly and salaried workforce in the United States. There was considerable volatility in the 1999–2000 data on the ratio of hourly-to-salaried workers, due in large part to a significant departure of hourly workers in 2000. For this reason, only the data from 2001–2006 were used for these projections. For Michigan's hourly-salaried split, CAR carried the current ratios forward, as Michigan is home to both the global headquarters and research and development operations for the Detroit Three. The company-provided attrition forecasts did not alter the balance between the two groups of employees going forward.

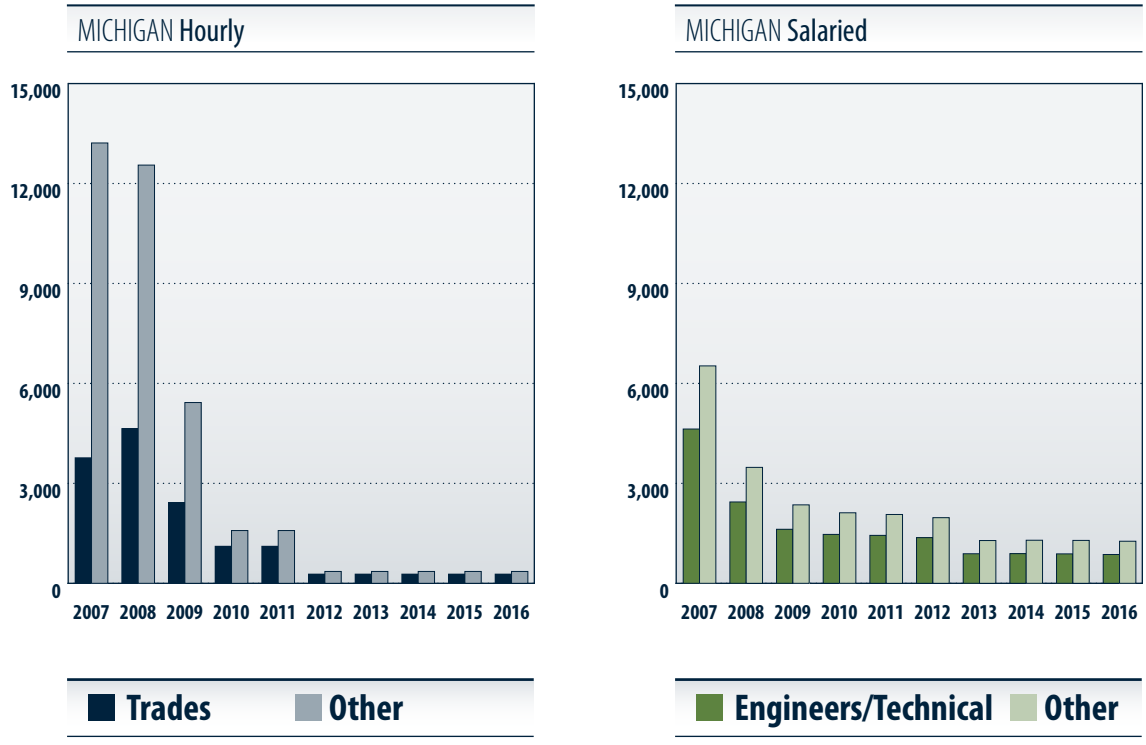
We projected the ratio of engineering/technical-to-other salaried workers through the use of linear regression techniques for the two companies showing declines in the 1999–2006 time period. For the remaining company, the historical data provided showed an unusually steep increase in the proportion of the salaried workforce that is engineering/technical. A linear projection of the engineering/technical ratio of total salaried workers would have cut other salaried and administrative employment to a level too low to maintain the other salaried functions within the company. In this instance, CAR capped the percent of engineering/technical labor at 40.0 percent in the United States and

Table II.5a: Forecast Detroit Three Employee Attrition in the United States by Occupational Group, 2007–2016



Source: Proprietary Company Data, Center for Automotive Research

Table II.5b: Forecast Detroit Three Employee Attrition in Michigan by Occupational Group, 2007–2016



Source: Proprietary Company Data, Center for Automotive Research

45.7 percent in Michigan—both ratios still exceed the split at the other two of the Detroit Three.

Finally, the ratio of production-to-skilled trades employees was forecast in a more direct manner. First, overall hourly employment levels were determined using assumptions discussed earlier in this section. Next, the number of current skilled trades workers was adjusted downward using projected skilled trades attrition rates. CAR then added in the number of skilled trades apprenticeships called for in the 2007 UAW-Detroit Three contracts. Finally, the skilled trades employment level was used to calculate the production-to-skilled trades ratio for the forecast period.

It is also important to note that CAR used the detailed information contained in the 2007 UAW-Detroit Three contracts to forecast a split between core and non-core hourly production workers. This split is key to the forecast as the productivity assumptions were applied only to the companies' core employment levels. The Detroit Three and the international automakers have very different ways of organizing work considered "non-core" in the agreement. For the international automakers, much of this work is accomplished by employees of upper-tier supplier companies. For the Detroit Three, the non-core work that is being retained—and is identified to be brought back into the company—is all work that could theoretically be performed by suppliers. In the next section, we will discuss this and other provisions of the 2007 labor agreements that impact CAR's forecast.

The 2007 UAW labor agreements

During the summer and fall of 2007, the UAW and the Detroit Three automakers negotiated new labor contracts that cover the period 2007–2011. GM and the UAW were the first to reach a deal in September; Chrysler's contract was completed in October and Ford wrapped up their agreement in November. These new agreements are considered groundbreaking in several areas, but the provisions that have the most influence on CAR's forecast model are those governing the two-tier wage structure for hourly employment.

Under the new labor agreements, up to 44,000 "non-core" new hires[8] will receive second-tier wages of $14.50–$16.23, which is 50 to 60 percent of the current first-tier wage. In addition, these new workers will receive a totally different benefit plan that eliminates defined benefit pensions as well as the companies' liability for future retiree health care. A separate portion of the contract was devoted to removing the liability for current retiree health care from the company balance sheet and transferring it into a Voluntary Employee Benefit Association, or VEBA trust, to be administered by the UAW. No current employees will be expected to take a cut in pay or benefits. New hires that eventually transfer into "core" positions will be paid the first-tier wage, but will retain their second-tier benefits package. There is some question as to whether the Detroit Three will make the same significant investment in training and preparing this lower-wage workforce for work inside their plants as they have committed to for training and preparing the incumbent first-tier labor force.

At GM and Chrysler, "non-core" employees will work in positions like machining, subassembly, inspection, non-core stamping, non-core blanks, and non-production areas such as truck driving, material handling, unitizing, warehousing, kitting, sequencing and repacking. Essentially, any work that can be outsourced to a supplier will now be paid the second-tier "supplier" wage. At Ford, the agreement allows for up to 20 percent of the workforce to be hired into second-tier jobs, regardless of the content of the work. The demographics of the Ford workforce did not support a significantly large second-tier workforce if these new hires were to be confined only to specific work assignments, as is the case in the agreements at the other two companies.

The UAW contracts with each of the Detroit Three spell out the exact number of non-core jobs for each company, which total 22,855 at GM, 13,405 at Chrysler, and 20 percent of the workforce at Ford. In the model, these non-core workers are subtracted from total hourly employment in order to calculate "core" worker productivity for each company. "Non-core" workers are not in the equation because the model compares Detroit Three

[8] *CAR conducted an analysis of all three Detroit Three-UAW contracts to determine how many positions would be labeled "core" and "non-core." This was done for purposes of calculating core worker productivity growth as shown in Figure II.9.*

productivity to the international industry leader productivity. International automakers have very few workers in such "non-core" positions; this type of work is mostly done by suppliers.

In order to realize the cost savings from the two-tier wage structure, CAR anticipated that the Detroit Three would launch another round of special attrition programs (SAPs) in early 2008. Since there will be incentives for current workers to leave, the model assumes all hourly workers who have 27 service years or above by the end of 2007 will retire by 2011, and all hourly workers who are retirement-eligible by 2011 will retire by 2016. The model also examined the demographic disparities between the companies and assumed 5 percent of non-retirement-eligible hourly workers at Ford and Chrysler will take buyout packages and leave by 2009. Considering the industry consensus that 2008 production may come in at or below 16-million units, the timing of the new hires may be delayed until later in the forecast period.

The forecast for Detroit Three automotive employment and new hires

CAR produced a detailed forecast of Detroit Three employment levels. This forecast, together with CAR's projection of Detroit Three attrition, allows us to produce an estimate of the number of new hires from 2008–2016. CAR has also produced a forecast of overall international automaker employment levels and growth projections from 2008–2016. In this section, we present the findings of these research efforts.

Tables II.6 and II.7 present the estimates for Detroit Three employment in the United States and in Michigan for 2007, 2011, and 2016. The tables also include the change in employment through 2011; and overall through 2016. As can be

Table II.6: Detroit Three U.S. Automotive Employment 2007 and Forecast for 2011 and 2016

U.S. Employment	2007 Preliminary	2011 Forecast	2016 Forecast	Change Thru 2011	Change Thru 2016
Total Employment	241,189	210,542	203,219	-30,647	-37,969
Hourly	166,575	145,148	136,488	-21,427	-30,087
Skilled Trades	39,775	25,128	21,869	-14,647	-17,906
Production	126,800	120,020	114,619	-6,780	-12,181
Salaried	74,614	65,394	66,731	-9,220	-7,883
Engineering/Technical	24,707	21,731	22,266	-2,977	-2,441
Other Salaried	49,907	43,664	44,465	-6,243	-5,442

Source: Center for Automotive Research

Table II.7: Detroit Three Michigan Automotive Employment 2007 and Forecast for 2011 and 2016

MI Employment	2007 Preliminary	2011 Forecast	2016 Forecast	Change Thru 2011	Change Thru 2016
Total Employment	129,037	114,254	108,430	-14,782	-20,607
Hourly	73,439	68,364	65,209	-5,075	-8,231
Skilled Trades	20,179	12,097	10,722	-8,082	-9,457
Production	53,260	56,268	54,487	3,007	1,226
Salaried	55,597	45,890	43,221	-9,707	-12,376
Engineering/Technical	22,844	18,813	17,580	-4,031	-5,264
Other Salaried	32,753	27,077	25,642	-5,676	-7,111

Source: Center for Automotive Research

seen in the tables, the Detroit Three's U.S. employment dropped to 241,189 in the United States and 129,037 in Michigan at the end of 2007. During the forecast period, these downward trends will continue, with the Detroit Three expected to shed 30,647 jobs in the United States and 14,782 jobs in Michigan by 2011, and a total of 37,969 jobs in the United States and 20,607 in Michigan by 2016. By 2016, Detroit Three employment levels are forecast to fall to 203,219 in the United States and 108,430 in Michigan.

Due to the higher average age and seniority among skilled trades workers, this category of workers is disproportionately impacted by the employment forecast. Over 52.8 percent of the United States and 54.1 percent of Michigan employment decline will result from the cuts in skilled trades employment. Throughout the forecast period, Michigan hourly production workers are the only employment category that will show overall gains. Estimates of employment loss overall are primarily driven by the projected cuts in U.S. production during the forecast period. CAR's model assumption that the Detroit Three must match Toyota's ever-increasing labor productivity rates in order to keep the unit labor cost competitive is another key factor.

In addition to employment levels, CAR forecasts new hires by the Detroit Three in the United States and Michigan during the forecast period 2008–2016. These results are shown in Tables II.8 and II.9. In the United States, the Detroit Three are expected to hire no less than 56,673 new workers during 2008–2011, and an additional 20,536 new hires—primarily salaried workers—by 2016. In Michigan, CAR projects that the Detroit Three will hire 36,250 employees by 2011. During 2008–2016, new hires in Michigan should be no less than 45,955 employees. All of the hourly new hires are expected to occur over the next four years (2008–2011), when tens of thousands of hourly employees are expected to retire from the Detroit Three. The Detroit Three granted only

All of the hourly new hires are expected to occur over the next four years (2008–2011), when tens of thousands of hourly employees are expected to retire from the Detroit Three.

Table II.8: Hiring Forecast for Detroit Three
U.S. Automotive Employment for 2011 and 2016

U.S. New Hires	Through 2011	Through 2016
Total New Hires**	56,673	77,209
Hourly**	38,390	38,848
Skilled Trades*	2,000	2,000
Production	38,390	38,848
Salaried	18,282	38,361
Engineering/Technical	6,078	12,890
Other Salaried	12,204	25,470

Source: Center for Automotive Research
**Transfer from production.*
***Sums do not include the number of workers transferred from production to skilled trades.*

Table II.9: Hiring Forecast for Detroit Three
MI Automotive Employment for 2011 and 2016

MI New Hires	Through 2011	Through 2016
Total New Hires**	36,250	45,955
Hourly**	24,154	24,154
Skilled Trades*	1,205	1,205
Production	24,154	24,154
Salaried	12,095	21,800
Engineering/Technical	4,927	8,846
Other Salaried	7,168	12,955

Source: Center for Automotive Research
**Transfer from production.*
***Sums do not include the number of workers transferred from production to skilled trades.*

2,000 apprenticeships nationwide under the 2007 UAW agreements, and these slots will likely be filled from within the ranks of hourly production workers. Retirement and early retirement will be used by the Detroit Three to cut the number of current skilled trades workers by as much as 45 to 47 percent by 2016.

Michigan will see significant numbers of hourly job openings starting as early as 2008. As mentioned earlier in this study, this hiring wave may be delayed by market conditions since forecasters are projecting U.S. sales at or below 16 million units for 2008. Even if the projected hiring does not take place until a market recovery in 2009 or 2010, there may not be sufficient time to train and prepare new hires for the automotive jobs of the future. This is a critical issue for community colleges and technical schools that will be expected to prepare this future labor force. The training and education programs at these institutions have been in a state of semi-hibernation over the past decade, since the Detroit Three have not been in a large-scale hiring mode for that many years. In fact, about 40 percent of current Detroit Three Michigan hourly workers were hired between 1991 and 2000. Fewer than seven percent of the Detroit Three's total hourly labor forces were hired in the last seven years.

CAR's forecast calls for 45,955 job openings at the Detroit Three between 2008–2016. This forecast includes 24,154 hourly production job openings in the next four years, and no new hourly hires in the 2011–2016 time period. A total of 1,205 skilled trades apprenticeships are projected to be granted in Michigan, and these skilled trades positions will be filled by current production workers. By 2011, 31 percent of Michigan hourly workers are projected to receive second tier wages, compared to 27 percent of the U.S. hourly workers. CAR estimates that roughly 21,800 salaried workers will be hired in Michigan in the forecast period—nearly 8,900 engineering and technical workers, with the remaining 12,900 filling other salaried positions within the Detroit Three.

The forecast for international automotive employment

Our CAR study also estimates international automakers' (Toyota, Honda, Nissan, etc.) U.S. employment, which is shown in Figure II.10. Currently the international automakers employ 113,410 workers in the United States according to *Association of International Automobile Manufacturers* (AIAM)[9], of which 65,579 workers (57.8 percent) are in manufacturing positions. The number of employees is expected (by CAR) to grow to 137,562 by 2011,

Figure II.10: United States Detroit Three and International Employment, 2001–2016

Source: Company surveys and Center for Automotive Research estimates

[9] *Center for Automotive Research studies for the Association of International Automobile Manufacturers and Alliance of Automobile Manufacturers, Association of International Automobile Manufacturers Annual Reports and Center for Automotive Research estimates.*

International automaker employment made up 32.0 percent of total automaker employment of 354,599 in 2007. CAR predicts that the international automakers will comprise 39.5 percent of total automaker employment by 2011 and 42.8 percent by 2016.

and 152,054 by 2016. In other words, the international automakers are expected to hire at least an additional 38,644 workers (19,927 manufacturing and 18,717 non-manufacturing employees) over the next ten years. At least one international automaker is now experiencing significant replacement hiring due to retirement. This estimate is produced by tracking the firms' current announcements of expansions as well as CSM's forecast of U.S. production for these automakers.

As shown in Table II.10, the expansion of international employment is driven by production increases. By 2016, the international automakers are estimated to produce 5.4 million light vehicles per year in the United States, according to CSM. This forecast indicates a 42 percent increase from their 2007 production level. During the forecast period, the number of manufacturing employees should grow by 30 percent to 85,506. The increase in international automaker employment is lower than the increase in production, due to increasing productivity.

The number of non-manufacturing workers employed by international automakers (e.g., engineers and administrative staff) is also expected to grow by 39 percent to 66,548. The growth of non-manufacturing employment is greater than the growth of manufacturing employment, because it is driven by increasing sales and research activities in the United States.

What is striking about the comparison of Detroit Three and international automaker U.S. employment is the increasing share of the international automaker in the total U.S. automaker employment. International automaker employment made up 32.0 percent of total automaker employment of 354,599 in 2007. CAR predicts that the international automakers will comprise 39.5 percent of total automaker employment by 2011 and 42.8 percent by 2016. Total automaker employment is expected to be 348,104 by 2011 and 355,274 by 2016. The second striking fact is that CAR forecast the rise in international automaker employment to almost exactly offset the loss of Detroit Three employment

Table II.10: U.S. International Automaker Employment 2007 and Forecast for 2011 and 2016

	2007– Preliminary	2011	2016	Change Through 2011	Change Through 2016
Vehicle Production	3,826,288	4,770,069	5,456,306	943,781	1,630,018
U.S. Total Employees	113,410	137,562	152,054	24,152	38,643
Productivity (Unit per core worker)	58.4	60.7	63.8	2.4	5.5
Manufacturing Employment	65,579	78,565	85,506	12,986	19,927
Manufacturing Worker Percentage	57.8%	57.1%	56.2%	-0.7%	-1.6%
Non-Manufacturing Employment	47,831	58,997	66,548	11,166	18,717

Source: Center for Automotive Research

in the United States during 2007–2011. Total automaker U.S. employment was 354,599 in 2007 and is forecast to be 355,274 in 2016—a small gain.

Labor supply trends in Michigan

A forecast of future automotive employment and demand would be incomplete without an investigation of labor supply trends. According to the employment forecasts conducted by the Michigan Department of Labor and Economic Growth, Michigan will have on average of 154,304 job openings each year during the forecast period 2004–2014[10]. Table II.11 presents the actual and projected Michigan public high school graduates, and degrees conferred, from 1997 through 2016. Only about 43 percent of Michigan high school graduates directly enter the workforce.[11]

Table II.11: Detroit Three Michigan Historical Employment Levels, Forecast New Hires and Michigan Labor Supply, 1997–2016

	Michigan						
	Detroit Three Employment (1)	Detroit Three Hourly New Hires (1)	Detroit Three Salaried New Hires (1)	HS Graduates (2)	Associates (3)	Bachelors (3)	TOTAL Degrees Conferred
1997	273,747			92,700	20,993	44,186	65,179
1998	263,705			94,125	21,731	44,289	66,020
1999	224,124			97,679	18,851	45,754	64,605
2000	222,834			96,515	19,534	46,115	65,649
2001	210,873			95,001	18,768	47,929	66,697
2002	199,464			100,301	21,298	50,178	71,476
2003	192,679			98,823	21,836	51,166	73,002
2004	182,783			101,450	23,509	51,207	74,716
2005	174,290			100,510	20,959	51,547	72,505
2006	159,519			102,990	20,924	52,354	73,278
2007	129,037			108,120	20,890	53,161	74,051
2008		12,378	3,087	107,170	20,856	53,969	74,824
2009		5,585	2,251	104,830	20,821	54,776	75,597
2010		3,501	3,721	102,920	20,787	55,583	76,370
2011	114,254	2,690	3,036	100,550	20,753	56,390	77,143
2012		0	1,784	98,940	20,719	57,198	77,916
2013		0	3,109	96,510	20,684	58,005	78,689
2014		0	2,568	96,120	20,650	58,812	79,462
2015		0	1,575	96,400	20,616	59,619	80,235
2016	108,430	0	668	95,900	20,582	60,427	81,008

Source: (1)Proprietary Company Data and Center for Automotive Research, (2) National Center for Education Statistics (NCES), "Projections of Education Statistics to 2016", December 2007, (3) National Center for Education Statistics (NCES), "Digest of Education Statistics", 1997–2006; CAR Estimates

[10] *Michigan Employment Forecasts by Occupational Groups 2004–2014, Michigan Labor Market Information, www.milmi.org*

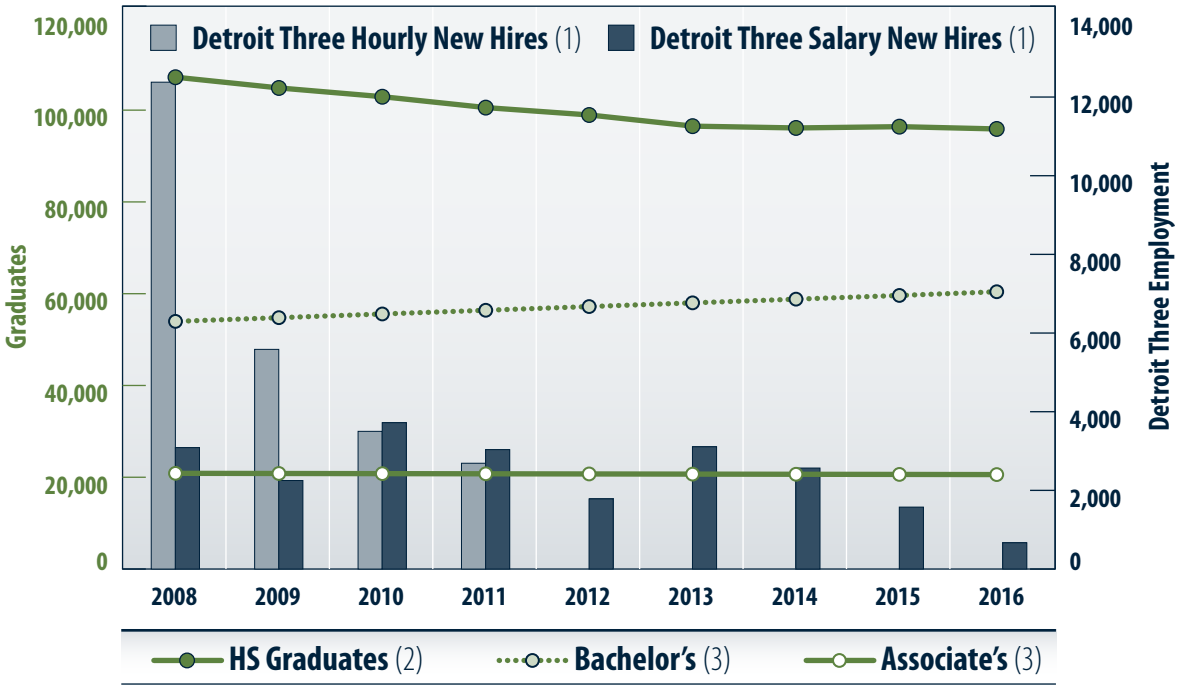
[11] *National Center for Public Policy & Higher Education,* Policy Alert, *April 2004*

CAR estimates that there are 41,000 to 47,000 local high school graduates in addition to approximately 21,000 graduates with two-year degrees entering the Michigan workforce annually through 2016. If the only source of potential new hires were these non-college-bound high school graduates and recent two-year degree graduates, CAR projects that the Detroit Three will require a large number of these new labor market entrants—roughly 9.2 percent of the total number of graduates from 2008–2011.

Figure II.11 shows the actual and projected numbers of high school graduates and students earning two- and four-year college degrees in Michigan. It also indicates projected Detroit Three new hires in Michigan from 2008 through 2016. The number of high school graduates is expected to fall by 11.3 percent during the forecast period, while the trend for two-year degree earners will remain flat over the next 10 years. The only growth is in the number of people who will earn bachelor's degrees during the same period.

Detroit Three hourly new hires will represent 11.3 percent of Michigan's total 2008 high school graduating class and 5.3 percent in 2009. However, because of a cyclical downturn in production and sales in 2008, it is highly unlikely that the Detroit Three will hire the number of new "non-core" employees CAR forecast for that year. The Detroit Three will delay their 2008 replacement hiring until 2009. This would allow more time for the companies, the UAW and the union locals to complete their negotiations on which job classifications will be considered "core" or "non-core." This would also mean that the total forecast hourly Detroit Three hires for 2008 should be added to the 2009 total. This total of 17,963 Detroit Three Michigan new hires represents 17.1 percent of all projected Michigan high school graduates in 2009, and 39.8 percent of Michigan's high school class of 2009 who enter the labor market directly, rather than pursuing additional training and education or joining the military.

Figure II.11: Actual and Projected Michigan Detroit Three New Hires, Public High School Graduates and Degrees Conferred, 1997–2016



Source: (1) Proprietary Company Data and Center for Automotive Research, (2) National Center for Education Statistics (NCES), "Projections of Education Statistics to 2016", December 2007, (3) National Center for Education Statistics (NCES), "Digest of Education Statistics", 1997–2006.

The strain on Michigan's labor market supply could be considerable in 2009, and perhaps into 2010. The Detroit Three will need to hire a total of 24,154 hourly new hires between 2008 and 2016, and a great proportion of them will be new labor market entrants. Historically, the Detroit Three have not hired new high school graduates directly into the plants in decades. The newly negotiated second-tier compensation level ($14.00 an hour and a lower level of benefits) will mean that, for the first time, the Detroit Three will be competing directly with the supplier sector for new hires.

The absence of a Detroit Three wage and benefit premium[12] means that the Detroit Three may no longer be able to attract experienced new hires from the supplier and dealer technician labor pools, as has been the case in the past. It should be remembered that only an initial group of new hires can confidently expect to be moved to higher "core" wage levels within a few years, based on need and contractual constraints.

Conclusions

In this section of the study, CAR provided a forecast of Detroit Three employment, attrition and hiring, as well as an employment forecast for the international automakers producing vehicles in the United States. CAR's forecasts are heavily influenced by high labor productivity growth in U.S. automotive manufacturing and engineering, the mass exodus of the "baby boomers" making room for large-scale hiring of younger workers at second-tier wages and benefits at the Detroit Three, and the replacement of Detroit Three automotive employment by international automotive employment in the United States. A key driver in CAR's Detroit Three employment and hiring model is the constraint that the Detroit Three must match the best practice labor productivity and unit labor cost levels of the industry leader in North America.

CAR forecasts considerable automaker hiring in the United States and Michigan. Estimating that the Detroit Three will hire over 77,000 new employees in the United States and nearly 46,000 in Michigan between 2008 and 2016. These new hires are necessary because the Detroit Three are projecting large-scale employee attrition through "baby boomer" retirements. Over 115,000 workers will leave the Detroit Three in the United States during the forecast period; over 54.2 percent of them will be in Michigan. CAR also predicts that the overall level of Detroit Three employment will fall by nearly 38,000 in the United States and roughly 20,600 in Michigan during the forecast period. This forecast drop in employment is largely the result of an anticipated decrease in Detroit Three domestic vehicle production. Total automaker employment in the United States is expected to stay level, however, due to a projected employment rise of over 38,600 at the international automakers—driven primarily by production increases at these companies.

A recession in 2008 moves CAR's Detroit Three hiring forecast forward into at least 2009. The available labor supply in Michigan could become a critical constraint. Potential Detroit Three employees now face lower starting wages and benefits (negotiated by the Detroit Three and the UAW in the 2007 labor agreements), as well as an indefinite wait in the plant until they have the opportunity to earn full Detroit Three automaker wages.[13] Historically, high wages and generous benefits have attracted many workers to this industry; without them, the Detroit Three may face challenges finding enough people willing to work in their plants. This means the Detroit Three will now compete directly with their suppliers and other sectors for new hires, and might force the companies to hire more new labor market entrants and less experienced workers. In the next sections of this study, CAR presents the results of our automaker and supplier interviews regarding future hiring, education and training requirements. Given the rapid pace of workforce turnover predicted in CAR's forecast, it is reasonable to express concern that there may not be enough time to train the new workers to meet the companies' stringent hiring requirements.

[12] *See The 2007 UAW Labor Agreements in Section 2.3.*

[13] *According to the 2007 agreements between the Detroit Three and the UAW, new hires will earn a second-tier of wages and benefits until they move into a "core" job (at GM and Chrysler) or they are no longer in the lowest 20 percent in terms of seniority (at Ford). When a "non-core" worker moves into a higher wage job, he or she will earn the traditional wage, but will retain the second tier benefits package.*

Section III
Hiring the New Autoworker of 2010: Production and Skilled Hourly Workers

Introduction

Working the line in an auto factory has been likened to being a "cog in the machine." Once thought to be merely strong backs and a pair of nimble hands doing repetitive manual tasks, the nature of automotive work has changed as both the product and the technology used to manufacture it have become increasingly complex. For the most part, tasks that can be automated have been automated—leaving behind work that requires both a strong body *and* a capable mind. More and more, production workers are being assigned responsibility for organizing their own work teams, monitoring their own product quality, performing routine maintenance, and managing the business case for the work they do.

The distinction between "skilled" and "non-skilled" work is becoming more fluid as there are no longer any "unskilled" positions in a modern automotive assembly or parts facility. The skilled trades are changing, too. Once the domain of highly specialized (and often underutilized) talent, the auto companies are now looking for a new breed of tradespersons who are flexible, multi-skilled, and thus, more productive in performing routine maintenance and repair tasks.

The auto industry needs more highly skilled workers, and it will need an even greater number of them in the years to come. In 2007, the Detroit Three employed 166,575 hourly workers—both production and skilled trades—and 73,439 (44.1 percent) of these employees worked in Michigan.

Roughly 24 percent of the 2007 U.S. hourly workforce populated the skilled trades classifications; the Michigan workforce was comprised of 27.5 percent skilled trades in that year. CAR's forecast calls for the Detroit Three to drop to just 136,488 hourly workers in 2016, with 65,209 (47.8 percent) in Michigan. The percent of workers in the trades is projected to drop to just 16.0 percent nationally and 16.4 percent in Michigan. Market share declines and increasing productivity rates can be blamed for most of the loss of hourly employment. However, due to workforce attrition, CAR's forecast also calls for the Detroit Three companies to hire 38,848 hourly workers in the United States between 2007–2016, with 24,154 (62.2 percent) of these hires in Michigan. The 2007 UAW contracts call for just

2,000 skilled trades apprentices across all three companies, most of which will come from within the ranks of the production workforce. The international automakers are adding over 1.6 million units of capacity in the United States, and are increasing their market share. CAR forecasts the total number of hourly employees at the international firms will increase by 19,927 to 85,506 by 2016. When considered together with the 30,087 jobs shed by the Detroit Three in that timeframe, this boost in international hourly employment yields an overall decline of 10,160 jobs. For comparison, the U.S. Department of Labor projects a loss of 10,300 jobs in motor vehicle manufacturing by 2016.[14]

There are two major factors driving the Detroit Three's need to hire nearly 39,000 new workers over the course of the next decade: the average age of the current workforce and the provisions in the 2007 UAW agreement for a second tier workforce. These two factors are obviously related, as much of the change in the union contracts centered around how and when the baby boom generation would leave the workforce and under what terms. In early 2007, the UAW published a table showing that over 44 percent of its current active members at GM, Ford and Chrysler (79,511) would be eligible to retire in the next five years. Retirement, early retirement and buyouts are being employed to usher out these workers and hire a whole new generation of hourly automotive workers at a second tier of wages and benefits. This churning in the automotive labor force will result in lower labor costs for the companies and a large number of workers in need of training and education to build increasingly complex vehicles in the state-of-the-art, highly-automated, flexible factories of tomorrow.

Retirement, early retirement and buyouts are being employed to usher out these workers and hire a whole new generation of hourly automotive workers at a second tier of wages and benefits. This churning in the automotive labor force will result in lower labor costs for the companies and a large number of workers in need of training and education to build increasingly complex vehicles in the state-of-the-art, highly-automated, flexible factories of tomorrow.

The five automakers interviewed for this section of the study (GM, Ford, Chrysler, Toyota and Honda) responded to questions regarding hiring and training their production/team members and skilled trades/maintenance associate workforces, the nature of future automotive work beyond 2010, and the performance of the U.S. education system. The topics covered are shown below in the interview outline.

[14] *Employment Outlook: 2006–2016, Industry output and employment projections to 2016, Eric B. Figueroa and Rose A. Woods,* ***Monthly Labor Review****, November 2007.*

INTERVIEW OUTLINE

AUTOMOTIVE HR ISSUES OF 2010 AND BEYOND: Production and Skilled Trades

Current and major changes expected

I. Production

a. Hiring qualifications

i. Work experience (types and length)

ii. General education and certification (level and achievement)

iii. Specific skills

1. *Numeracy*
2. *Literacy*
3. *Computer literacy*
4. *Business skills*
5. *Manual dexterity*
6. *Physical*
7. *Other*

iv. Other

b. Hiring process

i. Sources of applicants

1. *Referential*
2. *School to work, co-op, internships*
3. *Temporary workers*
4. *Probation and early status*
5. *Other*

ii. Screening criteria

iii. Other

c. Training

i. Types (e.g. problem solving, intro to electronics, safety)

ii. Hours of initial training

iii. Hours/year(s) of OJT and training beyond initial training

iv. Sources of Training

1. *Internal or corporate*
2. *External (outside colleges and training vendors—list types of programs)*
3. *Other*

II. Skilled Workers or Maintenance Associates

a. Number of classifications and types

b. Hiring qualifications

i. Work experience (types and length)

ii. General education and certification (level and achievement)

iii. Specific skills

1. *Numeracy*
2. *Literacy*
3. *Computer literacy*
4. *Business skills*
5. *Manual dexterity*
6. *Physical*
7. *Teams/Cross-functional work*
8. *Other*

iv. Other

c. Hiring process

i. Sources of applicants

1. *Internal (production pool through testing or reference)*
2. *External (program graduates or hires from other firms)*

ii. Screening criteria

iii. Other

d. Education and training

i. General training (curriculum and length)

ii. Specific training (curriculum and length)

iii. Hours of OJT required

iv. Hours/year of OJT and classroom training beyond initial training

v. Sources of training

1. *Internal or corporate*
2. *External (outside colleges and training vendors—list types of programs)*
3. *Other*

III. The Nature of Future Automotive Work Beyond 2010

a. Supervision

b. Teams/Cross-functional work

c. Automation

d. Types of work

i. Physical activity percentage

ii. In-house or contracted trades

iii. In house or contracted material handling, custodial

e. Regional differences

IV. Performance of Education System

a. K-12: Suggested curriculum and programs

b. Technical and community colleges: Suggested curriculum and programs

c. 4-year diploma schools: Suggested curriculum and programs

The interview respondents were all senior level HR executives responsible for hiring and training production and skilled trades labor at their companies. These discussions took place during the Spring and Summer of 2007, prior to the onset of contract negotiations between the UAW and the Detroit Three. What follows below is a summary of their combined responses. On many points, there was great agreement among those interviewed. In cases where there was a divergence of opinion, the paper indicates how many automakers agreed, how many disagreed (and in what areas), but it does not divulge the identity of any of the respondents or their companies.

Production work

Production workers (also called production associates or team members at some participating companies) comprise the vast majority of the hourly manufacturing workforce—between 73 and 88 percent at the companies interviewed. Interview subjects were asked to discuss their hiring qualifications, hiring process and training programs.

Hiring qualifications

In the area of work experience, all of the automakers interviewed for this study indicated that they examine the work history for the number of jobs applicants have had, any gaps in employment, and reasons given for leaving. Those who have moved from job to job while bettering their career are looked upon favorably, while those who appear to be "job hopping" are not. One domestic automaker placed high value on references saying, "they need to have glowing recommendations." The Detroit Three seek candidates that have worked in a manufacturing or a related industry such as construction or auto repair; the two international firms require no prior work experience, though experience is considered a plus. All automakers indicated that applicants must understand a hard day's work and exhibit personal discipline. One domestic automaker respondent mentioned that military service is a good indicator of future performance. Another domestic respondent expressed that attendance is still a significant problem for his company—with up to a 14 percent absentee rate—which is why indicators of a strong work ethic are looked upon so favorably in the hiring process.

All but one of the automakers interviewed for this study require that their production workers have a high school diploma or GED. The one international participant whose company does not require a diploma or GED reported that his company does require a demonstration of basic reading and math skills on a screening assessment test, and that generally, applicants who successfully complete this exam do have at least a high school diploma or GED. While most interview subjects agreed that the nature of automotive production work is becoming more technical and job designs are becoming broader, most thought that educational requirements would not increase (in the near future) beyond the current demands. One domestic automaker, however, noted that the required education level: "will be a lot different than it used to be. In the years to come, everyone—not just our company—will insist on higher levels of education because work is becoming more technical, job designs are broader (with quality control, materials management and other content entwined into the job). It's going to be a more demanding work environment, and education levels required will be more strenuous." When asked if his company might move toward requiring a two-year degree or equivalent—as the Global Engine Manufacturing Alliance in Dundee, Michigan requires of all hourly production workers—this respondent tempered his endorsement of the need for higher education levels with the following comment, "I understand their great demands for education, but I don't see us going this far at this juncture."

With regard to hiring requirements for specific skills, all of the firms use outside organizations to test a candidate's proficiency in relevant areas. All companies interviewed deemed basic numeracy and literacy as mandatory for new hires. One respondent went beyond basic literacy to prefer candidates who are skilled in technical reading because, as this respondent said, "no one is born knowing how to read this stuff." Computer literacy was cited by three companies as a critical skill, due to the increasing technical content of automotive work. One of the international firms noted that reading, understanding, critical thinking skills and problem solving are the key skills they seek, as well as a basic knowledge of how to read pareto charts and fishbone diagrams. One domestic respondent indicated that his company is moving

toward 100 percent empowered work teams, which means applicants will need to have or develop an understanding of basic business concepts such as accounting, budgeting and business planning. This respondent said that, "teams will have scrap budgets, tooling budgets, and will have specific performance goals. If there are performance gaps, they will need to develop corrective action plans to address them." He went on to say that information will be displayed visually so that everyone knows where they stand relative to team goals and that, "people love this, by the way, because it involves them in the business." It was noted that it takes more advanced skills to be able to participate in this type of team.

The physical aspects of a job—manual dexterity and physical strength—are screened for at all companies, either as part of the hiring process or during an evaluation period (probationary or temporary employment). Several respondents indicated that ergonomic advances have made jobs less physically demanding and injurious, but acknowledged that many ergonomic solutions increase the technological content of the work.

The three domestic companies and one international automaker reported that they look for existing team skills and leadership qualities in the applicants, while the remaining international company does not require these skills coming in and instead assumes that all new hires will attain proficiency in these areas through training and on-the-job practice.

Hiring process

For most of their locations, the automakers indicated that they have a surplus pool of applicants for their job openings. One respondent indicated that, while his domestic company does not have many openings, he has twice the number of applicants in the pool than they have open positions. One international company respondent noted that while his company finds they always have a good applicant pool, the company's suppliers sometimes have trouble finding good workers. The automakers interviewed for this study split when asked how they find their job applicants. For one domestic company, referrals are the primary source of applicants. Three of the other companies specifically stated they do not use referrals, and one did not indicate a preference. One of the international respondents whose company shuns referrals noted that they need more cultural diversity in their workforce than they believe they would get through an employee referral program. One of the domestic respondents noted that, "third or fourth generation workers aren't necessarily good." For the four who do not utilize referrals as a primary source, a range of strategies are employed to fill the applicant pool. One international company opens its hiring pool for one month every year or so by advertising in the papers in the immediate vicinity of the plant. The others advertise statewide or regionally. One international employer utilizes the state employment agencies as both a source of applicants as well as an administrator of the paper and pencil screening instrument. No automakers reported school-to-work, co-op or internship programs as a source of hiring production workers.

All automakers interviewed utilize temporary workers to various degrees, and four of them indicated that the temporary workforce is a source of permanent hires. In these cases, temporary workers must meet the standard employment qualifications, and must pass through the same screens prior to being hired as permanent. All of the automakers noted that the ability to observe a temporary worker during his/her tenure on the shop floor is an advantage to knowing how the worker will perform if hired as a permanent worker. In some cases, workers may be considered temporary for as long as two years. One domestic automaker calls contract workers, "a great way to hire," and notes that his company has a goal of having 25 percent of the workforce comprised of contract workers. An international company respondent noted that his company often hires from the pools of temporary workers, saying that between 7–10 percent of the workforce in existing plants are temporary workers. Several respondents reported that a majority of new hires for existing plants come from the ranks of their temporary workforce, but one international company respondent made it clear that while 90 percent of their new hires were once temporary, they make a concerted effort to consider off-the-street applicants because they recognize that not all people are in a position to accept temporary work.

Only one international company does not employ some form of a probationary period. For the

All companies report some degree of team cross-training; one international company wants all of their production workers to rotate through every production job in the plant so that they would, at least in theory, be able to assemble an entire vehicle.

remaining four companies, three have a standard 90-day probation period, while the other hires new workers on a permanent status with a 6-month evaluation period. During this evaluation period, employers look for the worker's attendance performance, safety compliance and ability to work to quality standards. The respondents whose companies employ an evaluation period report a high success rate for completion of the probation; they cite the effectiveness of their screening process as a major contributing factor to this success. One international company respondent noted that, "most who do not make it, leave for personal reasons versus issues of the ability to do the job."

All automakers employ a battery of employment screening tests, including a physical examination, drug testing and background/criminal checks, and all make their offer of employment contingent upon successful completion of these tests. In addition, screens are used during the hiring process to filter the applicant pool. All but one employer utilize a third party firm to do their pre-employment screening. For all, tests include math and reading ability. The Detroit Three respondents report that they screen for team work and other behavioral indicators of their work aptitude or personal attributes that predict attendance and work ethic. Problem solving and critical thinking skills are tested for by four of the automakers interviewed. At one international company, applicants who pass the screens are then brought to work in a team on the shop floor as a final screen. This company reports an overall failure rate of over 50 percent for applicants who enter their screening process. The other international firm looks for associates who are willing to rotate jobs.

Training

All of the companies in this study have extensive corporate training infrastructure and standardized training curricula for production workers. Initial training could take anywhere from 40 hours classroom training coupled with 40 hours of on-the-job training at the Detroit Three to three months of training to master both the basic concepts as well as a full job rotation at one of the international firms.

The types of initial training offered include health and safety, quality, environmental compliance, company procedures, ethics, and company and facility orientation. One respondent reports that they also train new hires on the company's business and business performance, as well as on how teams work and are structured. This respondent noted that, "we spend a lot of time on quality, the environment, a facility orientation, and safety is huge." At each of the automakers, a majority of the basic training is provided in a classroom setting, while some safety and quality education is hands-on. Training on the job (or jobs) the worker will perform is universally done on the shop floor. All companies report some degree of team cross-training; one international company wants all of their production workers to rotate through every production job in the plant so that they would, at least in theory, be able to assemble an entire vehicle. It was noted that this exposure helps workers identify quality problems that may have occurred in other areas of the production facility. This respondent notes that his company's work rotation is designed, "so that workers can move between more and less physically demanding work throughout the day."

Beyond the initial training for new hires, the automakers differ significantly in their continuing training requirements. Three companies report that their workers undergo between 40–80 hours per year in refresher training, including standardized regimens for health, safety, quality, environmental and legal (EEO, diversity, sexual harassment) training. At the Detroit Three, some of this annual refresher training is conducted jointly with the UAW. One domestic respondent boasted that, "our health and safety refresher courses are probably the best in the industry." One international company representative reported that refresher training is provided on an as-needed basis, and that training on the mandatory topics—health, safety, quality, environmental and legal—are incorporated into regular team and shop-floor meetings, rather than in separate training courses. Generally, this respondent notes that, "we try to train while they are getting paid anyway." All companies offer voluntary training—through a variety of delivery methods including self-paced computer, video, distance learning and classroom—on a range of other topics, including team communication skills, leadership and conflict resolution.

One international company respondent explained the process for being promoted from team member to team leader. To be considered for team leader, a team member must volunteer. Then the company looks at the employee's service, attendance, skill capabilities and work history. An interview and questionnaire process follows, and then there is a 40-hour classroom training session on leadership and conflict management that is provided prior to the promotion occurring. If the team member passes this training, he/she goes into a pool and waits for a team leader opening.

Most of the training offered at the participating automakers is provided internally. One international company respondent reported his company prefers corporate training because it allows them to maintain control over the content, delivery and quality as well as to monitor the workers' comprehension of the material. At each of the companies, certain types of training, such as training in legal matters and team skills, are conducted by third parties to increase the credibility of the message. One domestic respondent explained it this way, "we use outside trainers for very specific types of training like team training so it doesn't have an aura of the management and union telling you how it is here." External training is also employed across the board when new equipment is purchased and installed. Equipment-specific training is generally bundled as part of the purchase of such new equipment.

Skilled trades/maintenance associates

Skilled trades workers (also called maintenance associates at the international firms) are a critical part of the manufacturing workforce at each of the automakers interviewed for this study. In all but one company, these workers earn a substantial pay premium for their greater depth of knowledge in setting up and maintaining the plant and equipment. At the company that is the exception to this rule, maintenance workers are paid the same as production workers. Interview subjects were asked to discuss the hiring qualifications, hiring process and training programs for their skilled workers.

Number of classifications

There is a wide range of experience among—and even, within—participants in this study with regard to the number of skilled/maintenance classifications. On the extreme end, one domestic respondent reported that his company has 174 classifications, but that over 80 percent of the skilled workforce is classified into just five of them. This respondent noted that his company would like to

Table III.1: One Domestic Respondent Company's Plan to Reduce Skilled Trades Classifications to 9, and then 5 (marked with *)

Electrician*	Tool & Die*	Welder
Plumber/Pipefitter*	Machine Repair*	Powerhouse/Stationary Steam
Millwright*	Industrial Truck/Auto Mechanic	General Maintenance

Source: Company Interview

reduce the 174 classifications to nine in the years to come, and eventually get down to just five classifications, as shown in Table III.1., with no contract work in these basic classifications.

Another domestic respondent reported roughly 50 classifications in existence corporation-wide, but some plants (the newer ones, primarily) have only two. Another domestic respondent said that some of his company's global operations have just two classifications—mechanical and electrical—but that in UAW-represented plants, the number of skilled trades classifications ranges from three to five at some of the new facilities and 25–28 in some of the older plants. It is commonly agreed that the lowest possible number of classifications possible is two, but there is some disagreement as to which two are the key trades to maintain—mechanical and electrical, or general maintenance and tool & die. One respondent acknowledged, "We know the global best practice is two classifications, and if we're going to compete in a global environment, we have to be there, too." This same participant added that there are tradeoffs to going to fewer classifications—the main one being losing highly-skilled trouble-shooting ability—but he noted, "you do get people who can do the vast majority of the work, but the most difficult things must still be done by specialists or third parties." This respondent noted that his company benchmarks indirect labor in these areas: housekeeping, materials, quality, manufacturing support (which includes union officials) and maintenance. He added that the difference in staffing between "best practice" and his company, "can be in excess of 10,000 people."

The respondents from the Detroit Three all listed paring the number of skilled trades classification as a goal of their then-upcoming contract negotiations with the UAW. All sought to eliminate unpopulated classifications, and the more highly specialized single-purpose ones such as boring mill or lathe operator. One domestic respondent said, "beyond electrical and mechanical, we are looking at machine repair, tool & die and millwrights." In actual fact, only Ford reduced the number of skilled trades to 22 base classifications in its 2007 labor agreement with the UAW[15]. Those 22 base classifications are shown in table III.2:

More than one respondent remarked that many of the existing trades—especially those related to building maintenance—are not core to automotive manufacturing by saying, "We build cars, not buildings." All three domestic companies sought, and won, some flexibility in assignments and softer lines of demarcation within skilled trades with the aim of improving skilled trades productivity. On this topic, one domestic respondent acknowledged that, "over time, the union has recognized that everyone knows how to loosen a bolt." This respondent described how his company organizes the existing skilled trades classifications into two work groups: mechanical and electrical. Another domestic respondent noted that the UAW is worried about moving to a smaller field of trades, and he recognized that the fear is not

Table III.2: Ford's Skilled Trades Classification Consolidation

Electrician	Mechanic, auto	Pyrometer (Cleveland)
Tool & Die Maker	Industrial truck mechanic	Inspector, tooling layout
Tool Maker and Template Maker	Refrigeration/AC machine operator	Experimental parts and body maker
Machine Repair	Refrigeration maintenance and installation	Maintenance, general plant skilled
Millwright	Powerhouse mechanic	Machining specialist
Sheet Metal Worker	Stationary steam engineer	Machinist
Plumber/Pipe fitter	Metal model maker	Carpenter, all-around
Welder, general		

Source: UAW-Ford Report, November 2007

[15] *UAW-Ford Report, November 2007*

unfounded, "workers have to be trained well to be proficient, and cutting the specialized trades may mean we have to hire third party expertise in some areas." Finally, this respondent noted that, "no matter what we do, we're still going to have resident experts—but we don't want to rely on experts because we can't always wait for the expert to show up." This is why the Detroit Three have also sought to upskill production work to include minor maintenance.

Of the two non-union international companies, one has two classifications—a multi-skilled general skilled trades classification and tool & die, and the other has three—assembly equipment maintenance, stamping/die equipment maintenance and mold maintenance.

Hiring qualifications

The hiring qualifications for skilled trades workers are generally the same as those for production workers at all five companies. The only exception occurs at two participating companies when hiring journeyperson skilled trades workers from outside the company. In terms of work experience, one domestic automaker requires an outside journeyperson's card or eight years in the trade for all outside hires. The other international employer administers a written exam to assess math and ability to follow directions, interviews the candidate, and then conducts an eight-hour hands-on assessment. If all goes well, the candidate is given an apprenticeship—even if he or she already possesses a journeyperson's card or has experience in the trades. However, the vast majority of skilled trades apprentices come from within the ranks of the production workforce.

To transition from production work to skilled trades, workers at all five companies must demonstrate not only a desire, but also a demonstrated aptitude (through testing) for high level math, computer skills and technical work. One domestic respondent remarked that they do not have to dictate the qualifications for joining the skilled trades pool because, "only the most highly qualified will make it through." The domestic respondent who saw military experience as a plus in hiring production workers again praised this work history as an asset for potential skilled trades apprentices. He said, "they are highly skilled, have math and science ability, and can hit the ground running."

In terms of specific skills, the automakers interviewed for this study cited a high degree of math ability, proficiency in reading technical instructions, and computer literacy as the most important skills. Two domestic respondents ranked computer literacy as the most important specific skill because, "everything is computer-based," and "every trade uses computers." At two of the participating domestic companies, team skills are also among key skills sought in the skilled trades workforce. Finally, two other companies indicated they place high value on technical problem-solving and analytical skills. In support of this skill area, one domestic respondent said, "random times and random events require highly evolved problem-solving skills." Another respondent noted that newly-trained journeypersons have more problem-solving abilities than some of the more experienced workers—perhaps because problem-solving is so deeply embedded in the current education process.

Three of the automakers mentioned the existence of some form of pre-apprenticeship training, in some cases aimed toward increasing the pool of female and minority skilled trades candidates. One respondent remarked that some workers have used the tuition assistance program to develop skills that help them on their apprenticeship test, and that this puts them ahead of the other candidates. He said, "the opportunities are there, but not everyone takes advantage." One other international company respondent noted that they do not offer remedial courses for those who do not pass the test, though workers who wish to re-test are encouraged to seek outside remedial training. A domestic respondent noted that, within his company, those plants that have excellent apprenticeship programs also have effective outreach and recruiting in the 8th and 9th grades. He said, "if kids have a vision of what they need to do to get these jobs early, they can be more competitive." Another domestic respondent agreed, saying, "skilled trades need to be talked about in high schools. It is important to identify kids with technical interests at an earlier age like they do in Europe." This respondent emphasized that, "middle school is key to getting kids interested in technical careers."

Hiring process

Most new skilled trades hires are apprentices drawn from the ranks of the production workforce who are selected through a testing regime. One domestic respondent reported that the testing at his company of production workers wishing to enter the pool of potential apprentices was last conducted in 1996. At that time, workers were ranked by score, and for those who scored above the 70th percentile (roughly 90 percent of those tested), they were also ranked by seniority. Those on the list had 11 years of service on average. At one international company, production workers must have taken courses at an associates' level or at a technical school to be eligible for the technical development program.

In terms of specific skills, those seeking to enter the skilled trades or maintenance associate classifications must demonstrate a high degree of math ability; as one domestic respondent noted, "technical literacy required is a quantum leap over what we look for in the production workforce." Computer literacy is noted as an essential skill for workers seeking to enter these occupations. The other main skill area is technical problem-solving and analysis. As one domestic respondent put it, "These workers need to know when the theories apply and identify circumstances that can lead to trouble. The equipment is becoming more and more complicated and there are more things that can go wrong." Problem-solving was acknowledged as one area that must be embedded in the education process.

For external skilled trades hires—both from outside the company and outside the industry—all but one automaker reported using the exact same process used to hire production workers, including the full battery of screening tests. One domestic automaker said, "expectations increase when people are hired from the outside." He went on to state that his company now recognizes a journeyperson's card from another company or even another industry. This respondent noted that it takes about a year for an outside journeyperson to learn what is needed in a plant. Another domestic automaker acknowledges that his company has hired skilled trades workers from outside his company and outside the industry, as well. One international respondent noted that, while the process is the same, his company has to look to the national market for skilled trades talent, versus relying on the local market as they do for production workers. The exception is one company that reported that outside skilled hires are hired in a similar manner as exempt salary workers, which means a phone interview followed by a production interview and no testing. One respondent noted that his company would not hire contractors into the core classifications, but that they expect to employ contracted skilled trades in many of their non-core areas or hire third parties.

Each of the Detroit Three respondents noted that the next few years are crucial to managing their skilled trades workforce as they wait to see which of the incumbent workers might take retirement or early retirement incentive packages. These companies all reported a current oversupply of trades workers, with the exception of one domestic respondent who mentioned his company had a shortage of electricians. This respondent noted that over 52 percent of his current skilled trades workforce was eligible for full retirement. Another domestic automaker said that his company plans to, "raise the ratio of skilled to non-skilled until it is extremely high. We are looking for people who can fix things, and if you can, there are good $100,000-a-year jobs here for you." One of the domestic respondents lamented, "will there be a people shortage? No. Will there be a skills shortage? Yes. People will be responsible for a broader variety of tasks, and that will take a lot more training to close the knowledge gap. We won't have near the number of skilled trades going forward that we need." This respondent noted that students who seek to enter the trades either know someone who is a tradesperson, or, "they get in as a production employee and realize they want something more for themselves." Another domestic respondent said, "there are problems attracting people to skilled trades, and teachers and school administrators are partly to blame."

Education and training

There was a considerable split between the automakers when it comes to education and training. For the Detroit Three, who have union-represented skilled trades workforces, the types and amount of training are governed by the union agreement. In general, apprentices receive 8,000 hours of on-the-job training including specialized in-house training with hands-on experience coupled with

650–700 hours of classroom instruction, usually offered in cooperation with a local community college. One domestic company noted that there is a shared curriculum between the trades for the first year that covers math, measurement and safety, and another domestic manufacturer noted that although his company does not offer this common first year of training, he endorsed the concept and hoped to see it in place in the near future. One domestic respondent explained that the apprenticeship requires workers complete a skill rotation and have regular skill audits where the workers bring in their schooling, enrollment, hours accomplished and signed-off tasks. There is a disciplinary procedure for those who do not keep pace with both the classroom and on-the-job training (they must keep all areas within 5 percent ratio of completion), and falling behind can be cause for probation in the program, followed by possible suspension or removal from the apprenticeship program. Those interviewed at the Detroit Three stated that most of the education and training curriculum has not changed in a very long time. One respondent commented that changes in the apprenticeship programs will become necessary because the technology is changing so rapidly, particularly in the electrical trades where the work is becoming increasingly sophisticated and complex. Another domestic respondent noted that their skilled trades curriculum is very team-oriented stating, "everyone does a little of everything as their ability allows, with electricians as the leader. Team work varies for machining and stamping and production needs, but overall the idea of 'sharing hands' is the same, and for that we need highly trained proficient people with versatility."

For the two automakers that do not have a unionized skilled workforce, the training regimen is very different. At one international company, skilled workers undergo a minimum of two years of maintenance training even for workers who come from the outside. The training is almost exclusively on-the-job training, with no final test. Until this training is completed, there are pay steps, and once the worker has reached the highest step, he or she must take part in annual refresher training. At the other international company, skilled workers take part in a three-year program, with the first three to four months spent in classroom training followed by a combination of job rotation and classroom training. Near the end of the three years, the workers' strengths are identified and a permanent maintenance assignment is made. One international company respondent informed us that it is possible for outside journeypersons to test out of training.

Beyond initial training, the Detroit Three respondents described 40–80 hours of annual refresher training as typical, but noted that training could be much longer in cases where there is a new product launch or new equipment installation. One of the domestic respondents stated that they offer three to four weeks of classes per year and one week of safety training, but that these amounts could also increase with new products or new equipment. This respondent conducts regular testing to identify trades workers' strengths and weaknesses and to help create a development plan. Another international interview respondent noted that his company offers between 40–140 hours of training per year, but that most of the courses are voluntary.

The source of training courses varies widely. For the Detroit Three, training is provided by internal resources, joint company-union programs, community college and technical school providers and equipment vendors. One of the other international companies described their training as taught primarily by instructors from technical schools and community colleges. They offer the opportunity for these instructors to work on their shop floor, and regularly consult with them in problem solving to give them real- life work experience and to encourage an ongoing partnership between the individual instructors and the company. This respondent notes that they pay the colleges a fee for this problem-solving consultation service, and that they hope that the knowledge gained can be applied by the instructors in other settings outside of the company.

The nature of the future automotive work

In general, all five automakers reported that they do not see many major changes coming in the nature of future automotive work. They agreed that basic reading and math skills, along with communication and teamwork ability are currently core, and will likely remain so. We asked the respondents to comment specifically on the areas of supervision, use of teams and cross-functional

work, automation, and types of work and to mention if there are any foreseen regional differences in any of these areas.

Supervision

The Detroit Three respondents expected that there will be less supervision and less specific direction in the future. One elaborated by saying, "We need people who know how to be responsible." One of the other international interview subjects stated that they expect to increase the general level of communication, problem-solving and leadership skills among their supervisory employees, but that they see no change in their current philosophy related to supervision.

Teams and cross-functional work

All of the respondents commented that teams will be integral to the functioning of their company going forward. One domestic respondent noted that teams will be increasingly expected to take on a more strategic focus, and team members will need to know how to improve product and process, how to work a business plan and how to find and address performance gaps within the team. He also noted that teams will be empowered to know that if they can do something, they will do it. If not, they will be expected to know when to call on the team leader, technical resources, engineering staff or third party contractors. Only one respondent stated that, while they believe most companies will shift to a more high-functioning team process, at his company, "we value the idea of teamwork, but we don't want to relinquish control." One respondent said that his company is considering instituting a team concept for skilled trades workers in the plant. He expects that this skilled trades team would be responsible for providing training, working on new automation projects, analyzing problems and working with purchasing and planning functions to bring in new equipment.

Automation

In the area of automation, all company respondents see that, as manufacturing hardware becomes more flexible, there will be an increasing reliance on software development. The ability for workers to troubleshoot software problems is going to be key, and this will increase the need for computer skills and technical literacy in the workforce. One domestic respondent noted that, "trades are going to need to know how to analyze and improve software—talk about your computer skills and technical literacy!" An international firm noted that, "automation reduces injuries, but some things can't be automated."

Types of work

With regard to the physical component of future automotive work, the companies' opinions diverged slightly. Most see the percentage of physical activity declining, but they disagree on how much they can reduce physical needs. One domestic respondent noted that they want their workforce engaged in value-added activity 100 percent of the time, and that will mean a growing percentage of their work time will be spent on computers and automated equipment. Another international interview subject disagreed, saying that while physical needs may go down, he does not expect them to fall drastically because, "People make things work, and too much automation limits control. We will use automation to eliminate overburden, but not just for automation sake. Why lift 50 pounds when a robot can do it for you?"

On the question of in-house versus contracted trades, there was again a wide range of responses from the participant group. One respondent stated that each building has a building maintenance staff that either maintains the building or is responsible for hiring contractors where necessary. For the Detroit Three, respondents noted that they don't believe they should be staffing for non-core trades because it is a distraction from the core business, but they are limited by the terms of the union agreement as to how to outsource certain trades work. One domestic respondent reflected the opinion of the group by saying, "We made a mistake letting construction workers into maintenance and production—we're making vehicles, not buildings." In contrast, one of the international company respondents noted that each facility has a building maintenance crew that is responsible for the facility in terms of, "fixing roofs, hiring contractors and wetlands maintenance." Another domestic company respondent noted that highly-specialized work may be contracted to vendors.

This last sentiment was again evident when we asked respondents about in-house versus contracted material handling and custodial work. The Detroit Three respondents each noted that they know their global competitors outsource this work, but that it depends on both the opportunity costs and the union agreement as to whether or not their company can follow suit. At one of the Detroit Three, custodial work was already contracted out to other UAW workers at $12 per hour. In fact, two of the significant provisions of the new labor agreement between the Detroit Three and the UAW (which was negotiated after our interviews were completed) address this issue. First, the contract allows for new workers in non-core positions such as material handling to be paid a second tier wage (although incumbent workers will not see their wages cut), and second, all custodial, grounds and housekeeping work will be contracted out under the new agreement.

Regional differences

All of the respondents noted that the globalization of the industry is driving standardization and increasing commonality of product and work across continents, but each allowed for regional variation for the market and for the economics of the business, particularly as it relates to the substitution of labor for capital. In areas where workers earn lower wages, the companies agreed that there will be less automation. To the extent that product and processes can be the same, they will be the same.

Three respondents noted that it is becoming more common for hourly production and skilled workers to communicate and work with their counterparts in other countries on product launch issues. Workers at the international automakers are often sent to the home country for training opportunities. Some respondent companies note that when their North American facilities have the lead on a specific vehicle architecture, they routinely host workers from other regions. A domestic respondent noted, "the work from region to region will be common and that commonality exists on some level—there will be variation for the market and for the economics of the business in terms of substituting labor for technology."

A final note on regional differences: two of the respondents made a point to mention that the skills gap with other countries (such as China, India and Brazil) is closing very quickly. They also noted that language and cultural barriers are eroding—facilitated (they believe) by the internet, satellite communications and television. When speaking of labor in Mexico, one international company respondent said, "there is some skill there, but the workforce is not as sophisticated as in the United States or Canada and there is a higher turnover rate."

Performance of the educational system

The respondents to this survey all stressed the need for very high skills standards in the educational system. One domestic respondent noted that, "we need to focus on the applied sciences as opposed to those that don't make kids employable like geology or astronomy. Math and science are what prepare our young people for the occupations we want them to have." This respondent acknowledged the role of the education system in supporting business by saying, "what makes business competitive in this country is the hard things we can do and do better than the people we compete against." One of the international company respondents noted that while his company currently has no problems with the labor supply, suppliers to his firm are facing an inadequate supply. He also observed, "when a new plant opens, all the best people come out to apply, but that isn't necessarily the case ten years down the road."

The respondents differed on what schools must do to impart technical skills to the future workforce. One domestic respondent opined that, "Schools must stay in touch with what is cutting edge and make the investment. To not do that you're wasting your time, the student's time, and ultimately, our time." This respondent followed up by saying, "vocational education undershoots the audience. We don't focus them on the highly technical parts of the industry, and to support what automotive needs, we need highly technical people." Another domestic respondent said, "we are in survival mode, but we are making radical changes to apprenticeships as technology changes so rapidly. New work in the electrical trades is so sophisticated and complex. Keeping in step with current tech-

nology will be key." He went on to say that schools should focus on the fundamentals—including an emphasis on heavy math (e.g., college algebra), electronics schematics, more technical background than the basic "shop class," and conflict resolution. Another domestic respondent noted that schools could improve on troubleshooting software and computer work and general computer literacy, overall basic concepts, instituting multiple trade curriculums and cross-skilling between the trades. An international company respondent offered that his company is seeing a growing number of Hispanic workers in all of their plant locations. He said, "now it is necessary to have education programs for them to work on math, reading and English language skills. These workers tend to have a high work ethic and low turnover, and there is a need for assimilation."

The automakers interviewed did mention a few training and education programs that stand out from the pack. One domestic automaker noted that Henry Ford Community College, Washtenaw Community College and Macomb Community College (all in Michigan) have been, in his words, "extremely cooperative in meeting our specific needs." He notes that the need to cover more advanced subjects and technology will mean that some basics will have to be pulled from the curriculum to cover everything in the same amount of time. Another domestic respondent recommended using more co-operative education programs within the skilled trades workforce. This respondent recognized that, "Kettering University needs to be the norm for technical work, not the exception." One international automaker noted that educational facilities are a key factor in deciding on a new plant location. In some cases, they partner with one strong school, and in others, they look to multiple schools with strengths in different areas. This company sponsors an annual forum to bring together all of the schools that serve its facilities across the country. At this time, the forum is only open to participating schools, but the thought is it could widen in time. As the respondent noted, "partnerships with the schools are seen as a community-wide benefit."

"Manufacturing has changed and educators seem to steer people away from manufacturing because of the common misconception that it is a dying industry. In truth, the lower levels of manufacturing are going away, but the higher levels are growing. Manufacturing has a good work environment with advanced technologies and opportunities to advance. The educators need a better understanding of what manufacturing can offer."

Finally, an international automaker left us with this thought, "manufacturing has changed and educators seem to steer people away from manufacturing because of the common misconception that it is a dying industry. In truth, the lower levels of manufacturing are going away, but the higher levels are growing. Manufacturing has a good work environment with advanced technologies and

opportunities to advance. The educators need a better understanding of what manufacturing can offer."

Conclusions

For the most part, the automakers interviewed for this study reached general consensus on many of the topics related to hiring and training production workers/team members. In the area of skilled trades/maintenance associates, there was a marked division between the domestic (unionized) firms and the international automakers, but agreement among the representatives of each group as to how skilled trades work will be organized and the future needs for this category of worker. CAR believes that general consensus was reached in the following areas:

- The nature of production work is becoming more and more complex as the product—and the technology used to build it—become more and more advanced. This production complexity requires workers who may not have higher levels of formal academic preparation beyond high school or a GED, but nevertheless can demonstrate higher literacy and numeracy levels and more advanced communication and team skills than were previously required of automotive manufacturing workers. Computer literacy was cited as a critical skill by three companies.
- The physical demands of automotive work have lessened and injuries have declined, as a result of advances in ergonomics. Many ergonomic solutions bring with them higher levels of technological content, and require a more advanced workforce to master their proper use.
- The automakers agreed that they currently face a surplus of applicants for their positions. All of the companies interviewed for this study employ temporary or contract workers to some degree, and most use this temporary workforce as a source of permanent hires. The ability to "get to know" a temporary worker on the job eliminates much of the guesswork about how the worker will perform once hired. All of the respondents expressed concern about the adequacy of the future labor supply—for production work, as well as for skilled trades/maintenance associates. They cited common misconceptions about the nature of modern manufacturing work as a major barrier to students becoming interested in a career in automotive manufacturing.
- All of the study participants have extensive corporate training resources and standardized curricula for production workers. The length of initial training varies from a few weeks to three months. Annual refresher training is provided in the areas of health and safety, quality, environmental compliance and legal issues (e.g., EEO, diversity and sexual harassment). Additional training is available to workers who volunteer for it, at all of the companies. Vendors are generally called upon to provide equipment-specific training, which is generally bundled as part of a new equipment purchase.
- Skilled trades or maintenance associates are a critical part of the manufacturing workforce at each of the automakers interviewed for this study. There is a wide range of experiences with workers in the trades, as mentioned in the introduction to this section: the Detroit Three, who have represented workforces, and the internationals whose workers are not represented by a union. The Detroit Three have a large number of skilled trades classifications, with the goal of getting down to fewer than 10, and the international firms have just two to three maintenance classifications. The proportion of the workforce that is comprised of tradespersons varies across the two groups as well, with the domestic companies having greater than 20 percent of their workforce in the trades and the internationals with fewer than 15 percent of their workforce in these classifications.
- The vast majority of skilled trades/maintenance associate apprentices come from within the ranks of the production workforce at all firms interviewed for this study. Workers who seek to transition into a skilled job classification must demonstrate not only a desire, but a demonstrated aptitude (through testing) for high level math, computer skills and technical work.

- Math ability, technical reading skills and computer literacy were generally agreed to be the most important specific skills required for entering the skilled trades/maintenance associate workforce. Technical problem-solving and analytical skills were also cited as important skills.
- While the domestic manufacturers struggle with a current oversupply of trades workers in nearly all classifications, all of the automakers interviewed for this study expressed concern about the future pipeline of skilled workers. The participants believe there are problems attracting people to skilled trades because the common perception is that the work is dirty and not very challenging or well paid.
- The skilled trades training requirements are governed by the union agreements at the Detroit Three companies. Those interviewed stated that much of the education and training curriculum has not changed in a very long time, including the required 8,000 hours of on-the-job training coupled with 650–700 hours of classroom training. All three believed that technological changes will drive alterations to the program to prepare journeyperson skilled trades workers, and all three either have in place or have endorsed the concept of a shared curriculum between the trades for the first year. The Detroit Three companies are also seeking more teamwork within skilled trades, more flexibility in assignments, and higher utilization of the skilled trades workforce. Higher utilization is achieved through cross-skilling and the team approach to maintenance projects—the norm at the international automakers. At the two international firms that participated in this study, maintenance associates undergo two to three years of training that is almost exclusively on-the-job at one firm and a combination of job rotations and classroom training at the other. All five automakers offer ongoing training for journeyperson skilled trades/maintenance associates; the training is more intense when new equipment is being purchased or a new process is introduced into the manufacturing environment. Technical and community colleges play a key role in delivering both initial and ongoing training to this workforce at all of the respondent companies.
- In general, all five automakers reported that they do not see major changes coming in the nature of future automotive work.
  - The Detroit Three respondents expect there will be less supervision and less specific direction in the future, but no such change is expected at the international firms.
  - All of the respondents commented that teams will be integral to the functioning of their companies going forward.
  - In terms of automation, the companies see that as manufacturing hardware becomes more flexible, the need for workers who can interact with and troubleshoot software problems will be critical.
  - All companies interviewed for this study see the physical demands of automotive work declining.
  - The Detroit Three will seek to outsource "non-core" trades that are not directly related to building vehicles as well as highly-specialized skills that are infrequently required. The international firms will utilize their in-house trades as much as possible, and only hire contractors where their internal staffs do not have the skills to manage a project.
  - All of the firms interviewed either have or are in the process of outsourcing most custodial, grounds and housekeeping work.
  - All of the respondents recognized that to the extent that work can be common around the globe, it will be. However, regional labor markets may mean it makes better business sense to use less automation in lower wage areas of the world. Any skills gaps that may exist between workers in the United States and other regions are closing quickly.
  - All of the participants stressed the need for very high skills standards in the education system, and affirmed that the basics—reading, writing, math and computer literacy—will continue to be key to preparing the workforce of the future.

Section IV
Hiring the New Autoworker of 2010: Future Automotive Engineers and Technicians

Introduction

The automotive industry, at its very core, is an engineering industry. The motor vehicle can consist of up to 14,000 separate parts that must function under harsh environments to safely deliver passengers and cargo to far destinations at a reasonable, but impressive, speed. Although retailing and finance are important operations for any automotive firm, the ability to design, engineer, and manufacture an affordable vehicle at ever-higher levels of quality, and ever-improving levels of performance and function, is the very definition of a motor vehicle company today.

Vehicle design and manufacturing process engineers and technicians are absolutely vital to the operations of auto companies such as Toyota or General Motors. This has been an industry reality for over one hundred years. The importance of internal engineering labor will remain critical in the years to come as competition and government mandates drive companies to ever more dramatic changes in the product, over shorter and shorter periods of time.

In 2007, the Detroit Three employed 24,707 automotive engineers and technicians in the United States, and 22,845 (92.4 percent) of these employees worked in Michigan. Our CAR 2016 forecast calls for Detroit Three U.S. engineering staff levels to fall to 22,267 by 2016, and to 17,580 (79.0 percent) in Michigan. Declines in market share and production volume are responsible for most of the loss in total engineering employment. Yet, our forecast also calls for the three companies to hire 12,890 engineers and technicians in the United States during 2007–2016, with 8,846 (68.6 percent) of these hires in Michigan. In other words, most of the Detroit Three's engineering staff will be replaced by new engineers in the next ten years. The question of what kinds of engineers will be needed and what types of education and training will be necessary to produce this new technical labor force is paramount. International motor vehicle firms are rapidly growing their engineering labor force in Michigan, as well—almost 2,000 of the 3,100 international automotive employees in Michigan today are engineers and technicians, and many more will be hired to expand current and future technical centers for these firms.

The CAR research team interviewed five major motor vehicle manufacturers (GM, Ford, Chrysler, Toyota, and Honda) on the subject of future engi-

neers and technicians at their companies in the United States and Michigan. The interview parameters covered a wide range of topics (shown below in the interview outline). The interview respondents were all senior level HR executives responsible for the hiring and training of vehicle and manufacturing engineers at their companies. They were very candid on all topics. Future hiring of engineers is a critical necessity at each firm. The respondents were asked to discuss specific engineering needs (by types) in the future, as well as the sources that will be used to find this labor. The companies were also asked to describe their hiring criteria and process—currently and in the future. The respondents were interviewed on the subjects of what will constitute "core" and "non-core" fields of engineering at their firms in the future, and on technical and market changes that will affect their use and types of engineering. Finally, the respondents were asked to describe engineering training at their firms as well as their recommendations to educators on appropriate and necessary curricula for future automotive engineers. What follows below, is a succinct summary of their combined responses.

INTERVIEW OUTLINE

AUTOMOTIVE HR ISSUES OF 2010 AND BEYOND: Engineers and Technicians

Current and major changes expected

I. Level of demand/size of market for various types of engineers and technicians

- **a.** Manufacturing
- **b.** Industrial
- **c.** Mechanical
- **d.** Electrical
- **e.** Other

II. Hiring qualifications

- **a.** Work experience (types and lengths)
- **b.** Education and certification (level and achievement)
- **c.** Specific skills
  - *i. Business*
  - *ii. Teams/Cross-functional work*
  - *iii. Language and cultural*
  - *iv. Other*
  - *d. Other*

III. Hiring process

- **a.** Sources of new hires
  - *i. Referential*
  - *ii. Universities and colleges*
  - *iii. School to work, co-op, internships*
  - *iv. Contract workers*
  - *v. Other automotive firms*
  - *vi. Other*
- **b.** Screening criteria
- **c.** Other

IV. CAD technical and engineering fields that will be "core v. non-core" in 2010

V. Changes in engineering and technical employment NOT related to changes in company size in 2010 and beyond

- **a.** Design consolidation
- **b.** Partnerships with suppliers
- **c.** Use of contractors
- **d.** Global sourcing
- **e.** Vehicle technology content change

VI. Engineering/technical employment strategy in 2010 and beyond

- **a.** Proportion of engineers vs. technicians
- **b.** Future changes in allocation of work to degreed engineers vs. technicians

VII. Adequacy (2010 and beyond)

- **a.** Supply/U.S. relative position as a source of engineering and technical labor
- **b.** U.S. technical and engineering educational programs as a source of engineering and technical labor

VIII. Training

- **a.** Future engineering/technical skill needs
  - *i. Language and cultural training*
  - *ii. Business and management*
  - *iii. Other*
- **b.** Suggested curriculum changes at
  - *i. Technical and community colleges*
  - *ii. Four-year degree institutions*
- **c.** Importance and description of required internship or school-to-work

Recruiting and training engineers and technicians in the next decade

Types of engineers

One domestic firm stated that growth in hires of mechanical engineers will be stable through 2010 and beyond with the natural attrition of baby boomer engineers. However, the Company will mostly hire MechEs or "mechatronic" engineers straight out of schools. (Mechatronics is a combination of mechanical, electronic and software engineering.) This respondent thought it was interesting that, although U.S. schools are now developing such interdisciplinary programs, Mexican universities have been offering such programs for six or seven years. In general, more electrical courses must be required inside of mechanical engineering programs.

The respondent also stated that the need for electrical engineers is growing almost exponentially, due to the increasing electrical/electronic content in the vehicle. Such content will only increase in the future as will the proportion of engineers that are electrical engineers. Currently, there aren't enough electrical engineers inside of OEMs or supplier firms, while the use of electronics and software is constantly increasing.

This respondent also stated that Frederick Taylor-style industrial engineers (IEs or IOEs) are a thing of the past. Most vehicle companies or original equipment manufacturers (OEMs) are mastering some form of lean production. IEs will do more engineering simulations, huge math models: "We will count on IEs to run the factory virtually before we build it." Most domestic companies are turning to lean production and the Toyota System and there are more engineering simulations and math models. "Run the factory before you build it," is the new mantra. - Manufacturing engineering will be stable, but the Company will mostly hire MechEs for this purpose and not IEs.

A big difference between the types of engineers depends on the type of work environment. Typical 4-year college programs can support product or process engineering. Product development people have to think three to four years out, and will practice more theory. Ten or twenty years ago, the company valued broad knowledge—now it value centers of expertise much more. "Manufacturing engineers face a crisis environment every day," the respondent said.

This domestic respondent said that "the biggest change is that we are trying to get people who can be analysis engineers—who can believe the data and make decisions based on data." The respondent related that in a Honda plant they coordinated their A4 paper so people would have to manually enter the numbers and actually understand the data. In Honda plants, you'll see A4 paper with data written in pencil, printed reports from CMM, laser units with printed numbers on it—all so people can better understand data acquisition and analysis. The company is not advocating a paperless system; instead they want people to understand and check the data. Graduate engineers and technicians need to have the ability to collect and analyze data and recommend actions to improve outcomes.

Another domestic OEM firm stated that they are currently looking for diesel engineers and those familiar with fuel cells, energy management, IT, and electrical engineering and that are "systems thinkers". These respondents said that the industry is becoming more global, and it is important for new hires to have strong cultural backgrounds. There is more need for electrical engineers than mechanical, as most customer satisfaction problems are electrical-related and most electrical engineers can work in mechanical engineering while the reverse isn't true: "Electrical Engineering content can be added to Mechanical programs, but not the reverse."

Yet another domestic OEM admitted they were currently doing little external hiring. This respondent did cite one example of filling the staffing need for engineers following the agreement with several other OEMs to jointly develop hybrid powertrains. The company was able to fill the new positions with engineers in three to four months. The respondent expects similar future programs to continue to drive the hiring of engineers, with alternative powertrains and emissions reductions causing significant demand for new staff. Finally, he stated that partnerships with other OEMs, as

well as suppliers, are likely to cause a greater need for engineers with people skills. The ability to work with teams, with members from a wide array of backgrounds and nationalities, will be key. He listed foreign language skills as primarily important to instilling an appreciation for other cultures.

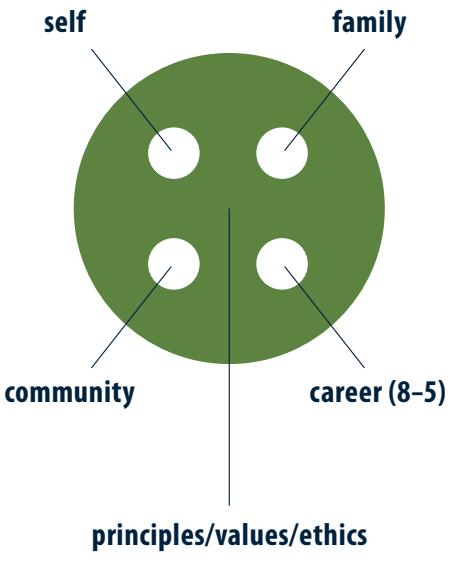
An international OEM respondent stated that mechanical engineers currently comprise the majority of the company's engineering hires—about 95 percent. The remaining five percent is comprised of electrical, material science, and chemical engineers. This respondent also stated that the increasing sophistication of CAD software is causing a change in current hiring practices. CAD is now the most important thing the company expects universities to teach engineering graduates. The company stated that it could teach them the rest of what they need to know to be effective engineers. The trend for engineers to do the majority of their own CAD work is behind this preference. The remaining CAD work is passed on to designers. The company only has only a few designers but their output is recognized as phenomenal. A second international OEM simply stated that electrical engineers must also have mechanical skills—an interesting twist when compared to other company statements. Long term engineers have been very successful because of this blend. Mechatronic engineers will continue to be needed by the Company for years to come.

Hiring qualifications

One domestic OEM respondent stated that there's a shortage of engineers and that the company has two choices: experienced or fresh graduates. When advertising in the paper, the company requests five years minimum experience but will take one to two. The requirements for education will be higher. The company will be looking for technicians with four-year degrees in the future. Even dealerships will be requiring a two-year degree for their service technicians.

Other specific skills now required by the company in hiring include:

1. Global business acumen: an understanding of total landed costs, product margins, and project management.
2. The ability to work in teams and perform cross-functional work: Engineers increasingly have to work in distributed teams, and this needs to be embedded in the undergraduate education system in all four years of the program. This is true for non-engineers, as well. "This business of ours is a team sport." The only exception is software engineers—where the company can accept "Tron" introverts.
3. Language and cultural skills: The Company is looking for people who have had "global experiences"—who have traveled/worked abroad, studied a foreign language. "If I had equal candidates, and one has studied a language—doesn't matter if he is fluent, just that he knows a little bit—then that would be a deciding factor."
4. The company is also looking for leadership roles in previous jobs or in education—something that shows initiative. They need leadership skills in motivating people and being "action-oriented." In the company's targeted interview process (best indicator of future performance is past performance), interviewers ask candidates to tell about a time when they showed leadership/initiative.
5. Finally, the Company also wants to know what applicants have done in their community. Activity in church, politics, illiteracy, homeless causes—shows a work-life balance. This respondent provided the diagram (below) to illustrate the Company's view of such a work-life balance:



Criteria such as language and cultural skills, working in teams, group learning and strong verbal and written communication skills are extremely important.

Another domestic OEM stated that it is only hiring in "critical skills areas" and not releasing in those areas. Such skill areas include fuel cells and diesel. The company's new hire development program is a two-year program of rotations, ending in graduation to a permanent position. It consists of about 60 engineers (less than 50 percent of their needs). Its intent is to bridge the gap between theory and practice and includes PhDs, OEs and suppliers. There are overall program advisors and individual advisors for each rotation. The students work on customer needs for product development and vehicle DNA. Across local universities, "The University of Michigan is very theoretical, Wayne State is better and so is Kettering or Michigan Tech." Growing product development needs in China is another challenge for this company. China has a low wage rate, and local engineers are not at all practically based and require a lot of U.S. immersion. Criteria such as language and cultural skills, working in teams, group learning and strong verbal and written communication skills are extremely important. The respondent wished there were more group-based work in undergraduate education and that applicants had a broader knowledge of diversity. Travel, social interaction and diversity were also mentioned as important, as well as an understanding that "not everyone is American." "Chinese engineers are willing to work outside of their home country and immerse themselves in culture and learn the language by trial and error. That is an important skill to have." Three major general skills both experienced and graduate engineers should have, this respondent stated, were,

1. The ability to translate a customer need.
2. The ability to incorporate customer needs into the DNA of engineering.
3. The ability to bridge theory to practice.

The third domestic OEM firm requires all incoming engineers to have a minimum of a bachelor's degree in engineering or, for experienced hires, equivalent work background. This respondent has not observed a difference in the quality of graduates emerging from engineering schools over the last several years but notes that the company demands more from these new hires sooner than has been the case in the past. More frequent model changes, the increased pace of technology change, and a generally more competitive industry have led to greater expectations by the company of its new engineering hires. The company makes use of outside engineering firms (such as MSX) and expects suppliers to take on a large role in engineering the components they supply. He expects both of these trends to continue. He did note, however, that certain key engineering roles will stay within the company and are unlikely to ever be outsourced. These tasks are performed by experienced engineers who are company employees, not contractors.

This respondent noted that the company has different requirements for new vs. experienced hires. While he has not observed a difference in the capability or quality of engineers from these two sources, he notes that new hires can be taken further in instilling, in them, the company's culture. This respondent also noted that the company has become more rigorous in choosing its new hires—both straight from universities and from other firms. He notes that failures have generally come from a lack of professional skills, not from a lack of technical knowledge. For this reason, the company has instituted more rigorous screening for engineers searching for a greater range of personal/life experiences that indicate this background. This becomes even more important as engineers advance in their careers and take on management responsibilities. The company would like universities to require more teamwork, technology, business, and foreign language education from their students to fill this need.

This respondent finally noted that the company is a more international automaker than it has been in the past. The coming relationship with a Chinese vehicle firm, as well as an increase in sourcing from low-cost countries, will require the firm to modify its engineering footprint and capabilities.

One international OEM stated that specific experience is expected of new hires. Engineering applicants need at least a four-year degree, although there are some engineers still around from the 1980s with only a two-year degree. In the future, the company will need to be more creative by running job fairs in communities and schools. The company has just started looking at contract workers because departments could never make up their minds on the use of such labor. Increasing electronic content of vehicles is seen as a powerful emerging trend, though its impact on engineering hiring is not as significant at this company as it may be at other OEMs. The respondent stated that its research scientists do a majority of the work in developing new technologies, and they are considered separate from the engineers.

Another international OEM firm stated that, in the past, the company had a preference for hiring experienced engineers with either automotive or aerospace industry experience. It has now broadened its preferences, as long as the candidate's experience is applicable to automotive engineering. Yet, a degree is now virtually required for incoming engineers. In the past, the company referred to non-degree engineering employees as engineering specialists, saving the term "engineer" for those with engineering diplomas. Currently, about 95 percent of hires are mechanical engineers with the remaining five percent split between electrical engineering, materials science, and chemical engineering. All applicants must be familiar with CAD design. He also stated that the domestic manufacturers still produce a broader group of parts internally than his firm and thus need a wider variety of engineers.

However, this respondent stated that his company is not looking for more business training in its engineering hires. He doesn't agree with the trend for engineering undergraduates to pursue MBA degrees as they continue their career. Cross/functional team work is also not a major concern, but such experience does help. The respondent indicated that the company is more concerned with its incoming engineers demonstrating interest and aptitude for automotive work. Participation in SAE or interest in motor sports, etc. is looked on very favorably. He also stated that foreign language skills are not particularly important but are looked upon favorably. The company does do some cultural awareness training during orientation for new employees. Finally, he indicated that he would like to see improved project management skills in new hires. He expects that the use of technicians will continue to wane.

Hiring process

One domestic OEM firm responded that it will continue to rely on universities and colleges for a portion of new hires. However, reliance on school-to-work and co-op programs and internships will increase and provide an ever more important source of labor: "The company cannot sustain a hiring pool without internships." As for contract workers, these will decrease over time, and will only be seen in non-core fields. This respondent didn't see his company hiring from the contract labor pool—"We are better off having interns or co-ops." As for raiding other OEM and supplier firms: "Yeah! Why wouldn't we? Suppliers and joint ventures are better sources of engineers than contract workers. There's a little pain for them to leave, and they have experience. They know our systems, they know CAD, and they have the language and cultural experiences. But we don't raid everyone."

In terms of engineers and technicians, the company looks for four-year degreed applicants. There is a talent acquisition process or D.D.I process (use of an outside firm). In terms of the ratio of applicants to respondents, this company considers approximately 50 to 1 for production, 10 to 1 for engineering, 3 to 1 for technician. After an application is accepted there is role playing and a team building interview process to make a final selection. "We employ role plays and other ways of screening. This is a science now—Herman Miller, Toyota, GM, we all have pretty robust screening processes." The company also relies on Global Centers in eleven cities around the world. "In 2010 and beyond, they won't just look in the United States," he predicted.

Another domestic OEM stated that technical expertise and subject matter expertise is very important in reviewing applicants. Generally the company does not hire at a managerial level, but are primarily looking for technical specialists or well qualified generalists. The company pre-screens applicants for technical skills, using phone interviews by company managers. If the applicants prove to be technically capable then they are given a behavioral assessment. Four-year degrees are now required, which has become much more apparent in the last five years. There is a real push to bring in industrial engineers for the implementation of lean production, and to find skilled trades workers who could later be promoted to supervisor. Skilled trades workers work as engineering assistants. Technicians are not represented and they'd prefer to keep it that way, although technician is not a managerial position. It is rare to hire from the streets, but agencies must be competitive in the external market. Technicians tend to have a two-year degree although it is not mandatory. Experience working in labs, setting up tests and gathering data is important. Two-year CAD, BSME engineering co-ops are available at universities such as Kettering and they tend to hire BSME students on a part-time basis for CAD openings. Technician applicants are pre-screened by company engineers for the appropriate skills. The company has always prided itself on the teaching process: "The company makes auto engineers."

A third domestic OEM depends mostly on two sources of engineers: converting contract employees and new staff from the company's Institute of Engineering. College engineering graduates enter the Institute of Engineering, and then join the company's workforce after graduation. The institute accounts for about 25 percent of the company's engineer hiring.

One international OEM reported that, during the hiring process, they use a combination of phone screens, two interviews, and a background check to screen potential new hires. This same OEM stated that, at their major U.S. technical center, they have increased the co-op program to about 100. He stated that co-op students must show purpose and direction in their combination of classes and co-op work at the center. The co-op program accounts for about 21 percent of the center's engineering hiring, another 21 percent comes from employee referrals, another 29 percent comes from websites such as the company's website and Monster.com, and another 12 percent comes from engineering contractors. The company recruits from universities such as the University of Michigan, Michigan State University, Lawrence Tech, Central Michigan, Purdue, Tennessee State, and Prairie State in Texas.

Another international OEM reported that they use an outside firm to collect applications online, and then the company reviews resumes and selects candidates for phone interviews. Hiring managers then decide if they want a face-to-face meeting. There are generally more experienced hires than new graduate hires. The company hires many engineers from co-ops because the company can test them before hiring. Very few hires at this firm are not from the co-op program. The company recruits at Purdue University, University of Toledo, Indiana University/Purdue University-Indianapolis, Ball State, University of Michigan, Ohio State University, Cleveland State University, Central Michigan University, University of Dayton, University of Cincinnati, Youngstown State University, Western Michigan University and Ohio University. There is a good percent of co-op taken from each school. This company also reported that there have always been partnerships with suppliers. As a result, they very seldom hire engineers from suppliers because they want suppliers to have good people.

Future core and non-core fields of engineering

One domestic OEM reported that their future core fields will include vehicle and powertrain engineering, product data management, engineering release activities, vehicle integration and development, and CAE for subsystems. In general, this respondent felt that: "The company will never give up the core. In fact, there's been a movement back to the basics at the Company. He listed as non-core any engineering related to a component (example: a radio—company needs drawing of size/mass of box, and number of pins) that can be purchased globally and is "mix and match." In summary, for this OEM:

Core Skills

- Vehicle and power train CAD
- Product data management
- Engineering release
- Vehicle integration
- CAE for sub systems

Non-Core

- Any component which can be assembled globally
- Most of the entertainment system
- Wheels, tires, wires, batteries
- CAD drawing
- Body Control Module

Another domestic firm stated that since it is too hard to teach design for manufacturing or assembly because it is too theoretical, it must remain with the OEM. Both international automotive firms felt their definitions of core and non-core would not change in the future but declined to supply details about the current split.

Changes for engineering and technical employment NOT related to changes in company size in 2010 and beyond

One domestic OEM reported that the company's engineering operations were disadvantaged by the recent movement to supplier modules versus individual components in the vehicle. For example, seat engineering has been decoupled from manufacturing and engineering and full service modules make it hard to control cost and quality. It seems such design work is better integrated if done in-house with suppliers on the teams and fewer full service suppliers. A movement away from modularity should improve and support internal engineering in the future. Suppliers seem to be unable to supply needed DFM (Design for Manufacturing), DFA (Design for Assembly), and DFS (Design for Serviceability).

Another domestic OEM reported that forthcoming design consolidation will result in OEMs worrying more about intellectual property (IP) in 2010 and beyond. On the other hand, partnerships with suppliers for fuel cell and hybrid technology will result in no change in overall employment but could result in a positive advantage for the U.S. Midwest, since location cost advantages are not a factor in this market. However, the use of contractors has not proven to be a business advantage for most OEMs. Further global outsourcing should result in no material change for engineers. Instead, changes in vehicle technology content will be "HUGE!" (the respondent referred us to an April 9, 2007 article by Martin Weiss on Flex-Fuel Revolution www.financialsense.com—90 percent of Brazilian engines are already flex fuel).

One international OEM does not expect partnerships with suppliers to be of increasing importance in the future. He likewise doesn't expect the company to change its policy of having very few contract engineers. They are used as needed during demanding periods but not as much as at many automakers. Engineers do not do any actual design. Such work is all performed at R&D centers.

Engineering/technical employment strategy in 2010 and beyond and future adequacy of supply

One domestic company reported that its proportion of engineers vs. technicians will remain the same, but roles for the two groups of employees will change. There will be a lot more degreed engineers than today. There will be more four-year degreed applied technology graduates in test labs and proving grounds. Another domestic OEM reported using about a 10 percent proportion of technicians to engineers. A third domestic OEM expects a decreasing emphasis on technicians. This is partially due to contractors fulfilling some of their tasks and partially due to engineers using a wide range of computer applications that provide the functionality previously provided by technicians.

Another domestic OEM said it was no longer an employer of choice or a supplier of choice so it is now more difficult to hire. With more experienced workers taking "early outs," the workforce looks as it will be comprised more of recent college graduates. The employment relationship is changing as well, and it is no longer cradle to grave employment at the OEM. Since many foreign born people are studying in American technical universities, research and advanced engineering at the firm will sponsor more green cards. This company also said that low-cost country sourcing actions are appealing since, "you can't beat the wage-rate." However,

there are "time-zone" problems; foreign engineers have no practical acumen; and they are difficult to immerse in the network of engineering work. Another domestic OEM said that the company has a very low attrition rate for its staff engineers, despite that fact that, unlike in the past, portable retirement plans make it easier for engineers to switch employers. He credits the company's unique culture for its low engineering staff turnover, believing that the firm draws a slightly different type of engineer than its competitors.

An international OEM is not considering hiring from overseas in the future. The Company sees the United States as an adequate source of engineers. He has not observed a change in recent years in terms of available supply. Another domestic OEM agrees and does not expect future problems in finding employable engineers. This respondent stated that OEMs may have to change how they pursue these employees—"they won't line up at the door anymore." He believes that other countries do a better job of preparing young engineers and that his company's culture gives it an edge over other OEMs. Despite the economic difficulty faced by the Detroit Three, he believes that it is critical that they continue to support universities to ensure that appropriate numbers of engineers are available in the future.

Yet another domestic OEM reported a concern about the hiring pool in the United States since 1999. His company's international co-op program (see below) contains universities worldwide that will expand to fill the hiring void. In 2010 and beyond the number of these international hires will be over 50 percent (including co-op students in the United States). "Our co-op program is part of the fabric of talent acquisition."

One of the international OEMs reported being satisfied with the people applying but realized that competition is getting stiffer. "There's no real feedback to universities on people lacking business skills," he complained. Also, people lack work ethic—"pay me for eight hours even if I'm only here six". This respondent also noted that, "New employees must realize that all are equally important—wear same uniforms—and that loyalty, commitment and growth have been areas of concern in terms of the quality of graduates over the recent years." He believes the situation may worsen when demand for engineers increases as the nation's economy improves. He indicated that University of Michigan, Michigan State University, Lawrence Technological University, Michigan Technological University, Purdue University, and other U.S. universities are good sources of engineers. Prairie View A&M University, a small school near Houston, was singled out as being very good.

Training

One domestic OEM reported the following internal training needs for engineers:

Language and cultural training: The company has a major initiative on cultural training. Uses a special website to help assess cultural sensitivity/awareness.

Business and management: This is critical for any technical person—global business acumen is essential. "The company wants more profit on every vehicle and we don't want profits to decrease just because we are optimizing the vehicle on the engineering side."

Project Management: He also expressed a desire for increased business training for technical workers with a greater understanding of total landed cost. The company now offers 770 internal classes for 65 different career roadmaps and is looking to create synergies within the training programs, wants to build relationships to lower training costs. Wants interactive learning from trusted sources, including collaboration and peer-to-peer work. "Learn by doing". After all, he said, "Those 40-and-under will be running the company in 2010 and beyond." He continued: "There are huge synergies in training and education programs. If we build relationships, our training costs go down. The goal is common tools that we can use in on-the-ground training." The respondent also noted certain "audience trends" such as engineers needing a blend of communications and training, "they like electronic performance support, and Gen X and Y want interactive learning from trusted sources—including collaborative and peer-to-peer. They like short videos, they want to master topics quickly, to search, find and retrieve topics quickly, and they like simulation and practice."

Another domestic OEM listed the following skills training needs within the company for engineers:

- Systems engineering
- Integration
- Focus on application
- More on VSM and Lean Systems
- Team leadership
- Real time learning
- Writing and verbal communication
- Supplier negotiation and management
- Basics on financials and cost optimization
- How to implement an idea and get it through the system
- "Engineering ideas don't get implemented just by engineers"
- "Passion around your idea enables a team"

It was presumed that the company was offering training in these areas to existing and new engineers.

An international OEM firm stated that their initial training involved new hires undergoing a week-long orientation program followed by two weeks of on-the-job training to build relations with their work team and to understand the problems of production staff who must deal with their engineering work. This is followed by about 80 hours training on technical systems such as KTEA and various parts systems. They are then required to spend time working on a line in a manufacturing facility. Other training includes ease of maintenance, software, and geometric tolerancing (GMT). In some cases, this training is sourced from local colleges and universities. Project management training is provided as needed (as engineers take on additional responsibility, moving from being responsible for a single part to several parts, to systems, etc.). The other international firm offers continuing education, tuition reimbursement, and training at the corporate Support Office, including classes in everything from accounting to problem solving to Japanese Business etiquette. There is also an expat program where you can volunteer to go to Japan for a few years for major model changes or other special skills.

Education

All the respondents were asked for their suggestions for curriculum changes at four-year and two-year engineering and technical colleges. One OEM respondent stated that the emerging technologies of alternative fuels and higher fuel economy must be embedded in the programs. (He mentioned a partnership with Wayne State University and Macomb Community College). Technical and community colleges should ready themselves for the prospect that higher education and certification for technicians at dealerships is certainly coming. This respondent stated that his company used to spend 144 hours for each newly graduated engineer just to bring people up to speed on

Technical and community colleges should ready themselves for the prospect that higher education and certification for technicians at dealerships is certainly coming.

CAE—so the company is very interested in saving time and money by driving CAE down to the educational programs. Four-year institutions must couple academic training with continuing education and use of analytical tools.

Another domestic OEM agreed that energy fuel economy technologies must be incorporated into school curriculums. A major international OEM firm also recommends that universities engage in more CAD instruction as well as a greater focus on the vehicle design process. This is important for the respondent's company, as it is known for being

a process-driven company. He also recommends more focus on root cause analysis and Six Sigma. He stated that engineers can't have enough of this type of training.

At the end of the interview, this international company respondent described his involvement in the national Action Council for Minorities in Engineering. The council's goal is to mentor potential future engineers at the high school level. These students typically have a 60 percent drop-out rate in college; those who have gone through the council's program have a drop-out rate of about 10 percent. The respondent stated that U.S. high schools need to undergo a radical restructuring, as they have not kept pace with the positive changes made at comparable institutions in Europe and Asia.

Internships and co-ops

The importance of required internship or school-to-work programs cannot be underestimated; one domestic OEM respondent declared: "Internships are the way to a rich hiring pool." This respondent strongly described his company's cooperative university program which includes the Company, EDS, Sun, UGS and university partners in the United States, Canada, Mexico, Australia, Sweden, China and Brazil. The program is in its second year. Teams consist of students taken from industrial design, mechanical engineering, and other fields. The students are given the challenge to design a vehicle from the ground up, with certain goals. This is an exercise in cross-cultural collaboration, problem-solving, the use of parametric design, and in using the company's tools in new ways. In the first year, the students put 60,000 hours into the projects—"talk about your hiring pool!" The Company ultimately will save time and money by driving the tools such as Photoshop, Unigraphics, and finite element analysis down to the education programs. "If we don't hire people with this kind of global experience, we won't have the best," he declared. The Company feels that it has a worldwide reach with its digital assets—the more video- and digital-rich the content, the lower the language and translation costs." This respondent also discussed a recent internal review of a foundation proposal on the subject of training for company engineering: "Things that were lacking included knowledge transfer and lessons learned, linkages with Michigan's strong community colleges, and M-Tecs—learning through only one delivery mechanism. We must offer multiple delivery channels in the future," he concluded. The company should invest in communities that contain institutions hosting the Company's academic initiatives. For example, the state of Indiana made a proposal to the Sloan Foundation for education grants to support the Company's co-op program. Automotive firms should take full advantage of community colleges and universities such as Michigan Tech and Kettering.

Conclusions

Disagreements between the firms' responses reviewed above were certainly outweighed by general consensus on many of the topics. General consensus, CAR believes, was reached on the following conclusions:

- Mechatronic engineering, a combination of mechanical, electronic and software engineering, will dominate future hiring at motor vehicle firms—not only for vehicle design and engineering, but also manufacturing engineering. The use of electrical engineers will also increase as electronic content greatly increases in the vehicle. Knowledge of specific powertrain technologies will also become critical.
- Future engineers must be well-versed in computer design and CAE techniques before arriving at the firm for employment. Future engineers must learn to work in teams, possess business acumen and project management skills, and be culturally aware.
- New engineers will be hired from other companies, on referral, and straight out of educational institutions. Relevant experience is highly valued. The hiring of engineering graduate cooperative engineering programs (often company based) will expand dramatically for graduate hires. Required education levels for both engineering and technician applicants will rise in the future. Technicians will need a four-year diploma; even auto service technicians at dealerships will require an associates degree.

- Outside screening firms are used by several of the companies to look for specific skills and the right experience. Further screening is done internally through interviews and various group exercises. Several firms are also increasing their hiring from a variety of global educational institutions participating in the company cooperative education program.
- "Core" fields identified by the companies certainly include vehicle integration and powertrain engineering, as well as CAE. Also, several firms that have outsourced significant engineering responsibilities to suppliers expect to reverse this trend in the future on the grounds of efficiency. The use of contract engineers is expected to decline in the future at all of the firms; the same in not true in the case of technicians. Fewer technicians will be used in the future by a number of the companies. The CAD drawing work in particular will be contracted out.

The companies are generally comfortable about the adequacy of the supply of engineers in the future. However, there were worries by at least one firm about not being the first choice of graduates. All of the firms had worries about the skills imparted to students by educational institutions in terms of practical hands-on knowledge, business skills, and attitudes towards employment.

- All of the responding firms offer and conduct extensive internal training programs on a wide variety of subjects for newly hired and experienced engineers. Many of the subject areas were non-technical and were related to other work skills needed on the job for working with other engineers around the world.
- The respondents had many recommendations for educational institutions. In general, the following types of programs were recommended:
- Training in the use of CAD drawing and CAE connected to actual subject material
- Education in subjects of fuel economy technologies and alternative fuels
- Training in quality analysis methods such as Six Sigma
- Education in project management and other business skills
- The development and maintenance of cooperative education programs connected to motor vehicle firms.

Section V
Hiring the New Autoworker of 2010: Automotive Supplier Employees

The CAR research team interviewed HR managers from eight Tier 1 automotive suppliers for this study. The questionnaire used for these interviews was the same as the one used for the automaker interviews. The respondents were encouraged to depart from the questions asked when they believed additional discussion might be beneficial.

Part I. Recruiting and training future automotive engineers and technicians

Engineering disciplines expected to be most critical in the future

The automotive suppliers interviewed for this study indicate that they expect the need for two categories of engineers to be critical in the next decade. The first category is the three branches of engineering that have historically been the most needed by the automotive industry: mechanical, electrical, and industrial.

The second category of engineers suppliers expect to need most in the future consists of more specialized disciplines. Their importance is being driven by dynamics that are reshaping the automotive industry: the use of more technology in the vehicle, a need for environmentally friendly vehicles and components, and the introduction of increasingly more sophisticated materials from which vehicle components are made.

The respondents' categorization of engineering disciplines can be summed up as follows:

Traditional engineering disciplines expected to experience gradual growth

- Mechanical engineering
- Electrical engineering
- Industrial engineering

Emerging engineering disciplines expected to experience more rapid growth

- Software engineering
- Materials engineering
- Environmental engineering
- Specialized engineering fields, e.g., Heat, Ventilation, and Air Conditioning (HVAC), Radio Frequency (RF), and circuit board design

Of the three traditional disciplines, suppliers indicate a slightly greater need for electrical engineers. While demand for mechanical engineers is currently high and is expected to remain high in the future, demand for industrial engineers appears to be slightly waning. One of the respondents suggested that some of the work performed by industrial engineers is gradually being absorbed by other engineering disciplines.

Respondents indicate a strong need for software engineers and expect this demand to continue in the future. The use of microprocessors to control an ever-increasing array of vehicle systems requires that automotive engineers have a grasp not only of the vehicle system but also of the software necessary to make it operate. This need is further increased by the trend of integrating disparate systems to make them work together. A given supplier's component may therefore need to communicate and work in tandem with components made by the automaker or by other suppliers. The automotive and software expertise necessary to execute so complex an integration makes software engineers a highly desired commodity in the automotive industry.

Supplier respondents also indicated a growing need for other specialized engineering disciplines, including materials; heat, ventilation and air conditioning (HVAC); radio frequency (RF); and environmental engineers. The increasing demand for these engineering specialties is driven by the evolution of the automobile from a purely mechanical device into one where mechanical systems made of sophisticated, environmentally friendly materials are controlled by electrical systems. This transformation of the automotive product is changing the automotive industry and driving demand for engineers who have the necessary capabilities.

Hiring qualifications

Respondents indicate that, when hiring experienced engineers, they prefer five or more years of relevant experience. When hiring an experienced engineer from an automaker or another automotive supplier, the responding firms are willing to accept engineers who have relevant experience but may not necessarily have an engineering degree. All of the responding firms indicated that a bachelor's degree in engineering is necessary for all new engineers.

The firms interviewed stressed the requirement that incoming engineers have a strong base of education or experience in the engineering discipline for which they're hired. Several other skills are important, including experience in working in teams. While this requirement is less important in certain disciplines, such as software engineering, it is gradually becoming more critical as vehicles become more complex and require components to be made jointly by engineers with varying specialties.

Supplier respondents also indicated a growing need for other specialized engineering disciplines, including materials; heat, ventilation and air conditioning (HVAC); radio frequency (RF); and environmental engineers.

Respondents also stressed a desire for incoming engineers to have a firm grasp of the business implications of the engineering decisions they make. Engineers are increasingly relied on to manage a given project to meet specific cost and revenue targets. It is critical to understand how engineering decisions translate to bottom line impact for both a given project and the supplier's overall financial health.

The ability to work in a multicultural team environment is also stressed. The increasing com-

plexity of vehicle systems calls for project teams comprised of engineers from different disciplines as well as representatives from a supplier's manufacturing, sales, and design departments. Similarly, the automotive industry's increasingly global scope dictates that members of such a project team may come from differing cultural backgrounds. All of the respondents indicated that experience working in a multicultural team environment is critical for hiring engineers from automakers and other suppliers. For engineers who are hired out of college, experience with group projects and exposure to a diverse environment at the given educational institution are desired.

The responding firms indicate a desire for engineers who can demonstrate a wide range of business and team-related skills including presentation skills, good written communication, team leadership, and networking/social skills. Several firms indicated that many of the engineers they hire, whether from other companies or straight out of college, are deficient in these skills and require training to offset these deficiencies.

When seeking new technicians, the responding firms require an associate's degree or higher for new hires out of college. As is the case with engineers, relevant experience is the critical factor when hiring experienced technicians from an automaker or another supplier.

Hiring process

Respondents indicated that, when seeking new engineers and technicians, their firms rely most heavily on referential hiring from other automotive firms and hiring new university graduates. References from contract employees and employment websites are also used, but not relied on as heavily.

Several other sources are used with varying frequency. For example, one respondent indicated that his firm has had success in hiring automotive dealership service techs to serve as engineering technicians in his firm. Headhunting or recruiting firms are sometimes used, particularly in situations that call for finding an engineer with a very specific skill set.

When hiring university graduates, an internship or co-op is virtually a requirement at all of the responding firms. Optimally, the internship or co-op should be at the supplier doing the hiring, as the firm would have had an opportunity to evaluate the candidate in a work environment. Requiring a reliable reference for hires coming from other firms serves the same role.

The firms interviewed indicated that hiring from other automotive firms is best suited for all engineering positions expect the company's senior management ranks. The responding firms showed a preference for growing senior leadership inside the company, where the candidate will have had ample opportunity to master not only the engineering field but the company's operations, as well. The responding firms also indicated greater success when hiring new engineers and technicians from other suppliers, rather than from automakers. Particularly for more experienced engineers, a pay gap exists between the typical earnings at an automaker and what most suppliers are willing to pay.

One respondent described an exception to the tendency to hire engineers from other suppliers, rather than automakers. This exception occurs when, a few years into his career, an engineer finds that it is more difficult to advance through the ranks of an automaker and determines to shift his career to the supplier sector.

Regardless of experience, prospective engineer hires are typically tested to judge their mastery of the basic skills necessary to do their jobs. Respondents indicated such tests may include asking the candidate to complete a two-dimensional drawing, solve a problem, or give a presentation on a specific topic. These tests are generally administered as part of the interview and are not usually performed by a third party.

The hiring process typically begins with the candidate submitting a written application, undergoing a phone interview, and then going through a formal interview with the employer. Several respondents mentioned that interviews administered by the engineering team with which the candidate would work, as opposed to the company's HR staff, tend to be a better predictor of the candidate's potential.

The respondents indicated that employment offers are typically contingent on a variety of checks, including employment verification, criminal history check, and a drug screening. These checks are usually performed by a third party firm retained

specifically for this purpose. Several respondents indicated that they have gradually increased the number of these checks performed, including checking a candidate's college transcript for adequate academic performance and degree earned as many as five years after the candidate's graduation.

Technical and engineering fields that will be "core" for automotive suppliers

While the question of which engineering and technical fields should remain "core" to a given company is typically asked of automakers, it also provides interesting insight into the impending needs of the supplier sector. After all, much of what automakers will consider "non-core" for their companies will become critical disciplines for their suppliers. Similarly,, what the suppliers ultimately will consider "non-core" will migrate either to lower tier suppliers or may be outsourced to business providers that don't necessarily specialize in the automotive industry.

The question of which engineering and technical fields should remain "core" to a given automotive supplier can be approached from two angles. First is the question of whether a given field should be considered "core" to the company or "farmed out" to other suppliers and outsourcing partners. Second, of the fields considered "core," a supplier needs to consider whether it will perform the given functions at its U.S. facilities or migrate them to divisions based in low-cost countries. This distribution of "core" and "non-core" fields is therefore a useful tool in establishing which topics American universities should emphasize in their curricula.

Respondents indicated that their most advanced engineering and technical fields are expected to remain "core" in all of the interpretations of the term. The "core" and "non-core" dynamics affecting the distribution of engineering and technical work in the automotive industry, from a suppliers' point of view, are summarized below:

Core vs. Non-Core: The distribution of automotive engineering changes

- Between automakers and suppliers
- Between Tier 1 and lower tier suppliers
- Between suppliers and outsourcing companies
- Between suppliers' domestic and overseas operations
- Between engineers and technicians within suppliers

Advanced fields such as Finite Element Analysis (FEA); customer interface development; on-site customer engineering support; high level software modeling and simulation; rapid prototyping; advanced product development; pre-launch engineering; and test simulation can be expected to remain critical to North America-based automotive suppliers and not be "farmed out" either to lower tiers or low-cost countries. Less advanced fields, such as basic engineering, basic programming, basic Computer Aided Design (CAD), and database management are likely to become "non-core" fields and are therefore less deserving of emphasis in U.S. educational institutions. Some coverage of these fields, however, will be unavoidable; these more basic functions are logical stepping stones in preparing engineers for the more demanding "core" fields their firms will emphasize.

Drivers of change in engineering and technical fields

Respondents were asked about which factors, apart from changing company size, are having the biggest impact on engineering and technical functions in their companies. The increasing electronics content of current and future vehicles was identified as the most important of these factors.

Increasing electronics content can be described as stemming from two distinct sources. The first of these is government regulation-mandated electronics content related to safety, emissions, and fuel economy performance. Because these features are mandated and not driven by consumer demand, they are likely to produce low profit margins for the suppliers who develop and build them. Increasingly stringent government control, perhaps best exemplified by the recent passing by the U.S. Congress of more strict Corporate Average Fuel Economy (CAFE) regulations, is likely to continue driving increases in vehicle electronics content.

Respondents were more optimistic about the second source of increasing vehicle electronic content, which is driven by consumer demand. These features include navigation systems; in-vehicle

entertainment such as DVD and MP3 players; and communications products such as Bluetooth-enabled cellular phones. Because consumers are willing to pay a premium for these features, they present suppliers with a rare opportunity to build products with relatively high margins. This correlates with a previous question which revealed that suppliers expect software and electronics engineers to be highest in demand in the near future.

Respondents also pointed to increasingly global operations as drivers of change in the engineering and technical functions in their companies. As automakers increasingly run their companies as global entities, as opposed to international companies with separate divisions scattered around the world, they are pushing their suppliers to do the same. A contract to source a given component for a vehicle, for example, may now require a supplier to develop the component in cooperation with automaker engineers spread around the world. Once development is finished, the supplier is more likely now than in the past to be required to supply the component in question to several vehicles built on the same basic architecture, in several locations around the world. It is not surprising, then, that suppliers demand engineers with more multicultural experience.

Changes in future engineering and technical employment strategy

The majority of the firms interviewed do not expect their companies' ratio of engineers to technicians to change in the foreseeable future. Several noted that the need for both is increasing while one foresees the possibility for a slight increase in the ratio of technicians.

It is apparent that technology advancement has impacted the work done by both engineers and technicians and made both groups of employees more valuable to their companies. The increasingly complex and sophisticated vehicles built by the automotive industry create a need for capable engineers. At the same time, computer applications used for vehicle design and engineering have become more powerful. This advancement has made it possible for technicians to take on work that, in the past, would have been done by engineers. The engineer's trade is likely to continue evolving to include more supervision and engineering management while less complex engineering work is done by technicians.

These developments must be considered in tandem with the various fields suppliers will consider "core" and "non-core" to their companies, as discussed above. When these developments are considered together, it is apparent that engineering and technical work is affected by distribution between automakers and suppliers, between Tier 1 and lower tier suppliers, between suppliers and outsourcing companies, between suppliers' domestic and international operations, and between categories of employees within automotive suppliers. The combined impact of these dynamics will result in the most complex work being done in the United States. American colleges and universities must therefore be prepared to provide the increasingly sophisticated education future engineers will need to perform these functions.

As mentioned above, more sophisticated modeling and simulation software has enabled automotive supplier technicians to take on more complex engineering tasks than they had previously performed. As a result, engineers are free to tackle more complex work themselves, as well as take on managerial responsibilities. At the same time, respondents pointed out the fact that engineers will also have to absorb some work that was previously assigned to technicians, including CAD responsibilities.

Adequacy of the United States and its educational institutions as sources of qualified engineering and technical staff

The respondents generally agreed that U.S. schools are an adequate source of new engineering and technical hires. One respondent, however, observed that European schools may be superior. He pointed to the fact that European undergraduate degrees typically take five years to complete, as opposed to four years for the average U.S. bachelor's degree, and are more focused on the discipline in which the degree is granted. Fewer non-engineering classes, however, may lead to a lighter emphasis on the other skills respondents' desire in their new engineering hires, including foreign languages and business acumen.

The respondents relayed that it is difficult to find large numbers of students who want to earn engineering degrees and work in the automotive industry due to an unfavorable opinion of the industry and of the quality of life in the U.S. Midwest. One respondent stated that the media focus on the growing practice of outsourcing basic engineering work to low cost countries may prevent some students from pursuing engineering degrees due to a fear that there will not be a sufficient need for engineers in the United States after they graduate.

Several respondents' comments echoed previous statements that, while U.S. schools are producing an adequate supply of graduates with adequate engineering skills, they could improve the quality of their graduates by stressing "soft skills," such as the multicultural and teamwork abilities discussed above.

Respondents expressed concern about the fact that, even in U.S. schools, a growing proportion of the engineering students are from overseas. Due to the likelihood of a large proportion of these students returning to their native countries after graduation, the lack of American engineering students in U.S. schools is perceived by the respondents as another challenge in finding sufficient engineering talent for their U.S. facilities.

Training practices for engineering and technical staff

Although each of the firms interviewed has developed its own customized engineer training program, certain traits were consistent among the companies. An employee's training needs are assessed—either as part of his annual review or on a schedule specific to the company's human resources department. Based on the employee's own preferences, as well as the needs of the company, training is then assigned and tracked.

The respondents were unanimous in citing the need for more training on cultural sensitivity and on working in a culturally diverse environment. One respondent stated that his firm, when interviewing potential engineers, asks about experience working with someone for whom English was a second language. This type of experience is one indicator of an employee's ability to work in a culturally diverse workplace. A majority of the respondents also indicated that their firms support training in foreign languages. The increasingly global scope of the automotive industry has increased the demand for engineers who exhibit the capacity and desire to take on an overseas assignment that may last for several years. Cultural training is a key enabler in increasing a company's capability to deliver the global performance its automaker customers demand.

The respondents indicated that business and management training is critical for today's engineers. This is particularly true for those engineers who have been identified as good candidates to eventually become managers. The need for engineers to understand the financial impact of their work was identified as critical for all engineering staff. For those in management roles, this understanding must be combined with the wherewithal to manage projects that involve input from other company departments, as well as the customer. One respondent stated that his firm "really struggle(s) to find good project managers who can influence without direct control, plan, and manage time."

In addition to core engineering knowledge, cultural sensitivity and business acumen, the respondents stated that interpersonal skills are important both for their internal training programs and for an engineer's college education. All business functions, including engineering, require more collaboration with coworkers today than they did in the past. For some engineering specialties, such as software engineering, this is less critical than for those that are more collaboration-intensive. One respondent stated that "engineers are black and white—different from other disciplines in terms of interpersonal skills." Interpersonal skills are particularly important when combined with the previously- discussed increase in workplace diversity. Working cooperatively with coworkers of different cultural backgrounds heightens the need for better interpersonal skills and makes engineers who exhibit these traits particularly valuable to their employers.

Suggestions for curriculum changes at community colleges and universities

The topics most critically addressed by the respondents' firms' engineer training programs drive their recommendations for what colleges and universities should emphasize in their engineering

programs. Cultural sensitivity, business acumen, and interpersonal skills are the areas the responding firms would like to see receive greater emphasis, in addition to core engineering disciplines.

When asked about the engineering-related changes community colleges and universities should make to their curricula, the respondents pointed to a need for more intensive CAD instruction and experience in schematics, benchmarking, simulation tools, and model-driven engineering tools. One respondent stated that "the basics are critical. We'll teach them what we want them to know, as long as they know the basics."

The respondents provided numerous specific recommendations in the area of business and management. One stressed the fact that finance, not economics, is the most appropriate financial discipline to require in engineering programs. Another stated that internships and co-ops are the best way for future engineers to learn business savvy and recommended that future engineers complete an additional internship at a financial institution. Another recommended that class projects completed as part of an engineering class require cooperation between a university's engineering and business schools in order to provide a complete simulation of managing a project in the real world.

A majority of the respondents recommended that universities maintain a close relationship with automotive firms and teach the disciplines that appear to be growing in importance. Many also pointed out the need for graduates with a better work ethic. Engineers typically work over 50 hours per week, making a work/life balance difficult to achieve. Graduates need not only to be able to make this time commitment but also to work in a high speed, high pressure environment.

Part II. Recruiting and training future skilled trades and production workers

Hiring qualifications for production workers

All but one of the respondents stated that their firm requires either a high school diploma or Graduation Equivalency Diploma (GED) when hiring new production workers. One respondent stated that his firm requires a high school diploma and does not hire production staff who have earned a GED. Another respondent stated that as productivity has improved, the expectation his firm has of potential new hires has increased. He added that his firm is considering requiring new manufacturing staff to hold at least a two year college degree in the future.

All of the participating firms test potential new production employees in the areas of math capability, literacy, computer skills, problem solving, and manual dexterity. These tests are generally performed in-house and are not outsourced to a third party. In general, the respondents' firms require potential new production employees to achieve moderate levels of performance in each of the disciplines noted above (at a level commonly described as that reasonably expected from a high school graduate). An unsatisfactory score in one field will generally not cause a candidate to be rejected if results in other tests indicate that the candidate has potential. Training would then be assigned to help the employee improve his performance in the field in question.

In addition to demonstrating competency in the fields discussed above, all of the respondents indicated that their firms' job offers are contingent on the candidate passing a background check for criminal history and a drug test. References from previous employers, as well as character references, are also used. A test of physical fitness (for purposes of health and safety and to ensure the employee is able to perform the tasks for which he is hired) is typically performed by an outside clinic or hospital.

Hiring process

The majority of the respondents stated that their firm uses referential hiring as a source of new production workers. Several of the participating firms offer a hiring bonus to the referring employee if that employee's recommended candidate is hired. One respondent indicated that his firm also pays a longevity bonus if the new employee attains six months and then one year of seniority. Referential hiring, as well as careful screening of new hires, was indicated to be of use when combating high

levels of manufacturing employee turnover—a problem many of the respondents mentioned.

All but one of the participating firms use temporary or seasonal workers in their facilities and pull from this pool of employees when filling permanent manufacturing positions. Several respondents pointed to their firms' temporary workers as their chief source of permanent hires. Evaluating an employee's performance, as well as reviewing absenteeism and other traits, provides a greater level of confidence that the employee will continue a satisfactory level of performance when hired permanently.

The respondents indicated that their firms do not make extensive use of school-to-work, internship, or co-op programs when hiring production workers. These programs were cited as critical when hiring engineers and technicians but are clearly less important for manufacturing staff. All but one of the responding firms indicated that new manufacturing employees undergo a probationary period, typically lasting between 90 and 120 days. One respondent indicated that probational employees at his firm wear an arm band to alert coworkers that they may require assistance with some elements of their work.

Respondents also indicated that their firms make use of several other sources of new hires, such as recruiting websites and newspaper advertisements. One respondent stated that his firm cooperated with a local church to hire immigrants from Asia. The firm co-sponsored English as a Second Language (ESL) classes for these employees and eased their transition into the company by first deploying them in non-core assembly functions.

Training for new hires and fulltime manufacturing employees

All of the responding firms require new production workers to undergo an initial phase of training prior to beginning work on the production floor. The fundamental portion of this training involves the manufacturing process the employee will execute on the production floor. One interviewed firm places new hires in a work cell that produces a product that will not be sold to customers. After three to five days of learning manufacturing processes in this cell, the employee is then ready for training in other necessary fields.

In addition to the processes the employee will use, the interviewed firms train all new hires in a variety of fields, including healthy and safety; quality; environmental training; ethics; sexual harassment; diversity; working in teams; hazardous materials handling; and interpersonal skills. The respondents indicate that their firms perform a majority of their own training, though outside firms are brought in for certain topics. Using a local attorney to train new hires on sexual harassment was given as one example of outside training.

All of the participating firms indicated that their companies provide On-The-Job (OJT) training for existing fulltime production employees. OJT is typically scheduled either annually or biennially and involves reinforcement of the manufacturing processes performed by the employees. In addition to manufacturing skills, OJT also typically includes refresher courses on sexual harassment, safety, and diversity. One respondent indicated that his firm's production employees are subject to random audits by executives who drill them on the specifics of their jobs and recommend training as needed. Employees in team leadership roles, or those showing aptitude for leadership assignments, may undergo leadership training as well as additional training in production skills.

Hiring qualifications and sources of skilled workers and maintenance associates

Respondents from three of the responding suppliers indicated that their firms have only one skilled trades classification. Of the remaining firms, none has more than four. Even with just one classification, however, considerable specialization is possible. Several respondents indicated that their skilled trades employees, even though they may have the same title, may be permanently assigned to different specific areas of their plant. Over time, they will therefore become expert at maintaining and repairing the type of machinery that is used most in that area. Likewise, skilled trades workers bring with them varying levels of experience and expertise in certain functions and are likely to be assigned work requiring their specific skills. The key point, then, is that the employer is free to deploy skilled trades workers in the fashion it deems most advantageous without being obligated to assignments based on classification.

None of the responding firms requires skilled trades hires to have a college degree. The respondents stated that they generally hire skilled workers with at least three to five years of relevant experience, though one stated that his firm requires a minimum of six. Although the experience generally does not have to be at an automotive firm, it must be relevant to the work the employee will be performing. While two of the participating firms require a journeyman's card for outside hires, the majority consider it preferable but not a requirement. While the respondents stated that specific skills such as simple math, literacy, and manual dexterity are important for skilled trades hires to possess, they do not stress them for skilled trades hires as much as they do for production workers. The underlying assumption appears to be that anyone who has achieved the experience necessary to be hired for skilled work will also possess these specific skills.

The majority of the responding firms hire a larger proportion of their skilled workers from outside their firm than from within. One firm, however, stated that about half of its skilled employees come from its production workforce. Production employees of this firm who wish to move up to skilled work must take a pay cut of approximately $2 per hour and undergo a five-year internal apprenticeship program. As the employee progresses through the program, his pay is gradually increased to a premium of about 30 percent over that of production workers once the employee completes the apprenticeship. External sources of skilled hires include some non-automotive firms though a majority of the respondents indicated that most of their skilled trades hires come from other automotive suppliers.

Initial training for new skilled trades employees can be said to most frequently take place in two phases. The first phase consists of the training necessary to integrate a new manufacturing employee into the company, e.g. safety, health, sexual harassment. The second phase consists of On the Job Training (OJT) that typically lasts between two and three years. During this period, the employee learns the specific skills necessary to service and maintain the machinery used in a specific facility, as well as any other tasks for which he will be responsible. Non-unionized firms generally favor as few classifications of skilled employees possible—often just one. Such employees must learn a wide variety of tasks; the long OJT phase provides them with the necessary experience.

The participating firms report a strong preference for using outside firms to provide ongoing OJT training for their skilled trades employees. This is in contrast to training for production workers, which is largely done in-house. Several of the firms interviewed have established relationships between specific facilities and community colleges and vocational schools in their area. They report a high level of satisfaction with the training provided by these institutions. In addition to ongoing OJT training, there is also a need to train all appropriate skilled trades employees to service certain new equipment as it is introduced into their facility. This training is typically provided by the vender from whom the equipment was purchased.

Recommendations for educational system improvements

The respondents' recommendations for improvements in K-12 and college institutions can be divided into two categories: one dealing with increased focus on math and science and one dealing with "soft skills." The respondents echoed comments from their previous answers in this report, in which they called for an increased focus on math and science classes. In response to this question specifically, many added that this focus should start in grade school, so that in can be "baked in" to the students' capabilities, adding that "it's not a hat you put on. It's a way of looking at life." Respondents also expressed an impression that other countries have been more successful at implementing these changes. One stated that "we will lose at this game if Michigan's educational system doesn't improve. We treat school like we're still an agricultural state respondent with the summer off."

Respondents also called for an increased focus on soft skills ranging from working in groups to respect for others, respect for property, work ethic, positive attitude, an appreciation of diversity, and attendance. One respondent commented that, at most public schools, "16 days unexcused absence is acceptable." At his company "if you miss three days you're fired."

Several respondents stated that technical and community colleges need to work to change the image

of manufacturing employment. One pointed out that not every student will go to college and that the proper vocational education can still provide them with a rewarding career and decent pay. Given the increasing sophistication of manufacturing work the respondents describe in the following section, this statement is likely to be even more relevant in the future.

The nature of future automotive work beyond 2010

The respondents expect that, beyond 2010, automotive production will be characterized by growing complexity, value, and technology. The drivers for this expected change include the use of low-cost countries and lower-tier suppliers for less sophisticated work that does not generate as much value-added to the final product. The work remaining at large tier 1 suppliers will therefore be more complex and demanding.

The respondents anticipate that their firms will respond to this challenge through several evolutionary changes, including increasing the use of cross-functional teams and automation. As improving technology brings more automation to the factory floor, manufacturing employees will be challenged to adapt. They will need a higher level of computer proficiency to operate increasingly complex machinery. One respondent pointed out that many of his firm's older employees are not comfortable around increasingly automated and sophisticated robots. His firm's younger employees have an easier time working in an environment where humans work closely with machines.

Beyond 2010, skilled trades employees will also need greater electronics and robotics expertise to service and maintain machinery that one respondent expected would become "more sophisticated and more temperamental." As a result, he anticipates that his firm will need to increase the proportion of skilled employees in its facilities.

All of the respondents expected that manufacturing employees will need to work more collaboratively in the future. The "soft skills" they seek in their employees will therefore become more important as time goes on. They cited the expectation that, in the future, all employees and particularly those in team leadership positions will need greater problem solving, coaching, and planning capabilities. One respondent pointed out that he anticipates a growing need for his firm's salaried and non-salaried workers to cooperate.

Another respondent pointed out that planning for future manufacturing operations is an opportunity to dramatically improve the manufacturing workplace. Safety, for example, can be significantly improved if the interaction between production workers and the increasingly capable machinery around them is optimally designed. He stated that automotive suppliers should "increase emphasis on incorporating the worker in the design of the work itself. We should be doing this—shame on us if we don't."

Conclusions

All of the firms interviewed for this study expect that the nature of the work done by both engineering/technical staff as well as their production employees will become more demanding over time and will require more skilled workers throughout the industry.

Among engineers and technicians, both groups are expected to grow in importance and the majority of the respondents do not expect the proportion of engineers to technicians to change. While all engineering disciplines will likely become more important over time, specialized fields such as materials, environment, and wireless communication engineers are expected to see the largest growth.

The hiring process for all employees has become more thorough as firms require more qualified staff and as they work to reduce employee-related problems in the workplace by employing more exacting screening processes. When hiring engineers and technical staff, the respondents stated that they achieve the best results by conducting a group interview, including employees with whom the candidate would be working. Interviews conducted by HR staff are deemed sufficient when hiring manufacturing workers.

When training production workers on how to perform their duties, the respondents' firms largely prefer to conduct the training in-house. When providing skilled trades employees with the technical training they need, however, the respondents indicated a heavy use of local community

colleges and vocational schools. In addition to their daily duties, respondents indicated that their firms engage in training manufacturing employees in a wide variety of subjects. In addition to instructional training on how to perform their job, all manufacturing employees receive training in healthy and safety; quality; environmental training; ethics; sexual harassment; diversity; working in teams; hazardous materials handling; and interpersonal skills.

The respondents made numerous recommendations for improvements at educational institutions. For all employee categories, an increased focus on math, science, and problem-solving is considered critical. The respondents also asked for more influence on "soft skills," including respect for others, respect for property, work ethic, positive attitude, an appreciation of diversity, and attendance. The respondents recommended that colleges fortify their engineering programs with a greater emphasis on business aptitude. They also recommended an increased focus on CAD skill—one that would go beyond the basic capabilities of most graduates.

In the future, the respondents expect all of their employees to face a more challenging workplace—whether they are engineers, technicians, production workers, or skilled trades workers. The vehicles the industry will produce will continue to become more complex and the industry's manufacturing facilities, whether they produce vehicles or vehicle parts, will continue to become more technologically advanced. The capability to work in this complex environment, calling for greater cooperation with a wide array of coworkers (both human and robotic), will be critical.

Appendices

U.S. Detroit Three Employment Forecast

	2007– Preliminary	2011	2016	Change Through 2011	Change Through 2016
U.S. Vehicle Production	6,680,927	5,775,159	5,865,229	-905,768	-815,698
U.S. Total Employees	241,189	210,542	203,220	-30,647	-37,969
Productivity (Unit per core worker)	53.4	58.3	65.4	5.0	12.1
Hourly Total*	166,575	145,148	136,488	-21,427	-30,087
Hourly "Core"	125,235	99,068	89,677	-26,167	-35,558
Hourly "Non-Core"	41,340	38,465	38,402	-2,876	-2,939
Skilled Trades	39,775	25,128	21,869	-14,647	-17,906
Production	126,800	120,020	114,619	-6,780	-12,181
Hourly Percentage	69.1%	68.9%	67.2%	-0.1%	-1.9%
Salaried Total	74,614	65,394	66,731	-9,220	-7,883
Engineering/Technical	24,707	21,731	22,266	-2,977	-2,441
Others	49,907	43,664	44,465	-6,243	-5,442

**Includes workers in job banks.*

U.S. Detroit Three Attrition Forecast

	Through 2011	Through 2016
Total Attrition	87,629	115,488
Hourly	61,818	70,935
Skilled Trades	16,647	19,906
Production	45,171	51,029
Salaried	25,811	44,553
Engineering/Technical	8,594	14,871
Other Salaried	17,217	29,682

U.S. Detroit Three New Hires Forecast

	Through 2011	Through 2016
Total New Hires**	56,673	77,209
Hourly**	38,390	38,848
Skilled Trades*	2,000	2,000
Production	38,390	38,848
Salaried	18,282	38,361
Engineering/Technical	6,078	12,890
Other Salaried	12,204	25,470

**Transfer from production.*
***Sums do not include the number of workers transferred from production to skilled trades.*

Michigan Detroit Three Employment Forecast

	2007– Preliminary	2011	2016	Change Through 2011	Change Through 2016
MI Vehicle Production	2,288,480	2,132,207	2,213,482	-156,273	-74,998
MI Total Employees	129,037	114,254	108,430	-14,782	-20,607
Productivity (Unit per core worker)	41.9	49.3	55.9	7.4	14.0
Hourly Total*	73,439	68,364	65,209	-5,075	-8,231
Hourly "Core"	54,625	43,234	39,581	-11,391	-15,045
Hourly "Non-Core"	18,814	17,111	17,244	-1,703	-1,570
Skilled Trades	20,179	12,097	10,722	-8,082	-9,457
Production	53,260	56,268	54,487	3,007	1,226
Hourly Percentage	56.9%	59.8%	60.1%	2.9%	3.2%
Salaried Total	55,597	45,890	43,221	-9,707	-12,376
Engineering/Technical	22,844	18,813	17,580	-4,031	-5,264
Others	32,753	27,077	25,642	-5,676	-7,111

**Includes workers in job banks.*

Michigan Detroit Three Attrition Forecast

	Through 2011	Through 2016
Total Attrition	47,424	62,577
Hourly	30,435	33,590
Skilled Trades	9,287	10,662
Production	21,147	22,928
Salaried	16,989	28,987
Engineering/Technical	6,971	11,870
Other Salaried	10,019	17,117

Michigan Detroit Three New Hires Forecast

	Through 2011	Through 2016
Total New Hires**	36,250	45,955
Hourly**	24,154	24,154
Skilled Trades*	1,205	1,205
Production	24,154	24,154
Salaried	12,095	21,800
Engineering/Technical	4,927	8,846
Other Salaried	7,168	12,955

**Transfer from production.*
***Sums do not include the number of workers transferred from production to skilled trades.*

U.S. International Automaker Employment Forecast

	2007– Preliminary	2011	2016	Change Through 2011	Change Through 2016
Vehicle Production	3,826,288	4,770,069	5,456,306	943,781	1,630,018
U.S. Total Employees	113,410	137,562	152,054	24,152	38,643
Productivity (Unit per core worker)	58.4	60.7	63.8	2.4	5.5
Manufacturing Employment	65,579	78,565	85,506	12,986	19,927
Manufacturing Worker Percentage	57.8%	57.1%	56.2%	-0.7%	-1.6%
Non-Manufacturing Employment	47,831	58,997	66,548	11,166	18,717

Table II.1a Data: Detroit Three United States Employment, 1999–2006

U.S. Hourly		
	Trades	Other
1999	68,753	249,205
2000	66,379	237,707
2001	63,685	219,949
2002	61,598	207,862
2003	60,332	198,696
2004	56,537	186,136
2005	55,115	178,870
2006	47,374	155,311

U.S. Salaried		
	Engineers/Technical	Other
1999	38,753	78,227
2000	41,202	79,844
2001	36,872	79,615
2002	34,700	76,783
2003	33,779	74,982
2004	33,649	71,845
2005	33,012	65,599
2006	31,637	61,292

Table II.1b Data: Detroit Three Michigan Employment, 1999–2006

MICHIGAN Hourly		
	Trades	Other
1999	35,531	105,893
2000	34,362	102,544
2001	33,082	96,058
2002	31,780	90,561
2003	30,862	85,872
2004	28,791	79,819
2005	27,705	74,616
2006	23,946	66,477

MICHIGAN Salaried		
	Engineers/Technical	Other
1999	34,874	47,826
2000	37,036	48,892
2001	32,958	48,775
2002	31,162	45,962
2003	30,515	45,430
2004	30,268	43,905
2005	30,050	41,919
2006	28,928	40,168

Table II.2a Data: Detroit Three Distribution of United States Employees by Service Years, 2006

U.S. All Workers	
Mean	17.70
Median	14.95

U.S. Hourly		
Mean		18.78
Median		16.53
	Trades	**Other**
Mean	21.47	17.94
Median	21.41	14.75
COUNT		
0-5 years	814	14,206
6-10	5,920	28,173
11-15	8,131	24,682
16-20	3,803	10,686
21-25	6,518	11,717
26-30	7,230	23,104
31-35	4,476	10,897
36+	4,150	8,206
TOTAL	41,042	131,671

U.S. Salaried		
Mean		15.52
Median		13.08
	Engineers/Technical	**Other**
Mean	14.72	15.95
Median	12.29	13.57
COUNT		
0-5 years	4,426	8,714
6-10	7,979	13,683
11-15	4,868	7,829
16-20	3,925	6,506
21-25	3,456	7,122
26-30	2,669	6,565
31-35	1,272	3,214
36+	687	2,329
TOTAL	29,282	55,962

Data as of Q1 2007

Table II.2b Data: Detroit Three Distribution of Michigan Employees by Service Years, 2006

Michigan All Workers	
Mean	17.80
Median	14.93

MICHIGAN Hourly		
Mean		19.42
Median		16.74
	Trades	**Other**
Mean	22.09	18.45
Median	17.26	14.71
COUNT		
0-5 years	343	4,763
6-10	2,778	12,331
11-15	4,309	12,456
16-20	1,756	4,766
21-25	2,749	3,562
26-30	3,876	9,891
31-35	2,570	5,860
36+	2,443	4,047
TOTAL	20,824	57,676

MICHIGAN Salaried		
Mean		15.79
Median		13.64
	Engineers/Technical	**Other**
Mean	14.83	16.50
Median	12.45	14.69
COUNT		
0-5 years	3,965	5,162
6-10	7,275	8,271
11-15	4,524	5,084
16-20	3,609	4,827
21-25	3,229	4,818
26-30	2,489	4,387
31-35	1,185	2,289
36+	640	1,568
TOTAL	26,916	36,406

Data as of Q1 2007

Table II.3a Data: Detroit Three Distribution of United States Employees by Age, 2006

U.S. All Workers	
Mean	46.02
Median	45.96

U.S. Hourly		
Mean		46.71
Median		46.79
	Trades	**Other**
Mean	50.73	45.46
Median	51.37	45.35
COUNT		
0-20 years	-	423
21-30	305	7,764
31-40	4,634	32,631
41-50	13,015	46,768
51-60	18,776	38,345
61-65	3,532	4,228
66+	780	1,512
TOTAL	41,042	131,671

U.S. Salaried		
Mean		44.62
Median		44.43
	Engineers/Technical	**Other**
Mean	44.22	44.82
Median	44.00	44.68
COUNT		
0-20 years	-	11
21-30	2,025	4,045
31-40	7,858	14,391
41-50	11,893	20,358
51-60	6,705	15,223
61-65	670	1,711
66+	131	223
TOTAL	29,282	55,962

Data as of Q1 2007

Table II.3b Data: Detroit Three Distribution of Michigan Employees by Age, 2006

U.S. All Workers	
Mean	45.80
Median	45.70

MICHIGAN Hourly		
Mean		46.65
Median		46.80
	Trades	**Other**
Mean	50.48	45.27
Median	51.10	45.18
COUNT		
0-20 years	-	189
21-30	149	3,672
31-40	2,410	14,631
41-50	6,805	19,965
51-60	9,495	16,850
61-65	1,689	1,687
66+	276	682
TOTAL	20,824	57,676

MICHIGAN Salaried		
Mean		44.74
Median		44.53
	Engineers/ Technical	**Other**
Mean	44.24	45.10
Median	44.02	44.93
COUNT		
0-20 years	-	-
21-30	1,836	2,190
31-40	7,197	9,119
41-50	11,013	13,983
51-60	6,129	9,949
61-65	621	1,027
66+	120	138
TOTAL	26,916	36,406

Data as of Q1 2007

Table II.4a Data: Detroit Three United States Employee Attrition, 2000–2006

U.S. Hourly		
	Trades	Other
2000	4,769	21,106
2001	3,675	17,702
2002	3,570	19,763
2003	3,017	16,635
2004	4,615	18,145
2005	3,134	17,129
2006	8,566	37,366

U.S. Salaried*		
	Engineers/Technical	Other
2000	2,170	4,449
2001	2,319	5,654
2002	2,728	4,929
2003	1,778	3,321
2004	1,699	3,543
2005	2,416	4,457
2006	2,254	3,972

** Excludes GM due to missing data*

Table II.4b Data: Detroit Three Michigan Employee Attrition, 2000–2006

MICHIGAN Hourly		
	Trades	Other
2000	2,681	8,836
2001	1,927	7,106
2002	1,877	8,844
2003	1,529	6,923
2004	2,421	7,322
2005	1,543	6,587
2006	4,375	14,154

MICHIGAN Salaried*		
	Engineers/Technical	Other
2000	1,941	2,849
2001	2,108	3,728
2002	2,395	2,995
2003	1,541	2,120
2004	1,482	2,217
2005	2,106	2,861
2006	2,004	2,506

** Excludes GM due to missing data*

Table II.5a Data: Forecast Detroit Three Employee Attrition in the United States by Occupational Group, 2007–2016

U.S. Hourly		
	Trades	Other
2007	7,599	28,511
2008	8,324	26,806
2009	4,360	11,611
2010	1,982	3,377
2011	1,982	3,377
2012	652	1,172
2013	652	1,172
2014	652	1,172
2015	652	1,172
2016	652	1,172

U.S. Salaried		
	Engineers/Technical	Other
2007	5,218	10,684
2008	2,927	5,758
2009	2,160	4,426
2010	1,775	3,569
2011	1,732	3,464
2012	1,717	3,432
2013	1,304	2,522
2014	1,083	2,171
2015	1,085	2,171
2016	1,087	2,170

Table II.5b Data: Forecast Detroit Three Employee Attrition in Michigan by Occupational Group, 2007–2016

MICHIGAN Hourly		
	Trades	Other
2007	3,767	13,217
2008	4,644	12,553
2009	2,421	5,426
2010	1,111	1,584
2011	1,111	1,584
2012	275	356
2013	275	356
2014	275	356
2015	275	356
2016	275	356

MICHIGAN Salaried		
	Engineers/Technical	Other
2007	4,631	6,526
2008	2,442	3,480
2009	1,622	2,355
2010	1,468	2,117
2011	1,439	2,066
2012	1,371	1,970
2013	888	1,284
2014	891	1,293
2015	884	1,288
2016	865	1,263

References

Crain Communications, *Automotive News Data Center*, www.autonews.com/section/DATA (Detroit: Crain Communications, 2007)

csm|worldwide, *Light Vehicle Production Forecast: North America*, Volume 16, Number 4, 4Q 2007 (Northville, MI: csm|worldwide, 2007)

DaimlerChrysler AG, Form 20-F, filed with the U.S. Securities and Exchange Commission February 27, 2007

Ford Motor Company, Form 10-K, filed with the U.S. Securities and Exchange Commission February 28, 2007

General Motors Corporation, Form 10-K, filed with the U.S. Securities and Exchange Commission March 15, 2007

Harbour Consulting, *The Harbour Report™ North America* (Troy, MI: Harbour Consulting, 1996-2007)

Honda Motor Co., LTD., Form 20-F, filed with the U.S. Securities and Exchange Commission July 18, 2007

International Union, United Automobile, Aerospace and Agricultural Workers of America (UAW), *Newsgram: UAW Chrysler Hourly Workers*, October 2007 (Detroit: UAW, 2007)

International Union, United Automobile, Aerospace and Agricultural Workers of America (UAW), *UAW Chrysler White Book*, October 2007 (Detroit: UAW, 2007)

International Union, United Automobile, Aerospace and Agricultural Workers of America (UAW), *UAW Ford Report*, November 2007 (Detroit: UAW, 2007)

International Union, United Automobile, Aerospace and Agricultural Workers of America (UAW), *UAW Ford White Book*, November 2007 (Detroit: UAW, 2007)

International Union, United Automobile, Aerospace and Agricultural Workers of America (UAW), *UAW GM Report*, September 2007 (Detroit: UAW, 2007)

International Union, United Automobile, Aerospace and Agricultural Workers of America (UAW), *UAW GM White Book*, September 2007 (Detroit: UAW, 2007)

McAlinden, Sean P. and Steven Szakaly, "Driving in Reverse? The Future of the Automotive Sector in the United States," *The Economic Outlook for 2007, Fifty-Third Annual Conference on the Economic Outlook* (Ann Arbor, MI: University of Michigan, 2006)

McAlinden, Sean P., Kim Hill, and Bernard Swiecki, *Economic Contribution of the Automotive Industry to the U.S. Economy-An Update*, A Study prepared for the Alliance of Automobile Manufacturers, Center for Automotive Research, (Ann Arbor, MI, Fall 2003)

Fulton, George A. and Sean P. McAlinden, *Contribution of the U.S. Motor Vehicle Industry to the Economies of the United States, California, New York, and New Jersey in 2003*, A Study prepared for Alliance of Automobile Manufacturers, Inc., Institute of Labor and Industrial Relations, The University of Michigan, and the Center for Automotive Research, (Ann Arbor, MI, May 2004)

McAlinden, Sean P. and Bernard Swiecki, *The Contribution of the International Auto Sector to the U.S. Economy: An Update*. A Study prepared for the Association of International Automobile Manufacturers, Inc., Center for Automotive Research, (Ann Arbor, MI, March 2005)

Michigan Department of Labor and Economic Growth, Michigan Labor Market Information, *Michigan Employment Forecasts by Occupational Groups 2004–2014*, www.milmi.org (Lansing, MI: State of Michigan, 2007)

National Center for Education Statistics (NCES), *Digest of Education Statistics*, 1997-2006 (Washington, D.C.: NCES, 2007)

National Center for Education Statistics (NCES), *Projections of Education Statistics to 2016*, December 2007 (Washington, D.C.: NCES, 2007)

National Center for Public Policy and Higher Education, *Policy Alert*, April 2004, www.highereducation.org (San Jose, CA: National Center for Public Policy and Higher Education, 2004)

Toyota Motor Corporation, Form 20-F, filed with the U.S. Securities and Exchange Commission June 25, 2007.

U.S. Department of Labor, Bureau of Labor Statistics, *Current Employment Statistics Survey*, www.bls.gov, December 2007 (Washington, D.C.: U.S. Department of Labor, 2007)

U.S. Department of Labor, *Employment Outlook: 2006-2016, Industry output and employment projections to 2016*, Eric B. Figueroa and Rose A. Woods, Monthly Labor Review, November 2007 (Washington, D.C.: U.S. Department of Labor, 2007)

PROGRAM FOR AUTOMOTIVE LABOR AND EDUCATION

This study launches the Program for Automotive Labor and Education at the Center for Automotive Research. This project brings together leaders in the automotive industry, education, labor, workforce development and government with the goal of sustaining and improving the quality of the automotive workforce in North America's automotive manufacturing and engineering center.

Through the Program, members will:

- participate in annual updates to this study
- gain access to key decision makers and experts in the field of automotive workforce development
- share best practices in automotive workforce development
- take part in regular meetings
- network with other individuals and organizations interested in automotive workforce development
- guide the Program's research, outreach and special projects, and
- tap in to CAR's broad industry intelligence, data and research initiatives.

For more information on how to participate in the Program for Automotive Labor and Education, please contact:

Kristin Dziczek, Director
Program for Automotive Labor and Education
pale@cargroup.org

1000 Victors Way, Suite 200
Ann Arbor, MI 48108
734-662-1287
pale@cargroup.org
www.cargroup.org

The Center for Automotive Research, a nonprofit organization, is focused on a wide variety of important trends and changes related to the automobile industry and society at the international, federal, state and local levels. CAR conducts industry research, develops new methodologies, forecasts industry trends, advises on public policy, and sponsors multi-stakeholder communication forums.

CAR
CENTER FOR AUTOMOTIVE RESEARCH