Auto-in-Michigan Project
FY 1987 Final Report

The AIM Project fulfilled its mandated objectives in fiscal 1987. This report restates those objectives, summarizes Project activities in support of them, and assesses the impact of those activities. Since AIM project management in FY 1987 was split between the Industrial Technology Institute (ITI, subcontractor) and the University of Michigan's Office for the Study of Automotive Transportation (OSAT, contractor), an expenditures statement is not attached; it will be provided under separate cover by the University's Accounting Department.

Goals and Objectives

AIM's goal in FY 1987 was to deepen our, and hence State government's, knowledge of major Big Three and independent supplier plants in the state. FY 1987 was, in a sense, the year in which the Project set out to test FY 1985-86 predictions against the concrete reality of plant leadership's perceptions of their competitive and technological contexts. Hence, supporting the Renew program (see *Activities*, below) of the Michigan Department of Commerce (MDC) was AIM's major focus until April 1987, after which plant access problems forced the negotiation of a revised workplan (see below) placing more emphasis on independent suppliers' sourcing opportunities.

Activities

The MDC's Renew program was an ambitious effort to send MDC account executives out to Michigan Big Three plants and the largest (by employment size) independent parts suppliers. At each site, an AIM-designed questionnaire protocol was to be used in interviews with management and local union leaders. Each such visitation was to be chronicled by the logging of a three-part (summary, management, union) Renew trip report on the MTS Confer system. Once logged, AIM staff were given five working days to file comments. On an occasional basis, as determined by Renew leadership, AIM participants were to prepare for MDC-Renew detailed memoranda summarizing the implications of the findings and commentaries; AIM members' responsibilities were divided by plant type. Forty-five (45) Renew visitations were logged, and a set of six AIM memoranda prepared for MDC-Renew. Attachment 1 presents a list of Renew visitations, the questionnaire used as an interview guide by MDC account executives at Renew visits, and the set of six AIM memoranda (including a cover memo transmitting

them to MDC-Renew).

Three newsletters, volume 2 numbers 1-3, were produced during FY 1987. Distribution was widened, as proposed in the AIM FY 1987 grant, to include more State government "drop points" and an expanded direct mail subscriber list that now numbers 500 and includes all plant managers and local union presidents in Michigan automotive facilities with 500 or more employees. Volume 2 number 3 includes an article summarizing the University of Michigan's study of the impact on the Michigan economy of the announced GM plant closures; AIM staff provided the detailed assumptions and supplier information needed for the University's projections. Attachment 2 is a set of the three FY 1987 (volume 2) newsletters.

Serious problems of access to GM plants began to be encountered early in calendar 1987. This was particularly unfortunate in light of the State's increasing concern over, and interactions with, GM in the context of the impending plant closures. As a result, a revised workplan was negotiated, and beginning in April 1987 the Project's activity focus changed from service to MDC-Renew to a set of activities that are the core of AIM's work in FY 1988. Attachment 3 presents three documents that, together, explain the reorientation. The first is the letter requesting State approval for the workplan revision; the second is a letter to the AIM Advisory Board explaining the reorientation; and the third is a copy of the now-approved AIM FY 1988 project proposal, which explains in more detail each of the subprojects that together compose the reoriented AIM mission.

Ironically, just as the reorientation became official, GM -- while remaining adamantly opposed to open MDC-Renew access to its Michigan plants -- began making increasing requests of MDC and GOJT for training assistance. AIM staff, pursuant to a request by the MDC's Auto Policy Group, was commissioned to produce a model of GM in the State economy, one that could be used to guide, and predict results of, State assistance efforts to GM facilities. The model, with supporting materials on each of GM's 58 Michigan production facilities, is Attachment 4.

The AIM slide show was expanded to cover the topics contained in the three issues of volume 2 of the newsletter; a total of 23 new slides were added, and 11 pre-FY 1987 slides were updated. Complete sets of the slides are in the possession of the University's Industrial Development Division, the Michigan Modernization Service's Research and Analysis Program, and ITI's Industry Affairs and Policy group.

An AIM advisory board meeting and dinner was held in September 1987. Attachment 5 includes the letter sent to speakers, and a copy of an example of the type of sourcing information that AIM staff is now busy collecting.

Project communications were managed on the MTS Confer system. Twenty-nine permanent items and 452 messages were logged during FY 1987. CPU and connect time charges were approximately $2300.

AIM's Impact

AIM Project members Andrea, Baum, Flynn, Luria, and Russell between them made thirteen (13) AIM-related presentations around the State in FY 1987, using the expanded Project slide show. Talks were given in Detroit, Southfield, Novi, Grand Rapids, Lansing, Kalamazoo, Ann Arbor, and Traverse City to local development groups, technology councils, supplier forums, and community college educators.

Newsletter distribution is covered above under *Activities*. AIM staff also received and answered 13 letters from Michigan auto suppliers asking for more detailed information pursuant to newsletter articles.

AIM staff attended three meetings of the MDC's Auto Policy Group during FY 1987, and responded to 54 telephone inquiries from MDC staff.

Expenditures

This information will be provided under separate cover by the University's Accounting Department.

ATTACHMENT 1

AIM AND RENEW

- Renew Visitation Log
- AIM Protocols for Renew Visits
- AIM Meomoranda to MDC-Renew

Renew Visitation Summary

Despite access problems at GM, Michigan Department of Commerce account executives made 45 visitations under the Renew program in FY 1987, following the procedures set up for AIM-Renew work:

- Renew visit, using AIM protocol
- Renew trip report -- summary sheet, management report, and union report -- logged
- AIM commentaries logged within five (5) working days

Renew-AIM Sites, FY 1987

Between October 1, 1986 and September 30, 1987, visits were made to:

1. GM CPC Pontiac Engine
2. GM CPC Bay City (included AIM briefing on camshaft technology and competitors)
3. GM Inland Livonia (AIM staff were also involved in early warnings on movement of work from Livonia and Tecumseh plants to Euclid and Grand Rapids facilities)
4. GM CFD Saginaw (3 plants), including AIM participation in an Auto Policy Group meeting on CFD issues
5. Ford Wayne Assembly
6. Ford Monroe Stamping
7. Ford T&C Livonia
8. Ford PPD Milan
9. Ford CCD Plymouth

10. Chrysler Sterling Heights Assembly (Renew was able to procure for AIM detailed parts sourcing lists)

11. Chrysler Acustar Detroit Axle

12. Chrysler Acustar Winfield Foundry

13. Chrysler Acustar Detroit Forge

14. Chrysler Acustar Detroit Trim

15. Chrysler Acustar Trenton Chemical

16. Chrysler Eagle Jeep Toledo

17. Active (Elkton)

18. Autodie (Grand Rapids)

19. Borg Warner (Sterling Heights)

20. Checker (Kalamazoo)

21. Cross (Fraser)

22. Dana (Detroit)

23. GenCorp, Diversitech (Ionia)

24. Donnelly (Holland)

25. Eaton (Marshall)

26. Emhart (Warren)

27. Harvard [was Hayes-Albion] (Jackson)

28. Kelsey-Hayes (Detroit)

29. Kelsey-Hayes (Romulus)

30. [F. Joseph] Lamb Technicon (Warren)

31. Lear Siegler, General Seating (Detroit)

32. Lear Siegler, General Seating (Mendon)

33. Lobdell-Emery (Alma)

34. Monsanto (Trenton)

35. Motor Wheel (Lansing)

36. Motor Wheel (Ypsilanti)

37. Prince (Holland)

38. Riverside Metal Products (Port Huron)

39. Roberts (Grand Ledge)

40. Sealed Power (Dowagiac)

41. Sterling Engineered Products (Mt. Clemens)

42. Tecumseh Products (Tecumseh) - as part of a TDS-led team, AIM staff also worked with management and local union personnel in State effort to win investment commitment

43. Walbro (Cass City)

LINES OF INQUIRY FOR OEM/SUPPLIER ESTABLISHMENTS

1. MANAGEMENT QUESTIONS

A. Basic Company Information

Name, location, number of employees, SIC codes, etc. (Essentially what is already captured through the Client File Lead/Prospect form. This should include the reporting relationship of the plant manager.)

B. Product Lines

1) Specific products, destination (customers and specific plants) and volume (including what percent of the total product line sales).

2) Major competitors. Who are your major competitors? Where are they located? What are their strengths and weaknesses?

3) Elements of risk associated with these product lines over the next several years (e.g., carburetors replaced by fuel injection, body panels going plastic, vehicle programs terminating, etc.)

4) Products they expect to bid on over the next several years (including non-OEM work) and what their competitive advantages/disadvantages are relative to those new markets.

C) Suppliers

1) Suppliers of key inputs and the volume of each. How much of their supply base is located in Michigan? U.S.? Off shore?

2) Strengths and weaknesses of their supplier base. Do they have problems with quality, timely delivery, etc.?

D) Strategic Planning

1) Who does strategic planning for the facility?

2) How is it done (specific unit, plant team, interactions with corporate, etc.)?

3) What is your current long-term strategic plan? What do you think will be the state of your product in five-years?

E. Advantages/Disadvantages In Specific Production Factors

1) Capital

- What is the process for making capital expenditure decisions? At what level are these decisions made?
- Is the price or availability of capital an issue? If so, why?
- What amount of capital do they need over what period of time to remain competitive?
- What form of financing do they expect to use?

2) Labor

- What are the characteristics of the current labor force (age, education level, etc.)?
- What are the functional skill levels of the current work force? Are functional literacy and math skills an issue? What proporation of the work force requires remedial training in order to remain productive?
- What specific skill training is needed?
- What is the state of labor-management relations at the plant?

3) 3) Culture

- How aware are the plant management and the work force of the competitive challenges facing them?
- How prepared are management and workforce to make the changes and sacrifices necessary to stay in business?

4) Physical Plant (Personal Property)

- What competitive advantages/disadvantages does the plant's personal property endowment present? Is the building sound? Is the machinery modern and competitive?

5) Technology

- How competitive is the technology used in the production process (by product line)?
- What major technology issues are critical to the plant's competitiveness over the next five-years?

6) Quality

- What quality ratings, if any, apply to this facility?
- How are you working to address quality demands of industry?

7) Desired Changes

- What three things would you do to make your plant more competitive?

8) Government

- How important are government-imposed costs to the plant's competitiveness? Which costs? Why?
- What is the appropriate role of government in helping a plant like this remain competitive?

UNION LOCAL QUESTIONS

A) Product Lines

- What are current product lines at this plant?
- What is the union's perception of the competitiveness of current product lines, and the prospects for future work?
- Who are your major competitors?
- Elements of risk associated with these product lines over the next several years (e.g., carburetors replaced by fuel injection, body panels going plastic, vehicle programs terminating, etc.
- What steps (if any) has the union taken to increase the plant's competitiveness in future product bids?
- What union participation is there to meet quality goals within the plant?

B) Strategic Planning

- What are the long range plans for this plant?
- Is the union involved in strategic planning? What form does this involvement take?
- What do you see as the function of the plant in five years?
- What are this plant's location advantages or disadvantages?
- What three things would you change to make your plant more competitive?
- How does new technology and automation affect union members?

C) Relations with Management

- Does the union feel it has a real rapport (working relationship) with management?
- What formal mechanisms exist for communication?
- Is the union involved in advance deliberations on major strategic issues (e.g., bids for new work?)

D) Culture

- How aware are the plant management and the work force of the competitive challenges facing them?

- How prepared are management and workforce to make the changes and sacrifices necessary to stay in business?

E) Classification Issues

- How do current and expected work rule changes effect labor/management relations?

- Are job classifications an issue at this plant?

- What are the politics of classification issues at this plant? (E.g., management abuse, union willingness to negotiate, etc.)

F) Seniority Levels

- What are the seniority levels of the work force?

G) Politics

- How stable is the union leadership? What is the current election status?

H) Government

- How important are government imposed costs to this plants competitiveness? Which costs? Why?

- What is government's appropriate role in making or keeping this plant competitive?

Industrial Technology Institute
P.O. Box 1485
Ann Arbor, Michigan 48106

MEMO TO: Alan Baum, Director, AIRS-ITS-MDC

FROM: Dan Luria, Director, AIM

DATE: January 21, 1987

SUBJECT: First Set of AIM Memoranda for Renew and APG

This brief document transmits to you the first batch of AIM Central Research Team memoranda linking AIM research and Renew trip report findings. As I think you will agree, this experiment in cross-fertilization seems to be working.

We have not added much new to the assembly area beyond restating AIM conclusions that the State needs to monitor CT20 (Escort successor) sourcing and to be aware of the possible impacts of GM's overcapacity in C, H, and E cars (Orion, Buick City, Willow Run, and Poletown). With respect to the first of these, key things to watch are major body stampings (will Dearborn and Woodhaven lose out?) and engines (will the CT20 use the Dearborn 1.9-liter?)

Where I think we've added value is in the supplier plant area. If there is a consistent theme running through this first set of memos, it is the challenged position of captive supplier plants, especially in General Motors. As the Andrea/Cole and Hervey memos, in their treatment of trim and engine part plants respectively, make clear, many captives lack the product expertise -- and often the in-house engineering resources to develop it -- needed to compensate for their high labor and overhead costs. Indeed, GM's CPC division has, we are told, made a conscious decision *not* to fund product engineering except in body (stamping), assembly, and engines. While some captive plants may last a while because of a shortage of outside capacity, the long-term outlook is bleak for many. A general rule of thumb: when a captive is in a business in which it

has no particular technology-based advantage, it can be undersold by 25-40% by specialist independents.[1]

As for the timing of the outsourcing that is predicted by the aforegoing, new vehicle launches and reskinnings constitute the "moments" of (outsourcing) danger for the captives. This suggests somewhat lower risk for Chrysler's remaining captives than for Ford and GM's, since Chrysler's big launch push (in cars, at least) will soon be complete.

To be sure, not all captives are in trouble. As the Andrea/Cole discussion of Ford CCD Sheldon Road (Plymouth), and the Jurek discussion of Ford T&C Livonia, suggest, when captives do have engineering resources, *and where the product is subject to a capital- and technology-intensive process*, they can often thrive. Moreover, there are cases in which an OEM's willingness to provide resources can turn around the prospects of captive plants, e.g., Ford's decision to make major investments in its EED plants in Rawsonville and Ypsilanti.

Some captive engine plants, especially in GM, are at risk because of overcapacity and overproliferation. GM in particular has far too many engines in its stable, and too much capacity in several of them. Unfortunately, the steps they will be taking to deal with this problem *in a period of constrained cash flow* will not tend to benefit Michigan. For example, redoing (and upping the displacement of) the 2.8-liter V6 will anchor investments in New York, Canada, and Mexico; upteched variants of the 2.8 may squeeze out the (less well-designed) Buick 3.0-liter (Flint), and make it possible to cancel the now "indefinitely postponed" 3200 (3.2-liter V6) engine, for which Pontiac, Romulus, and Bay City were candidates. In other cases, not developing new engines may help: if the 2.5-liter made at Pontiac is upteched and its life thereby extended, that *might* be a better result than its previously planned replacement by the Manhattan engine, since the latter might not have been sited in Michigan.

In independent suppliers, the picture is, on the whole, brighter, but two significant risks loom. The first is that, in the long-term, large materials-smart suppliers (GE, 3M, DuPont) have the potential to move downstream and drive out pure "product" suppliers. The other is that, as sourcing moves to built-up modules, there is no unique logic to who will supply them: e.g., if Eaton Marshall's power steering pumps become

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[1] In camshafts, treated at length in the Hervey memo, CPC Bay City is not even aware, it appears, of the emerging consensus processing choice.

part of a steering/suspension module, will Rockwell integrate "downstream" into pumps?

All independents will have to get, and stay, clear on what their specialty really is, since that is their core advantage over the captives (e.g., should Autodie really get into injectors?) In addition, some may have to be flexible as to plant location (e.g., will GM decide that to supply the APV at -- tentatively -- Tarrytown, Diversitech must build a panel plant contiguous to the assembly site?); contiguity requirements, on balance, hurt Michigan, since our parts share is roughly double our assembly share.

MEMO TO: AIM CRT and Renew Staff

FROM: Dan Luria

DATE: January 17, 1987

SUBJECT: AIM-Renew: Assembly

This memorandum attempts to illuminate the situation of light vehicle assembly plants in Michigan, based on AIM research and on Renew trip reports. It begins by listing relevant trip reports, recaps the main AIM issues for this plant type, provides a matrix that functions as a checklist of plants and issues, and concludes with a discussion that expands on the matrix entries.

Renew Trip Reports: Assembly

Renew intelligence-gathering to date covers Ford's Wayne (car) Assembly Plant (*Erika*: Escort/Lynx/EXP - Renew items 13, 15, and 30) and Chrysler's Sterling Heights Assembly Plant (*H*-body LeBaron GTS and Lancer, *P*-body Sundance and Shadow - Renew items 34, 35, and 36).

Major AIM Issues: Assembly

The AIM Project, particularly in its FY85 report, identified three assembly plant issues as being central for the State:

- Car plants' capacity rendered "excess" by the increasing market share of import and transplant vehicles

- Risks due to the age of certain RWD vehicle programs, particularly those produced in older plants (e.g., *Fox*: Mustang/Capri at Ford Dearborn Assembly; *G*: Supreme/Regal/Monte Carlo at GM Pontiac Plant 8; *B* and *D*: Caprice/Parisienne/Fleetwood at GM Clark/Fleetwood)

- Declining employment and value-added levels in assembly plants because of the sourcing of built-up modular subassemblies (e.g., assembly plants no longer having their own seat "cushion rooms" and no longer assembling all features of the instrument panel). If module suppliers need to be proximate to assembly plants, AIM argued, then State policy should tenaciously guard assembly share.

In addition, AIM has tried to maintain up-to-date "risk ratings" for Michigan's light vehicle assembly plants, based on these two issues, plus the attributes of the plant (including ease of conversion to FWD, if not FWD already), its perceived labor-management climate, and the effect (if any) of fuel prices or regulations. The most recent set of ratings (October 1986) is presented below. (For digital-only readers of this, see the bottom of page 2 of the AIM Newsletter, vol. 2 no. 1).

AIM Project work in FY86 has added two new issues to the list:

- Too much *overall* assembly capacity, even in relatively new FWD models. This also relates to the alleged problem of insufficient market differentiation. This has Michigan implications for BOC Buick City (Flint), Willow Run, and Orion.

- The prospect that one or more of the Big Three may use a Japanese company to design its future small cars, which could endanger small car assembly plants' links to their current suppliers (e.g., if the *Erika* successor, even if it's assembled at Wayne, is a Mazda-designed car, will it use engines from Dearborn, brakes from Kelsey-Hayes [Detroit, Jackson], and instrument panels from Saline?)

Discussion: Assembly

Import and Transplant Competition

The likely prospect of another 3-5% market share loss to more imports (mainly from Korea and Taiwan between now and 1992) and 7-10% to transplants suggests that at the next business cycle peak, there may well be some two million fewer traditional domestic light vehicles made in the U.S. Since Michigan assembles about 30% of U.S. light vehicles, one might expect a loss of about 600,000 units (or three plants' worth) of required capacity.

Because much of the 10-15% share loss expected is centered in small cars, one might conclude that only one Michigan assembly plant -- Ford's Wayne car assembly facility, which makes the Escort/Lynx/EXP line -- is significantly vulnerable. For several reasons, this is not our view: Wayne is less, and other plants somewhat more, at risk than the conventional wisdom would hold.

Wayne is the lead plant of three making the *Erika* line. It is considered by Ford to be a good plant, the one in which "new approaches are tried first." Its proximity to the Ford Body and Assembly division headquarters appears to play a role in that. Its plant manager describes it as using 60% of "available" automation as of late 1986.[1] It is slated to drop the Lynx in late 1987, when the Mazda 323-based Mercury Tracer begins being imported from Mexico at a rate of about 100,000 units annually, and the EXP at approximately the same time. Escort is slated to end at the close of the 1989 model year; any post-1989 output would probably be sited at Edison, NJ. Wayne management and union leaders expect

[1]Renew reports a divisional or corporate hurdle rate for automation investments of 27.5% per year, i.e., a 3.6-year payback period.

to get the Escort successor, codenamed CT20.[2] If so, 85-90% of available automation is slated, suggesting a different approach than the low-tech NUMMI system. *A first test of whether Wayne will indeed get that vehicle will come within a year: an expansion of the plant is slated by the end of 1987 to accomodate tooling and prototyping of the CT20.*[3]

Other Michigan assembly plants are, we think, at more risk than is immediately apparent from the import/transplant onslaught. We see the Pontiac Fiero (Pontiac Plant 1) at risk from Toyota MR2 and similar Japanese products. The propensity of the Japanese to upsize their vehicles and segment mix promises growing competition for GM's N body cars (Lansing) and Chrysler's H body cars (Sterling Heights). With regard to the latter, Renew reporting[4] also notes the competitive threat from Honda Accord, Mazda 626 (and, less

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[2]At the time of this writing, *Metalworking News* has reported that the CT20 will indeed be sited at Wayne. However, the State has been told the decision is not 100% "in stone"; this seems to be a play for State resources. If so, based on AIM research, the State would maximize its return on any assistance by conditioning it on pledges that the CT20 would retain as many as possible of Escort's sourcing linkages with Michigan facilities.

[3]The Renew-reported expansion size of 500,000 square feet seems excessive, *unless* additional operations – e.g., bumper, fuel tank, body panel stamping – are to be sited contiguously.

[4]The Renew interviewer(s) is (are) not identified in the trip reports filed. Also, at times it is difficult to interpret what is the interviewee's versus the interviewer's statement, and in three cases questions are reported as answers: (i) Strategic planning is said to be "driven by the market and what products need to be produced and in what location they need to be produced." Needed was a quick follow-up about *how* "in what location" is thought about in Chrysler, at what level, etc.; (ii) Technology is said to be abundant, but no details (e.g., number of robots) are given, and some technologies not now in use are described as "looming but ... not economically feasible now." Which?; and (iii) Quality measurement parameters are described, but never used to rank the H and P body products. Obviously, these comments are meant in the spirit of constructive input in this young process of plant reportage. Expanded interview guides will no doubt help here.

credibly, from Taurus/Sable); we would add Toyota Camry and Nissan Maxima to the list as well. Lancer/LeBaron GTS is slated for phaseout in approximately 1989. That would leave Sterling Heights dependent on P body (Sundance, Shadow) sales; while these cars are having a good reception in the 1986 market, they face daunting competition from a raft of small cars. Chrysler launched them quite cheaply (approximately $240 million) by having them share many parts, and a paint shop, with the H bodies. Should the latter be phased out, costs would rise. In addition, there is discussion within Chrysler about dual sourcing the P body in Mexico.[5] Finally, the fact that Renew was told that the P body was to end in 1990-92 is in itself interesting,if true. A 1986-92 run would span a single six-year "skinning cycle": Chrysler may be showing signs that it believes, consistent with AIM work by Richard Hervey and Don Smith, that the era of 10-plus year models is incompatible with a contested mature market.

Aging Vehicle Programs

Dying RWD programs are leading to slated closings at (GM) Clark/Fleetwood, Pontiac 8, half of Flint Truck, and (Ford) Dearborn by 1990. Action to backfill these facilities[6] is obviously desirable, though one should not be overly sanguine about the potential for that; sale or lease to transplant companies is one option. A post-Mustang product for Dearborn Assembly is perhaps the highest priority, since

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[5]This implied threat was raised with the local union in bargaining for a new local contract on the Jefferson/Trenton/Huntville model. It apparently did not work: such a contract was voted down, and the contract that eventually passed had few of the elements -- 5-plus years' duration, a single production classification, and pay-for-knowledge -- management had sought.

[6]In the case of Flint Truck and Bus, division-level discussions regarding GMT400 platform spinoffs might shed light on future light truck capacity planning.

AIM research indicates that without an "anchor," much or all of the Rouge complex is at risk.[7]

The way the supplier base changes in the face of RWD plant closings will also be instructive. For example, some have alleged only modest supplier impacts of the announced GM closings. They note that Conner Stamping will continue to ship D body panels to Arlington, Texas and CPC Grand Rapids B underbodies to Arlington and Lakewood, GA as long [1990?] as the current B/D design is made. But if there is a successor model and it's assembled in the South, will its supply base be constituted closer to the assembly sites?

Module Sourcing

A key issue for Michigan is how the chain of automotive value-added is configured: how much in the assembly plant, how much in parts plants, and of the latter how much in Michigan. Three forces seem to be at work, with conflicting implications for Michigan. First, many activities formerly centered in Michigan *but not adjacent to assembly plants* are tending to decentralize and cluster around final assembly sites (e.g., contiguous stamping, dedicated plastic parts operations). Second, subassembly work traditionally done in assembly plants is tending to be done in parts plants (e.g., assembly plant cushion rooms replaced by Hoover and Lear-Siegler seat assembly plants; instrument panel molding plant adds ashtray, glove box, and even sound system before shipping). Third, companies (and captive parts plants) that used to make discrete parts are trying to become subsystem assemblers, using smaller companies that used to sell direct to vehicle assembly plants as *their* suppliers (e.g., GM Delco in spring/strut suspension assemblies, Kelsey-Hayes in wheel/brake "corners.")

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[7]Alan Baum will soon have available results from some AIM-contracted forecasting work about Rouge facility closure effects.

These three developments give rise to a host of Michigan-relevant concerns. Will the multiple sourcing that Ford Wayne's plant manager says he prefers remain possible or cost-effective when so much of the responsibility for a subsystem lies outside the OEM? Are Michigan assembly plants magnets for module suppliers? For their subsassembly operations only, or also for the manufacture of their constitutent parts? Will transplant suppliers clustered around Toyota, Nissan, Saturn, and Honda become the module giants? Will more modular sourcing affect whether assembly plants have purchasing autonomy?

Close inspection of the sourcing list for Sterling Heights Assembly that was given to Renew should be undertaken. The plant describes its supply base as 60% JIT and 70% Michigan, with the former figure en route to 78%. What is the pattern? Is most of Michigan's 70% from captive parts plants? Is there a difference for discrete parts versus subsassemblies? For machined versus molded parts? What is the radius of the JIT circle for each type of component?

Overcapacity and Underdifferentiation

GM has too many large car plants, and the cars they assemble are said to be insufficiently differentiable in the market. Four of GM's five large FWD car assembly facilities[8] are in Michigan: BOC Buick City in Flint and BOC Willow Run in Ypsilanti make H body cars, Orion makes Olds and Cadillac C cars, and Hamtramck makes the E/K. Except for the Cadillac C cars, all of these vehicles are similar in size, and share the same standard engine (Buick 3.8-L V6 EFI) and transmission (440). A number of auto analysts describe the situation as "the cost of three platforms with the market perception of one car." Likely are steps toward *styling* differentiation but a platform

[8]The fifth is in Wentzville, MO.

standardization.

In any case, however, even were there to be no additional import (e.g., Mazda 929 series, Volvo sedan) penetration in this segment, GM is, we think, overcapacitized. Especially if it goes forward with two plants' worth of large car RWD capacity (the major makeover of the B body in the 1989-93 timeframe), it is hard to see why more than three and a half plants' worth of FWD large cars should find a market: today, at the cyclical peak, GM is running about 2.8 shifts' capacity in H cars, 3 in C bodies, and one in E/K. With platform consolidation, one or more likely two plants could be dropped. From where we sit, it's hard to be sanguine about Buick City, and -- after 1990 or so -- Orion as well.[9]

The just-announced "rebirth" pf the Cadillac Motor Car Company -- in apparent violation of the GM reorganization -- also raises some interesting capacity management issues. It is expected, for instance, that the DeVille would be resourced from Orion to Hamtramck; this would leave Orion entirely dependent on Olds 98 sales, which if not enough to justify a plant could be moved to Buick City, Willow Run, or Wentzville (Missouri). Cadillac's new independence could also influence the timing of any sourcing shifts for RWD Cadillacs, affecting (among others) Conner Stamping.

The overcapacity/underdifferentiation problem may go beyond GM, however. It is hard to be sure that an Escort successor would find a large market in the 1990s, making CT20 siting at Wayne something short of in the bag. We advise a close watch on the light truck operations of GM in Pontiac: more imports, transplants, and Chrysler trucks may

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[9]We have been told that Orion, despite its youth, has a bad physical layout and an old-style labor-management climate, and that quality is rated better at its C-car sister plant in Wentzville.

make three plants' worth of GMT400 unnecessary.[10] Finally, there may be grounds for concern that the new L-body LeBaron about to be launched at St. Louis may cannibalize Sterling Heights' H-bodies: styling is similar, and one wonders what led Chrysler to name yet another car "LeBaron."

Foreign Designs

In several ways, there are pressures to reduce the extent to which cars assembled and sold by the Big Three are truly *theirs*. These include the increased outsourcing of vehicle and subsystem engineering (design) responsibilities to both engineering service firms and parts suppliers (see AIM FY86 report); the trend toward small car joint ventures with the Japanese (e.g., NUMMI, Diamond Star); and a greater inclination to source parts globally.[11]

For Michigan assembly plants, none of these pressures are of great moment. However, it matters mightily to Michigan's current and future parts plants, captive and independent, whose designs are being made into cars in our assembly plants. Some of the more interesting possibilities one might reasonably speculate about include (i) a light truck, probably 4WD, joint venture between GM and Suzuki; (ii) a GM-Isuzu sports car to supplement (replace?) Fiero; (iii) a Chrysler-Jeep or Chrysler-Mitsubishi joint venture for a 4WD vehicle; and, least speculatively, (iv) a Mazda-designed vehicle to succeed Escort at Wayne.

Renew reports that the Wayne plant manager has met and

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[10]The three plants that will make GMT400 beginning in 1987 are Pontiac, Fort Wayne [lead plant], and Oshawa.

[11]While the recent, welcome decline in the dollar has reduced the *likelihood* of any given part being bought offshore, it has not affected the strategic orientation to *shop* Mexico, Brazil, and the Pacific Rim when planning a new vehicle.

been "heavily involved in production decisions with the Japanese for the new model." This strongly suggests that, in process if not also in product design, the CT20 slated for Wayne is a Mazda animal. Given the 626 class product scheduled for Flat Rock, a 323 design (like the Tracer successor to the Lynx) seems most likely.

Labor feels secure at Wayne, and assumes theirs would be the only CT20 plant. Moreover, the union president expects no decline in employment (from 3200 hourly today) with the CT20 because a higher build rate would offset more automation. The existing local contract, which is still quite far from the NUMMI/Flat Rock or Jefferson/Trenton/Huntsville standards of "modernity," is represented as satisfactory by both sides.

We smell a rat. We wonder why both sides are so certain that there will be a post-Escort product at Wayne. We wonder how management can be happy with the current agreement but seek "labor cost reduction" but not reduced employment. We wonder how a production system co-designed and perhaps run or co-run by Mazda reconciles "85-90% automation" with 3200 hourly workers, well above Honda or NUMMI workers-per-car levels. We wonder about management describing labor-management relations as good when the local union president, who also describes relations as excellent, takes the position that modern work rules overload workers by making them do more than one job.[12]

Lore: Assembly

This memorandum ends with a catch-all "gossip column" covering plant, division, and uncategorizable "lore."

- Not mentioned in the context of either the

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[12]He may well be right on the substance. Our point is simply that we're puzzled to hear relations between a management seeking labor cost cuts and a union protecting classifications described so glowingly.

Wayne or Sterling Heights plants is the matter of automation problems in assembly facilities. The BOC Hamtramck problems have been written about; we are told of a similar set of problems with Chrysler's Dodge City truck plant.

- Ford and Chrysler are talking with worrisome confidence about the performance of their Mexican operations, assembly as well as parts. The Big Three's involvement and the fact of U.S. banks' exposure in any Mexican debt writeoff means that Mexico probably would be allowed to export cars and parts to the U.S. even if Japanese and Korean exports are limited politically.

- Is the Mazda-Ford small car responsibility deal in effect? Who will design Ford's future small cars? Who will run the Wayne plant? How will the parts sourcing be done?

- Can parts plant clusters, e.g., transplant parts clusters in the lower-Midwest/upper South, turn the tables and become a magnet for assembly investment?

Renew visitors may need to have a second set of questions ready for cases in which existing questions are answered with platitudes or where necessary to illuminate an answer. This seems particularly true in the strategic planning area (everyone tells a story, but few inform) and in the labor relations area. Perhaps there needs to be a checklist in each issue category (e.g., in labor-management relations: skilled/production body count split; number of populated production and trades classifications; pay-for-knowledge? teams?)

Concluding Remarks

Now that Chrysler has firmed up its intentions for Jefferson, the assembly program uncertainties have shifted to GM and Ford. In GM, the dominant questions for the State relate to how GM will source parts in the future and how it will

manage its overabundant large car capacity; both are major issues for Michigan. In Ford's case, what happens at Wayne may provide many of the answers about small car futures, captive and independent supplier plant fitness, engineering outsourcing, and more.

Memo

To: AIM CRT and RENEW Staff

From: Mike Flynn

Date: 1/19/87

Subject: Independent Suppliers

RENEW reports: Suppliers

Four suppliers have been visited as of my last check (have been unable to access since 12/24/86):

Eaton Fluid Power Operations, Marshall

PRODUCT: Viscous Converter Clutch, Differentials (traction modifiers), Viscous Fan Drive Clutches, Power Steering Pumps (44, 46, 22);

Diversitech, Ionia

PRODUCT: thermoset compression molded products, using SMC (sheet molded compound 48") made of resin and fiberglass. Some assembly and painting is also done at this plant, along with deflashing, bonding and priming of some pieces. (17, 18, 24);

Riverside Metals, Port Huron

PRODUCT: trim for wheel wells and windows. (9, 25);

and Autodie, Grand Rapids

PRODUCT: tooling for metal stampings and plastic moldings; fuel injectors. (12, 29).

Major AIM Issues: Suppliers

The AIM work from FYs '85 and '86 identified a fairly long list of potential threats to auto suppliers. Many of these threats are more a problem for some, and less for others, depending upon an equally long list of specific factors. On reflection, it seems useful to group these various threats into five broad categories, and then specify the elements of the

categories that seem to be relevant for a particular company. This will encourage asking the question of each supplier, and thus allow comparison, rather than simply relating the "major" or "most likely" problems for each.

The first category is **Product Risk.** Beyond the specific risks to a company's given part number(s), the more general threats would include *material changes* and, probably, the increased use of *electronic* rather than mechanical controls, and the changes involved in the *drive-train*: moving to increased FWD (although slower than expected a few years ago), more manual transaxles and transmissions, and more 4WD. For many, the increased share of the personal vehicle market held by *light trucks* may represent a threat to some suppliers' level of business, just as do import passenger vehicles; for others, of course, light trucks may present new opportunities. It seems reasonable to include here any advantages or disadvantages in their current *business mix*, whether across their automotive product lines or between their automotive and nonautomotive business.

The second category is **Structural Risk.** This would include the often reported (but so far less frequently observed) emergence of *modular sourcing*, the move by the OEMs to purchase "higher-order" parts or assemblies to minimize their internal assembly costs. We may see more of this in the future, however, since the OEMs appear more likely to introduce this change during program development rather than the manufacturing of a program. Sometimes, but by no means always, related to this is the thrust of the OEMs to purchase from outside suppliers parts and components that they currently make in-house, or *decreasing vertical integration*, largely driven by the same cost considerations. The well publicized *tiering* of a shrinking supplier industry would also fall here. This is the notion that

the industry will come to represent a pyramid of decreasing numbers of suppliers as manufacturing moves up the chain of value-added to the manufacturers. Also cost-driven, the ultimate position of a given supplier will have major implications for the type and profitability of the work available to it, and, by extension, the types and wage-levels of the jobs it provides.

The third category is **Competitive Threat**, and this is meant to cover the general threat of both *transplant and offshore suppliers*, leaving the general issue of *customer's competitive performance* in vehicle sales somewhat in the background.

The fourth category is **Supplier Capability.** This category covers those attributes or characteristics of a supplier that are thought to be of increasing importance in the OEM's selection process. The dominant two are *quality and cost* -- indeed, one could argue that the others are important for their implications for these two dimensions. A capability that may be a critical determinant of where a company winds up in the "tiered-industry" is its *engineering capacity.* It is unclear whether that capacity must be in-house or might be secured through an engineering service firm. A general perception of *responsiveness to the customer* will be important, and it will include willingness to meet specific demands such as JIT delivery, electronic communications and data transfer, and new product development. This area will be a fertile field for the manufacturers to grow crops to whipsaw suppliers, and will be a mechanism for the sorting of suppliers into tiers and the differentiating of them into markedly different "classes."

The fifth category is **Local Reality**, including all those specific factors that have a bearing on plant viability. Most notable here is *labor relations*, covering the imponderables of climate, "modern" agreements, and

particular workforce assets and debits. The other major element of this category is the strength of the supplier's own *supplier base.* This element is probably more important the higher in the value-added chain the supplier under consideration is. Other elements would include *physical plant*; recent and required *capital investment* in product, process, or housing; and any particular problems or advantages of *location.* For plants that are part of larger, multi-plant corporations, the *independence* of the plant and its *reputation* within the corporation are important considerations, since they clearly impact the likely decisions about plant future.

A general note on Michigan: we are heavily dependent on autos, so anything that hits the industry hits us hard. That will be true of suppliers, and the proper orientation for the State is probably one of realistic damage limitation. In particular, if the supplier industry shrinks and tiers, there are a lot of small Michigan companies that are likely to be among the early casualties. On the other hand, the RENEW list does not include any of these, since it is currently focused on larger facilities. For these suppliers, the advantages and disadvantages of their Michigan location will likely play out on an individual basis, rather than according to a predictable larger logic. That means that a more aggressive and tailored posture is reasonable. Hopefully, these memos will help identify fruitful approaches.

Issue/Plant Matrix: Suppliers

Issues	Autodie	Diversitech	Eaton	Riverside
Product	change to plastics?	business mix?	potential market?	plastics?
Structural	change of customer base? Vertical Integration?	module? tiering?	module? new business from OEM? new business?	Candidate for shrinkage? Any hope for
Competitive	plastics may mean offshore?	lots of competition?	offshore/T coming?	Could be in real trouble?
Capability	material suppliers?	Process plus? Quality smug? Prod. Eng.?	source of new product? Sales per employee?	Spear 3? Supplier Q?
Local Reality	Strong on Cap/labor?	Good on Labor? Plant vs. Corp?	Why keep UAW? Plant vs. Corp?	Manager turnover? Labor Rels?

Discussion

This discussion will be organized around the issues; I have appended cleaned-up copies of the trip report comments, if you're inclined to absorb company by company.

Product Risks are endemic to the industry, and these suppliers have their share. Two of them, Autodie and Riverside, may face problems with the shift from metals to plastics, although the exact nature of the threat is quite different. Riverside appears to be a marginal candidate for survival in a number of regards, and one of these is theire apparent reliance on technical problems in the move to large-scale use of plastics in exterior (I assume) trim. That is really leaving your fate in the hands of others, and, while they may be right in this instance, they seem generally to adopt that posture. Autodie probably faces a much different problem, if they face one at all. They expect a ten-fold increase in plastics (referring, I assume, to part numbers, not to weight). If that expectation is accurate, Autodie needs to consider another threat in addition to the direct threat involved in material substitution. These parts are likely to be small (so the number of them can be large, and the weight change remain within more typical expectations of doubling), and thus may well be candidates for offshore sourcing, according to AIM work. The issue here is the value to weight ratio, and many small plastic parts can be nested so that such ratios are attractive for offshore sourcing. It may be right that the move to plastics doesn't threaten them because they can do plastics too, at least in body panels. But the nature of the competition in plastics may be fundamentally different, and perhaps tougher, for those parts that go increasingly offshore.

Eaton faces a further decrease in an already massively shrunken number of products. That can be useful in terms

of manufacturing, but problematic for survival in bad times. Does their main product have sufficient volume currently and/or potentially to maintain the plant? Is it a constant product that all cars need, with no major competitor? If so, how many variants are developed or on the way? I'm not sure on this, but it is certainly worth following up with the plant.

Diversitech has suffered, I suspect, a major disappointment with the cancellation of GM80, and the loss of a major slice of business they expected to get. Still, they seem diversified enough within autos (both by product and customer) to survive most of the ups and downs ahead. Does their small (15%) nonauto business afford them the opportunity to diversify, either within or outside automotive?? There is speculation that if GM does not do contiguous stamping at Framingham for the APV, then Diversitech may be a major winner. In this case, GM is expected to come up with a supplier "train" from the midwest, and Diversitech is likely to play a major role in the APV.

It is interesting that Autodie is diversifying. Why are they, and how are they doing? For example, what is their Spear rating for the fuel injectors, since this has implications for how much encouragement they might receive for further diversification into on-board parts and components? This is about 25% of their employment -- does it also represent about 25% of sales, profits, and so on? If so, and they are getting into vehicle parts, then they may face a very different business climate than they have until now: the players are different, and the rules different enough, I suspect, that the capabilities that have led to their success may not be immediately transferrable. That means they might face a substantially different game. Their injectors can be seen as creative building on their basic machining

capacities, or as rather fruitless because of their lack of engineering and test capacities.

Structural Risks present some interesting twists for two of these suppliers. In the case of Autodie, it makes sense to ask how much of their current business at the automotive manufacturers will move to other customers (change of customers) because of OEM outsourcing of products. Since almost all of their current business is GM, they need to determine whether they they make dies and molds for production that will remain in GM or for production that is likely to be outsourced as GM decreases vertical integration. GM may already have plans to team with Ogihara, Active, etc. Further, if there is outsourcing, and no fixed plans in place at GM, they still may find that their secure reputation is less of a comparative advantage than they anticipate. They should be aware that as the OEs have outsourced some suppliers have lost business because they couldn't find it. That is, a component is outsourced, and all the constituent parts go with it -- but the purchasing guys for those parts at the OE don't know where the component went, so they can't tell the old suppliers where they should go for the business, and the OE guy who does the component outsourcing can't tell the new supplier where the OE used to get the parts. That changes the nature of the market pretty drastically, and Autodie should consider that impact on their current business. Now may be the time to begin to identify who their future customers might be, and how that fits with the Autodie business plan. There are other tooling and mold producers that are already more heavily into production parts, and that is important for them to consider in theri plans and strategies.

To the extent that Autodie is heavily dependent on GM (ranks first among customers, but what share of sales?), then they may be among those interesting (to us) but

unlucky suppliers that lose business to increased OE vertical integration at a time when most of the business is flowing the other way. GM may be pulling tool and die work in-house to utilize their own capacity, which has about doubled with their modernization programs, and is probably subject to contractual restriction on outsourcing. That raises the possibility that outsourcing of stamping may be predicated on use of GM dies, and that undercuts the competitive advantage of being a good die-maker.

Riverside appears to be well placed to pick up outsourced work from the OEMs, since trim is a high priority for them to shed. But the report really suggests that they may have a hard time protecting existing work, and may in fact be a loser among winners. They may be a likely candidate for the Supplier Shrinkage Sweepstakes that the OEMs keep promising.

If modularity grows, both Eaton (Marshall) and Diversitech need to figure out what it means for them. Diversitech buys lots from its competitors, and unless those competitors also buy lots from Diversitech, and that might suggest that they are a more likely candidate to be shaken-out, or at least wind up in a less favorable position of supplying a modular supplier or suppliers. So too with Eaton -- where will they land: can they be, or are they already, a fully modularized suplier, or will their clutch be absorbed into someone else's module, such as Dana or Rockwell? How does Eaton -- company-wide -- look in terms of modularity, and where Marshall fit into any such corporate plans. Does their past experience of multiple product lines give them the possibility of going after other products that the OEMs want to shed? Or will this be blocked by the corporation's preference for product-focused plants? For both of these suppliers, the issue of modularity is closely connected to where they might end up in a tiered industry, and thus for

their "class" position. As such, they are worth RENEW pursuing in greater depth.

Competitive Issues are many. Diversitech identified lots of competitors that could make their products, unless that simply reflects their more complete listing compared to other suppliers' preference for naming just one or two. Especially if demand for SMC products fails to grow, that might suggest this area is one that will be "rationalized" to fewer players. Both Eaton (Marshall) and Autodie probably face a combination of transplant and offshore threats: Autodie, both as the industry moves further into plastics and in their injectors too; Eaton because of the value of the product (although the ratio of sales to employees makes me wonder if it is not a loss-leader). Judging from the trip report, Riverside sums up to be a plant in real trouble given any of a number of developments, and not much hope if any of their competitors go after them.

Capabilities vary a lot among these suppliers. Autodie does indeed sound tough, although nothing was said in the report about the quality of their materials suppliers -- many think that that is an Achilles heel of U.S. suppliers. They should also be cautioned that the quality rating represented by last year's order may not mean much when the customer's options increase. A given level of quality may be fine until something better comes along, and that is a lesson more American suppliers should have learned in the past decade. So too, Diversitech looks good, but here again their current quality *vis a vis* their competitors' shouldn't lull them into a sense of security. Have they gained any efficiencies from their multiple products? If they have, fine, but if not, they should pursue this. How are they on product engineering? Are they okay, good, or what; where is it done -- Ionia or Indiana? Eaton (Marshall) appears to have low sales per employee: a survey of Midwest manufacturers

recently completed at ITI suggests that 270k per employee is average, and they're way below that. Did they do the engineering for their award-winning product, or was that done in Cleveland? Riverside's Spear 3 means that they can continue existing work, but not bid for new GM work. That obviously is a major threat, unless they are in a product that only has Spear 3 or lower suppliers. How much of their quality problem traces to their suppliers, and are they capable of helping those suppliers upgrade? Getting Spear 2 would be good news; not getting it could be real bad.

Local Realities are more specific. Autodie sounds good, with a reasonable capital and labor climate. Diversitech also sounds good on labor, but capital decisions are less under their control. The fact that they face a number of ordinance and regulatory restrictions on type of growth could turn out to be a problem, depending on whether they eventually must grow in order to survive. Diversitech and Eaton both face some problems of being one among a number of plants in a company: that makes their reputation and power within the corporation important factors in their survival, since many companies will be shrinking the number of plants as domestic share erodes and suppliers are pared. One clue: are they growing or shrinking beyond fluctuations in vehicle sales? The report suggests that Eaton benefits from being the show (and last) UAW plant in the corporation. I find that small comfort, since someone at Cleveland could eventually decide it would be easier with no UAW plants. Riverside's plant manager turnover is scary -- why is it so high? Another scary thing about Riverside is the hint of bad labor await the union interview to confirm or dispel this concern.

Summary ratings, were I forced, would place Riverside as the one most in need of assistance. From the report, however, it is not clear that much effective assistance could be offered. They want SPC, obviously need it, but might

lack the will to take the actions its information suggests; can anything be done from the outside to improve the climate of the plant, a climate that appears to be bad for both managers and workers?

Trip Report Comments

Autodie is generally thought of as a first-rate supplier.

Two immediate impressions. First, how much of their current business at the automotive manufacturers will change in terms of customers because of OEM outsourcing of products? Do they make dies and molds for production that will remain in the OEMs or for production that is likely to be outsourced as the OEs decrease vertical integration? If there is outsourcing, then their secure reputation may be less of a comparative advantage. They should be aware that as the OEs have outsourced some suppliers have lost business because they couldn't find it. That is, a component is outsourced, and all the constituent parts go with it -- but the purchasing guys for those parts at the OE don't know where the component went, so they can't tell the old suppliers where they should go for the business, and the OE guy who does the component outsourcing can't tell the new supplier where the OE used to get the parts. That changes the nature of the market pretty drastically, and autodie should consider that impact on their current business.

Second, the expected ten-fold increase in plastics has to refer, I assume, to part numbers, not to weight. If that expectation is accurate, autodie needs to consider another threat in addition to the direct threat involved in material substitution. These parts are likely to be small (so the number of them can be large, and the weight change remain within more typical expectations of doubling), and thus may well be candidates for offshore sourcing, according to AIM work. He may be right that the move to plastics doesn't threaten him because he can do plastics too, but the nature

of the competition in plastics may be fundamentally different.

It is interesting that autodie is diversifying. Why are they, and how are they doing? For example, what is their Spear rating for the injectors? This is about 25% of their employment -- does it also represent about 25% of sales, profits, what have you?

There is some possibility of business shrinkage within the confirmed lines. It may be, for example, that the J-car will lose sales to Saturn, and thus require only one or at most two plants. The rosy Saturn sales expectations may downsize like the production plans (volumes, not size of vehicle!), and pushing out from the 88 contract for J may find that Saturn plus J total much less business that J by itself today.

The comment on the direct computer tie-in to the Big Three is interesting, but vague. The report suggest that they can receive design, download to the CNC and produce -- that's how I read "This full implementation of computer aided manufacturing ...." I'm skeptical that that is reality, but it would be useful, I think, to find out exactly how far along they are. They may be a useful model for other Renew clients.

Diversitech is indeed a "good repute" supplier. Looking ahead to a market that we believe will increasingly be a niche vehicle market with increasing use of SMC, one might ask some specific questions about the current situation of Diversitech. They currently are producing multiple products for multiple customers: is there any evidence that they are managing to secure any efficiencies in so doing, or are they running the traditional multiple dedicated processes, with one set of operations for each product x customer cell, with minimal "shared" subsets, or have they begun to identify significant areas where processes for their

multiple products can be combined? Nothing was indicated about possible changes in the manner of sourcing their products -- any likely developments of modular sourcing such that they would supply an intermediary or would themselves be sourcing from suppliers that now feed the OEMs? What is the "modular assembly molding" they will provide which GM model in 1990? Do their liftgates, for example, incorporate hinges, locks, wiring, and, if so, where are they added? If added at OEM, might Diversitech find that they could or will have to assume that responsibility. How is their engineering? The comments suggest that process/manufacturing engineering is quite good, but what about product engineering? Do they do much of this, and, more importantly, will they have to in the future?

This company is about 85% automotive, and that puts them in the upper third of suppliers in terms of dependency on autos. But what are there nonauto products, and how do they fit into their business? Do they represent possible avenues for decreasing dependence, are they fillers, do they represent "leading edge" development for their auto business? These kinds of products may be trivial or very important for future development. I see this as an issue area that should routinely be explored.

It does appear that Diversitech (whether Ionia or Ionia plus Marion) will be a major beneficiary of the APV decision to do less at Framingham than originally planned; but GM80 is canceled. Did the union folk mean something else, or is this a major lack of awareness? I must say that the trip report suggests that the union folk were pretty aware, so might this be a reporting error?

Interesting that management and union define different "major competition," with management worried about nonunion plants and union about two other major suppliers. Is their competitive situation such that all

competitors are potential problems for all products, or do they face more specific competition -- e.g. Budd and Premix for Fierro hood, Eagle-Pitcher for liftgate? My guess is that there are some general competitors, and the current sourcing of Fierro SMC allowed GM to develop multiple sources when SMC was seen as more of a boomer and GM had the typical nervousness about back-ups, especially with new stuff. If capacity exceeds demand (perhaps less likely here than for other suppliers) then suppliers that can efficiently do multiple products (hood, headlight covers, roof, and rear deck) may be winners. How do they look?

Meade commented that most plants try to have some type of strategic planning at plant level. Well, what type do they have in Ionia?

In terms of need for local training, have they explored the possibility of LCC providing training at the plant? My understanding is that community colleges will do this if sufficient enrollment is available. If they want a lot of people trained in computer technologies.

On quality, remember problem of multiple sources of Ford Q awards, and that they are given on a product basis. Therefore, Diversitech possession of Q-1 and competitor's lack doesn't necessarily mean that Ford views Diversitech as "better." More importantly, if Meade seriously believes that they have gone about as far as they can go ("has already addressed the quality demands ... as competitive as they can be."), then they might find themselves rudely surprised over the next few years. The current quality expectations of GM and Ford, according to one well-place supplier, are just the bare minimum for current survival -- the Japanese transplant standards are way higher. If they hope to crack the transplants, or to maintain their current business down the road, they are very ill-advised to see the quality issue as one they've addressed.

On the materials issue, I'll defer to Hervey, but it is my impression that SMC is here to stay, although not currently seen as the boom area people thought it would be a few years ago. The problems are processing time (noted in report) and problems with painting. If these are solved, likely to boom again, since it allows cheaper reskinning and provides manufacturing options thought to increase production efficiency.

This was a nice ample set of trip reports; what happens in terms of further Renew contact? There are questions and issues for follow-up.

Eaton reports suggest a number of items would be useful. Eaton is moving to plants that are 1) nonunion, 2) under 500 employees, and 3) one product line. Why, then, do they care about their innovative relationship with the UAW? What is the size of this plant? Is there an inconsistency in the plant strategy of CNC to accommodate small, and presumably variable, orders and the corporate strategy of dedicated plants? What percent of their sales does each of their current four (?) products represent, and can any of them form the base for a one-product plant? Ford Q ratings can be from a number of internal divisions. Which one gave this plant Q-1, for which product, and is that the most important source of the rating and major product? Plants will boast about their ratings, but you need to be careful that it's clear exactly what is covered and who it is from so its real meaning can be assessed. For example, a Q-1 can be from a Ford division and for a product that accounts for 10% of Ford sales, while a Ford division that accounts for 90% of sales has the plant on termination status. On quality more broadly, how they doing at Nissan? Awards, or does Nissan have an inspector in the plant, have they sent notices, etc. I guess the main point is to remember that plant's can have very different quality in different products,

and be viewed quite differently by the "same" customer. So assessing how a plant is doing on quality needs to go way beyond "we have Q-1 from Ford." Will there be a union trip report? Onwards and upwards!

Riverside raises a number of concerns. The overall flavor suggests a company with lots of problems, one that may be in serious trouble down the road.

Riverside is in an "opportunity" situation. Plastics should be a concern, but in regard, perhaps, to specific products rather than overall levels of business. They could benefit from increased OEM outsourcing, since all the AIM work suggests that trim and moldings are "natural" candidates for sending outside in seeking decreased vertical integration. This sector, in fact, may well find increased levels of business in spite of offshore inroads into domestic vehicle production. Mere existence, however, will not be enough, since transplant operations from Japan are increasing and increasingly likely. And Riverside has some problems that might make them a loser among winners.

Quality is clearly a major problem. Spear 3 is marginal at best, and supplier quality is obviously important. Do they do business with other OEMs? How about nonauto -- is there any? The big question is whether Riverside internally is up to quality standards at a level that suggests that they can reasonably be of much help to their own suppliers. That is compounded by the possibility (unclear from the report) that their suppliers are larger than they are: even first-rate suppliers on the smallish side have problems with the large commodity suppliers. Quality -- and not just implementation of SPC -- ought to be their number 1 priority. If they don't move quickly and broadly they could be easy pickings for their competition.

How long ago was Dumitru plant manager? Real recently, one hopes, because he hasn't been replaced. But if

that is true, then it is very troublesome that he doesn't know all their customers. The reported level of turnover in plant managers could be real bad: why is it so high? People quitting, corporate using it as training ground (do they have other plants; if so, where?), corporate treating this plant as an afterthought? Important to know in assessing how plant might fit into corp's view of the future.

This trip report is rather thin, but alarming. Its thinness may reflect the problems at Riverside. Union report coming?

MEMO TO: AIM CRT AND RENEW STAFF

FROM: DAVID COLE AND DAVID ANDREA

DATE: JANUARY 19, 1987

SUBJECT: **AIM-RENEW: OEM CAPTIVE SUPPLY PLANTS**
(Exclusive of engine, transmission, and stamping)

This memorandum will pull together Renew trip reports and outside information concerning other OEM captive supply plants (those not falling within the categories of forming, engine, or transmission).

RENEW TRIP REPORTS: OEM CAPTIVE SUPPLY PLANTS

(Exclusive of engine, transmission, and stamping)

Renew data covers **GENERAL MOTORS INLAND DIVISION LIVONIA TRIM PLANT** (seat covers and door panels - Renew items 4 and 16), **FORD MOTOR CLIMATE CONTROL** (Plymouth) **DIVISION SHELDON ROAD PLANT** (air conditioning and heating modules, heater controls, and radiator modules - Renew items 14 and 31), and **CHRYSLER CORPORATION DETROIT TRIM PLANT** (soft trim, seats, door panels - Renew items 7 and 32).

MAJOR AIM ISSUES: OEM CAPTIVE SUPPLY PLANTS

(exclusive of engine, transmission, and stamping)

The AIM project has identified five major issues/trends that the State should monitor concerning the health of these facilities:

-Product Considerations: competitors, market capacities, fit to OEMs competitive strategies, level of integration into the overall vehicle

-Modular Assembly: impact of future modular assembly or procurement on the supplier or sourcing location.

-Component Technology: impact of new technology vs. present design-levels of product and manufacturing engineering.

-Material Trends: impact on facilities or products due to material changes

-Cost Structure: cost competitiveness of facility

ISSUE/PLANT MATRIX: OTHER OEM CAPTIVE SUPPLY PLANTS

	GM	FORD MOTOR	CHRYSLER
AIM ISSUE	LIVONIA	SHELDON RD.	DETROIT TRIM
PRODUCT CONSIDER-	MANY CAPABLE INDEPENDENT SUPPLIERS; NOT KEY TO GM OVERALL STRATEGY; LOW PRODUCT INTEGRATION WITH TOTAL VEHICLE	SEEMS SECURE W/IN FORD'S D.P.O. WORLD; LOW VOLUME PRODUCTS MAY BE AT RISK; FORD WILL CLOSE GREEN ISLAND: SECURES ALUMINUM RADIATORS AT PLANT	LARGE INDE-PENDENT SUPPLIER CAPACITY DEPENDENTS; STRATEGY TO RE-DUCE CAPTIVE CAPACITY OF LABOR INTENSIVE PRODUCTS
MODULAR ASSEMBLY	SEATS/DOORS TO LEAD TREND LIKELY TO LOSE CONTRACTS W/EA. NEW PROGRAM; OEMS MAY SOURCE ENTIRE INTER-IOR TO ONE SUPPLIER	MODULAR SOURCING MOST LIKELY: ALL HEAT EXCHANGE COMP. TO ONE SUPPLIER; SHELDON RD COULD PROVIDE ALL THAT'S NEEDED	CHRYSLER BIG ON IN SEQUENCE PRODUCTION/JIT SUPPLY; INDEPENDENT SUPPLIERS CAN EASILY SUPPLY
COMPONENT TECHNOLOGY	FOAM IN PLACE SEAT AND COVER MAKES CUT& SEW SHOPS OBSOLETE	MATERIALS ARE CHANGING BUT NOT BASIC PROD-UCT; WILLING TO PLACE NEW PROD-UCTS AT PLANT	SEAT CUT & SEW OPERA-TIONS OUT-MODED BY FOAM IN PLACE MOLDING
MATERIAL TRENDS	ELASTOMERS FOR FOAM IN PLACE; PLASTICS W/BLOW-MOLD CAPABILITIES FOR SEAT SHELLS	ALUMINUM IS KEY; SHELDON RD HAS CAPABILITIES: RECENTLY CONVERTED FROM COPPER	SAME AS LIVONIA
COST STRUCTURES	HIGH COSTS COMPARED WITH INDEPENDENTS	MODERN PLANT; APPEARS COST COMPETITIVE	HIGH COSTS COMPARED WITH INDEPENDENTS

DISCUSSION: OEM CAPTIVE SUPPLY PLANTS

(Exclusive of engine, transmission, and stamping)

PRODUCT CONSIDERATIONS

The U.S. market for passenger cars and light-trucks has reached maturity, and growth is expected to increase at only 0.8 to 1.0 percent per year as an overall trend---economic cycles, booms and crashes, will impact this trend on a year to year basis. This, coupled with a reduction of the "traditional domestic" market share, is forcing every domestic OEM to reevaluate needed internal manufacturing capabilities. Low factory sales expectations can only be dealt with through a reduction of internal capacity---assembly as well as component manufacturing.

Trim Facilities

One area where internal downsizing will occur is in the seat and interior trim area. It is clear from discussions at high corporate staff levels that each of the Big 3 wants out of this business. Component costs will be the primary consideration in determining the sourcing of seats, door panels, and soft trim (such as arm rests, head rests, storage bags, and sun visors). Considerations of quality, delivery, etc. will also be very important, but, these criteria will be used only after cost considerations determine the "first cut." The products lend themselves to this type of strategy due to

the fact that they are not an integral part of the vehicle and hence are easily spec'ed-out to outside vendors; cause little worry of potential future litigation due to design or manufacturing flaws; and have virtually no interface to vehicle integrity or function of the automotive mechanics; have numerous and capable competitors with ample capacity (Hoover division of Johnson Controls, Lear-Siegler, Magna, Sheller-Globe, etc.); and is well outside the OEMs' declared core business of assembly, distribution, and marketing of automobiles. Independents are also thought to have shorter lead times and, thus, are better to meet shifting customer trends. There is also a great potential for from some lower tier, but large, material suppliers (GE, 3M, du Pont, etc.) to move up stream.

The deck is stacked against GM Livonia and Chrysler Detroit Trim (as well as other Michigan-based trim facilities such as GM Tecumseh and Grand Rapids) Ford Utica and Chesterfield plants are in a slightly better position due to their ability to offer product engineering. On none of the five AIM issue categories listed above does either GM Livonia or Chrysler Detroit Trim have even a slight possibility of being competitive vis-a-vis independent competitors. Even if captive trim facilities were cost and quality competitive, it can be said that the directive from corporate management to exit the trim business leaves little chance for captive plants

to remain under an OEM banner. Livonia losing the 1987 L-Car program (Chevy Baretta and Corsica) is only an omen for the future: all new vehicle program components are being put out for competitive bid; one-by-one programs will be lost to independents as the captive trim plants are not cost competitive and the independents, initially at least, will pull out all the stops to get long-term, single- or dual-sourced contracts for new vehicle programs. Detroit Trim is in a similar position: no replacement for products as the vehicle program ends (L-body) and new programs are being sourced to independents (H-body to Hoover Universal).

Looking at the vehicle programs served, every one of Livonia's major door trim programs is either dropped (G-body), replaced (B-body by GM300?), or experience "major" facelifts (H-, A-, J-,N-, and C-body) by 1991; all of these provide "moments" for decisions to resource. And then the bombshells of 1994-1996 when A and N; C, Z, V, K and E; H and W; and J and L are to be merged together on four platforms. There is limited chance of captive trim plants' survival after this slew of new or reskinned programs comes online. GM would like to get out from underneath the captive plants' fixed and operating costs as soon as possible, but may opt for their slow death, reducing employment as contracts are not renewed. We disagree with the Livonia plant manager's two indicated points of advantage, the embossed door dielectric process

and the ability to handle GM's product proliferation: anyone can duplicate the first and GM is trying to reduce the latter. As was indicated in the Renew report, GM has recently initiated a plan of consolidation: door trim business has been consolidated at Livonia, leaving Grand Rapids with seats covers. It appears that GM can consolidate the four Michigan Inland plants into three, and possibly two, facilities along its road to phasing out of the seat and trim business; the exact timing and method have not been determined.

It could be speculated that Tecumseh would be the first plant to close (smallest plant of the four: product not sourced to independents could be sourced to Livonia).

Detroit Trim's products (cushions, seat backs, arm rests, head rests, and storage bags) are in a similar situation: no replacement for expiring programs (L-body), and new programs using foam in place technology is not being sourced inhouse but is being outsourced (reference to Magna). Chrysler surely does not need internal door trim manufacturing capability for capacity reasons. This product could easily be outsourced to Ajax (a Chrysler Canadian operation which is well respected), Allen Industries, Lear-Siegler, Tricon, etc. The single best indicator of the plant's survival potential will be whether or not the Component Business Operation approves the five year $8 to $9 million capital expenditure plan cited in the Renew report. We believe that Chrysler can

earn a higher return on investment through capital acquisitions of equipment other than sewing machines. And will do so---most likely in non-trim automotive facilities. Chrysler certainly does not need to "keep Detroit Trim in operation to keep its external suppliers' prices down"; that is what it pays its purchasing agents to do, and the trim market competition is fierce.

Sheldon Road Plant

The heat exchanger units produced at the Sheldon Road plant seem to be competitive in terms of quality, cost, and product technology. Some products (such as heater controls) may be at risk as Ford rationalizes its internal and external supply bases. However, it doesn't appear that plant management or labor views new products that could make current products obsolete (electronic vacuum controls) in a fearful manner. It is most likely that any rationalization moves would be initiated by the Climate Control Division in response to overall Diversified Products Operation and Ford corporate goals. As it appears that Sheldon Road is competitive in new product bids, the plant could upgrade its production of cable slide heater controls to the assembly of electronic vacuum controls. A good predictor of the exact competitiveness of this plant will be the outcome of its CT-20 (North American Escort replacement program) bid. As Mazda is heavily involved with this program, it can be

assumed that a CT-20 bid approval means that Sheldon Road cleared many a hurdle. It could also mean the plant impressing the right Mazda officials for Flat Rock sourcing, although the Japanese supply family may be difficult to crack.

Although specific car programs were not listed in the trip report, Sheldon Road is in a good position of winning renewal and replacement programs. Internal competition will lessen with the closing of the Green Island, NY facility. Sheldon Road is an example of a competitive captive supply plant that was given capital to modernize both product and process and not allowed to waste away under some assumed noncompetitiveness of captive parts plants.

In recent meetings with top engineers from Ford Climate Control Division, it was indicated that Sheldon Road is very up-to-date and is seen as doing a very good job on all its programs. There is little risk for its main stream products. OSAT recently conducted a study for the Copper Development Association that is pertinent to both heat exchanger and electronic/electrical component trends. The study forecasts copper usage in electrical and electronic use to increase while deceasing in heat exchangers. The expected net impact will be an increase of copper use per passenger car from 48.5 pounds in 1986 to 51.3 pounds in 1990. The study can be made available to anyone interested.

MODULAR ASSEMBLY

As was noted above, the trim plants are very vulnerable to modular sourcing. Seats, complete with tracks, can be outsourced very easily to suppliers who have complete capabilities (including product design and engineering) to produce such a package. In fact, one of the major deficiencies of the captive plants is their lack of design and product engineering resources. Seat and door trim could be mated and made available in sequence (as to color and option) and shipped JIT to vehicle assembly plants. Complete JIT operation may be a while away, but, suppliers are doing it in seats with some success. Captive trim plants cannot compete in a cost competitive manner to the package of value provided by the independent---captive overhead (fixed assets and management staffing) and labor costs are too great. Old, central, regional facilities may be impacted as decentralized production sourcing of seats and trim occurs.

We don't see modular assembly as such affecting Sheldon Road as much as modular sourcing. Because heat exchangers are placed in a variety of positions under the hood (heater cores in the cowls, radiators behind the grill, intercoolers attached to turbocharger plumbing, etc.) it is unlikely that the heat exchangers themselves will placed in a built-up module and shipped into the assembly plant. What may occur is that Sheldon Road

would get a sole-source contract for all heat exchangers and controls for a particular engine or car model. Sheldon Road would ship product to the engine plant or instrument panel assembly point where its products will be "bundled" into a package that can be shipped in sequence to an assembly plant. In either case, it is most likely that the plant's customer will remain mainly Ford. Additionally, the plant is in line to supply Ford's competitors. This appears to be a growing trend throughout the supply structure.

COMPONENT/MATERIAL TECHNOLOGY

The captive trim plants are being passed by new foam in place technology that involves the reducing labor content (completely eliminating the cut and sew rooms) and vehicle weight. Hoover has been a big winner with its "Uni-Trim" seat getting contracts for Ford Aerostar and GM E-Cars. ICI America claims cycle times for a fully formed seat to be approximately 40 seconds. ICI claims "this advance eliminates the need for huge racetrack curing lines; thus the whole operation can be confined in a small satellite plant adjacent to the main automotive assembly plant." How Livonia and Detroit Trim can compete against these types of process advances is beyond us.

Sheldon Road is in much better shape. Aluminum is the preferred material at Ford for heat exchanger cores and Sheldon Road was the first Ford facility to handle

this material. Ford is fully committed to aluminum and this plant is facilitized with the most modern brazing equipment that is needed to work with the aluminum cores. Capital expenditure levels at the plant indicate that Ford is committed to keeping the plant within the category state-of-the-art. Its program to automate the process an additional 45% clearly indicates that Ford is keeping pace in component, process, and material technology.

GM and Chrysler are less committed to aluminum in heat exchangers, although GM is heading in that direction. Neither has Michigan facilities in heaters, radiators, or intercoolers.

COST STRUCTURE

The process of cut and sew is very labor intensive and thus places the operations at a disadvantage to the non-union (or even non-UAW) operations of its competitors. But labor is not the only single cost out of line, GM's excessive overhead burden of fixed costs and indirect costs is well known among the financial community. Chrysler runs a much leaner operation.

It appears that Ford's operation is cost competitive (based on its success on competitively-bid programs and its belief of competitiveness for new business such as the CT-20). We do not feel that this new business is an unrealistic expectation. Sheldon Road's costs (along

within DPO's Climate Control Division) appear to be lean and in line with the competition's.

PLANT LORE/ANECDOTES: OTHER CAPTIVE SUPPLY PLANTS

A GM Inland Grand Rapids trim industrial engineer, reports a great deal of confusion and uncertainty. Inland feels very vulnerable, with the expectation that "big" capacity reduction decisions are coming soon. Few new product programs are being committed to GM captive suppliers. There is a feeling that outside suppliers are being given better jobs (ie, with more predictable run lengths, more profitable) than inside suppliers, which then get left carrying extra capacity and trying to deal with unstable hard-to-make parts.

AIM/RENEW/STATE ACTION

As it appears that the Sheldon Road plant is fairly secure (except for some employment at risk due to the automation program ---though expanded output may result in no net employment loss), the State should be most concerned with the future of the two captive trim plants. Than being the case, we recommend the following monitoring the following issues:

1. Is Michigan a good candidate for new or expanded employment by the independent seat, door panel, and soft trim operations? Is it realistic the we become a base for (e.g.) expanded Magna employment (however small an increment that might be)?

2. How competitive are Michigan-based suppliers of GM's Livonia and Chrysler's Detroit Trim (Detroit Plastic, Blue Water, Sackner, and Northern Fiber)? Is is viable that they can continue operations at present level by supplying the independent seat and door trim package suppliers, or will they lose business as Livonia and Detroit Trim shrink or close?

3. What are the alternative uses for the human and physical resources of present Michigan-based captive trim plants?

MEMORANDUM

TO: AIM CRT and
RENEW Staff

FROM: Richard P. Hervey

SUBJECT: Engines and Engine Components

DATE: January 19, 1987

1: Introduction

This memorandum is meant to bring together Renew trip reports and AIM research in the area of Engines and Engine Components. Since to date there has only been one Renew visit which falls into this general product area (CPC Bay City) and since other more detailed papers have been and are being written on engine-related issues, this first memorandum may be a bit uneven.

2: Major AIM Issues - Engines and Engine Components

What follows is a crude structuring of what, based on pervious AIM research, appear to be the issues which apply to engines and engine components. Obviously, the more general matters of market conditions, market share of Traditional Domestics, Imports, Transplants, market share of specific firms, assembly plant locations and linkages implied therein, etc. also apply to engine-related plants.

Readers are directed to the AIM I report for a more detailed discussion of item 2.5 and to the AIM II report for detailes on 2.3.

2.1: Future Demand of Different Engines
- ** Impact of Domestic/Import/Transplant Shifts
- ** Baseline Qualitative Trends
- ** Volatility Factors

2.2: Redesign/Rationalization of Current Engine Product Lines
- ** Technological Drivers
- ** Market Drivers
- ** Organizational Drivers
- ** Contemplated Design Trends

2.3: Basic Engine Manufacturing Strategies

** Size/Flexibility of Engine Plants
** Extent and Types of Components to be Made in Engine Plants
** Interlinkings/Competition Among Engine Plants

2.4: Engine-Making Capital Equipment and Tooling Sourcing

2.5: Specific Mechanical Engine Component Design Changes
** Use of Aluminum in Manifolds, Heads and Blocks
** Other New Materials Usage (e.g., Ceramics, Powdered Metal)

2.6: Role of Electronics in Engine Design and Manufacturing

2.7: Basic Sourcing Variables: Rationale for Vertical Integration
** Required Capabilities for Modular Sourcing
** Product or Process Focus
** Technological Volatility
** Administrative/Organizational/Pricing Issues
** JOB Bank Variables

2.8: Increased Engine Part Competition by Foreign Entrants
** Technology-Based
** Cost-Motivated
** Transplant-Linked

3: Renew Plant List - Engines and Engine Components

The following list was derived from what I could find on Confer regarding possible plant visit candidates. The numbers in brackets refer to the "Major AIM Issues" (see above) which I hypothesize apply to these plants. (All plants are affected directly or indirectly by issues 2.1 and 2.2. Also, there must be a spinoff effect on parts plants from engine plants "reactions" to 2.3.)

3.1: Chrysler

Winfield Foundry [2.5, 2.7, 2.8]
Trenton Engine Plant [2.3]
Mound Road Engine Plant [2.3]

3.2: Ford

Dearborn Engine Plant [2.3]
Vulcan Forge Works [2.5, 2.7, 2.8]

3.3: General Motors

CPC
- Bay City [2.5, 2.7, 2.8]
- Flint Engine [2.3]
- Pontiac Engine [2.3]
- Romulus Engine [2.3]

BOC
- Delta Township Plant [2.3]
- Flint Engine #36 [2.3]
- Lansing Engine [2.3]
- Livonia Engine [2.3]

Central Foundry [all 2.5, 2.7, 2.8]
- Pontiac Foundry
- Saginaw Nodular Iron
- Saginaw Grey Iron
- Saginaw Malleable Iron

Other Divisions
- RPD Coopersville Plant 3 [2.5, 2.6, 2.7, 2.8]
- RPD Grand Rapids [2.5, 2.6, 2.7, 2.8]
- NDH Detroit Forge [2.5, 2.7, 2.8]
- AC Spark Plug Div. [2.5, 2.6, 2.7, 2.8]

3.4: Other

Bohn Engine and Foundry [2.5, 2.7, 2.8]
Cross Company [3.3, 3.4]
Eaton Engine Components [2.5, 2.7, 2.8]
Lamb Technicon [3.3, 3.4]
Sealed Power [2.5, 2.7, 2.8]
Simpson Industries [2.5, 2.7, 2.8]
Walbro Corporation [2.5, 2.7, 2.8]

4: Discussion - Engines and Engine Components

4.1: Review of Publicized Engine Product/Sourcing Plans

Attached to this memorandum are two Exhibits. Exhibit A is a summary of clipping headlines from my file (mainly from 1986) which deal with engine product plans, applications, manufacturing locations, etc. Note that these do not deal with specific components of specific engines.

Exhibit B is a summary from Wards Engine Update entitled "World Engines, 1986". It is a compendium of passenger car engines throughout the world. Wards has identified 275 base engines and 560 variants. [A variant is an engine based on a base engine - usually defined by the block - but varied in some way, for example by adding a turbocharger, or changing the compression ratio, etc. To cite one case, there are three variants listed for the GM 3.8 liter V-6 engine built in Flint and Lansing.] Of these, the Big Four Use (don't necessarily build) as follows:

	Base Engines	Variants	Imported Engines
AMC	8	9	4
Chrysler	5	7	2
Ford	8	14	-
G.M.	13	24	1

Two comments are in order on this Ward's data. First, I have tried to exclude engines just for captive imports (which Wards includes). Second, I have not tried to distinguish Mexican engines as imports as they are usually identical to their US/Canada counterparts. (Their production volume does, however, matter and thus is included in the following table.)

Wards in other articles provides the following information on imported engines (in thousands):

	1986MY	1985MY	1984MY	1983MY
Chrysler	538	673	579	NA
Ford	NA	486	383	145
G.M.	NA	681	782	218

NA = Not Available

All of Ford's imported engines and the vast majority of G.M.'s are made in Mexico to U.S. design. At least for these firms, it seems clear that their management wants to design and build engines, although they will reap cost saving and political

benefits (and suffer the "confusion cost") from Mexican production where appropriate. [It is also worth noting that both Ford and G.M. have functionally reorganized their Mexican operations from their Latin American to part of their North American operations in the recent past.]

A quick review of the headlines in Exhibit A allows us to make a few (granted oversimplified) characterizations of each of the automakers in question. For example, Chrysler, with its straightforward engine product line, is considering how to strengthen the larger displacement end of its line. The 2.6 and 3 liter Mitsubishi imports are just a stopgap, especially considering currency shifts. On the other hand, Chrysler wonders whether its own needs justify the investment it would have to make in a truly high tech V-6. The recent concessions at the Trenton Engine Plant probably assure that the next generation of Chrysler engine (3.3 liter) goes there.

An interesting question: will Chrysler try to sell some of the output to another automaker or even joint venture the high tech V-6? This decision may depend on how much internal demand Chrysler sees for this engine (compared to the minimum cost module size) and who else might be in the market for it who wouldn't compete too effectively directly with Chrysler due to having access to the engine without the whole capital outlay. Note that this set of questions could apply to all automakers; Ford is clearly asking them.

Ford is also focussing its attention at the top end of its engine lineup. The discussion of running both V-6 and V-8 engines on the same line is consistent with interviews I had with Ford management about a year ago. There is still a real question whether the cost/benefit of doing so is compatible with capital equipment now available from American (or foreign - now costing much more due to the dollar's drop) machine tool builders. And: where would that plant be located? Is there real substance to the recent rumors of Ford-Nissan negotiations regarding attacking this project jointly?

General Motors, as usual, is another story altogether. There has been a complete "flip-flop" over the course of 1986 from "invest the hell out of everything" to "lets rationalize and refine". Considering the investment in engine plants implied by the earlier strategy, the shift to the latter is not surprising, given G.M.'s current cash flow posture. For example, many of the CPC 3200 engineers are now working on a "Mod 3" 2.8 to 3.2 liter V-6 update for the 1990s ("Mod 2" is just being implemented now). This would allow many (but by no means all) of the concepts developed for 3200 to be tried out at a much lower cost/risk. But the 2.8 is produced at Tonawanda, Canada and Mexico, while the 3200 was a possiblity for Romulus, Pontiac or Bay City.

We can only hope that G.M. is seriously addressing its over-proliferated engine lineup. One key to doing so effectively

will be to merge the CPC and BOC engine groups. I can see no justification (other than pride) for maintaining these separate, and all-too-often competitive, hierarchies. Then engineering effort and capital investment can be more focussed, with the eventual goal of reducing G.M. North American product line to a structure more like Ford's: 8 base engines with about twice that number of variants. At G.M.'s likely 1990s market share, that could be quite a profitable engine product line. (See my comments in the AIM II report for a discussion of the advantages of a rational engine lineup combined with flexible capacity.)

Even if one started rationalizing G.M.'s engine capacity today, it might take 15 years to accomplish a true de-proliferation. (I remember first hearing about the need to de-proliferate G.M. engines in 1969. Engine engineers fought it then as now.) The impact on Michigan is almost certainly negative, since duplicated employment (especially at the staff level) would be eliminated and much of that employment is in Michigan. But the alternative, a overspent, underdisciplined G.M., may be even worse.

Honda's new engine plant in Ohio is worthy of mention as well. Currently, this is little more than a small kit assembly plant. But it seems clear based on this month's announcements that Honda wants to build it into much more, qualitatively and quantitatively (and to add transmission capacity to boot). Are Michigan engine parts suppliers going to get their fair share (and more) of this potential business? Is there anything state government can do to assist in this area? Especially if we feel that Japanese engine plants in North America are likely to be more common in the 1990s, it might be worth spending more time addressing this issue, including direct discussions with Honda where, to date, U of M researchers have been most welcome.

4.2: The Bay City Parts Plant as a Prototype

In many respects, the CPC Bay City plant is an anomaly. It is the last of the old Chevrolet parts plants to remain within a car group; the others have been transferred to one of the component divisions, mainly within the Mechanical Components Group. Why was Bay City retained by CPC? Probably because of the hope of that group's engine manufacturing management of using the camshaft program to demonstrate the viability of a (last gasp?) strategy of centralized engine parts production. It is not by accident that the plant reports through the same chain as the engine plants. At the time the decision had to be made, the camshaft program was at a critical juncture, and it probably was better for the plant (but not necessarily the Corporation) to leave the plant where it reported to the same place as its main customers.

However, in many other respects Bay City provides a good model for investigating the problems and opportunities facing parts plants in general (and within G.M. in particular). It is a glorified job shop, granted one which is increasingly focussed on serving engine and transmission plants parts needs. In that regard, it has the typical job shop confusion (whether captive or independent) of whether it should focus on products or on processes.

This confusion was exemplified in the Renew trip report: in section 2.B.1 (which apparently came from the notes provided by the Union), products and processes were mixed up. Cast iron camshafts, oil pumps, channel plates, aluminum sleeves, steel cam shafts, steel transmission belts, and piston pins - mentioned later on - are products. Automatic screw machines, heat treat, precision grinding and die casting are processes or equipment.

Is there is a long term role for integrated (captive) job shops such as Bay City. This is only partially a question of wage rates or work rules or how well the plant is run. Certainly, there seems to be a fair cooperation between labor and management at Bay City, and good leadership on the part of plant management. The real question is: what does Bay City bring their customers that is better or cheaper than their competitors bring. This is particularly important for new business that the plant is trying to attract.
Bay City management say they perceive their main competitors as "other GM plants and foreign component plants". I would add to that all of the entrepreneurial machine shops and the like, both in Michigan and elsewhere. Carpenter Industries in Flint and environs is a good example of this type of competition (e.g., machining conn rods, work which Bay City could in principle do), especially interesting because it is owned and managed by individuals who were formerly senior G.M. manufacturing management. That is really where they have lost business to, GM of Canada notwithstanding. For example, when they shucked off the spindle business to make room for steel camshafts, the work did not go to another GM plant; it went to a Canadian entrepreneur, Linimar. Certainly in the long term, independents are their major threat. Car groups' purchasing departments essentially have more independence in selecting vendors; this does not normally work to captive plants' advantage. On the other hand, product rationalization might tip the competitive balance towards captives, all other things being equal (which they normally are not).

Bay City should start thinking differently about competition. A good exercise for the plant (if they haven't already done so) and for Renew (if it is practical) is to discover where the work that Bay City shucked to make room for steel camshafts went, and determine the cost impact to the customers.

Looking at camshafts in a bit more detail (but not in as much as will be contained in the Components Paper) might be

instructive beyond the specific issues. Oversimplifying, car engine camshafts fall into one of the following categories:

1. Cast Iron and Machined;
2. Machined from Steel Bar;
3. Closed Die Forged and Machined;
4. Cast Steel and Machined;
5. Composite (powdered metal or cold formed) Lobe and (Hollow) Shaft.

The classical approach, generally used in engines with flat valve lifters is 1 (and Bay City has taken over conventional machining lines from some of the engine plants to continue to supply these). Bay City, to the best of my knowledge uniquely in the world in such quantity, uses 2 for CPC for roller lifter engines. Jernberg, located in Chicage IL (to some extent using Inverson Industries of Wyandotte MI), uses 3 for BOC (3.8 liter V-6 plus Cadillac 4.2 liter V-8). Chrysler appears to be opting for 4 (perhaps using the Winfield foundry, although my information may be out-of-date). Ford is importing composite camshafts from Nippon Piston Ring for their 1.9 liter engine, although currency shifts raise the question of whether that sourcing can be generalized. As I understand it, roller lifters more-or-less exclude the classical approach but that the selection of alternatives 2 through 5 is not especially engine design determined - for now (but see below re. reducing inertial mass). That is, the selection currently is presumably based on cost/value rather than engine performance.

Most observers (including those currently using other manufacturing techniques) seem to feel that some sort of composite design will be a relatively stable camshaft technology (perhaps by the early 1990s) and that the other techniques are really transition technologies, "holding the fort" while the multi-part camshaft technology is refined. Composite camshafts have the advantage of reduced rotating mass (which probably requires engine redesign and development to fully exploit) and elimination of many machining operations. At the present point on the learning curve, composite camshafts probably cost slightly more to produce. And there is relatively little real capacity to use this technique. But this is likely to change. At least there is much investigation and development and increasing production capability. There is even some development in Germany which may even eliminate the need for final lobe grinding.

The Bay City steel camshaft costs a CPC engine plant about $ 20 while the forged and machined approach costs BOC about $ 16 at the same stage of completion. (A composite camshaft might cost

something like $12 eventually -- and if the German development pans out, that would be more finished than the others!) I believe that the differences are largely process-intrinsic, and therefore "new deals" in the Bay City plant would be "fighting technological nature". It is rare that more chips on the floor make sense in the long term.

Since Bay City's core skill seems to be machining, why not network with a forge for the transition technology? Perhaps it's too late: what does Bay City bring the overall system that couldn't be procured less expensively on the open market? Not much, I would argue, unless perhaps social costs are brought into the picture.

To complete this not too bright picture, I see Bay City at risk because, like most job shops, it has no product, process or market development specialty. It is essentially a "make to print" shop. Since these generally survive only by being a low cost producer (in the true sense of the term), I have difficulty seeing Bay City attracting new capital and business on a medium- to long-term basis on strictly economic grounds. (In fact, I doubt that the commitment of capital for steel camshafts would have passed true economic/technological tests.)

5: Prioritization of Future Plant Visits

Some significant plant visitation effort will be required if Renew is really to become effective in the engine effort. Visitations should be made by one or two teams of individuals meant to become Renew's experts in this area. I would suggest beginning with engine plants and then going on to component plants. My own engine plant priority would be:

1 -- Chrysler Trenton (*)
2 -- Ford Dearborn (*)
3 -- BOC Flint or Lansing.

I would suggest asking the management and union at these plants which captive and independent supplier plants to visit. We can then set some sort of priorities in this area. Meanwhile, the following parts plants (from the list in 3.2) seem most interesting:

-- Ford Vulcan Forge (*)
-- Something at Central Foundry Div.
-- NDH Detroit Forge
-- Bohn Engine and Foundry
-- Walbro Corp.

[* Signifies plant visits where, time allowing, I would ask to be included.]

1: General

1.1: Foreign Multivalvers Crowd U.S. Market
Automotive Industries (AI), Oct. 1986

1.2: Powertrains for '87: Thr refined Get Finer
AI, Oct. 1986, p. 68.

1.3: Little Engines that Can
High Technology, June 1986, p12.

1.4: Cheap Gas Into '90s to Boost Bigger Engines
Wards Engine Update (WEU), 4/1/86, p. 5.

1.5: Cheap Oil is Back
Wards Auto World (WAW), April 1986, p. 50.

1.6: Engines '86: Sweeter Yet
AI, Oct. 1985, p. 64.

2: Chrysler

2.1: Mitsu/Chrysler 3 L. V-6 Makes US Debut in Stretched Minivan.
WEU, 12/15/86.

2.2: Chrysler Import Numbers Shift
WEU, 12/15/86.

2.3: Chrysler Eyes Cummins as Engine Source
Wards Automotive Reports (WAR), 12/11/86.

2.4: Chrysler Engine Imports Top 500,000 Mark
WEU, 12/1/86.

2.5: Chrysler V-6 Output Could Hit 800,000 by '90s
WEU, 11/15/86.

2.6: Mitsu-Chrysler V-6s Alter LeBarons
WEU, 11/1/86.

2.7: Chrysler Imports Half-Million Engines in '86
WAR, 10/20/86

2.8: Chrysler Ponders Engine Mfg. Center
AMM, 10/13/86.

2.9: Three Liter V-6 Debuts
Automotive Engineering (AE), Oct. 1986, p. 58.

2.10: Chrysler says about 25% of its Engines are Imported vs. Near 50%
a Few Years Ago and Is Targeting 10-15% Imports by 1990
WAR, 9/15/86.

2.11: Japanese V-6 Units for Chrysler Will Contain Aluminum Parts
American Metal Market/Metalworking News (AMM), 7/21/86.

2.12: Chrysler Shelves Production on New 1.8 L. Engine
WEU, 6/15/86.

2.13: Chrysler's New V-6 for 1990s is 3.3 Liter
WAR, 4/21/86.

2.14: Chrysler Developing Own Front Drive 3.2 L. V-6
WEU, 2/1/86.
2.15: Chrysler V-6 is Based on V-8
Automotive News (AN), 1/20/86, p. 16.
2.16: New Chrysler 3.9 L. V-6 Converted from V-8
WEU, 1/15/86.

3: Ford

3.1: Ford, Nissan Eye V-8 JV
WEU, 12/15/86.
3.2: Ford of Europe Shuns Aluminum for New 2.9 L
WEU, 11/15/86.
3.3: Ford Essex Engine Plant 'Q1'; Gears for Second Line of V-6s
WAR, 11/3/86.
3.4: Ford Weighing Moves to Build Modular Engines
WAR, 10/15/86.
3.5: Ford Eyes 'Factory of the Future'
AMM, 9/15/86.
3.6: Are Yamaha Engines in Ford's Future
AN, 9/15/86.
3.7: Ford Engine and Transmission Imports Near 1.4 Million Annually
WAR, 6/2/86.
3.8: Ford Eyes Multi-Valves, Power Boost
AN, 4/7/86.
3.9: Ford Plan: V-6 and V-8 on Same Line
AN, 4/7/86.
3.10: U.S. Ford to Export Engines
AN, 3/17/86.
3.11: Mazda Cars Made in U.S. Will Mount Ford Engines
Japan Economic Journal (JEJ), 11/9/85.

4: General Motors

4.1: Olds Starts Quad-4 Engine Output
WAR, 12/22/86.
4.2: BOC Spins Off an SOHC from Olds Quad 4
WEU, 12/15/86.
4.3: Saturn Engine is Not Locked In
WEU, 12/15/86.
4.4: V-6s Take More than Half of '86 Olds Engine Installations
WAR, 12/1/86.

4.5: Mexican Plant Expands Work on GM Engines
AN, 11/10/86.

4.6: Olds Aerotech Showcases Quad 4 Possibilities
AI, November 1986.

4.7: CPC Romulus Roars Back from the Dead
AI, November 1986.

4.8: GM Continues Series 3200 Research
WEU, 11/1/86.

4.9: GM's Plans to Upsize Four Engines Could Require $70 Million Tool Spending
AMM, 10/27/86.

4.10: GM Budget Axe Puts CPC's 3.2 L V-6 on Hold
WEU, 10/15/86.

4.11: GM Group Study Could Lead to Quad4 Tooling
AMM, 10/6/86.

4.12: GM Budget Cuts Doom CPC Plans for V-6 Engine
AMM, 10/6/86.

4.13: Pontiac's Iron Duke 4 is a Conversation Piece
AN, 9/29/86.

4.14: Olds 10 Valve 4-Cyl. for '88 Calais
WAR, ???,

4.15: Quad4 Will be Introduced for the 88 MY on All Three N-Cars
WAR, 9/22/86.

4.16: Getrag Shifter, New Engines from GM
WEU, 9/15/86.

4.17: GM Switching Manhattan Engine Plans
WAR, 7/21/86.

4.18: General Motors Doubles Import Powertrain Use Since '83
WAR, 7/14/86.

4.19: GM Plans 2400 V-6s a Day from New Line (Lansing)
WEU, 7/1/86.

4.20: CPC Orders Tooling for Romulus 4.3 L Production
WEU, 7/1/86.

4.21: 5 Liter Application Shifts
WAR, 6/30/86.

4.22: BOC Lansing Adds V-6s
WAR, 6/30/86.

4.23: CPC to Spend $1 Billion at V-6, V-8 Plants
WEU, 5/15/86.

4.24: GM Quad4 Engine Use to Spread by '89
WEU, 5/15/86.

4.25: All GM Engines Heading for Multivavle Design
WEU, 4/15/86.

4.26: GM to Centralize Component Making at Single-Purpose Manufacturing Sites
WEU, 4/1/86.

4.27: GM99 Slates New Cars, Engines, Transmissions
WEU, 4/1/86.

4.28: Trident V-6 Engine Being Developed by GM for 1991 Models
WEU, 4/1/86.

4.29: GM Powers Up With Quad 4, More V-6s
WEU, 3/15/86.

4.30: GM Studies V-Shape Engine Modernization
AMM, 2/24/86.
4.31: GM Plans Series of New Parts-making Plants
AMM, Feb. 24, 1986.
4.32: GM Considering 2d Romulus Tooling Program
AMM, 2/10/86.
4.33: High-Tech 4-Banger by GM May be Made at Pontiac Foundry
WEU, 2/1/86.
4.34: GM Sets Big Output of Redesigned V-6
WEU, 2/1/86.
4.35: GM Will Put Quad4 Engine in 3 Car Lines
AMM, 1/6/86.

5: Honda

5.1: Honda's Anna Plant: Marysville's Sister Debuts!
AI, November 1986, p. 83.
5.2: Joy in 'Land of the Car'
WAW, October 1986.
5.3: Honda Starts Production of Engines in U.S.
JEJ, Oct. 4, 1986.
5.4: Honda Inaugurates Japanese Engine Production in U.S.
WEU, 10/1/86
5.5: Honda Starts Car Engine Output
WAR, 9/29/86.
5.6: Honda Starts Ohio Build of Car Engines
AN, 9/29/86.
5.7: Honda to Start Full Production of Automobile Engines in U.S.
JEJ, 6/21/86.
5.8: 3 L V-8 Engine is Coming from Honda
WEU, 5/15/86.
5.9: Honda to Add 2 L Engines to US Production
5/15/86.

6: Toyota

6.1: Supra Turbo Adds Refinements
WEU, 9/15/86.
6.2: Supercharged MR2 Boasts More Power
WEU, 9/15/86.
6.3: All the Big News is Under the Hood
WEU, 9/15/86.

6.4: Toyota Uses New, Small DOHC Setup
WEU, 9/1/86.

6.5: Three New Engines in Tercel Switch to Transverse Mount
WEU, 6/1/86.

7: Others

7.1: Audi Plans First V-8 for Debut in 18 Months
WEU, 10/1/86.

7.2: '86-1/2 Scirocco Gets 16 Valve Power Boost
WEU, 5/1/86.

7.3: '87 Scirocco to Use VW's First 6-Cyl
WEU, 5/1/86.

World Engines 1986

EXHIBIT B

275 engines, 560 variations catalogued by WEU

World Engines 1986 is a first-time effort by the staff of *Ward's Engine Update* to compile significant specifications covering all passenger-car engines, transmissions and variations produced by major automobile manufacturers in the United States, Japan and Western Europe.

Because of the technical and geographical scope of the project, *WEU* believes *World Engines 1986* to be the most comprehensive compendium of drivetrain specifications yet assembled in a single publication. We welcome your comments and suggestions concerning future annual issues of *World Engines*.

Our goal was to come as close as possible to a complete list of engines from the world's three primary automotive-producing regions. Variations are noted where horsepower ratings change because of fuel-system, valving or changes in the compression ratio — largely when an engine is turbocharged or a block is made to be fueled by either diesel fuel or gasoline. Variations also are noted when an engine installed in a different vehicle makes a significant difference in the horsepower rating.

WEU catalogs 275 separate engines with more than 560 variations. The U.S. offers 41 blocks with 59 variations. Japan has 82 blocks with 259 variations, and Europe offers 152 blocks with 245 variations.

As *WEU* compiled the list, some findings stood out. The Japanese, as is well known, are far ahead of the rest of the world in use of 3- and 4-valve-per-cylinder engine technology. More than 10% of the Japanese engine variations listed have multivalve fueling systems. Not quite 3% of the European engine variations listed carry that distinction and none of the U.S. engines currently have multivalve treatment, although that will change soon with the late-1986 introduction of General Motors Corp.'s Quad-4.

While turbocharging is waning in popularity, it still is offered in about 13% of engine variations offered in both Japan and the U.S. In Europe, the figure is only slightly more than 8%.

Europe leads, however, in offering diesel engines — with about 15% of the variations being either diesel or turbodiesel. In Japan, diesels only make up a little more than 4% of the selection and in the U.S. the two engines offered for 1986 amount to a scant 3% of the number in the list.

In all instances, the name of the vehicle in its home country is listed, although efforts were made to catalog all names that a vehicle carries throughout the world. □

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Legend:

R-2 = 2-rotor Wankel engine; boxer-4 = horizontally opposed 4-cyl.; FI = fuel injection; EFI = electronic fuel-injection; OHV = overhead valves; OHC = overhead cam; SOHC = single overhead cam; DOHC = double overhead cams; carb = 1, 2 or 4 bbl. carburetor; 4v/c = 4 valves per cylinder; 3p/r = 3 ports per rotor; M5 = manual, 5 speed; M4 = manual, 4 speed; A3 = automatic, 3 speed; CVT = continuously variable transmission; 4wd = 4-wheel drive; R = Renault; G = General Motors; M = Mitsubishi; P = Peugeot; S = Suzuki; I = Isuzu, T = Toyota

UNITED STATES & CANADA

Engine size (liters)	Bore/stroke (inches)	Comp. ratio	HP	Fuel system & valving	Drive & transmission	Models
American Motors Corp.						
1.4L/I-4(R)	2.99/3.03	9:1	56	EFI/OHV	front/M4,M5,A3	Alliance, Encore
1.7L/I-4(R)	3.19/3.29	9.5:1	77	EFI/OHC	front/M4,M5,A3	Alliance, Encore
2.1L/I-4(R)	3.39/3.50	21.5:1	85	turbodiesel/OHV	rear-4wd/M4,M5,A3	Cherokee, Wagoneer
2.2L/I-4(R)	3.46/3.50	8.7:1	91	EFI/OHV	front/M5,A3	Sportwagon
2.5L/I-4	3.88/3.19	9.2:1	117	TBI/OHV	rear-4wd/M5,A3	Cherokee, CJ-7, Wagoneer
			84	carb/OHV	4wd/M5,M4	Jeep CJ
2.8L/V-6(G)	3.50/2.99	9.2:1	115	carb/OHV	rear-4wd/M5,M4,A3	Cherokee, Wagoneer, Jeep
4.2L/I-6	3.75/3.89	9.2:1	112	carb/OHV	4wd/M5,M4,A3	CJ-7, Grand Wagoneer, Eagle
5.9L/V-8	4.08/3.44	8.25:1	144	carb/OHV	4wd/M4,A3	Grand Wagoneer
Chrysler Corp.						
1.5L/I-4(M)	2.97/3.23	9.4:1	68	carb/OHC	front/M5,M4,A3	Colt
1.6L/I-4(M)	3.03/3.39	7.6:1	102	turbo/OHC	front/M5,A3	Colt Turbo
1.6L/I-4(P)	3.17/3.07	8.8:1	64	carb/OHV	front/M4	Horizon, Omni, Turismo, Charger
2L/I-4(M)	3.35/3.46	8.5:1	88	carb/OHC	4wd/M5,A3	Colt Vista
2.2L/I-4	3.44/3.62	9.5:1	96	carb/OHC	front/M5,A3	Horizon, Omni, Turismo, Charger
			97	EFI/OHC	front/M5,A3	Reliant, LeBaron, LeBaron GTS, Laser, Aries, Daytona, 600, Lancer
		9:1	95	EFI/OHC	front/M5	Caravan, Voyager
		8.1:1	146	turbo/OHC	front/M5,A3	Caravelle, LeBaron GTS, Limo, New Yorker, LeBaron, Laser, Daytona, Shelby, Omni, 600, Lancer
		9.6:1	110	EFI/OHC	front/M5,A3	Turismo, Omni, Charger
2.5L/I-4	3.44/4.09	9:1	100	EFI/OHC	front/M5,A3	Reliant, Caravelle, LeBaron, New Yorker, Laser, Aries, Daytona, 600, Lancer
2.6L/I-4(M)	3.59/3.86	8.7:1	106	carb/OHC	front/M5,A3	Caravan, Voyager
		7:1	145	turbo/OHC	rear/M5,A4	Conquest
			170	turbo/OHC intercooled	rear/M5,A4	Conquest
5.2L/V-8	3.91/3.31	9:1	140	carb/OHV	front/M4,A3	Gran Fury, Fifth Avenue, Diplomat
Ford Motor Co.						
1.9L/I-4	3.22/3.46	9:1	86	carb/OHC	front/M5,M4,A3	Escort, Lynx, EXP
			108	EFI/OHC	front/M5,A3	Escort, Lynx, EXP
2L/I-4	3.39/3.39	22.7:1	52	diesel/OHC	front/M5	Tempo, Topaz, Escort, Lynx
2.3L/I-4	3.68/3.31	9:1	86	EFI/OHV	front/M5,A3	Tempo, Topaz
			100	EFI/OHC		Tempo, Topaz
	3.78/3.13	9.5:1	88	carb/OHC	rear/M4,A3	Mustang, Capri, LTD, Marquis
		8:1	145	EFI/OHC	rear/M5,A3	Capri, Merkur, Mustang, T-Bird, Cougar
			200	turbo/OHC	rear/M5	Mustang SVO, Cougar XR7, T-Bird
2.5L/I-4	3.68/3.58	9:1	92	EFI/OHV	front/M5,A3	Taurus, Sable
3L/V-6	3.50/3.15	9.3:1	140	EFI/OHV	front/A4	Taurus, Sable
3.8L/V-6	3.81/3.39	8.7:1	120	EFI/OHV	rear/A4,A3	T-Bird, Mustang, Cougar, Capri, LTD, Marquis
5L/V-8	4.00/3.00	8.3:1	150	EFI/OHV	rear/M5,A4	Cougar, Mustang, Capri, Crown Victoria, Grand Marquis, T-Bird, Colony Park Mark VII, Continental, Town Car
		9.2:1	200	EFI/OHV	rear/M5,A4	Mustang GT, Capri, Mark VII
5.8L/V-8	4.00/3.50	8.3:1	180	carb/OHV	rear/A4	Crown Victoria, Grand Marquis, Colony Park

Engine size (liters)	Bore/stroke (inches)	Comp. ratio	HP	Fuel system & valving	Drive & transmission	Models
General Motors Corp.						
1L/I-3(S)	2.91/3.03	9.5:1	48	carb/OHV	front/M5,A3	Sprint
1.5L/I-4(I)	3.03/3.11	9.6:1	70	carb/OHC	front/M5,A3	Spectrum
1.6L/I-4(T)	3.19/3.03	9:1	55	carb/OHV	front/M5,A3	Nova
1.6L/I-4	3.23/2.98	9:1	65	carb/OHC	rear/M5,M4,A3	Chevette, 1000
1.8L/I-4	3.31/3.23	22:1	51	diesel/OHC	rear/M5	Chevette
1.8L/I-4	3.34/3.13	8.8:1	84	EFI/OHC	front/M5,A3	Skyhawk, Firenza, Sunbird
			150	turbo/OHC	front/M4,A3	Skyhawk, Sunbird
2L/I-4	3.50/3.15	9:1	88	EFI/OHV	front/M5,M4,A3	Cavalier, Skyhawk, Cimarron, Firenza
2.5L/I-4	4.00/3.00	9:1	88	EFI/OHV	rear/M5	Camaro, Firebird
	4.00/3.00	9:1	92	EFI/OHV	front/M5,M4,A3	Century, Skylark, Somerset, Celebrity, Calais, Ciera, 6000, Fiero, Grand Am
2.8L/V-6	3.50/3.00	8.9:1	135	EFI/OHV	rear/M5,A4	Camaro, Firebird
		9.0:1	112	carb/OHV	front/A4,A3	Celebrity, Century, 6000, Ciera
		8.5:1	120	EFI/OHV	front/M4,A4,A3	Cavalier, Ciera, Firenza, Cimarron, Celebrity, 6000
	3.50/2.99	8.4:1	140	EFI/OHV	front-rear/M4,A3	Celebrity, 6000, Fiero
3L/V-6	3.80/2.66	9:1	125	EFI/OHV	front/A4,A3	Somerset, Grand Am, Calais, LeSabre, Delta 88, Skylark
3.8L/V-6	3.80/3.40	8:1	110	carb/OHV	rear/A3	Regal, Cutlass Supreme, Bonneville, Grand Prix
		8.5:1	150	EFI/OHV	front/A4	Century, Ciera, LeSabre, Delta 88
			140	EFI/OHV	front/A4	Olds 98, Electra, Riviera, Toronado
		8:1	235	turbo/OHV	rear/A4	Grand National Regal
4.1L/V-8	3.46/3.30	9:1	130	EFI/OHV	front/A4	Coupe deVille, Eldorado, Fleetwood, Sedan DeVille, Seville
4.3L/V-6	4.00/3.48	9.3:1	140	EFI/OHV	rear/A4,A3	Monte Carlo, El Camino, Parisienne, Caprice
5L/V-8	3.73/3.48	9.5:1	165	carb/OHV	rear/M5,A4,A3	Camaro, Firebird, Parisienne, Grand Prix, Bonneville, El Camino, Monte Carlo, Caprice
			190	carb/OHV	rear/M5	Camaro, Firebird, Monte Carlo
			210	EFI/OHV	rear/A4	Camaro, Firebird
	3.80/3.39	8:1	140	carb/OHV	rear/A4,A3	Regal, Estate Wagon, Custom Cruiser, Cutlass Supreme, Fleetwood Brougham
5.7L/V-8	4.00/3.48	9.5:1	230	EFI/OHV	rear/M4,A4	Corvette

JAPAN

Engine size (liters)	Bore/stroke (inches)	Comp. ratio	HP	Fuel system & valving	Drive & transmission	Models
Daihatsu Motor Co. Ltd.						
.55/I-3	2.44/2.38	10:1	34	carb/SOHC	front/M5,A4,A2	Mira, Cuore
			52	turbo/SOHC	front/M5,A2	Mira, Cuore
.926/I-3	2.89/2.87	8:1	76	turbo/SOHC	front/M5	Charade 926
.99/I-3	2.99/2.87	9.5:1	59	carb/SOHC	front/M5,A3	Charade
		8:1	79	turbo	front/M5	Charade
		21.5	38	diesel/SOHC	front/M5	Charade diesel
			49	turbodiesel	front/M5	Charade turbodiesel
1.3/I-4 (Toyota)	2.95/2.87	9.5:1	74	carb/OHV	rear/M5	Charmant
1.45/I-4 (Toyota)	3.05/3.03	9:1	83	carb/SOHC	rear/M5,A4,A3	Charmant

Engine size (liters)	Bore/stroke (inches)	Comp. ratio	HP	Fuel system & valving	Drive & transmission	Models
Honda Motor Co. Ltd.						
.545/I-2	2.83/2.64	9.5:1	31	carb/SOHC	front/M5,A2	Today
1.2/I-4	2.60/3.54	10:1	63	carb/SOHC	front/M5,M4,A3	City
		9:1	61	carb/SOHC	front/M5	City PRO
		7.6:1	110	turbo EFI/SOHC intercooled	front/M5	City Turbo II
1.3/I-4	2.91/3.07	10:1	79	carb/SOHC-3v/c	front/M5,A4	Civic, Ballade, CRX
1.5/I-4	2.91/3.41	9.2:1	90	carb/SOHC-3v/c	front/M5,A4,A3	Civic, Ballade, Shuttle
		8.7:1	100	EFI/SOHC-3v/c	front/M5,A4	Civic, Ballade
			109	EFI/SOHC-3v/c	front/M5,A4	CRX
1.6/I-4	2.95/3.54	9.3:1	118	EFI/DOHC-4v/c	front/M5,A4	Civic, CRX, Integra
			135	EFI/DOHC-3v/c	front/M5,A4	Ballade, CRX
			98	carb/DOHC-3v/c	front/M5,A4	Accord
1.8/I-4	3.15/3.58	9:1	109	carb/SOHC-3v/c	front/M5,M4	Accord
	3.19/3.50	9.4:1	128	carb/DOHC-4v/c	front/M5,A4	Accord
	3.15/3.58	9.4:1	123	carb/SOHC-3v/c	front/M5,A4	Prelude
2.0/I-4	3.19/3.74	9.4:1	158	EFI/DOHC-4v/c	front/M5,A4	Accord, Prelude
2.0/V-6	3.23/2.48	9.2:1	143	EFI/SOHC-4v/c	front/M5,A4	Legend Zi and Gi
2.5/V-6	3.31/2.95	9:1	163	EFI/SOHC-4v/c	front/M5,A4	Legend Xi
Isuzu Motors Ltd.						
1.5/I-4	3.03/3.11	9.8:1	85	carb/SOHC	front/M5,A5,A3	Gemini
1.5/I-4	2.99/3.23	23:1	54	dieselFI/SOHC	front,M5,A3	Gemini diesel
		22:1	69	turbodiesel/SOHC	front/M5,A3	Gemini turbodiesel
1.8/I-4	3.31/3.23	9:1	104	carb/SOHC	front/M5	Aska
2.0/I-4	3.46/3.23	8.8:1	109	carb/SOHC	front/M5,A3	Aska
		9:1	113	elec. carb/SOHC	front/M5	Aska
		8.2:1	148	EFI/turbo	front/M5	Aska
2.0/I-4	3.31/3.54	21:1	65	diesel/SOHC	front/M5	Aska diesel
	3.46/3.23	8.2:1	178	turbo EFI/SOHC	rear/M5,A4	Piazza
	3.43/3.23	8.8:1	118	EFI/SOHC	rear/M5	Piazza
		9:1	133	EFI/DOHC	rear/M5	Piazza
Mazda Motor Corp.						
1.14/R-2		9.4:1	128	carb/3p/r	rear/M5,A4	Cosmo Luce, RX-7
		8.5:1	163	turbo EFI/2p/r	rear/M5,A4	Cosmo Luce
1.3/R-2		9.4:1	158	EFI/3p/r	rear/A4	Cosmo Luce
		8.5:1	183	turbo EFI/3p/r intercooled	rear/M5,A4	RX-7
1.3/I-4	3.03/2.74	9.2:1	73	carb/SOHC	front/M5,M4,A3	Familia
1.5/I-4	3.03/3.15	9:1	84	carb/SOHC	front/M5,A3	Familia
			94	EFI/SOHC	front/M5,A3	Familia
			69	carb/SOHC	4wd/M5	Familia 4wd
		8.2:1	113	turbo EFI/SOHC	front/M5	Familia cabrio
1.6/I-4	3.07/3.29	7.9:1	138	turbo EFI/DOHC-4v/c	4wd/M5	Familia 4wd
	3.19/3.03	8.6:1	89	carb/SOHC	front/M5,M4,A3	Capella
1.8/I-4	3.39/3.03	8.6:1	94	carb/SOHC	front/M5,A3	Capella
			99	EFI/SOHC	front/M5,A4	Capella
2.0/I-4	3.39/3.39	7.8:1	143	turbo EFI/SOHC intercooled	front/M5,A4	Capella
		22.7:1	71	diesel/SOHC	front/M5,A3	Capella diesel
		8.6:1	109	carb/SOHC	rear/M5,A3	Cosmo Luce
			118	EFI/SOHC	rear/M5,A4	Cosmo Luce
2.2/I-4	3.50/3.50	22:1	69	diesel/OHV	rear/M5	Cosmo Luce
Mitsubishi Motors Corp.						
.55/I-2	2.76/2.80	9:1	43	carb turbo/SOHC	front/M5	Minica
1.3/I-4	2.80/3.23	9.7:1	66	elec.carb/SOHC	front/M4,A3	Mirage

Engine size (liters)	Bore/stroke (inches)	Comp. ratio	HP	Fuel system & valving	Drive & transmission	Models
1.4/I-4	2.97/3.23	9.4:1	72	elec.carb/SOHC	front/M5,A3	Mirage
	2.91/3.23	9:1	79	carb/SOHC	rear/M5,A3	Lancer
1.6/I-4	3.03/3.39	8.5:1	85	carb/SOHC	rear/M5,A3	Lancer
		7.6:1	104	turbo EFI/SOHC	front/M5	Mirage
		8.5:1	89	carb/SOHC	front/M5	Chariot
		9:1	78	elec.carb/SOHC	front/M5,M4,A3	Sigma
1.8/I-4	3.17/3.39	9:1	84	elec.carb/SOHC	front/M5,A4	Sigma
	3.17/3.46	8.8:1	93	EFI/SOHC	front/M5,A4	Sigma
		21.5:1	78	diesel/SOHC intercooled	front/M5,A4	Sigma diesel
		21.5:1	60	diesel/SOHC	front/M5	Mirage diesel
		7.5:1	133	turbo EFI/SOHC	rear/M5,A3	Lancer
			159	intercooled	rear/M5	Lancer
		8.5:1	99	carb/SOHC	front/M5,A3	Chariot
2.0/I-4	3.35/3.46	8.5:1	99	EFI/SOHC	front/M5,A4	Sigma
		7.5:1	123	turbo EFI/SOHC	front/M5,A4	Sigma
			200	intercooled-3v/c	front/M5	Sigma
			175	turbo/SOHC intercooled	rear/M5,A4	Starion
2.6/I-4	3.59/3.86	8.2:1	118	carb/SOHC	rear/A3	Debonair
		7:1	145	turbo/OHC	rear/M5,A4	Starion
Nissan Motor Co. Ltd.						
1.0/I-4	2.68/2.68	9.5:1	56	carb/SOHC	front/M5,M4,A3	March
		8:1	84	EFI/SOHC/turbo	front/M5,A3	March
1.3/I-4	2.99/2.76	9:1	67	carb/SOHC	front/M4,A3	Pulsar, Sunny
1.5/I-4	2.99/3.23	9:1	72	carb/SOHC	front/M5,A3	Pulsar, Sunny
			81	EFI/SOHC	front/M5,A4	Pulsar, Sunny
		8:1	99	EFI/SOHC/turbo	front/M5,A4	Pulsar, Sunny
1.6/I-4	3.07/3.29	10:1	118	EFI/SOHC	front/M5	Pulsar
		9:1	89	carb/SOHC	front/M5,A3	Bluebird, Auster
1.7/I-4	3.15/3.29	22.2:1	54	diesel/SOHC	front/M5,A3	Pulsar, Sunny
1.8/I-4	3.27/3.29	8.8:1	99	carb/SOHC	front-rear/M5,A4	Bluebird, Auster, Silvia
			113	EFI/SOHC	front/M5,A4	Bluebird
			104	EFI/SOHC	front/M5,A4	Auster
		8:1	133	EFI/SOHC/turbo	front-rear/M5,A4	Bluebird, Auster, Silvia
		8:5:1	158	EFI/DOHC/turbo-4v/c	front/M5	Auster
			143	EFI/DOHC/turbo	front-rear/M5,A4	Bluebird, Silvia
2.0/I-4	3.35/3.46	8.5:1	109	carb/SOHC	rear-4wd/M5,M4	Cedric, Gloria, Prairie
	3.35/3.39	21.3:1	66	diesel/SOHC	front/M5,A4	Bluebird
2.0/I-6	3.07/2.74	9.5:1	128	EFI/SOHC	rear/M5,A4	Laurel, Skyline
		8:1	168	EFI/SOHC/turbo	rear/A4	Skyline
		10.2:1	163	EFI/DOHC-4v/c	rear/M5,A4	Skyline
		8.5:1	207	EFI/DOHC/turbo 4v/c/intercooled	rear/M5,A4	Skyline
			178	EFI/DOHC/turbo 4v/c/intercooled	rear/M5	Fairlady, 2000Z
2.0/V-6	3.07/2.74	9.5:1	128	EFI/SOHC	rear/M5,A4	Laurel, Cedric
		8:1	168	EFI/SOHC/turbo	front-rear/M5,A4	Laurel, Bluebird, Maxima
			178	EFI/SOHC/turbo var. nozzle	rear/M5,A4	Cedric
		8.5:1	155	EFI/SOHC/turbo var.nozzle/intercooled	rear/A4	Leopard
		9.5:1		EFI/SOHC	front/M5,A4	Maxima, Bluebird
2.8/I-6	3.35/3.27	21.2:1	99	diesel/SOHC	rear/M5,A4	Skyline, Cedric, Gloria
3.0/V-6	3.43/3.27	9:1	178	EFI/SOHC	rear/A4	Cedric
		8:1	227	EFI/SOHC/turbo	rear/M5,A4	Cedric, 300ZX, Fairlady
		10:1	183	EFI/DOHC-4v/c	rear/A4	Leopard
4.4/V-8	3.62/3.27	8.6:1	197	EFI/OHV	rear/A3	President
Fuji Heavy Industries Ltd. (Subaru)						
.544/I-2	2.99/2.36	9.5:1	31	carb/SOHC	front/M4	Rex
		8.5:1	40	carb/SOHC/turbo	front/M5	Rex

Engine size (liters)	Bore/stroke (inches)	Comp. ratio	HP	Fuel system & valving	Drive & transmission	Models
1.0/I-3	3.07/3.27	9.5:1	56	carb/SOHC	front/M5	Justy LJ
			62	carb/SOHC	front/M5	Justy LE, LS, RS
1.2/I-3	1.07/3.27	9.5:1	73	carb/SOHC-3v/c	front-4wd/M5	Justy RT
1.6/boxer-4	3.62/2.38	9:1	86	carb/OHV/oppsd	front-4wd/ M5,M4,A3	Leone
1.8/boxer-4	3.62/2.64	9:1	84	carb/OHC/oppsd	4wd/M5,A3	Leone, XT Coupe, Sedan, Wagon, Brat, 3-Door
			99	carb/OHC/oppsd	front-4wd/M5	Leone
		9.5:1	90	EFI/OHC/oppsd	front-4wd/M5,A3	Sedan, Wagon, 3-Door
		7.7:1	133	EFI/SOHC/oppsd turbo	front-4wd/M5,A4	Leone, Sedan GL-10, Wagon, Coupe, 3-Door, Alcyone
Suzuki Motor Co.Ltd.						
.543/I-3	2.44/2.36	9.7:1	31	carb/SOHC	front/M5	Fronte, Alta
		8.6:1	40	elec.carb/SOHC turbo	front/M5	Cervo/Fronte
			43	turbo/intercooled	front/M5	Fronte, Alto
1.0/I-3	2.91/3.03	9.5:1	59	carb/SOHC	front/M5,M4,A3	Cultus
		8.3:1	79	elec.carb/SOHC turbo	front/M5	Cultus
1.3/I-4	2.91/3.03	9.5:1	74	elec.carb/SOHC	front/M5,A3	Cultus
		8.9:1	64	EFI/SOHC	rear-4wd/M5	Samurai, Jimny
Toyota Motor Corp.						
1.3/I-4	2.95/2.87	9.5:1	73	carb/OHV	rear/M5	Corolla wagon
	2.87/3.05	9.5:1	80	carb/SOHC-3v/c	front/M4,A3	Starlet
		10:1	75	carb/SOHC-3v/c	front/M5,M4,A3	Starlet, Corolla
		9.5:1	92	EFI/SOHC-3v/c	front/M5	Starlet
		8.2:1	104	EFI/SOHC-3v/c turbo/intercooled	front/M5,A4	Starlet
	2.99/2.81	9.3:1	74	carb/SOHC	front/M4,A3	Tercel
1.5/I-4	3.05/3.03	9.3:1	84	carb/SOHC	front/M6,M5,M4,A3	Tercel
			82	carb/SOHC	rear/M5,M4,A4,A3	Corona, Carina, Corolla
			89	carb/SOHC	front-4wd/M6,M5	Tercel
1.6/I-4	3.19/3.03	9.3:1	99	EFI/SOHC	front/M5,A4,A3	Corolla, Carina
		9.4:1	128	EFI/DOHC-4v/c	front-rear/M5,A4	Corolla, MR2, Celica, Levin, Trueno
1.8/I-4	3.17/3.54	9:1	113	EFI/SOHC	front/M5,A4	Corona, Carina
			104	EFI/SOHC	front/M5,A4	Corona, Camry
			99	carb/SOHC	rear/M5,A4	Corona, Carina, Mark II
	3.27/3.35	23:1	67	diesel/SOHC	front-rear/ M5,M4,A4	Corona wagon, Corolla
		22.5:1	.79	diesel/SOHC turbo	front/M5,A4	Camry
2.0/I-4	3.31/3.54	8.7:1	118	EFI/SOHC	front/M5,A4	Camry
	3.39/3.39	9.2:1	158	EFI/DOHC/4v/c	front/M5,A4	Camry, Celica, Carina
	3.38/3.35	23:1	74	diesel/SOHC	front/M5,A4	Corona, Carina
2.0/I-6	2.95/2.95	9.2:1	104	EFI/SOHC	rear/M4,A4	Soarer, Supra
			128	EFI/SOHC	rear/M5,M4,A4	Mark II, Crown
		9.1	138	EFI/DOHC/4v/c	rear/M5,A4	Soarer, Supra
			158	EFI/DOHC/4v/c	rear/M5,A4	Mark II, Crown
		8.5:1	183	EFI/DOHC/turbo intercooled/4v/c	rear/M5,A4	Soarer, Supra, Mark II
		8:1	160	EFI/DOHC suprchg-4v/c	rear A4	Crown
2.4/I-4	3.62/3.62	22.3:1	82	diesel/SOHC	front/M5,M4,A4	Crown, Mark II, Blizzard
		20:1	95	diesel/SOHC/turbo	rear/M5,A4	Crown, Mark II, Blizzard
		21:1	105	EFI/SOHC turbo diesel	rear/A4	Crown
2.8/I-6	3.23/3.35	8.8:1	156	EFI/DOHC	rear/M5,A4	Cressida Sedan/Wagon
3.0/I-6	3.27/3.58	9.2:1	187	EFI/DOHC	rear/M5,A4	Crown, Supra
		8.4:1	227	EFI/DOHC/turbo/ 4v/c/intercooled	rear/M5,A4	Soarer, Supra
4.0/V-8	3.43/3.31	8.6:1	187	EFI/OHV	rear/A3	Century

FRANCE

P.S.A (Peugeot, Citroen & Talbot)

Engine size (liters)	Bore/stroke (inches)	Comp. ratio	HP	Fuel system & valving	Drive & transmission	Models
.6L/boxer-2	2.91/2.76	8.5:1	29	carb/OHV	front/M4	2CV6, Special, Charleston, Mehari, Acadiane
.7L/boxer-2	3.03/2.70	9.5:1	34	carb/OHV	front/M4	LNA, Visa Club, Visa Enterprise
1.0/I-4	2.76/2.44	9.3:1	45	carb/OHC	front/M4	205
1.1/I-4	2.84/2.72	9.7:1	50	carb/OHC	front/M5,M4	Visa, 104, 205, LNA
	2.91/2.56	9.6:1	55	carb/OHV	front/M5,M4	309
1.1/boxer-4	2.91/2.58	9:1	57	carb/OHV	front/M4	Axel
1.3/I-4	3.07/2.66	8.8:1	63	carb/OHC	front/M4	305
	3.02/2.76	9.5:1	65	carb/OHV	front/M5	309
1.3/boxer-4	3.13/2.58	8.7:1	62	carb/OHV	front/M5,M4	Axel, GSA
1.4/I-4	2.95/3.03	9.3:1	60	carb/OHC	front/M5,M4	Visa, 205, BX
			80	carb/OHC	front/M5,M4	Visa, 205, BX
1.5/I-4	3.07/3.03	9.2:1	71	carb/OHC	front/M4	305
1.6/I-4	3.27/2.87	9.8:1	105	EFI/OHC	front/M5	205, Visa
			115	EFI/OHC	front/M5	205, Visa
		9.4:1	80	carb/OHC	front/M5	305, 309, BX
		9.5:1	94	carb/OHC	front/M5,M4	305, BX
	3.17/3.07	9.4:1	86	carb/OHV	front/M5	Solara
1.8/I-4	3.31/3.19	8.8:1	82	carb/OHV	front/M5	505
	3.15/3.46	23:1	60	diesel/OHC	front/M5,M4	205, 309 Visa
1.9/I-4	3.27/3.46	9.3:1	105	carb/OHC	front/M5	305, 309, BX
			126	carb/OHC	front/M5	305, 309, BX
		23.5:1	65	diesel/OHC	front/M5,M4	BX, 305, Solara, Horizon
2.0/I-4	3.46/3.23	9.2:1	106	carb/	front/M5,M4	CX
	3.46/3.19	8.8:1	109	carb/OHV	front/M5,A4	505
2.1/I-4	3.60/3.21	7:1	200	turbo EFI/OHC	4wd/M5	BX 4 x 4
2.2/I-4	3.46/3.50	9.8:1	130	EFI/OHC	front/M5,A4	505
			115	carb/OHC	front/M5	CX
	3.61/3.21	8:1	180	turbo/OHC	front/M5	505
2.5/I-4	3.66/3.62	8.75:1	138	EFI/OHC	front/M5,A3	CX
		7.75:1	168	turbo EFI/OHC	front/M5	CX
		22.3:1	75	diesel/OHC	front/M5,M4	CX
		21:1	95	turbodiesel/OHC	front/M5	CX
	3.70/3.54	21:1	68	diesel/OHV	front/M5,A4	505
			88	turbodiesel/OHV	front/M5,A4	505
2.8/V-6	3.58/2.87	9.5:1	149	EFI/OHC	front/M5,A4	605

Regie Renault

.845/I-4	2.28/3.15	8:1	29	carb/SOHC	front/M4	4 series
.956/I-4	2.56/2.83	9.2:1	44	carb/SOHC	front/M4	5 Laureate series
1.1/I-4	2.76/2.83	8:1	34	carb/SOHC	front/M4	4 series GTL
		9.2:1	48			9 series, 11 coach series
		9.5:1	45			Laureate Berline
			47			Supercinq series
1.4/I-4	2.99/3.03	8.6:1	110	carb-turbo/SOHC	front/M5	Laureate Turbo
			60	carb/SOHC	front/M4	Supercinq GTL
			72	carb/OHV	front/M5	Supercinq GTS
		7:1	160	turbo EFI/SOHC	rear/M5	5 Turbo Z
		9.5	60	carb/SOHC	front/M4	9 Series, 11 Series
			68	carb/SOHC	front/A3	9 series automatic
		8:1	105	carb-turbo/SOHC	front/M5	11 2+1 Berline
		9.2	64	carb/SOHC	front/M4	18 Type 2 Berline
1.7/I-4	3.19/3.29	10:1	82	carb/SOHC	front/M5	9 series Berline/11 series
1.6/I-4	3.11/3.31	9.3:1	64	carb/SOHC	front/M4	18 Type 2
1.6/I-4	3.07/3.29	22.5:1	55	diesel/SOHC	front/M5	9 series Berline
2.0/I-4	3.46/3.23	9.2:1	104	carb/SOHC	front/M5	18 Type 2, 25 series
			110	carb/SOHC	front/M5,A3	18 Type 2, Espace
2.0/I-4	3.39/3.50	21.5:1	66	diesel/SOHC	front-4wd/M5	18 Type
			88	turbodiesel/SOHC	front/M5	18 Type
2.2/I-4	3.46/3.50	9.9:1	123	FI/SOHC	front/M5	25 Series
2.7/V-6	3.46/2.87	9.2:1	144	FI/OHC	front/M5	25 Series

HOLLAND & SWEDEN

Engine size (liters)	Bore/stroke (inches)	Comp. ratio	HP	Fuel system & valving	Drive & transmission	Models
Saab AB						
2.0L/I-4	3.54/3.07	9.25:1	110	EFI/SOHC	front/M5,A3	900
		10.1:1	125	EFI/DOHC-4v/c	front/M5,A3	900S
		9:1	160	EFI turbo/DOHC intercooled-4v/c	front/M5,A4,A3	900 Turbo, 9000
AB Volvo						
1.4/I-4	2.99/3.03	9.2:1	64	carb/SOHC/	rear/M5,CVT	340
1.6/I-4	3.07/3.29	22.5:1	55	diesel/SOHC	rear/M5	340D
2.0/I-4	3.50/3.15	10:1	102	carb/SOHC	rear/M5	360 Series
			116	EFI/SOHC	rear/M5	
	3.50/3.15	10:1	103	carb/SOHC	rear/M4	240 Series
		7.5:1	155	EFI/SOHC/turbo	rear/M5	240 wagon
		8.5:1	160	EFI/SOHC/turbo	rear/M5	740 turbo
2.3/I-4	3.78/3.15	10.3:1	110	carb/SOHC	rear/M5	760 GL
			129	EFI/SOHC	rear/M5	740 GLE
			182	EFI/SOHC/turbo	rear/M4	760 turbo
2.4/I-6(VW)	3.01/3.40	23:1	82	diesel/SOHC	rear/M4	240 diesel
			109	turbodiesel/SOHC	rear/M4	740 turbodiesel
2.8/V-6	3.58/2.87	9.5:1	156	FI/OHC(2)	rear/A3	760 GLE

ITALY

Engine size (liters)	Bore/stroke (inches)	Comp. ratio	HP	Fuel system & valving	Drive & transmission	Models
Alfa Romeo S.p.A.						
1.4/boxer-4	3.15/2.65	9.7:1	86	carb/OHC	front/M5	Sprint 1.3
		9:1	79	carb/OHC	front/M5	Alfa 33
1.5/boxer-4	3.31/2.65	9.5:1	105	carb/OHC	front-4wd/M5	Sprint Quadrifoglio Verde, Alfa 33
		9:1	95	carb/OHC	front/M5	Sprint Quadrifoglio Oro
1.6/I-4	3.07/3.23	9:1	109	carb/OHC	rear/M5	Nuova Giulietta
1.8/I-4	3.15/3.8	9.5:1	122	carb/OHC	rear/M5	Nuova Guilietta
2.0/I-4	3.31/3.48	9:1	128	carb/OHC	rear/M5	Spider, Quadrifoglio Verde
1.6/I-4	3.07/3.28	9:1	104	carb/OHC	rear/M5	Spider, Alfa 90 Iniezione
1.8/I-4	3.15/3.48	9.5:1	120	carb/OHC	rear/M5	Alfa 90
2.5/V-6	3.46/2.69	9:1	156	carb/OHC	rear/M5	Alfa 9 Quadrifoglio
			160	EFI/OHC	rear/M5	GTV
2.0/V-6	3.5/2.61	9:1	135	carb/OHC	rear/M5	Alfa 6
2.5/I-5	3.46/3.23	22:1	105	turbodiesel/OHC	rear/M5	Alfa 6 TD
2.4/I-4	3.62/3.54	22:1	110	diesel/OHC	rear/M5	Alfa 90
Fiat S.p.A.						
.65/I-2	3.03/2.76	7.5:1	24	carb/OHV	rear/M4	126
		8:1	30	carb/OHV	front/M4	30L Saloon, Panda 30
`0/I-4	2.56/2.68	9:1	45	carb/OHV	front/M5	Panda 45 Super, Uno 45
_/I-4	2.65/2.68	9.2:1	48	carb/OHV	front-4wd/M5,M4	Panda, Uno 45
	2.76/2.56	9.8:1	45	carb/OHV	front/M5,M4	Panda 1000 S, Uno 45
	2.99/2.28	9.3:1	50	carb/SOHC	front/M5	127, 127 Panorama
1.1/I-4	3.15/2.19	9.2:1	58	carb/SOHC	front/M5,M4	Uno 55, Uno 60, Ritmo 60
		9.6:1	55	carb/OHC	front/M5, M4	Ritmo
1.3/I-4	3.40/2.18	9.1:1	70	carb/SOHC	front/M4,M3	Uno 70/Uno SX, Ritmo 70
		9.5:1	65	carb/SOHC	front/M5	Uno 70 SL, Regata 70/ES

Engine size (liters)	Bore/stroke (inches)	Comp. ratio	HP	Fuel system & valving	Drive & transmission	Models
	3.17/2.52	8:1	105	EFI/turbo/SOHC	front/M5	Uno Turbo
	3.00/2.81	20:1	45	diesel/SOHC	front/M5	Uno DS/127 diesel
1.5/I-4	3.40/2.52	9.2:1	82	carb/SOHC	front/M5	Regata 85
		9.5:1	79	carb/SOHC	front/M5,A3	Regata 85 S
1.6/I-4	3.31/2.81	9.3:1	105	carb/DOHC	front/M5	Ritmo 105, Ritmo 100
			100	carb/DOHC	front/M5	Regata 100
		9.7:1	83	carb/SOHC	front/M5	Croma
	3.34/2.81	9.7:1	100	carb/DOHC	front/M5	Regata 100 S
1.7/I-4	3.27/3.12	20.5:1	58	diesel/SOHC	front/M5,M4	Ritmo DCL/Regata D
1.9/I-4	3.39/3.54	21:1	65	diesel/SOHC	front/M5	Regata DS
2.0/I-4	3.31/3.54	9.4:1	130	carb/DOHC	front/M5	Ritmo, Abarth 130 TC
		9:1	122	EFI/DOHC	rear/M5,A3	Argenta 120
		7.5:1	135	carb/DOHC/turbo	rear/M5,A3	Argenta, SX
		8.6:1	80	carb/OHV	4wd/M5	Campagnola
		9.5:1	90	carb/DOHC	front/M5	Croma CHT
		9.8:1	120	EFI/DOHC	front/M5,A3	Croma i.e.
		8:1	155	EFI/turbo/DOHC	front/M5	Croma Turbo
	3.25/3.54	20:1	80	EFI/turbo/DOHC	front/M5	Ritmo Turbo DS
2.4/I-4	3.66/3.54	22:1	72	FI/OHC/diesel	rear/M5	Argenta
			100	turbodiesel/SOHC	front/M5	Croma Turbo D
		23:1	90	turbodiesel/SOHC	front/M5	Argenta turbodiesel
		22:1	72	diesel/SOHC	4wd/M5	Campagnola Diesel
2.5L/I-4	3.66/3.62	22:1	75	diesel/SOHC	front/M5	Croma D

Maserati S.p.A.

3.2L/V-8	3.26/2.90	9.8:1	270	EFI/OHC	rear/M5	328 GTB, 328 GTS, 3.2 Mondial
4.9L/V-12	3.23/3.07	9.6:1	340	EFI/OHC	rear/M5,A3	412
			390	EFI/OHC-4v/c	rear/M5	Testarossa

SPAIN

Engine size (liters)	Bore/stroke (inches)	Comp. ratio	HP	Fuel system & valving	Drive & transmission	Models
SEAT S.A. (excluding engines made by Fiat in Italy)						
1.2/I-4	2.95/2.66	9.5:1	63	carb/SOHC	front/M5,M4	Ibiza, Ronda, Malaga
1.4/I-4	3.15/2.81	9:1	75	carb/SOHC	front/M5	Fura Crono
1.5/I-4	3.27/2.66	10.5:1	85	carb/SOHC	front/M5	Ibiza, Ronda, Malaga
1.7/I-4	3.27/3.12	20:1	55	diesel/SOHC	front/M5	Ibiza, Ronda, Malaga

UNITED KINGDOM

Engine size (liters)	Bore/stroke (inches)	Comp. ratio	HP	Fuel system & valving	Drive & transmission	Models
BL PLC (Austin Rover)						
1.0/I-4	2.54/3.00	10.3:1	40	carb/OHV	front/M4	Mini
		9.6:1	44	carb/OHV	front/M4	Metro
		8.3:1	46	carb/OHV	front/M4	Metro
1.3/I-4	2.54/3.20	9.7:1	62	carb/OHV	front/M4,A4	Metro
	2.78/3.20	9.7:1	68	carb/SOHC	front/M4	Maestro, Montego
1.3/I-4	2.91/3.07	8.7:1	70	carb/SOHC	front/M5	Rover 213
1.6/I-4	3.00/3.45	9.7:1	85	carb/SOHC	front/M4	Maestro, Montego
2.0/I-4	3.33/3.50	9.7:1	102	carb/SOHC	front/M5	Montego
		9:1	100	carb/SOHC	rear/M5	Rover 2000
2.4/I-6	3.19/2.99	9.2:1	118	carb/SOHC	rear/M5,A3	Rover 2300
	3.62/3.54	20.5:1	90	turbodiesel/SOHC	rear/M5,A3	Rover 2400SD
2.6/I-6	3.19/3.31	9.2:1	130	carb/SOHC	rear/M5,A3	Rover 2600
3.5/V-8	3.50/2.80	9.3:1	155	carb/SOHC	rear/M5,A3	Rover 3500 Vanden Plas
			190	EFI/SOHC	rear/M5,A3	Rover 3500 Vitesse

Engine size (liters)	Bore/stroke (inches)	Comp. ratio	HP	Fuel system & valving	Drive & transmission	Models
Ford of Europe (U.K. and W. Germany)						
.96/I-4	2.91/2.19	8.5:1	45	carb/OHV	front/M4	Fiesta
1.1/I-4	2.91/2.56	9.5:1	50	carb/OHV	front/M4	Fiesta
1.3/I-4	3.15/2.54	9.5:1	69	carb/SOHC	front/M4	Fiesta
	3.11/2.60	9:1	60	carb/SOHC	rear/M4	Sierra
1.4/I-4	3.04/2.93	9.5:1	75	carb/SOHC	front/M4	Escort
1.6/I-4	3.15/3.13	9.2:1	73.5	carb/SOHC	rear/M5	Capri Laser
		9.5:1	96	carb/SOHC	front/M5	Fiesta XR2
			105	EFI/SOHC	front/M5	Escort, Orion
		8.3:1	132	turbo EFI/SOHC	front/M5	Escort RS Turbo
	3.11/2.60	9:1	75	carb/SOHC	rear/M4	Sierra
	3.14/3.14	21.5:1	54	diesel/OHC	front/M5	Fiesta, Escort,
	3.20/3.03	9.5:1	75	carb/SOHC	rear/M5,M4	Sierra
1.8/I-4	3.39/3.03	9.5:1	90	carb/SOHC	rear/M5,M4	Sierra, Granada L, GL
2.0/I-4	3.89/3.03	9.2:1	101	carb/SOHC	rear/M5,A4	Capri Laser
			105	carb/SOHC	rear/M5,M4,A4,A3	Sierra, Granada L, GL
2.2/V-6	3.54/2.37	9:1	115	EFI/OHV	rear/M5,A4	Sierra, Granada GL, Ghia
			204	Cosworth head	rear/M5	Sierra
2.5/I-4	3.70/3.54	22.2:1	69	diesel/OHV	rear/M5,A3	Granada L
2.8/V-6	3.66/2.70	9.2:1	150	EFI/OHV	rear-4wd/M5,A4	Sierra, Granada, Ghia, Scorpio
			160	EFI/OHV	rear/M5	Capri Injection Special
Lotus Cars Companies PLC						
2.2/I-4	3.7/3.0	9.4:1	160	carb/DOHC-4v/c	rear/M5	Esprit
		7.5:1	210	+ turbo	rear/M5	Turbo Esprit
WEST GERMANY (Federal Republic)						
BMW AG						
1.8L/I-4	3.50/2.80	9.5:1	90	carb/SOHC	rear/M5,M4,A4	316
			105	EFI/SOHC	rear/M5,M4,A4	318i, 518i
2.0/I-6	3.15/2.60	9.8:1	129	EFI/SOHC	rear/M5,A4	320i, 520i
2.3L/I-4	3.68/3.31	10.5:1	200	EFI/SOHC-4v/c	rear/M5,M3M3	
2.4L/I-6	3.15/3.19	22:1	86	diesel/OHC	rear/M5,A4	324d, 524d
			115	turbodiesel/OHC	rear/M5,A4	524td
2.5L/I-6	3.39/2.82	9.6:1	150	EFI/OHC	rear-4wd/M5,A4	325i, 325iX
2.7L/I-6	3.31/3.19	10.2:1	129	EFI/OHC	rear/M5,A4	525e
2.8L/I-6	3.39/3.15	9.3:1	184	EFI/OHC	rear/M5,A4	528i, 728i, 628csi
3.2L/I-6	3.50/3.39	10:1	197	EFI/OHC	rear/M5,A4	732i
3.4L/I-6	3.62/3.39	10:1	218	EFI/OHC	rear/M5,A4	535i, M535i, 635csi, 735i
		8:1	252	turbo/OHC	rear/A4	745i
3.5/I-6	3.68/3.31	10.5:1	286	EFI/OHC-4v/c	rear/M5	M5, M635csi
Daimler-Benz AG (Mercedes)						
2.0/I-4	3.5/3.16	9.1:1	105	carb/SOHC	rear/M5,M4,A4	190
		9.1:1	109	carb/SOHC	rear/M5,M4,A4	200
			122	EFI/SOHC	rear/M5,M4,A4	190E
	3.43/3.31	22:1	72	diesel/SOHC	rear/M5,M4,A4	190D/200D
2.3/I-4	3.76/3.16	9.1:1	136	EFI/SOHC	rear/M5,M4,A4	230E limo
		10.5:1	185	EFI/DOHC-4v/c	rear/M5	190E limo
2.4/I-4	3.58/3.60	21:1	72	diesel/SOHC	rear/M5,M4,A4	240D
2.5/I-5	3.43/3.31	22:1	90	diesel/SOHC	rear/M5,M4,A4	250D limo
2.5/I-6	3.39/2.85	9:1	140	carb/SOHC	rear/M5,M4,A4	250
2.6/I-6	3.26/3.16	10:1	170	EFI/SOHC	rear/M5,M4,A4	260E limo
2.7/I-6	3.39/3.10	9:1	185	EFI/DOHC	rear/M5,M4,A4	280E/280SE/280SEL/roadster
			156	carb/DOHC	rear/M5,M4,A4	280S
3.0/I-5	3.58/3.64	21:1	88	diesel/SOHC	rear/M5,M4,A4	300D
		21.5:1	125	turbodiesel/SOHC	rear/A4	300 TD
3.0/I-6	3.48/3.16	10:1	190	EFI/SOHC	rear/M5, A4	300E limo
	3.43/3.31	22:1	109	diesel/SOHC	rear/M5,A4	300D limo
3.8/V-8	3.46/3.11	9.4:1	204	EFI/OHC	rear/A4	380SE/380SEL/roadster
5.0/V-8	3.80/3.35	9.2:1	231	EFI/OHC	rear/A4	500SE/500SEL/roadster

Engine size (liters)	Bore/stroke (inches)	Comp. ratio	HP	Fuel system & valving	Drive & transmission	Models
Adam Opel AG (GM)						
1.0/I-4	2.84/2.40	9.2:1	45	carb/OHV	front/M5,M4	Corsa
1.2/I-4	3.06/2.48	9.2:1	55	carb/OHC	front/M5,M4	Corsa, Kadett
1.3/I-4	2.95/2.89	8.2:1	60	carb/OHC	front/M5,M4	Corsa, Kadett, Ascona
				EFI/OHC	front/M5,M4	Kadett
		9.2:1	70	carb/OHC	front/M5,M4	Corsa, Kadett, Ascona
			75	carb/OHC	rear/M5,M4	Manta
1.6I-4	3.15/3.13	9.2:1	90	carb/OHC	front/M5,M4	Ascona, Kadett
		23:1	55	diesel/OHC	front/M5,M4,A3	Ascona, Kadett
1.8/I-4	3.34/3.13	8.2:1	75	carb/OHC	rear/M4	Rekord
		9.2:1	90	carb/OHC	rear/M5,M4,A3	Manta, Rekord
		8.9:1	100	EFI/OHC	front-rear/M5,M4	Kadett, Ascona, Rekord
		9.5:1	115	EFI/OHC	front/M5	Kadett, Ascona
2.0/I-4	3.74/2.75	9:1	100	carb/OHV	rear/M5,M4,A3	Rekord
		9.4:1	110	EFI/OHV	rear/M5,A3	Manta
2.2/I-4	3.74/3.05	9.4:1	115	EFI/OHV	rear/M5,M4,A4,A3	Rekord, Monza, Senator
2.3/I-4	3.62/3.05	23:1	86	turbodiesel/OHC	rear/M5	Senator
2.5/I-6	3.42/2.75	9.2:1	140	EFI/OHV	rear/M5,A4	Monza, Senator
3.0/I-6	3.74/2.75	8.5:1	156	EFI/OHV	rear/M5,A4	Monza, Senator
		9.4:1	180	EFI/OHV	rear/M5,A4	Monza, Senator
Porsche AG						
2.0/I-4	3.41/3.3	29.3:1	125	EFI/SOHC	rear/M5,A3	924
2.5/I-4	3.94/3.11	10.6:1	163	EFI/SOHC	rear/M5,A3	944
		9.5:1	150	EFI/SOHC	rear/M5,A3	944 (U.S.)
3.2/boxer-6	3.74/2.93	10.3:1	231	EFI/OHC	rear/M5	911 Carrera Coupe, Targa, Cabrio
		9.5:1	207	EFI/OHC	rear/M5	911 SC Coupe
3.3/boxer-6	3.82/2.93	7:1	300	turbo/OHC	rear/M4	911 Turbo
4.7/V-8	3.83/3.11	10.4:1	310	EFI/OHC	rear/M5,M4	928 S
5.0/V-8	3.94/3.11	10:1	292	EFI/OHV	rear/M5,A4	928 S (U.S.)
Volkswagen AG						
1.0/I-4	2.95/2.32	9.5:1	40	carb/SOHC	front/M4	Polo series
		11:1	75	carb/SOHC	front/M4	Polo GT
1.3/I-4	2.95/2.83	9.5:1	55	carb/OHC	front/M4	Polo series, Jetta, Golf
		9:1	60	carb/OHC	front/M4	Passat, Santana, Audi 80
1.6/I-4	3.19/3.05	9:1	75	carb/OHC	front/M5,M4,A3	Jetta, Golf, Passat, Santana, Scirocco, Audi 80
	3.01/3.40	23:1	54	diesel/OHC	front/M5,M4,A3	Jetta, Golf, Passat, Santana, Audi 80 Diesel
			70	turbodiesel/OHC	front/M5	Jetta, Golf, Passat, Santana, Audi 80, 100 Turbo Diesel
1.8/I-4	3.19/3.40	10:1	90	carb/OHC	front/M5,A3	Jetta, Carat, Golf, Passat, Santana, Scirocco, Audi 80, Coupe, 100, Avant
		8.7:1	75	carb/OHC	front/M5,M4,A3	Audi 100/Avant
			112	EFI/OHC	front-4wd/M5	Jetta, Carat, Golf, Scirocco, Audi 80
		10:1	139	EFI/DOHC-4v/c	front/M5	Scirocco 16V Coupe
2.0/I-5	3.19/3.05	10:1	115	EFI/OHC	front/M5,A3	Passat, Variant Syncro, Santana, Audi 90/GT Coupe/100/Avant
	3.01/3.40	23:1	70	diesel/OHC	front/M5	Audi 100 Avant
			87	turbodiesel/OHC	front-4wd/M5	Audi 100 Avant Turbo Diesel
2.1L/I-5	3.13/3.40	8.8:1	182	turbo/OHC	4wd/M5,A3	Audi 200 Turbo, 200 Quattro, 200 Avant Quattro
2.2L/I-5	3.19/3.40	10:1	136	EFI/OHC	front/M5,A3	Audi 90/GT Coupe/100/Avant/100 Avant CS Quattro, 90 Quattro, Audi 200
		7:1	200	turbo/OHC	4wd/M5	Quattro Coupe
	3.12/3.40	8:1	305	turbo/DOHC-4v/c	4wd/M5	Quattro Sport

1: Status of Detailed Components Paper

Believe it or not, I still intend to write the paper I have promised on engine components. My current target date for issuing a working draft is during the first quarter of 1987. For those who don't have an outline, it runs something like this:

1. Introduction
2. Implications of Basic Engine Manufacturing Strategy
3. "Core" Components
   - 3.1 Cylinder Blocks
   - 3.2 Cylinder Heads
   - 3.3 Intake Manifolds
   - 3.4 Exhaust Manifolds
4. Moving Parts
   - 4.1 Camshafts and Other Valve Train Parts
   - 4.2 Crankshafts
   - 4.3 Connecting Rods
   - 4.4 Pistons
5. Service Functions
   - 5.1 Water Pumps
   - 5.2 Oil Pumps
   - 5.3 Accessory Drive
6. Engine Electrical
   - 6.1 Starters
   - 6.2 Alternators
   - 6.3 Engine Wiring
   - 6.4 Spark Plugs
7. Fuel System, Engine Controls and Miscellaneous
   - 7.1 Fuel System
   - 7.2 Engine Controls
   - 7.3 Miscellaneous Engine Parts
8. Strategic Thinking for Engine Component Manufacturers
   - 8.1 New Products and Processes
   - 8.2 New Customers and Channels
   - 8.3 New Competitors
9. Implications for Michigan (and Others)

I have clipping files set up for items 2 through 7 above. Renew participants should feel free to visit my offices to thumb through them. Likewise, I remain available for telephone inquiries or meetings on specific engine-related subjects.

2: Research into Vertical Integration Theory, Applied to Engine Parts

I am increasingly convinced of the value of understanding theories of vertical integration (based in economics and corporate strategy) as applied to the automotive industry. Particularly, I feel that we have to understand better what fundamentals have changed to alter the optimum level and form or integration. (Certainly, international competition and the need for technological and marketplace flexibility play an important role in this shift.)

I am reviewing the literature in this field, and over the coming months will try to apply this to the automotive industry. Engine manufacturing will be a good case to examine as there are several vertical stages of manufacture, different horizontal specialization options, etc. I will keep AIM CRT and Renew informed of my fumbling in this area.

MEMO TO: AIM CRT and Renew Staff

FROM: Jerry Jurek

DATE: January 19, 1987

SUBJECT: AIM-Renew: Transmissions and Axles

A "complete" transmission plant has an assembly line with final test facilities. It manufactures all of the components for the transmission except bearings and some of the miscellaneous small parts such as shifter valves sleeves, clutch plates, springs, etc. It will have its own die cast department for housings, extensions, covers, etc. It will have progressive sheet metal presses for stamping the converter components including turbine vanes. The Toledo Plant of Hydramatic and the 700R4 transmission is a textbook example of a "complete" plant.

RENEW TRIP REPORTS: Transmissions and Axles

Renew trip reports to date on these components cover Ford's Livonia Transmission Plant (Renew Items 10 and 26) and Chrysler's Detroit Axle Plant (Renew Items 8 and 28).

MAJOR AIM ISSUES: Transmissions and Axles

The AIM Project in its 1985 FY report identified several driveline component issues as cause for concern for the State's industrial base:

- Product design shift - RWD to FWD and the advent of the 4WD option.
- Material useage - Cast Iron applications shifting to Aluminum
- Market place preference for smaller, sportier vehicles and rising truck share may shift automatic transmission demand to manual transmissions

BIG THREE CAPACITY OVERVIEW

All of the U.S. produced GM captive transmissions and transaxles are manufactured by the GM Hydramatic Division. This Division has Michigan plants located in:

Ypsilanti	- THM 200R4, THM 300, THM 325, THM 400 and THM 125C
Warren	- THM 440T4
Three Rivers	- THM 200C
Constantine	- parts
Flint (Buick)	- converters and THM 125C differential assemblies.

The Muncie, Indiana plant produces manual transmissions and transaxles.

The Windsor, Ontario plant produces THM 125 and 440 differential assemblies.

In addition, GM purchases transmissions from GM Strasbourg - THM 180, and 4- and 5-speed manuals from Borg Warner and Isuzu.

Ford transmissions and transaxles are manufactured at the Livonia plant - AOD and AXOD; at Batavia, Ohio - AXT; and at Sharonville, Ohio - C5 and C6.

Chrysler obtains its automatics from its Kokomo, Indiana plant and its manuals from its New Process Gear Division in Syracuse, New York.

PRODUCT DESIGN SHIFT: RWD-FWD-4WD

Discussion: Transmissions

The continuing shift from RWD passenger cars to FWD and the current interest in 4WD will affect transmission-supplying plants. Michigan has the majority of the Big 3's North American manufacturing capacity for RWD automatic transmissions, and FWD transaxles. Both GM and Ford have significant automatic transmission manufacturing capacity in the State. Except for some castings, and bearings and a few forgings, the majority of the components of these units are manufactured in-house, many in Michigan. The FWD transaxle combines the automatic transmission and the differential assembly from the rear axle meaning increased product content for the transmission plant at the expense of the axle plant. The cost of the automatic driveline for FWD vehicles is approximately $200-$300 more expensive than RWD. This added cost is in the differently designed differential assembly and the front drive universal joints (Rzeppa design). Finally, the added components for FWD transaxles requires the increased usage of lighter weight materials to reduce mass; this affects component suppliers, captive and independent.

The 4WD vehicles being designed at present will complicate further the design of the FWD transaxles. The take-off for the drive shaft for the rear axle and the requirement for some sort of a transfer case will increase the work required in the transaxle plant. Transfer case manufacturing can also be sourced separately from the transaxle creating an opportunity for outside suppliers.

PRODUCT DESIGN SHIFT: RWD-FWD-4WD

Discussion: Axles

The consequences of the shift from RWD to FWD vehicles on the RWD axle plants is nothing short of devastating. Chrysler is the only auto OEM that has put FWD rear trailing axle in their RWD axle plant. GM rationalized their RWD axle capacity and closed a number of their RWD axle plants; Oldsmobile, Pontiac and Buick RWD axle plants and Chevrolet's Warren Axle Plant were consolidated into two Chevrolet axle plants (Detroit and Buffalo) and one Canadian plant (Ste. Catharines). The Oldsmobile and Pontiac axle plants were used for other products, the Chevrolet Warren Axle Plant was transferred to the GM Hydramatic Division. Buick offered to become the GM supplier of FWD rear trailing axles, but cost problems at Buick prevented the full implementation of this plan. Trailing axles are being produced in Ste. Catharines, at Pontiac Met. Fab. at the Truck & Bus Met. Fab. Plant in Flint, as well as the Buick plant there. A tubular design is being installed at Pontiac Met. Fab. and, I believe will become the standardized design for the smaller GM platforms. The larger platforms in GM use an independent design suspension with individual pivot (control) arms at each rear wheel. The center section of this design is incorporated in the platform's underbody. The independent suspension control arms are currently manufactured by GM Canada in Oshawa. (The Warren Plant, the current supplier of the front control arms could not compete with Canada on cost of these rear arms.)

RWD axles used on the few remaining RWD passenger vehicles are a classic case of overcapacity. GM is in the process of further rationalization of its capacity with Buffalo, Detroit and Canada. One of these facilities will be removed from the passenger car manufacturing system. The Buffalo Axle is reported as the most likely candidate for closure. As my response to Item 8 and 28 have indicated, the future of the Chrysler RWD axle facility is also at risk.

Major competitors are Dana, Budd, Kelsey-Hayes and A.O. Smith. Budd and A.O. Smith compete in trailing axles; Kelsey-Hayes on brakes and Dana on drive axles.

The anticipated 4WD vehicle demand may provide an opportunity for existing RWD axle plants. The RWD axles required for the new 4WD passenger vehicles will be of a new design, not an adaptation of existing RWD axles. The present differential assembly could be utilized, but the axle housing will have to be significantly different. A design of independent suspension, like the Corvette, may be required. Because new designs will be needed, because independent axle suppliers like Eaton and Dana are hungry for this business, and because of relatively low volumes (optional vehicle feature) the independents, heavily concentrated in Indiana, Michigan, and Ontario, may have the edge.

MATERIAL USAGE:

Discussion: Transmission and Axles

The design of vehicles utilizing FWD axles would, if nothing were done, shift the weight distribution from the conventional and highly desired 50% - 50% to placing about 60% of the weight over the front axle. This change in weight distribution created the need for material substitution in engine and transaxle components. A shift to aluminum in place of cast iron is taking place for cases, covers, extensions, etc.. The effect on the automatic transaxle has been minimal in that aluminum castings were already prevalent in the RWD automatic transmission, and the knowledge of how to process aluminum parts thus existed in these plants. The manual transmission in the domestic passenger car has been associated with high- performance vehicles. Extensive use of cast iron cases and housings, and of forged steel shafts and gears, have been the trademark of these designs. The substitution of aluminum for cast iron and steel is more prevalent in manual transaxles, a deleterious effect on the iron pouring foundries who supplied the manual transmission plants. These have been independent casters.

MARKETPLACE: Shift from Automatic to Manual Transmission

Discussion:

The preference in the marketplace for smaller, sportier vehicles has the side effect of increasing the penetration of manual transmissions. Since most of these smaller vehicles are FWD, the transaxles used are for the most part, not manufactured in Michigan. GM gets their manuals from its manual transmission plant in Muncie, Indiana, from Warner Gear , (also in Muncie), or from Isuzu in Japan. Chrysler gets theirs from the New Process Gear Division in Syracuse, New York as well as from Borg Warner; and Ford from Mazda and from Batavia, Ohio. The increasing penetration of the manual transmission vehicles will have a negative effect of the State's manufacturing base, unless Michigan wins manual transmission work, e.g., from Mazda, Isuzu, and the Big 3's European plants.

MISCELLANEOUS:

This was my response to Item 10 - Ford Transmission Plant:

"This plant has been plagued with Quality/Cost problems for several years. The AOD transmission came out of the chute with serious quality problems resulting in a number of recalls. They also took part of the "rap" for the shifter level fiasco that caused the transmission to engage and allegedly killed people. Because of their field experience, they became almost obsessed with the idea of quality. A number of good people lost their jobs over this one.

The AXOD transaxle had the misfortune of being process sensitive. Quality problems topped even the AOD. Process Engineering did not do well on this project and quality problems were topped by cost problems. A number of equipment suppliers were "black listed" (saved the Process Engineers' hide) and the top management was replaced several months ago.

Ford staff hired an engineering firm in Troy to do a complete analysis of the GM 440T transaxle to try to determine the shortcomings of this unit. My BOC compatriots advised that this analysis is now complete and Ford is designing an improved '440T ' for replacement of the AXOD.

It appears that the Livonia Plant is gearing itself for the future with reorganized management and a product that will be more manufacturable (less quality sensitive). These two efforts should position them for better cost/quality performance."

The confidence shown about the future by both the union and management at the transmission plant is the result of too narrow a view of the marketplace. There are transmission or transaxles on the drawing boards that will obsolete the product being manufactured at this plant. The introduction of the CVT (Constant Variable Transmission) for small vehicles and the Electronically Controlled Transmission would adversely effect this facility.

This was my response to Item 8 - Chrysler Detroit Axle:

"GM's Detroit Axle Plant on Holbrook Avenue was asked to bid on Chrysler's RWD volume several years ago. Their prices were too high and they offered a conversion of the GM axle 7.5" instead of 7.25", 8.5" vs 8.25" and 9.5" vs 9.25". The price was more competitive but Chrysler declined the requirement of product redesign. (Detroit Axle has reduced their costs internally quite significantly in the last 2 years.)"

CONCLUDING REMARKS:

Additional questions need to be asked at the auto OEM transmission and axle plants as to future product plans. Saturn is purported to be the future auto assembly mode, and it has a contiguous transaxle plant in its plans. It also appears that Ford plans a whole generation of vehicles in the Taurus/Sable type, many sharing the same platform. This will add to the AXOD capacity requirements and reduce AOD needs. Livonia's plan also ignores the effect of any increase in manual transmission penetration.

GM Hydramatic needs to find a product for Three Rivers. It needs to rationalize the non-transmission product at their Warren plant. What is the future of the wheel and control arm business there?

The future of the RWD axle business is dependent upon clearer venicle definition than now exists. Ford seems to have announced a more firm commitment to continued production of mid- and full-sized RWD venicles than either GM or Chrysler. GM's commitment of several year's ago to FWD passenger cars seems to be in place, even if there is a GM 300 successor to the B body. Chrysler seems to be in a "me too" position on RWD, afraid to drop its soon-to-be-at-Kenosha RWD line lest it lack such a product. The FWD/RWD question will affect severely the future of Michigan's GM Detroit Axle, Chrysler's Detroit Axle and Ford's Sterling Axle plants. The rationalization of the RWD axle business in this industry has not yet fully occurred. Even though most light trucks will remain RWD, independents - mostly with non-Michigan operations - may be the survivors.

ATTACHMENT 2

AIM NEWSLETTER
VOLUME TWO

AIM NEWSLETTER
The Auto in Michigan Project
A State of Michigan Program with the
Office for the Study of Automotive Transportation
University of Michigan
Volume 2, Number 1 November 1986

This issue launches the second volume of the *AIM Newsletter*. In addition to our Volume 1 audience of local and State economic developers, we will now also be distributing to plant managers and local union presidents at all Big Three and major independent supplier facilities in Michigan. — DDL

Currencies and Competition: Implications for Michigan Suppliers

AIM Analysis by Michael S. Flynn

The U.S. dollar has weakened dramatically against the Japanese yen since September 1985. Then, it took 240 yen to buy one dollar; in September 1986, it takes fewer than 160 yen to buy one U.S. dollar. At 160, the yen buys 50% more dollars than it did at 240; the dollar buys 33% fewer yen. This change in comparative currency values substantially impacts the competitive situation of the traditional U.S. automotive industry, especially the independent supplier. The weakened dollar strengthens the supplier's overall competitiveness with suppliers in Japan, and also suggests that the form of Japanese competition will change. At the very least, it provides traditional suppliers with a window of opportunity to pursue aggressive strategies.

Yen strengthening from 240 to 160 per dollar means:

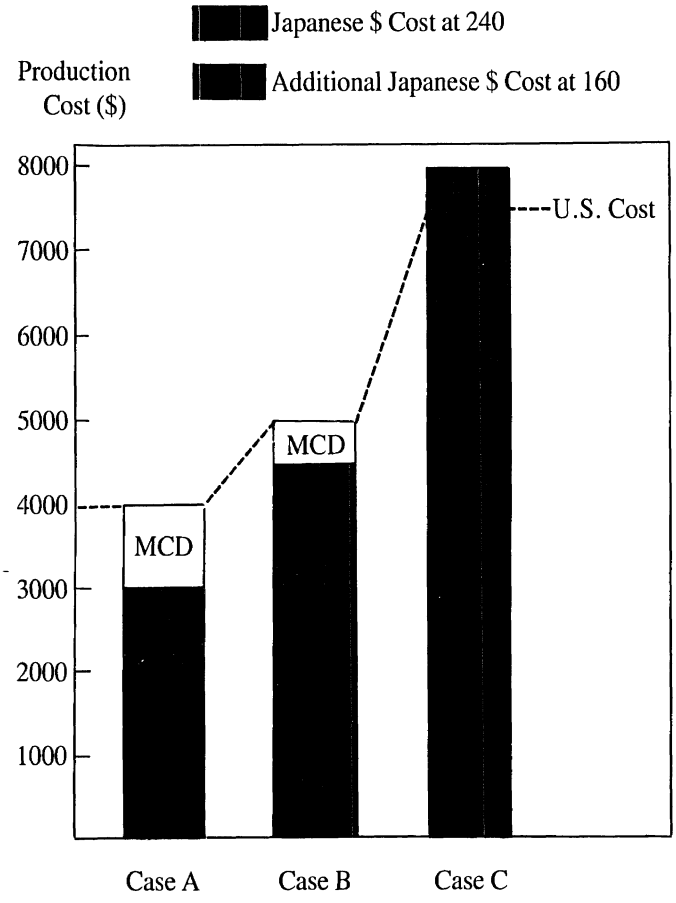
- 50% INCREASE in Cost of Japanese Production for Export to North America
- 33% DECREASE in Costs of Japanese Investment in the U.S.
- Dramatically REDUCED Japanese Cost Advantage
- INCREASED Pressure on Big Three to Outsource to Domestic Suppliers

The U.S.-Japan *manufacturing cost difference*, or MCD, has been an important overall measure of the competitiveness of the U.S. industry since the early 1980s, one that has influenced the industry's definition of its competitive weaknesses and its responses to those weaknesses. The MCD is the difference (in dollars) between the cost of manufacturing a vehicle in Japan and of manufacturing it here. The Japanese have normally followed the pricing of the Big Three, so a large MCD implies high profit levels for the Japanese assemblers, profits simultaneously denied the Big Three and invested in Japanese programs. Nevertheless, the ultimate threat of a price-competitive strategy has made the MCD a major driver of the Big Three's competitive response to the Japanese, including (i) reliance on captive imports to service certain vehicle segments, (ii) increased outsourcing in order to decrease vertical integration, and (iii) more sourcing of parts from offshore. The weakening of the dollar means that the Japanese have experienced a major surge in their manufacturing costs *in dollars, though not in yen* — on the order of 50% — and thus the MCD has narrowed.

Higher Cost to Export to the U.S. . . .

The size of the MCD clearly depends on the exchange rate that is used to convert yen costs to dollars. What is not so clear, judging from some treatments in the popular and trade press, is that the change in the MCD as the yen moves from 240 per dollar to 160 per dollar *depends on the size of the Japanese base costs, not the size of the MCD*. One cannot say what the MCD is at 160 yen given only that it is $2000 at 240 yen. As Figure 1 indicates, an MCD of $2000 at 240 yen becomes, at 160 yen, an MCD of $1000, or $500, or even a manufacturing cost *advantage* of $500, depending on whether Japanese manufacturing costs at 240 are $2000, $3000, or $5000. The fact that the Japanese dollar costs at 240 yen increase by 50% when converted to dollars at 160 yen means that the dollar change in the MCD is different in each example.

Fig. 1: Change in MCD as a function of value of Yen



Who We Are and How We Work

The AIM Project is a team of researchers, policy leaders, consultants, and local economic developers working to understand the concrete implications for Michigan of a changing automotive industry. An eight-person central research team (CRT) whose work is overseen by an advisory board of top-level industry, labor, and local development representatives sets the research agenda. Working in parallel with the CRT, a database development team coordinates an information-gathering effort involving local economic development agencies around the state. The current CRT and core Project staff includes:

Daniel Luria
AIM Project Coordinator
Manager, Industry Affairs and Policy
Industrial Technology Institute

Alan Baum
Director
Auto Industry Research Section
Innovation and Technology Services
Michigan Department of Commerce

David E. Cole
Director
Office for the Study of Automotive Transportation
University of Michigan Transportation Research Institute

Michael S. Flynn
Senior Researcher
Center for Social and Economic Issues
Industrial Technology Institute

Richard P. Hervey
President
Sigma Associates

Bernard "Jerry" Jurek
President
Pyrenees Consulting Corporation
Field Agent
Michigan Technology Deployment Service

Jack Russell
Director
Innovation and Technology Services
Michigan Department of Commerce

Donald N. Smith
Director
Industrial Development Division
Institute of Science and Technology
University of Michigan

David Andrea
Research Assistant

Lisa Hart
Administrative Assistant

J. Downs Herold
Liaison Coordinator, Local Economic Development Agencies

(continued from pg. 1)

The recalculation of the MCD to reflect a change in exchange rates, then, is quite straightforward, but must be based on Japanese costs, not just the difference between Japanese and U.S. costs. If Japanese costs are given as a *percentage* of U.S. costs, the calculation is still quite simple: merely add (or subtract, if the yen is weakening) the appropriate percent to the base percent. If a supplier estimates its Japanese competitor's costs are 70% of its own at 240 yen, then as the yen moves to 160 yen, its competitor's costs rise to 105% of its own. Figure 2 illustrates the impact of the value of the yen on Japanese costs that are estimated to be 40% and 70% respectively of their U.S. competitors' at 240 yen. Notice that the absolute impact is greater on the Japanese costs that are 70% rather than 40% at 240: this is because the base on which the percent operates is larger.

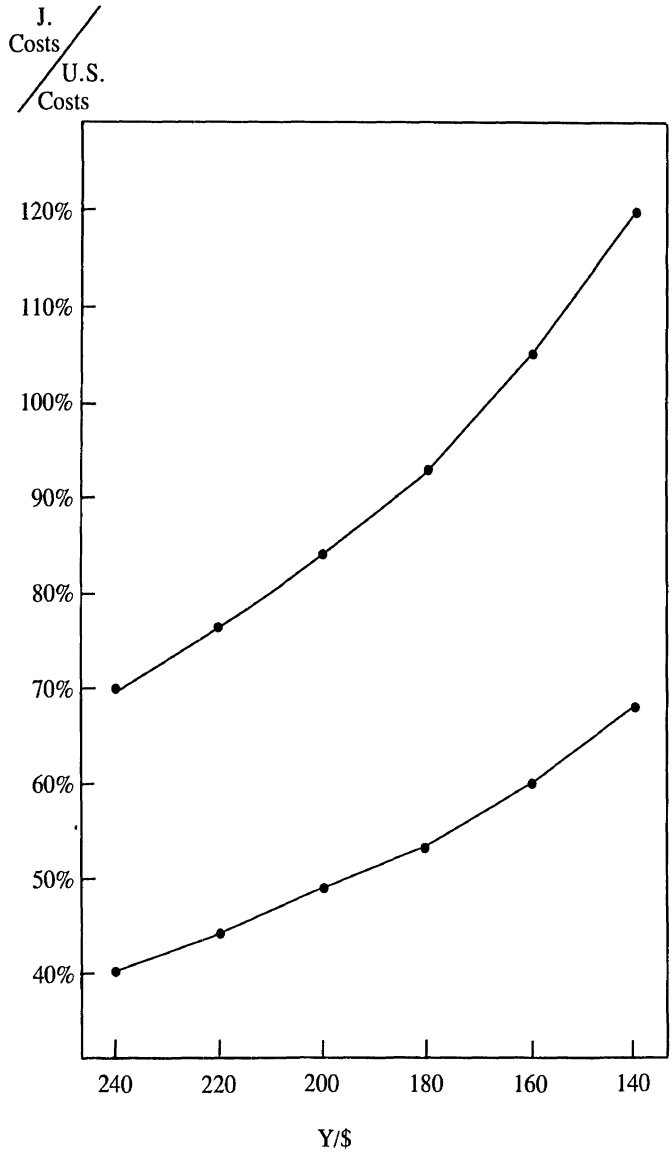
These recalculations of the MCD may appear to imply that U.S. firms are now fully competitive. Unfortunately, that is not the case. The Japanese have been competitively hurt, to be sure, since so much of their income — and even more of their profit — comes from the North American market. These profits have been an important competitive resource, especially since margins available in the fiercely competitive

UPDATED RISK RATINGS OF MICHIGAN CAR AND LIGHT TRUCK ASSEMBLY PLANTS 1986-1992

			Risk factor				
Co.	Plant	Current (1986) Program(s)	Age of Current Program – Future Plans	Attributes of Plant	Perceived Labor Climate	Imports or Out-sourcing	Plant Risk Score
GM	Clark/Fleetwood	B,D	8	8	6	0	22
	Pontiac 1	P	3	2	2	7	14
	Pontiac 8	G	9	6	3	2	20
	Pontiac 5	S10	5	2	4	3	14
	Willow Run	H	0	3	5	2	10
	Buick City	H	0	2	3	2	7
	Lansing	N (2 plants)	2	4	4	6	16
	Orion	C	3	2	7	2	14
	Flint Truck	C/K,K	7-2	4	8	0	17
	Poletown	E/K	0	0	3	2	5
Ford	Wixom	LS, Panther	7-3	3	4	0	11
	Wayne (Truck)	Bronco, F	7-4	3	4	0	11
	Wayne (Car)	Erika	6	2	2	9	18
	Dearborn	Fox	8	5	3	5	21
Chrysler	Jefferson	K,E,CV	8-6	5	2	4	13
	Sterling	H,P	2	2	4	5	13
	Warren	D/W,N	0	1	4	3	8

(A "Plant Risk Score" of 20 or higher indicates grave danger; 15-19 indicates significant risk.)

Fig. 2: Japanese Cost as a Percent of U.S. Costs As Yen Moves from 240 to 140



Japanese home market are slim to nil. All suppliers producing in the United States have benefited from the weakened dollar, and many of them now enjoy cost parity with, or even a cost advantage over, their Japanese competitors, especially when Japanese transportation costs (typically incurred in yen) are included in the comparison.

However, the weakened dollar does not lessen the fundamental quality and efficiency of the Japanese industry, nor does it improve ours. Cost parity may not be enough for suppliers with serious quality disadvantages, or those with fundamental inefficiencies that make their future competitiveness solely dependent on exchange rates staying at current levels. There are also offshore competitors whose home countries' currencies have changed little in relation to the dollar — most notably South Korea, Taiwan, and Brazil. While these competitors often do not have world class quality, they frequently are the low-cost producers.

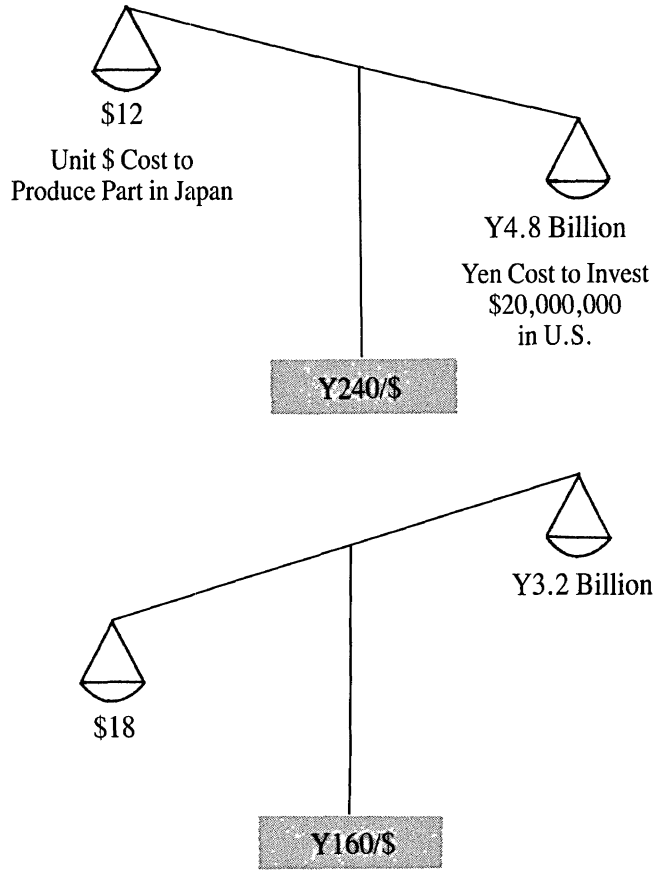
. . . *But Lower Cost to Invest Here*

Nevertheless, it has been the Japanese that pose the most critical threat because of their combined cost and quality advantages, and they have been competitively damaged by the weakened dollar. Still, the weakened dollar is more likely to alter the exact form of the Japanese competitive threat than it is to diminish it seriously.

Specifically, the transplant assembly operations of the Japanese assemblers will be the launch pad for another substantial erosion of traditional domestic market share. Further, they act as a magnet for Japanese suppliers, since they provide a ready market for whatever the suppliers produce here, and the Big Three represent an attractive possibility for expanded business. The establishment of Japanese supplier production facilities here thus represents a real threat to the traditional Big Three business of the North American supplier, and in many cases effectively bars the North American supplier from gaining access to the transplant manufacturers.

Japanese investments in the United States, of course, become cheaper in terms of yen, and therefore we will see an acceleration of Japanese assemblers' and suppliers' investment in U.S. production facilities, especially since the difference in production costs in Japan and the U.S. simultaneously narrows. A Japanese supplier's plant investment yen now buys 50% more plant (in dollars) than it did a year ago, a remarkable savings. A $20 million investment in the United States costs 4.8 billion yen at an exchange rate of 240:1; it costs 3.2 billion yen at a rate of 160:1. But production costs in Japan have "increased" 50% compared to anticipated costs of U.S. production. So *the weakening of the dollar simultaneously lessens the cost advantage of keeping production in Japan and lowers the cost of establishing production here.* A Japanese supplier that considered establishing production facilities here at 240 yen may find it irresistible to do so at 160 yen, as Figure 3 suggests.

Fig. 3: Y:$ Rate Can Tip the Japanese Decision to Supply from Japan or to Produce in the U.S.



Thus the most immediate impact of the yen's strength is likely to be an increase in the already rapid pace of Japanese supplier investments in U.S. production facilities. Nor does it matter much whether the supplier believes the yen will stay at 160; since investment costs are largely one-time capital costs, Japanese suppliers with any intention to move here have a strong incentive to do it now to guard against a weakening of the yen in the future.

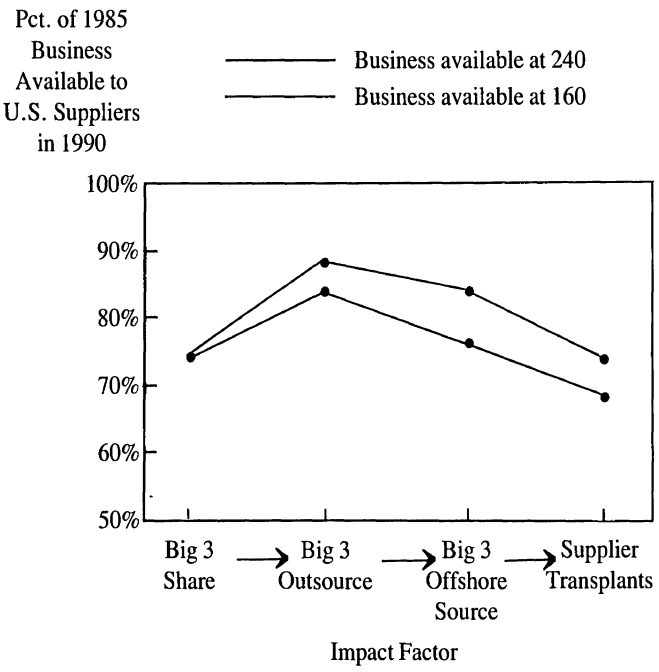
This is grim news for the traditional supplier. The Japanese appear to be quite successful in replicating their quality and efficiency in U.S. plants, and they will have the advantages of greenfield sites, including the lower health, pension, and other labor costs associated with a new plant and workforce.

How Much Supplier Business?

In vol. 1 no. 2 of the *AIM Newsletter*, we detailed some of the implications for Michigan suppliers of industry overcapacity, Big Three outsourcing, and offshore sourcing. Share loss and offshore sourcing suggest a *loss* of Big Three business for suppliers as high as 28%, but possibly held to 12% due to increased Big Three outsourcing, if all that outsourcing goes to domestic suppliers. As is shown in Figure 4, these scenarios can be modified to reflect the impact of the change in the exchange rate and the likely increase in transplant suppliers on the business available to U.S. suppliers in a world in which their traditional Big Three customers' 1990 market is 74% the size it was in 1985.

First, consider *Big Three outsourcing*. Once the automakers decide to go outside for a part or component they have traditionally made themselves, they invariably consider offshore sources as one option. The Japanese, at 240 yen, offered an admirable combination of cost and quality, and they and other sources may well have garnered as much as 50% of that newly available business. At 160 yen, their cost edge is severely eroded, although they are still strong competitors on quality. Other foreign sources, of course, can offer major cost, if not quality, advantages to the Big Three. But at least the competition is split, with the Japanese often having an edge where quality is critical and other nations having an edge where cost is critical. The U.S. supplier, however, may now offer a "balancing" choice (e.g., better-than-Taiwanese quality at lower-than-Japanese cost). If so, the proportion of newly outsourced business that goes offshore could well be held to 25% rather than 50%. If 1990 outsourcing increases 20% compared to 1985, that means that in 1990 suppliers can expect 89% of their 1985 business at 160 yen to the dollar, compared to 84% at 240.

Fig. 4: Business Available to U.S. Suppliers at Two Exchange Rates



Second, some of the business traditionally outsourced by the Big Three will also go *offshore*. At 160 yen, we would expect about half the level of offshore sourcing that would be likely at 240 yen. Drawing on conventional estimates of increased outsourcing, that means 1990 business would fall to 84% of 1985, rather than to 76%.

Third, there *is* a downside to the stronger yen: it is likely to increase the number of *supplier transplants* from Japan in North America. The number likely to establish facilities here by 1990 with the yen trading at 240 would probably suffice to capture about a 10% share of traditional Big Three business, reducing the traditional suppliers' 1990 share to 69% of 1985 levels. Because the stronger yen will attract more transplant supplier capacity for Big Three business, we now expect these suppliers to take about 13% of Big Three business. This reduces the traditional suppliers' available business to 73% of 1985 levels at 160 yen.

The bottom line is grim. Traditional suppliers to the Big Three face a likely loss of about 31% of 1985 business with a yen trading at 240, and still about 27% at 160. Of course, some will prosper and increase business; some parts and components are relatively immune to offshore sourcing, while others are particularly susceptible to such sourcing. Every supplier will have to analyze its own competitive situation and determine appropriate responses. But these *average expectations* suggest that many suppliers will not make it.

What Is to Be Done?

A competitive strategy built only on exchange rates is risky indeed, but a competitive strategy that ignores exchange rates is equally so. Exchange rates are the *context* for more focused and directed competitive strategies, not the fundamentals of such a strategy. There are a number of considerations that Michgian suppliers should factor into their thinking.

First, many suppliers that have primarily faced offshore competition from Japan have secured *more time* to make themselves competitive. It will take the Japanese time to adjust to the new competitive situation, and that provides traditional suppliers time to address the fundamentals of their competitive performance: cost, quality, productivity, and technical development. Now may be the time for suppliers to seek long-term contracts with their customers. Many catch-up and defensive strategies appropriate at 240 yen per dollar should be replaced with offensive share-recapture strategies at 160.

At 160 yen
- TIME available to improve competitive performance
- Importance of ACCESS TO TRANSPLANTS
- JOINT VENTURE benefits and costs
- NATURAL PROTECTION from offshore competitors

Second, *access to transplants* becomes even more critical, both to replace lost Big Three business *and* to block the entry of new, onshore competitors for that Big Three business. Transplant assemblers are expected to increase their onshore sourcing in any case: they may well double that increase at 160 rather than 240 yen to the dollar, moving from 30% to 50% domestic content. It is imperative that traditional suppliers gain access to that business, representing as many as 1.5 million vehicles by 1990, and deny it as a base for expansion to currently offshore competitors.

Third, the general balance of interest in *joint ventures* is altered. Big Three market access and familiarity is worth more to the Japanese partner now, and the cost of providing it higher for the traditional U.S. supplier. More traditional suppliers are now in a position to compete, rather than cooperate (often on junior-partner terms), with their Japanese rivals. Moreover, the transplant assembly operations may be better sources of quality and productivity assistance to traditional suppliers than the would-be joint-venture partner suppliers attracted from Japan by the weakened dollar.

Fourth, companies that were *naturally protected* from offshore threats must be particularly alert to the competitive moves of potential rivals. The lower costs of investment here may attract Japanese firms that supply products that have not been sourced offshore. The basic economic calculations that may have deterred such Japanese firms from establishing production facilities in the past are quite different today than they were a year ago. Suppliers of such protected products may be especially likely to face transplant competition in the near future.

Some Michigan suppliers will do well in the next few years. These will be suppliers that succeed in competition with offshore suppliers, prevent the successful establishment of transplants that are direct competitors, and gain access to transplant manufacturers. They will lose business because of more imported vehicle sales, but those losses can be compensated for by securing additional business due to increased Big Three outsourcing and the thinning of supplier ranks. Profits, if not volumes, can be protected by aggressive cost reduction efforts. How many suppliers will be in this category is impossible to predict, but there will be more at 160 than there would have been at 240. Traditional suppliers that properly appreciate the impact of the weakened dollar on their competitive situation and tailor their strategies accordingly increase their changes of succeeding.

Of course, suppliers cannot assume that the yen will trade at 160 (or less) per dollar forever. Our view is that they should plan for 175, and hold a realistic hope for 140, but be prepared to operate with a move back to 220.

Engineering Outsourcing

AIM Analysis by Michael S. Flynn

Big changes are happening in how the domestic automotive industry accomplishes its design and engineering, both for product and process. The Big Three want to rely on suppliers for more of the engineering work, and less on their own in-house engineering staffs. Which work goes outside, who does it, how the relationship between the manufacturers and their engineering suppliers is managed, and how these changes will affect the traditional structure of automotive production are not yet clear.

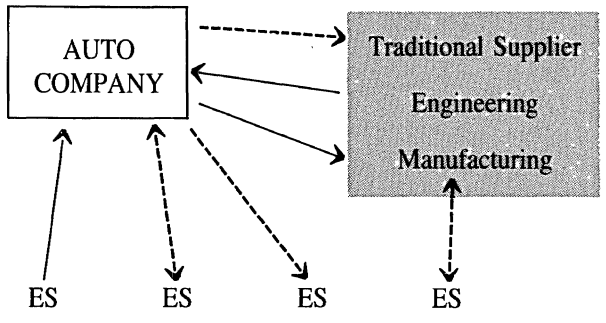
The answers matter mightily to Michigan. The state plays a major role in automotive engineering: most Big Three engineering work is performed here, many of the technically sophisticated suppliers of parts and components are located here, and so are the substantial majority of contract engineering service (ES) firms. That's why the AIM Project has been studying engineering outsourcing, with particular emphasis on the emerging role of the ES industry. We interviewed representatives at each of the Big Three, at seven ES firms, and at fifteen traditional parts suppliers.

Engineering Service Firms: Yesterday...

The ES industry has developed from the old "contract engineering" shops that typically provided a pool of temporary technical manpower for the manufacturers, often working at the manufacturer's location under its direct and close supervision. The length of contract was typically of fixed and limited duration, and the work extremely specific and narrow in scope. Some, but very little, engineering was outsourced on a broader basis, most often in process engineering projects. Employee turnover was extremely high, and the low investment required for entry brought high firm turnover as well.

The manufacturers generally did the vast bulk of design and engineering functions themselves — especially in the product area — and were unwilling to allow control of this vital function to leave their own shops. To be sure, ES firms provided extra personnel, and some traditional suppliers provided extensive design and engineering for parts and components. But the manufacturers insisted on close supervision, detailed reviews and revisions, and final approvals that were far from cursory. (In some cases traditional suppliers' final drawings were copied onto the manufacturer's paper and then released to the *same* supplier for production!) Engineering changes involved complicated processing by the manufacturers. Figure 1 illustrates this traditional division of engineering activity, and also shows the relatively greater use of ES firms by the manufacturers than by traditional suppliers.

Figure 1: 1950-1980 Model of Automotive Engineering



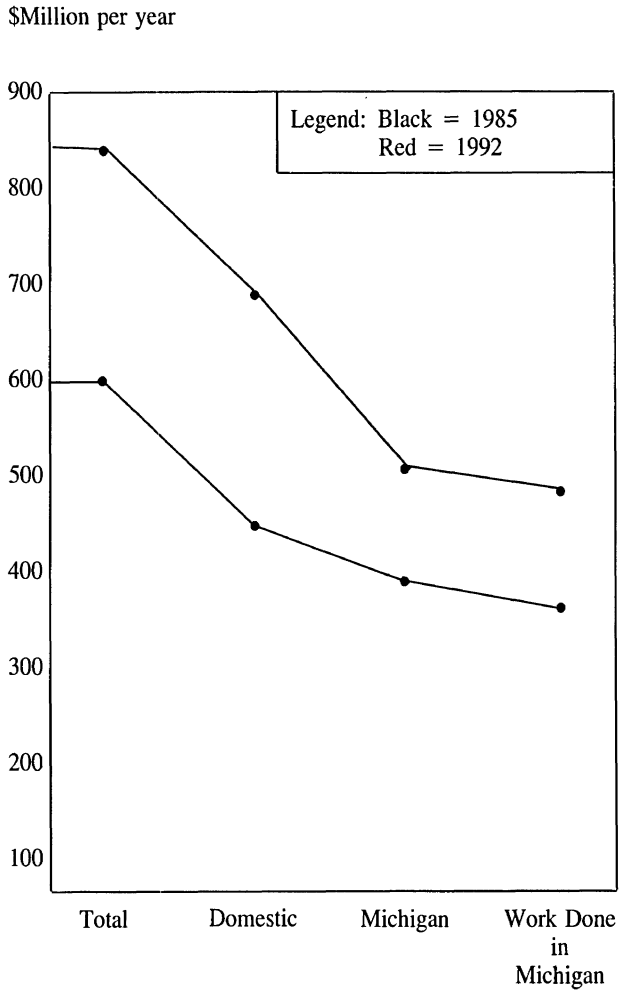
(Solid lines indicate main locus of engineering work and responsibility. Arrows indicate flow of work and/or people. The terms "Auto Company," "OEM," and "Manufacturer" are used interchangeably in these diagrams.)

...*Today*...

The ES industry today comprises an unknown number of firms and practitioners, probably constituting more than 1,000 different "businesses." It has grown and stabilized somewhat since its early days: some larger and more stable firms have emerged, reflecting the higher capital requirements of the computer age; workforce turnover has declined, though it is still quite high by manufacturing standards. The largest two dozen firms may well account for over half of the total employment of Michigan's ES industry, estimated at 15-20,000 jobs, although the bulk of the firms still are small, shifting coalitions of key personnel and supplementary staff.

Figure 2 displays our respondents' estimates of the market for ES services to the Big Three in 1985 (already reflecting substantial growth in the previous five years) and 1992, how much of that total market goes to domestic firms, how much to Michigan firms, and what work those Michigan firms perform here. (These are averages, and probably conservative because of two respondents' particularly low estimates.) The ES industry is large, heavily domestic, and heavily concentrated in Michigan, though some erosion in Michigan's share is expected by 1992.

Figure 2



The ES industry has recently taken on major design responsibility for vehicle bodies and major engineering responsibility for vehicle components. *The manufacturers are now sending out product engineering assignments for vehicles and components rarely outsourced just a decade ago.* Most notably, design houses have been contracted for entire vehicles. The manufacturers are also sending out work in packages, or modules, whose parts used to be separately contracted, sometimes to different ES firms. The manufacturers are also contracting out work on the chassis, transmission, and engine — areas restricted to in-house engineering for the past 25 years. In sum, the manufacturers are relying on the ES firms to perform a broader scope of design and engineering activities than has been the case in the past, although close monitoring of their work remains the pattern.

ES firms represent an alternative source for engineering services to the traditional parts suppliers, and an additional source of engineering services for the manufacturers that is not directly tied to the manufacturing of the product. More of the engineering work is being accomplished in project teams staffed by both the manufacturer and the ES firm (or firms) and, in some cases, the traditional supplier.

The Contract Engineering Service Industry

- About $1 Billion in Annual Sales
- 20,000 Employees
- Development Driven by Need for Lower Cost, More Flexible Overhead, and Market Fragmentation in Automotive Industry
- Future of ES Firms: European Model of Larger, More Highly Capitalized, More Stable Workforce, More Full-service
- ES Industry Will Consolidate and Diversify Services, Locations, and Customers

— from remarks by
Ralph Miller, *President, Modern Engineering*, at
Management Briefing Seminar, *Traverse City, August 1986*

The ES industry today is in the midst of a series of transitions: from a temporary manpower pool to a stable service supplier, from performing marginal to core design and engineering tasks, and from sporadic and cyclical work to more stable growth.

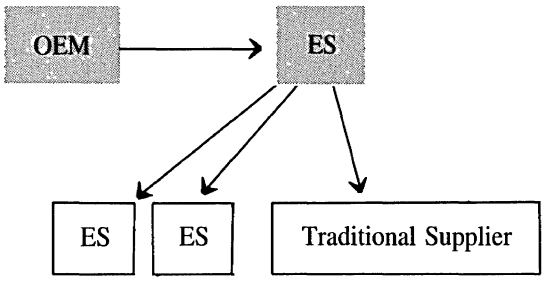
. . . And Tomorrow

The auto industry is placing increased emphasis on the *simultaneous engineering* of the product and the process used to manufacture it. The way the automakers balance this with the pressure to outsource both forms of engineering, often to different sources, and the ways ES firms respond to these pressures will powerfully influence the future role of the ES industry. The automakers prefer to outsource engineering work to the supplier that will manufacture the part or component. How well these traditional suppliers perform, and the competitive/cooperative nature of the relationship between them and the ES firms, will have major impact on tomorrow's role for the ES. The manufacturers are *outsourcing some engineering responsibility*, but still unclear are how much altogether, how much to ES firms, and how much to traditional parts suppliers.

There are three plausible models for how automotive engineering will be accomplished in the future. In reality, of course, all three of these models (and combinations of these models with each other and with the model typical of the 1950-1980 period) will coexist. But which model becomes the most frequent is important, because each implies quite a different role for the ES industry.

Possible Models of Automotive Engineering Futures

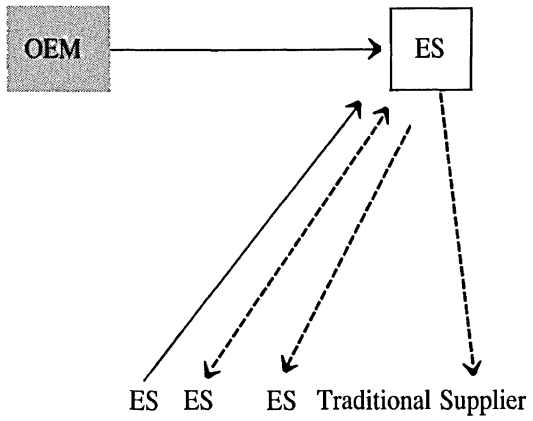
Construction Model



The ES industry might develop into an industry of general contractors and subcontractors, like the *construction industry*. Here, general contractors subcontract virtually *all* the specialty work, and act largely as a coordinator for the client's project. Management service as much as engineering is what the general contractor offers; the real engineering work goes to subcontracting ES firms. *Outsourced engineering responsibility is divided* in this model, with the general contractor ES firm taking responsibility for coordination, and the subcontracting ES firms for the engineering work. Throughout the AIM interviews, the manufacturers' cost for both product and process engineering came through as the real driver behind engineering outsourcing. Cost pressures are likely to shape the ES industry along the lines of many specialized firms competing for limited pieces of the action, rather than permit the concentration of the industry into fewer, more broadly capable players, because in the latter case these firms would face the same pressures that the manufacturers currently experience: coordination overhead costs, penalties of idle capacity, pressure on compensation levels, etc.

Another possibility is that the ES industry might develop along the lines of *legal services*, where large law firms themselves serve most of the needs of the client, with only *occasional farming out* of specialty work. Here, the responsibility for engineering and coordination is transferred to one ES firm. This firm, in turn, depending on the skills required and time pressures on its own staff, would use other ES firms in much the fashion that the manufacturers have in the past. The legal model suggests a level of dependence on the ES firm that the OEMs might find unacceptable, one that might complicate the integration of engineering and manufacturing activities, unless broadly capable (but then probably more expensive) ES firms emerge.

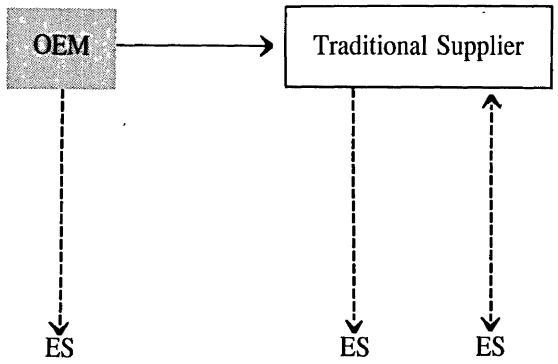
Legal Model



The ES industry may find itself switching clients more than changing the scope and nature of the tasks it performs. In this *alternative model, engineering is outsourced to the traditional supplier* that manufactures the product. In this model, therefore, the ES industry mainly serves suppliers. That will likely block, or at least delay, the evolution of the ES industry in the direction of either the construction or legal models, although eventually such relationships may develop with suppliers. The manufacturers' desire for simultaneous engineering and the product expertise of traditional suppliers are two factors suggesting this model.

Which of these models is more likely to develop? The manufacturers and traditional suppliers think that outsourcing engineering to traditional suppliers is the preferred strategy. The ES firms also recognize the advantages that this pattern provides the manufacturers. The reliance of the manufacturer upon ES firms, then, may depend on the performance of traditional suppliers: direct work with ES firms may be a second choice for engineering outsourcing. If traditional suppliers perform well, the ES sector may change not so much in the type and

Alternative Model



level of service it provides as in the primary customer base it serves. As for the construction versus the legal model, two manufacturers and four ES firms AIM interviewed think the construction model is likely, while the other manufacturer and three ES firms anticipate something closer to the legal model. However, both of the manufacturers and one of the four ES firms that lean toward the construction model believe that the manufacturer in fact will continue to act as its own general contractor. That suggests that the *volume* of work for the ES industry will increase substantially, but that its role may not change as significantly as some are predicting.

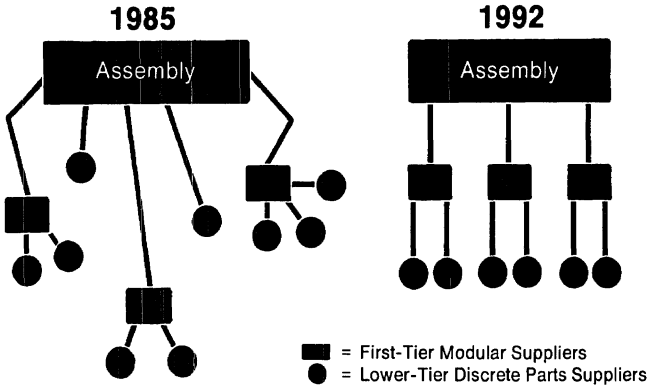
Implications for Michigan Suppliers

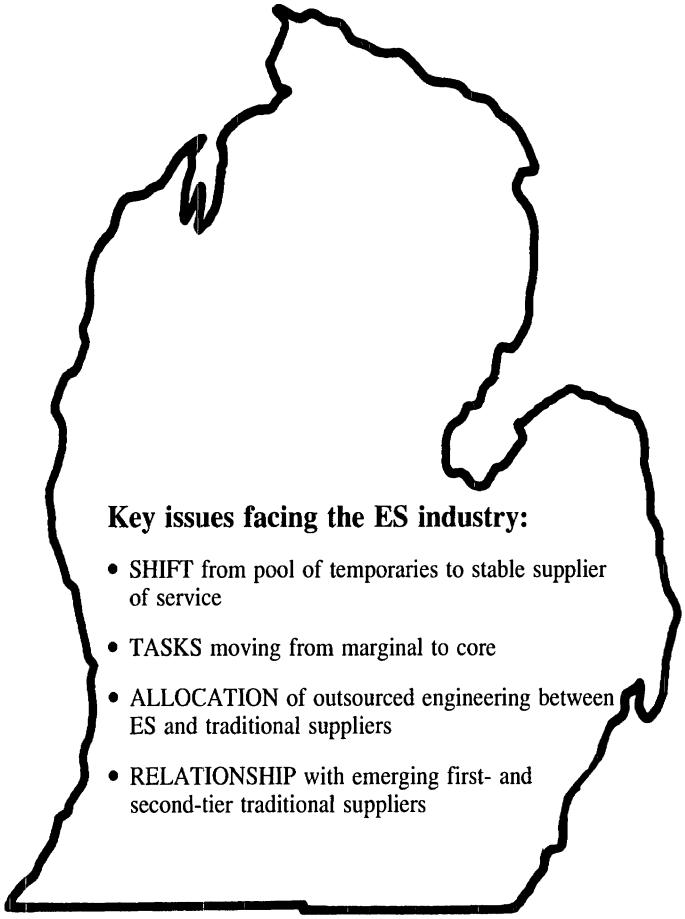
The Detroit area is likely to remain the center of the ES industry, and that industry will continue to grow. To be sure, the manufacturers are sending out larger programs, and larger programs will be less constrained by the proximity useful for intense supervision and monitoring when the part being engineered must fit with surrounding parts developed by other sources. Similarly, the rapid introduction of electronic communications technology *may* shrink the coordination costs and problems of remote work. But our respondents predict that neither of these developments will undercut the advantage of face-to-face discussion in achieving integration: proximity remains critical for that. Locational diversification of engineering is apparently not a substantial threat. The wholesale development of an alternative center of design and engineering for the domestic automotive industry is unlikely — as long as the Big Three continue to market *their own* vehicles in most market segments.

There are a number of implications for the Michigan traditional supplier of this strong ES presence.

There is little question that the structure of the supplier industry will come to approximate more closely the *tiered* structure that exists in Japan. Engineering and technical capability are likely to be the primary selection factors for first-tier suppliers, while manufacturing excellence may be the critical survival determinant for lower-tier suppliers. The ready availability of a strong ES industry can be important for both types of supplier.

Fewer Suppliers, More Explicitly Tiered





Those traditional suppliers that hope to remain or to become first-tier will need to expand their engineering and technical contributions to their customers, virtually without regard to the current level of that contribution. However onerous, intrusive, and untrusting the automakers' role in traditional supplier engineering efforts has seemed, it served a coordination function that in the future will have to be performed more by the first-tier supplier. These suppliers will need to provide design and engineering assistance for *their* own lower-tier suppliers, assistance today often provided by the Big Three. The tiering of the supplier industry will be closely linked to increased reliance on patterns of modular sourcing, and this will require expanded engineering capacity for the first-tier supplier, both to coordinate the engineering work for the entire module, and perhaps to assume responsibility in new parts.

Regardless of the model of engineering that develops, the potential first-tier supplier will have to increase its reliance on the ES industry. The direct transfer of engineering work from the automaker to the supplier is unlikely by itself to address the cost problem: suppliers that, like the Big Three in the past, try to be experts at everything will succeed only at having high overheads. Instead of trying to do all design and engineering itself, the successful supplier will recognize that some of the work can be performed more effectively by ES firms, both because they are already specialized and because of their lower cost structure. Just as the legal model of the ES firm suggests higher costs, so too does the completely "full service" modular supplier. The proximity of so many ES firms gives Michigan's emerging first-tier suppliers a range of strategic options.

Michigan suppliers likely to remain (or become) lower-tier can also profit from the State's rich endowment of ES firms. For these suppliers, proximity offers the opportunity to ensure that part designs reflect their own manufacturing strengths. Just as product and process engineering must be well integrated and coordinated, engineering must be smoothly joined to actual manufacturing, and proximity can be an advantage in accomplishing this. So, too, ES firms that are strong in process engineering can also, as noted above, assist the lower-tier supplier that may currently be getting help from its Big Three customer(s). This assistance may well be critical for some suppliers in their efforts to attain the manufacturing excellence on which their survival hinges.

THE AIM PROJECT ADVISORY BOARD

The Auto in Michigan Project
Room 107
University of Michigan
Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109

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AIM NEWSLETTER
The Auto in Michigan Project
A State of Michigan Program with the
Office for the Study of Automotive Transportation
University of Michigan
Volume 2, Number 2 March 1987

In this, our fifth issue, we present a series of reports on ongoing work by AIM Project participants.

Subjects include casting, U.S.-Japan auto trade, and selling to the transplants. We also report on AIM-sponsored econometric modeling of the Michigan effects of more offshore parts sourcing and of changes in where — and of what material — body panels are made. -DDL

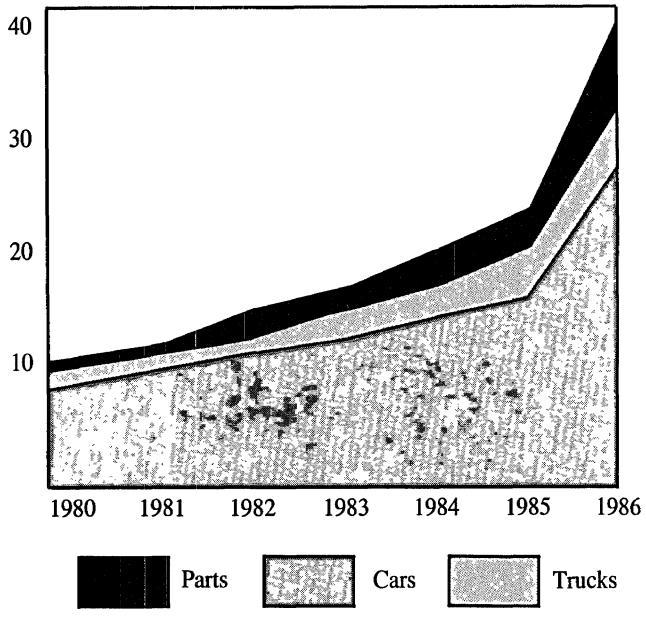
Trade and Capacity

Dan Luria

Despite large increases in the prices of most Japanese vehicles sold in the U.S. last year, Japan sold 300,000 more cars and small trucks here in 1986 than in 1985, and twice as many as in 1978, the previous cycle peak. And partly because of those price increases, the value of Japan's net auto exports to the U.S. grew a whopping $14.9 billion until, at nearly $40 billion, it represents two-thirds of the entire U.S.-Japan trade imbalance, and nearly a quarter of the entire U.S. trade deficit.

U.S. Net Imports from Japan, 1980-86

($ billion)



Since 1978, traditional domestic vehicles have lost 15% of the U.S. market to import and transplants. Sales of Japanese-nameplate vehicles have grown in the same period from 1.7 million to 3.9 million units.

The U.S. Market at Business Cycle Peaks

(millions of units sold at retail)

CARS + TRUCKS	1978	1986	Change
Imports	2.34	4.16	+ 78%
Transplants	0.02	0.70	+2939
Imp + Tplt	2.36 (15%)	4.86 (30%)	+ 106
Trad Domestic	12.88 (85%)	11.46 (70%)	− 11
GRAND TOTAL	15.24	16.32	+ 7

Source: Ward's Automotive Reports, 1/8/78, 1/15/78, 1/12/87, and 1/19/87.

The dramatic strengthening of the Japanese yen against the U.S. dollar (see AIM Newsletter Vol. 2, No. 1) probably will mean no increase in future shipments of finished vehicles from Japan in the next several years. However, 1.5 million units of additional Japanese-managed North American assembly capacity and a growing wave of imported cars from South Korea, Mexico, Taiwan, and Brazil seem sure to render redundant more and more Big Three production capacity.

Luria Trend Forecast of U.S. New Car and Truck Market, 1986-90

(millions of units sold at retail)

	Actual	Forecast		
	1986	1988	1990	1995
CARS				
Trad Domestic	7.61	6.6	6.0	5.7
Imported	3.24	3.7	3.9	4.3
Transplant	.60	1.0	1.5	1.8
Total	11.45	11.3	11.4	11.8
TRUCKS				
Trad Domestic	3.85	3.4	3.6	3.5
Imported	.92	1.0	1.0	1.2
Transplant	.10	.2	.3	.5
Total	4.87	4.6	4.9	5.2
CARS + TRUCKS				
Trad Domestic	11.46	10.0	9.6	9.2
Import + Transplant	4.86 (30%)	5.9 (31%)	6.7 (41%)	7.8 (46%)
Total	16.32	15.9	16.3	17.0

(continued on pg. 2)

Who We Are and How We Work

The AIM Project is a team of researchers, policy leaders, consultants, and local economic developers working to understand the concrete implications for Michigan of a changing automotive industry. An eight-person central research team (CRT) whose work is overseen by an advisory board of top-level industry, labor, and local development representatives sets the research agenda. Working in parallel with the CRT, a database development team coordinates an information-gathering effort involving local economic development agencies around the state. The current CRT and core Project staff includes:

Daniel Luria
AIM Project Coordinator
Manager, Industry Affairs and Policy
Industrial Technology Institute

Alan Baum
Director
Auto Industry Research Section
Innovation and Technology Services
Michigan Department of Commerce

David E. Cole
Director
Office for the Study of Automotive Transportation
University of Michigan

Michael S. Flynn
Senior Researcher
Industrial Technology Institute

Richard P. Hervey
President
Sigma Associates

Bernard "Jerry" Jurek
President
Pyrenees Consulting Corporation

Jack Russell
Director
Innovation and Technology Services
Michigan Department of Commerce

Donald N. Smith
Director
Industrial Development Division
University of Michigan

David Andrea
Research Assistant

Lisa Hart
Administrative Assistant

J. Downs Herold
Liaison Coordinator, Local Economic Development Agencies

Trade *(continued from pg. 1)*

In this context, Michigan's future depends on a three-pronged effort:

- Maximize the productivity and competitiveness of Big Three facilities in the state;
- Where Big Three outsourcing does occur, maximize the share of the resulting work won by Michigan independents; and
- Ensure that Michigan manufacturers have fair access to transplant firms' component business.

Selling to the Transplant Market

Alan Baum

With traditional domestic vehicles market share almost certain to fall (see Trade article in this issue), selling to the new transplant producers will be more and more important to Michigan suppliers. The following chart shows the list of transplant assembly facilities that have been built or announced.

Company	Site	Capacity By 1990	Startup
Diamond Star	Bloomington, IL	240,000	1988
Fuji/Isuzu	Lafayette, IN	120,000	1990
Honda	Marysville, OH	360,000	1982
Honda	Alliston, ONT	80,000	1988
Hyundai	Bromont, QUE	120,000	1989
Mazda	Flat Rock, MI	260,000	1987
Nissan	Smyrna, TN	240,000	1983
NUMMI	Fremont, CA	260,000	1985
Renault	Kenosha, WI	180,000	1983
Suzuki	Ingersol, ONT	200,000	1989
Toyota	Cambridge, ONT	50,000	1988
Toyota	Georgetown, KY	200,000	1988
Volkswagen	Westmoreland, PA	180,000	1978
		2,500,000	

UPDATED RISK RATINGS OF MICHIGAN CAR AND LIGHT TRUCK ASSEMBLY PLANTS, 1986-1992

			Risk factor				
Co.	Plant	Current (1986) Program(s)	Age of Current Program – Future Plans	Attributes of Plant	Perceived Labor Climate	Imports or Out-sourcing	Plant Risk Score
GM	Clark/Fleetwood*	B,D	8	8	6	0	22
	Pontiac 1	P	3	2	2	7	14
	Pontiac 8*	G	9	4	5	2	20
	Pontiac 5	S10	5	2	4	3	14
	Willow Run	H	0	3	5	2	10
	Buick City	H	0	2	3	2	7
	Lansing	N (2 plants)	2	4	4	6	16
	Orion	C	3	2	7	2	14
	Flint Truck*	C/K,K	9-2	5	8	0	20
	Poletown	E/K	0	0	3	2	5
Ford	Wixom	LS, Panther	7-3	3	4	0	11
	Wayne (Truck)	Bronco, F	7-4	3	4	0	11
	Wayne (Car)	Erika	6	2	2	9	18
	Dearborn	Fox	8	5	3	5	21
Chrysler	Jefferson	K,E,CV	8-6	5	2	4	13
	Sterling	H,P	2	2	4	5	13
	Warren	D/W,N	0	1	4	3	8

(A "Plant Risk Score" of 20 or higher indicates grave danger; 15-19 indicates significant risk. * indicates full or partial closing announced.)

(continued from pg. 2)

While sales are unlikely to equal capacity, it seems certain that at least 2 million transplants — 1.3 million more than in 1986 — will be sold in the U.S. by 1990.

More Domestic Sourcing . . .

The recent weakening of the value of the dollar vs. the yen has resulted in increased interest in local (North American) sourcing. The increase is coming in businesses that are energy intensive or produce a bulky product such as batteries, car seats, trim, paint, and steel. Products that require significant engineering, machining, and tooling are still generally imported from Japan.

As an example of the interest in domestic sourcing, Honda of America has been shopping for stamping suppliers, and is expected to announce its choices soon. Diamond Star is also quite interested in local sourcing of many components. They require that prospective suppliers have statistical process control, just-in-time delivery, high levels of quality, full design capacities, and a solid financial footing. Toyota recently announced plans to use 60 percent local content in its Georgetown, KY plant. Toyota has said it will procure more than 500 items from domestic vendors, including metals, components, and production machinery. About two-thirds of its steel is to come from domestic sources. Suppliers currently doing business with NUMMI may have an edge in obtaining this work.

Toyota has specifically stated that it is interested in obtaining the following components domestically: chassis-related parts; accessory items such as air conditioners and audio equipment; interior items such as carpeting and seats; electrical parts, wiring harnesses and lamps; glass; and tires. Toyota will also be looking at U.S. firms for such production equipment as plastic injection-molding machines. After making a preliminary survey of about 1,200 firms, Toyota has selected 60 parts suppliers for final evaluation. Sourcing decisions will be made jointly by a team of 180 agents in Japan and 6 at an office in Southfield.

Although sourcing decisions for startup production at some of the automakers are in the final stages, opportunities do exist for subsequent years. At a number of transplant facilities, even initial sourcing decisions are not yet set.

. . . But New Competitors . . .

In addition to the increased interest in domestic sourcing from traditional North American suppliers, the weakening of the dollar (see AIM Newsletter Vol. 2 No. 1) also makes the siting of North American facilities by Japanese automakers and parts suppliers more attractive. Recent announcements have illustrated this trend, and this will continue, at least in the short term. Approximately 500 such locations already exist or have been announced, including a number in Michigan. Some estimates suggest an additional 300 could be established by 1990, and even this number is viewed as conservative by many industry observers.

And Long Courtships

Suppliers that have obtained contracts from the Japanese have found a long-term commitment to be absolutely necessary; contracts are signed only after a long period of "courtship." An understanding of how the product one wants to sell fits into the chain of suppliers is also critical. In some cases, contracts with the manufacturers will be appropriate, while in other cases the higher tier suppliers will be the proper channel. Contracts are often for the life of the part, reflecting the lasting relationship desired by the automakers. Many of the Japanese producers and suppliers have sales offices in the Detroit area, and contacts at these offices may be the first step in a relationship with a Japanese-based manufacturer. At some point, contacts with officials in Japan may be necessary, particularly if design of the part becomes an issue.

Measuring the Value of Michigan Auto Content

Alan Baum and Dan Luria

Articles elsewhere in this issue illustrate the tremendous impact the import and transplant market is having on domestic assemblers and suppliers. With the emphasis on just-in-time production methods, modular assembly, and quick response to changes in product, many suppliers face a loss in business. Since Michigan suppliers are heavily dependent on the domestic Big Three producers, a group whose share of the market is declining, the impact on the Michigan facilities of many major suppliers (and on the state's economy in general) has been a focus of interest for the AIM Project.

AIM, with assistance from the Institute of Labor and Industrial Relations at The University of Michigan, has performed a series of computer simulations using the Michigan model of Regional Economic Models, Inc. (REMI) to estimate the difference in the economic value to Michigan of automotive assembly (and its associated activity) of (i) traditional Big Three cars, (ii) "decontented" domestic cars with more foreign parts, and (iii) transplant cars.

The scale of operations simulated is a plant producing 240,000 cars per year, to be sold at $10,000 each (in 1986 dollars), for total plant sales of $2.4 billion. Although production at this level would require 3,500 hourly employees today, we have estimated that productivity increases and changes in manufacturing process will reduce the head-count to 2,750 by 1990. White collar employment has been added in differing amounts in the three cases, according to estimates deemed appropriate (see below).

In all cases, we have used sourcing information we believe appropriate for 1989 and beyond, since it is in that time frame that we see "decontented" and transplant car production in full bloom. It should be noted that the model is dynamic, allowing us to look at the differential impact on the appropriate economic sectors as events occur over time. For example, the effect on indirect (primarily the suppliers to the assembly facility) and induced (primarily service and retail) sectors is a gradual one as work moves from a domestic to foreign source.

Table 1
U.S. Share of Factor Purchases for Different Types of Automobile Assembly Plants in 1990

Industry (SIC code)	Value	Traditional domestic	Decontented domestic	Transplant
Labor	$1,070	100%	90%	80%
Capital	1,160	100	100	100
Fuel	60	100	100	100
Textiles (22)	40	85	75	35
Apparel (23)	270	85	75	35
Furniture (25)	30	85	75	35
Chemicals (28)	50	90	80	30
Rubber & plastics (30)	370	95	85	40
Stone, clay, glass (32)	40	95	95	80
Primary metals (33)	190	90	75	35
Fabricated metals (34)	1,420	95	85	55
Nonelectrical machinery (35)	290	95	85	20
Electrical machinery (36)	410	80	60	10
Motor vehicles & parts (371)	3,550	95	80	15
Instruments (38)	20	80	60	10
Transportation (40-47)	150	100	95	35
Wholesale trade (50-51)	590	100	95	35
Finance, insurance, real estate (60-67)	30	100	100	100
Services (70-89)	200	100	100	100
Other	60	NA	NA	NA
Total	$10,000	96%	85%	44%

Table 1 illustrates the distribution of material and factor inputs used in the production of a typical $10,000 automobile. Labor is defined as the value of labor contained in each vehicle that is contributed at the assembly level. Labor costs that are embodied in the parts supplied to the final assembler are shown as a product input from that sector. Profit is contained in two sectors — capital and wholesale trade. Marketing expenses are generally reflected in the service sector. These distributions are meant to reflect the average compact vehicle. The first simulation is a baseline run using a direct impact of 2,750 employees in automotive assembly for 1989 and beyond. Sourcing information consistent with "traditional domestic" production is assumed for the duration of the experiment. As shown in the table, the traditional domestic utilizes a high level of domestic sourcing, with no category less than eighty percent. In this case, 100 percent of the labor is domestically sourced, representing not only the hourly component, but the salaried as well, which is provided by domestic manufacturers or engineering service firms. A weighted average of the various sectors produces a vehicle in which ninety-six percent of the inputs are supplied by domestic sources.

"Decontenting"

The second run simulates the "decontented" domestic. Even with the recent weakening of the value of the dollar, the major domestic automakers continue to aggressively source parts from not only Japan, but Mexico, South America, Europe, and countries throughout the Pacific Rim. This run assumes that a number of smaller parts would be sourced from overseas, while major parts such as engines and transmissions would continue to be sourced domestically. We expect that these estimates of domestic sourcing will increasingly be the rule, particularly for the smaller cars assembled in the U.S. by the Big Three.

The domestic content of labor drops from 100 percent to ninety percent, owing primarily to the leaner engineering staffs necessary. Many parts are both designed and produced overseas (often shared between domestic and overseas models), reducing the labor impact domestically. In this case, a weighted average reveals that eighty-five percent of the value of the vehicle is sourced domestically.

Transplant Sourcing

The final run of this section shows the impact of the transplant case. The percentage of domestic sourcing is dramatically different from the previous two simulations. Engines and transmissions (and many of their components) are assumed to be sourced from overseas and are reflected in the "motor vehicles and parts" category. Although Honda has made plans (and begun limited production) to source some engines and transmissions domestically, our information indicates that this is not likely to be the common practice. (Even in the case of Honda, most of the parts production will continue to be done overseas. And even if that sourcing were to be domestic, it would not in most cases be with traditional domestic firms, but rather transplant operations of Japanese suppliers. Thus, even in the Honda case, this data can be thought of as representative of the traditional domestic supplier.)

Minimal amounts of electronics and production equipment are sourced domestically in this scenario, while significant shares of glass, stampings, paints, and other similar products are obtained locally. Note also the drop to eighty percent for the domestic component of labor, reflecting a further pruning of white collar employment as more parts are sourced and designed from abroad. The weighted average of domestic production for this case is only forty-four percent.

Table 2
Impact on the Michigan Economy of Three Types of Assembly Plants, 1989-95

	1989	1990	1991	1992	1993	1994	1995
Traditional domestic							
Total employment	17,782	20,705	21,343	21,545	21,673	21,286	22,022
Direct employment	3,650	3,650	3,650	3,650	3,650	3,650	3,650
Employment multiplier	4.9	5.7	5.9	5.9	5.9	6.0	6.0
Personal income (millions of current $)	674	902	985	1,046	1,100	1,152	1,204
Decontented domestic							
Total employment	15,806	18,507	19,079	19,284	19,399	19,520	19,716
Direct employment	3,290	3,290	3,290	3,290	3,290	3,290	3,290
Employment multiplier	4.8	5.6	5.8	5.9	5.9	5.9	6.0
Personal income (millions of current $)	601	810	886	941	989	1,036	1,082
Transplant							
Total employment	9,242	11,093	11,483	11,628	11,695	11,790	11,907
Direct employment	2,930	2,930	2,930	2,930	2,930	2,930	2,930
Employment multiplier	3.2	3.8	3.9	4.0	4.0	4.0	4.1
Personal income (millions of current $)	366	505	555	590	620	649	678

Table 2 shows the economic impact in Michigan of the various scenarios presented in Table 1. If one were to model Table 1's assumptions for the nation as a whole, the traditional domestic transplant gap would obviously be much greater.

Although the impact changes over time, one can think of steady state being achieved by the mid 1990's. In 1995, the total number of jobs in the Michigan economy due to the activity at the assembly plant (including the direct jobs at the facility) ranges from 11,900 in the transplant case to 22,000 in the traditional domestic case. The differing number of direct jobs reflects the previously mentioned varying percentage of white collar jobs necessary in each situation. The employment multiplier is derived by dividing the total jobs into the direct jobs. An employment multiplier of six indicates that five additional jobs are created as a direct result of each direct (assembly) job. The personal income generated (in current, non-adjusted-for-inflation, dollars) drops from $1.2 billion in the traditional case to less than $700 million in the transplant case.

These results again make clear the enormous economic consequences riding on Michigan suppliers' success or failure in getting contracts with the transplant manufacturers.

Modeling the Impact of Changes in Body Panel Forming

Alan Baum and Dan Luria

In Vol. 1, No. 3 of the AIM Newsletter, Don Smith and Richard Hervey described three challenges to the stamping industry, particularly that segment of the industry that produces large body panels.

- Shrinking production volumes, particularly in traditional domestic vehicles, which have served as the principal customer base for Michigan's captive regional stamping facilities;
- A shift in body panel material choice from steel to plastics in some vehicle programs; and
- A tendency to shift from large, regional facilities to smaller stamping facilities contiguous to vehicle assembly plants.

To illustrate the importance of captive stamping facilities to Michigan, General Motors has nine locations employing 30,000, Ford has four employing 7,500, and Chrysler has two employing 7,500, for a total of fifteen plants employing 45,000 (salaried and hourly) people. A portion of this employment (estimates range from a third to a quarter) is not involved in body panels and therefore we have not included it in this exercise. Even so, we estimate body panel stamping employs roughly 32,000 Michigan workers. Using the REMI multiplier (see below) that gives body panel stamping a total Michigan job impact of 70,000.

A Shrinking Base

One estimate of the size of the domestic market from now until 1995 is presented below. Notwithstanding other factors, the decline in production volume will result in less business for the captive plants, as well as for many independent plants. By 1995, the market for true domestic cars is expected to be no higher than eighty percent of its 1986 total (see table in this issue's Trade article).

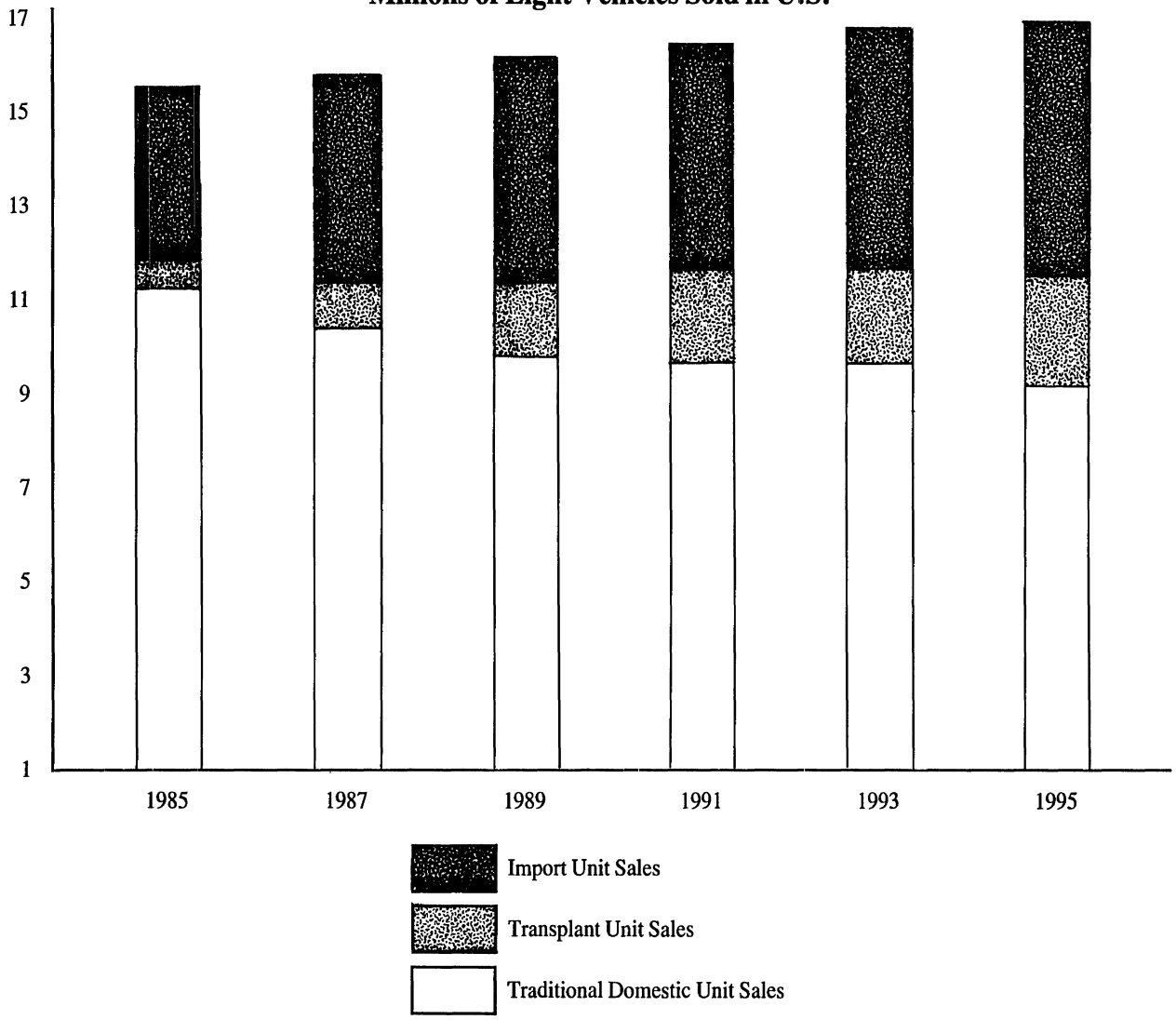
Plastics

The shift to plastic panels is another factor affecting the production of steel body panels. Although the GM80 project was cancelled due to technical and financial difficulties, plastics remain a viable and growing choice for body panels. Panels for some vehicles are and will be made primarily from plastic (Fiero and GM's recently announced "APV" being two notable examples), but numerous other vehicles will be made at least in part with plastic panels. Plastic bumpers and fenders are increasingly the norm on many newer models. The following chart shows the percent of current body panels estimated by AIM to be plastic in the next eight years.

Period	Percent Plastic
1981-1983	1%
1984-1987	2%
1988-1991	6%
1992-1995	10%

This obviously represents a threat to the steel press plants, but an opportunity for plastics fabrication facilities. (A number of processes and technologies are under intense investigation, and further inroads by the plastic industry are likely; the details of that work are beyond the scope of this article.)

Chart 1
Millions of Light Vehicles Sold in U.S.

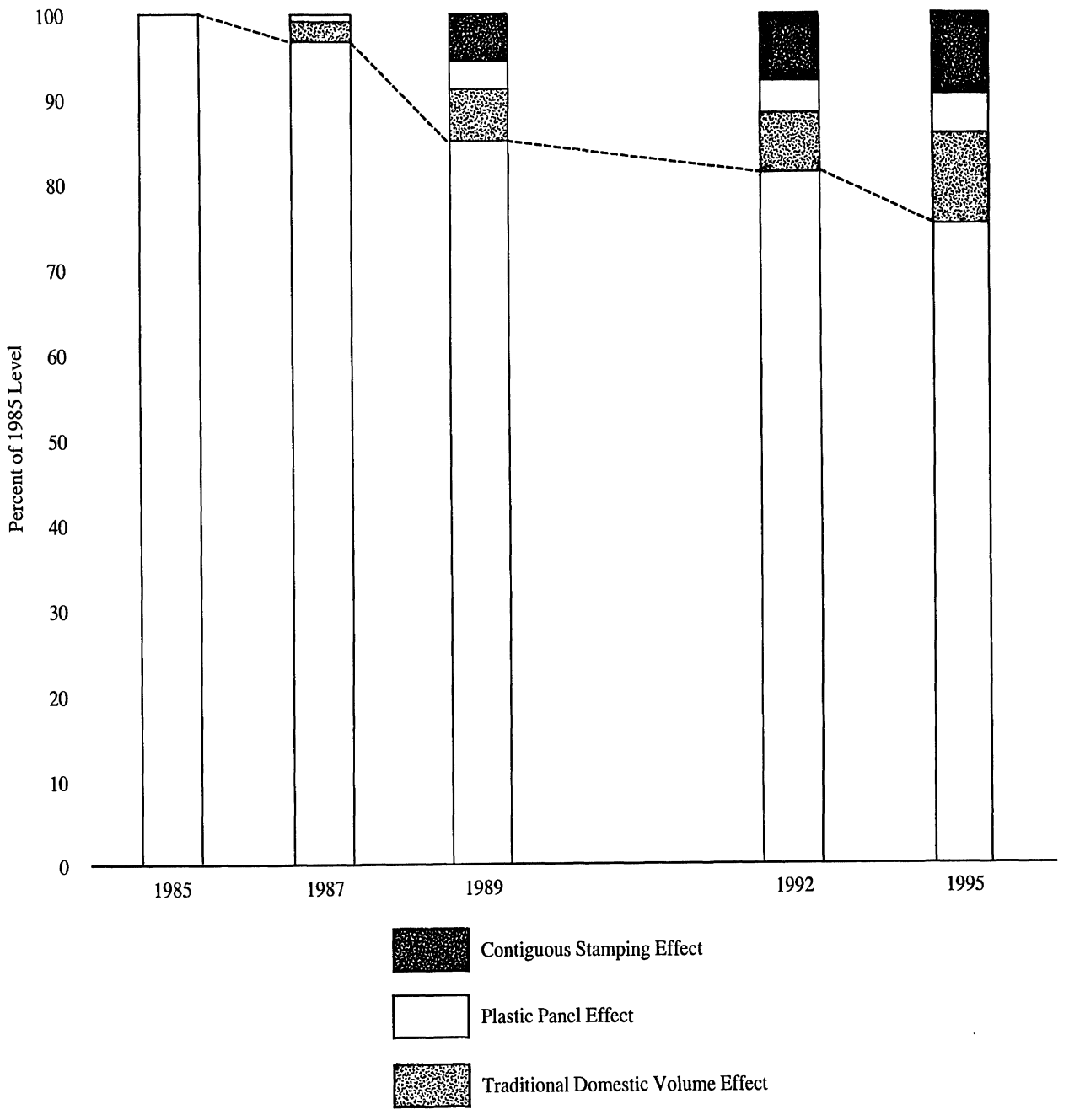


Contiguous Stamping

The final major factor affecting the stamping industry is the trend towards contiguous, smaller-volume stamping facilities, and consequently less work for the regional stamping plants. Michigan's large number of these regional stamping facilities makes this a critical issue for the State. With contiguous stamping, the siting of assembly capacity becomes crucial not only in preserving assembly jobs, but stamping employment as well. Contiguous stamping allows for reduced transportation for panels, thus improving their quality and cost. The problem is that Michigan assembles about thirty percent of the cars and light trucks made in the U.S. by the Big Three, but we stamp sixty to seventy percent of the panels.

In order to use the REMI model described in the previous article to estimate the quantitative impact upon Michigan facilities, we have estimated the number of vehicles for which panels are stamped in the state, but whose assembly occurs elsewhere. It is these stampings that are at risk if and as stamping is moved closer to the point of vehicle assembly. Clearly, only a portion of these "non-contiguous stampings" are at risk. Our estimates suggest that thirty percent of these panels will be stamped elsewhere in the 1989-1990 period, forty percent from 1991-1992, and fifty percent in 1993-1995. These estimates are based on the announced plans of the automakers, particularly with respect to new products that will be produced with stampings sourced contiguously.

Chart 2
Three Effects on Michigan Body Panel Stamping Employment
(1985 Total Employment Set at 100)



The impact of these three trends, individually and in combination, is shown below.

Impact of Three Trends on Automotive Stamping in Michigan

Volume Declines

	Employment			Personal Income
	Total	Direct	Multiplier	(Current $ Millions)
1987	− 2,115	−1,127	1.9	$ − 67
1989	− 5,946	−2,817	2.1	−231
1992	− 7,342	−3,661	2.0	−337
1995	−10,488	−4,788	2.2	−540

More Plastic Panels

	Employment			Personal Income
	Total	Direct	Multiplier	(Current $ Millions)
1987	− 851	− 400	2.1	$ − 30
1989	−2,352	−1,097	2.1	− 92
1992	−3,548	−1,714	2.1	−157
1995	−3,629	−1,629	2.2	−189

More Contiguous Stamping

	Employment			Personal Income
	Total	Direct	Multiplier	(Current $ Millions)
1987	− 0	− 0	0	$ − 0
1989	− 5,785	−3,081	1.9	−205
1992	− 8,496	−3,896	2.2	−390
1995	−10,242	−4,671	2.2	−527

Total of All Three Impact Factors

	Employment			Personal Income
	Total	Direct	Multiplier	(Current $ Millions)
1987	− 2,966	− 1,527	1.9	$ − 97
1989	−14,083	− 6,995	2.0	− 528
1992	−19,386	− 9,271	2.1	− 884
1995	−24,359	−11,088	2.2	−1,256

Michigan's captive stamping industry could be at risk by 1995. The reductions due to declining volume and contiguous stamping are the most important factors. The impact on particular plants depends upon the programs they supply, characteristics of the facility (financial, physical, management, and labor), and the competition against which they are measured. Investment in new equipment and the securing of new contracts are critical for the continued life of Michigan's pressed metal plants. In many cases, work may be outsourced to independent suppliers that may have lower cost structures and are able to adapt more easily to new products. The sale of some existing facilities to independents is also possible.

The growth in the plastics industry represents an opportunity in the midst of likely decline in the stamping industry. However, the magnitude of the decline in stamping means that growth in plastics cannot fully offset the decline in steel stampings. In addition, plastics jobs have a much lower Michigan economic impact than jobs in the stamping industry, partly because they pay less, but also because more of their inputs (resins, for example) come from out of state. Our research indicates that for each job lost in the stamping industry, 1.2 jobs would have to be gained in the plastics sector to negate the loss of stamping jobs and the indirect jobs they support. In order to offset the loss of personal income when a stamping job is lost, 1.5 plastics jobs must be created.

Introducing AIM Research on Casting

Donald N. Smith

The automotive casting industry is going through an accelerating capacity rationalization process. As the Big Three seek ways to reduce non-essential vertical integration, their captive foundries are at particular risk vis-a-vis independent specialists. Since 1980, Ford closed a regional casting plant in Flat Rock, MI and has announced plans to close its Canton, OH forge by 1990. GM has closed its Central Foundry Division's Tonawanda, NY casting plant, is in the process of phasing out its Pontiac, MI foundry, and has announced foundry closings in Saginaw, MI (grey iron plant) and Massena, NY. Chrysler and GM are heavily dependent on Fiat's TEKSID division for their aluminum cylinder head castings. Recognizing many of their foundries' lack of competitiveness, several modernization projects are in process; GM alone is putting $200 million into the surviving CFD plants in Saginaw.

Is Upgrading Enough?

The upgrading of facilities may not, however, address a fundamental problem: because the Big Three traditionally designed their castings with relatively little input from the engine or transmission designer, they often turned out thick-wall, heavy, imprecise castings easy for the foundry to make but not optimal for the end product. Production quality practices also often reflected this "black art" caster mentality. As non-Big Three casters — many of them offshore — have become significant suppliers to the automakers, radical technology and strategy shifts are now being contemplated. One route available is to close many, even most, of the captive facilities by (i) buying castings outside, (ii) substituting other processes for casting where feasible, (iii) substituting materials such as aluminum or magnesium for the traditional grey iron, and/or (iv) developing drastically new methods for casting (see box).

The major processes used for automotive casting include:
- Sand casting — used with iron and aluminum
- Semi-permanent mold — used with aluminum
- Diecasting — used with aluminum, magnesium, and zinc
- Evaporative casting (lost foam) — used with iron and aluminum

The major automotive applications of castings include:

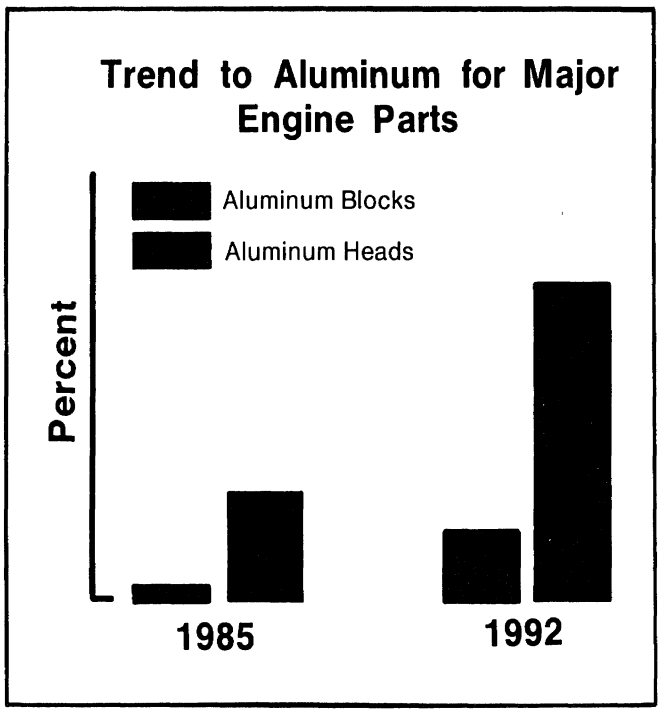
Engines	Transmissions/Transaxles
Cylinder blocks	Cases
Cylinder heads	Case covers
Manifolds	Extensions
Oil pumps	Channel plates
Water pumps	

With the exception of the exhaust manifolds, all of the major castings can be produced in aluminum and by alternative processes to the traditional sand casting method. (The cast-and-machined exhaust manifold has been largely replaced by the composite sheet metal (stamped) manifold.)

Our work will focus on the prospects for the fourth route: new casting processes, and particularly the evaporative casting technology in both iron and aluminum. Our initial findings suggest that a unique "window of opportunity" may exist to make a quantum leap forward in the casting business; such a leap could mean a great deal to Michigan, with its heavy foundry endowment.

In the near-term, however, more outsourcing of castings appears inevitable, particularly by GM as it strives to eliminate "non-core" operations. In the past year or so alone, GM has outsourced blocks for its Quad Four engine to John Deere and announced that Teksid (a

(continued on pg. 8)



division of Fiat) will supply aluminum heads for its high-volume 60-degree V6s and 2.0-L 4. The 1990-92 Manhattan and Saturn engines are both planned with aluminum heads and cylinder blocks.

Evaporative Casting to the Rescue?

The retrofitting of grey iron casting plants to allow the pouring of aluminum is, we fear, unlikely. The accelerated development of the evaporative casting process for iron appears to be the most plausible (though perhaps still a long shot) way to save existing grey iron casting operations in the state. If its apparent promise proves out, it may also be a processing approach that pays dividends for the state's aluminum casters as well.

The evaporative casting process (ECP), or "lost foam," offers design flexibility, reduced machining, and other economies compared to traditional casting approaches. It uses polystyrene foam beads to make an exact duplicate of the part (the pattern), which is then coated with a refractory material and surrounded by loose sand. The container is vibrated to pack the sand around the pattern, creating a mold. Molten metal vaporizes the foam pattern, and as the vapor diffuses through the sand, the casting precisely duplicates the pattern's geometry, right down to tiny holes and channels.

The viability of the technology has been demonstrated in a number of materials, but it is not yet fully commercial in high-volume automotive applications for complex parts such as cylinder heads and differential cases. If lost foam is to take hold and make a difference, several things have to happen, among them:

- improved systems for reliable polystyrene pattern-making
- thorough process control methodologies for high volumes
- better understanding of certain key interactions:
  - — between molten metal and foam
  - — between pattern and sand during vibration
- more skilled casting plant blue- and white-collar staffs

Perhaps most important, the change to a radically new casting approach permits what may well be the most important cost-saving possibility: the optimization of product designs to take full advantage of a casting technology that can turn out *appropriately designed* parts close to their final shape, radially reducing machining time.

Can ECP turn Michigan casting around? If the process were already fully-refined in volume production around the world, it would probably be too late for Michigan to gain much from an adoption push. The early evidence we have gathered indicates that most potential competitors are still at the stage of pilot line production and laboratory experimentation; thus there may still be time to act profitably.

The Auto in Michigan Project
Room 107
University of Michigan
Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109

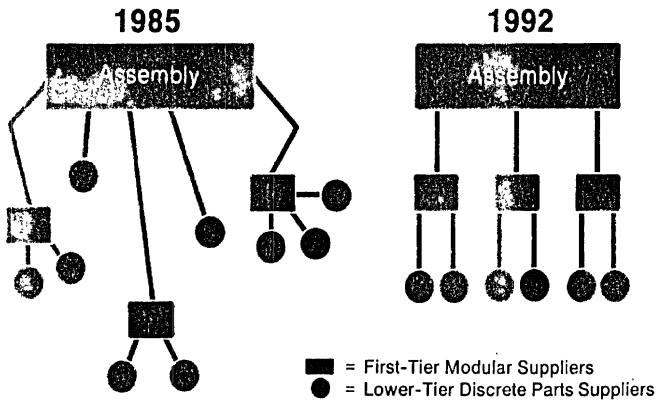
AIM NEWSLETTER
The Auto in Michigan Project
A State of Michigan Program with the
Office for the Study of Automotive Transportation
University of Michigan
Volume 2, Number 3 September 1987

AIM in 1988: Year of the Supplier

The AIM Project enters its fourth year in fiscal 1988, which begins October 1. In planning for the upcoming fiscal year (FY), the Project and State government have been engaged in a rethinking of the AIM's emphasis and its "angle of view."

That rethinking runs like this. In its early period — roughly until the Spring of 1986 — AIM had to focus on the Big Three automakers' new vehicle plans, and to develop the expertise to link those plans to the likely fates of particular Michigan facilities. A quick look back over five sets of assembly plant risk ratings in the *AIM Newsletter* reveals our achievement in that regard.

As the Project progressed, however, more and more of our time came to be spent studying and forecasting the impact on *supplier* plants — captive and independent alike — of various scenarios for particular assembly programs and automaker vertical integration strategies. We reached the conclusion, by now familiar to *Newsletter* readers, that the future was likely to bring downsized domestic automakers — in terms of both vehicle sales and share and parts-making self-sufficiency — and a qualitatively larger role for first-tier suppliers. We described the 1990s situation as one of "modular sourcing chains": smaller automakers, atop a more pyramidal structure, would assign engineering and assembly responsibility for more and more vehicle subsystems to a shrinking number of first-tier suppliers, which in turn would ride herd on a large number of smaller, discrete parts-making firms.



This vision, we recognized, posed a serious challenge to Michigan. For a variety of historical reasons, we are home to a disproportionately large share of Big Three parts operations, and to a declining share of first-tier independent supplier establishments. At the same time, we recognized that the State, while it surely had to try, was inevitably limited in its ability to influence multinational corporations such as the Big Three's strategy in such a way as to safeguard particular captive parts plants.

The set of State decisions that evolved from this AIM analysis was that primary emphasis should be on nurturing the small and medium-sized firms at the bottom of the pyramid. *By increasing the technological and managerial competence of these firms, State programs would be aiding captive and independent first-tier supplier plants alike by lowering the cost and improving the quality of their purchased parts.* It was based in large part on this analysis that the State's Technology Deployment Service (TDS) was launched in the Fall of 1985.

In the Fall of 1987, State government is launching a larger and more ambitious program that builds on TDS. The Michigan Modernization Service (MMS — see box below) will offer firms with fewer than 500 employees a full array of upgrading services, from TDS assistance with deploying programmable automation to a market analysis service to workforce development consulting.

FY88 Projects

The AIM Project, quite logically, becomes the automotive think-tank of MMS. We seek to bring to MMS for its clients' use tools with which to maintain and increase the size and range of their automotive markets. Described below are some of the FY88 AIM projects that aim to build those tools.

- While continuing to monitor the sourcing decisions of the Big Three and the transplant assemblers, AIM will spend much more time on detailed analysis of our existing database of Michigan assembly programs' sourcing.

(continued on page 2)

AIM and the Michigan Modernization Service

As of October, the AIM Project will be a program of the Michigan Modernization Service (MMS), an important new agency of State government. The Modernization Service is designed to assist "foundation firms," manufacturing and engineering service companies that employ fewer than 500 workers. Michigan's 5,000 foundation firms provide jobs for nearly 500,000 wage earners. Their combined payroll is a tidy $10 billion a year.

The Modernization Service support offered to foundation firms will include technology assessment, workforce training, and market analysis. MMS will consult with individual firms and provide services to groups of clients. It incorporates several already well-established programs, such as the Technology Deployment Service (TDS) and the Office for New Enterprise Services (ONES).

MMS will work closely with the Industrial Technology Institute in Ann Arbor. Several MMS programs, including AIM, will therefore be based at ITI starting in October.

MMS will conduct a substantial, ongoing program of research on Michigan's industrial base. As part of that, in 1987-88 AIM will focus on automotive suppliers below the OEMs and the first-tier Fortune 500 suppliers. Elsewhere in this issue, we provide an overview of this "Year of the Supplier" activity.

The State economic development leaders who are launching the Michigan Modernization Service are also those who founded and have supported the AIM Project since 1984. As part of MMS, AIM research will reach a broader audience and be even more closely linked to Michigan's economic development strategy.

Who We Are and How We Work

The AIM Project is a team of researchers, policy leaders, consultants, and local economic developers working to understand the concrete implications for Michigan of a changing automotive industry. An eight-person central research team (CRT) whose work is overseen by an advisory board of top-level industry, labor, and local development representatives sets the research agenda. Working in parallel with the CRT, a database development team coordinates an information-gathering effort involving local economic development agencies around the state. The current CRT and core Project staff includes:

Daniel Luria
AIM Project Coordinator
Manager, Industry Affairs and Policy
Industrial Technology Institute

Alan Baum
Director
Auto Industry Research Section
Innovation and Technology Services
Michigan Department of Commerce

David E. Cole
Director
Office for the Study of Automotive Transportation
University of Michigan

Michael S. Flynn
Senior Researcher
Industrial Technology Institute

Richard P. Hervey
President
Sigma Associates

Bernard "Jerry" Jurek
President
Pyrenees Consulting Corporation

Jack Russell
Director
Innovation and Technology Services
Michigan Department of Commerce

Donald N. Smith
Director
Industrial Development Division
University of Michigan

David Andrea
Research Assistant

Lisa Hart
Administrative Assistant

J. Downs Herold
Liaison Coordinator, Local Economic Development Agencies

AIM in 1988 *(continued from page 1)*

- Once this analysis provides us with a better sense of which components offer the best opportunities for Michigan suppliers, we plan to model, for a few of those components, how each of the Big Three, plus Honda and Mazda, goes about making sourcing decisions for new programs, and how it differs from the way they did so in the past.

- We will then stir into the mix further work on the state's engineering service (ES) sector, with an eye to identifying — and characterizing competencies by component (product and process) — the ES capacities available to Michigan suppliers as they are forced to offer more "black box" and "grey box" design-engineering in their quest for both Big 3 and transplant business.

- AIM Staff will be involved in a State database-building effort focused on what the transplants buy in the U.S. (and where within it), what the Big Three buy offshore, and which suppliers are winning Saturn business. As with the sourcing analysis work described above, the goal is to find the best openings, including "import-substitution" opportunities, for Michigan suppliers, captive and independent alike.

In sum, AIM is becoming (1) less automaker-angled, (2) more focused on small and medium-sized suppliers; (3) more concerned with the nitty-gritty of component level decisions; and (4) more focused on business development and less on pure research.

There will be three issues of the *AIM Newsletter* published in FY88; they will appear in January, May, and September of next year. Besides reporting on the sourcing and supplier projects introduced above, we also anticipate articles on non-AIM work commissioned by MMS in the areas of technology, employment, and industry structure in the Michigan automotive economy. As always, we welcome our readers' comments.

UPDATED RISK RATINGS OF MICHIGAN CAR AND LIGHT TRUCK ASSEMBLY PLANTS, 1987-1992

			Risk factor				
Co.	Plant	Current (1986) Program(s)	Age of Current Program (Firm new Product = 0)	Attributes of Plant	Perceived Labor Climate	Imports or Out-sourcing	Plant Risk Score
GM	Clark/Fleetwood*	B,D	9	8	6	0	23
	Pontiac 1	P	4	2	3	5	14
	Pontiac 8*	G	9	5	5	2	21
	Pontiac 5	S10	5	3	5	2	15
	Willow Run	H	1	3	4	1	9
	Buick City	H	1	3	5	1	10
	Lansing	N (2 plants)	3	4	4	5	16
	Orion	C	4	3	7	1	15
	Flint Truck*	C/K,K	9	6	7	0	22
	Poletown	E/K	0	1	3	2	6
Ford	Wixom	LS, Panther	0	3	4	1	8
	Wayne (Truck)	Bronco, F	0	4	4	0	8
	Wayne (Car)	Erika	3	2	2	8	15
	Dearborn	Fox	8	6	3	3	20
C ler	Jefferson	K,E,CV	0	4	3	4	11
	Sterling	H,P	2	2	4	6	14
	Warren	D/W,N	1	2	4	3	10

(A "Plant Risk Score" of 20 or higher indicates grave danger; 15-19 indicates significant risk. * indicates full or partial closing announced.)

Modeling Michigan Plant Closings and Openings

J. Crary, G. Fulton, D. Grimes, S. Hymans

This article is a summary of the June 1987 forecast of "The Michigan Economic Outlook for 1987-88" done by the University of Michigan's Research Seminar in Quantitative Economics. AIM staff assisted the effort by providing plant-specific forecasts and supplier data used by RSQE researchers in fine-tuning their job multiplier and local purchase assumptions. — DDL

. . . GM and Ford have announced that 14 automotive facilities in the state are facing closure or major reductions between now and the end of 1989. . . . In addition, a substantial reduction in the white collar work force is planned over the same period. On the positive side, at least one facility is planning an expansion, and Mazda is coming on line over this period. Most of the plants targeted for closure or reduction are situated in Detroit, Pontiac, and Flint. The plants affected are involved in automotive assembly and supplier activity, the latter including automotive stampings, iron and steel foundries, farm equipment, and [seat covers].

By 1989.3 (i.e., the third quarter of 1989), closings are expected to result in a . . . direct job loss of 46,400 workers compared to the situation in 1987.1. We assume that 20 percent of the affected blue-collar workers will be transferred within the state, or will be assigned to the JOBS Program (. . . a collectively-bargained arrangement that permits some workers to maintain full straight-time pay for non-traditional work). [Thus] after accounting for in-state transfers and JOBS Program participants, and including the additions due to Mazda, we estimate a *net* direct loss of 37,400 jobs by 1989.3. Almost half these jobs are expected to be in the white-collar category. . . .

Spin-Off Impacts

[However, in addition to these *direct* job losses, there will also be certain "spin-off" effects. We used our computer models] to estimate the number of [these] spin-off jobs [that will be] lost in the state. . . . A lost spin-off job is one that results from reduced purchases from local vendors (the "indirect effect") plus the reduced purchasing activities of local households (the "induced effect"). The total number of jobs lost — direct plus spin-off — for every net direct job terminated constitutes the "employment multiplier" . . . [e.g., if there is one spin-off job lost for each direct job lost, the multiplier would be two.]

[To ensure accuracy, we] made a number of important adjustments to standard [forecasting] procedures. [Based on AIM project advice:]

- We obtained the best information possible on the percentage of purchases made by assembly plants targeted for closure from supplier plants also closing. We then reduced the impact of the supplier closing commensurately to avoid double-counting.
- We adjusted the Mazda impact to reflect its planned internal supply of automotive stampings.
- For plants [on which] adequate information was available, we attempted to estimate the actual percentage of purchases made within the state of major component parts for the vehicles assembled. . . .
- We . . . forced the model to retain certain supplier activity that it otherwise would routinely remove. This [reflects AIM's] assessment that some . . . suppliers will continue, at least in the short-term, to produce components for companion plants outside of the state [e.g., for GM B-bodies in Arlington, TX and G-bodies in Ste. Therese, Quebec]. . . .

Detailed Results

The direct and indirect impacts were phased across ten quarters from 1987.2 to 1989.3 consistent with the . . . announced timing of the plant closings and openings. For 1989.3 the direct and indirect employment effects of these activities, aggregated to major industry sector, are shown in Table 1.

The total job loss is 71,000 jobs by 1989.3: [of that figure] 47,600 are in manufacturing, 20,600 in private nonmanufacturing, and 2,800 in government. The time path of this job loss impact, from the second quarter of 1987 through the third quarter of 1989, is presented in Chart 1 . . . [The] major losses occur during 1988 . . .

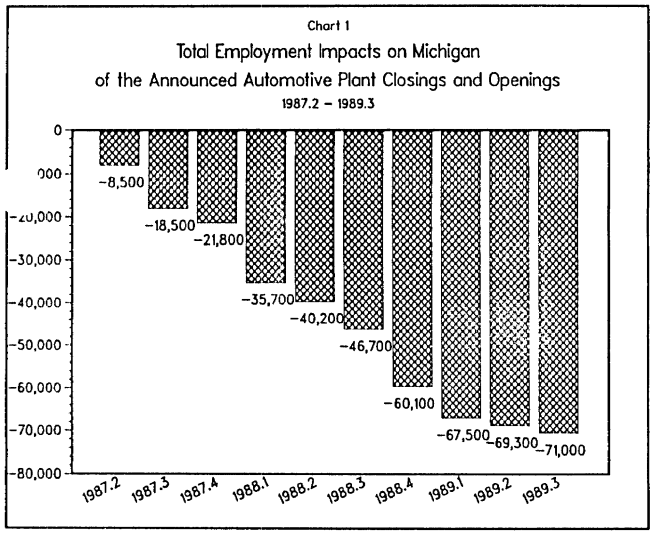
. . . [Other] effects of the closings [are] summarized in Table 2. The plant closings and reductions, net of openings, are projected to contribute an additional 0.6 [percentage points] to the state unemployment rate in fiscal year 1988, and a full percentage point in fiscal year 1989. Losses in personal income are expected to amount to $717 million in fiscal 1988 and $1.6 billion in fiscal 1989. Over the ten quarters projected, the state is expected to lose almost $2.5 billion in personal income due to the scaling down of the automotive sector.

TABLE 1

Projected Employment Impacts in Michigan of Announced Automotive Plant Closings and Openings: Direct, Indirect, and Induced Components, 1989.3 (thousands, SA)

	Total Change	Direct	Indirect	Induced
Wage and Salary Employment	−71.0	−37.4	−21.8	−11.8
Manufacturing	−47.6	−37.4	−10.2	0
Motor Vehicle	−30.4	−26.6	−3.8	0
Other Manufacturing	−17.2	−10.8	−6.4	0
Private Nonmanufacturing	−20.6	0	−11.6	−9.0
Wholesale & Retail Trade	−8.8	0	−5.1	−3.7
Services	−6.9	0	−4.1	−2.8
Other Nonmanufacturing	−4.9	0	−2.4	−2.5
Government	−2.8	0	0	−2.8

SA — Seasonally Adjusted



The implications for General Fund General Purpose tax revenues are [also shown in] Table 2. . . . Revenue losses (on a cash basis) in fiscal years 1987, 1988, and 1989 are forecast to equal $8.5 million, $38.5 million, and $82.6 million, respectively. The total revenue loss over the ten quarters amounts to almost $130 million.

Income Supports Delay Impact

[The final line] in Table 2 is the employment multiplier, which is estimated to be close to two; that is, [one spin-off] job lost for every direct job. This number is lower than . . . expected . . . for at least [three] reasons:

- Almost half of the direct job losses are white-collar. These jobs are associated with much lower multiplier effects in this state than factory worker jobs. Also, the majority of the blue-collar job losses are in supplier [operations], rather than in assembly. . . .
- Some suppliers are not expected to be affected fully in the short-term . . . [Our] assumptions on supplier retention "save" approximately 3,750 jobs by 1989.3.
- Private income maintenance programs provide support for many laid-off workers, at least in the short term. . . . By 1989.3, these programs save 4,400 jobs. . . .

Additional job losses due to these plant closings can be anticipated in the longer term. This is the consequence of an additional 1,500 direct job losses scheduled for fiscal year 1990, increases in the number of workers exhausting their income maintenance support, and the potential phasing out of suppliers retained in our estimates as certain model lines are discontinued. The extent of these additional job losses will be partially determined by the ability of auto suppliers to alter their product mix, and by the capacity of Michigan's workers to be retrained.

TABLE 2
Projected Impacts on Michigan of Announced Automotive Plant Closings and Openings, 1987.2 - 1989.3

	1987.2	1987.3	1987.4	1988.1	1988.2	1988.3	1988.4	1989.1	1989.2	1989.3
Unemployment Rate (%) Effect	0.2	0.3	0.4	0.6	0.6	0.7	0.9	1.0	1.0	1.0
rsonal Income										
(millions of current $, SAQR)	−39.4	−93.0	−111.9	−170.6	−197.9	−236.9	−310.1	−398.0	−436.7	−476.0
Cumulative Effect	−39.4	−132.4	−244.3	−414.9	−612.8	−849.7	−1159.8	−1557.8	−1994.5	−2470.5
Total GFGP Tax Revenue										
(millions of current $, NSA)	−2.8	−5.7	−5.9	−9.4	−11.1	−12.1	−17.2	−20.9	−22.3	−22.2
Cumulative Effect	−2.8	−8.5	−14.4	−23.8	−34.9	−47.0	−64.2	−85.1	−107.4	−129.6
Employment Multiplier	1.9	2.2	2.4	1.9	1.8	1.7	1.7	1.8	1.9	1.9

SAQR — Seasonally Adjusted Quarterly Rate
NSA — Not Seasonally Adjusted

Excerpts from "Japanese Auto Parts Companies in the U.S. and Japan: Implications for U.S. Competitors"

P. J. Arnesen, R. E. Cole, and A. R. Krishna

The threat of protectionist legislation and, more recently, the rise in the yen have led Japanese automakers increasingly to establish extensive manufacturing presences in the U.S. This represents a new phase in the intense competitive struggle for control of the American and global automotive markets. . . .

The challenge to U.S. automotive suppliers is perhaps even more significant than that to the automakers (or OEMs: Original Equipment Manufacturers). U.S. suppliers provide some 55% of the car's total based value, and a conservative rule of thumb is that for every OEM employee there are 1.5 supplier employees. [But] the potential domestic market for U.S. supplier products has shrunk as the Japanese share of the market has increased, and the remainder is threatened by global outsourcing on the part of American OEMs.

In addition, Japanese auto parts makers' exports to the U.S. have been growing rapidly, rising 67% in 1984 and another 30% in 1985 [and again in 1986]. Meanwhile, U.S. auto suppliers' attempts to sell to the Japanese have met with relatively little success: in a $40 billion Japanese parts market, American sales are less than $300 million.

In seeking to explain these results, Americans often focus on the close affiliations among Japan's OEM and supplier firms and assert that "group ties" among Japanese "corporate families" have excluded American suppliers from the Japanese market. Now, it is feared, the Japanese transplants will draw their affiliated suppliers into the American market as well, [drowning] American suppliers in a wave of supplier transplants. Indeed, an increasing number of Japanese suppliers have been building factories here, especially since 1985.

Southern Drift

Notable in the physical distribution of Japanese OEMs and suppliers is their southern drift relative to the traditional center of U.S. auto production in lower Michigan, eastern Wisconsin, western New York and Pennsylvania, and northern Ohio, Indiana, and Illinois. This drift has been led by the new assembly locations selected by Nissan in Smyrna, Tennessee; Toyota in Georgetown (Lexington), Kentucky; and Honda in Marysville, Ohio. While this trend had already been set in

motion by U.S. suppliers prior to the recent explosion of Japanese auto supplier investment in the U.S., the Japanese have accelerated the movement.

Company	Site	Capacity By 1990	Startup
Diamond Star	Bloomington, IL	240,000	1988
Fuji/Isuzu	Lafayette, IN	120,000	1990
Honda	Marysville, OH	360,000	1982
Honda	Alliston, ONT	80,000	1988
Hyundai	Bromont, QUE	120,000	1989
Mazda	Flat Rock, MI	260,000	1987
Nissan	Smyrna, TN	240,000	1983
NUMMI	Fremont, CA	260,000	1985
Renault	Kenosha, WI	180,000	1983
Suzuki	Ingersol, ONT	200,000	1989
Toyota	Cambridge, ONT	50,000	1988
Toyota	Georgetown, KY	200,000	1988
Volkswagen	Westmoreland, PA	180,000	1978
		2,500,000	

For the Japanese, the southern drift means closer access to the rapidly expanding markets of the south, cheaper building and operating costs, and more "virgin" labor supplies from rural locations with fewer union ties. A number of the manufacturing sites by Japanese OEMs to date are strategically located just far enough from major urban centers to allow the Japanese to stay within EEOC guidelines while avoiding the recruitment of what they see as difficult urban groups.

The new Japanese operations are selling to both American and Japanese carmakers, as well as meeting the aftermarket demand for Japanese vehicles. In fact, it is only by selling to the U.S. OEMs — and thereby further cutting into traditional markets of U.S. auto suppliers — that Japanese auto supplier transplants can obtain sufficient orders to justify full-scale operations....

An unpublished study commissioned by the U.S. Embassy in Tokyo declared in August 1986 that by 1988 there would be some 300 Japanese auto parts makers in the U.S. [Our work has uncovered] 110 "Japanese" plants announced or already operational, 40 of them joint ventures with American (38) or European (2) partners....

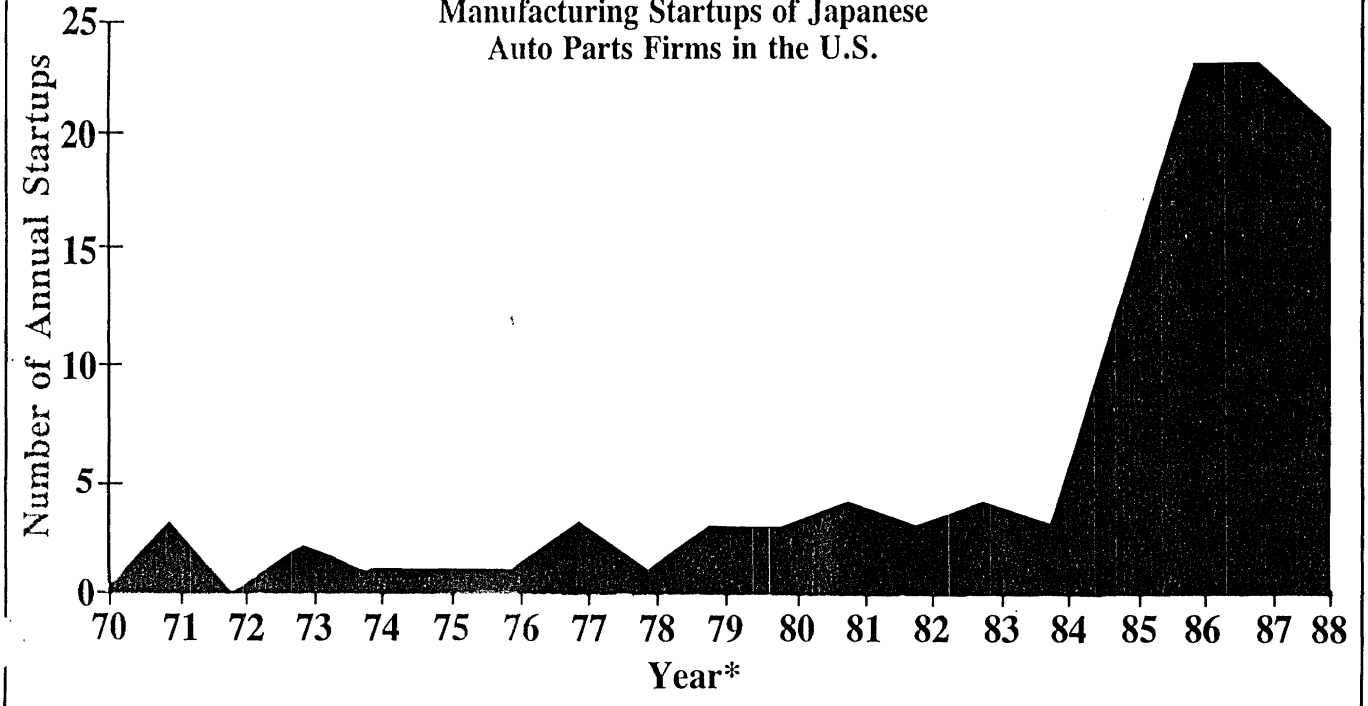
The large number of joint ventures conveys the impression that [many] U.S. firms are sharing in the growth of the Japanese supplier firms. Yet there can also be no doubt as to the substantial threat to the U.S. supplier industry.... Joint ventures or "strategic alliances" have been a traditional Japanese method of gaining entry into unfamiliar markets. There is no reason to believe that these joint ventures will last once the Japanese partner obtains "skills" that would have taken too long and cost to much to acquire had the Japanese firm gone it alone. Such joint ventures only make sense for American firms if they represent a sustainable balance of interests and are a conscious part of the strategic intent of American parts suppliers to build up their core competencies....

Automotive Groups and OEM-Supplier Relations

To focus on the "family" character of Japanese supplier-OEM relations suggests a noneconomic basis for decision-making. [We believe this suggestion to be] at variance with results that all can see. [Rather, history compelled the Japanese OEMs to follow a nationalist and "groupish" sourcing strategy.] Japanese government controls over both imports and foreign investment, in place until 1971, ... [prevented] Japan's automakers from seeking foreign suppliers. The [only] choice was whether to make parts or buy them.... In the Japanese case, three factors dictated a rejection of vertical integration. First, scarcity of capital compelled the OEMs to rely upon other firms — sometimes recruited from the defunct arms industry — to produce many of the parts they needed. Second, it was financially attractive to take advantage of the lower wage structure that prevailed among these smaller firms. And third, heavy home market competition [in an immature vehicle market] forced the OEMs to devote as much of their capital as possible to [building] final assembly [capacity].

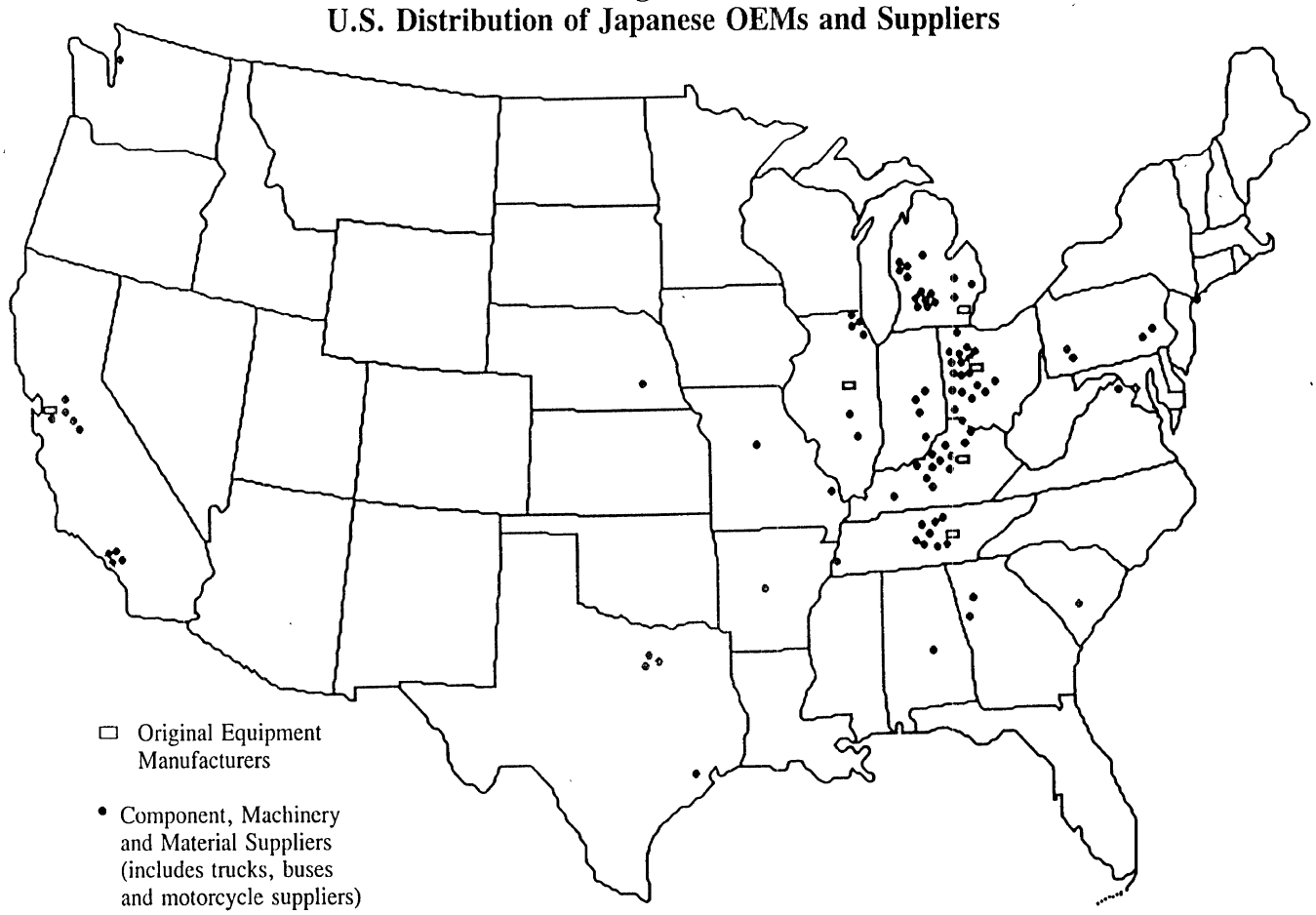
The historical outcome of these factors is that the cost of purchased parts has come to account for roughly 75% of the OEMs total production costs, [compared to 50-70% at the U.S. Big Three]. While this would seem to suggest a massive marketing opportunity for American suppliers, there are a number of factors that have kept that opportunity from materializing.

Figure 1
Manufacturing Startups of Japanese Auto Parts Firms in the U.S.



***Data for 1988 include 7 announced startups for which no startup date has been provided.**

Figure 2
U.S. Distribution of Japanese OEMs and Suppliers



Floating vs. Stable, Exclusive Relationships

[Low vertical integration presented three potential] . . . difficulties to Japanese OEMs: (1) a low level of technological competence on the part of some suppliers; (2) a cost disadvantage from using so many suppliers that none could achieve economies of scale; and (3) the high cost of policing the OEM-supplier relationship.

The response of OEMs . . . was to [give] a great deal of technical assistance to their suppliers, to keep the number of these suppliers as low as was consistent with maintaining sufficient volumes and some measure of [price] competition among them, [and to screen suppliers carefully to select only the best for stable and exclusive relationships]. . . .

Although Toyota is the only firm with an explicit policy of having two, and only two, suppliers for each part, the desire to restrict the number of suppliers is widely apparent. This means that OEMs tend to be extremely reluctant to take on a new supplier — especially for the high value-added items where industrial concentration is extreme. After all, unless the new supplier is good enough to . . . displace an old one, taking [it] on can only serve to increase the number of firms with which the OEM has to deal, thereby increasing transaction costs.

The implications for firms trying to win an OEM account are graphically apparent in figure 3. It shows 1967 figures for how long the members of Toyota's supplier association, the Kyohokai, had been supplying Toyota. At the time, Toyota had been dealing with a third of these firms since the 1930s, nearly two-thirds since the 1940s, and all but 7% since the 1950s.

Precise data on developments since 1967 are not readily available, but a 1984 study of 171 firms then comprising the Kyohokai found that o 21 of those firms had been admitted since 1973. . . . Thus, A...erican firms, even if they experienced no special disadvantages from being foreign firms, . . . would have great difficulty in being accepted as new suppliers to Japanese OEMs.

One must be careful, [however], in generalizing from the Toyota case. Honda, a relative newcomer to the automotive scene, began to produce cars in the early 1960s, a time when the national auto supplier infrastructure was rapidly maturing. Consequently, it established relationships with a wide range of existing automotive suppliers, many of which by definition were already supplying other OEMs. This has led to their having somewhat looser relationships with their suppliers and [to] being more open to accepting new suppliers [in both their Japanese and] American operations. Honda is the only Japanese OEM to date to have used an American construction firm in buildings its U.S. plant; 95% of the steel for its U.S. fabricated components comes from American companies; 50% of its Marysville machine tools were supplied by U.S. firms; and . . . it is operating a rapidly expanding engine plant in Anna, Ohio. In March 1987, Honda raised its 1990 target for the local content of its U.S. built cars to 70%. Even allowing for the "slippery accounting" that typically underlies such claims, . . . this represents a significant commitment to localization.

OEM Support for Supplier-Firm Development

Despite difficulties of access, there are obvious rewards for those who learn how to secure Japanese OEM business. One potential benefit is that the OEMs have long been extremely strong in promoting the technological and managerial development of their suppliers. . . . For example, in 1975 Honda instituted a five-year plan for improving the performance of 150 of its parts suppliers. It began by requesting 2-3-year management plans from each of these firms, and then provided production know-how and managerial advice. When this program concluded in 1979, the firms involved had achieved inventory reductions of 30-40% over 1974 figures; casting and forging firms had increased output by 70% while reducing their work force by 5%. . . .

Early Involvement in Design

Japanese OEMs typically expect that their suppliers will be involved in product design long before production of any given model begins. An important distinction is made . . . between suppliers capable of designing parts and suppliers that must be provided with specific drawings. The former are clearly providing a more valuable service since their capabilities reduce the size of the design staff that the OEM must maintain, and the prices they receive reflect this fact. But both must be prepared to work [for up to four years] before any cash flow begins. . . .

Prices on Japanese supplier contracts are initially set at the stage of trial production of a new model, six to nine months before mass production begins. They are then subject to review every six months for the duration of the contract, which is normally four years (the normal life cycle of a car model in Japan) or two years (the length of time between model introduction and midterm modification). [But what is] most distinctive about pricing . . . is the amount of information it allows the OEMs to extract from the suppliers. [All elements of cost] are subject to disclosure and negotiation. . . . [Thus] the savings realized through a supplier's efforts to reduce costs throughout the life cycle of the product [do not] automatically accrue to the supplier. . . .

Just-in-Time, Scale, and Flexibility

As practiced by the Japanese, JIT is designed to lower not only inventory costs but other production costs as well. It achieves the latter by forcing the production of parts in extremely small lots through flexible production methods. Even if American suppliers are willing to absorb the inventory costs that American OEMs used to accept, they would not have satisfied Japanese expectations. . . .

To be seen by the Japanese as a genuinely capable supplier, a firm cannot be fixated on the old high-volume, long-run mentality. . . . Toyota, Nissan, and Honda introduce about five models a year in Japan, so the pressure is for speed of product innovation and flexibility, not just cost advantage.

Joint Ventures — a Way Out . . . or In?

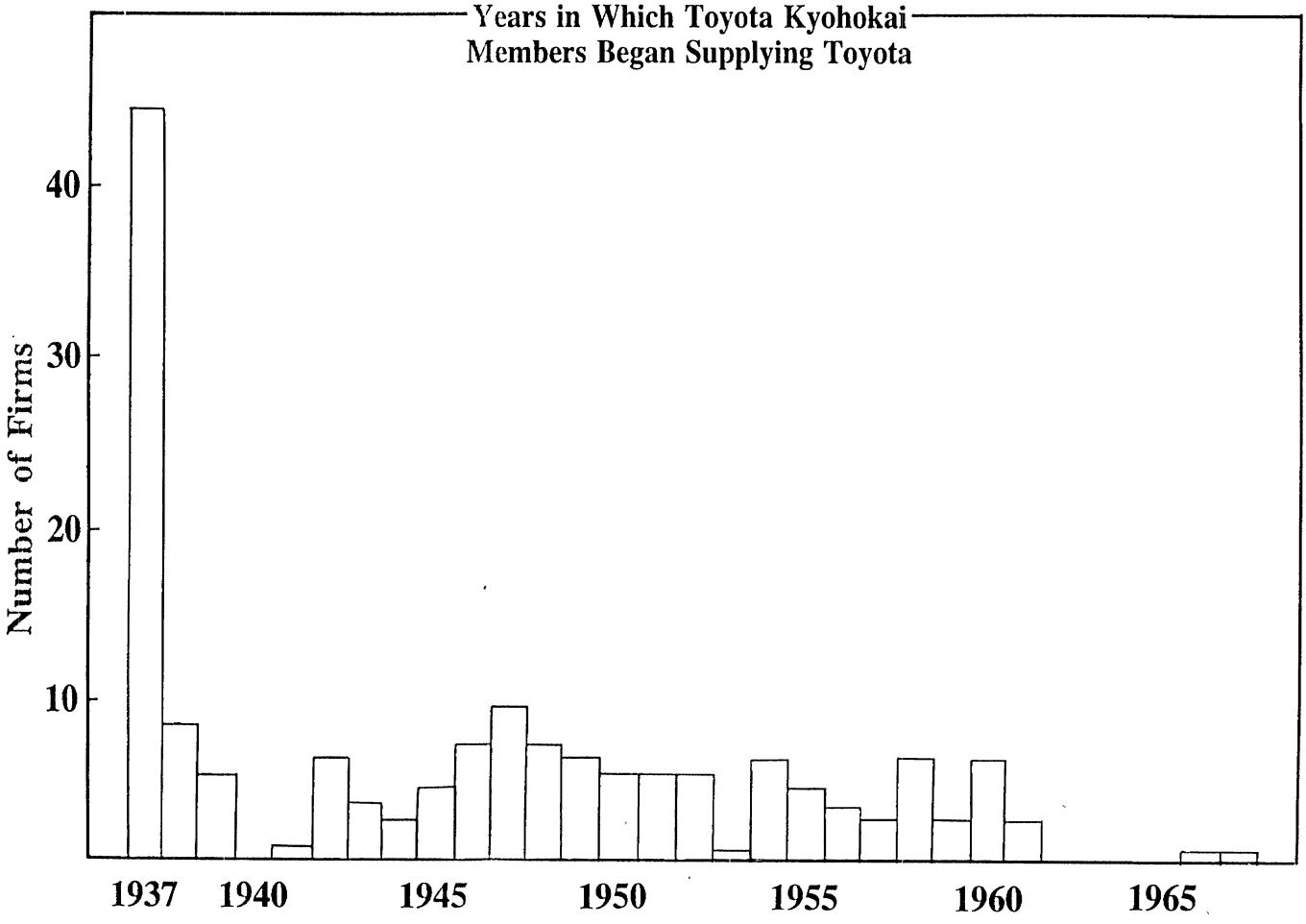
Given these access difficulties, it is scarcely surprising that many American suppliers have seen joint ventures with their Japanese counterparts as a means of cracking the OEM market. . . . [Will] these joint ventures benefit American suppliers in the long run, or will they instead diminish the capacity of the American firms to compete in both global and domestic markets?

There are at least three reasons that a U.S. parts supplier might be willing to enter into a joint venture with a Japanese supplier: (1) to benefit from the Japanese partner's superior access to the Japanese OEM and transplant markets; (2) to master a Japanese firm's superior technology. . .; and (3) to continue providing product lines that the American firm no longer wishes to produce. . . .

[Many U.S. suppliers have more urgent temptations to join with a Japanese partner.] Even extremely sophisticated American suppliers may feel that joint ventures offer them their only opportunity to crack the Japanese market [here and in Japan]. For instance, General Motors found that the only way it could supply Nissan with radiators in Japan was by forming a joint venture with Nihon Radiator, even though its own technology was believed to be superior.

Another factor [pushing] American suppliers into joint ventures is that the basis of competition is shifting. . . . Reliability and low cost are increasingly regarded as minimum hurdles, not sources of competitive advantage. The efficient marriage of different technologies is the key to being an integrated supplier. Since [on average] the Japanese are clearly ahead in this field, a tie-up with a Japanese supplier could enable an American supplier to gain knowledge. . . .

Figure 3
Years in Which Toyota Kyohokai Members Began Supplying Toyota



Source: Adachi, Ono, and Odaka, in *The Motor Vehicle Industry in Asia* (Singapore Univ. Press, 1983)

From the Japanese perspective, a joint venture with a U.S. parts supplier reduces both investment and marketing risks. First, in an unfamiliar market, it gains access to the market and the distribution networks of American suppliers. [Second, in some U.S. OEMs, in which captive supplier plants are the default sourcing choice,] the only way for the Japanese suppliers to break into the American OEM market through joint ventures.

[Third, while] Japanese OEM would prefer not to rely on an American supplier with which they have not had much experience, [they recognize that] . . . bringing exclusively their own suppliers to the U.S. would increase protectionist sentiment [here]. . . .

The Yen it is A-Changin'

The Japanese OEMs that established early operations in the U.S. [often] looked over the American supplier base, were not particularly impressed with the quality they saw, and quickly turned to encouraging some of their key Japanese suppliers to join them in the U.S. With the accelerating political pressure and the changing economic incentive produced by the rapidly appreciating yen, however, they increasingly are giving American suppliers a second look. [Moreover, many] U.S. suppliers have moved aggressively to adopt Japanese practices, [so] they look a lot more attractive. . . .

For Japanese OEMs coming to the United States later, e.g., Toyota in Kentucky, there was a greater sensitivity to the new situation. It [has been reported] that Toyota has told its suppliers (with three exceptions — Nippondenso, Aisin Seiki, and Toyoda Gosei) that they *must* form joint ventures with U.S. firms. . . . Honda now claims that it only encourages its Japanese suppliers to move to the United States to establish fully-owned subsidiaries when no local independent producer of materials or components is available, i.e., when local independent production is entirely done by U.S. OEM internal subsidiaries. . . .

The Need for Caution

All too frequently, joint ventures in the U.S. [do little except] to transfer Japanese management practices to U.S. manufacturing sites. Japanese managers and engineers are brought to the joint venture to provide guidance for the manufacture of a component that was designed in Japan with minimal input from the American partner. Rarely do joint ventures involve shared experience in research, either basic or applied. . . . The U.S. firm tends to provide little more than financial support . . . and marketing. . . . The Japanese control all the parts of the value-chain that offer opportunities for developing and controlling the next generation of process and product designs. The higher value-added jobs that create higher incomes are kept in Japan, and the U.S. partner retains little incentive to develop product and process design skills. . . . Over time, the U.S. partner's "will to win" may be gradually sapped, leading to reliance on the Japanese partner. . . .

Tilting the Tables — An Action Agenda

Joint ventures should only be undertaken in the context of a clearly defined framework for the [American] firm. . . . Once a joint-venture agreement is arrived at and implemented, management . . . should continuously monitor [its] performance and direction and assess the outcomes and future implications. Contractual provisions are not a proxy for active management: changing external competitive conditions require constant reformulation of the goals of the joint venture. . . .

Managers and workers should constantly build their skill levels and [insist that they be allowed to] learn the product and process technologies of the Japanese partner. They should concentrate on mastering core competencies that can be transferred from the joint venture to [their] other product lines. . . . In this way, the American partner will not only gain access to the [Japanese] OEMs, . . . but also gain learning that can strengthen its business with the Big Three. [This is defense as well as offense:] the Japanese partner will have the same objective of internalizing the core competencies of the American partner while giving away as little as possible of its own advantages.

To insure reciprocity, U.S. suppliers must use the desire of the Japanese firms to form joint ventures in the U.S. as a lever to negotiate for their own access to the Japanese OEMs, both here and in Japan, as well as to the whole process of product design and supply. . . .

The Auto in Michigan Project
Room 107
University of Michigan
Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109

ATTACHMENT 3

REORIENTATION OF AIM PROJECT ACTIVITIES, APRIL - SEPTEMBER 1987

- Workplan Revision Request
- Letter to Advisory Board
- AIM Project FY 1988 Proposal

14 July 1987

Mr. Alan Baum
Director, Research and Analysis Program
Michigan Modernization Service
212 Hollister Building
106 W. Allegan
Lansing, MI 48913

Dear Alan:

This letter is to set out for you as Program Manager for the Auto-in-Michigan project certain changes in the work plan for the balance of FY 1987. As we have discussed, several project participants have recently been redeployed to tasks not anticipated in the original FY87 work plan.

As you know, AIM funds in FY87 cover the time and expenses of project coordinator Dan Luria and of Michael Flynn through a subcontract to ITI, as well as a portion of Dave Andrea's and my time -- with clerical and administrative support -- here at OSAT. As you also are aware, the Project's main activity in FY87 was to have been an intensive, highly-structured, on-going interaction with the Commerce Department's "Renew" program. Under that program, Commerce account executives use an AIM-designed protocol to guide site visits to major automotive facilities throughout the state, and then file detailed trip reports. AIM participants are charged with maintaining up-to-date commentaries on those trip reports, and with preparing periodic briefing memoranda for the Department's Auto Policy Group, based on the patterns that emerge from the amended trip reports.

This project design worked without a hitch until early February, when problems of facility access sharply reduced the volume of Renew visits and report-filings and, frankly, reduced the "momentum" of that program. While there has been a marked pickup in Renew visitations since late May, clearly Renew has not since mid-Winter provided a full base for AIM activities.

In recognition of this fact, you and I and Dan Luria have made, *de facto*, a series of redeployment judgments, which this letter makes explicit as an amendment to the original FY87 work plan. The redeployments have been in accordance with your March-May discussions with Luria that resulted in the design and, for all intents and purposes, start of FY88 AIM research efforts.

Those efforts will be targeted on our state's independent auto suppliers, and specifically on identifying opportunities for them as a result of changes in Big Three sourcing strategies. Specific approaches include:

- improving our GM sourcing database coverage;

- analyzing data already collected by AIM on Michigan car and light truck assembly plant component purchases ("sourcing analysis" or "SA" below);

- a set of case studies on subsystem sourcing at each of the Big Three and at Honda and Mazda ("strategic sourcing methodologies" or "SSM" below); and

- developing a database on Michigan engineering service firms specializing in the design of the subsystems that other research[1] forecasts as presenting the best opportunities for Michigan's independent suppliers ("engineering services" or "ES" below).

Each of these sub-projects has a set of deliverables; I understand that you have been "negotiating" these with Luria as part of the development of the FY88 proposal.

---

[1]This includes AIM's "SA" and "SSM" work, just described, as well as non-AIM FY87 Commerce-funded work on transplant firms' and Saturn's parts sourcing patterns.

This has certain implications for how most AIM participants have been allocating their time and effort since April 1, i.e., in the second half of FY87. The matrix below shows the time allocation anticipated in the original FY87 work plan -- and which was actually followed in the October, 1986 - March, 1987 period -- and the revised time allocation in effect since April 1, 1987.[2]

	Original			Revised					
Participant	Renew	NL	Adm	Renew	NL	Adm	SA	SSM	ES
OSAT:									
D. Andrea	70%	-	30%	20%	-	30%	50%	-	-
D. Cole	90	-	10	90	-	10	-	-	-
Support staff	-	20%	80	-	20%	80	-	-	-
ITI:									
M. Flynn	100	-	-	40	-	-	-	-	60%
D. Luria	50	25	25	-	25	25	20	25%	5

I trust that this revised work plan will be satisfactory for the balance of FY 1987. If not, I will look forward to your suggestions.

Sincerely,

David E. Cole
Director

cc: D. Luria

[2]In the table below, "NL" means the AIM *Newsletter* and "Adm" refers to project administration -- including Advisory Board relations, database maintenance, clerical, and day-to-day management.

THE AUTO IN MICHIGAN PROJECT

A State of Michigan Program with the
Office for the Study of Automotive Transportation
The University of Michigan Transportation Research Institute
2901 Baxter Road, Ann Arbor, Michigan 48109 (313) 764-5604

June 5, 1987

Mr. Fred Bolling
Director
Manufacturing Processes Laboratory
Ford Motor Company
24500 Glendale
Redford, MI 48239

Sent to all Advisory Board Members.

Dear Fred:

I am writing to update you on AIM's activities since we met in October. As you're about to read, the Project has been busy--and has also changed substantially, at least in its "angle of view."

The change is evidenced by the extent to which AIM's continuing work is blended with other economic development research in State government. For example, AIM staff have been working with another group at the University of Michigan, as part of their broader work for State government, to model the impacts of the predictions we've made, often with your help and feedback. The most recent issue of the AIM Newsletter presented the results of some of that work in the areas of parts sourcing and changes in where, and of what material, body panel forming is done.

We think it is a measure of AIM's, and hence of your, usefulness to State policymakers that AIM has assumed a lower-profile role as the catalyst and "auto think tank" for several of the State's most promising higher-visibility efforts. The Technology Deployment Service (TDS), for example, which has worked on technical upgrading with over a hundred Michigan firms since October 1985, was formed largely because of AIM's conclusion that the public sector's most powerful role could be in nurturing the "value-added chains" emanating from first-tier suppliers. If partsmakers (captive and independent alike) engineer, manufacture, and assemble more built-up subsystems, then Michigan has to fight not just to retain and attract these "module-makers" but, even more important, to maximize the proportion of their suppliers that are capable Michigan firms.

In fiscal 1988, TDS is being absorbed into a larger entity called the Michigan Modernization Service. MMS seeks to work with many times more of Michigan's small and medium-sized firms. It aims to provide them an integrated package of assistance in marketing, business planning, workforce up-grading, and labor-management relations as it works with them on their technology programs.

Meanwhile, our work this fiscal year with the OEMs has not been what we hoped it would be. Beginning about a year ago, the Project began an exercise to forecast the prospects of every Big Three and major supplier facility in the state. We in AIM, and the State's Auto Policy Group as well, were excited about this ambitious effort, as it promised to produce a wealth of policy-useful results, e.g., which suppliers were likely to need help if such-and-such OEM plant closed; which large plants could be "turned around" by appropriate private-public intercession?

To test our forecasts, we urged the State to begin what became its "Renew" program, under which Commerce Department account executives undertook to visit all of the State's major auto-related facilities, and to report back to the Auto Policy Group and to AIM on discussions covering business strategies, suppliers, labor relations, and items for quick State action. AIM's primary job in fiscal 1987, in fact, was to have been to react to trip reports filed on these visitations, and to integrate information collected with Renew with our analyses of larger industry trends.

While Renew got off to a good start, the process as a whole has not been successful. First, we found--and I and others on the AIM staff may have been naive not to expect--that all of the Big Three OEMs did not consider it appropriate to comment on our forecasts at the establishment level. Also reflecting this, Renew encountered significant problems of access to some OEM plants.

In light of these experiences, the staff and its advisors in State government decided to rethink and redeploy.

The rethinking runs like this. Given (1) the (in retrospect) understandable problems facing sensitive work on OEM (especially component) plants; (2) the general approval, on the part of OEM and independents alike, for State action to help upgrade smaller suppliers' technology, quality, and workforce; (3) AIM's identification of strong "modular sourcing chains" as the key to maintaining auto wealth in the state; (4) the suppliers' fast-increasing needs for more engineering expertise and for greater market access to the transplants; and (5) the State's commitment, evidenced by TDS and soon MMS, to seek industrial modernization through an emphasis on a full range of services for firms with fewer than 500 employees, we have decided to harness AIM more fully and explicitly to the concerns and needs of Michigan independent auto suppliers.

Obviously, these needs and concerns include selling to and working with OEM customers, so we anticipate a continuing need for advice from non-supplier representatives on the Advisory Board. What has changed, really, is the angle from which we are choosing to view the industry in the state.

De facto, we have initiated an early launch for fiscal 1988 AIM work, and have designated FY'88 as "the year of the supplier." Thus, we have declared or, more accurately, admitted the end of the first OEM-

centered, macro context-setting phase of AIM, and inaugurated the second.

AIM, in this second phase, sees its primary business as closely analyzing the wealth of information we've collected on Michigan assembly programs' sourcing. Once this analysis provides us with a better sense of which components offer the best opportunities for Michigan suppliers, we plan to model for those components how each OEM makes sourcing decisions for new car and light truck programs.

We will then stir into the mix further work on the state's Engineering Service (ES) sector, with an eye to identifying--and characterizing competencies by component (product and process)--the ES capacities available to Michigan suppliers as they are forced to offer more "black box" and "grey box" design/engineering in their quest for both Big Three and transplant business.

These AIM projects feed and interact with non-AIM work also being funded by the State in FY'87 and '88. This includes another study of component sourcing, this time focused on what the transplants buy where, what the Big Three buy offshore, and who is winning Saturn business. As with the sourcing analysis work described two paragraphs above, the goal is to find the best "import-substitution" opportunities and mechanisms for Michigan suppliers.

Another, highly complementary, State-supported study will survey suppliers in the subsystems identified in the work just described and attempt to characterize their capabilities and performance, e.g., their relative technical sophistication, quality ratings by their customers, and their progress in meeting (and their concept of) JIT demands.

In sum, AIM is becoming (1) less OEM-"angled," (2) more focused on small and medium-sized suppliers; (3) more involved with the nitty-gritty of component-level decisions; and (4) more focused on business development and less on "pure research." This reorientation inevitably means much more digging into individual companies' purchasing data and policies; more work with sensitive firm-specific information; and more integration with other State economic development activities. It also makes more of what AIM does less appropriate to present at multicompany gatherings.

Since we continue to value your advice (and your willingness as individuals to help when we call you for a favor at the worst possible time), we certainly want to keep the Board a going concern. Our solution is to go from regular twice-a-year get-togethers to meeting on an occasional basis--what Jack Russell succinctly calls "becoming loosey-goosey by design." We will, of course, keep you regularly posted on our activities, through letters such as this one and via the AIM Newsletter. (Please let me know if you could use more copies of the Newsletter, and what you think of it.)

We're planning an early fall event, hopefully returning to Inglis House in Ann Arbor. I'll try to set a date, and at least a rough agenda, by early summer, and will let you know.

I hope you're well and that business is good; I look forward to seeing you in the fall.

Sincerely,

Dan Luria

cc: David Andrea
Alan Baum
David Cole
Mike Flynn
Richard Hervey
Jerry Jurek
Greg Main
Pete Plastrik
Doug Ross
Jack Russell
Don Smith

Industrial Technology Institute (ITI)
P.O. Box 1485
Ann Arbor, Michigan 48106

Submitted By:
Center for Social and Economic Issues (CSEI)

April 6, 1987

Auto-in-Michigan FY88: The Year of the Supplier

Prepared by: Daniel Luria

ITI Proposal # E42-87 CS 16

Approved by:

Donald Falkenburg	Louis G. Tornatzky	Susan L. Rasmussen
Vice President, R&D	Director, CSEI	Manager, Contracts, BSC

AIM in FY88: A Proposal

This is a proposal from the Industry Affairs and Policy Group of ITI to the State of Michigan for management of the Auto-in-Michigan project during fiscal year 1988. The proposal recognizes that, consistent with the needs of the State as it launches the Michigan Modernization Service, the research agenda must shift its focus from the OEMs to the suppliers.

"The Year of the Supplier"

In its first three years of existence (FY85-87), the AIM Project focused on the siting, sourcing, materials, and technology decisions of the major auto assembly companies. This work continues, but is increasingly in a "maintenance mode." Thus the real contribution of the Project in FY88 should be to study, and to model in useful ways, the network of thousands of smaller firms in the Michigan automotive economy. FY88 should be, for AIM, the year of the supplier. It is our conviction that the State's most significant leverage can be exercised in the technology and training assistance needed to nurture the chains of value-added below the Big Three level; indeed, the formation of the Technology Deployment Service and the launch of the Michigan Modernization Service (MMS) represent the same conclusion.

Hence, the program of research and analysis proposed below speaks to the needs of a responsibly activist State government seeking to assist its economic base firms to survive and prosper as the domestic automakers "decontent" their vehicles and lose market share to transplant assemblers that are, absent a push, less likely to look to Michigan suppliers for parts. The elements of the proposed research program all aim to provide State government with the information it needs to provide that push. By (i) improving our picture of GM's Michigan assembly plant parts sources, we seek to identify opportunities for smaller suppliers as GM looks outside for more of its inputs. By linking this work with non-AIM State-supported investigations of transplant, offshore, and Saturn sourcing ("TOSS"), we seek to identify the subsystems that represent the best openings for new Michigan supplier work. By (ii) modeling how each of the Big Three goes about making sourcing determinations for those subsystems in their new vehicle programs, we hope to arm the State with the elements of a strategy for Michigan independents seeking to expand their role as primary suppliers. By (iii) determining the specialties of the state's automotive design firms, we hope to arm Michigan suppliers with the information they need to form alliances that bring OEM customers complete design, engineering, prototyping, and production capabilities. We

also propose (iv) to use the AIM Newsletter and (v) Auto Supplier Show, the latter conducted jointly with MMS, to bring our findings to Michigan's supplier community.

Proposed AIM FY88 Activities

We propose the following activities for FY88:

- Improved GM sourcing database. Preliminary agreement has been reached between AIM and its top consultant to add detail to the GM sourcing data currently in the AIM sourcing database. This work would be completed in stages, with BOC first, followed by Truck and Bus and then CPC. A sum of $6,500 is requested for this activity, with work to be completed by August, 1988. Significant deliberables would, however, be available before that point, because data will be provided by vehicle program. The same consultant would also continue to supply periodic phone updates to add value and currency to AIM's existing Ford and Chrysler sourcing records.

- Analysis of Big Three Parts Sourcing. With the assistance of David Andrea and Mark Everett, the Project proposed to perform detailed analyses of its Ford, Chrysler and, when available, GM Michigan assembly plant parts sourcing lists. Also studied will be at least one list showing *all* inputs into Chrysler's P- and H-body cars. The goal is to discover "pattern rules" that may enable us to develop lists of parts representing the best opportunities for Michigan suppliers. This analytical study will require $5,000 of FY88 support, including $500 for database software consulting.

- Strategic Sourcing Methodologies. This work, which would be led by Project consultant Richard Hervey, is aimed at discovering and modeling the emerging component and subsystem sourcing "rules" of the Big Three OEMs. This effort would seek such rules or patterns both at the level of general principles, and for several selected product programs. By undertaking a few case studies of sourcing for several subsystems of both new and more mature vehicles, it is anticipated that this study would assist in understanding how, where, and by whom decisions that advantage or disadvantage Michigan suppliers are made. This activity would require $9,000 in FY88 funds.

- AIM Newsletter. Dan Luria proposes to continue as publisher-editor of the Project's newsletter, with text derived from the projects listed above and, if and as appropriate, the non-AIM State-supported study of transplant and Saturn sourcing. The newsletter would be published three to four times during FY88. Costs are estimated at $15,000; this includes production of at least 6,000 copies of each issue and maintenance of an up-to-date computerized mailing list.

- AIM Slide Show Update: $1,500 is sought to update the AIM slide show to include work done since FY1986. Virtually all of this sum would be spent for artwork.

- Project Direction/Administration. Dan Luria proposes to continue as Project director, and would make available 60 days during FY88. Included is responsibility for occasional MMS staff briefings.

- Annual Advisory Board Event. $2,000 is sought to stage a dinner and meeting of the Project's long-standing Advisory Board.

- Auto Supplier Show. AIM would co-produce with MMS at least one major event in FY88 that will bring together major players from the auto industry. Its focus would be to showcase MMS to the automotive supplier community. $2,500 in AIM funds is sought for this event, with AIM activities forming a major core of the program. These dollars will cover the logistical costs of the event, as well as supplies and handouts.

- Engineering Services (ES) Database. IAPG, with Mike Flynn as principal contributor, seeks funding of $13,460 with which to construct an ES database, using ISR, MRA, or other appropriate outside survey capacity for final instrumentation, survey execution, and data entry and reportage. The format of "census" and detailed level datasets pioneered in the State-funded study of automation suppliers would be followed. Included in the database would be fields showing on which vehicle programs and subsystems various ES firms specialize; this would permit orderly identification of cases in which Michigan suppliers' choice of ES partners may affect their prospects for winning bids. An MD1-style dBaseIII+ database will be a required deliverable. All fields will be selected in consultation with the funder. Checkpoints will include (i) agreement that a satisfactorily complete listing of Michigan ES firms has been developed, (ii) agreement on census dataset fields, and (iii) signoff on detailed dataset fields and data collection methods, including the mix of telephone and personal interviewing. The census-level database will be completed by December 31, 1987 and the more detailed database, along with an analytical study and AIM Newsletter article, by May 31, 1988.

- Computer Conferencing for AIM Participants. ITI will continue to maintain the AIM Project computer conference using the Confer package on MTS. Based on FY87 usage, $2,800 will be required.

Budget

A proposed budget is presented below. ITI staff's time is charged out with 20% for fringe benefits and a 60% overhead rate on pay-plus-fringes (an implied overhead rate, including fringes, of 92%). All other costs are charged at an overhead rate of 10%.

	Direct Cost	Overhead Cost	Total Cost
GM Sourcing	$6,500	$650	$7,150
Sourcing Analysis	5,000	500	5,500
Sourcing Decisions	9,000	900	9,900
Newsletter	15,000	1,500	16,500
Slides	1,500	150	1,650
Supplier Show	2,500	250	2,750
Director: 60 days at $265	15,900	14,628	30,528
Travel	1,000	100	1,100
Advisory Board	2,000	200	2,200
Postage, incl Newsletter	1,000	100	1,100
Phone	1,500	150	1,650
Supplies & xeroxing	1,000	100	1,100
Newsletter mailing list	1,000	100	1,100
ES dB: - ITI staff time	3,000	2,760	5,760
- Outside services	7,000	700	7,700
Confer on MTS	2,800	280	3,080
TOTAL	$75,700	$23,068	$98,768

ATTACHMENT 4

A MODEL OF GM IN MICHIGAN TO INFORM TARGETED PLANT-LEVEL ASSISTANCE

Industrial Technology Institute
P.O. Box 1485
Ann Arbor, Michigan 48106

MEMO TO: Auto Policy Group

FROM: Dan Luria

DATE: August 19, 1987

SUBJECT: A Model for Assessing the Need for and Payoff to State Efforts with GM Manufacturing Plants in Michigan

Attached are the results, and explanation, of a model developed over the past nine days to assist the State in selecting GM manufacturing plants for which public sector effort is both needed and likely to be high-return.

The **first attachment** to this memorandum is a set of three spreadsheets. The first presents key information about the 58 GM manufacturing plants in Michigan. The second presents only the 23 facilities that scored above the threshold score of ten and for which no imminent shutdown has been announced. The third shows only the 13 plants that scored over 10 *and* are in high-poverty, high-auto-dependence areas.

The scoring system is explained in the **second attachment**, entitled "GM Plant Targeting Model." As it explains, each plant's score is a function of:

- its employment weight in the Michigan GM economy,
- its degree of linkagedness with other Michigan manufacturing sites,
- the likelihood and extent of threatened outsourcing of work,
- the likely destination of any work outsourced, and
- the proportion of the plant's current suppliers that would not remain suppliers to the facilities likely to win the outsourced work.

Scores range from 0.1 for the extremely-safe BOC Delta Township plant to 287.4 for the doomed BOC Clark/Fleetwood complex. Very large plants, such as AC Flint and Inland Livonia, make the first cut despite their relatively low linkagedness to the rest of the Michigan manufacturing economy. Very small plants, such as T&B Detroit (Piquette Road), fail to make the cut despite their reasonably high degree of Michigan linkagedness.[1]

The **third attachment** is composed of 58 sheets, one for each plant, that provide the rationale for the values selected for each plant on the variables in the model.

I think you will find this model a useful tool in your efforts to develop an affirmative strategy for GM's Michigan production facilities. If I can be useful in clarifying any of the entries or formulae, please don't hesitate to contact me. See you September 1st.

[1]This cutoff is inevitably arbitrary but, as an inspection of the first spreadsheet makes clear, thoroughly reasonable.

GM PLANT TARGETING MODEL

SCORE = JOBWT x LINK x OUT x 1/DESTIN x KEPT

Where:

JOBWT	is the plant's percentage of total GM manufacturing jobs in Michigan;
LINK	is a measure of how richly the plant's activities are linked to the state economy;
OUT	measures the likelihood and extent of work being outsourced; and
KEPT	measures the percentage of the plant's current Michigan suppliers likely not to be kept as suppliers to the plant(s) to which work might be outsourced.

Ranges of Values

JOBWT ranges from 0.1 to 4.9,

LINK ranges from 2.0 to 10.0,

OUT ranges from 1.0 to 10.0,

DESTIN ranges from 1.0 to 10.0,

where 10 = Michigan;
5= other upper Midwest;
4= Ontario;
3= rest of U.S.;
2= Mexico; and
1= rest of world, and

KEPT ranges from 0.5 to 8.0.

Background Formulae

JOBWT = EMPL/sum(EMPL), where EMPL is the plant's current hourly plus salaried employment.

LINK = 1/100 x [(LINK1 x PCT1) + (LINK2 x PCT2)], where LINK 1 is the extent to which the plant's primary product(s) link to other Michigan production, and PCT1 measures how much of the plant's output is of its primary (set of) product(s). LINK2 and PCT2 are analogously defined, for the plant's other (set of) product lines(s).

Plant Type Linkage Ratings

Car Assembly	10
Light Truck Assembly	8
Engines, Traditional Materials/Technology	6
Engines, Non-traditional	5
Transmissions	5
Machined Parts & Subassemblies	5
Medium and Heavy Truck or Bus Chassis/Assembly	4
Body Panel Stampings	4
Other Stampings or Extrusions	4
Plastic/Molding, incl. Door Trim	3
Castings and Forgings	3
Tooling	3
Hardware	3
Misc. Electrical/Electronic	2
Textiles/Fabric, Incl. Seat Cvrs.	2

OUT = 1/100 x CHANCE x EXTENT, where CHANCE is the likelihood of a major outsourcing event, and EXTENT describes the percentage of the plant's output likely to be affected in that event.

KEPT = 1/10 x (100 - SAME), where SAME estimates the percentage of the plant's current Michigan suppliers (captive and independent) likely to remain suppliers to the facility(ies) to which work might be outsourced.

Variables Not Currently Used in Model

DEMOG is intended to depict the demographic impact of a major outsourcing event at the plant. It tries to capture both the local (city, county) economy's fiscal dependence on the plant, and the local area's overall poverty and unemployment situation.

Auto-dependent and/or high-unemployment major urban centers, most employees resident (Detroit, Flint).....10

Auto-dependent and/or high-unemployment areas, many employees from less depressed cities/towns (Pontiac, Saginaw).....9

Small cities with significant fiscal dependence on facility (Adrian, Tecumseh, Three Rivers).....8

Industrial "suburbs" of two categories above (Livonia, Romulus, Redford, Warren, Grand Blanc, Bay City).....6

Major commercial/government centers of moderate auto-dependence (Lansing).....4

Less dependent (county) areas (Kalamazoo, Grand Rapids, Orion).....3

COOP gives a rating of the labor-management cooperation climate at the plant. While the scale is from 1 (persistent acrimony and frequent wildcat strikes) to 10 (continuous love-in; janitor's son dates plant manager's daughter), the real range is more like 3 (significant acrimony, high grievance volume, resistance to "modern labor agreement") to 7 (reasonable trust and shared information, modern agreement). Ratings are fluid, and strongly (but not predictably) reflect relative security, e.g., recent loss of business at CPC Bay City improved COOP by scaring labor and management into a pull-together-to-win-new-work coalition; loss of GM80, and hence plant's future, lowered COOP at Pontiac Plant 8.

ID	TYPE	PLANT	CITY	DEMOG	COOP	EMPL	JOBWT	LINK1	PCT1	LINK2	PCT2	LINK	CHANCE	EXTENT	OUT	DESTIN	SAME	KEPT	SCORE
1	ASSY	BOC CLARK-FLTWD	DET	10	3	6800	3.668	10	90	4	10	9.4	10	100	10.0	3.0	75	2.5	287.4
2	ASSY	BOC HAMTRMCK	DET	10	6	4700	2.535	10	100		0	10.0	1	100	1.0	10.0	95	0.5	1.3
3	ASSY	BOC FLINT-BCITY	FLNT	10	3	5100	2.751	10	85	4	15	9.1	5	100	5.0	7.5	90	1.0	16.7
4	ASSY	BOC LANSING	LNSG	4	6	6000	3.237	10	100		0	10.0	3	50	1.5	5.0	75	2.5	24.3
5	ASSY	BOC LANSING 2	LNSG	4	7	600	0.323	10	100		0	10.0	1	100	1.0	10.0	95	0.5	0.2
6	ASSY	BOC ORION	ORIN	3	3	6700	3.614	10	100		0	10.0	5	100	5.0	8.3	95	0.5	10.9
7	ASSY	BOC WILLOW RUN	YPSI	6	5	4300	2.319	10	100		0	10.0	2	100	2.0	7.5	95	0.5	3.1
8	ASSY	CPC PONTIAC 1	PONT	9	6	2400	1.294	10	100		0	10.0	1	100	1.0	7.5	80	2.0	3.5
9	ASSY	CPC PONTIAC 8	PONT	9	5	1800	0.971	10	100		0	10.0	10	100	10.0	4.0	80	2.0	48.6
10	ASSY	T&B DET (PIQT)	DET	10	6	650	0.350	4	75	4	25	4.0	5	100	5.0	5.0	60	4.0	5.6
11	ASSY	T&B FLINT	FLNT	10	4	4500	2.427	8	100		0	8.0	9	100	9.0	6.0	75	2.5	72.8
12	ASSY	T&B PONTIAC 2	PONT	9	3	3000	1.618	4	90	4	10	4.0	9	100	9.0	5.0	90	1.0	11.7
13	ASSY	T&B PONTIAC 5	PONT	9	5	2200	1.186	8	100		0	8.0	4	40	1.6	4.0	90	1.0	3.8
14	ASSY	T&B PONTIAC 6	PONT	9	6	3800	2.050	8	100		0	8.0	2	100	2.0	4.5	95	0.5	3.6
15	STMPG	BOC CONNER	DET	10	4	2000	1.079	4	100		0	4.0	9	100	9.0	3.0	30	7.0	90.6
16	STMPG	BOC FLINT BODY	FLNT	10	3	3200	1.726	4	100		0	4.0	10	100	10.0	7.0	80	2.0	19.7
17	STMPG	BOC GRAND BLANC	GRBL	6	6	3400	1.834	4	100		0	4.0	3	100	3.0	10.0	80	2.0	4.4
18	STMPG	BOC K200	K200	3	5	3400	1.834	4	100		0	4.0	2	100	2.0	8.7	80	2.0	3.4
19	STMPG	BOC OLDS FAB	LNSG	4	5	4700	2.535	4	80	3	20	3.8	4	70	2.8	7.5	80	2.0	7.2
20	STMPG	CPC GRD RPDS	GR	3	5	3400	1.834	4	100		0	4.0	6	100	6.0	8.7	80	2.0	10.1
21	STMPG	CPC PONT METFAB	PONT	9	6	4000	2.158	4	70	4	30	4.0	6	90	5.4	7.5	80	2.0	12.4
22	STMPG	T&B FLNT METFAB	FLNT	10	4	4500	2.427	4	100		0	4.0	5	100	5.0	7.5	80	2.0	12.9
23	ENG	BOC DELTA TWP	DLTP	4	7	1000	0.539	5	100		0	5.0	1	100	1.0	10.0	95	0.5	0.1
24	ENG	BOC FLINT ENG	FLNT	10	4	4000	2.158	6	100		0	6.0	3	50	1.5	7.5	80	2.0	5.2
25	ENG	BOC LNSG ENG	LNSG	4	5	3700	1.996	6	100		0	6.0	3	50	1.5	7.5	80	2.0	4.8
26	ENG	BOC LIVONIA ENG	LIV	6	6	1850	0.998	5	100		0	5.0	1	100	1.0	7.5	95	0.5	0.3
27	ENG	CPC FLINT ENG	FLNT	10	3	4500	2.427	6	100		0	6.0	2	50	1.0	5.3	75	2.5	6.9
28	ENG	CPC PONTIAC ENG	PONT	9	5	4000	2.158	6	100		0	6.0	2	50	1.0	5.7	60	4.0	9.1
29	ENG	CPC ROMULUS	ROM	6	7	850	0.458	6	100		0	6.0	1	100	1.0	5.0	90	1.0	0.6
30	ENG	DDA REDFORD	RDFD	6	4	4300	2.319	6	50	5	50	5.5	5	75	3.8	4.5	60	4.0	42.5
31	TRANS	HMD CONSTANTINE	CNST	8	5	200	0.107	4	100		0	4.0	10	100	10.0	10.0	90	1.0	0.4
32	TRANS	HMD FLINT 10	FLNT	10	3	3200	1.726	5	60	4	40	4.6	5	100	5.0	5.0	75	2.5	19.9
33	TRANS	HMD THREE RIV	TRIV	8	6	2000	1.079	5	100		0	5.0	8	100	8.0	5.0	80	2.0	17.3
34	TRANS	HMD WARREN	WRN	6	5	4200	2.265	5	75	4	25	4.8	5	25	1.3	4.5	40	6.0	17.9
35	TRANS	HMD WILLOW RUN	YPSI	6	4	8900	4.801	5	100		0	5.0	2	25	0.5	6.0	60	4.0	8.0
36	PARTS	AC	FLNT	10	5	11000	5.934	5	25	2	75	2.8	8	75	6.0	2.5	40	6.0	235.0
37	PARTS	BOC AXLE&FORGE	FLNT	10	4	2000	1.079	5	60	3	40	4.2	6	100	6.0	4.0	50	5.0	34.0
38	PARTS	BOC PLANTS 3&5	LNSG	4	5	2000	1.079	4	40	3	60	3.4	6	50	3.0	4.0	30	7.0	19.3
39	PARTS	CFD SAG GREY IR	SAG	9	3	2500	1.348	3	100		0	3.0	4	50	2.0	6.0	30	7.0	9.4
40	PARTS	CFD MALLEABLE	SAG	9	3	1500	0.809	3	100		0	3.0	3	50	1.5	3.5	30	7.0	7.3
41	PARTS	CFD NODULAR	SAG	9	4	2000	1.079	3	100		0	3.0	10	100	10.0	4.0	30	7.0	56.6
42	PARTS	CFD PONTIAC	PONT	9	4	2000	1.079	3	100		0	3.0	10	100	10.0	7.5	80	2.0	8.6
43	PARTS	CPC BAY CITY	BAY	6	7	1700	0.917	5	85	3	15	4.7	5	100	5.0	4.0	60	4.0	21.6
44	PARTS	DM SAGINAW	SAG	9	4	1700	0.917	5	40	4	60	4.4	5	100	5.0	3.8	30	7.0	37.2
45	PARTS	DP PLANT 31	FLNT	10	4	200	0.107	4	100		0	4.0	6	100	6.0	3.5	20	8.0	5.9
46	PARTS	DP LIVONIA	LIV	6	4	2900	1.564	4	100		0	4.0	7	50	3.5	4.0	30	7.0	38.3
47	PARTS	GUIDE FORT ST	DET	10	4	2500	1.348	4	40	3	60	3.4	9	100	9.0	6.0	50	5.0	34.4
48	PARTS	GUIDE FLINT MFG	FLNT	10	4	4000	2.158	4	85	3	15	3.9	7	100	7.0	4.8	50	5.0	60.6
49	PARTS	GUIDE CLDNTR RD	FLNT	10	5	1700	0.917	4	60	3	40	3.6	6	100	6.0	4.0	50	5.0	24.8
50	PARTS	INLAND ADRIAN	ADR	8	6	1100	0.593	3	100		0	3.0	3	50	1.5	3.5	50	5.0	3.8
51	PARTS	INLAND GD RPDS	GR	3	6	1800	0.971	3	25	2	75	2.3	3	100	3.0	5.0	70	3.0	3.9
52	PARTS	INLAND LIVONIA	LIV	6	3	3000	1.618	3	50	2	50	2.5	9	75	6.8	6.0	60	4.0	18.2
53	PARTS	INLAND TECUM	TEC	8	3	1000	0.539	2	100		0	2.0	10	100	10.0	5.0	70	3.0	6.5
54	PARTS	NDH DET FORGE	DET	10	6	1100	0.593	3	100		0	3.0	5	100	5.0	3.5	50	5.0	12.7
55	PARTS	RPD COOPERSVL	CPRL	3	5	500	0.269	5	80	3	20	4.6	4	100	4.0	3.0	60	4.0	6.6
56	PARTS	RPD GD RPDS 1	GR	3	6	2600	1.402	5	65	4	35	4.7	2	50	1.0	7.5	60	4.0	3.5
57	PARTS	SD DET GR&AXLE	DET	10	4	4200	2.265	5	60	4	40	4.6	5	50	2.5	4.5	80	2.0	11.6
58	PARTS	SD SAG STG GR	SAG	9	5	8500	4.585	5	80	4	20	4.8	2	25	0.5	4.0	70	3.0	8.3

ID	TYPE	PLANT	CITY	DEMOG	COOP	EMPL	JOBWT	LINK1	PCT1	LINK2	PCT2	LINK	CHANCE	EXTENT	OUT	DESTIN	SAME	KEPT	SCORE
3	ASSY	BOC FLINT-BCITY	FLNT	10	3	5100	2.751	10	85	4	15	9.1	5	100	5.0	7.5	90	1.0	16.7
4	ASSY	BOC LANSING	LNSG	4	6	6000	3.237	10	100		0	10.0	3	50	1.5	5.0	75	2.5	24.3
6	ASSY	BOC ORION	ORIN	3	3	6700	3.614	10	100		0	10.0	5	100	5.0	8.3	95	0.5	10.9
11	ASSY	T&B FLINT	FLNT	10	4	4500	2.427	8	100		0	8.0	9	100	9.0	6.0	75	2.5	72.8
12	ASSY	T&B PONTIAC 2	PONT	9	3	3000	1.618	4	90	4	10	4.0	9	100	9.0	5.0	90	1.0	11.7
20	STMPG	CPC GRD RPDS	GR	3	5	3400	1.834	4	100		0	4.0	6	100	6.0	8.7	80	2.0	10.1
21	STMPG	CPC PONT METFAB	PONT	9	6	4000	2.158	4	70	4	30	4.0	6	90	5.4	7.5	80	2.0	12.4
22	STMPG	T&B FLNT METFAB	FLNT	10	4	4500	2.427	4	100		0	4.0	5	100	5.0	7.5	80	2.0	12.9
30	ENG	DOA REDFORD	RDFD	6	4	4300	2.319	6	50	5	50	5.5	5	75	3.8	4.5	60	4.0	42.5
32	TRANS	HMO FLINT 10	FLNT	10	3	3200	1.726	5	60	4	40	4.6	5	100	5.0	5.0	75	2.5	19.9
33	TRANS	HMO THREE RIV	TRIV	8	6	2000	1.079	5	100		0	5.0	8	100	8.0	5.0	80	2.0	17.3
34	TRANS	HMO WARREN	WRN	6	5	4200	2.265	5	75	4	25	4.8	5	25	1.3	4.5	40	6.0	17.9
36	PARTS	AC	FLNT	10	5	11000	5.934	5	25	2	75	2.8	8	75	6.0	2.5	40	6.0	235.0
37	PARTS	BOC AXLE&FORGE	FLNT	10	4	2000	1.079	5	60	3	40	4.2	6	100	6.0	4.0	50	5.0	34.0
38	PARTS	BOC PLANTS 3&5	LNSG	4	5	2000	1.079	4	40	3	60	3.4	6	50	3.0	4.0	30	7.0	19.3
43	PARTS	CPC BAY CITY	BAY	6	7	1700	0.917	5	85	3	15	4.7	5	100	5.0	4.0	60	4.0	21.6
44	PARTS	DM SAGINAW	SAG	9	4	1700	0.917	5	40	4	60	4.4	5	100	5.0	3.8	30	7.0	37.2
46	PARTS	DP LIVONIA	LIV	6	4	2900	1.564	4	100		0	4.0	7	50	3.5	4.0	30	7.0	38.3
48	PARTS	GUIDE FLINT MFG	FLNT	10	4	4000	2.158	4	85	3	15	3.9	7	100	7.0	4.8	50	5.0	60.6
49	PARTS	GUIDE CLOWTR RD	FLNT	10	5	1700	0.917	4	60	3	40	3.6	6	100	6.0	4.0	50	5.0	24.8
52	PARTS	INLAND LIVONIA	LIV	6	3	3000	1.618	3	50	2	50	2.5	9	75	6.8	6.0	60	4.0	18.2
54	PARTS	NDH DET FORGE	DET	10	6	1100	0.593	3	100		0	3.0	5	100	5.0	3.5	50	5.0	12.7
57	PARTS	SD DET GR&AXLE	DET	10	4	4200	2.265	5	60	4	40	4.6	5	50	2.5	4.5	80	2.0	11.6

ID	TYPE	PLANT	CITY	DEMOG	COOP	EMPL	JOBWT	LINK1	PCT1	LINK2	PCT2	LINK	CHANCE	EXTENT	OUT	DESTIN	SAME	KEPT	SCORE
3	ASSY	BOC FLINT-BCITY	FLNT	10	3	5100	2.751	10	85	4	15	9.1	5	100	5.0	7.5	90	1.0	16.7
11	ASSY	T&B FLINT	FLNT	10	4	4500	2.427	8	100		0	8.0	9	100	9.0	6.0	75	2.5	72.8
12	ASSY	T&B PONTIAC 2	PONT	9	3	3000	1.618	4	90	4	10	4.0	9	100	9.0	5.0	90	1.0	11.7
21	STMPG	CPC PONT METFAB	PONT	9	6	4000	2.158	4	70	4	30	4.0	6	90	5.4	7.5	80	2.0	12.4
22	STMPG	T&B FLNT METFAB	FLNT	10	4	4500	2.427	4	100		0	4.0	5	100	5.0	7.5	80	2.0	12.9
32	TRANS	HMD FLINT 10	FLNT	10	3	3200	1.726	5	60	4	40	4.6	5	100	5.0	5.0	75	2.5	19.9
36	PARTS	AC	FLNT	10	5	11000	5.934	5	25	2	75	2.8	8	75	6.0	2.5	40	6.0	235.0
37	PARTS	BOC AXLE&FORGE	FLNT	10	4	2000	1.079	5	60	3	40	4.2	6	100	6.0	4.0	50	5.0	34.0
44	PARTS	DM SAGINAW	SAG	9	4	1700	0.917	5	40	4	60	4.4	5	100	5.0	3.8	30	7.0	37.2
48	PARTS	GUIDE FLINT MFG	FLNT	10	4	4000	2.158	4	85	3	15	3.9	7	100	7.0	4.0	50	5.0	60.6
49	PARTS	GUIDE CLDWTR RD	FLNT	10	5	1700	0.917	4	60	3	40	3.6	6	100	6.0	4.0	50	5.0	24.8
54	PARTS	NDH DET FORGE	DET	10	6	1100	0.593	3	100		0	3.0	5	100	5.0	3.5	50	5.0	12.7
57	PARTS	SD DET GR&AXLE	DET	10	4	4200	2.265	5	60	4	40	4.6	5	50	2.5	4.5	80	2.0	11.6

GM Michigan Plant Targeting Model

Plant: BOC Clark-Fleetwood, Detroit

- **Product Line 1:** Assemble large RWD B- and D-body Cadillac, Chevrolet, Oldsmobile

- **Percent Product Line 1:** 90%

- **Product Line 2:** Body stamping and subsassembly for D-body Cadillac

- **Percent Product Line 2:** 10%

- **CHANCE of Outsourcing:** On a 1-10 scale, **10.** Closing has been announced.

- **Likely EXTENT of Outsourcing:** 100%.

- **Likely DESTINation of Outsourcing, if not 100%:** On average, **3** on a 10-point locational scale. Immediate destination is CPC plant in Arlington, TX. Likely successor product (GM300) expected to be sited at Arlington and/or Lakewood, GA.

- **Percent of Current Michigan Suppliers KEPT if Outsource:** 75%. Little change before 1991. For GM300, expect to keep Michigan engine and transmission suppliers, but to lose major panel stampings to contiguous press plants in Texas and/or Georgia.

GM Michigan Plant Targeting Model

Plant: BOC Detroit [Hamtramck] Assembly

- **Product Line 1:** Assemble FWD Cadillac, Buick, and Oldsmobile E/K-body cars, plus Cadillac Allante
- **Percent Product Line 1:** 100%
- **Product Line 2:**
- **Percent Product Line 2:** %
- **CHANCE of Outsourcing:** On a 1-10 scale, **1.**
- **Likely EXTENT of Outsourcing:** 100%.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **10.** Any work sent out of this plant (e.g., Allante, if GM decided to consolidate low-volume Cadillac products) would go to other Michigan plants (e.g., Allante would join Reatta in Lansing).
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 95%. [NB: 95% is the highest attainable entry here. *Any* re-sourcing inevitably opens slight risk; we define slight as 5%.]

GM Michigan Plant Targeting Model

Plant: BOC Flint Assembly ["Buick City"]

- **Product Line 1:** Assemble FWD H-body Buick and Oldsmobile
- **Percent Product Line 1:** 85%
- **Product Line 2:** Stampings and plastic parts for same vehicles
- **Percent Product Line 2:** 15%
- **CHANCE of Outsourcing:** On a 1-10 scale, **5.** GM is over-capacitized in C- and H-body large FWD cars; reportedly, a decision has been reached to drop one of the four plants (Orion, Buick City, Wentzville MO, and Willow Run) that make them. The betting is on Orion or Buick City taking the hit.
- **Likely EXTENT of Outsourcing:** 100%.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **7.5.** This score is an average of a Michigan plant (e.g., Willow Run and/or Orion) getting the work (10) or of Wentzville (5) getting it.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 90%. If Wentzville is the destination, slight re-sourcing of panels is possible, e.g., out of CPC Pontiac Met Fab or CPC Grand Rapids.

GM Michigan Plant Targeting Model

Plant: BOC Lansing Assembly [2 plants]

- **Product Line 1:** Assemble FWD N-body (J/N program) Pontiac, Oldsmobile, and Buick

- **Percent Product Line 1:** 100%

- **Product Line 2:**

- **Percent Product Line 2:** %

- **CHANCE of Outsourcing:** On a 1-10 scale, **3.** After 1991, the J/N program will be up for grabs; Lansing and Lordstown, OH are the likely competitors.

- **Likely EXTENT of Outsourcing:** 50%. Most likely, if Lordstown wins a major role in the son-of-N program in the early 1990s, one of the two Lansing plants will remain.

- **Likely DESTINation of Outsourcing, if not 100%:** On average, **5** -- Lordstown.

- **Percent of Current Michigan Suppliers KEPT if Outsource:** 75%. No movement of engine or transmission work, but Lordstown would get a significant panel-stamping allocation if it gets the work.

GM Michigan Plant Targeting Model

Plant: BOC Lansing Plant 2

- **Product Line 1:** Assembly [beginning 1988] of Buick Reatta
- **Percent Product Line 1:** 100%
- **Product Line 2:**
- **Percent Product Line 2:** %
- **CHANCE of Outsourcing:** On a 1-10 scale, **1.**
- **Likely EXTENT of Outsourcing:** 100%.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **10.** Only BOC Hamtramck is even thinkable.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 95%.

GM Michigan Plant Targeting Model

Plant: BOC Orion Assembly, Orion Twp

- **Product Line 1:** Assemble RWD C-body Cadillac and Oldsmobile cars
- **Percent Product Line 1:** 100%
- **Product Line 2:**
- **Percent Product Line 2:** %
- **CHANCE of Outsourcing:** On a 1-10 scale, **5.** See BOC Flint Assembly (Buick City) sheet. Also, discussions have been held within GM about moving the Oldsmobiles to Wentzville, MO and the Cadillacs to Detroit/Hamtramck.
- **Likely EXTENT of Outsourcing:** 100%.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **8.3.** Two-thirds of Orions builds are Cadillacs, prone to moving to Hamtramck (10). One-third are Oldsmobiles, prone to moving to Wentzville (5). Hence: .67 x 10 + .33 x 5 = 8.3.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 95%.

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GM Michigan Plant Targeting Model

Plant: BOC Willow Run Assembly, Ypsilanti

- **Product Line 1:** Assemble FWD H-body Pontiac
- **Percent Product Line 1:** 100%
- **Product Line 2:**
- **Percent Product Line 2:** %
- **CHANCE of Outsourcing:** On a 1-10 scale, **2.** Hot sales, smooth-running plant, decent labor-management relations. Only risk (slight) is from overcapacity.
- **Likely EXTENT of Outsourcing:** 100%.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **7.5,** the average of Buick City (10) and Wentzville, MO (5).
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 95%.

GM Michigan Plant Targeting Model

Plant: CPC Pontiac Plant 1

- **Product Line 1:** Assemble mid-engine RWD P-body Pontiac Fiero
- **Percent Product Line 1:** 100%
- **Product Line 2:**
- **Percent Product Line 2:** %
- **CHANCE of Outsourcing:** On a 1-10 scale, **1.**
- **Likely EXTENT of Outsourcing:** 100%.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **7.5,** an average of a Michigan (10) or other Midwest (5) site for a Magna-, ASC-, or C&C-type contract assembly shop if volume continues to drop.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 80%. Some panels would be re-sourced, but it would not pay an independent to tool up for the space frame.

GM Michigan Plant Targeting Model

Plant: CPC Pontiac Assembly [Plant 8]

- **Product Line 1:** Assemble RWD G-body Oldsmobile and Buick
- **Percent Product Line 1:** 100%
- **Product Line 2:**
- **Percent Product Line 2:** %
- **CHANCE of Outsourcing:** On a 1-10 scale, **10:** closing announced.
- **Likely EXTENT of Outsourcing:** 100%.
- **Likely DESTINation of Outsourcing, if not 100%:** **4:** Ste Therese will be the last G-body assembly plant.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 80%.

GM Michigan Plant Targeting Model

Plant: T&B Detroit [Piquette Road]

- **Product Line 1:** Assemble chassis for medium-truck-based recreational vehicles
- **Percent Product Line 1:** 75%
- **Product Line 2:** Stamped subassemblies for RV chassis
- **Percent Product Line 2:** 25%
- **CHANCE of Outsourcing:** On a 1-10 scale, **5**: lots of small plants could do this work.
- **Likely EXTENT of Outsourcing:** 100%.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **5**. Janesville would be one option, as would outsourcing to, e.g., A.O. Smith (IL or WI).
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 60%.

GM Michigan Plant Targeting Model

Plant: T&B Flint Assembly ["Chevy Truck"]

- **Product Line 1:** Assemble full-sized K-body Chevrolet and GMC utility vehicles. [Until 5/87, also assembled C/K pickup; new version C/K now assembled at Fort Wayne, IN; Oshawa, ONT; and Pontiac East.]

- **Percent Product Line 1:** 100%

- **Product Line 2:**

- **Percent Product Line 2:** %

- **CHANCE of Outsourcing:** On a 1-10 scale, **9**: only chance lies in a successor to the current K-body Blazer and Suburban.

- **Likely EXTENT of Outsourcing:** 100%.

- **Likely DESTINation of Outsourcing, if not 100%:** On average, **6**. Janesville (5), Pontiac Plant 2 (10), or Shreveport (3).

- **Percent of Current Michigan Suppliers KEPT if Outsource:** 75%.

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GM Michigan Plant Targeting Model

Plant: T&B Pontiac Central [Plant 2]

- **Product Line 1:** Assemble GMC medium and heavy trucks and buses
- **Percent Product Line 1:** 90%
- **Product Line 2:** Stampings and misc. parts for trucks and buses
- **Percent Product Line 2:** 10%
- **CHANCE of Outsourcing:** On a 1-10 scale, **9**. Heavy truck operations are now part of "GM-White," a joint venture with Volvo. Bus operation recently sold. Medium truck successor program (1989-90) lost to Janesville.
- **Likely EXTENT of Outsourcing:** 100%.
- **Likely DESTINation of Outsourcing, if not 100%: 5**: Janesville
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 90%. Mainly outside and non-Michigan already.

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GM Michigan Plant Targeting Model

Plant: T&B Pontiac West [Plant 5]

- **Product Line 1:** Assemble RWD S-body Chevrolet and GMC pickup and sport utility light truck
- **Percent Product Line 1:** 100%
- **Product Line 2:**
- **Percent Product Line 2:** %
- **CHANCE of Outsourcing:** On a 1-10 scale, **4.** Safe unless volume collapses, in which case Shreveport would be the remaining plant. Sport utilities (40% of output) could be on the way out of Pontiac and/or Shreveport: the 4-door 1990 S Blazer has been sited at Moraine, Ohio.
- **Likely EXTENT of Outsourcing:** 40% (see above)
- **Likely DESTINation of Outsourcing, if not 100%:** **4**, average of Shreveport (3) and Moraine (5).
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 90%.

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GM Michigan Plant Targeting Model

Plant: T&B Pontiac East [Plant 6]

- **Product Line 1:** Assemble RWD C/K-body Chevrolet and GMC pickup trucks
- **Percent Product Line 1:** 100%
- **Product Line 2:**
- **Percent Product Line 2:** %
- **CHANCE of Outsourcing:** On a 1-10 scale, **2.** Showcase MAP plant; very safe. However, there are three new C/K (GMT400 program) assembly plants, and lead plant is Fort Wayne, IN, just built; third plant is in Oshawa, ONT.
- **Likely EXTENT of Outsourcing:** 100%.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **4.5**, i.e., either Fort Wayne (5) or Oshawa (4).
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 95%.

GM Michigan Plant Targeting Model

Plant: BOC Conner Stamping, Detroit

- **Product Line 1:** Major body panel stamping and subassemblies for B- and D-body RWD large cars

- **Percent Product Line 1:** 100%

- **Product Line 2:**

- **Percent Product Line 2:** %

- **CHANCE of Outsourcing:** On a 1-10 scale, **9.** Closing announced, slated for 1990. Any chance beyond that (10%, perhaps) depends on a decision to extend the B/D platform through a reskinning instead of its full repladcement by the GM300 program.

- **Likely EXTENT of Outsourcing:** 100%.

- **Likely DESTINation of Outsourcing, if not 100%:** **3**: GM300 likely to be stamped contiguously to its assembly, in Arlington, TX or Lakewood, GA.

- **Percent of Current Michigan Suppliers KEPT if Outsource:** 30%. Some current equipment and tooling suppliers would probably be retained; by 1992, however, southern minimills are likely to win southern press plants' steel orders. [NB: Steel is 50-55% of the value of stamping plants' output.]

GM Michigan Plant Targeting Model

Plant: BOC Flint Body

- **Product Line 1:** Stampings and subassemblies for RWD G-body Chevrolet, Oldsmobile, and Buick cars

- **Percent Product Line 1:** 100%

- **Product Line 2:**

- **Percent Product Line 2:** %

- **CHANCE of Outsourcing:** On a 1-10 scale, **10.** Closing is underway.

- **Likely EXTENT of Outsourcing:** 100%.

- **Likely DESTINation of Outsourcing, if not 100%:** On average, **7.** Some stampings will move to Michigan press plants (10), and some will go to small Canadian (4) stampers close to Ste. Therese. In any case, the vehicle itself is close to extinction.

- **Percent of Current Michigan Suppliers KEPT if Outsource:** 80%. Only panels, and perhaps some trim, are likely to be re-sourced.

GM Michigan Plant Targeting Model

Plant: BOC Grand Blanc

- **Product Line 1:** Stampings and subassemblies for E/K-, C-, H-, andb B/D-body large cars
- **Percent Product Line 1:** 100%
- **Product Line 2:**
- **Percent Product Line 2:** %
- **CHANCE of Outsourcing:** On a 1-10 scale, **3.** Only risk is that continuing volume/share erosion by GM cars could lead to a consolidation that would close either BOC Grand Blanc (probability 0.3), BOC Kalamazoo (probability 0.2), or CPC Grand Rapids (probability 0.5).
- **Likely EXTENT of Outsourcing:** 100%.
- **Likely DESTINation of Outsourcing, if not 100%: 10:** see above.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 80%.

GM Michigan Plant Targeting Model

Plant: BOC Kalamazoo

- **Product Line 1:** Stampings and subassemblies for C-, H-, A-, and J/N-body FWD cars
- **Percent Product Line 1:** 100%
- **Product Line 2:**
- **Percent Product Line 2:** %
- **CHANCE of Outsourcing:** On a 1-10 scale, **2** - see plant 17 entry.
- **Likely EXTENT of Outsourcing:** 100%.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **8.7.** Three-quarters of its panels would go to BOC Grand Blanc and/or CPC Grand Rapids; the J/N-body portion, however, could follow the son-of-J/N program to Lordstown (5) after 1992 if it moves there: .75 x 10 + .25 x 5 = 8.75.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 80%.

GM Michigan Plant Targeting Model

Plant: BOC Olds Fab, Lansing

- **Product Line 1:** Stampings and subassemblies for FWD J/N- and C-, H-, and A-body cars
- **Percent Product Line 1:** 80%
- **Product Line 2:** Plastic moldings and panels for same programs
- **Percent Product Line 2:** 20%
- **CHANCE of Outsourcing:** On a 1-10 scale, **3.** The C-, H-, and A-body panels could be re-sourced, e.g., to BOC Kalamazoo and/or CPC Grand Rapids. Some or all J/N-body work could follow son-of-J/N (after 1992) to Lordstown, if it is moved there, in whole or in part.
- **Likely EXTENT of Outsourcing:** 70%. At least some J/N-body panel work would remain in any event.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **7.5:** Kalamazoo and/or Grand Rapids (10), or Lordstown (5).
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 80%.

GM Michigan Plant Targeting Model

Plant: CPC Grand Rapids

- **Product Line 1:** Stampings and subassemblies for A-, N-, and E/K-body cars, especially door and roof panels

- **Percent Product Line 1:** 100%

- **Product Line 2:**

- **Percent Product Line 2:** %

- **CHANCE of Outsourcing:** On a 1-10 scale, **6.** Despite its share of CPC's recent, and probably unwise, press modernization program, Grand Rapids suffers from the move to "modular panel allocation." It does doors and roofs for many models, whereas the new approach is to do *all* front- or rear-of-pillar panels for a single vehicle program. Lower productivity than BOC Grand Blanc and Kalamazoo plants, which could become the modular panel plants for C/H- and E/K-body plants, leaving CPC Grand Rapids with dwindling A-body work and hence a likely closing circa 1993.

- **Likely EXTENT of Outsourcing:** 100%.

- **Likely DESTINation of Outsourcing, if not 100%:** On average, **8.7** - see plant 18 entry.

- **Percent of Current Michigan Suppliers KEPT if Outsource:** 80%.

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GM Michigan Plant Targeting Model

Plant: CPC Pontiac Met Fab

- **Product Line 1:** Stampings and subsassemblies for P-, L-, A-, C/H-, J-, and F-body cars, especially fenders and hoods, several in plastic (SMC)

- **Percent Product Line 1:** 70 %

- **Product Line 2:** Stamped engine cradles and trailing axles, and miscellaneous plastic parts

- **Percent Product Line 2:** 30%

- **CHANCE of Outsourcing:** On a 1-10 scale, **6.** This is a pot-pourri stamping/molding plant. P-, A-, J-, and especially F-body volumes are falling, and trailing axle work is threatened by tubular designs made elsewhere.

- **Likely EXTENT of Outsourcing:** 90%. It would not pay to move the P-body panel or space frame work unless the entire vehicle was outsourced.

- **Likely DESTINation of Outsourcing, if not 100%:** On average, **7.5.** L- and J-body panels, plus tubular axles, could go to GM stamping plants in Ohio (5). A- and C/H-body panels would probably go to Kalamazoo or Grand Blanc (10).

- **Percent of Current Michigan Suppliers KEPT if Outsource:** 80%.

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GM Michigan Plant Targeting Model

Plant: T&B Flint Met Fab

- **Product Line 1:** Stampings and subassemblies for light trucks (including vans) and cars, especially engine cradles, van subframes, hoods, and fenders

- **Percent Product Line 1:** 100%

- **Product Line 2:**

- **Percent Product Line 2:** %

- **CHANCE of Outsourcing:** On a 1-10 scale, **5.** Excess GM press plant capacity in hoods and fenders. Cradles and subframes easily outsource-able, e.g., to A.O. Smith. Recent contracts for some GM10 and GMT400 stampings make a full closing unlikely, however.

- **Likely EXTENT of Outsourcing:** 100%.

- **Likely DESTINation of Outsourcing, if not 100%:** On average, **7.5.** CPC Pontiac and BOC Grand Blanc (10) could pick up some panels in a closing, but cradle and subframe work would probably go to Illinois, Indiana, and/or Wisconsin independents (5).

- **Percent of Current Michigan Suppliers KEPT if Outsource:** 80%.

GM Michigan Plant Targeting Model

Plant: BOC Delta Township

- **Product Line 1:** Quad-Four 4-valve (per cylinder) 4-cylinder engine, initially for N-body cars
- **Percent Product Line 1:** 100%
- **Product Line 2:**
- **Percent Product Line 2:** %
- **CHANCE of Outsourcing:** On a 1-10 scale, **1.**
- **Likely EXTENT of Outsourcing:** 100%.
- **Likely DESTINation of Outsourcing, if not 100%: 10**: nowhere to put it except Pontiac or Romulus.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 95%.

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GM Michigan Plant Targeting Model

Plant: BOC Flint "Buick" Engine

- **Product Line 1:** 3.0- and 3.8-liter V6 engines for (mainly FWD) cars
- **Percent Product Line 1:** 100%
- **Product Line 2:**
- **Percent Product Line 2:** %
- **CHANCE of Outsourcing:** On a 1-10 scale, **3.** The 3.8-liter is also made in Lansing (see entry 25), and both engines are due for 1989-92 upgrading (probably aluminum heads, roller lifters, and increased displacement of the 3-liter to 3.2 or 3.3). These upgrades combine with uncertain volumes, especially for the 3.0, to present GM with the option of re-sourcing. One example: Flint could get all 3-liters and Lansing all 3.8s.
- **Likely EXTENT of Outsourcing:** 50% - see above.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **7.5:** Tonawanda (5) or Lansing (10) are the most obvious competitor sites.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 80% - higher if Lansing, but lower if Tonawanda (mainly due to piston and head casting differences).

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GM Michigan Plant Targeting Model

Plant: BOC Lansing ["Oldsmobile"] Engine

- **Product Line 1:** 3.8-liter V6 and 5.0-liter V8 engines for cars and light trucks
- **Percent Product Line 1:** 100%
- **Product Line 2:**
- **Percent Product Line 2:** %
- **CHANCE of Outsourcing:** On a 1-10 scale, **3** - see entry 24.
- **Likely EXTENT of Outsourcing:** 50% - see entry 24.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **7.5** - see entry 24.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 80% - see entry 24.

GM Michigan Plant Targeting Model

Plant: BOC Livonia Engine

- **Product Line 1:** 4.1-liter aluminum head and block engines for Cadillac cars

- **Percent Product Line 1:** 100%

- **Product Line 2:**

- **Percent Product Line 2:** %

- **CHANCE of Outsourcing:** On a 1-10 scale, **1.** Good plant with lots of recent investment; nowhere else makes sense.

- **Likely EXTENT of Outsourcing:** 100%.

- **Likely DESTINation of Outsourcing, if not 100%:** On average, **7.5.** In principle, it could use part of the Hamtramck assembly complex (10), or GM could consolidate aluminum engine work at Spring Hill (5). No move is likely.

- **Percent of Current Michigan Suppliers KEPT if Outsource:** 95%.

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GM Michigan Plant Targeting Model

Plant: CPC Flint ["Chevy"] Engine

- **Product Line 1:** 5.0- and 5.7-liter V8 engines, half for cars and half for light trucks; ended 1.6-liter production with death of T-body (Chevette) program

- **Percent Product Line 1:** 100%

- **Product Line 2:**

- **Percent Product Line 2:** %

- **CHANCE of Outsourcing:** On a 1-10 scale, **2.** It's a slight possibility that CPC would move one of the two remaining engines.

- **Likely EXTENT of Outsourcing:** 50%.

- **Likely DESTINation of Outsourcing, if not 100%:** On average, **5.3.** Romulus (10), Tonawanda (5), Ste. Catherines (4), and Ramos Azripe (2) are all possibilities, though none is likely.

- **Percent of Current Michigan Suppliers KEPT if Outsource:** 75%, an average of 90% for the first three destinations above and 25% for Ramos.

GM Michigan Plant Targeting Model

Plant: CPC Pontiac Engine

- **Product Line 1:** 2.5-liter 4-cylinder "Iron Duke" engine for cars and light trucks
- **Percent Product Line 1:** 100%
- **Product Line 2:**
- **Percent Product Line 2:** %
- **CHANCE of Outsourcing:** On a 1-10 scale, **2.** The decision to drop the Manhattan engine and to upgrade the Iron Duke makes loss of this engine unlikely.
- **Likely EXTENT of Outsourcing:** 50% - one of two "modules."
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **5.7.** The only sensible new sites would be Romulus (10), Tonawanda (5), or Ramos (2).
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 60%, an average of 90% and 30%.

GM Michigan Plant Targeting Model

Plant: CPC Romulus

- **Product Line 1:** [Starting in 1988] 4.3-liter V6 engine for cars and light trucks
- **Percent Product Line 1:** 100%
- **Product Line 2:**
- **Percent Product Line 2:** %
- **CHANCE of Outsourcing:** On a 1-10 scale, **1.**
- **Likely EXTENT of Outsourcing:** 100%
- **Likely DESTINation of Outsourcing, if not 100%: 5:** in principle, it could join the other 4.3 line, at Tonawanda.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 90%.

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GM Michigan Plant Targeting Model

Plant: DDA Redford

- **Product Line 1:** Diesel engines
- **Percent Product Line 1:** 50%
- **Product Line 2:** Bearings and other transmission parts for heavy trucks and buses; diesel locomotive machined parts
- **Percent Product Line 2:** 50%
- **CHANCE of Outsourcing:** On a 1-10 scale, **5.** Massive overcapacity in heavy truck engines and transmissions. On-again off-again joint venture with Deere creates new sourcing options.
- **Likely EXTENT of Outsourcing:** 75%. Most vulnerable are engine cams, cranks, and pistons; and the non-engine work.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **4.5:** Deere or Caterpillar in Illinois or Iowa, Cummins in Indiana, and DDA in Indiannapolis are all possible sites.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 60%.

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GM Michigan Plant Targeting Model

Plant: HMD Constantine

- **Product Line 1:** Parts for 125 and 440 automatic transmissions; torque converters
- **Percent Product Line 1:** 100%
- **Product Line 2:**
- **Percent Product Line 2:** %
- **CHANCE of Outsourcing:** On a 1-10 scale, **10.** GM has announced it will consolidate this work into its HMD Three Rivers plant (see entry 33).
- **Likely EXTENT of Outsourcing:** 100%.
- **Likely DESTINation of Outsourcing, if not 100%: 10**
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 90%: some pinion outsourcing.

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GM Michigan Plant Targeting Model

Plant: HMD Plant 10, Flint

- **Product Line 1:** Gear sets and shafts for FWD 440 and 125 automatic transmissions
- **Percent Product Line 1:** 60%
- **Product Line 2:** Torque converters
- **Percent Product Line 2:** 40%
- **CHANCE of Outsourcing:** On a 1-10 scale, **5.** Falling GM market share gives GM the option to walk away from an old plant with a rigid labor agreement.
- **Likely EXTENT of Outsourcing:** 100%
- **Likely DESTINation of Outsourcing, if not 100%:** Firms like Sheller-Ryobi, Winters, and others in Indiana and Ohio have the best shot: **5.**
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 75%.

GM Michigan Plant Targeting Model

Plant: HMD Three Rivers

- **Product Line 1:** 2004R automatic transmission for RWD large cars
- **Percent Product Line 1:** 100%
- **Product Line 2:**
- **Percent Product Line 2:** %
- **CHANCE of Outsourcing:** On a 1-10 scale, **8.** In the near-term, what counts is B/D-body sales volume; if it falls enough, the 2004R could be moved to HMD Toledo. After 1992, the issue is which transmission is used in the GM300 program.
- **Likely EXTENT of Outsourcing:** 100%.
- **Likely DESTINation of Outsourcing, if not 100%:** **5** - HMD Toledo seems most likely.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 80%.

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GM Michigan Plant Targeting Model

Plant: HMD Warren

- **Product Line 1:** 440THM automatic transmission for midsize and large FWD cars

- **Percent Product Line 1:** 75%

- **Product Line 2:** Steel wheels, suspension control arms

- **Percent Product Line 2:** 25%

- **CHANCE of Outsourcing:** On a 1-10 scale, **5.** Despite a recent $30 million wheel line investment, there are many able, lower-cost wheel and control arm competitors.

- **Likely EXTENT of Outsourcing:** 25%: only wheels and control arms are vulnerable, though 440 output is directly sensitive to GM sales of C-, H-, and E/K-body cars.

- **Likely DESTINation of Outsourcing, if not 100%:** On average, **4.5:** GM Oshawa (4) and Hitachi (1) for control arms, and Kelsey-Hayes and/or Motor Wheel plants in Michigan (10), Missouri (3), and Ontario (4) for wheels, are examples.

- **Percent of Current Michigan Suppliers KEPT if Outsource:** 40%: many new suppliers, especially if Hitachi cast arms are used.

GM Michigan Plant Targeting Model

Plant: HMD Willow Run, Ypsilanti

- **Product Line 1:** 125, RWD 200, 325, and 400 model automatic transmissions for cars and light trucks

- **Percent Product Line 1:** 100%

- **Product Line 2:**

- **Percent Product Line 2:** %

- **CHANCE of Outsourcing:** On a 1-10 scale, **2:** some "decontenting" of transmissions is likely, and Willow Run is one of HMD's two highly-integrated transmission plants, i.e., purchased parts less than 65% of product cost.

- **Likely EXTENT of Outsourcing:** 25% - see above.

- **Likely DESTINation of Outsourcing, if not 100%:** On average, **6:** Michigan, Ontario, Ohio, and Indiana have many transmission-experienced gear, pinion, and channel plate independents.

- **Percent of Current Michigan Suppliers KEPT if Outsource:** 60%.

GM Michigan Plant Targeting Model

Plant: AC ["Spark Plug"], Flint

- **Product Line 1:** Fuel pumps for cars and light trucks
- **Percent Product Line 1:** 25% (2500 employees)
- **Product Line 2:** Spark plugs (2500 employees), Instruments-Electronics-Moldings (5500 employees), and filters (500 employees)
- **Percent Product Line 2:** 75%
- **CHANCE of Outsourcing:** On a 1-10 scale, **8.** Many lower-cost suppliers for "product line 2" outputs.
- **Likely EXTENT of Outsourcing:** 75%.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **2.5** - non-Midwest U.S. (3) and Mexico (2). A short list: Delco Remy Juarez, Nippondenso (not Battle Creek), Bosch (SC), Fram (Allied), ITT, UT/Essex, Yazaki, Matsushita, Comgeneral, American Industries, Parker Hannifin/Ideal.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 40% - many of AC's current suppliersare the very companies to which work might be outsourced.

GM Michigan Plant Targeting Model

Plant: BOC Axle and Forge [Plant 36], Flint

- **Product Line 1:** Machining of pistons, water pumps, and other engine parts
- **Percent Product Line 1:** 60%
- **Product Line 2:** Forgings for water pumps and front engine covers; stamped intake manifolds
- **Percent Product Line 2:** 40%
- **CHANCE of Outsourcing:** On a 1-10 scale, **6.** There are lower-cost suppliers for most of this plant's products.
- **Likely EXTENT of Outsourcing:** 100%.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **4.** Examples include a Mahle piston plant in Tennessee, a Budd precision stamping plant in Ontario, and several Indiana forges.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 50%.

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GM Michigan Plant Targeting Model

Plant: BOC Plants 3 and 5, Lansing.

- **Product Line 1:** Steel bumpers, rocker covers, and oil pans
- **Percent Product Line 1:** 40%
- **Product Line 2:** Tooling, and tool engineering
- **Percent Product Line 2:** 60% (high salaried employment)
- **CHANCE of Outsourcing:** On a 1-10 scale, **6:** some tooling, and much if not all of "product line 1," is vulnerable; see also entry 52.
- **Likely EXTENT of Outsourcing:** 50%.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **4.** Only the large scale required for efficient plating of shiny steel bumpers protects BOC and Delco Products bumper operations. Much cheaper steel and electricity costs make Canadian firms an attractive alternative. A number of Midwest and upper South independents are also players.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 30%.

GM Michigan Plant Targeting Model

Plant: CFD Saginaw Grey Iron

- **Product Line 1:** Castings for engine blocks, cylinder heads, and brake drums and rotors
- **Percent Product Line 1:** 100%
- **Product Line 2:**
- **Percent Product Line 2:** %
- **CHANCE of Outsourcing:** On a 1-10 scale, **4.** All products face some risk, but loss of cylinder heads to Fiat's Teksid division (Italy, Mexico, and soon Tennessee) looms largest as more and more heads are shifted to aluminum.
- **Likely EXTENT of Outsourcing:** 50%.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **6:** Teksid (TN, 3), Deere (5), and CMI (10) are representative of likely sites.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 30%.

GM Michigan Plant Targeting Model

Plant: CFD Malleable Iron, Saginaw

- **Product Line 1:** connecting rods, housings, hubs, yokes, and gears and other transmission parts

- **Percent Product Line 1:** 100%

- **Product Line 2:**

- **Percent Product Line 2:** %

- **CHANCE of Outsourcing:** On a 1-10 scale, **3.** Some risks in connecting rods (e.g., from powder metal approaches) and gears. High volumes and large outside sales (to Ford, Dana, and Whirlpool, among others) protect housings and hubs.

- **Likely EXTENT of Outsourcing:** 50%.

- **Likely DESTINation of Outsourcing, if not 100%:** On average, **3.5:** ample malleable capacity in Mexico and throughout the Midwest.

- **Percent of Current Michigan Suppliers KEPT if Outsource:** 30%.

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GM Michigan Plant Targeting Model

Plant: CFD Saginaw Nodular Iron

- **Product Line 1:** Castings for exhaust manifolds, crankshafts, differential cases, and steering knuckles
- **Percent Product Line 1:** 100%
- **Product Line 2:**
- **Percent Product Line 2:** %
- **CHANCE of Outsourcing:** On a 1-10 scale, **10**: closing is underway.
- **Likely EXTENT of Outsourcing:** 100%.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **4**: independents in the U.S. Midwest (e.g., Dana in Richmond, IN) and South (e.g., Lynchburg Foundry), and in Ontario (e.g., CAE Diecast) are likely gainers.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 30%.

GM Michigan Plant Targeting Model

Plant: CFD Pntiac Foundry

- **Product Line 1:** Grey iron castings of engine blocks and cylinder heads
- **Percent Product Line 1:** 100%
- **Product Line 2:**
- **Percent Product Line 2:** %
- **CHANCE of Outsourcing:** On a 1-10 scale, **10:** closing is underway.
- **Likely EXTENT of Outsourcing:** 100%.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **7.5** - work was split between CFD Saginaw Grey Iron and CFD Defiance, OH.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 80%.

GM Michigan Plant Targeting Model

Plant: CPC Bay City

- **Product Line 1:** Machined iron and steel camshafts, channel plates, spindles, and carburetor bodies
- **Percent Product Line 1:** 85%
- **Product Line 2:** Zinc diecasting
- **Percent Product Line 2:** 15%
- **CHANCE of Outsourcing:** On a 1-10 scale, **5**: many lower-cost suppliers in most products; plant is at less than 50% of capacity.
- **Likely EXTENT of Outsourcing:** 100%.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **4**: firms such as Jernberg (5) and Lynchburg (3) are challengers.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 60%.

GM Michigan Plant Targeting Model

Plant: DM Saginaw

- **Product Line 1:** Disk brakes (mainly rotors and assembly)
- **Percent Product Line 1:** 40%
- **Product Line 2:** Drum brakes
- **Percent Product Line 2:** 60%
- **CHANCE of Outsourcing:** On a 1-10 scale, **5:** many lower-cost producers.
- **Likely EXTENT of Outsourcing:** 100%.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **3.8.** Brazil (e.g., Vargas, 1), Mexico (e.g., Revestimientos and Kelsey-Hayes, 2), Allied in Ontario (4), and Kelsey-Hayes and DM Dayton (5) are examples of the competition -- all with excess capacity.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 30%.

GM Michigan Plant Targeting Model

Plant: DP Flint [Plant 31]

- **Product Line 1:** Coil suspension springs [Plant 31 is part of "Buick City" complex]
- **Percent Product Line 1:** 100%
- **Product Line 2:**
- **Percent Product Line 2:** %
- **CHANCE of Outsourcing:** On a 1-10 scale, **6** - many competitors, and increasing disillusionment with Buick City qua pot-pourri.
- **Likely EXTENT of Outsourcing:** 100%.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **3.5**: independents in Canada and the U.S. south have plenty of capacity and low costs.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 30%.

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GM Michigan Plant Targeting Model

Plant: DP Livonia

- **Product Line 1:** Plated steel bumpers, steel coil suspension springs
- **Percent Product Line 1:** 100%
- **Product Line 2:**
- **Percent Product Line 2:** %
- **CHANCE of Outsourcing:** On a 1-10 scale, **7.** Both bumpers and springs are hard to support at GM labor and overhead costs.
- **Likely EXTENT of Outsourcing:** 50%. Livonia looks to be the plant into which steel bumpers (see entry 38) *or* coil springs (see entry 45) are consolidated, but probably not both.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **4.** The U.S. Midwest and South, and Ontario, have plenty of potential gainers. Canadian steel costs are a plus for them.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 30%.

GM Michigan Plant Targeting Model

Plant: Fisher Guide Fort Street, Detroit

- **Product Line 1:** Assorted hardware, including aluminum extrusions
- **Percent Product Line 1:** 40%
- **Product Line 2:** Door trim and like moldings; miscellaneous small parts
- **Percent Product Line 2:** 60%
- **CHANCE of Outsourcing:** On a 1-10 scale, **10**: closing announced, probably effective 1988-89.
- **Likely EXTENT of Outsourcing:** 100%.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **6.** Within GM, some re-sourcing to Inland Livonia or Adrian (door trim) and/or Fisher Guide Flint ("Coldwater Road") is possible (10), but more likely are the Guide plant in Columbus, OH (5) or southern plants of independents such as ITT-Higbie (3).
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 50%.

GM Michigan Plant Targeting Model

Plant: Fisher Guide Flint ["Chevy"] Manufacturing

- **Product Line 1:** Exhaust manifolds, SMC headers, valves, fuel tanks, and grilles

- **Percent Product Line 1:** 85%

- **Product Line 2:** Door stampings for M-body van

- **Percent Product Line 2:** 15%

- **CHANCE of Outsourcing:** On a 1-10 scale, **7.** Other firms have better technology and costs on most of "product line 1" business, e.g., GM has a joint venture with NH-based Hitchener that will obsolete this plant's approach to exhaust manifold processing. Van door stamping could go to Flint Met Fab or Pontiac Met Fab, among others.

- **Likely EXTENT of Outsourcing:** 100%.

- **Likely DESTINation of Outsourcing, if not 100%:** On average, **4.8.** Van doors could move to Flint or Pontiac (see above). Other work could move to other U.S., Midwest and South, independents; grilles could be made in Mexico, perhaps at Fisher Guide Ramirez, which already makes some Fiero panels.

- **Percent of Current Michigan Suppliers KEPT if Outsource:** 50%.

GM Michigan Plant Targeting Model

Plant: Fisher Guide [Coldwater Road], Flint

- **Product Line 1:** Window regulators, door handles, and related hardware assemblies

- **Percent Product Line 1:** 60%

- **Product Line 2:** Head liners and hinges

- **Percent Product Line 2:** 40%

- **CHANCE of Outsourcing:** On a 1-10 scale, **6.** European companies, some of which might locate here if they win the business, have superior technology and cost structure in window regulators and hinges.

- **Likely EXTENT of Outsourcing:** 100%.

- **Likely DESTINation of Outsourcing, if not 100%:** On average, **4.** Fisher Guide Columbus, OH (5) and southern independents (3) are in line for this kind of outsourcing. Active courting of Europeans should be considered *if and when* the regulator and hinge businesses are confirmed to be on the way out of GM. Recent award of Saturn, L-body, and some GM10 window regulators to this plant is only a "stopgap."

- **Percent of Current Michigan Suppliers KEPT if Outsource:** 50%.

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GM Michigan Plant Targeting Model

Plant: Inland Adrian

- **Product Line 1:** Instrument panel assemblies, plastic heating/cooling duct molding, and (small) truck trim

- **Percent Product Line 1:** 100%

- **Product Line 2:**

- **Percent Product Line 2:** %

- **CHANCE of Outsourcing:** On a 1-10 scale, **3.** A favored Inland plant, moving into more subassembly work to use up the time between mold shoots on instrument panels. Still, all products are of the type that is outsourceable because alternative capacity can be brought on line cheaply.

- **Likely EXTENT of Outsourcing:** 50%. The plant looks to be getting more uptech door trim work; recent automation investments anchor that product line for a while.

- **Likely DESTINation of Outsourcing, if not 100%:** On average, **3.5.** Midwest IP suppliers (e.g., Sheller Globe) and Inland Juarez (2) are examples of the competition.

- **Percent of Current Michigan Suppliers KEPT if Outsource:** 50%.

GM Michigan Plant Targeting Model

Plant: Inland Grand Rapids

- **Product Line 1:** Door trim
- **Percent Product Line 1:** 25%
- **Product Line 2:** Seat covers
- **Percent Product Line 2:** 75%
- **CHANCE of Outsourcing:** On a 1-10 scale, **3.** New labor agreement and re-sourcing of some seat covers from Inland Tecumseh will help. In the long-run, however, this is risky business with $25-an-hour labor costs.
- **Likely EXTENT of Outsourcing:** 100%.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **5.** While Livonia (10) or Euclid, OH (5) could win away some of the work, so could southern independents (e.g., Milliken, 3) and Inland Juarez (2).
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 70%.

GM Michigan Plant Targeting Model

Plant: Inland Livonia

- **Product Line 1:** Door trim
- **Percent Product Line 1:** 50%
- **Product Line 2:** Seat covers
- **Percent Product Line 2:** 50%
- **CHANCE of Outsourcing:** On a 1-10 scale, **9.** Partial closing recently announced, mainly in seat cover operations. Rumors have some trim work heading for Inland Adrian.
- **Likely EXTENT of Outsourcing:** 75%.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **6.** Grand Rapids and Adrian Inland plants are possibles, as are Euclid, Juarez, and a number of southern U.S. independents.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 60%.

GM Michigan Plant Targeting Model

Plant: Inland Tecumseh

- **Product Line 1:** Seat covers
- **Percent Product Line 1:** 100%
- **Product Line 2:**
- **Percent Product Line 2:** %
- **CHANCE of Outsourcing:** On a 1-10 scale, **10**: closing announced, and could come as early as Spring 1988.
- **Likely EXTENT of Outsourcing:** 100%.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **5.** Initially, the covers are headed for Euclid and Grand Rapids' longer-term, the odds favor Juarez and southern U.S. independents.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 70%: main input is cloth, a non-Michigan product, so there isn't much Michigan supplier work to lose.

GM Michigan Plant Targ(ting Model

Plant: NDH Detroit Forge

- **Product Line 1:** Forgings for connecting rods, transmission parts, stabilizer bars, RWD axles, and wheel spindles

- **Percent Product Line 1:** 100%

- **Product Line 2:**

- **Percent Product Line 2:** %

- **CHANCE of Outsourcing:** On a 1-10 scale, **5.** An excellent plant, but GM has made an "anti-commitment" to further forge and foundry modernization. Might be more viable outside GM.

- **Likely EXTENT of Outsourcing:** 100%.

- **Likely DESTINation of Outsourcing, if not 100%:** On average, **3.5.** Forges (and alternative process suppliers, e.g., sintered con rod plants) in Mexico, the southern U.S., Canada, and the upper Midwest all could win away bits and pieces of this work.

- **Percent of Current Michigan Suppliers KEPT if Outsource:** 50%.

GM Michigan Plant Targeting Model

Plant: RPD Coopersville

- **Product Line 1:** TBI (throttle body injection) fuel injectors
- **Percent Product Line 1:** 80%
- **Product Line 2:** MFI (multipoint) fuel injectors
- **Percent Product Line 2:** 20%
- **CHANCE of Outsourcing:** On a 1-10 scale, **4.** Good, well-regarded plant, deep in favored Dutch territory. Risks, to the extent they exist, are from a new RPD plant in Aspern, Austria (which has too much capacity for the European market), Bosch (SC), and RPD Rochester, NY.
- **Likely EXTENT of Outsourcing:** 100%.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **3** - see "CHANCE" above.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 60%.

GM Michigan Plant Targeting Model

Plant: RPD Grand Rapids 1

- **Product Line 1:** Engine roller and hydraulic roller lifters
- **Percent Product Line 1:** 65%
- **Product Line 2:** Other valve train products
- **Percent Product Line 2:** 35%
- **CHANCE of Outsourcing:** On a 1-10 scale, **2.** Good plant, which even exports some lifters to Toyota in Japan. Slight risk to some valve train components from, among others, casters (e.g., Montupet) moving downstream, and from major independents, e.g., Eaton.
- **Likely EXTENT of Outsourcing:** 50%.
- **Likely DESTINation of Outsourcing, if not 100%:** On average, **7.5.** Michigan (10) hosts some good engine part processors, but Ohio and Indiana (5) have more, including Dana, Doehler Jarvis, and TRW.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 60%.

GM Michigan Plant Targeting Model

Plant: SD Detroit Gear and Axle

- **Product Line 1:** RWD axles for cars and light and medium trucks
- **Percent Product Line 1:** 60%
- **Product Line 2:** Carrier assemblies and machined brake parts
- **Percent Product Line 2:** 40%
- **CHANCE of Outsourcing:** On a 1-10 scale, **5.** Improving cost position, but overcapacity -- axles also made at Saginaw Divisiun plants in Buffalo, NY and Ste. Catherines, ONT -- spells risk. Brake work is especially vulnerable.
- **Likely EXTENT of Outsourcing:** 50%. More likely than a full closing is the consolidation of one or several sized of axle.
- **Likely DESTINation of Outsourcing, if not 100%: 4.5**, an average of Buffalo and Ste. Catherines.
- **Percent of Current Michigan Suppliers KEPT if Outsource:** 80%.

GM Michigan Plant Targeting Model

Plant: SD Saginaw Steering Gear

- **Product Line 1:** FWD axles (also called CV -- constant velocity -- joints or "final drives"), power rack and pinion steering gear, and regular and tilt steering columns for GM *and many other* companies' cars and light trucks

- **Percent Product Line 1:** 80%

- **Product Line 2:** Pumps and axle shaft subassemblies

- **Percent Product Line 2:** 20%

- **CHANCE of Outsourcing:** On a 1-10 scale, **2.** Slight chance, confined mainly to some mature vehicle programs' CV joints, and pumps. Also, Chrysler's Toledo Acustar plant has won back, starting in 1989, the tilt steering column job that SSG had been doing for Chrysler.

- **Likely EXTENT of Outsourcing:** 25% - see above.

- **Likely DESTINation of Outsourcing, if not 100%:** On average, **4.** SSG has a small clone of itself in Athens, AL; Indiana (Ford Indiannapolic T&C), Ohio (Chrysler Toledo), and Tennessee (TRW) have plants that could win away rack and pinion and steering column work.

- **Percent of Current Michigan Suppliers KEPT if Outsource:** 70%.

ATTACHMENT 5

AIM ADVISORY BOARD

- Letter to Meeting Speakers
- Honda Supplier List

Industrial Technology Institute
P.O. Box 1485
Ann Arbor, Michigan 48106

MEMO TO: Dave Andrea
Dave Greeneisen
Gary Guertin

FROM: Dan Luria

DATE: August 20, 1987

SUBJECT: AIM Advisory Board Meeting, 9-30-87

Thank you all for agreeing to serve as reacters to the presentations by Peter Arnesen and Don Smith. This memorandum is to make more precise what we are looking for from the three of you in your 5-8-minute soliloquies.

The theme for this session is "The Transplants' Challenge to Michigan's Automotive Economy." The first presentation, by Peter Arnesen, will be a 20-25-minute summary of his recent paper with Bob Cole and A. Krishna. Attached you will find a copy of the galleys of the *AIM Newsletter* summary of that paper. I have asked Peter to emphasize the following points:

- The transplants represent a growing market for U.S. suppliers,
- ... but the qualification requirements and timelines are difficult and long,
- ... and, moreover, the "southern drift" of transplant assemblers *and of the new plants of traditional U.S. suppliers* is a major problem for Michigan suppliers (except those content to serve only Mazda).

I hope Peter will be so bold as to float a few of his ideas about what Michigan suppliers -- and the State -- ought to do in the face of the mounting transplant supplier presence.

Don Smith will then give a 20-25-minute talk as a "case study" in (as I count them) four related aspects of the transplants' challenge to Michigan plants:

1. Though there is no unique successful stamping strategy or approach, transplant stamping plants all benefit from more formable *designs* that permit shorter, and less finnicky, lines;

2. Though there is substantial variance across companies, transplant stamping plants have *systematized* what they do, with a consistent approach to tool tryout, team-based rapid tool change, etc.;

3. For a variety of reasons, transplant stamping plants have all been built contiguous to assembly facilities (though at least one company follows in Japan, and may here as well, a strategy of non-contiguous hang-on panel-making). Given the "southern drift" (per Arnesen) of transplant assembly plants, this bodes ill for Michigan, since dispersed transplant capacity displaces concentrated Big Three press plant capacity; and

4. These conclusions from looking at NUMMI, Ogihara, Honda, and Mazda here, and at many plants in Japan, cut two ways for Michigan. First, they strongly suggest that the Big Three will want and need to move aggressively toward contiguous stamping for their new assembly programs, which can only hurt regional plant-based Michigan. But second, what the Japanese have been able to do here with American facilities and workers, gives much reason for optimism that domestic stampers, captive and independent alike, can greatly improve their performance. And, since -- at least until the year 2000 -- there are not likely to be more than a handful of new assembly plants built by the Big Three, steps can be taken now that will have real payoff for the domestic industry, in Michigan, in the 1990s.

5. Moreover, because -- in rather different ways -- Honda (Marysville) and NUMMI represent the state of the art in stamping, there now exist "local" models from which to learn. In one case, the model describes "world class" for the roughly 40% of body panels for which contiguous stamping is the long-term appropriate approach; in the other, there are methodologies directly transferable to non-contiguous press plants.

Don will circulate to you, around September 10-12, a draft copy of the interim report of a group working on stamping issues. (That group includes AIM's Richard Hervey and Jerry Jurek as well as Don.) That report looks well beyond Michigan concerns, of course, but Don has promised to focus on the implications for our state in his remarks.

Value-Added Reacters

We selected the three of you for more than your good looks and your track records with AIM.

Dave Andrea is leading a current AIM research effort to study systematically where each of the transplant assemblers source their roughly 100 main purchased components. Thus, I would like you, Dave, to present whatever you've come up with by that time. Your reaction will bring hard subsystem-level data to bear on some of Arnesen's hypotheses about the transplant supplier threat.

Dave Greeneisen has a deep interest in -- and a well-thought-out stance on -- the question of how traditional U.S. suppliers should deal with the transplant assemblers, several of which Sheller Globe supplies. Sheller also has a JV with Ryobi in Indiana that is getting more and more Big Three business. I look to you therefore, Dave, for an analysis of how suppliers should position themselves vis a vis transplant assemblers and transplant suppliers -- and, if you're willing, what if anything the State could do to help them.

Finally, Gary Guertin -- if I read the situation accurately -- has to look at transplant suppliers both as potential low-cost GM suppliers *and* as competitors to GM captive parts plants. Your views, Gary, on how the two aspects get balanced would be most useful. Also, I hope you'll also react to Don's presentation, particularly his exposition of the NUMMI stamping model and its applicability in regional press plants.

I look forward to your reactions, and to seeing you on September 30th. If I can be useful to you before that, please give me a call.

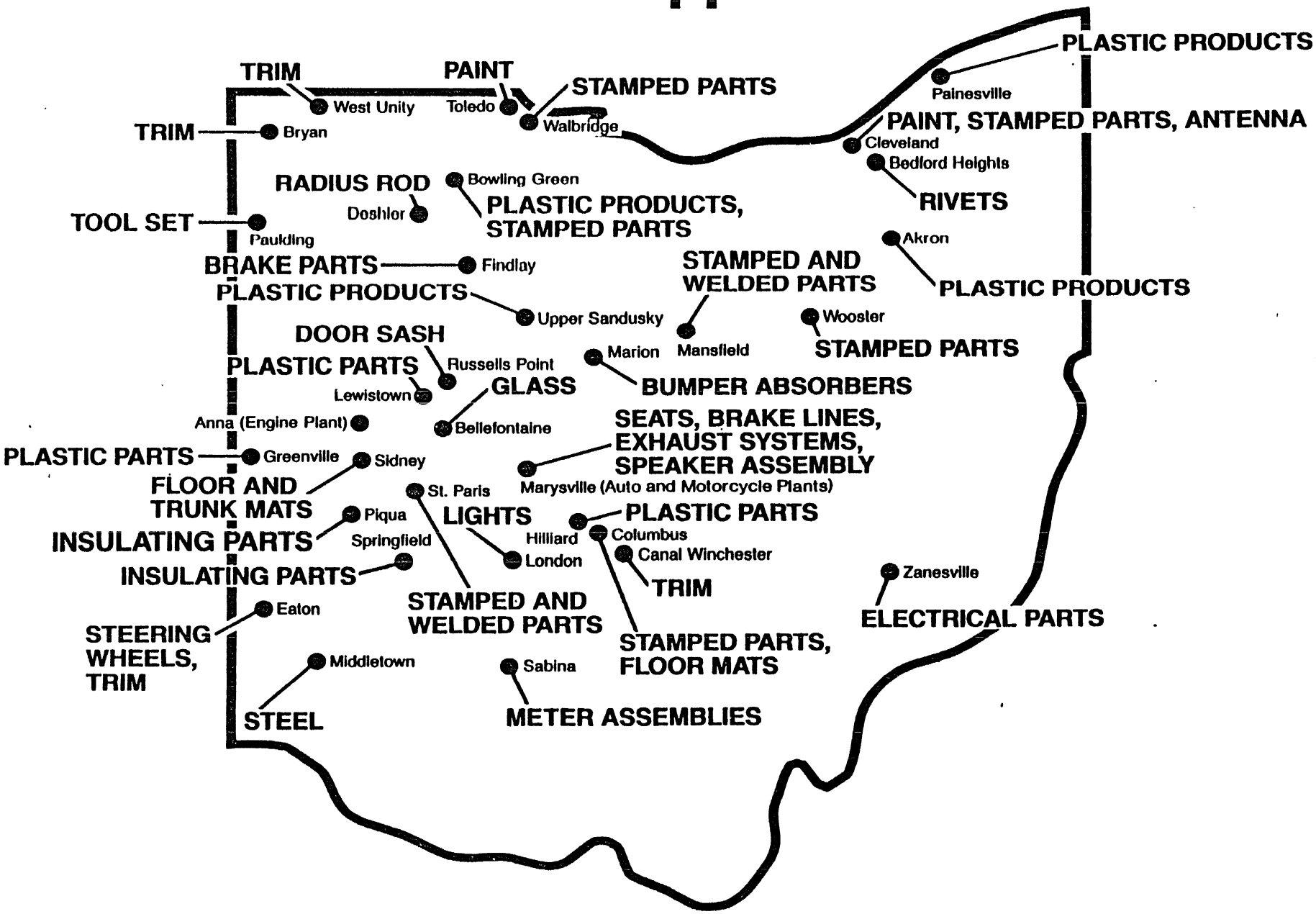
I'll call *you* around September 20th just to make sure everything is on track.

cc: Peter Arnesen
Alan Baum
Jack Russell
Don Smith

HONDA

Honda of America Mfg., Inc.

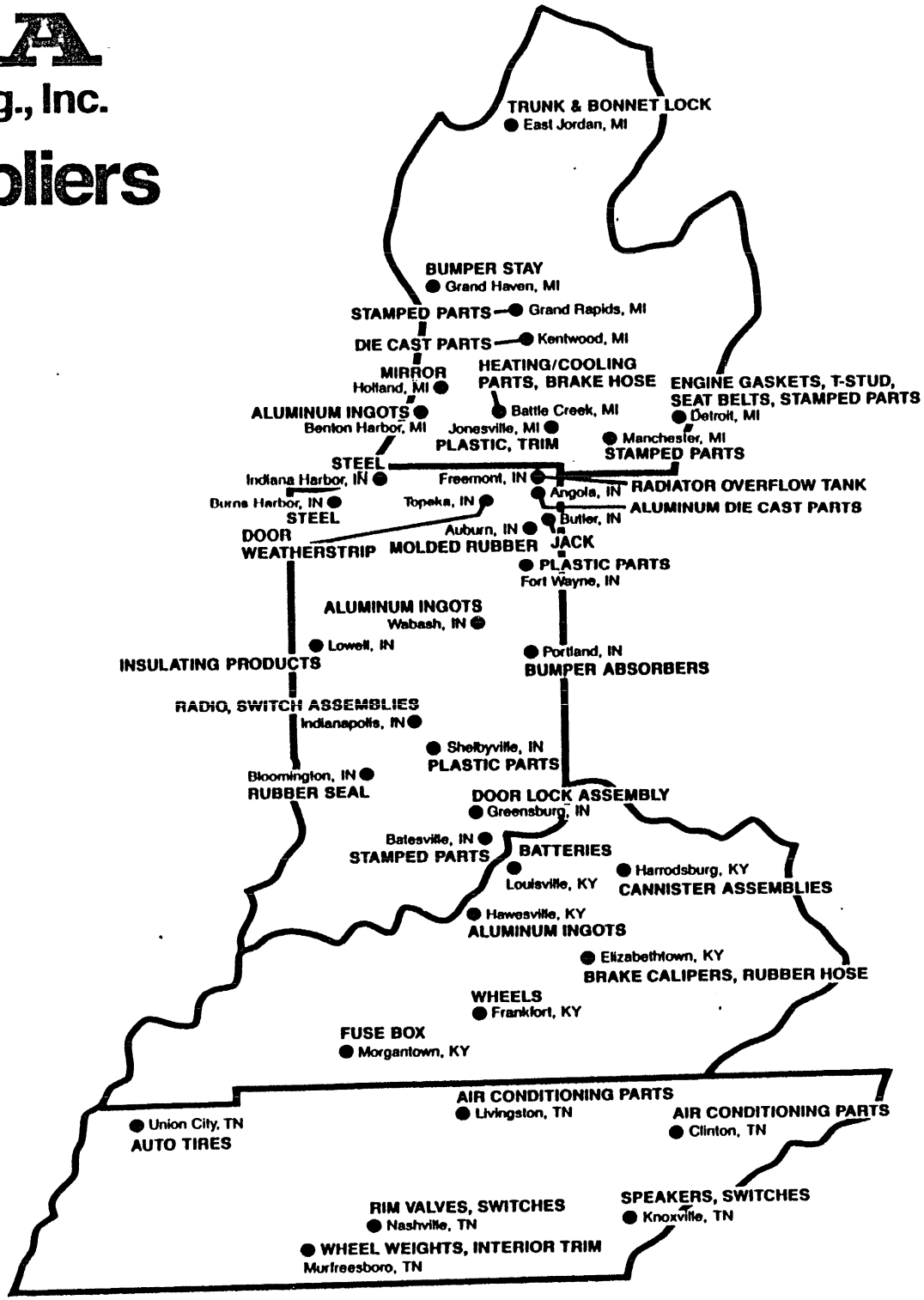
Ohio Suppliers



HONDA

Honda of America Mfg., Inc.

Regional Suppliers



HONDA

Honda of America Mfg., Inc.

U.S. Suppliers