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Surrogate Plant Data Base

Volume I Introduction

Appendix A: The Development of Surrogate Plant Data

Appendix B: Application of the Surrogate Plant Data Base

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May 1983
Final Report

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National Highway Traffic Safety Administration

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16. Abstract

This four volume report consists of a data base describing "surrogate" automobile and truck manufacturing plants developed as part of a methodology for evaluating capital investment requirements in new manufacturing facilities to build new fleets of automobiles. The report describes the data base, its past uses and potential applications. Separately bound appendices contain the actual data base information.

The surrogate plants are typical of automotive manufacturing plants in terms of size, production rates, manufacturing processes, technological sophistication and flexibility. The data for a particular type of surrogate plant, while not representing any specific plant, provides information that, when appropriately aggregated or scaled, will yield accurate industry statistics.

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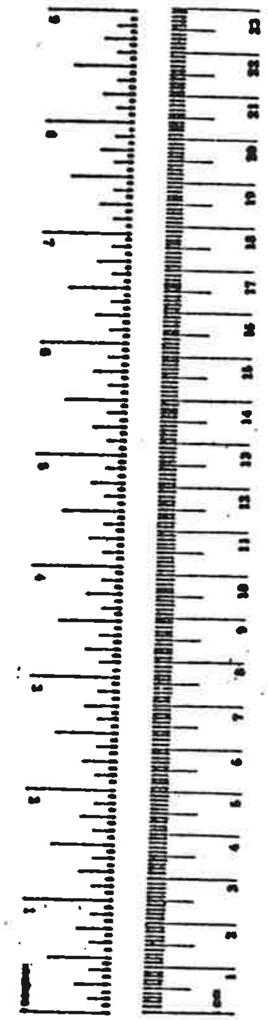
PREFACE

The development of Appendix B--Application of Surrogate Plant Data Base-- was made possible through the efforts of Joseph F. Petrie, who is responsible for this Appendix. The author also wishes to acknowledge the Transportation Consulting Division, a division of Booz, Allen & Hamilton, Inc., and Harbour Associates, Inc., who carried out Contract DOT-TSC-1609 encompassing the acquisition and analysis of information relative to manufacturing equipment required to produce a socially acceptable and efficient motor vehicle. He would also like to thank the staff of Raytheon Service Company for providing support.

METRIC CONVERSION FACTORS

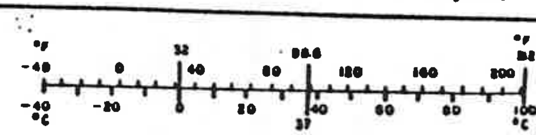
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



REPORT CONTENT AND ORGANIZATION

This report documents the Surrogate Plant Data Base, covering typical manufacturing plants and facilities representing the major types used to produce motor vehicles. This report is organized into four separate volumes as follows:

- VOLUME I

  - INTRODUCTION

  - Appendix A describes how the surrogate plant data was developed. It also describes how a manufacturer would plan for a new component or assembly plant including the staffing functions, personnel requirements, leadtime requirements, and cost requirements associated with the planning of a new component, part, or assembly plant.

  - Appendix B describes how the surrogate plant data base can be used to develop estimates of the capital cost impacts of developing new facilities or modifying existing facilities. It includes a summary of capital cost impact data on 39 automotive manufacturing plants plus a surrogate plant coding scheme and a method for identifying suppliers to the automotive industry.

- VOLUME II

  - Appendix C provides capital cost data for 39 automotive manufacturing plants broken down by major cost element: land, building and equipment, plant facilities, machinery and equipment, and tooling. It also contains a breakdown of the data by major department in the plant, a summary of the plant's size (i.e., square footage) by major department and a diagram depicting the layout of the plant.

- VOLUME III

  - Appendix D provides operating manpower, manufacturing plant budgets (i.e., labor, maintenance, utilities, taxes and insurance expenses), and pre-production and launch timing charts and expenses for 10 automotive manufacturing plants. The information presented for the 10 plants is representative of the 39 plants included in Volume II, Appendix C.

- VOLUME IV

  - Appendix E discusses the major differences in manufacturing light and heavy duty vehicles in terms of the processes employed and make-up of the plant, and the need to develop surrogate plant data on medium and heavy duty truck assembly and component plants. It includes a list of plants proposed for initial development.

TABLE OF CONTENTS

SURROGATE PLANT DATA BASE REPORT

1. INTRODUCTION

Efforts by the United States Automotive Industry to design, develop and manufacture a new generation of automobiles with improved fuel efficiency, lower emissions, and increased safety have had and will continue to have major impacts on the resources for production--capital investment in facilities, equipment and tooling, and human resources.

In order to understand the magnitude of these impacts, the National Highway Traffic Safety Administration asked the Transportation Systems Center to develop a methodology for evaluating capital investment requirements in new manufacturing facilities to build new fleets of automobiles. TSC responded by developing a comprehensive data base on automobile manufacturing plants called the "surrogate plant" data base.

This report describes the surrogate plant data base, its past uses, and potential applications. Separately bound appendices contain the actual data base information for all the available surrogate plants.

2. DESCRIPTION OF SURROGATE PLANT DATA BASE

The surrogate plant data base consists of data on various standard or "typical" automotive plants. It has been developed with the hypothesis that the inherent economics of U.S. auto manufacturing have resulted over time in standard manufacturing plant design. The "surrogate" automotive plants are typical of automotive manufacturing plants in terms of:

- Size
- Production rate
- Manufacturing process
- Technological sophistication
- Flexibility.

Thus a surrogate automobile engine plant, while not representing any particular manufacturer's plant, will provide information that when appropriately aggregated or scaled will yield accurate industry statistics.

The Transportation Systems Center estimates that to produce a modern automobile which has over 15,000 parts requires between 85 and 100 types of manufacturing plants. At the present time baseline data has been developed on thirty-nine types of plants that produce the major components and raw materials associated with the manufacture of the vehicle. These 39 plants provide the vast majority of the economic value added in the manufacturing process and include the plants listed in Table 1.

TABLE 1.· PLANTS COVERED IN THE DATA BASE

Plant #	Type	Plant #	Type
1)	CAR-ASSEMBLY	22)	ENGINE: 8-CYLINDER GAS
2)	LIGHT TRUCK & VAN ASSEMBLY	23)	MANUAL: TRANSAXLE
3)	BODY STAMPING	24)	AUTOMATIC TRANSMISSION
4)	HARDWARE	25)	AUTOMATIC TRANSAXLE
5)	ELECTRONIC COMPONENTS	26)	AXLE
6)	PLASTICS MOLDING	27)	C.V. JOINTS AND HALF SHAFTS
7)	TRIM	28)	SUSPENSION
8)	FABRICATED GLASS	29)	BRAKE
9)	HEATER AND AIR CONDITIONER	30)	STEERING COMPONENTS
10)	STEEL FORGING	31)	BUMPER (PLASTIC FASCIA)
11)	GREY IRON FOUNDRY	32)	SEAT BELT
12)	NODULAR IRON FOUNDRY	33)	INSTRUMENTATION
13)	ALUMINUM FOUNDRY	34)	FOAM, PAD AND SUPPORT
14)	ALUMINUM DIE CASTING	35)	SEAT FRAME AND SPRING
15)	ROAD WHEEL	36)	FIBERGLASS REINFORCED PLASTIC PRODUCTS
16)	BUMPER (STEEL)		
17)	ENGINE ELECTRICAL	37)	MANUAL TRANSMISSION
18)	ENGINE: 4-CYLINDER GAS	38)	FRAME
19)	ENGINE: 4-CYLINDER DIESEL	39)	AIR BAG
20)	ENGINE: 6-CYLINDER GAS		
21)	CONDENSER & RADIATOR		

For each plant shown in Table 1, the following information has been developed:

- <u>Manufacturing processes</u>. A description of the key manufacturing processes in the plant.

- Capital cost. A detailed description of capital costs associated with the plant site, building, building and manufacturing facilities and machine tools and equipment. The capital costs are presented at four levels of detail (see Figure 1):

  Level 1 - Total Facility

  Level 2 - Plant and Equipment

  Level 3 - Major Department

  Level 4 - Major Equipment

- Layout. A layout is provided for each plant showing a typical floor plan and typical area requirements.

- Manpower. Detailed manpower requirements are provided for each plant department. Department manning requirements to the level of each job position are also provided for some plants.

In addition, for selected automotive manufacturing plants which are typical of groups of plants, the following information has been developed.

- Operating expenses. Manufacturing budgets for various plants show expenses for labor, maintenance, utilities, and taxes and insurance.

- Manufacturing cost. Operating and capital costs are allocated on a per unit basis to provide the total manufacturing cost of plant products, not including materials. The output of one plant becomes the material input into another.

- Pre-production timing. Timing charts are provided showing the planning requirements for the plant prior to product launch.

- Launch rates. Typical start-up employment and plant volume are shown for a new product launch (actual start of production).

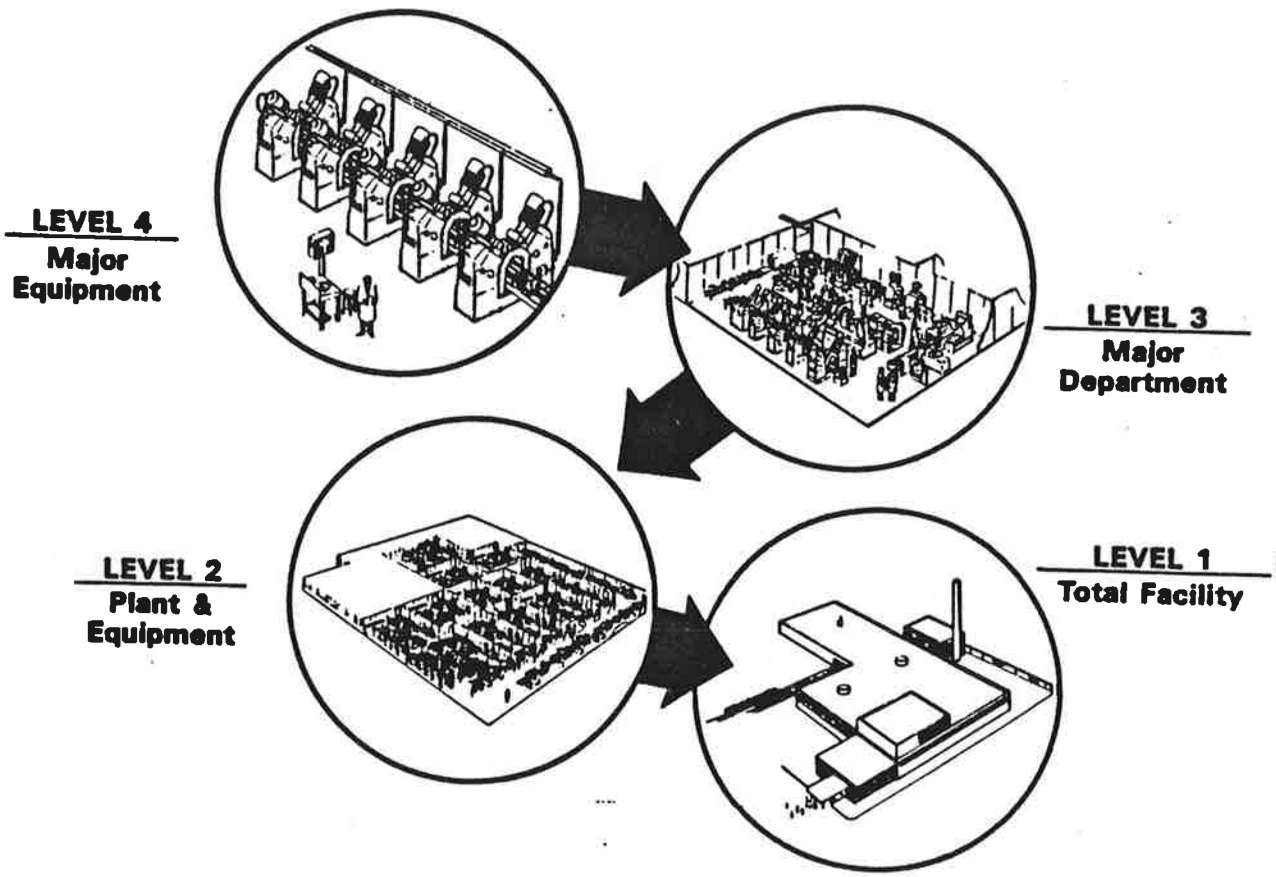


FIGURE 1. SURROGATE PLANT PROGRAM: FOUR LEVELS OF DETAIL

- Pre-production and launch expenses. Capital, manpower and other manufacturing expenses are detailed for the pre-production and launch period.

3. PAST USES AND POTENTIAL APPLICATIONS OF THE SURROGATE PLANT DATA BASE

The data on automotive manufacturing plants has proven valuable in providing answers to questions concerning automotive industry production and capital requirements on a quick reaction basis. For example, the data base has been used to respond to NHTSA and Congressional inquiries regarding facilities planning, capital costs, and regional employment impacts for selected vehicle design/production changes. Figure 2 shows how the data base is typically used for impact assessment:

- A vehicle configuration/production scenario is described in terms of changes to the vehicle, manufacturing process, production level, and sourcing plans.
- The information in the scenario is then related to the plant or segments of the industry affected.
- The impact of the scenario (i.e., vehicle design/production change) is measured at the appropriate level of detail (i.e., Level 1, 2, 3, or 4) in plant data developed for that plant.
- The typical plants are compared to actual plants from the Plants and Lines Data Base* and the impacts are summed across all plants of that type.

The resulting analysis provides an assessment of the capital investment and facilities planning impacts--in total, by plant type, by specific plant and even by department within a plant--and the employment impacts that may occur by plant location. This methodology has been used by TSC, for example, in assessing industry

*A data base with three years of publicly available information on manufacturers' plants within the industry; organized by company and plant location.

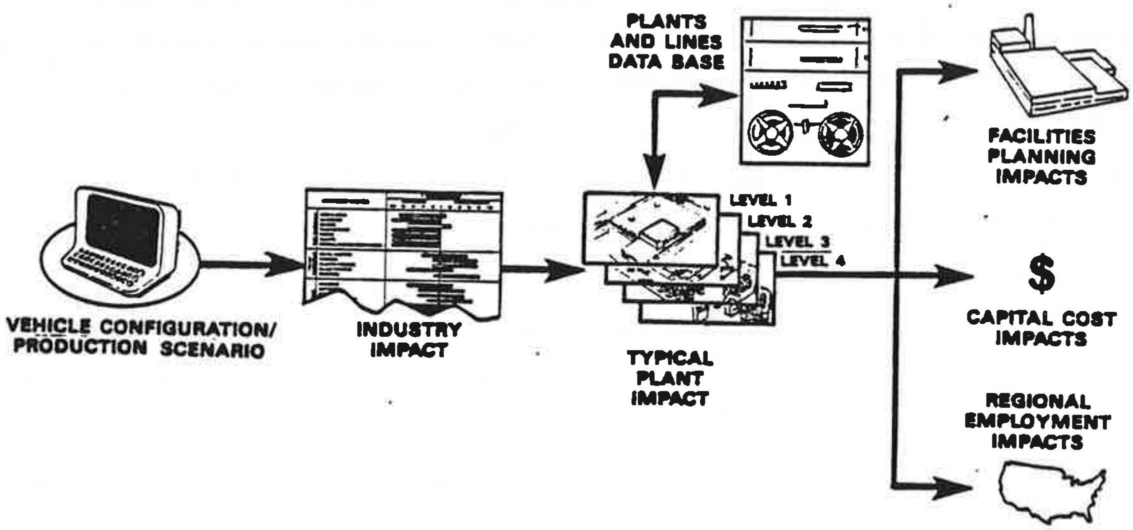


FIGURE 2. THE OVERALL PROGRAM FOR FACILITIES PLANNING AND REGIONAL EMPLOYMENT ASSESSMENT

impacts associated with (1) downsizing passenger cars and (2) switching from rear-wheel drive to front wheel drive automobiles.

In a similar fashion to that described above, the data base can also be used to help answer the following types of questions:

- o What is the impact of new automotive designs or new manufacturing technology on plant manpower?
- o How do changes in automotive manufacturing requirements affect local economies?
- o How can productivity of American automotive plants be improved?
- o What is the impact of a vehicle part design change on manufacturing cost?

APPENDIX A: THE DEVELOPMENT OF SURROGATE PLANT DATA

The surrogate plant data contained in this report was developed using estimating techniques for automotive manufacturing. Consultants familiar with the automotive industry, Harbour & Associates and Booz, Allen and Hamilton, developed the data based upon manufacturing experience and knowledge of existing manufacturing facilities.

The surrogate plant data essentially captures the major elements of automotive manufacturing process and technology as developed by the automotive industry using thousands of labor-years of effort. The data cannot be easily obtained since it is in general not available from the automotive manufacturers and cannot be developed independently from them without investing in manpower to a level comparable to the manufacturers. Thus the use of consultants has made available data with a high degree of credibility without the huge investment required to develop the data from the ground up. Since the data was developed for "typical" plants using industry rules of thumb it is subject to some error and this has been indicated within the data base.

The rest of this appendix describes how the auto manufacturers actually develop the information on capital and manpower requirements of production facilities. It will illustrate the extensive manpower and financial resources required to develop a new automobile plant. It is organized into the following sections:

- Staff functions
- Personnel requirements
- Leadtime requirements
- Cost requirements

STAFF FUNCTIONS

Before a new component, part or assembly plant can be built, a considerable amount of staff work is required. This staff work is needed to ensure that the new part or component is designed and manufactured in the most cost-effective manner possible.

To illustrate the magnitude of this effort, presented below is a summary of the various staff functions involved in developing a plant to produce a new 4-cylinder engine. (See Figure A-1). The steps outlined represent those an automobile manufacturer would take to develop a new automotive facility. (See Figure A-2).

- Research and Development. Research and development personnel are responsible for performing basic engine research related to fuel economy and emissions and for designing the new four cylinder engine. Specific research includes designing the engine for maximum fuel economy and minimum emissions based on the vehicle design, weight and driveline configuration.

- Product Engineering. Product Engineering personnel design the engine within the parameters defined by Research and Development. In designing the engine, Product Engineering takes into consideration the level of machine tool technology that will be employed in the facility. As such, Product Engineering works very closely with Plant Manufacturing Engineering and Quality Assurance.

- Manufacturing Engineering. Manufacturing Engineering performs the following activities:

  - Defines the specific processes to be used in manufacturing each component, subassembly and assembly of the engine (see Table A-1)

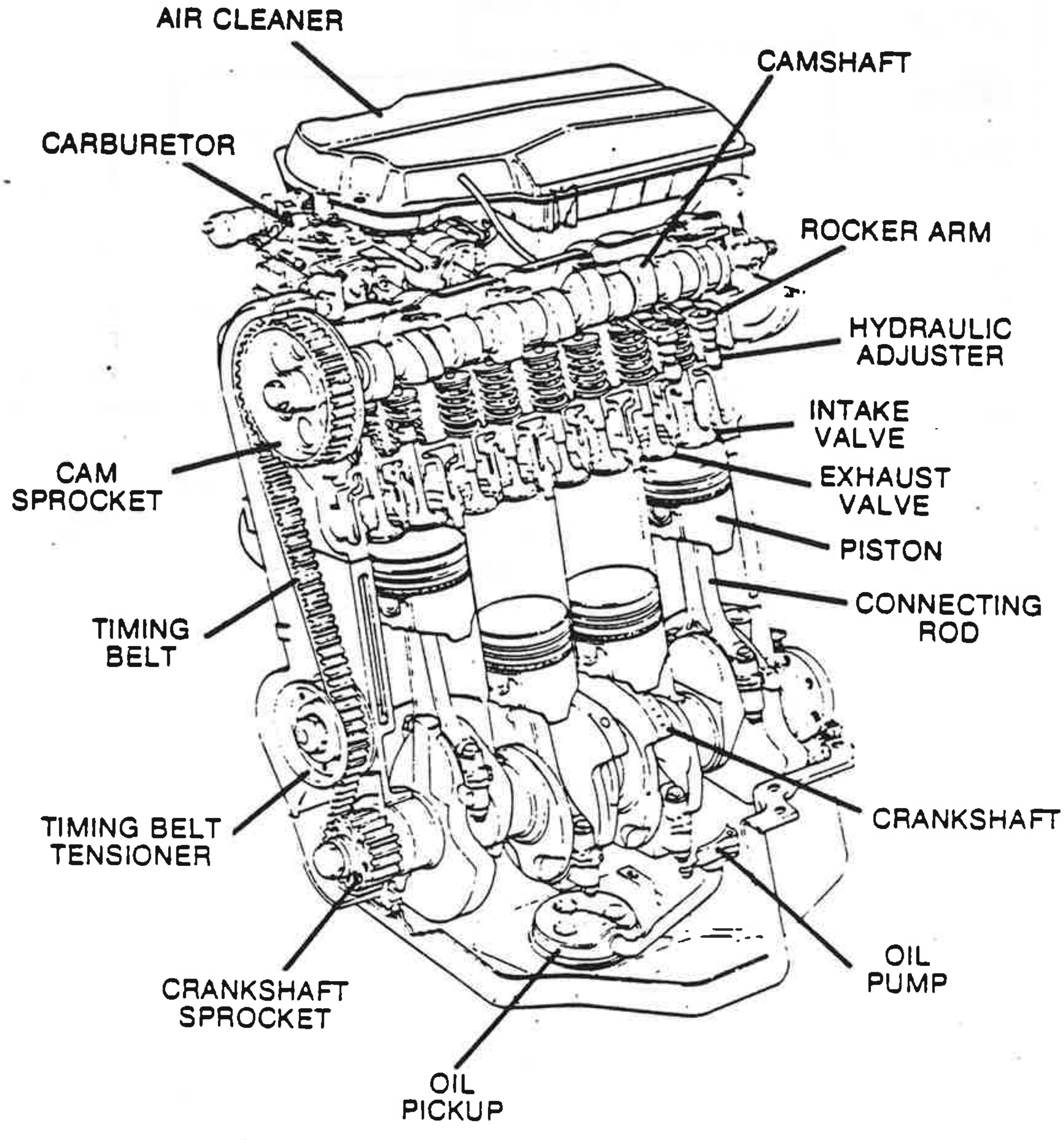


FIGURE A-1. Four Cylinder Engine

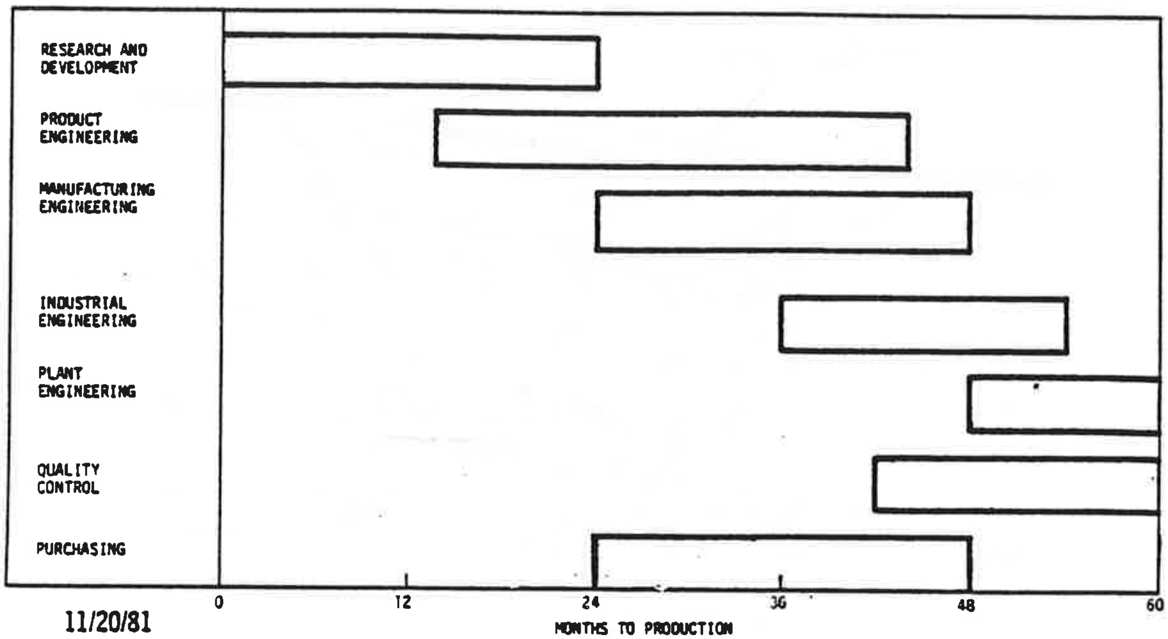


FIGURE A-2. Leadtime Requirements Associated with Planning and Engineering a new 4-Cylinder Engine Plant

TABLE A-1. Manufacturing Processes Involved in Manufacturing a 4-Cylinder Engine

- Cylinder Block Machining
- Main Bearing Caps
- Cylinder Block Assembly
- Cylinder Head Machinery
- Crankshaft Machining
- Camshaft Machining
- Piston Machining
- Connecting Rod and Cap Machining and Assembly
- Intake Manifold Machining
- Exhaust Manifold
- Waterpump Machining and Assembly
- Oil Pump Machining and Assembly
- Engine Assembly
- Engine Testing

  - Evaluates the impacts of the new product on other manufacturing and supplier plants. In the case of a 4-cylinder engine plant, the following plants would be affected: forge, grey iron foundry, nodular iron foundry, aluminum foundry, die-cast plant, powder metal plant, valve-train plant, and bearing, carburetor and catalyst plants.

  - Defines specific machinery, equipment and tooling to be made or purchased*.

  - Develops a specific timing chart for all equipment purchases and makes regular visits to the suppliers to confirm design intent and delivery timing.

- Industrial Engineering. Industrial Engineering works jointly with Manufacturing Engineering to define the processing and assembly methods that will produce the lowest labor hours per engine component and assembly. Industrial Engineering also works with Plant Engineering on plant layout to provide for the most efficient flow of materials to the individual machinery and assembly line.

* Each potential supplier for every machine, and piece of equipment and tooling is specified for use by the purchasing department.

- <u>Plant Engineering</u>. Plant Engineering performs the following activities:

  - Details specific plant engineering layouts for installation of all machinery and equipment.

  - Defines additions/deletions or changes to present plant facilities, electrical systems, pits/flumes/foundation, conveyor systems, power house, building structure, discharge stacks and air makeup.

  - Removes, installs or supervises the removal and installation of all old and new equipment and machinery, including the connection of all electrical, water, and air systems.

- <u>Quality Control</u>. Quality Control works with Manufacturing Engineering to insure that each piece of new machinery and equipment can achieve total process control and be in conformance with defined specifications*.

- <u>Purchasing</u>. Purchasing supervises the acquisition of all machinery and tools.

PERSONNEL REQUIREMENTS

Table A-2 shows the manpower requirements associated with each staff function from planning through completion of the activity involved. As shown, approximately 1870 employees are needed for from one to two and a half years to design a new 4-cylinder engine plant. Research and Development, Product Engineering, Manufacturing Engineering, and Plant Engineering account for the bulk of the personnel. On a man-year basis, Product Engineering is by far the largest planning activity.

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* Quality specifications are established and published for each operation and required inspection gauges and devices are defined and ordered.

TABLE A-2. Staffing Requirements by Function

Function	No. of Employees	Duration (years)	Man-Years
Research & Development	300	2.0	600
Product Engineering	450	2.5	1125
Manufacturing Engineering	200	2.0	400
Industrial Engineering	100	1.5	150
Plant Engineering	600	1.0	600
Quality Control	180	1.5	270
Purchasing	40	2.0	80
TOTAL	1870	--	3225

LEADTIME REQUIREMENTS

As shown in Figure A-2, it takes approximately five years from product conceptualization to plant construction to be able to produce a new product or component. The early planning phases (years one, two, and three) include research and development, product engineering, manufacturing engineering, and purchasing. The later phases (years four and five) include the activities directly related to the plant--industrial engineering, plant engineering and quality control.

STAFF COST REQUIREMENTS

Table A-3 shows the cost requirements for all the staff functions needed to plan and engineer a new 4-cylinder plant. The total for all functions over five years is $133 million. The early phases of planning for a new product--Research and Development, Product Engineering, Manufacturing Engineering and Purchasing--account for 69 percent of the cost and the later activities--Industrial Engineering, Plant Engineering and Quality Control--account for 31 percent of the cost.

TABLE A-3. Cost Requirements to Plan and Engineer a Plant for One New 4-Cylinder Engine to Produce 400,000 Engines a Year

	No. of Employees		Salary		Years		Total Salary
- Research & Development	300	X	$42,000.00	X	2.0	=	$25.2M
- Product Engineering	450	X	$42,000.00	X	2.5	=	$47.3M
- Manufacturing Engineering	200	X	$42,000.00	X	2.0	=	$16.8M
- Industrial Engineering	100	X	$42,000.00	X	1.5	=	$6.3M
- Plant Engineering	600	X	$42,000.00	X	1.0	=	$25.2M
- Quality Control	30	X	$42,000.00	X	1.5	=	$1.9M
	150	X	$35,000.00	X	1.5	=	$7.9M
- Purchasing	40	X	$35,000.00	X	2.0	=	$2.8M
				TOTAL			$133.4M

NOTE: Does not include an estimated 6000 employees needed for plant rearrangement and installation.

APPENDIX B

APPLICATION OF THE SURROGATE PLANT DATA BASE

The surrogate plant data base has been primarily used in the past to analyze the capital cost impacts associated with automobile manufacturers' new product and production plans. This appendix describes use of the surrogate plant data in computing facility capital costs. It also describes a computer model developed by TSC to facilitate the capital cost computation.* It also discusses potential future applications of the surrogate plant data base.

USE OF THE SURROGATE PLANT DATA BASE IN ANALYZING MANUFACTURERS' PRODUCT AND PRODUCTION PLANS

Figure B-1 illustrates use of the surrogate plant data in analyzing manufacturers' product and production plans. Specifically, the surrogate plant data is used to develop facility capital cost requirements, i.e., estimates of capital requirements by calendar year, by model year, and by plant, associated with a new product. As shown in Figure B-1, the analysis starts with an estimate of motor vehicle demand. This estimate is either provided directly by the manufacturer or generated by the analyst. Using this estimate, the analyst then develops a product plan which defines the key features of the product to be developed and a production plan which describes the implementation schedule and volume of products to be produced.

*For further information on the capital cost calculator, reference the volume (unpublished) documentation prepared by Joseph F. Petric of TSC. Volume I is a User's Manual designed for a user with limited ADP skills who requires detailed information on the user prompts and especially on the error correction process. Volume II is a Programmer's Manual designed to assist a user with SDP skills in either installing the software on another computer or maintaining the software. It contains three parts: (A) Programmer System Documentation; (B) Program and Data Base Structure Listings; and (C) Programmer Oriented User Guide.

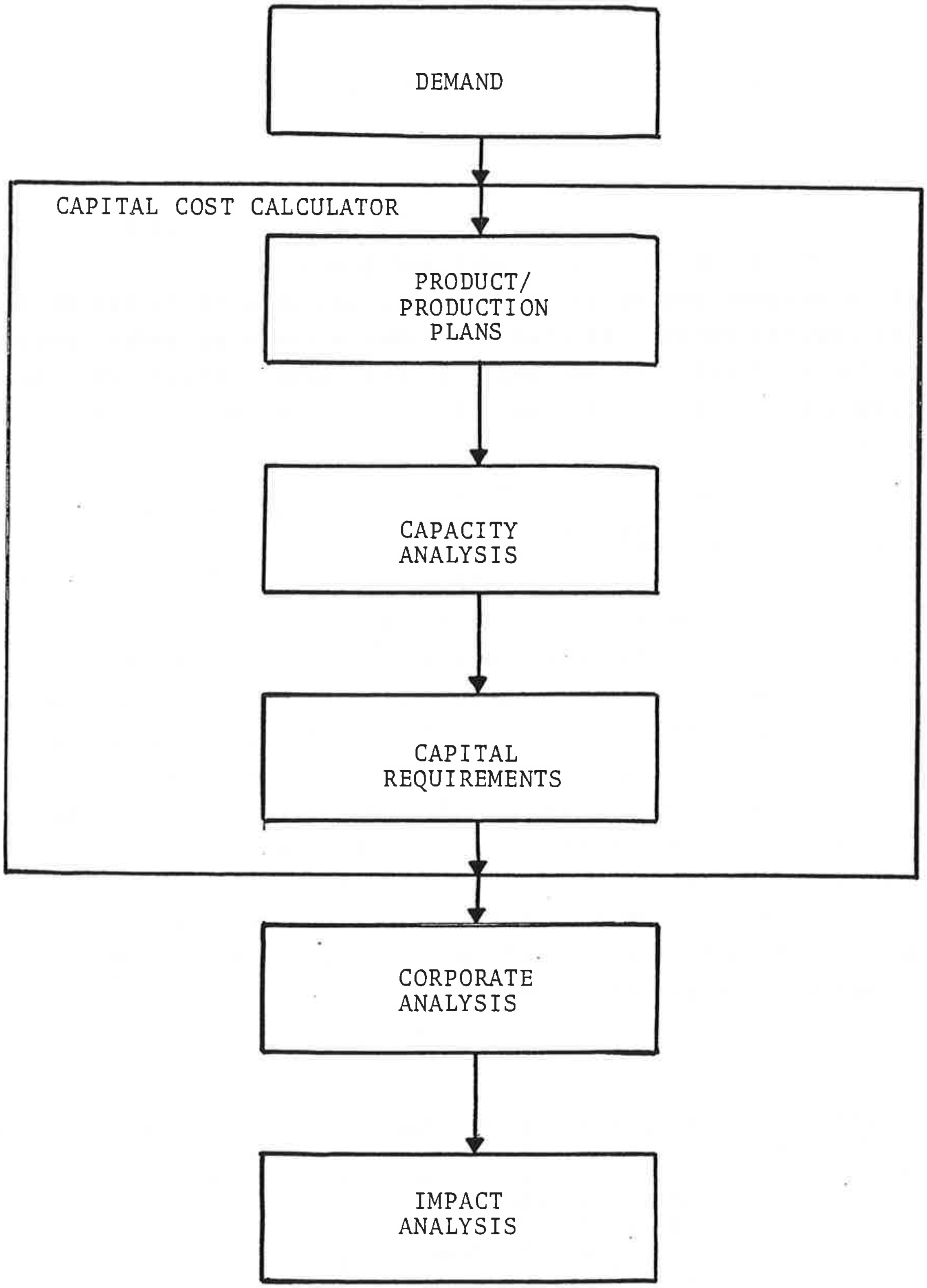

FIGURE B-1. METHODOLOGY FLOW CHART FOR THE ANALYSIS OF MANUFACTURERS' PRODUCT AND PRODUCTION PLANS AND CAPITAL REQUIREMENTS

Next a comparison of the needed capacity to produce the estimated volume is made with the actual and planned capacity of the manufacturer's facilities to assess whether sufficient capacity will be available to produce the required product. Plant production estimates developed from public information sources and consultants are used for this comparison and, when there is insufficient capacity, the analyst decides whether to introduce purchase of the product, build a new plant or expand an existing plant. This decision is then translated into facility capital cost requirements using the surrogate plant data base for capital cost data. Applying engineering judgement to the surrogate plant data base, the capital cost impacts of a new product can be developed in terms of the impact on buildings, land, equipment, and tooling. These capital cost estimates are then used as input to a corporate analysis which focuses on the manufacturers' ability to meet the required capital in an economic sense. Manufacturers' capital spending plans announced by the manufacturers, building contractors, capital equipment suppliers and state and local governments are used for this analysis.

Finally, the resulting corporate analysis provides an input into an impact analysis which examines the national and regional impacts of the changes in production plants, such as openings or closings to adjust to changing demand.

DESCRIPTION OF AN ANALYTICAL TOOL TO ESTIMATE FACILITY CAPITAL COSTS

To facilitate computation of facility capital costs, the TSC was requested by the National Highway Traffic Safety Administration to develop a computer model called the "Integrated Capital Cost Calculator". The purpose of the model is to estimate the facility capital cost requirements associated with a new product. The structure of the model, the model software and the data bases required to support the model are described below.

Structure of the Model

Figure B-2 outlines the structure of the integrated capital cost calculator. As shown, the calculator has four components:

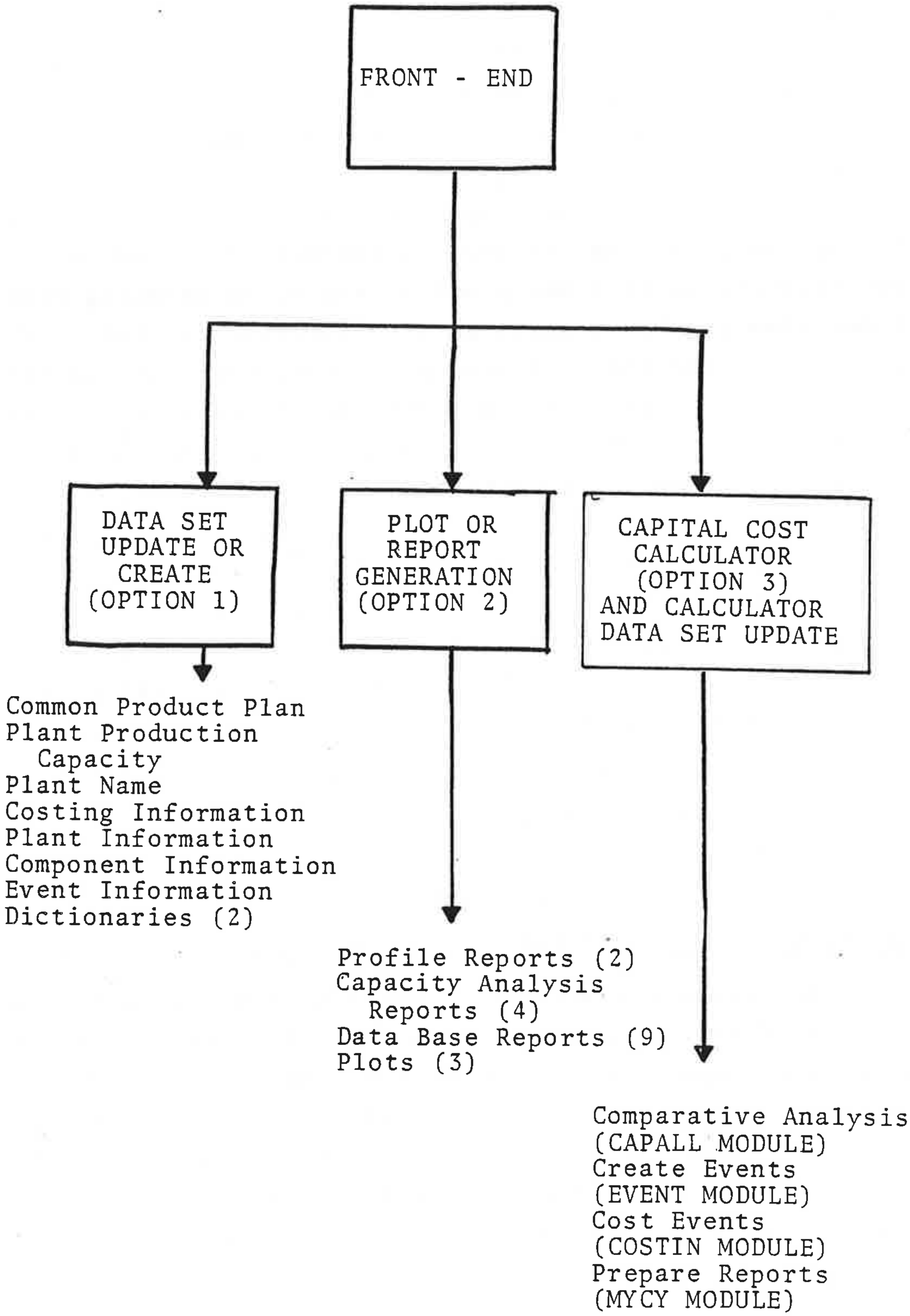

FIGURE B-2. STRUCTURAL OVERVIEW

- Front-End

  The user-oriented, interactive front-end software which guides the user through the process. The front-end software gives the user the capability to start anywhere in the process, to use selected capabilities, and to exit easily without destroying prior work.

- Option 1 Data-Set Update and Create

  The update or create option (option 1) which facilitates data entry, deletion, etc. and the creation of new data sets used in the other two options. The analyst can use this first option to create and/or update the data sets required to determine whether there is sufficient capacity, including planned capacity, to produce the product.

- Option 2 Plot or Report Generation

  The report or plot generation option (option 2) which contains virtually all the reports for the Calculator. This second option is used to generate reports using, as input, data on sales, plans, productivity increases and other basic assumptions. Essentially, the analyst uses the reports to match the sales data against projected production on a plant by plant, product line by product line basis. All variances greater than ± 15 percent are analyzed on a case by case basis.

- Option 3 Calculator

  The Capital Cost Calculator and calculator data-set update option (option 3) which assists the user in creating a record called an event, i.e., a change in assembly, transmission, or engine production capacity or in manufacturing processes for a specific model year which results in a capital investment by the manufacturer. In addition, this option also assists the user in entering

  - data regarding the plants that will be affected by the changes in production or the production processes

- data about whether the manufacturer will make complementary component plant investments

Using this data as input, the Calculator estimates the facility costs required to build and equip the plants and generates reports for distribution.

Model Software

The model was written for the DEC-10 computer. Little knowledge of the DEC-10 operating system (monitor) commands is required to operate the Calculator. A person who can log on and log off can operate the Calculator, including generating the various reports from the existing data bases. To start the Calculator, the user types the DEC-10 monitor command "run" followed by a carriage return.

Intimate knowledge of the system 1022 software is not required. The Calculator's programs contain sophisticated user prompts to assist the user with limited experience with the System 1022 language and the DEC-10 monitor commands. A person with some ADP skills can generate the reports, change the data, etc. A more advanced user, one with some System-1022 skills, does not need to use the Calculator to retrieve data from the various data bases, change the basic data, generate new reports, add data, etc. Accordingly, acquisition of basic System-1022 skills is encouraged.

Data Bases

There are nine data base structures in the Integrated Capital Cost Calculator. Two of the structures are for dictionaries which specify the valid codes to be entered and which specify the items to be displayed on reports. The remaining data sets which contain data for retrieval, plots, reports, etc., are:

- Common Product Plan (CPP): one summary record for each unique item in the fleet by year.
- Plant Production Capacity (PROD): one record for each combination of plant, product line, and year.

- Plant Name (PNAME): one record for each plant identified in the data sets.
- Costing Information (CRIB): the original events analysis/capital cost data base which contains one record for each type of physical change required in a facility to meet the change in production or processes. (See Figure B-3.)
- Plant Information (EVPRO): at least one record for each event depending on whether one or many plants are involved. This is a plant specific data base which is linked to the event file for report generation by common attributes: event identification, manufacturer, and scenario.
- Component Information (TABLE): component costing details with one record for each event highlighting the analyst's decisions on component costing.
- Event Information (EVENT): one record for each event created by the analyst.

POTENTIAL FUTURE APPLICATIONS OF THE SURROGATE PLANT DATA BASE

The TSC has employed the methodology discussed above to assess the capital cost impacts of vehicle downsizing and the switch to front wheel drive. In addition to this application, the model can also be used to answer the following types of questions:

- What is the impact of new automotive designs or new manufacturing technology on plant manpower?
- How do changes in automotive manufacturing requirements affect local economies?
- How can productivity of American automotive plants be improved?
- What is the impact of a vehicle part design change on manufacturing cost?

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G. BYRON

	FACILITY TYPE	PRODUCT/FUNCTION	ANNUAL PRODUCTION RATE (000)	LEAD TIME EQUIP. MONTHS	COSTS ($M) BLG/LAND LEVEL	EQUIP II	TOTAL I	CONVERSION DESCRIPTION	COST	LEAD TIME (MONTHS)	PREPRODUCTION & LAUNCH COSTS
BODY ASSEMBLY	FINAL ASSY PASSENGER CAR	BODY-IN-WHITE, CHASSIS, TRIM & FINAL ASSY	300	24	170	266	436	FACE LIFT	$16M	24	15%/25% OF TOTAL FACILITIES
								RE-SKIN	$32M	24	15%/25% OF TOTAL FACILITIES
								NEW CAR	$74M	30	15%/25% OF TOTAL FACILITIES
SHEET METAL	FINAL ASSY LIGHT TRUCKS	BODY-IN-WHITE, CHASSIS TRIM & FINAL ASSY	150	24	117	153	270	FACE LIFT	$16M	24	15%/25% OF TOTAL FACILITIES
								RE-SKIN	$32M	24	15%/25% OF TOTAL FACILITIES
								NEW CAR	$74M	30	15%/25% OF TOTAL FACILITIES
TRIM	BODY STAMPING BODY SHEET METAL	ALL STAMPED PARTS & SUB-ASSEMBLY OF STAMP PARTS	900 CAR SETS	24	285	284	569	FACE-LIFT	$53M	24	
								RE-SKIN	$95M	24	15%/25% OF TOTAL FACILITIES
								NEW CAR	$138M	24	15%/25% OF TOTAL FACILITIES
	INTERIOR TRIM	SEATS & SEAT COVERS, ROOFING, CARPET MATL. PADDED INSTR. PANEL, ETC.	400 CAR SETS	-	22.7	24.9	47.6	ALTERNATE NAME PLATE	$11M	-	15%/25% OF TOTAL FACILITIES
								ALTERNATE BODY STYLE			
								(STATION WAGON)	$21M	-	15%/25% OF TOTAL FACILITIES
								(2 DR/SPORT)	$5M	-	15%/25% OF TOTAL FACILITIES
								(4 DR)	$21M	-	15%/25% OF TOTAL FACILITIES
POWER TRAIN	ENGINE INLINE 4-CYL	FABRICATED, ASSEMBLE & TEST	400	36	123	203.5	326.5	DOWNSIZE (DESIGN PERMITS)	$127M	24	15%/25% OF TOTAL FACILITIES
	V-6	FABRICATED, ASSEMBLE & TEST	400	36	130.5	256.5	387	S.I. TO DIESEL (DESIGN PERMITS)	$106M	24	15%/25% OF TOTAL FACILITIES
	V-8	FABRICATED, ASSEMBLE & TEST	400	36	137	274.5	411.5				
	DIESEL 4 CYL	FABRICATED, ASSEMBLE & TEST	400	36	80.3	212	292.3				
	TRANSMISSION	FABRICATED, ASSEMBLE & TEST									
	(FWD) AUTO 3 SPEED	FABRICATED, ASSEMBLE & TEST	500	36	144.5	265	409.5				15%/25% OF TOTAL FACILITIES
	(RWD) AUTO 3 SPEED	FABRICATED, ASSEMBLE & TEST	400	36	129.5	225.8	355.3				15%/25% OF TOTAL FACILITIES
	(FWD) MANUAL 3 SPEED	FABRICATED, ASSEMBLE & TEST	400	36	80.3	95.4	175.7				15%/25% OF TOTAL FACILITIES
	FOUR WHEEL DRIVE	FABRICATED, ASSEMBLE & TEST	400	36	61.5	145.8	207.3				15%/25% OF TOTAL FACILITIES
COMPONENTS (SYSTEM LEVEL)	DISC BRAKES		400	36	13.4	32.3	45.7				15%/25% OF TOTAL FACILITIES
	STEERING		400	36	21.4	42.4	63.8	NOTES: COMPONENT COST			15%/25% OF TOTAL FACILITIES
	SUSPENSION		400	36	11.8	22.3	34.1				15%/25% OF TOTAL FACILITIES
	COOLING		1000	24	45.5	63.6	109.1	o (400,000 UNITS)			15%/25% OF TOTAL FACILITIES
	ENGINE ELECTRICAL		1000	24	41.9	123.8	165.7				15%/25% OF TOTAL FACILITIES
	CARBURETOR		400	24	13.4	32.3	45.7	o ALL NEW FWD $655M			15%/25% OF TOTAL FACILITIES
	BUMPERS		400	24	11.2	17.5	28.7				15%/25% OF TOTAL FACILITIES
	EMISSIONS - AIR PUMP		1000	24	3.2	37.1	40.3	o ALL NEW RWD $705M			15%/25% OF TOTAL FACILITIES
	EMISSIONS - CATALYTIC CONVERTER		400	24	6.4	14.9	21.3				15%/25% OF TOTAL FACILITIES
	FRAME		400	24	64.2	94.3	158.5				15%/25% OF TOTAL FACILITIES
	AXLES - F.W.D.		400 CAR SETS	36	18.2	45.1	63.3				15%/25% OF TOTAL FACILITIES
	AXLES - R.W.D.		400 CAR SETS	36	60.9	96.6	157.5				15%/25% OF TOTAL FACILITIES
	WHEELS		2000	24	12.5	34.8	47.3				15%/25% OF TOTAL FACILITIES
SUPPORT	ALUMINUM DIE CASTING	Tx CASE, PUMP HOUSINGS,						ENGINE CAST PARTS	$31M	12	
	ALUMINUM SAND	CYL. HEADS, ETC.	400	30	10.7	49.3	60	IRON/ALU. (400,000)			15%/25% OF TOTAL FACILITIES
	IRON CASTINGS	CYL. HEADS	400	24	8.0	15.9	23.9	TRANSMISSION ALU.	$17M	12	15%/25% OF TOTAL FACILITIES
	STEEL FORGE	ENGINE PARTS	400	18	42.8	127.2	170	PARTS (400,000)			15%/25% OF TOTAL FACILITIES
	PLASTICS PROCESSING	CONNECTING RODS	400	24	10.7	29.7	40.4				15%/25% OF TOTAL FACILITIES
		TRIM, PANS	400 SETS	24	48.2	111.3	159.5	OTHER COMPONENTS (400,000)	$5M		15%/25% OF TOTAL FACILITIES
								TOTAL	$53M		
SPECIALITY	TURBOCHARGER	FABRICATE, ASSEMBLE & TEST	400	24	26.8	68.9	95.7				15%/25% OF TOTAL FACILITIES
	ENGINE ELECTRONICS	SENSORS, PROCESSORS	400	24	8.6	20.1	28.7				15%/25% OF TOTAL FACILITIES

FIGURE B-3. FACILITIES PLANNING ESTIMATES COSTS (1981$) FOR TYPICAL AUTOMOTIVE PRODUCTION FACILITIES (CRIB Sheet)

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