A Systematic Method for Valuing a Product Platform Strategy

by

Stephen L. Kidd

B.S. Mechanical Engineering, Northeastern University (1990)
Master of Engineering, University of Hartford (1994)

Submitted to the Sloan School of Management and Department of Mechanical Engineering in partial fulfillment of the requirements for the degrees of

Master of Science in Management

and

Master of Science in Mechanical Engineering

In conjunction with the Leaders for Manufacturing Program
at the
Massachusetts Institute of Technology
June 1998

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ABSTRACT

Competitive pressure is forcing many manufacturing companies to invest in product platform consolidation. The belief is that fewer, more robust product platforms will significantly improve competitiveness by dramatically reducing product development times and life-cycle costs while effectively increasing product line-up offering and customer satisfaction. However, most companies lack a framework for valuing a product platform strategy and therefore are at risk of making platform-related decisions which result in suboptimal business performance.

This thesis addresses the need for a systematic method for valuing a product platform strategy. The importance of the method is its ability to systematically capture the complex interrelationship between platform strategy and platform performance while recognizing the uncertainty associated with product platform decisions. The best platform configuration requires that benefits be optimized given the costs. System analysis methods and data visualization are demonstrated which communicate cost-benefit interactions and the risk of pursuing different platform strategies. Risk is related to platform performance uncertainty. The greater the range of possible performance outcomes, the greater the risk.

The thesis framework is applied to an example from the automobile industry. The application considers an automobile company in the early stages of a major reorganization that is interested in developing a new product platform for its compact truck vehicle segment. Three separate vehicle platform strategies are evaluated and compared.

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ACKNOWLEDGMENTS

I wish to acknowledge the support and resources made available through the Leaders For Manufacturing (LFM) Program, a partnership between MIT and major US manufacturing companies.

I would like to thank the LFM sponsor company that supported this research project. There were many people who made the internship an enjoyable and educational experience. I specifically want to recognize; Bill Eagan, Chris Ring, Kristen Morrow, Glenn Vangelderen, and Chris Magee.

I would also like to thank my fellow students in the LFM program and my LFM sponsor UTC/Pratt and Whitney. Both have been a great source of knowledge and inspiration during this 24-month educational experience.

Mostly I would like to thank my wife Paula. She is my true love and the reason why LFM has been a great experience. I am extremely grateful for her love and support.

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1.0 INTRODUCTION

Many companies suffer from having too many platforms, sharing too little technology. Each market niche is served by a different product platform. Such companies generally allow each product development team to operated independently. This permits the engineering of products and processes with as many variations as the number of teams that design and build them. As each product is designed and processed separately, there is minimal opportunity to promote synergy across similar products. The result is a myriad of products with few shared subsystems or manufacturing technologies, higher cost and lower margins.

Competitive pressure is forcing many companies to invest in product platform consolidation. The belief is that fewer, more robust product platforms will significantly improve competitiveness by dramatically reducing product development times and life-cycle costs while effectively increasing product line-up offering and customer satisfaction. However, most companies lack a framework for valuing a product platform strategy. This impedes adoption of robust product platform strategies since assessment of platform value requires evaluation of cost-benefits in a systemwide context.

This thesis addresses the need for a systematic method for valuing a product platform strategy. The importance of the method is its ability to systematically capture the complex interrelationship between platform strategy and platform performance while recognizing the uncertainty associated with product platform decisions. The best platform configuration requires that benefits be optimized given the costs. System analysis methods and data visualization are demonstrated which communicate cost-benefit interactions and the risk of pursuing different platform strategies. Risk is related to platform performance uncertainty. The greater the range of possible performance outcomes, the greater the risk

Thesis Outline

Following this introduction, Section 2 provides a discussion regarding the theory of product platforms. The concept of a product platform, its definition and relationship to a product family, and how platform benefits can lead to competitive advantage are all discussed in this section of the paper.

Section 3 provides an overview of the methodology developed for valuing a product platform strategy. It presents a 5-step process; 1) identify platform performance metrics, attributes and uncertainty, 2) develop platform scenarios, 3) analyze platform scenarios, 4) evaluate and compare strategies, and 5) identify preferred platform strategy.

Section 4 applies the framework to an example from the automobile industry. It considers a company in the early stages of a major reorganization that is interested in developing a new product platform for its compact truck vehicle segment. This section describes the framework in detail and shows how it can be used to compare three compact truck platform proposals.

The last section, Section 5, draws conclusions from the thesis research. It discusses the benefits of the proposed platform analysis process.

2.0 THEORY BEHIND PRODUCT PLATFORMS

Product Platform as a Competitive Advantage

Product platform strategy can be used to compete in today's competitive global climate. A product platform provides competitive advantage in two ways: 1) *platform efficiency*, the degree to which a platform allows economical generation of derivative products, and 2) *platform effectiveness*, the degree to which the derivative products produce revenue for the firm [Meyer and Lehnerd]. See Figure 1. The optimal platform, that is the platform which offers the greatest competitive advantage, has both efficiency *and* effectiveness advantages. Figure 2 lists the potential benefits of a product platform in terms which relate to efficiency and effectiveness measures.

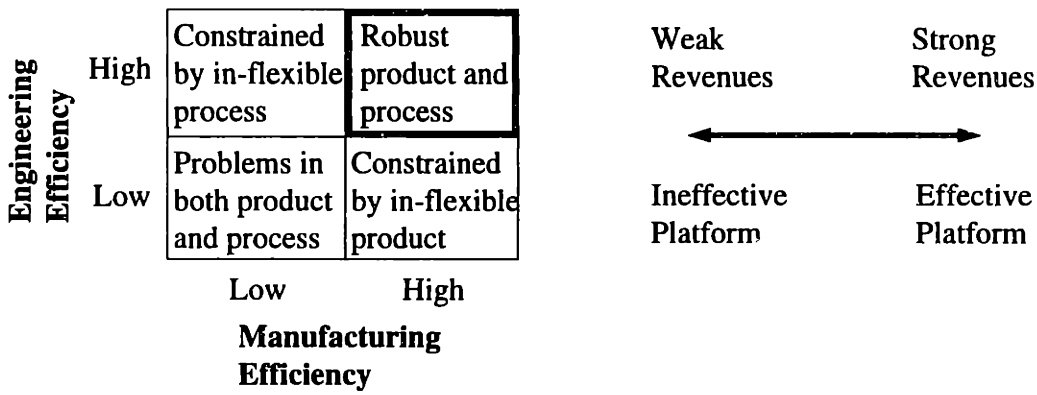

Figure 1: The Power of a Product Platform is Efficiency and Effectiveness

Faster Product Development

- Less time needed to develop product and process
- Common systems/components reduces testing requirements
- Less product complexity increases engineering productivity

Lower Total Cost

- Savings in total engineering and manufacturing investment
- Lower variable costs
  - Economies of scale in procurement and manufacturing
  - Reduced quality losses
  - Lower transportation costs

Increased Production Volume

- Manufacturing flexibility to increase volume in response to demand changes
- Reduction in plant downtime during model changeover

Figure 2: Benefits of a Product Platform

Product platforms as a means for competitive advantage has been studied previously. In 1992, Wheelwright and Clark differentiated between product families, derivative products and product platforms in their study of vacuum cleaners. In 1993, Meyer and Utterback did the same in their study of electronic imaging systems, as did Sanderson and Uzumeri in 1996 in a study of Sony's portable cassette players, as well as Meyer and Lehnerd in 1997 in a study of Hewlett-Packard's ink jet printers and Black & Decker's consumer power tools. Each of these studies has contributed insights as to how product platform design can lead to efficiency and effectiveness in product development and manufacturing.

Product Platform Defined

To develop an understanding of the definition of a product platform, it is helpful to start with the concept of a product family. A product family addresses a market segment while derivative products or groups of products target niches within the segment. See Figure 3.

A product platform is an element of the product family core, serving as the technical foundation for each product in the family.

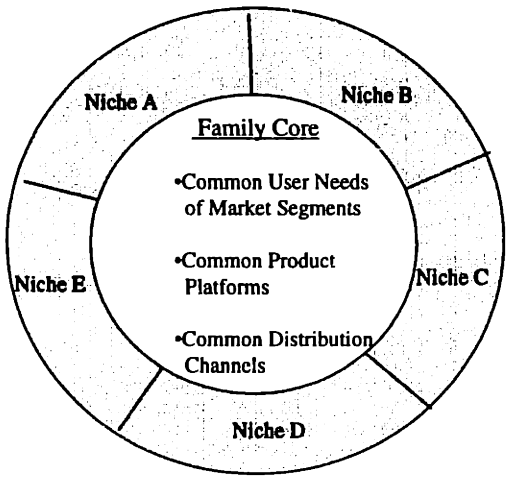

Figure 3: A Product Platform is at the Core of a Product Family

A product platform can be thought of as the physical implementation of a product design that serves as the base architecture for a series of derivative products [Meyer et al.]. Every product has an architecture comprised of subsystems and interfaces. The architecture of a product has the potential of becoming a platform if it serves as the foundation (base) for creating several or more derivative products.

With this background, a precise definition of a product platform can now be understood. Meyer and Lehnerd define a product platform as *the set of subsystems and interfaces which forms a common structure from which a stream of derivative products can be efficiently developed and produced.* It is important to note that in addition to product architecture, a product platform embraces manufacturing. See Figure 4.

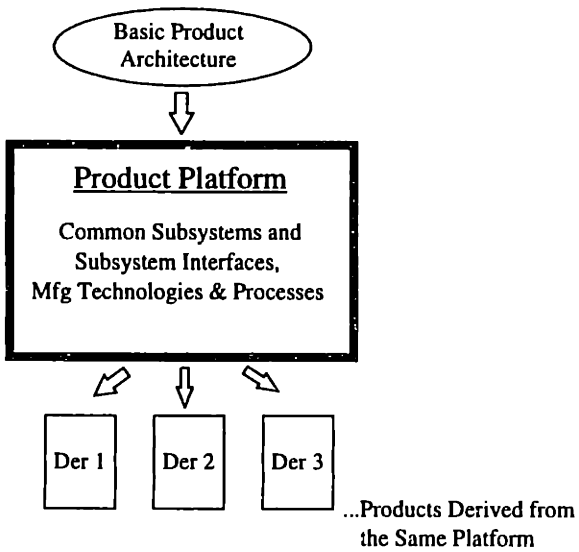

Figure 4: Product Platform Embraces Product Architecture and Manufacturing

Product Platform Strategy

The goal of a product platform strategy is to efficiently and effectively product development and manufacturing. A strategic approach to product platforms is one that is highly selective, carefully choosing the elements that should be common [Meyer and Lehnerd]. First and foremost are the subsystem interfaces. Once the interfaces are established and fixed into place, degrees of freedom emerge for developers to improve particular subsystems. Second, is the examination of product subsystems to identify which particular subsystems have the potential of being leveraged across derivative products. Such subsystems have the potential of becoming valuable competitive assets. Lastly, when third party components or modules are freely available, is the effective integration of third party components with in-house subsystems to create diverse and competitive product families.

In is important to note that a platform strategy is not product standardization. Many product standardization approaches to product platform have had disastrous results. For example, in early 1990 Ford Motor Company spent $6 billion on a product platform program which premiered the Ford Mondeo in Europe and the Ford Contour in the United States. The mondeo and contour were essentially the same vehicles sold under different names in different markets. The Mondeo did well in Europe but the contour never took off in the U.S.. Similarly, GM based its Cadillac Catera on its European Opel Omega platform. The U.S. Catera hasn't come close to the success of the Omega [Naughton et al.].

3.0 A FRAMEWORK FOR VALUING A PRODUCT PLATFORM STRATEGY

5-Step Process[1]

The purpose of this section is to introduce to the reader a 5-step framework for valuing product platform strategies. See Figure 5.

Step 1 - Identify Platform Performance Metrics, Attributes, and Uncertainties

Platform value analysis begins with the identification of important performance metrics and the set of attributes with which to measure platform performance relative to the metrics. Performance metrics are needed to quantify the value of a platform strategy and allow for platform strategy comparisons. Platform attributes capture the cost-benefit implications of a particular platform strategy and allow for the calculation of platform performance metrics. In addition, since knowledge regarding cost-benefit implications are incomplete (as a result of assumptions being made regarding future events), an understanding of uncertainty is needed to transform cost-benefit assumptions into information which can be used in the platform evaluation process.

Performance Metrics

Net Present Value (NPV) and Return On Sales (ROS) are two financial measures which can be used to evaluate platform strategies. NPV is the equivalent worth of a platform's net cash flow. A platform strategy creates value when its expected return exceeds the cost of capital employed[2]. ROS is the ratio of profits before tax minus other cash charges (i.e., engineering and manufacturing investment) to total sales revenue. Platform NPV and ROS together capture the expected value of a platform strategy.

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[1] This 5-step process is based on two separate works; one by Jordan and Graves (See paper by Jordan and Graves) and the other by AGREA, Analysis Group for Regional Electricity Alternatives, MIT Energy Lab (See paper by Stephen R. Conners).

[2] The cost of capital is an opportunity cost to investing in the platform strategy, or in other words, the rate of return the company could have earned on an alternative, similar-risk investment.

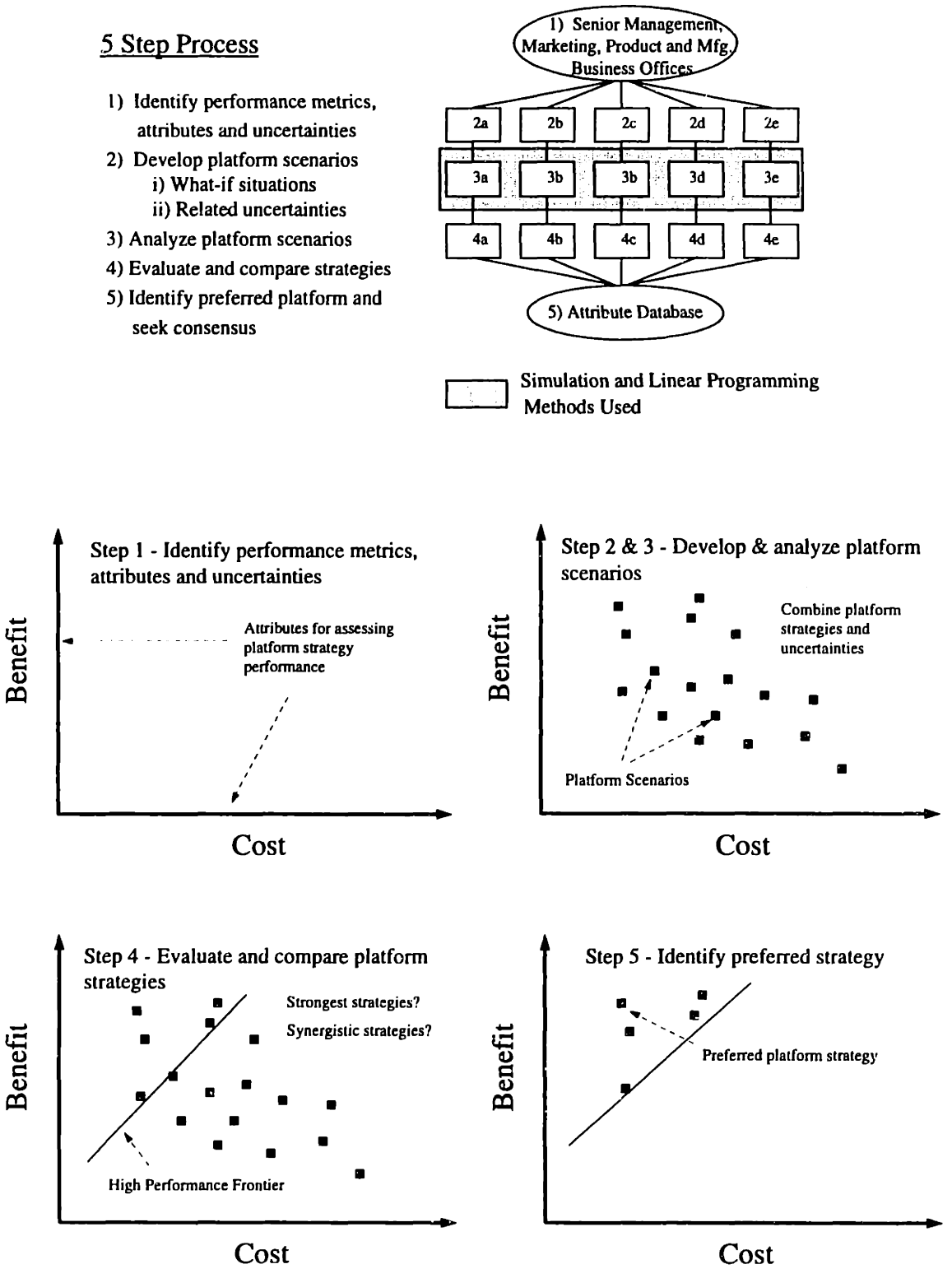


Figure 5: 5-Steps in Valuing a Product Platform Strategy

In addition to expected NPV and ROS results is the quantification of platform risk. Platform risk refers to the bunching of possible platform performance results about the expected value. The greater the range, the greater the risk.

Platform Attributes

Platform attributes capture the cost-benefit implications of a platform strategy. They are the factors used to evaluate platform strategy performance. Eight platform attributes are defined. They are; engineering and manufacturing investment, fixed costs, manufacturing capacity, production costs, transportation cost, product timing, sale price and customer demand.

Platform Uncertainties

While attributes describe cost-benefit implications, uncertainties describe unknowns faced along the way. Effective platform planning involves determining how to meet a set of desired goals subject to constraints *and* unknowns. The unknowns reflect possible changes in both long-term cost-benefit trends and short-term (year-to-year) volatility.

Step 2 - Develop Platform Scenarios

A platform scenario represents the evaluation of a platform strategy for a single set of attributes and related uncertainties. Platform scenarios are useful for studying how a platform strategy responds to a number of plausible cost-benefit assumptions. The multiplicative effect of combining different strategies and plausible cost-benefit assumptions can yield a large number of scenarios.

Platform Strategy

Platform strategies themselves are strategic plans. Three strategic areas need to be consider in the development of a platform strategy. They are marketing plan, product plan, and manufacturing plan.

Marketing Plan[3]

Product platform strategy begins with the development of a marketing plan. The main objective of the marketing plan is to segment the markets. Market segmentation can be facilitated with the use of a market segmentation grid. See Figure 6. In a market segmentation grid, major markets segments are arrayed horizontally each representing the principal customer groups identified by the firm. The vertical axis reflects the different tiers of product price and performance which will serve the markets.

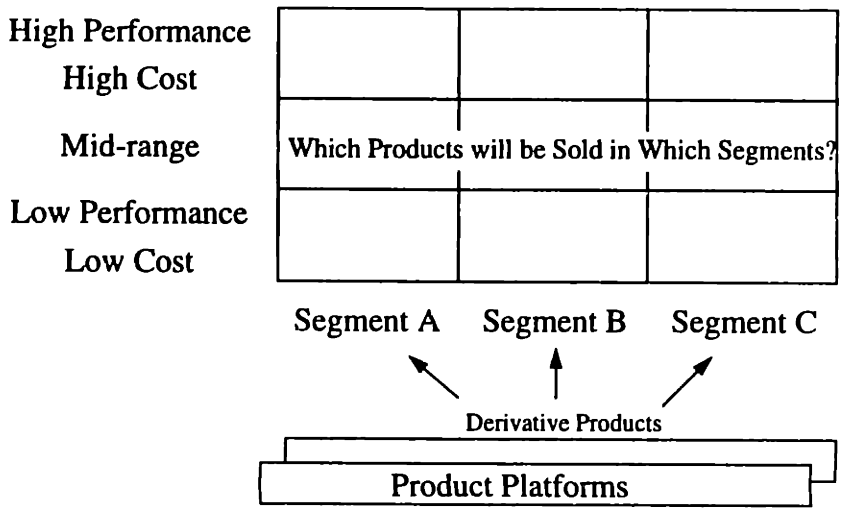


Figure 6: Market Segmentation Grid

[3] This framework for formulating a marketing plan is discussed in detail in "The Power of Product Platforms" by Meyer and Lehnerd.

Product Plan[4]

After the marketing plan, the next step is to define the product plan. Four types of product planning strategies are defined below.

Niche Specific

In a niche specific strategy, each market niche is served by a different base architecture. The result is a variety of products with few shared subsystems or manufacturing technologies. See Figure 7.

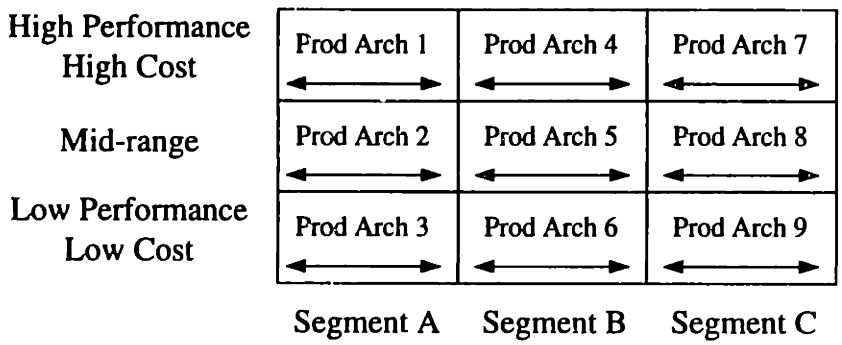


Figure 7: Niche Specific Product Strategy

Horizontal Leveraging

An alternative to the niche strategy is horizontal leveraging. A product architecture is leveraged horizontally when its architecture is shared across a given tier of price-performance. An example of horizontal leveraging is shown in Figure 8. The benefit of a

[4] This framework for formulating a product plan is discussed in detail in "The Power of Product Platforms" by Meyer and Lehnerd.

horizontal strategy is that a company can introduce a stream of new products across a series of related customer groups without having to design and produce totally separate products for each group. However, for the horizontal leveraging strategy to be effective the customer groups have to be similar in their needs regarding the subsystems. Horizontal leveraging occurs to the degree that common subsystems are shared horizontally across market segments.

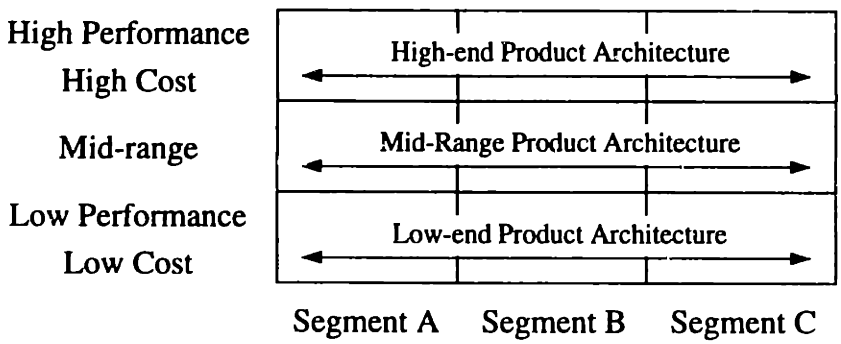


Figure 8: Horizontal Leveraging Product Strategy

Vertical Leveraging

Another type of product plan is one in which the firm seeks to leverage the base architecture across a range of price-performance tiers. See Figure 9. For example, one variation of vertical leveraging occurs when a company that has traditionally excelled in the high-end of the market scales its product down into the lower price-performance tiers. In its simplest form, high-end vertical scaling is accomplished by removing certain functionality from the high-end products to achieve a lower price point. A second variation occurs when a company that has traditionally excelled in the low-end of the

market scales its product up into the higher price-performance tiers. In this case, low-end vertical scaling is accomplished through the addition of more functional component technologies or new modules which meet the customer needs from higher price-performance tiers. The benefit of vertical leveraging is that a company can introduce a stream of new products within a segment of related customer groups without having to design and produce totally separate products for each group. However, for the vertical leveraging strategy to be effective the products have to be produced at a value-cost level which is appropriate for the market niche.

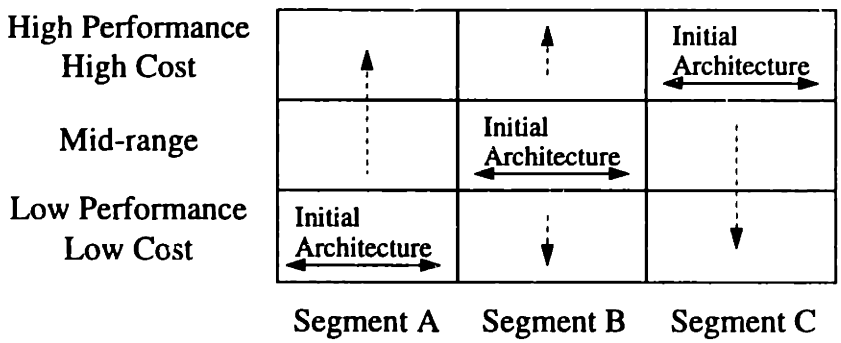


Figure 9: Vertical Scaling Product Strategy

Beachhead Strategy

A product plan which combines horizontal with vertical leveraging is called a beachhead strategy [Meyer and Lehnerd]. See Figure 10. With a beachhead strategy, the company develops a base architecture for one particular segment. From that initial foothold, the firm scales up/down and leverages horizontally in a way which best appeals to the needs of other market niches. The benefit of a beachhead strategy is that it combines the

benefits of horizontal and vertical leveraging. It attempts to maximize product and manufacturing efficiencies. If successful at implementing a beachhead strategy, a company has great potential to enter new market niches from a superior cost position.

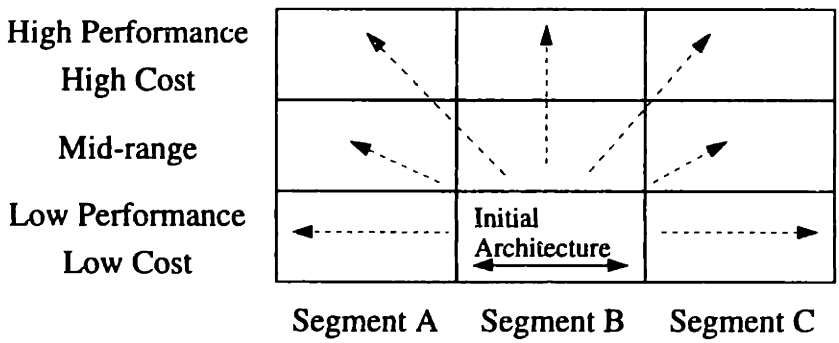


Figure 10: The Beachead Strategy: Horizontal and Vertical Leveraging

Manufacturing Plan

A third plan to consider when developing a product platform strategy is the manufacturing plan. The manufacturing plan defines which products will be produced at which plant and the manufacturing technology used in the manufacturing process. See Figure 11. The links in the network define the level of process flexibility at each plant. The manufacturing plan is a function of both the product architecture and the manufacturing technology available at the plant.

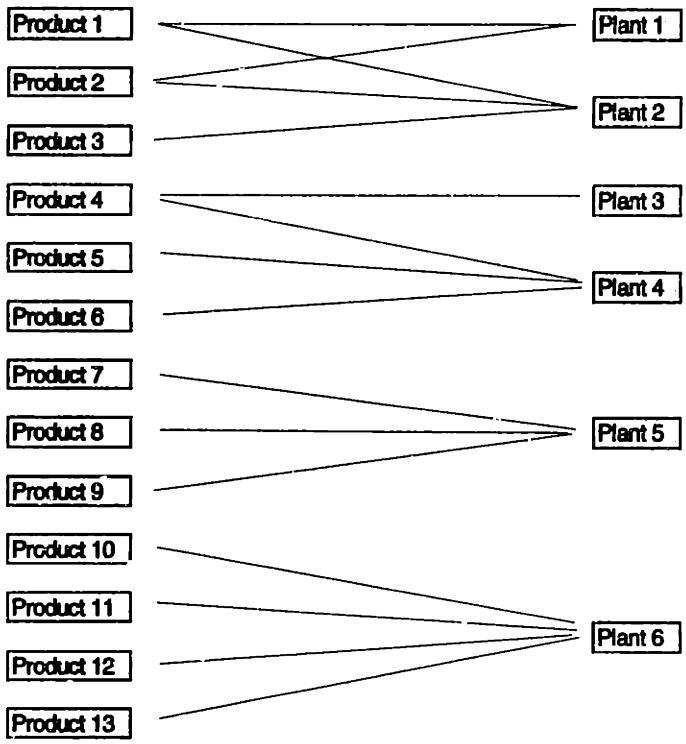


Figure 11: Example of a Manufacturing Plan

Platform Definition

Once the marketing, product and manufacturing plans are fully considered, the next step is actually defining the platform. Recall from Section 2, a product platform is the *set of subsystem and interfaces that forms the common structure from which the stream of derivative products can be efficiently developed and produced.* With platform design, the goal is to define the platform based on a product architecture and manufacturing process which will efficiently and effectively accommodate product development and manufacturing.

Platform Attributes

Engineering and Manufacturing Investment

Associated with each platform strategy is an investment in product development and manufacturing. Money is needed to engineer and test the product(s), to acquire the necessary manufacturing tooling and equipment, as well as to ramp-up production during product launch.

Different platform strategies will require different levels of engineering and manufacturing investment. Figure 12 shows the investment requirements for three different platform strategies. Strategies which are more expensive initially but require less spending over time are often representative of platforms which are more flexible. The reason for this is because the cost of flexibility is initially high, but future expenditures are less.

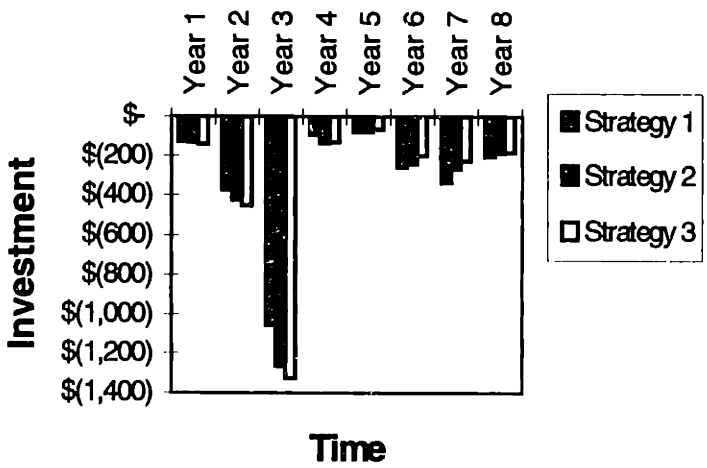


Figure 12: Platform Engineering and Manufacturing Investment Requirements

Fixed Costs

In addition to engineering and manufacturing investment, there are fixed costs related to manufacturing, administration and selling, and marketing. A platform strategy influences fixed costs through its impact on the number of derivative products and manufacturing plants required by the product platform. For the purpose of this analysis, fixed cost will be allocated by plant and projected throughout the analysis period as is shown in Table 1. The forecast for Plant 1 in shown in Figure 13. As an example of a platform implication, the Plant 1 forecast considers a constant annual fixed cost increase of 2%.

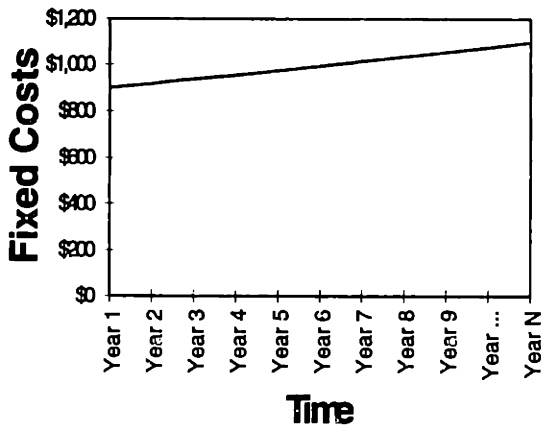


Figure 13: Fixed Cost Forecast

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year ...	Year N
Plant 1	$900	$918	$936	$955	$974	$994	$1,014	$1,034	$1,054	$1,076	$1,097
Plant 2	$650	$242	$980	$715	$445	$1,622	$2,246	$3,391	$3,058	$2,746	$2,406
Plant 3	$400	$1,464	$1,145	$823	$999	$1,132	$2,222	$2,329	$2,455	$2,597	$2,217
Plant 4	$300	$372	$1,061	$1,247	$1,430	$1,570	$2,168	$1,282	$1,414	$2,064	$2,190

Table 1: Fixed Costs by Plant

Manufacturing Capacity

Manufacturing capacity is the production capacity of the platform's manufacturing network. A platform strategy impacts manufacturing capacity as a result of product cycle time, setup and changeover effects. Manufacturing capacity is estimated by plant and projected throughout the analysis period as is shown in Table 2. As an example of a platform implication, the reduction in volume shown in Figure 14 is intended to represent Plant 1 downtime in year 2 as a result of suspending production for installation of flexible manufacturing equipment.

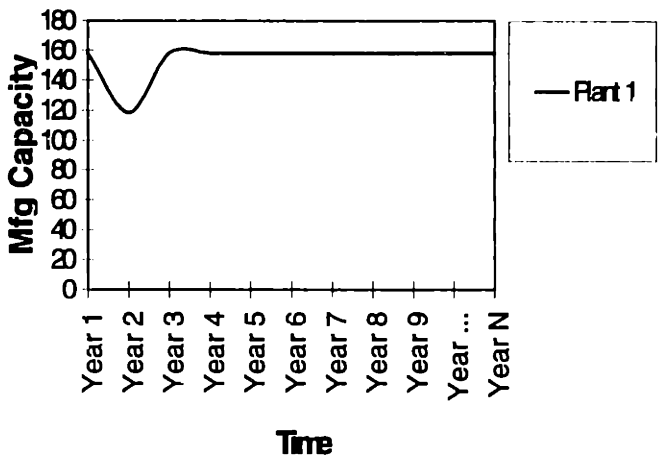


Figure 14: Plant 1 Forecast of Manufacturing Capacity

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year...	Year N
Plant 1	158	119	158	158	158	158	158	158	158	158	158
Plant 2	176	134	176	176	176	176	176	176	176	176	176
Plant 3	56	56	56	56	56	42	56	56	56	56	56
Plant 4	73	64	73	73	73	73	73	73	73	73	73

Table 2: Manufacturing Capacity by Plant

Production Costs

Production cost is the variable cost of producing the products. Production cost can be thought of as a function of two factors; material and labor. A platform strategy influences both material and labor costs. Production cost is defined by the product-plant combination and is projected over the analysis period as is shown in Table 3. As an example of one platform implication, the forecast in Figure 15 reflects expected production cost reduction of 2% annually.

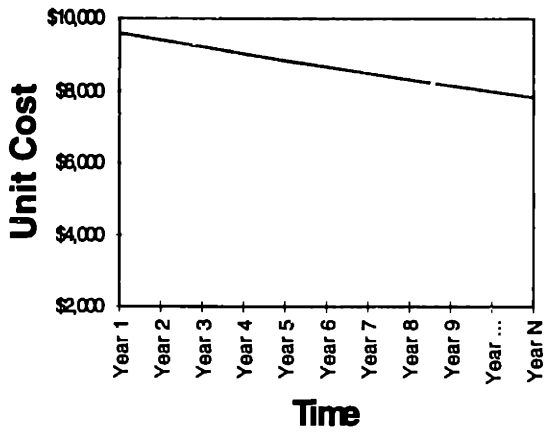


Figure 15: Product X-Plant 1 Variable Production Cost Forecast

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year ...	Year N
Prod X - Plant 1	$9,600	$9,408	$9,220	$9,035	$8,855	$8,678	$8,504	$8,334	$8,167	$8,004	$7,844
Prod Y - Plant 2	$9,600	$9,408	$9,220	$9,035	$8,855	$8,678	$8,504	$8,334	$8,167	$8,004	$7,844
Prod X - Plant 3	$7,200	$7,056	$6,915	$6,777	$6,641	$6,508	$6,378	$6,251	$6,125	$6,003	$5,883
Prod Y - Plant 4	$7,600	$7,448	$7,299	$7,153	$7,010	$6,870	$6,732	$6,598	$6,468	$6,336	$6,210

Table 3: Production Cost by Plant

Transportation Costs

Transportation cost is the cost of getting the product from the point where it is manufactured to the buyer. A platform strategy influences transportation costs as a result of platform decisions regarding manufacturing flexibility. Transportation cost is defined by product-plant-region combination and is projected over the analysis period as is shown in Table 4.

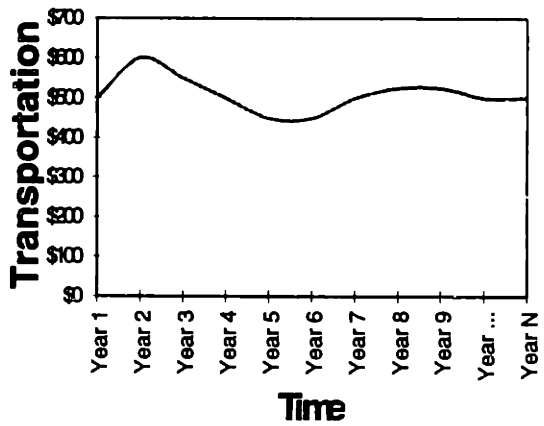


Figure 16: Transportation Cost Forecast

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year ...	Year N
Prod X-Plant 1-Region 1	$500	$600	$550	$500	$450	$450	$500	$525	$525	$500	$500
Prod X-Plant 1-Region 2	$750	$850	$800	$750	$700	$700	$750	$775	$775	$750	$750
Prod Y-Plant 2-Region 1	$400	$480	$440	$400	$360	$360	$400	$420	$420	$400	$400
Prod Y-Plant 2-Region 2	$600	$680	$640	$600	$560	$560	$600	$620	$620	$600	$600

Table 4: Transportation Costs by Product-Plant-Region Combination

Product Timing

Product timing refers to the schedule for product introduction and enhancements. The important element of product timing is when the product starts generating revenue for the company. A platform strategy influences product timing to the extent at which it delays or expedites product introductions or enhancements.

A product cycle plan maps product introduction and evolution. See Figure 17. Mapping of each product begins at the start of commercial sale and continues to the end of commercial sale. At some time during a product's life-cycle, modifications are made to enhance the product based on changes in market requirements or technology[5]. The thickest lines on the map represent the distinct platform architectures supporting the underlying products.

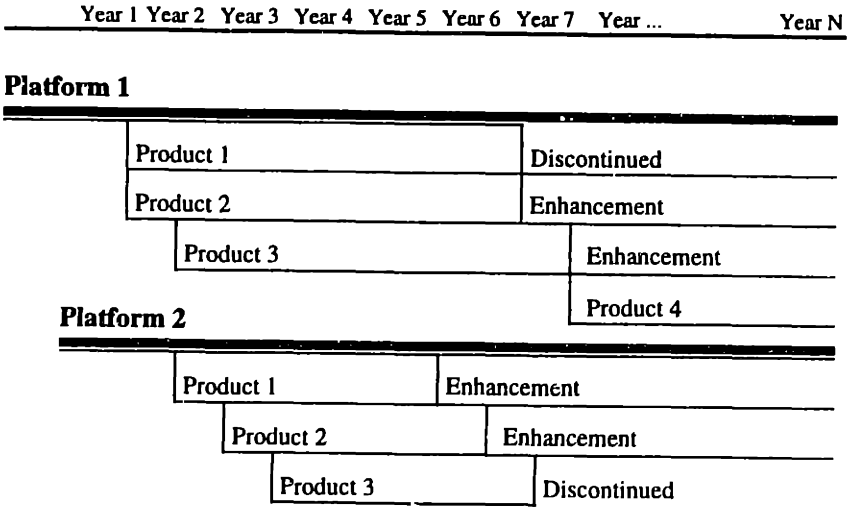


Figure 17: Example of a Product Cycle Plan

[5] These enhances are often referred to as product freshenings.

Sale Price

Sale price is the price of the derivative product in the market where it is sold. The sale price forecast is believed to be based on market factors and thus is independent of the platform strategy[6]. Sale price is defined by product-market combination and projected over the analysis period as is shown in Table 5. Different sale price forecasts may be used for considering different what-if scenarios. For example, a dip in sales price in year 7 may reflect a firm's reaction to lower its price in response to a competitor who offers a new (and improved) product that year.

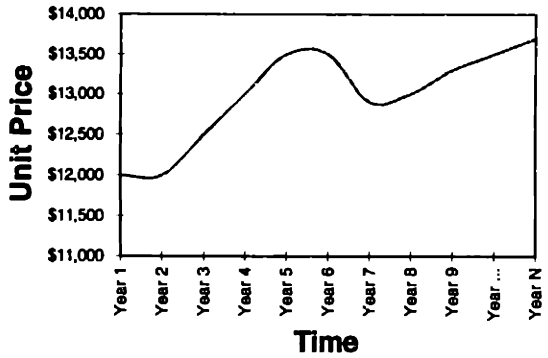


Figure 18: Product X Sale Price Forecast in Market 1

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year ...	Year N
Market 1	$12,000	$12,000	$12,500	$13,000	$13,500	$13,500	$12,900	$13,000	$13,300	$13,500	$13,700
Market 2	$12,000	$11,500	$12,000	$11,500	$11,000	$12,000	$12,500	$13,500	$13,000	$12,500	$12,000
Market 3	$9,000	$10,000	$9,500	$9,000	$9,000	$9,000	$10,000	$10,000	$10,000	$10,000	$9,500
Market 4	$9,500	$9,500	$10,000	$10,000	$10,000	$10,000	$10,500	$9,500	$9,500	$10,000	$10,000

Table 5: Product X Sale Price by Market

[6] This would be the case if we assume external factors, such as competitor behavior, are the primary factors influencing the sale price.

Customer Demand

Customer demand is the expect demand for the derivative products. A platform strategy influences customer demand by the extent to which it effects the attractiveness of the product offering. Customer demand is defined by the product-market combination and projected over the analysis period as is shown in Table 6. Customer demand is also a function of external factors. Different demand forecasts may be used for considering different what-if scenarios. For example, a dip in demand price in year 5 may reflect an economic recession.

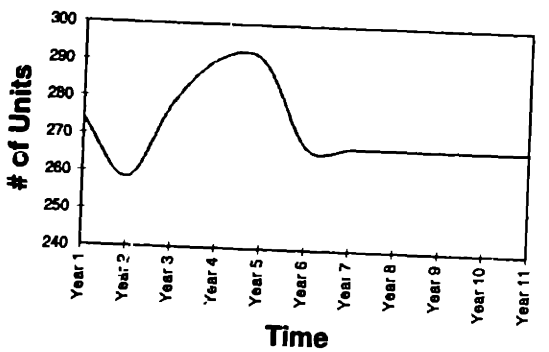


Figure 19: Customer Demand Forecast

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year ...	Year N
Prod X - Market 1	274	259	279	291	291	267	267	267	267	267	267
Prod Y - Market 2	8	6	7	7	7	7	7	7	7	7	7
Prod X - Market 3	11	12	13	15	17	19	19	19	19	19	19
Prod Y - Market 4	25	25	25	27	27	29	29	29	29	29	29

Table 6: Customer Demand ('000) for Product X by Region

Platform Uncertainties

The platform attributes characterize the *expected* cost-benefit implications associated with a platform strategy. Uncertainties reflect all plausible scenarios in terms of both long-term trends and year-to-year volatility. Plausible long-term trends are captured by different cost-benefit scenarios. Volatility is captured by representing each expected value in the forecast with a probability distribution as is shown in Figure 20.

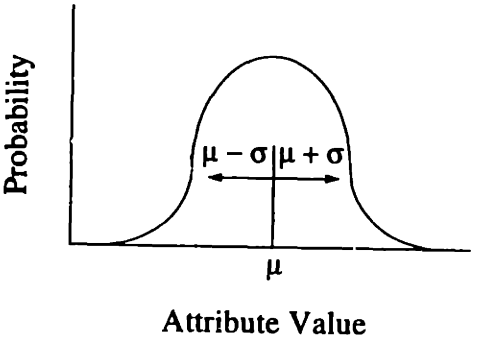


Figure 20: Forecast Volatility

Step 3 - Analyze Platform Scenarios

After developing the platform scenarios, the next step is scenario analysis. Scenario analysis is performed by simulating the operation of a platform following each strategy and related uncertainty. The scenario analysis process consist of three modules; 1) simulation, 2) linear programming, and 3) analysis. See Figure 21. These three modules taken together effective quantify the operation of a platform strategy.

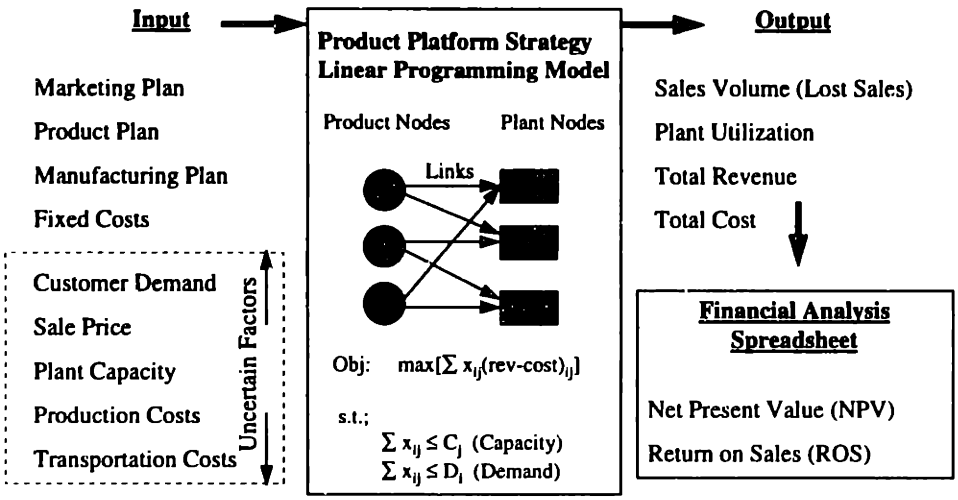


Figure 21: Computer-Based Scenario Analysis Tool

Simulation

Scenario analysis and simulation are useful for assessing platform strategies under uncertainty. Simulation is used, as an extension to scenario analysis, to repeatedly select values for the expected attribute factors according to their probability of occurring. In terms of valuing a product platform strategy, simulation is used to select values for manufacturing capacity, production cost, transportation cost, sale price, and customer demand.

Linear Program Modeling[7]

Linear programming is a tool for solving optimization problems. In all linear programming problems, the decision maker wants to maximize (usually revenue or profit) or minimize (usually cost) some function of the decision variables. This function is called the objective function. In terms of valuing a product platform strategy, linear programming is used to model the platform strategy and simulate platform operation. The linear programming model consists of product nodes, demand nodes, and links. See Figure 22.

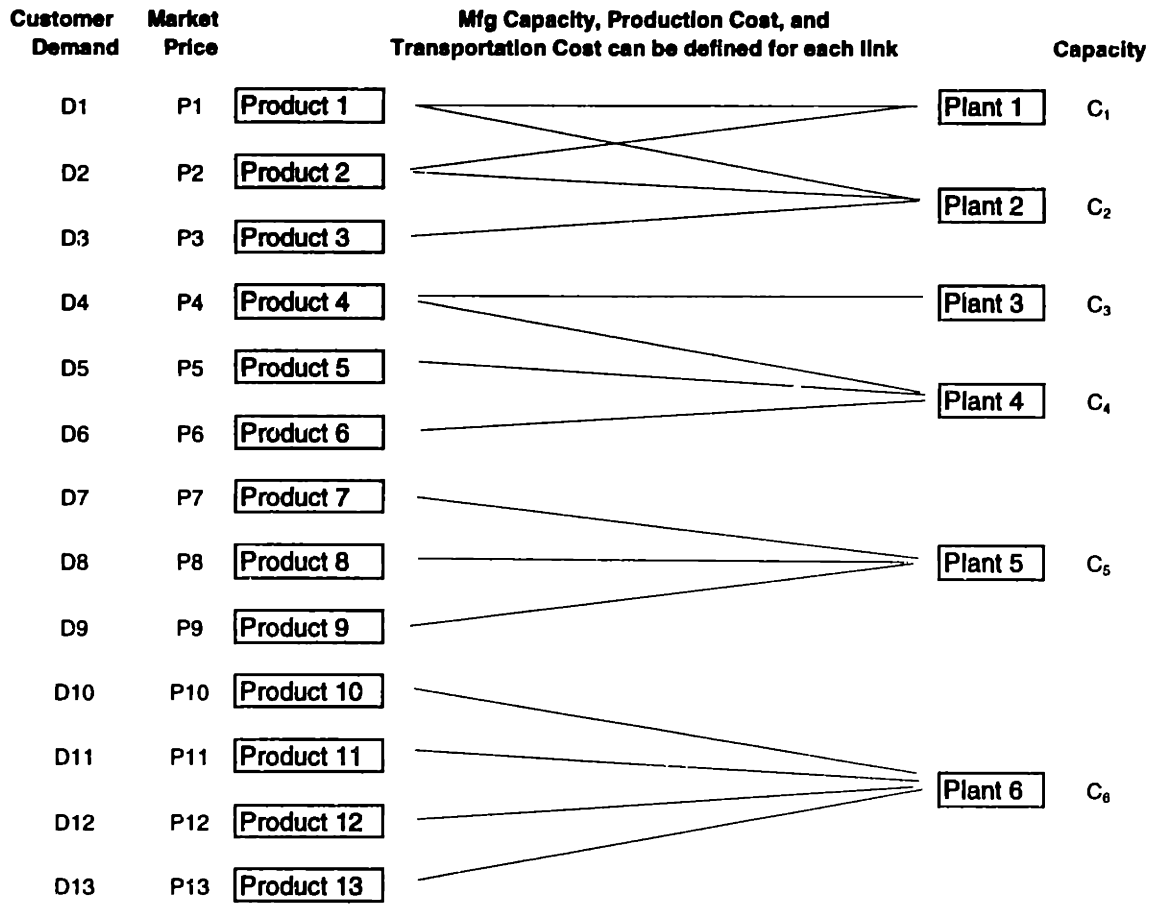


Figure 22: Formulating Linear Programming Model

[7] The linear programming software used was developed by the Leaders For Manufacturing Scheduling and Logistics Research Group.

Product Nodes

The product nodes are used to input data from the demand side of the equation. Platform scenario data of interest is; 1) marketing plan (how many product and the markets where they will be sold), 2) product timing, 3) sale price and, 4) customer demand. Uncertainty in the factors which are input into the product node is represented by different demand side platform scenarios and forecast volatility.

Plant Node

The plant nodes are used to input data from the supply side of the equation. Platform scenario data of interest is; 1) manufacturing plan (i.e., how many plants) and 2) manufacturing capacity . Uncertainty in the factors which are input into the plant node is represented by different supply side platform scenarios and forecast volatility.

Links

The links represent the manufacturing plan for which products will be made in which plants. Platform scenario data of interest is; 1) manufacturing plan (process flexibility) 2) production costs and, 3) transportation costs. Uncertainty in the factors which are input into the links is represented by different platform scenarios and forecast volatility.

Output

The linear programming model simulates platform performance and outputs expected sales, revenue and variable cost (production and transportation) data for each platform along with expected plant utilization and lost sales (lost sales data is greater than zero when customer demand exceeds the platform's manufacturing capacity).

Analysis

Table 7 is an example of a spreadsheet which can be used to assess a platform's performance. At the top of the spreadsheet, fixed investment spending in Engineering and Manufacturing is collected by year for each derivative product. Below investment spending are the operational attributes output by the linear program model. This is where the plant utilization, sales volume, sales revenue and total cost operating results are

collected. Also, in this section of the spreadsheet is the fixed costs (not including above investment). Below the platform's operating results, profit before tax is measured as total revenue minus total cost. Down further in the spreadsheet is where depreciation of equipment is considered. A tax rate is used to estimate earnings after tax. Operating cash flow is the earnings after tax plus noncash charges (depreciation). Net cash flow is the operating cash flow minus cash charges (Engineering and Manufacturing investment). All calculations are adjusted for inflation. The spreadsheet data is used to evaluate platform performance based on traditional financial measures. At the bottom of the spreadsheet, net present value (NPV) and annual return on sales (ROS) are calculated.

		Method of Depreciation	Period of Depreciation	Year 1	Year 2	Year 3	Year 4	Year 5	Year ...	Year N
Investment Spending (Mils)										
Engineering										
Product 1	$ 176			$ (12)	$ (37)	$ (49)	$ (83)	$ (12)	$ (35)	$ (46)
Product ...	$ 1			$ (9)	$ (27)	$ (36)	$ (38)	$ (9)	$ (26)	$ (34)
Product N	$ 75			$ -	$ -	$ -	$ -	$ (0.10)	$ (0.30)	$ (0.40)
Manufacturing	$ -	MARC	3	$ (3)	$ (10)	$ (13)	$ (25)	$ (3)	$ (9)	$ (12)
Product 1	$ 576			$ (9)	$ (77)	$ (303)	$ (63)	$ (8)	$ (70)	$ (276)
Product ...	$ 9			$ (6)	$ (54)	$ (214)	$ (45)	$ (6)	$ (51)	$ (199)
Product N	$ 223			$ -	$ -	$ -	$ -	$ (0)	$ (2)	$ (7)
Adjustment for Inflation				$ (3)	$ (23)	$ (89)	$ (19)	$ (2)	$ (18)	$ (70)
				$ (21)	$ (116)	$ (368)	$ (135)	$ (22)	$ (118)	$ (370)
Operational Cash Flows										
Average Plant Utilization							83.82%	88.35%	89.83%	89.21%
Total Sales ('000)							869	916	932	925
Lost Sales ('000)							4.88	8.13	11.55	13.31
Sales Revenues (Mils)				$ -	$ -	$ -	$ 15,275	$ 16,098	$ 16,318	$ 16,139
Total Variable Costs (Mils)				$ -	$ -	$ -	$ (9,334)	$ (9,830)	$ (9,967)	$ (9,865)
Other Fixed Costs (Mils)				$ -	$ -	$ -	$ (2,054)	$ (2,054)	$ (2,054)	$ (2,054)
Profits Before Tax				$ -	$ -	$ -	$ 3,887	$ 4,214	$ 4,297	$ 4,220
Adjustment for Inflation				$ -	$ -	$ -	$ 4,162	$ 4,615	$ 4,815	$ 4,837
Depreciation (Mils)										
Building				$ -	$ -	$ -	$ -	$ -	$ -	$ -
Equipment				$ -	$ -	$ -	$ (149)	$ (204)	$ (68)	$ (32)
Earnings Before Taxes				$ -	$ -	$ -	$ 4,012	$ 4,412	$ 4,747	$ 4,805
Tax Rate =	40%									
Taxes				$ -	$ -	$ -	$ 1,605	$ 1,765	$ 1,899	$ 1,922
Earnings After Tax				$ -	$ -	$ -	$ 2,407	$ 2,647	$ 2,848	$ 2,883
Add Depreciation				$ -	$ -	$ -	$ 149	$ 204	$ 68	$ 32
Operations Cash Flow				$ -	$ -	$ -	$ 2,557	$ 2,851	$ 2,916	$ 2,915
Net Cash Flows (Mils)				$ (21)	$ (116)	$ (368)	$ 2,421	$ 2,629	$ 2,798	$ 2,545
Inflation Factor, Rate=	2.3%			1.0000	1.0230	1.0465	1.0706	1.0952	1.1204	1.1462
NPV	$5,904									
Cost of Capital	10.0%									
Pre-Tax ROS	25.13%			-	-	-	24.62%	26.05%	25.69%	24.15%

Table 7: Analysis Spreadsheet of Platform Performance

Figure 23 represents the notion of risk as it relates to platform performance. It shows the output performance values for each scenario in the form of a bell-shaped curve. According to the left figure, if 12.14 is the expected NPV the probability the expected return is the actual result is between 11 and 12 percent. In other words, there is about 88% chance that the actual NPV performance will be something other than 12.14.

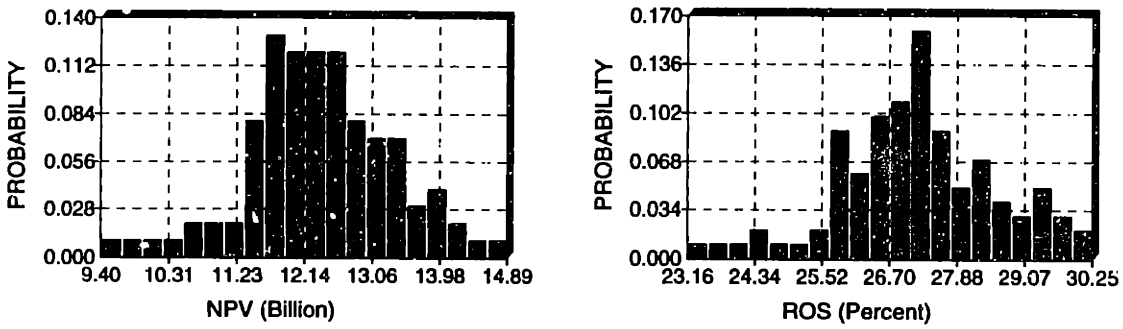


Figure 23: Distribution of Platform Strategy Performance

Step 4 - Evaluate and Compare Platform Strategies

The scenario analysis process yields an database from which platform strategies can be evaluated and compared. At this point, better combinations of options may be identified and uncertainties may be added or dropped. Additional scenario analysis may then be performed, until the range of strategies evaluated constitutes a set of scenarios for which significant improvements are unlikely.

Step 5 - Identify Preferred Platform

Once this point in the process is reached, all of the important impacts associated with the choice of platform strategy have been identified. The expected performance associated with the platform strategies have been quantified, as well as the risk. At this time, the platform stakeholders and other decision-makers can identify a preferred. Fine tuning and implementation of the strategy can then commence.

4.0 DEMONSTRATION OF 5-STEP FRAMEWORK

This section uses the 5-step framework to assess and compare the value of three product platform strategies. It considers an automobile company in the early stages of a major reorganization that is interested in developing a new product platform strategy for its compact truck vehicle segment. The compact truck family had proliferated into four separate platforms. Many company representatives however believed that fewer platforms would improve compact truck competitiveness by dramatically reducing product development times and life cycle costs while effectively increasing product line-up offering and customer satisfaction.

The key question the 5-step framework will address is w*hich compact truck platform consolidation strategy has the highest value*? The remainder of this section demonstrates the framework for valuing a platform strategy. All data confidential to the U.S. automobile company has either been disguised or removed all together.

Step 1 - Identify Performance Metrics, Attributes and Uncertainties

The first step in the process is to identify the platform performance metrics, attributes and related uncertainty. A summary of the platform metrics, attributes and uncertainty considered in this demonstration is shown in Table 8.

Performance Metrics

Net Present Value (NPV)
Return on Sales (ROS)

Attributes

Engineering Investment	Transportation Cost
Manufacturing Investment	Product Timing
Fixed Costs	Sale Price
Manufacturing Capacity	Customer Demand
Production Costs	

Uncertainty

Long-term Trends
Short-term Volatility

Table 8: Platform Performance Attributes

Step 2 - Develop Platform Scenarios

A platform scenario represents the evaluation of a platform strategy for a single set of platform attributes. Platform scenarios are useful for studying how a platform strategy responds to a number of plausible cost-benefit assumptions. The multiplicative effect of combining different strategies and cost-benefit assumptions can yield a large number of platform scenarios.

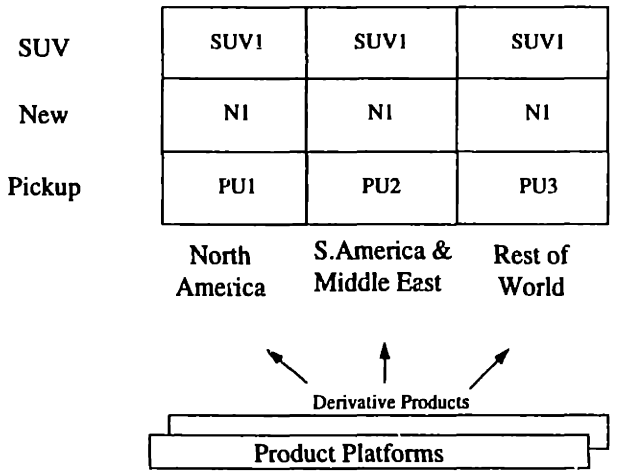
Platform Strategy

In this study, three platform strategies are defined. They are called individual, global pickup and North American truck. Each strategy represents a different approach to product platforming and results in a unique set of cost-benefit implications.

Marketing Plan

Figure 24 is an example of a market segmentation grid for the compact truck family of products. It shows a total of 5 products serving three market segments. The five products are SUV1 (Sport Utility Vehicle), N1 (New compact truck offering), PU1 (Pickup Truck 1), PU2 (Pickup Truck 2), and PU3 (Pickup Truck 3). The three market segments are North America, South America (including Central America) & Middle East, and the Rest of the World.

In this marketing plan, SUV1 and N1 products are expected to serve all markets segments whereas PU1, PU2, and PU3 are expected to serve only one market segment each. This will have implications later in the platform valuation process. For example, if the platform analyst feels that offering the same SUV1 product in Rest of World as in North America would lower product demand for SUV1 in Rest of World, the low demand expectation will be expressed in the modeling of customer demand for SUV in Rest of World.



North America	South America & Middle East	Rest of World
USA	Chile	Thailand
Canada	Brazil	Other Asia-Pacific
Mexico	Argentina	Australia
Puerto Rico	Venezuela	New Zealand
	Latin America	Former Soviet Union
	Persian Gulf Countries	Africa
	Other Middle East	Denmark
	Israel	Germany
		Turkey
		Norway/Sweden/Finland
		United Kingdom
		Austria
		Greece
		Portugal
		Other Europe

Figure 24: Compact Truck Marketing Plan and Countries by Market Segment

Product Plan

Figure 25 - Figure 27 characterize the three different product plan approaches for the compact truck family. The product plans will be referred to as *individual, global pickup* and *North American truck.*

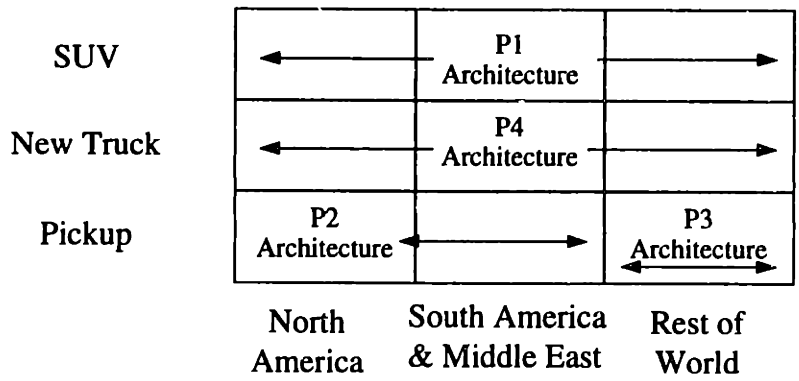
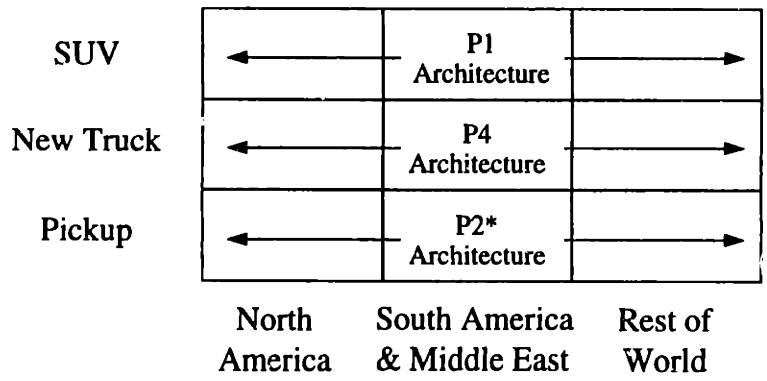
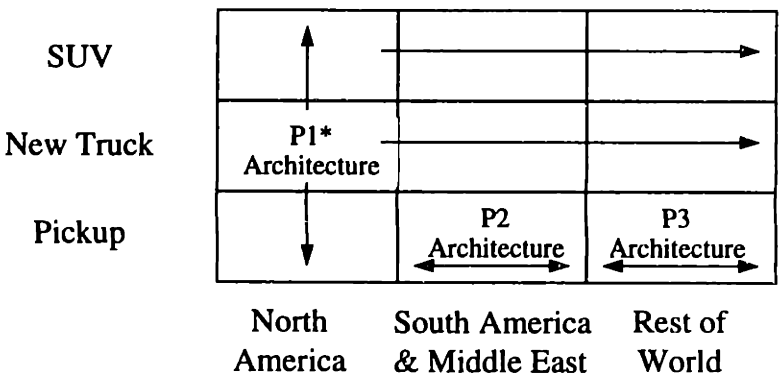


Figure 25: Individual Product Plan



* New P2 Architecture

Figure 26: Global Pickup Product Plan



* New P1 Architecture

Figure 27: North America Truck Product Plan

Manufacturing Plan

Figure 29 - Figure 31 capture the individual, global pickup, and North American truck manufacturing plans. Six plants are available for manufacturing the compact truck family of products as defined by the marketing plan. The location of each plant is as shown in Figure 28. In the case of this study, the six plants are facilities already owned by the company.

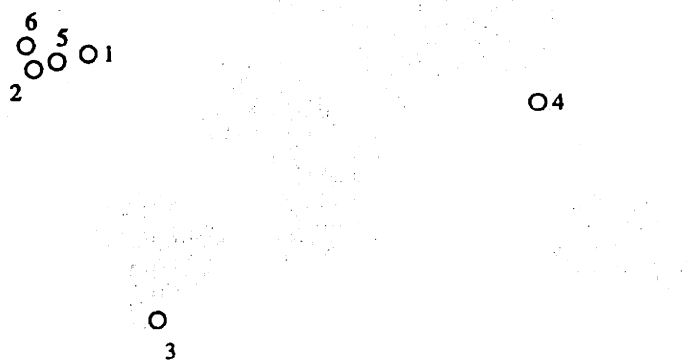


Figure 28: Geographic Location of Compact Truck Manufacturing Plants

The decision for which products will be made in which plant is not straightforward. There are constraints and cost implications associated with the sourcing decision. For example, the product plan places constraints on the sourcing decision due to the fact that the product architecture is a determinant of whether or not two products can be built in the same plant. In addition, the level of flexibility required at the plant is a determinant of the type and cost of the manufacturing equipment, the expected throughput rate (capacity), and the distance between where the product is made and where it is sold (transportation cost). These implications associated with the individual, global pickup and North American truck strategies are captured in their platform attributes.

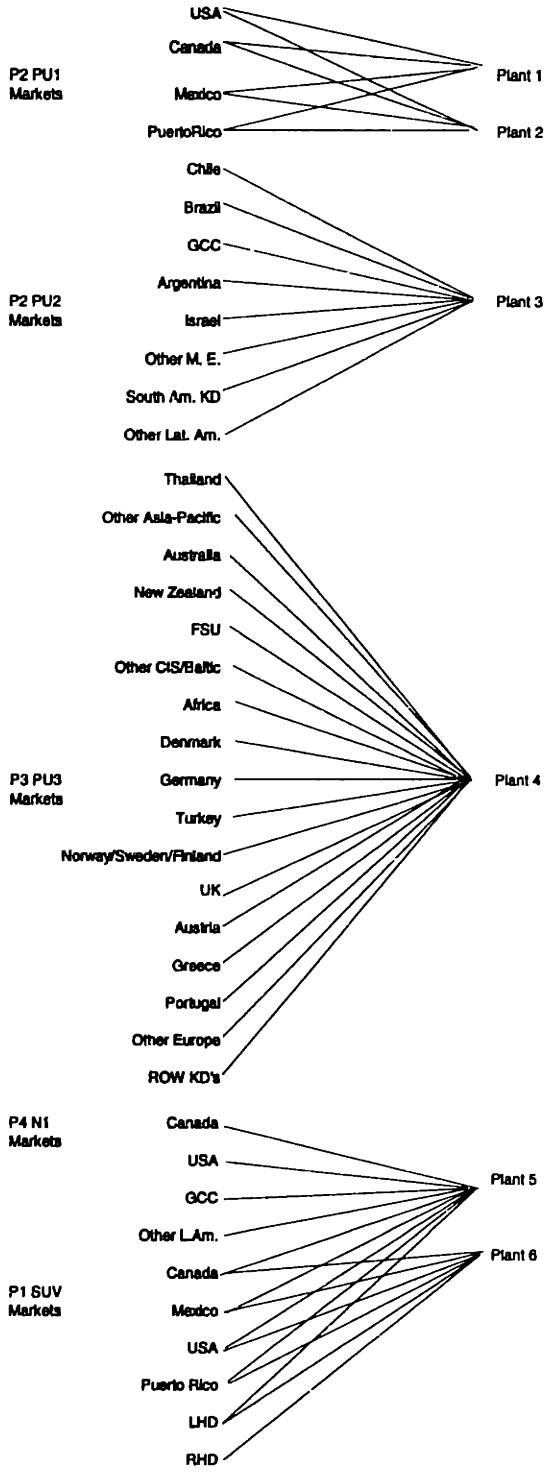


Figure 29: Individual Platform Manufacturing Plan

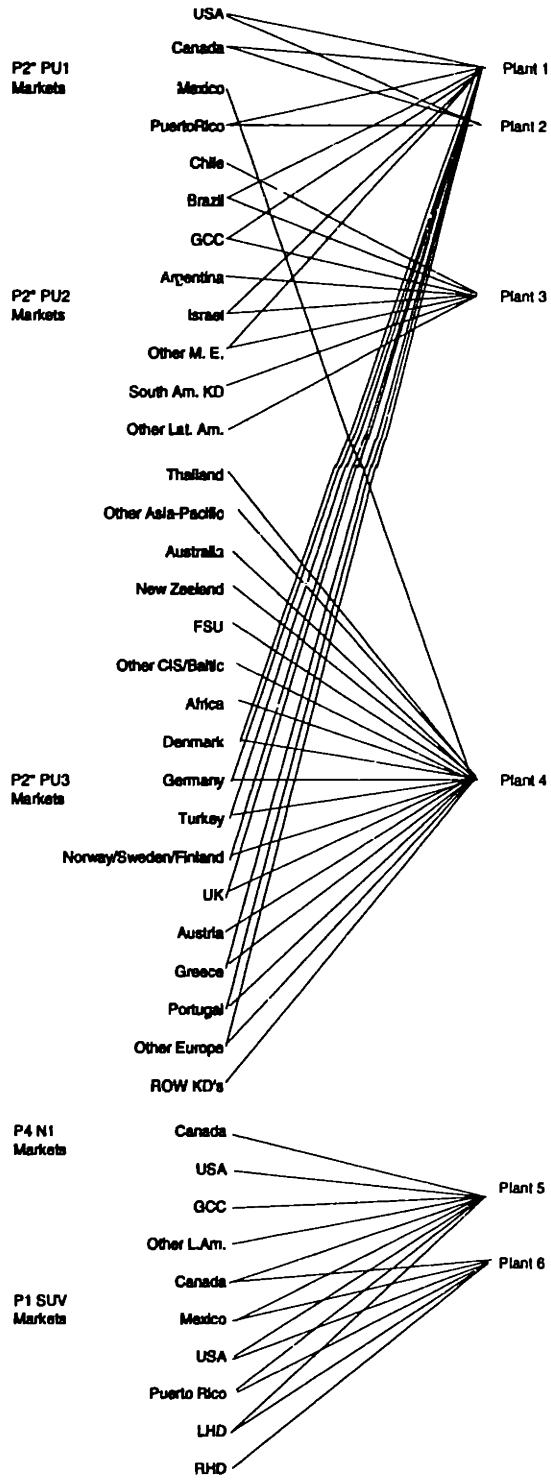


Figure 30: Global Pickup Platform Manufacturing Plan

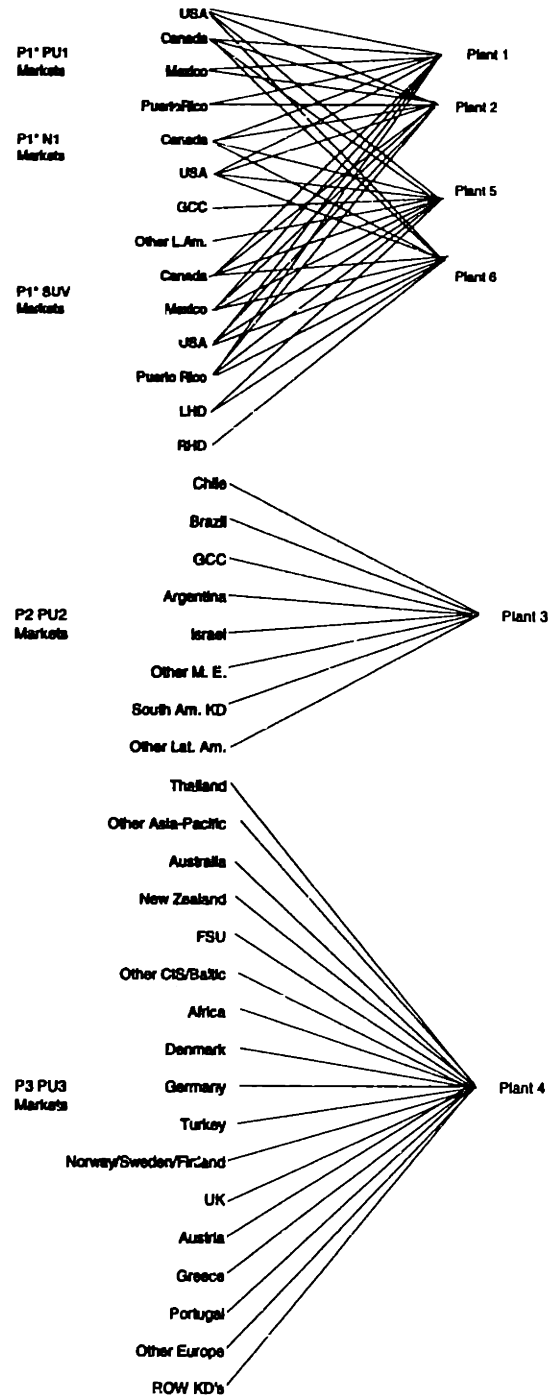


Figure 31: North American Truck Platform Manufacturing Plan

Platform Definition

A cross-functional engineering team made up of design and manufacturing representatives specified the product architecture and manufacturing technology

requirements for the individual, global pickup, and North American truck proposals. The goal was to define each compact truck platform based on an architecture and manufacturing process which could efficiently and effectively accommodate product development and manufacturing.

The team decided to focus the platform development effort on the body structure architecture and Body-in-White (BIW) manufacturing process. See Figure 32 - Figure 33[8]. The team believed that a platform for the body structure subsystems had great benefit potential. This opinion was based on the quality, lead-time and cost implications which are associated with product variety and changeover in the body structure subsystem, as well as the perceived acceptance in the market place for a high degree of commonality in body structure design.

In the design of the individual, global pickup and North American truck platforms, a great deal of attention was paid to body structure interfaces and assembly technology. Interfaces were defined to promote freedom in particular subsystem designs while promoting reusability in manufacturing equipment and handling devices . For example, each platform was designed with common underbody interfaces and a main line assembly sequence. This was done to enable movement of vehicles between plants as well as permit production of existing products while introducing new models.

[8] New truck, N1, subsystems and assembly sequence is similar but not shown due to confidentiality reasons.

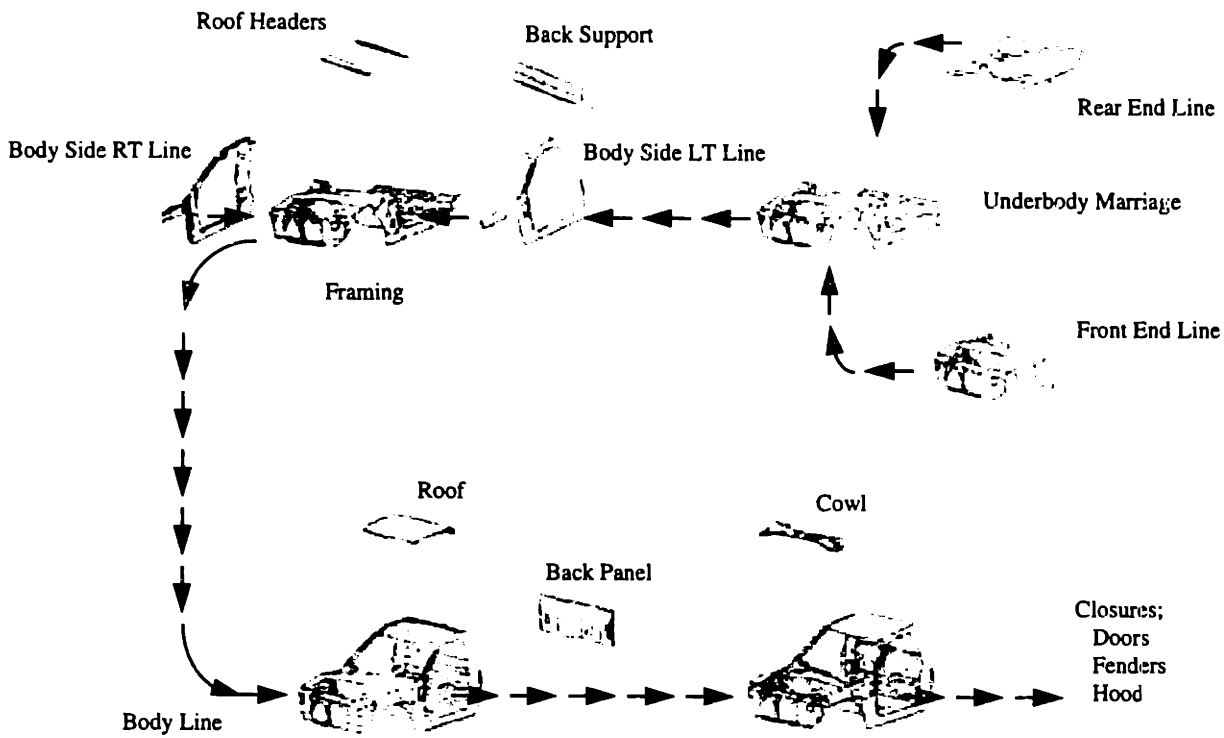


Figure 32: Pickup Body Structure Subsystems and Assembly Sequence

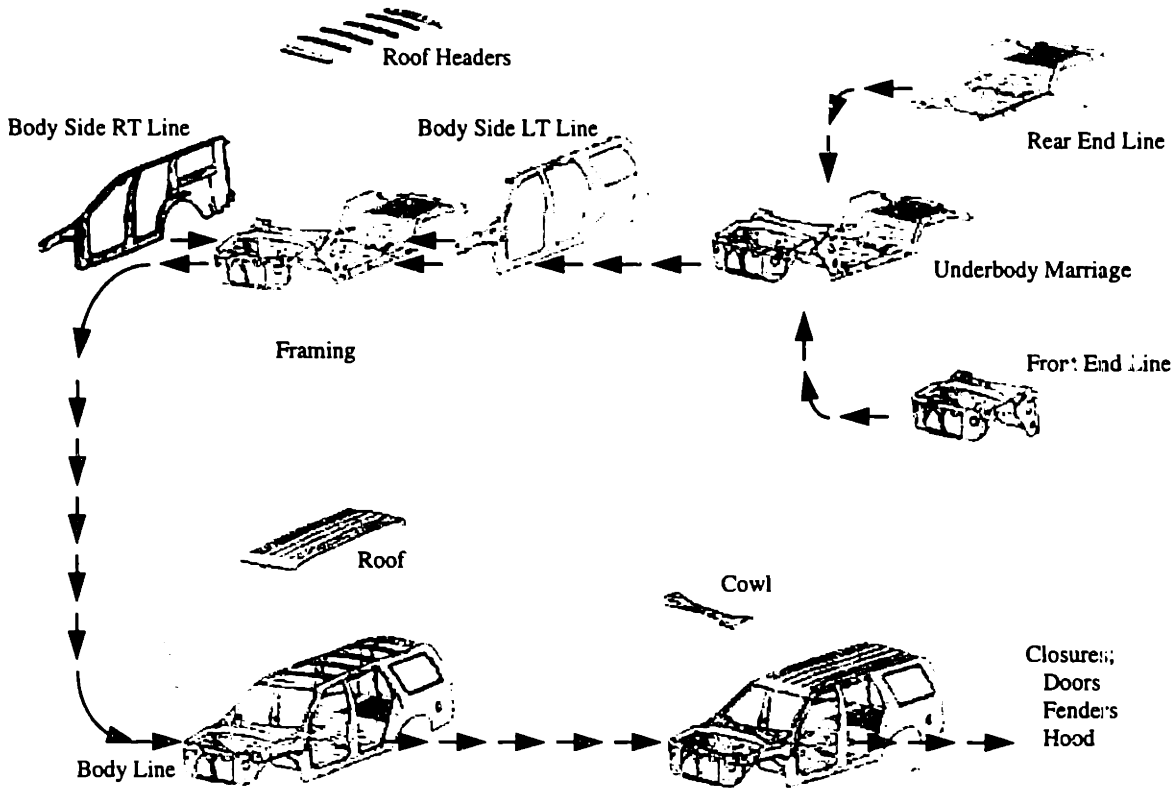


Figure 33: SUV Body Structure Subsystems Assembly Sequence

Platform Attributes

Platform attributes capture the cost-benefit implications of each platform strategy thereby capturing how one platform differs from another in terms that matter for platform evaluation. Below are quantification of eight platform attributes. They are; engineering and manufacturing investment, fixed costs, manufacturing capacity, production costs, transportation cost, product timing, sale price and customer demand.

Engineering and Manufacturing Investment

Associated with each platform strategy is an investment in engineering and manufacturing. Engineering investment is needed to design and test the derivative products. Manufacturing investment is needed to acquire the necessary manufacturing tooling and process equipment. Figure 34 plots the investment requirement for each compact truck platform strategy. On the left of Figure 34 is engineering investment, on the right is manufacturing investment. Both the global and North American truck strategies are more expensive initially, because of the higher degree of product and process flexibility which must be incorporated into the product and process, but less expensive later in the analysis period as a result of this flexibility.

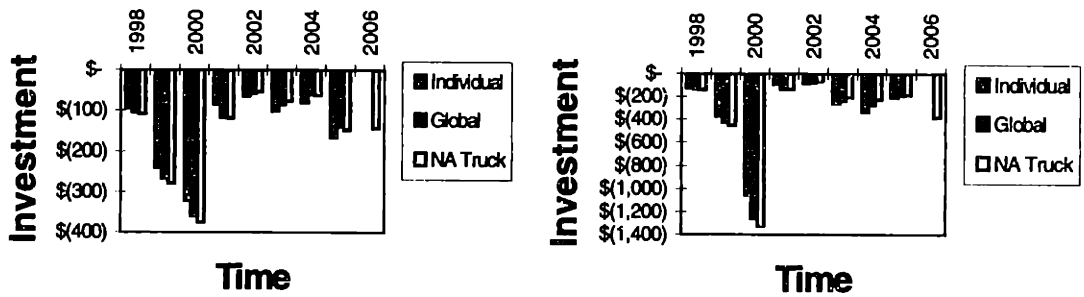


Figure 34: Engineering and Manufacturing Investment

Fixed Costs

Table 9 - Table 11 tabulate the fixed cost implication for the compact truck study. Fixed costs are related to manufacturing overhead, administration and selling, and marketing.

The fixed cost forecast for each platform strategy is based on two platform related factors. First, it is believed that the fixed cost for each strategy does not change over time. Second, a 10% reduction in manufacturing overhead is credited to the global pickup and North American truck strategies[9]. This reduction in manufacturing overhead is based on the expected overhead savings resulting from a higher level of component and assembly commonality found in the global pickup and North American truck strategies compared to the individual strategy.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Plant 1	$ 301	$ 301	$ 301	$ 301	$ 301	$ 301	$ 301	$ 301	$ 301	$ 301
Plant 2	$ 301	$ 301	$ 301	$ 301	$ 301	$ 301	$ 301	$ 301	$ 301	$ 301
Plant 3	$ 57	$ 57	$ 57	$ 57	$ 57	$ 57	$ 57	$ 57	$ 57	$ 57
Plant 4	$ 179	$ 179	$ 179	$ 179	$ 179	$ 179	$ 179	$ 179	$ 179	$ 179
Plant 5	$ 535	$ 535	$ 535	$ 535	$ 535	$ 535	$ 535	$ 535	$ 535	$ 535
Plant 6	$ 535	$ 535	$ 535	$ 535	$ 535	$ 535	$ 535	$ 535	$ 535	$ 535

Table 9: Individual Platform Fixed Costs (Millions)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Plant 1	$ 285	$ 285	$ 285	$ 285	$ 285	$ 285	$ 285	$ 285	$ 285	$ 285
Plant 2	$ 285	$ 285	$ 285	$ 285	$ 285	$ 285	$ 285	$ 285	$ 285	$ 285
Plant 3	$ 54	$ 54	$ 54	$ 54	$ 54	$ 54	$ 54	$ 54	$ 54	$ 54
Plant 4	$ 169	$ 169	$ 169	$ 169	$ 169	$ 169	$ 169	$ 169	$ 169	$ 169
Plant 5	$ 535	$ 535	$ 535	$ 535	$ 535	$ 535	$ 535	$ 535	$ 535	$ 535
Plant 6	$ 535	$ 535	$ 535	$ 535	$ 535	$ 535	$ 535	$ 535	$ 535	$ 535

Table 10: Global Pickup Platform Fixed Cost (Millions)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Plant 1	$ 285	$ 285	$ 285	$ 285	$ 285	$ 285	$ 285	$ 285	$ 285	$ 285
Plant 2	$ 285	$ 285	$ 285	$ 285	$ 285	$ 285	$ 285	$ 285	$ 285	$ 285
Plant 3	$ 57	$ 57	$ 57	$ 57	$ 57	$ 57	$ 57	$ 57	$ 57	$ 57
Plant 4	$ 179	$ 179	$ 179	$ 179	$ 179	$ 179	$ 179	$ 179	$ 179	$ 179
Plant 5	$ 511	$ 511	$ 511	$ 511	$ 511	$ 511	$ 511	$ 511	$ 511	$ 511
Plant 6	$ 511	$ 511	$ 511	$ 511	$ 511	$ 511	$ 511	$ 511	$ 511	$ 511

Table 11: North America Truck Platform Fixed Cost (Millions)

Manufacturing Capacity

Table 12 - Table 14 tabulate the manufacturing capacity implications for each of the platform strategies. The manufacturing capacity forecast is based on platform related

[9] Because manufacturing overhead is not 100% of the total fixed cost represented in the table, the net change in fixed cost is less than 10%.

factors. The major difference accounted for in each platform's manufacturing capacity forecast is the expected plant downtime. See Figure 35 - Figure 37. Plant downtime occurs when the platform strategy is implemented and during product changeovers.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Plant 1	158	152	158	158	158	152	158	158	158	158	158
Plant 2	176	169	176	176	176	169	176	176	176	176	176
Plant 3	56	56	56	56	56	54	56	56	56	56	56
Plant 4	73	70	73	73	73	70	73	73	73	73	73
Plant 5	385	370	385	370	385	385	370	385	385	385	385
Plant 6	190	182	190	182	190	190	182	190	190	190	190

Table 12: Individual Platform Plant Capacity ('000)

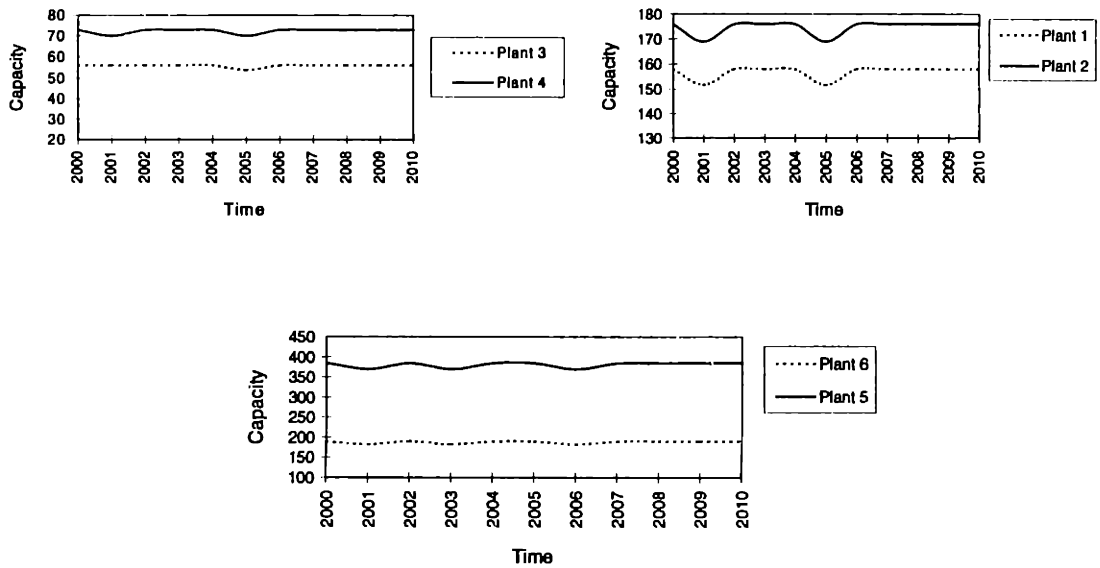


Figure 35: Individual Platform Plant Capacity Graphs

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Plant 1	158	119	158	158	158	155	158	158	158	158	158
Plant 2	176	134	176	176	176	172	176	176	176	176	176
Plant 3	56	56	56	56	56	42	56	56	56	56	56
Plant 4	73	64	73	73	73	72	73	73	73	73	73
Plant 5	385	370	385	370	385	385	370	385	385	385	385
Plant 6	190	182	190	182	190	190	182	190	190	190	190

Table 13: Global Pickup Platform Plant Capacity ('000)

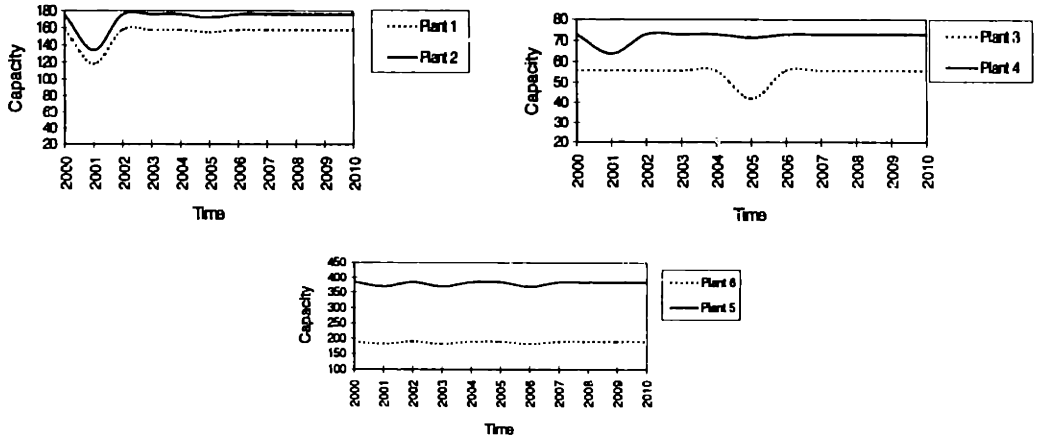


Figure 36: Global Pickup Platform Plant Capacity Graphs

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Plant 1	158	119	158	158	158	155	158	158	158	158	158
Plant 2	176	132	176	176	176	172	176	176	176	176	176
Plant 5	385	370	385	370	385	385	370	385	385	385	385
Plant 6	190	182	190	182	190	190	182	190	190	190	190
Plant 3	56	56	56	56	56	54	56	56	56	56	56
Plant 4	73	70	73	73	73	70	73	73	73	73	73

Table 14: North American Truck Platform Plant Capacity ('000)

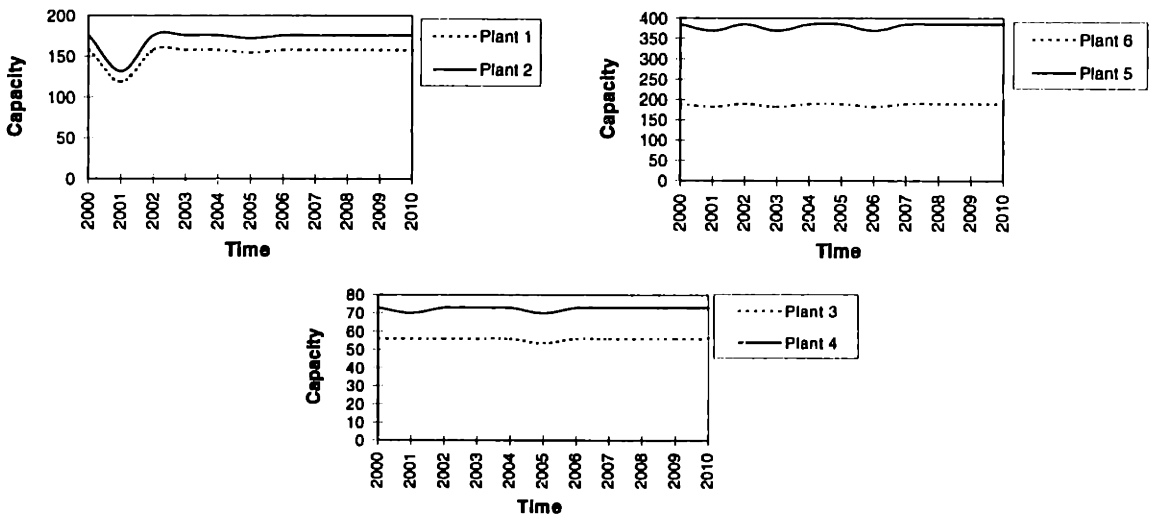


Figure 37: North American Truck Platform Plant Capacity Graphs

Production Costs

Table 15 - Table 17 tabulate the variable production costs for the individual, global pickup and North American truck strategies. The production cost forecast for each platform strategy is based on two platform-related factors.

First, the production costs associated with the individual, global pickup and North American truck platform strategies are different. In the global pickup strategy PU1, PU2, and PU3 are derivatives of the same platform. The PU1 and PU2 derivative products will experience a reduction of variable production cost due to economies of scale in procurement and manufacturing. However, the PU3 (low-end pickup for Rest of World Markets) will experience an increase in variable production cost due to its commonality with the higher performance PU1 and PU2. Similarly, in the North American truck platform strategy SUV1, N1 and PU1 are derivatives of the same platform. SUV1 and N1 will experience a reduction of variable production costs, but PU1 experiences an increase in variable production cost. Second, it is believed that a constant cost reduction of 2% annually will be achieved by each platform strategy. The 2% annual decrease in production cost represents cost reduction efforts at the plant which are independent of the platform strategy chosen.

	2001	2002	2003	2004	2005	2006	2007	2008	2009
PU1-Plant 1	$ 7,171	$ 7,027	$ 6,887	$ 6,749	$ 6,614	$ 6,482	$ 6,352	$ 6,225	$ 6,101
PU1-Plant 2	$ 7,171	$ 7,027	$ 6,887	$ 6,749	$ 6,614	$ 6,482	$ 6,352	$ 6,225	$ 6,101
PU2- Plant 3	$ 10,965	$ 10,745	$ 10,530	$ 10,320	$ 10,113	$ 9,911	$ 9,713	$ 9,519	$ 9,328
PU3-Plant 4	$ 5,830	$ 5,714	$ 5,599	$ 5,487	$ 5,378	$ 5,270	$ 5,165	$ 5,061	$ 4,960
N1-Plant 5	$ 9,902	$ 9,704	$ 9,510	$ 9,320	$ 9,133	$ 8,951	$ 8,772	$ 8,596	$ 8,424
SUV1-Plant 5	$ 11,436	$ 11,207	$ 10,983	$ 10,764	$ 10,548	$ 10,337	$ 10,131	$ 9,928	$ 9,729
SUV1-Plant 6	$ 11,436	$ 11,207	$ 10,983	$ 10,764	$ 10,548	$ 10,337	$ 10,131	$ 9,928	$ 9,729

Table 15: Individual Platform Variable Production Costs

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
PU1-Plant 1	$ 6,445	$ 6,316	$ 6,190	$ 6,066	$ 5,945	$ 5,826	$ 5,709	$ 5,595	$ 5,483	$ 5,374
PU1-Plant 2	$ 6,445	$ 6,316	$ 6,190	$ 6,066	$ 5,945	$ 5,826	$ 5,709	$ 5,595	$ 5,483	$ 5,374
PU2- Plant 3	$ 9,918	$ 9,720	$ 9,525	$ 9,335	$ 9,148	$ 8,965	$ 8,786	$ 8,610	$ 8,438	$ 8,269
PU3-Plant 4	$ 6,606	$ 6,474	$ 6,344	$ 6,217	$ 6,093	$ 5,971	$ 5,852	$ 5,735	$ 5,620	$ 5,507
N1-Plant 5	$ 9,902	$ 9,704	$ 9,510	$ 9,320	$ 9,133	$ 8,951	$ 8,772	$ 8,596	$ 8,424	$ 8,256
SUV1-Plant 5	$ 11,436	$ 11,207	$ 10,983	$ 10,764	$ 10,548	$ 10,337	$ 10,131	$ 9,928	$ 9,729	$ 9,535
SUV1-Plant 6	$ 11,436	$ 11,207	$ 10,983	$ 10,764	$ 10,548	$ 10,337	$ 10,131	$ 9,928	$ 9,729	$ 9,535

Table 16: Global Pickup Platform Variable Production Costs

	2001	2002	2003	2004	2005	2006	2007	2008	2009
PU1-Plant 1	$ 7,784	$ 7,628	$ 7,476	$ 7,326	$ 7,180	$ 7,036	$ 6,895	$ 6,758	$ 6,622
PU1-Plant 2	$ 7,784	$ 7,628	$ 7,476	$ 7,326	$ 7,180	$ 7,036	$ 6,895	$ 6,758	$ 6,622
PU2- Plant 3	$ 10,965	$ 10,745	$ 10,530	$ 10,320	$ 10,113	$ 9,911	$ 9,713	$ 9,519	$ 9,328
PU3-Plant 4	$ 5,830	$ 5,714	$ 5,599	$ 5,487	$ 5,378	$ 5,270	$ 5,165	$ 5,061	$ 4,960
N1-Plant 5	$ 9,024	$ 8,844	$ 8,667	$ 8,494	$ 8,324	$ 8,157	$ 7,994	$ 7,834	$ 7,678
SUV1-Plant 5	$ 10,423	$ 10,214	$ 10,010	$ 9,810	$ 9,613	$ 9,421	$ 9,233	$ 9,048	$ 8,867
SUV1-Plant 6	$ 10,423	$ 10,214	$ 10,010	$ 9,810	$ 9,613	$ 9,421	$ 9,233	$ 9,048	$ 8,867

Table 17: NA Truck Platform Variable Production Costs

Transportation Costs

Table 18 - Table 20 tabulate the transportation costs for the product-plant-region combination defined by each of the platform strategies. Figure 38 shows the geographic location of the six plants in the manufacturing plan. The transportation cost forecast is based on the expected costs associated with getting the product from the plant where it is produced to the customer.

Transportation costs are estimated as either $0, $50, or $100 per vehicle[10]. If the product is sold in the region where it is produced, no transportation costs are incurred. If the product is sold in a region where an established shipping route is available (i.e., U.S. to Europe), a $50 transportation cost is incurred. Otherwise, the transportation cost is $100.

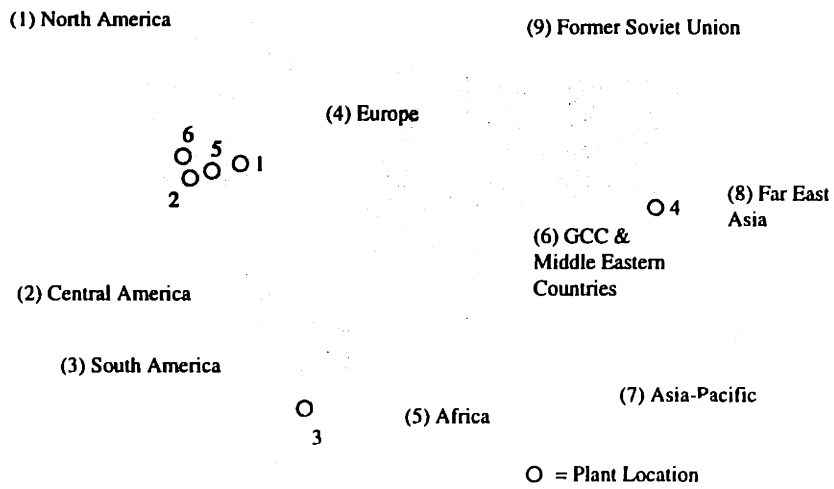


Figure 38: Worldwide Production Plant Locations

[10] Transportation costs were estimated as such because of a lack of available data.

	2001	2002	2003	2004	2005	2006	2007	2008	2009
PU1 - Plant 1 - Region 1	$0	$0	$0	$0	$0	$0	$0	$0	$0
PU1 - Plant 2 - Region 1	$0	$0	$0	$0	$0	$0	$0	$0	$0
PU2 - Plant 3 - Region 2	$50	$50	$50	$50	$50	$50	$50	$50	$50
PU2 - Plant 3 - Region 3	$50	$50	$50	$50	$50	$50	$50	$50	$50
PU2 - Plant 3 - Region 6	$100	$100	$100	$100	$100	$100	$100	$100	$100
PU3 - Plant 4 - Region 4	$100	$100	$100	$100	$100	$100	$100	$100	$100
PU3 - Plant 4 - Region 5	$100	$100	$100	$100	$100	$100	$100	$100	$100
PU3 - Plant 4 - Region 7	$100	$100	$100	$100	$100	$100	$100	$100	$100
PU3 - Plant 4 - Region 8	$0	$0	$0	$0	$0	$0	$0	$0	$0
PU3 - Plant 4 - Region 9	$100	$100	$100	$100	$100	$100	$100	$100	$100
N1 - Plant 5 - Region 1	$0	$0	$0	$0	$0	$0	$0	$0	$0
SUV1 - Plant 5 - Region 1	$0	$0	$0	$0	$0	$0	$0	$0	$0
SUV1 - Plant 5 - Region 2	$50	$50	$50	$50	$50	$50	$50	$50	$50
SUV1 - Plant 5 - Region 3	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 5 - Region 4	$50	$50	$50	$50	$50	$50	$50	$50	$50
SUV1 - Plant 5 - Region 5	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 5 - Region 6	$50	$50	$50	$50	$50	$50	$50	$50	$50
SUV1 - Plant 5 - Region 7	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 5 - Region 8	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 5 - Region 9	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 6 - Region 1	$0	$0	$0	$0	$0	$0	$0	$0	$0
SUV1 - Plant 6 - Region 2	$50	$50	$50	$50	$50	$50	$50	$50	$50
SUV1 - Plant 6 - Region 3	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 6 - Region 4	$50	$50	$50	$50	$50	$50	$50	$50	$50
SUV1 - Plant 6 - Region 5	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 6 - Region 6	$50	$50	$50	$50	$50	$50	$50	$50	$50
SUV1 - Plant 6 - Region 7	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 6 - Region 8	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 6 - Region 9	$100	$100	$100	$100	$100	$100	$100	$100	$100

Table 18: Individual Platform Average Transportation Costs

	2001	2002	2003	2004	2005	2006	2007	2008	2009
PU1 - Plant 1 - Region 1	$0	$0	$0	$0	$0	$0	$0	$0	$0
PU3 - Plant 1 - Region 4	$50	$50	$50	$50	$50	$50	$50	$50	$50
PU2 - Plant 1 - Region 6	$50	$50	$50	$50	$50	$50	$50	$50	$50
PU1 - Plant 2 - Region 1	$0	$0	$0	$0	$0	$0	$0	$0	$0
PU2 - Plant 3 - Region 2	$50	$50	$50	$50	$50	$50	$50	$50	$50
PU2 - Plant 3 - Region 3	$50	$50	$50	$50	$50	$50	$50	$50	$50
PU2 - Plant 3 - Region 6	$100	$100	$100	$100	$100	$100	$100	$100	$100
PU1 - Plant 4 - Region 1	$100	$100	$100	$100	$100	$100	$100	$100	$100
PU3 - Plant 4 - Region 4	$100	$100	$100	$100	$100	$100	$100	$100	$100
PU3 - Plant 4 - Region 5	$100	$100	$100	$100	$100	$100	$100	$100	$100
PU3 - Plant 4 - Region 7	$100	$100	$100	$100	$100	$100	$100	$100	$100
PU3 - Plant 4 - Region 8	$0	$0	$0	$0	$0	$0	$0	$0	$0
PU3 - Plant 4 - Region 9	$100	$100	$100	$100	$100	$100	$100	$100	$100
N1 - Plant 5 - Region 1	$0	$0	$0	$0	$0	$0	$0	$0	$0
SUV1 - Plant 5 - Region 1	$0	$0	$0	$0	$0	$0	$0	$0	$0
SUV1 - Plant 5 - Region 2	$50	$50	$50	$50	$50	$50	$50	$50	$50
SUV1 - Plant 5 - Region 3	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 5 - Region 4	$50	$50	$50	$50	$50	$50	$50	$50	$50
SUV1 - Plant 5 - Region 5	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 5 - Region 6	$50	$50	$50	$50	$50	$50	$50	$50	$50
SUV1 - Plant 5 - Region 7	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 5 - Region 8	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 5 - Region 9	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 6 - Region 1	$0	$0	$0	$0	$0	$0	$0	$0	$0
SUV1 - Plant 6 - Region 2	$50	$50	$50	$50	$50	$50	$50	$50	$50
SUV1 - Plant 6 - Region 3	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 6 - Region 4	$50	$50	$50	$50	$50	$50	$50	$50	$50
SUV1 - Plant 6 - Region 5	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 6 - Region 6	$50	$50	$50	$50	$50	$50	$50	$50	$50
SUV1 - Plant 6 - Region 7	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 6 - Region 8	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 6 - Region 9	$100	$100	$100	$100	$100	$100	$100	$100	$100

Table 19: Global Pickup Platform Average Transportation Cost

	2001	2002	2003	2004	2005	2006	2007	2008	2009
PU1 - Plant 1 - Region 1	$0	$0	$0	$0	$0	$0	$0	$0	$0
N1 - Plant 1 - Region 1	$0	$0	$0	$0	$0	$0	$0	$0	$0
SUV1 - Plant 1 - Region 1	$0	$0	$0	$0	$0	$0	$0	$0	$0
PU1 - Plant 2 - Region 1	$0	$0	$0	$0	$0	$0	$0	$0	$0
N1 - Plant 2 - Region 1	$0	$0	$0	$0	$0	$0	$0	$0	$0
SUV1 - Plant 2 - Region 1	$0	$0	$0	$0	$0	$0	$0	$0	$0
PU2 - Plant 3 - Region 2	$50	$50	$50	$50	$50	$50	$50	$50	$50
PU2 - Plant 3 - Region 3	$50	$50	$50	$50	$50	$50	$50	$50	$50
PU2 - Plant 3 - Region 6	$100	$100	$100	$100	$100	$100	$100	$100	$100
PU3 - Plant 4 - Region 4	$100	$100	$100	$100	$100	$100	$100	$100	$100
PU3 - Plant 4 - Region 5	$100	$100	$100	$100	$100	$100	$100	$100	$100
PU3 - Plant 4 - Region 7	$100	$100	$100	$100	$100	$100	$100	$100	$100
PU3 - Plant 4 - Region 8	$0	$0	$0	$0	$0	$0	$0	$0	$0
PU3 - Plant 4 - Region 9	$100	$100	$100	$100	$100	$100	$100	$100	$100
PU1 - Plant 5 - Region 1	$0	$0	$0	$0	$0	$0	$0	$0	$0
N1 - Plant 5 - Region 1	$0	$0	$0	$0	$0	$0	$0	$0	$0
SUV1 - Plant 5 - Region 1	$0	$0	$0	$0	$0	$0	$0	$0	$0
SUV1 - Plant 5 - Region 2	$50	$50	$50	$50	$50	$50	$50	$50	$50
SUV1 - Plant 5 - Region 3	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 5 - Region 4	$50	$50	$50	$50	$50	$50	$50	$50	$50
SUV1 - Plant 5 - Region 5	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 5 - Region 6	$50	$50	$50	$50	$50	$50	$50	$50	$50
SUV1 - Plant 5 - Region 7	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 5 - Region 8	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 5 - Region 9	$100	$100	$100	$100	$100	$100	$100	$100	$100
PU1 - Plant 6 - Region 1	$0	$0	$0	$0	$0	$0	$0	$0	$0
N1 - Plant 6 - Region 1	$0	$0	$0	$0	$0	$0	$0	$0	$0
SUV1 - Plant 6 - Region 1	$0	$0	$0	$0	$0	$0	$0	$0	$0
SUV1 - Plant 6 - Region 2	$50	$50	$50	$50	$50	$50	$50	$50	$50
SUV1 - Plant 6 - Region 3	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 6 - Region 4	$50	$50	$50	$50	$50	$50	$50	$50	$50
SUV1 - Plant 6 - Region 5	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 6 - Region 6	$50	$50	$50	$50	$50	$50	$50	$50	$50
SUV1 - Plant 6 - Region 7	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 6 - Region 8	$100	$100	$100	$100	$100	$100	$100	$100	$100
SUV1 - Plant 6 - Region 9	$100	$100	$100	$100	$100	$100	$100	$100	$100

Table 20: North America Truck Platform Average Transportation Cost

Product Timing

Figure 39 - Figure 41 represent the product timing for each of the three compact truck platform strategies. The timing of products is based on market factors and thus is independent of the platform decision. As can be seen in the figures, the timing of products for each of the strategies is the same.

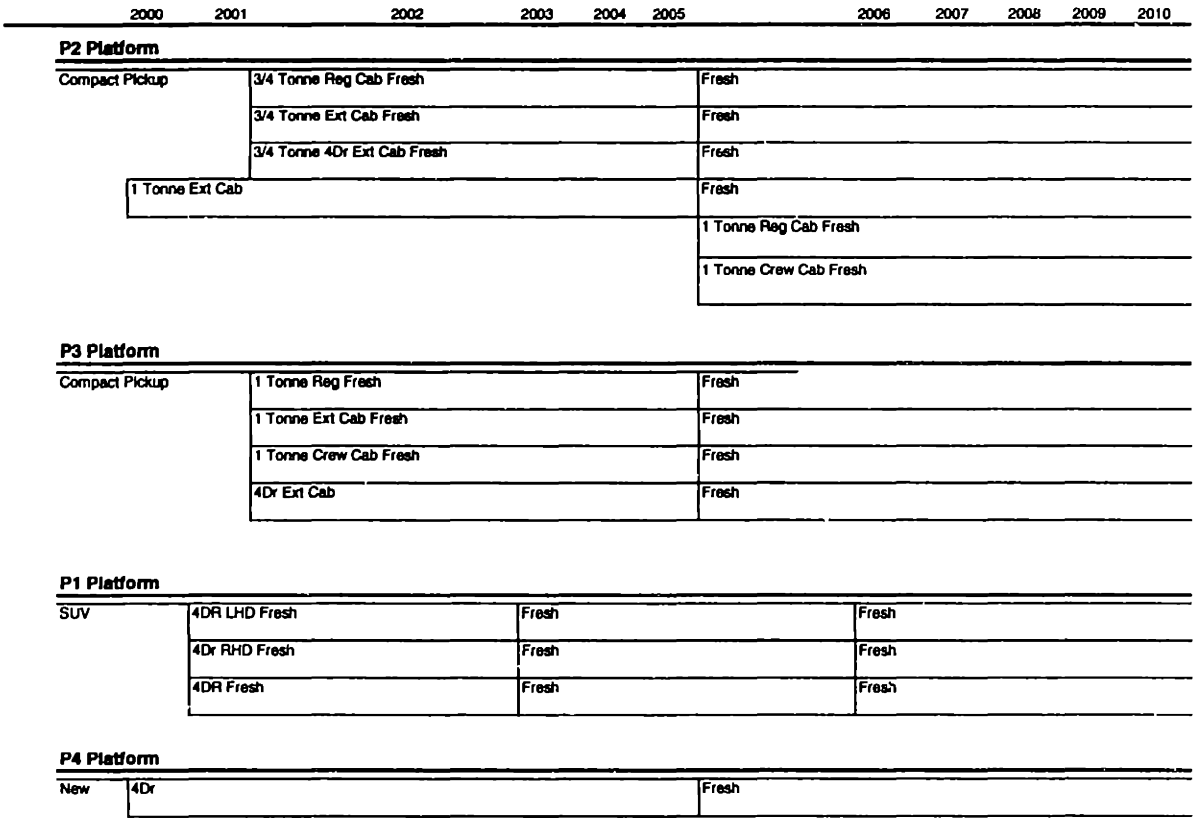


Figure 39: Individual Compact Truck Platform Product Timing

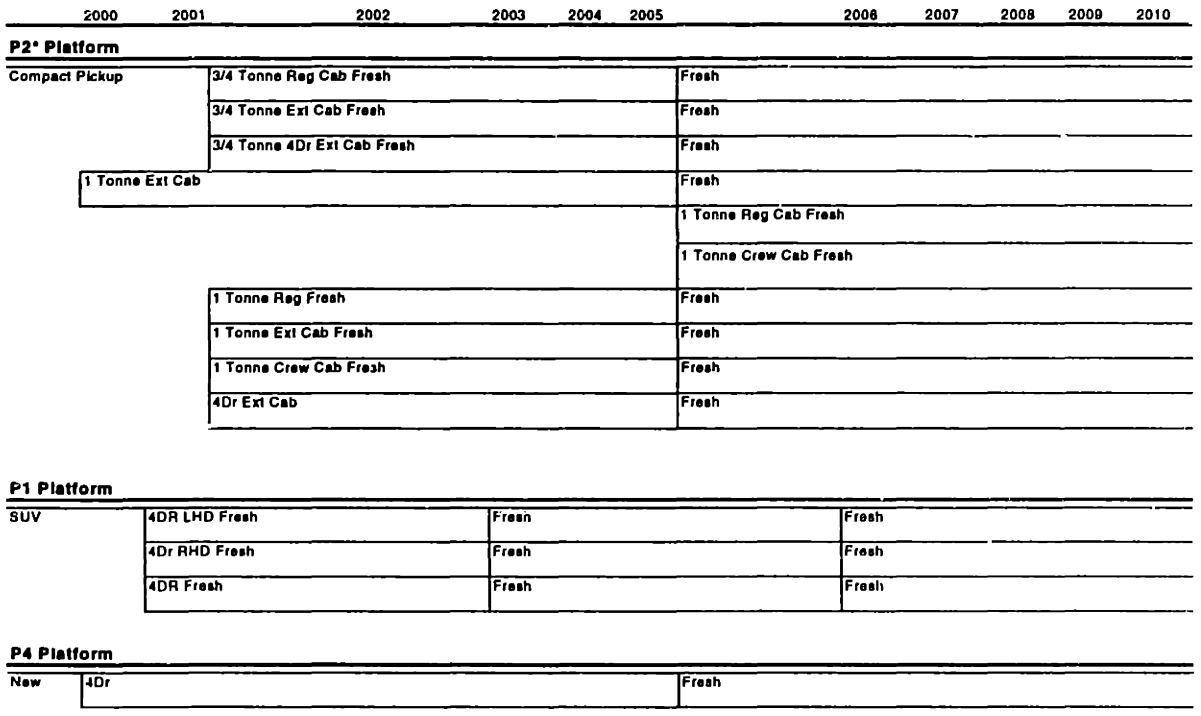


Figure 40: Global Pickup Platform Product Timing

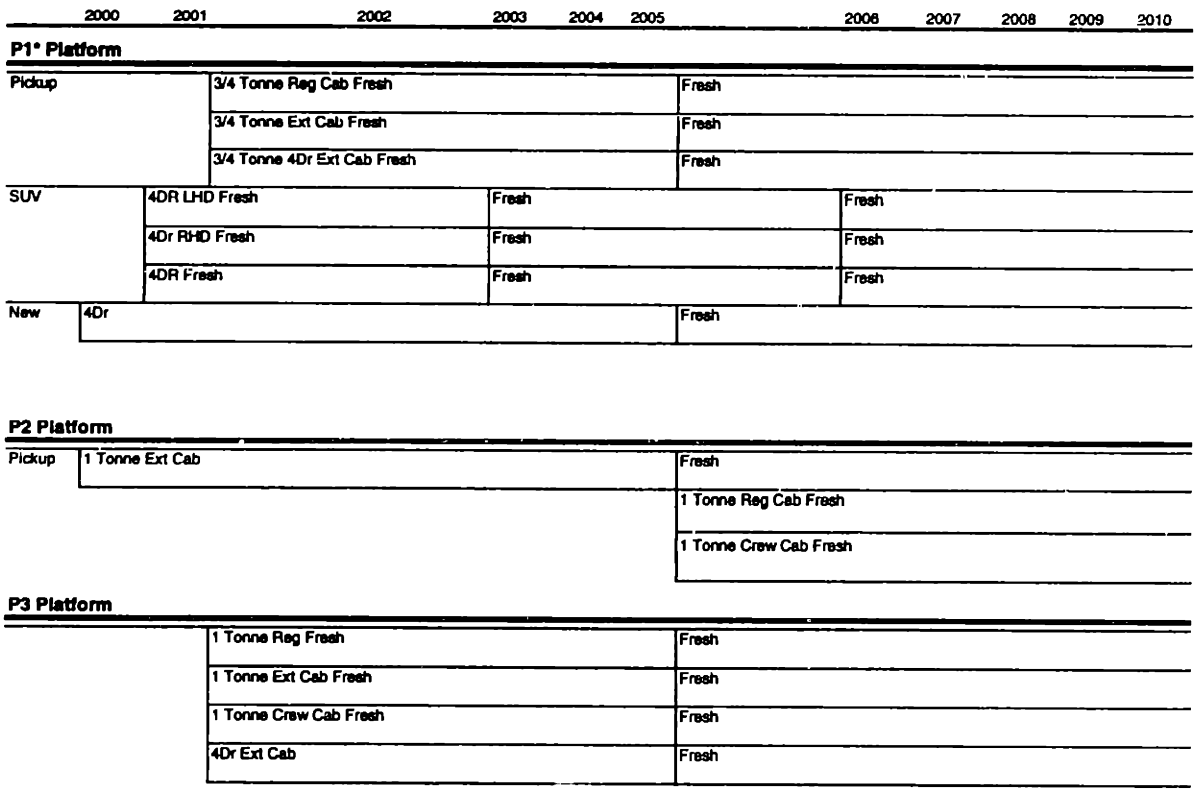


Figure 41: North America Truck Platform Product Timing

Sale Price

Table 21 tabulates the average sale price for each product in the compact truck family. The average sale price is the weighted-average sale price across all markets. The sale price forecast is believed to be based on market factors and thus is independent of the platform decision[11].

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
PU1	$ 12,072	$ 12,072	$ 12,072	$ 12,072	$ 12,072	$ 12,072	$ 12,072	$ 12,072	$ 12,072	$ 12,072
PU2	$ 15,686	$ 15,686	$ 15,686	$ 15,686	$ 15,686	$ 15,686	$ 15,686	$ 15,686	$ 15,686	$ 15,686
PU3	$ 9,700	$ 9,700	$ 9,700	$ 9,700	$ 9,700	$ 9,700	$ 9,700	$ 9,700	$ 9,700	$ 9,700
N1	$ 19,079	$ 19,079	$ 19,079	$ 19,079	$ 19,079	$ 19,079	$ 19,079	$ 19,079	$ 19,079	$ 19,079
SUV1	$ 22,035	$ 22,035	$ 22,035	$ 22,035	$ 22,035	$ 22,035	$ 22,035	$ 22,035	$ 22,035	$ 22,035

Table 21: Average Sale Price for Each Derivative Product

[11] This would be the case if we assume external factors, such as economic conditions, are the primary factors influencing the sale price.

Customer Demand

Table 22 - Table 24 tabulate expected customer demand for each product and market in the compact truck product family. Figure 43 - Figure 43 list the markets and countries applicable to this study. The customer demand forecast is based on market factors and thus and is independent of the platform decision[12]. As can be seen in the tables, the customer demand forecast is the same for each platform strategy.

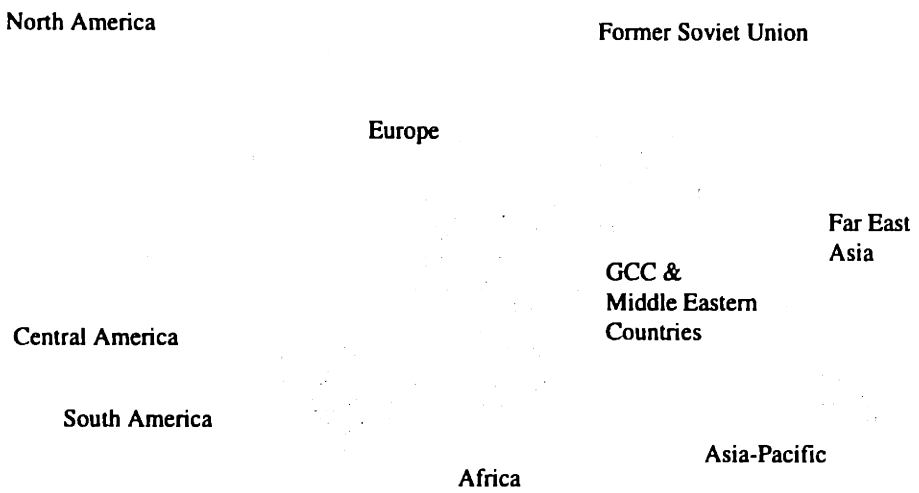


Figure 42: Overview of International Markets

[12] The assumption here is that the customer could not tell if a product, let say PU1, was designed and built from the individual platform strategy, the global pickup platform strategy or the North American Truck.

North America	South/Central America & M ' lle East	Rest of World
USA	Chile	Thailand
Canada	Brazil	Other Asia-Pacific
Mexico	Argentina	Australia
Puerto Rico	Venezuela	New Zealand
	Latin America	Former Soviet Union
	Persian Gulf Countries	Africa
	Other Middle East	Denmark
	Israel	Germany
		Turkey
		Norway/Sweden/Fin
		United Kingdom
		Austria
		Greece
		Portugal
		Other Europe

Figure 43: Worldwide Customer Demand by Country/Region

			2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
P2	PU1	USA	258.5	278.5	290.5	290.5	267.4	267.4	267.4	267.4	267.4	267.4
P2	PU1	Canada	6.3	6.8	6.8	6.9	6.9	6.9	6.9	6.9	6.9	6.9
P2	PU1	Mexico	11.9	13.5	15.0	17.1	18.8	18.8	18.8	18.8	18.8	18.8
P2	PU1	PuertoRico	3.3	3.4	3.4	3.5	3.5	3.5	3.5	3.5	3.5	3.5
P2	PU2	Chile	7.7	8.7	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5
P2	PU2	Brazil	25.1	25.4	26.7	27.5	28.5	28.5	28.5	28.5	28.5	28.5
P2	PU2	GCC	6.1	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6
P2	PU2	Argentina	6.6	6.9	7.2	7.5	7.8	7.8	7.8	7.8	7.8	7.8
P2	PU2	Israel	1.2	1.3	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.5
P2	PU2	Other M. E.	3.1	3.5	3.7	3.7	3.8	3.8	3.8	3.8	3.8	3.8
P2	PU2	South Am. KD's	8.4	8.5	8.7	9.0	9.2	9.2	9.2	9.2	9.2	9.2
P2	FU2	Other Lat. Am.	5.1	5.5	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8
P3	PU3	Thailand	31.8	31.3	30.8	30.8	30.8	30.8	30.8	30.8	30.8	30.8
P3	PU3	Other Asia-Pacific	1.4	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.4
P3	PU3	Australia	6.1	6.1	5.8	5.5	7.8	7.8	7.8	7.8	7.8	7.8
P3	PU3	New Zealand	1.3	1.3	1.3	1.3	1.5	1.5	1.5	1.5	1.5	1.5
P3	PU3	FSU	5.0	5.0	6.0	6.0	6.0	6.0	7.0	7.0	7.0	7.0
P3	PU3	Other CIS/Baltic	0.5	0.8	1.2	1.3	1.4	1.4	1.4	1.4	1.4	1.4
P3	PU3	Africa	3.2	3.4	3.8	3.9	4.1	4.1	4.1	4.1	4.1	4.1
P3	PU3	Denmark	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3
P3	PU3	Germany	2.0	2.0	2.0	1.9	1.5	1.5	1.5	1.5	1.5	1.5
P3	PU3	Turkey	1.5	1.6	1.7	1.8	1.9	1.9	1.9	1.9	1.9	1.9
P3	PU3	Norway/Sweden/Finland	0.4	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4
P3	PU3	UK	3.1	3.0	3.0	3.0	2.1	2.1	2.1	2.1	2.1	2.1
P3	PU3	Austria	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
P3	PU3	Greece	1.0	1.1	1.1	1.2	1.1	1.1	1.1	1.1	1.1	1.1
P3	PU3	Portugal	1.1	1.0	1.0	0.9	0.7	0.7	0.7	0.7	0.7	0.7
P3	PU3	Other Europe	0.3	0.4	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7
P3	PU3	ROW KD's	12.1	13.2	9.8	9.8	9.9	9.9	9.9	9.9	9.9	9.9
P4	N1	Canada	4.7	4.7	4.7	4.7	4.8	4.8	4.8	4.3	4.8	4.8
P4	N1	USA	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
P1	SUV1	GCC	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
P1	SUV1	Other L.Am.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P1	SUV1	Canada	14.2	14.9	15.0	15.0	15.4	15.4	15.4	15.4	15.4	15.4
P1	SUV1	Mexico	3.4	3.9	4.2	4.8	5.3	5.3	5.3	5.3	5.3	5.3
P1	SUV1	USA	370.0	393.0	396.0	385.0	388.0	388.0	388.0	388.0	388.0	388.0
P1	SUV1	Puerto Rico	2.9	2.9	3.0	3.1	3.1	3.1	3.1	3.1	3.1	3.1
P1	SUV1	Other LHD	20.2	22.9	22.6	23.0	23.4	23.4	23.4	23.4	23.4	23.4
P1	SUV1	Other RHD	17.4	17.2	17.5	17.9	18.3	18.3	18.3	18.3	18.3	18.3

Table 22: Individual Platform Customer Demand ('000)

			2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
P2	PU1	USA	258.5	278.5	290.5	290.5	267.4	267.4	267.4	267.4	267.4	267.4
P2	PU1	Canada	6.3	6.8	6.8	6.9	6.9	6.9	6.9	6.9	6.9	6.9
P2	PU1	Mexico	11.9	13.5	15.0	17.1	18.8	18.8	18.8	18.8	18.8	18.8
P2	PU1	PuertoRico	3.3	3.4	3.4	3.5	3.5	3.5	3.5	3.5	3.5	3.5
P2	PU2	Chile	7.7	8.7	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5
P2	PU2	Brazil	25.1	25.4	26.7	27.5	28.5	28.5	28.5	28.5	28.5	28.5
P2	PU2	GCC	6.1	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6
P2	PU2	Argentina	6.6	6.9	7.2	7.5	7.8	7.8	7.8	7.8	7.8	7.8
P2	PU2	Israel	1.2	1.3	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.5
P2	PU2	Other M. E.	3.1	3.5	3.7	3.7	3.8	3.8	3.8	3.8	3.8	3.8
P2	PU2	South Am. KD's	8.4	8.5	8.7	9.0	9.2	9.2	9.2	9.2	9.2	9.2
P2	PU2	Other Lat. Am.	5.1	5.5	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8
P3	PU3	Thailand	31.8	31.3	30.8	30.8	30.8	30.8	30.8	30.8	30.8	30.8
P3	PU3	Other Asia-Pacific	1.4	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.4
P3	PU3	Australia	6.1	6.1	5.8	5.5	7.8	7.8	7.8	7.8	7.8	7.8
P3	PU3	New Zealand	1.3	1.3	1.3	1.3	1.5	1.5	1.5	1.5	1.5	1.5
P3	PU3	FSU	5.0	5.0	6.0	6.0	6.0	6.0	7.0	7.0	7.0	7.0
P3	PU3	Other CIS/Baltic	0.5	0.8	1.2	1.3	1.4	1.4	1.4	1.4	1.4	1.4
P3	PU3	Africa	3.2	3.4	3.8	3.9	4.1	4.1	4.1	4.1	4.1	4.1
P3	PU3	Denmark	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3
P3	PU3	Germany	2.0	2.0	2.0	1.9	1.5	1.5	1.5	1.5	1.5	1.5
P3	PU3	Turkey	1.5	1.6	1.7	1.8	1.9	1.9	1.9	1.9	1.9	1.9
P3	PU3	Norway/Sweden/Finland	0.4	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4
P3	PU3	UK	3.1	3.0	3.0	3.0	2.1	2.1	2.1	2.1	2.1	2.1
P3	PU3	Austria	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
P3	PU3	Greece	1.0	1.1	1.1	1.2	1.1	1.1	1.1	1.1	1.1	1.1
P3	PU3	Portugal	1.1	1.0	1.0	0.9	0.7	0.7	0.7	0.7	0.7	0.7
P3	PU3	Other Europe	0.3	0.4	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7
P3	PU3	ROW KD's	12.1	13.2	9.8	9.8	9.9	9.9	9.9	9.9	9.9	9.9
P4	N1	Canada	4.7	4.7	4.7	4.7	4.8	4.8	4.8	4.8	4.8	4.8
P4	N1	USA	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
P1	SUV1	GCC	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
P1	SUV1	Other L.Am.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P1	SUV1	Canada	14.2	14.9	15.0	15.0	15.4	15.4	15.4	15.4	15.4	15.4
P1	SUV1	Mexico	3.4	3.9	4.2	4.8	5.3	5.3	5.3	5.3	5.3	5.3
P1	SUV1	USA	370.0	393.0	396.0	385.0	388.0	388.0	388.0	388.0	388.0	388.0
P1	SUV1	Puerto Rico	2.9	2.9	3.0	3.1	3.1	3.1	3.1	3.1	3.1	3.1
P1	SUV1	Other LHD	22.2	22.9	22.6	23.0	23.4	23.4	23.4	23.4	23.4	23.4
P1	SUV1	Other RHD	17.4	17.2	17.5	17.9	18.3	18.3	18.3	18.3	18.3	18.3

Table 23: Global Pickup Platform Customer Demand ('000)

			2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
P2	PU1	USA	258.5	278.5	290.5	290.5	267.4	267.4	267.4	267.4	267.4	267.4
P2	PU1	Canada	6.3	6.8	6.8	6.9	6.9	6.9	6.9	6.9	6.9	6.9
P2	PU1	Mexico	11.9	13.5	15.0	17.1	18.8	18.8	18.8	18.8	18.8	18.8
P2	PU1	PuertoRico	3.3	3.4	3.4	3.5	3.5	3.5	3.5	3.5	3.5	3.5
P4	N1	Canada	4.7	4.7	4.7	4.7	4.8	4.8	4.8	4.8	4.8	4.8
P4	N1	USA	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
P1	SUV1	GCC	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
P1	SUV1	Other L.Am.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P1	SUV1	Canada	14.2	14.9	15.0	15.0	15.4	15.4	15.4	15.4	15.4	15.4
P1	SUV1	Mexico	3.4	3.9	4.2	4.8	5.3	5.3	5.3	5.3	5.3	5.3
P1	SUV1	USA	370.0	393.0	396.0	385.0	388.0	388.0	388.0	388.0	388.0	388.0
P1	SUV1	Puerto Rico	2.9	2.9	3.0	3.1	3.1	3.1	3.1	3.1	3.1	3.1
P1	SUV1	Other LHD	20.2	22.9	22.6	23.0	23.4	23.4	23.4	23.4	23.4	23.4
P1	SUV1	Other RHD	17.4	17.2	17.5	17.9	18.3	18.3	18.3	18.3	18.3	18.3
P2	PU2	Chile	7.7	8.7	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5
P2	PU2	Brazil	25.1	25.4	26.7	27.5	28.5	28.5	28.5	28.5	28.5	28.5
P2	PU2	GCC	6.1	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6
P2	PU2	Argentina	6.6	6.9	7.2	7.5	7.8	7.8	7.8	7.8	7.8	7.8
P2	PU2	Israel	1.2	1.3	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.5
P2	PU2	Other M. E.	3.1	3.5	3.7	3.7	3.8	3.8	3.8	3.8	3.8	3.8
P2	PU2	South Am. KD's	8.4	8.5	8.7	9.0	9.2	9.2	9.2	9.2	9.2	9.2
P2	PU2	Other Lat. Am.	5.1	5.5	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8
P3	PU3	Thailand	31.8	31.3	30.8	30.8	30.8	30.8	30.8	30.8	30.8	30.8
P3	PU3	Other Asia-Pacific	1.4	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.4
P3	PU3	Australia	6.1	6.1	5.8	5.5	7.8	7.8	7.8	7.8	7.8	7.8
P3	PU3	New Zealand	1.3	1.3	1.3	1.3	1.5	1.5	1.5	1.5	1.5	1.5
P3	PU3	FSU	5.0	5.0	6.0	6.0	6.0	6.0	7.0	7.0	7.0	7.0
P3	PU3	Other CIS/Baltic	0.5	0.8	1.2	1.3	1.4	1.4	1.4	1.4	1.4	1.4
P3	PU3	Africa	3.2	3.4	3.8	3.9	4.1	4.1	4.1	4.1	4.1	4.1
P3	PU3	Denmark	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3
P3	PU3	Germany	2.0	2.0	2.0	1.9	1.5	1.5	1.5	1.5	1.5	1.5
P3	PU3	Turkey	1.5	1.6	1.7	1.8	1.9	1.9	1.9	1.9	1.9	1.9
P3	PU3	Norway/Sweden/Finland	0.4	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4
P3	PU3	UK	3.1	3.0	3.0	3.0	2.1	2.1	2.1	2.1	2.1	2.1
P3	PU3	Austria	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
P3	PU3	Greece	1.0	1.1	1.1	1.2	1.1	1.1	1.1	1.1	1.1	1.1
P3	PU3	Portugal	1.1	1.0	1.0	0.9	0.7	0.7	0.7	0.7	0.7	0.7
P3	PU3	Other Europe	0.3	0.4	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7
P3	PU3	ROW KD's	12.1	13.2	9.8	9.8	9.9	9.9	9.9	9.9	9.9	9.9

Table 24: North American Truck Annual Customer Demand ('000)

Step 3 - Analyze Platform Scenarios

Simulation

In this study, simulation is used to select values for manufacturing capacity, production cost, transportation cost, sale price, and customer demand.

Linear Program Modeling

Figure 44 - Figure 46 are graphical representations of the linear program models developed for the individual, global pickup and North American truck platform strategies. All platform scenario data is input on a yearly basis[13]. Platform operating results are simulated for each set of input factors started in Year 2001 through Year 2010. Year 2001 through 2010 represent 10 years of platform operation.

Table 25 - Table 27 collect linear program output for each of the three platform strategies. The linear programming output tables record the expected sales, revenue and variable cost (production and transportation) for each platform along with expected plant utilization and lost sales. If lost sales are expected, it is due to the fact that total customer demand for the product is at times greater than the manufacturing capacity.

[13] The data displayed in Figure 44 - Figure 46 correspond to Year 1 or 2001

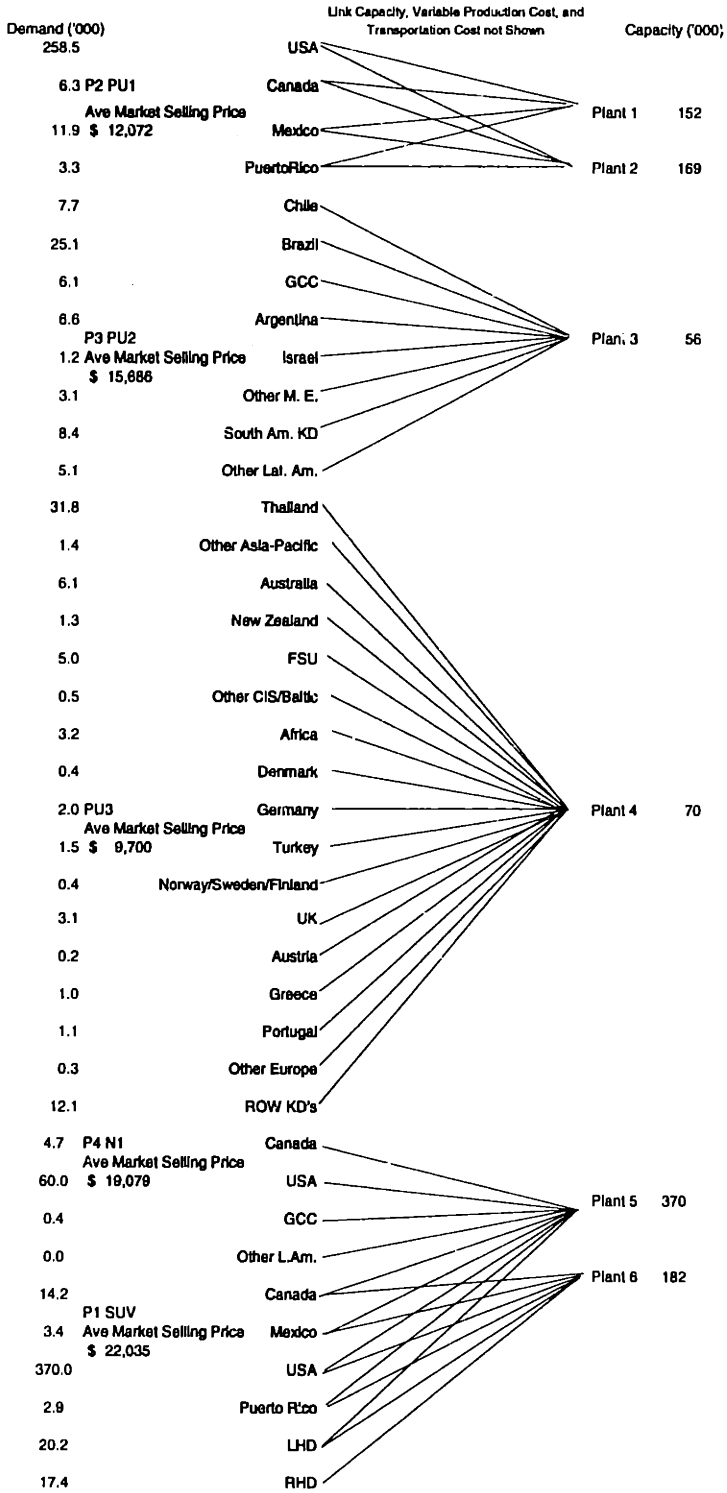


Figure 44: Individual Platform Linear Program Model

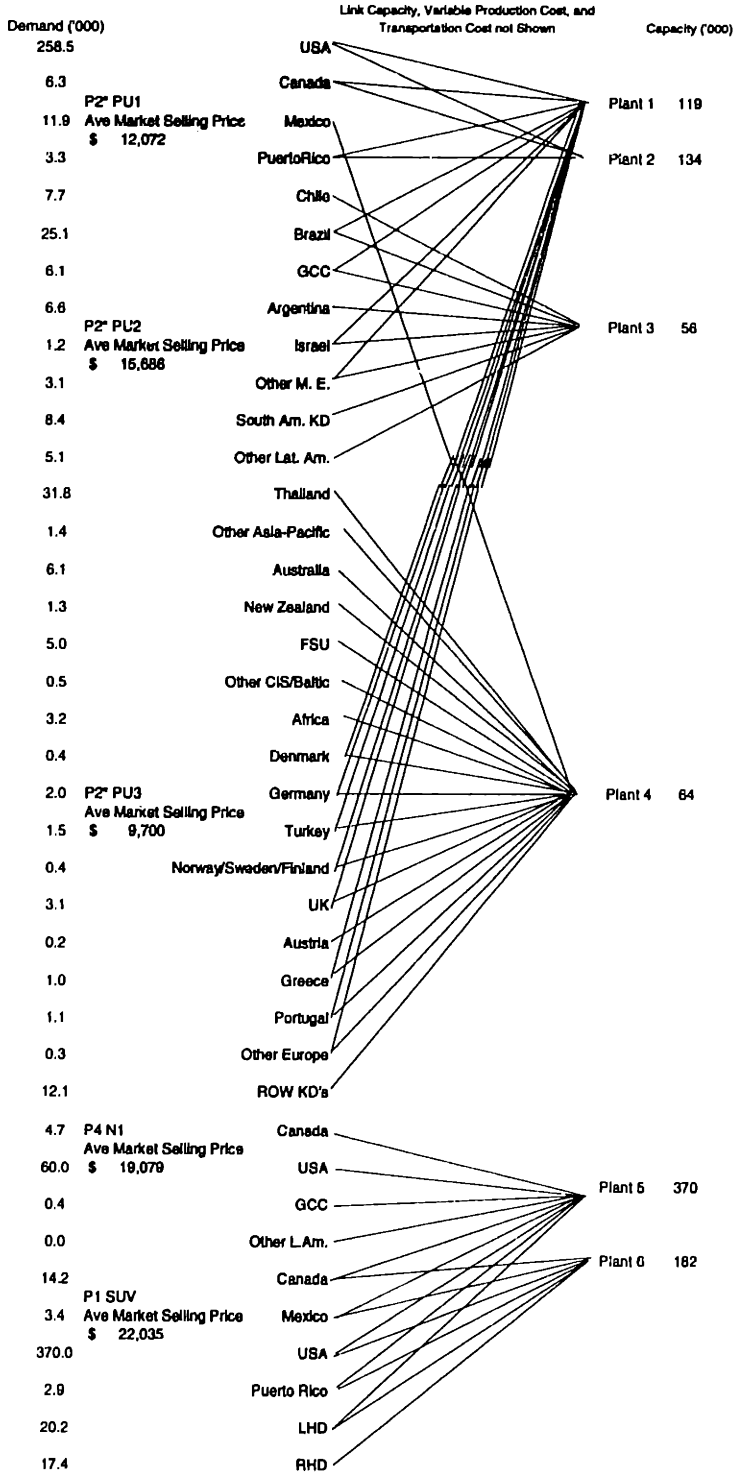


Figure 45: Global Pickup Platform Linear Program Model

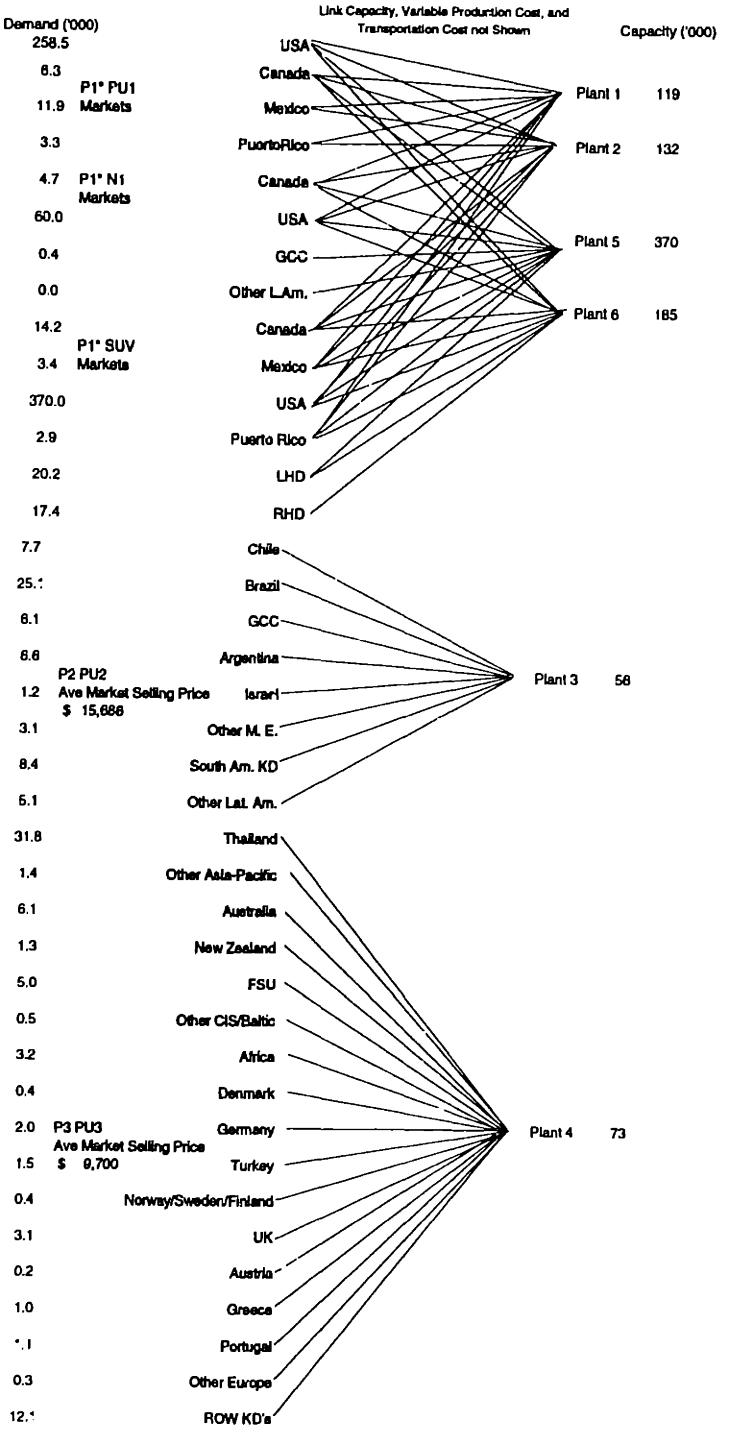


Figure 46: North American Truck Platform Linear Program Model

EXPECTED LOST SALES ('000)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
"USA"	0.00	0.00	0.56	0.93	0.00	0.00	0.00	0.00	0.00	0.00
"Canada"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Mexico"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"PuertoRico"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Chile"	0.25	1.16	3.41	4.64	6.29	6.18	6.18	6.18	6.18	6.18
"Brazil"	0.00	0.00	0.00	0.02	0.17	0.16	0.16	0.16	0.16	0.16
"GCC"	4.22	5.96	6.33	6.39	6.40	6.37	6.37	6.37	6.37	6.37
"Argentina"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Israel"	0.33	0.80	1.24	1.31	1.38	1.39	1.39	1.39	1.39	1.39
"Other M. E."	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"South Am. KD"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Other Lat. Am."	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Thailand"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Other Asia-Pacific"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Australia"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"New Zealand"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"FSU"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Other CIS/Baltic"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Africa"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Denmark"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Germany"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Turkey"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Norway/Sweden/Fin	0.03	0.06	0.01	0.01	0.03	0.03	0.03	0.03	0.03	0.03
"UK"	0.05	0.15	0.01	0.01	0.04	0.05	0.05	0.05	0.05	0.05
"Austria"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Greece"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Portugal"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Other Europe"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"ROW KD's"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Canada"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"USA"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"USA"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"GCC"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Other L.AM"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Canada"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Mexico"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"USA"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"PuertoRico"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Other LHD"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Other RHD"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL:	**4.88**	**8.13**	**11.55**	**13.31**	**14.31**	**14.18**	**14.18**	**14.18**	**14.18**	**14.18**
EXPECTED PLANT UTILIZATION										
Plant 1	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Plant 2	63%	75%	82%	83%	72%	73%	73%	73%	73%	73%
Plant 3	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Plant 4	94%	96%	93%	93%	95%	94%	94%	94%	94%	94%
Plant 5	74%	81%	82%	79%	81%	81%	81%	81%	81%	81%
Plant 6	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
AVERAGE:	**84%**	**88%**	**90%**	**89%**	**88%**	**88%**	**88%**	**88%**	**88%**	**88%**
EXPECTED OPERATING RESULTS										
Total Sales ('000)	869	916	932	925	911	911	911	911	911	911
Total Revenue (MILS)	15275	16098	16318	16139	16016	16025	16025	16025	16025	16025
Total Cost (MILS)	9334	9830	9967	9865	9778	9784	9784	9784	9784	9784

Table 25: Individual Platform Linear Program Output

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
EXPECTED LOST SALES ('000)										
"USA"	19.08	0.86	2.77	2.65	0.19	0.19	0.27	0.18	0.18	0.18
"Canada"	2.46	0.07	0.42	0.46	0.01	0.03	0.03	0.00	0.00	0.00
"Mexico"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"PuertoRico"	1.06	0.03	0.22	0.25	0.01	0.02	0.01	0.01	0.01	0.01
"Chile"	0.17	0.01	0.01	0.00	0.14	0.00	0.03	0.00	0.00	0.00
"Brazil"	2.45	0.60	1.77	2.03	2.65	0.81	0.80	0.95	0.95	0.95
"GCC"	0.47	0.39	1.14	1.26	0.39	0.29	0.39	0.31	0.31	0.31
"Argentina"	1.37	0.29	0.47	0.30	0.07	0.04	0.05	0.00	0.00	0.00
"Israel"	0.04	0.01	0.01	0.01	0.05	0.01	0.01	0.01	0.01	0.01
"Other M. E."	1.56	0.33	0.37	0.46	0.40	0.25	0.24	0.23	0.23	0.23
"South Am. KD"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Other Lat. Am."	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Thailand"	7.86	1.30	1.44	2.32	2.45	1.54	1.84	2.03	2.03	2.03
"Other Asia-Pacific"	1.19	0.21	0.30	0.37	0.34	0.22	0.23	0.24	0.24	0.24
"Australia"	3.75	0.64	1.31	1.43	1.70	1.28	1.39	1.14	1.14	1.14
"New Zealand"	0.83	0.23	0.39	0.44	0.45	0.32	0.38	0.33	0.33	0.33
"FSU"	1.27	0.35	0.71	0.70	0.37	0.18	0.30	0.24	0.24	0.24
"Other CIS/Baltic"	0.10	0.03	0.13	0.15	0.14	0.05	0.08	0.07	0.07	0.07
"Africa"	0.77	0.11	0.05	0.05	0.24	0.06	0.12	0.12	0.12	0.12
"Denmark"	0.07	0.02	0.05	0.05	0.01	0.01	0.01	0.01	0.01	0.01
"Germany"	0.27	0.11	0.16	0.12	0.02	0.03	0.02	0.02	0.02	0.02
"Turkey"	0.18	0.04	0.06	0.04	0.02	0.02	0.01	0.02	0.02	0.02
"Norway/Sweden/Finla	0.05	0.01	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00
"UK"	0.48	0.12	0.18	0.13	0.03	0.03	0.02	0.03	0.03	0.03
"Austria"	0.05	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01
"Greece"	0.00	0.01	0.09	0.13	0.02	0.02	0.03	0.03	0.03	0.03
"Portugal"	0.80	0.14	0.15	0.19	0.12	0.08	0.08	0.09	0.09	0.09
"Other Europe"	0.27	0.08	0.19	0.25	0.15	0.11	0.12	0.12	0.12	0.12
"ROW KD's"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Canada"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"USA"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"USA"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"GCC"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Other L.AM"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Canada"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Mexico"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"USA"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"PuertoRico"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Other LHD"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Other RHD"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL:	**46.60**	**5.97**	**12.41**	**13.80**	**9.98**	**5.59**	**6.46**	**6.18**	**6.18**	**6.18**
EXPECTED PLANT UTILIZATION										
Plant 1	100%	91%	93%	94%	94%	91%	91%	90%	90%	90%
Plant 2	100%	98%	99%	100%	99%	98%	98%	98%	98%	98%
Plant 3	100%	99%	99%	100%	97%	99%	100%	99%	99%	99%
Plant 4	100%	95%	96%	96%	97%	96%	96%	96%	96%	96%
Plant 5	74%	81%	82%	79%	81%	81%	81%	81%	81%	81%
Plant 6	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
AVERAGE:	**90%**	**91%**	**92%**	**91%**	**92%**	**91%**	**91%**	**91%**	**91%**	**91%**
EXPECTED OPERATING RESULTS										
Total Sales ('000)	847	942	953	946	935	942	941	941	941	941
Total Revenue (MILS)	15050	16444	16618	16441	16362	16459	16446	16446	16446	16446
Total Cost (MILS)	8980	9871	9978	9878	9824	9893	9884	9884	9884	9884

Table 26: Global Pickup Platform Linear Program Output

	EXPECTED LOST SALES ('000)									
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
"USA"	0.27	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Canada"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Mexico"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"PuertoRico"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Canada"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"USA"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"USA"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"GCC"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Other L.AM"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Canada"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Mexico"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"USA"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"PuertoRico"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Other LHD"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Other RHD"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Chile"	7.08	8.76	8.99	9.16	9.16	9.16	9.16	9.16	9.16	0.00
"Brazil"	0.67	2.18	3.38	4.83	4.83	4.83	4.83	4.83	4.83	0.00
"GCC"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Argentina"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Israel"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Other M. E."	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Other Lat. Am."	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Thailand"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Other Asia-Pacific"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Australia"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"New Zealand"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"FSU"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Other CIS/Baltic"	0.03	0.11	0.02	0.01	0.09	0.09	0.09	0.09	0.09	0.09
"Africa"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Denmark"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Germany"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Turkey"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Norway/Sweden/Finland"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"UK"	0.04	0.08	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02
"Austria"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Greece"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Portugal"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"Other Europe"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
"ROW KD's"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL:	**5.37**	**7.94**	**10.98**	**12.38**	**14.09**	**14.09**	**14.09**	**14.09**	**14.09**	**14.09**
	EXPECTED PLANT UTILIZATION									
Plant 1	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Plant 2	58%	35%	56%	40%	34%	43%	31%	31%	31%	31%
Plant 5	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Plant 6	100%	99%	100%	100%	99%	100%	99%	99%	99%	99%
Plant 3	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Plant 4	94%	96%	93%	93%	94%	94%	94%	94%	94%	94%
AVERAGE	**93%**	**88%**	**92%**	**89%**	**88%**	**90%**	**88%**	**88%**	**88%**	**88%**
	EXPECTED OPERATING RESULTS									
Total Sales ('000)	869	918	932	925	910	910	910	910	910	910
Total Revenue (MILS)	15268	16112	16319	16151	16010	16010	16010	16010	16010	16010
Total Cost (MILS)	9104	9614	9742	9647	9548	9548	9548	9548	9548	9548

Table 27: North American Truck Platform Linear Program Output

Analysis

Table 28 - Table 30 record all platform attributes into a spreadsheet which calculates platform performance metrics. At the top of the spreadsheet, the platform investment in Engineering and Manufacturing is shown by year for each derivative product. Below investment spending are the operational performance output by the linear program model. Also, in this section of the spreadsheet is the fixed costs associated with the platform. Net cash flow is calculated and recorded at the bottom of the spreadsheet. Net Present Value (NPV) and average Return on Sale (ROS) are as shown in the tables. Figure 47 - Figure 49 graph the risk of achieving the platform performance as calculated by the spreadsheet given the uncertainty in platfc m attributes.

		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Investment														
Engineering & Launch		$ (94)	$ (241)	$ (322)	$ (84)	$ (63)	$ (102)	$ (80)	$ (167)	$ (144)	$ -	$ -	$ -	$ -
PU1	$ 238	$ (9)	$ (27)	$ (36)	$ (38)	$ (9)	$ (26)	$ (34)	$ (60)	$ -	$ -	$ -	$ -	$ -
PU2	$ 6	$ (2)	$ (3)	$ -	$ -	$ (0.10)	$ (0.30)	$ (0.40)	$ (1.20)	$ -	$ -	$ -	$ -	$ -
PU3	$ 96	$ (3)	$ (10)	$ (13)	$ (25)	$ (3)	$ (9)	$ (12)	$ (21)	$ -	$ -	$ -	$ -	$ -
SUV1	$ 845	$ (70)	$ (174)	$ (238)	$ (15)	$ (39)	$ (46)	$ (34)	$ (85)	$ (144)	$ -	$ -	$ -	$ -
N1	$ 112	$ (11)	$ (28)	$ (35)	$ (5)	$ (13)	$ (21)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Plant	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Equipment	$ -	$ (126)	$ (373)	$ (1,053)	$ (92)	$ (80)	$ (256)	$ (335)	$ (204)	$ (381)	$ -	$ -	$ -	$ -
PU1	$ 618	$ (6)	$ (54)	$ (214)	$ (45)	$ (6)	$ (51)	$ (199)	$ (42)	$ -	$ -	$ -	$ -	$ -
PU2	$ 20	$ (2)	$ (6)	$ -	$ -	$ (0)	$ (2)	$ (7)	$ (1)	$ -	$ -	$ -	$ -	$ -
PU3	$ 237	$ (3)	$ (23)	$ (89)	$ (19)	$ (2)	$ (18)	$ (70)	$ (15)	$ -	$ -	$ -	$ -	$ -
SUV1	$ 1,751	$ (97)	$ (241)	$ (627)	$ (20)	$ (50)	$ (130)	$ (59)	$ (146)	$ (381)	$ -	$ -	$ -	$ -
N1	$ 275	$ (19)	$ (47)	$ (123)	$ (9)	$ (22)	$ (55)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Tot Invest Adj for Inflation		$ (221)	$ (626)	$ (1,439)	$ (188)	$ (155)	$ (401)	$ (476)	$ (435)	$ -	$ -	$ -	$ -	$ -
Operational Performance														
Average Plant Utilization					83.82%	86.35%	89.83%	89.21%	87.79%	87.84%	87.84%	87.84%	87.84%	87.84%
Total Sales ('000)					868	916	932	925	911	911	911	911	911	911
Lost Sales					4882	8130	11550	13313	14312	14184	14184	14184	14184	14184
Sales Revenues (Mils)		$ -	$ -	$ -	$ 15,275	$ 16,098	$ 16,318	$ 16,139	$ 16,016	$ 16,025	$ 16,025	$ 16,025	$ 16,025	$ 16,025
Total Variable Costs (Mils)		$ -	$ -	$ -	$ (9,334)	$ (9,830)	$ (9,957)	$ (9,865)	$ (9,778)	$ (9,784)	$ (9,784)	$ (9,784)	$ (9,784)	$ (9,784)
Other Fixed Costs (Mils)		$ -	$ -	$ -	$ (1,908)	$ (1,908)	$ (1,908)	$ (1,908)	$ (1,908)	$ (1,908)	$ (1,908)	$ (1,908)	$ (1,908)	$ (1,908)
Profits Before Tax		$ -	$ -	$ -	$ 4,033	$ 4,360	$ 4,443	$ 4,366	$ 4,330	$ 4,333	$ 4,333	$ 4,333	$ 4,333	$ 4,333
Adjustment for Inflation		$ -	$ -	$ -	$ 4,317	$ 4,775	$ 4,978	$ 5,004	$ 5,077	$ 5,197	$ 5,317	$ 5,439	$ 5,564	$ 5,692
Depreciation (Mils)														
Plant	10	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Equipment (Total)	10	$ -	$ -	$ -	$ (149)	$ (204)	$ (68)	$ (32)	$ (136)	$ (186)	$ (62)	$ (29)	$ -	$ -
Earnings Before Taxes		$ -	$ -	$ -	$ 4,168	$ 4,571	$ 4,910	$ 4,972	$ 4,941	$ 5,012	$ 5,255	$ 5,410	$ 5,564	$ 5,692
Rate =	40%													
Taxes		$ -	$ -	$ -	$ 1,667	$ 1,829	$ 1,964	$ 1,989	$ 1,976	$ 2,005	$ 2,102	$ 2,164	$ 2,226	$ 2,277
Earnings After Tax		$ -	$ -	$ -	$ 2,501	$ 2,743	$ 2,946	$ 2,983	$ 2,964	$ 3,007	$ 3,153	$ 3,246	$ 3,338	$ 3,415
Add Depreciation		$ -	$ -	$ -	$ 149	$ 204	$ 68	$ 32	$ 136	$ 186	$ 62	$ 29	$ -	$ -
Operating Cash Flow		$ -	$ -	$ -	$ 2,650	$ 2,946	$ 3,014	$ 3,015	$ 3,101	$ 3,193	$ 3,215	$ 3,275	$ 3,338	$ 3,415
Net Cash Flows		$ (221)	$ (626)	$ (1,439)	$ 2,462	$ 2,790	$ 2,613	$ 2,539	$ 2,666	$ 3,193	$ 3,215	$ 3,275	$ 3,338	$ 3,415
Inflation Factor, Rate=	2.3%	1.0000	1.0230	1.0465	1.0706	1.0952	1.1204	1.1462	1.1725	1.1995	1.2271	1.2553	1.2842	1.3137
NPV	$ 11,429													
Cost of Capital	10.0%													
Pre-Tax ROS	25.8%	-	-	-	25.25%	26.20%	25.03%	24.48%	24.72%	23.76%	27.04%	27.04%	27.04%	27.04%

Table 28: Individual Platform Financial Analysis Spreadsheet

		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Investment														
Engineering & Launch		$ (104)	$ (268)	$ (359)	$ (118)	$ (58)	$ (85)	$ (58)	$ (141)	$ (144)	$ -	$ -	$ -	$ -
PU1	$ 293	$ (18)	$ (54)	$ (72)	$ (76)	$ (4)	$ (12)	$ (16)	$ (41)	$ -	$ -	$ -	$ -	$ -
PU2	$ 6	$ (2)	$ (2)	$ -	$ -	$ (0.10)	$ (0.30)	$ (0.40)	$ (1.20)	$ -	$ -	$ -	$ -	$ -
PU3	$ 79	$ (3)	$ (10)	$ (14)	$ (22)	$ (2)	$ (6)	$ (8)	$ (14)	$ -	$ -	$ -	$ -	$ -
SUV1	$ 845	$ (70)	$ (174)	$ (236)	$ (15)	$ (39)	$ (46)	$ (34)	$ (85)	$ (144)	$ -	$ -	$ -	$ -
N1	$ 112	$ (11)	$ (28)	$ (35)	$ (5)	$ (13)	$ (21)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Plant	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Equipment	$ -	$ (133)	$ (426)	$ (1,263)	$ (136)	$ (78)	$ (239)	$ (267)	$ (190)	$ (381)	$ -	$ -	$ -	$ -
PU1	$ 778	$ (13)	$ (109)	$ (429)	$ (90)	$ (3)	$ (23)	$ (92)	$ (19)	$ -	$ -	$ -	$ -	$ -
PU2	$ 100	$ (2)	$ (8)	$ -	$ -	$ (2)	$ (15)	$ (60)	$ (13)	$ -	$ -	$ -	$ -	$ -
PU3	$ 208	$ (3)	$ (21)	$ (84)	$ (18)	$ (2)	$ (14)	$ (56)	$ (12)	$ -	$ -	$ -	$ -	$ -
SUV1	$ 1,751	$ (97)	$ (241)	$ (627)	$ (20)	$ (50)	$ (130)	$ (59)	$ (146)	$ (381)	$ -	$ -	$ -	$ -
N1	$ 275	$ (19)	$ (47)	$ (123)	$ (9)	$ (22)	$ (58)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Tot Invest Adj. for Inflation		$ (236)	$ (710)	$ (1,697)	$ (272)	$ (148)	$ (369)	$ (373)	$ (388)	$ -	$ -	$ -	$ -	$ -
Operational Performance														
Average Plant Utilization					90.24%	91.01%	92.09%	91.14%	91.59%	91.02%	90.91%	90.84%	90.84%	90.84%
Total Sales ('000)					847	942	953	946	935	942	941	941	941	941
Lost Sales					4803	5973	12407	13801	9985	5589	6455	6178	6178	6173
Sales Revenues (Mils)		$ -	$ -	$ -	$ 15,050	$ 16,444	$ 16,618	$ 16,441	$ 16,362	$ 16,459	$ 16,446	$ 16,446	$ 16,446	$ 16,446
Total Variable Costs (Mils)		$ -	$ -	$ -	$ (8,990)	$ (9,871)	$ (9,978)	$ (9,878)	$ (9,824)	$ (9,893)	$ (9,884)	$ (9,884)	$ (9,884)	$ (9,884)
Total Fixed Costs (Mils)		$ -	$ -	$ -	$ (1,863)	$ (1,863)	$ (1,863)	$ (1,863)	$ (1,863)	$ (1,863)	$ (1,863)	$ (1,863)	$ (1,863)	$ (1,863)
Profits Before Tax		$ -	$ -	$ -	$ 4,207	$ 4,710	$ 4,777	$ 4,700	$ 4,675	$ 4,703	$ 4,699	$ 4,699	$ 4,699	$ 4,699
Adjustment for Inflation		$ -	$ -	$ -	$ 4,504	$ 5,158	$ 3,352	$ 5,387	$ 5,482	$ 5,641	$ 5,766	$ 5,899	$ 6,034	$ 6,173
Depreciation														
Plant	10	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Equipment (Total)	10	$ -	$ -	$ -	$ (252)	$ (344)	$ (115)	$ (54)	$ (102)	$ (140)	$ (47)	$ (22)	$ -	$ -
Earnings before Taxes		$ -	$ -	$ -	$ 4,251	$ 4,814	$ 5,237	$ 5,333	$ 5,379	$ 5,501	$ 5,719	$ 5,877	$ 6,034	$ 6,173
Rate =	40%													
Taxes		$ -	$ -	$ -	$ 1,701	$ 1,926	$ 2,095	$ 2,133	$ 2,152	$ 2,201	$ 2,288	$ 2,351	$ 2,414	$ 2,469
Earnings After Tax		$ -	$ -	$ -	$ 2,551	$ 2,888	$ 3,142	$ 3,200	$ 3,227	$ 3,301	$ 3,432	$ 3,526	$ 3,621	$ 3,704
Add Depreciation		$ -	$ -	$ -	$ 252	$ 344	$ 115	$ 54	$ 102	$ 140	$ 47	$ 22	$ -	$ -
Operating Cash Flow		$ -	$ -	$ -	$ 2,803	$ 3,233	$ 3,257	$ 3,254	$ 3,330	$ 3,441	$ 3,478	$ 3,548	$ 3,621	$ 3,704
Net Cash Flows		$ (236)	$ (710)	$ (1,697)	$ 2,532	$ 3,085	$ 2,894	$ 2,881	$ 2,942	$ 3,441	$ 3,478	$ 3,548	$ 3,621	$ 3,704
Inflation Factor, Rate=	2.3%	1.0000	1.0230	1.0465	1.0706	1.0952	1.1204	1.1462	1.1725	1.1995	1.2271	1.2553	1.2842	1.3137
NPV	$12,533													
Cost of Capital	10.0%													
Pre-Tax ROS	27.37%	-	-	-	26.27%	27.82%	26.80%	26.61%	26.55%	25.39%	28.57%	28.57%	28.57%	28.57%

Table 29: Global Pickup Platform Financial Analysis Spreadsheet

		Year 1998	Year 1999	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010
Investment														
Engineering & Launch		$ (109)	$ (280)	$ (324)	$ (119)	$ (52)	$ (77)	$ (62)	$ (148)	$ (144)	$ -	$ -	$ -	$ -
PU1	$ 293	$ (18)	$ (54)	$ (72)	$ (76)	$ (4)	$ (12)	$ (16)	$ (41)	$ -	$ -	$ -	$ -	$ -
PU2	$ 6	$ (2)	$ (2)	$ -	$ -	$ (0.10)	$ (0.30)	$ (0.40)	$ (1.20)	$ -	$ -	$ -	$ -	$ -
PU3	$ 98	$ (3)	$ (10)	$ (13)	$ (25)	$ (3)	$ (9)	$ (12)	$ (21)	$ -	$ -	$ -	$ -	$ -
SUV1	$ 865	$ (70)	$ (174)	$ (238)	$ (15)	$ (39)	$ (46)	$ (34)	$ (85)	$ (144)	$ -	$ -	$ -	$ -
NT	$ 128	$ (16)	$ (40)	$ (51)	$ (3)	$ (7)	$ (10)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Plant	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Equipment	$ -	$ (142)	$ (460)	$ (1,326)	$ (133)	$ (67)	$ (203)	$ (228)	$ (182)	$ (381)	$ -	$ -	$ -	$ -
PU1	$ 778	$ (13)	$ (109)	$ (429)	$ (90)	$ (3)	$ (23)	$ (92)	$ (19)	$ -	$ -	$ -	$ -	$ -
PU2	$ 20	$ (2)	$ (6)	$ -	$ -	$ (0)	$ (2)	$ (7)	$ (1)	$ -	$ -	$ -	$ -	$ -
PU3	$ 237	$ (3)	$ (23)	$ (69)	$ (19)	$ (2)	$ (18)	$ (70)	$ (15)	$ -	$ -	$ -	$ -	$ -
SUV1	$ 1,751	$ (97)	$ (241)	$ (627)	$ (20)	$ (50)	$ (130)	$ (59)	$ (146)	$ (381)	$ -	$ -	$ -	$ -
NT	$ 325	$ (28)	$ (70)	$ (181)	$ (5)	$ (12)	$ (30)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Tot Invest Adj for Inflation		$ (250)	$ (746)	$ (1,779)	$ (270)	$ (130)	$ (314)	$ (333)	$ (386)	$ -	$ -	$ -	$ -	$ -
Operational Performance														
Average Plant Utilization					93.35%	88.45%	91.86%	89.20%	88.40%	89.79%	87.79%	87.79%	87.79%	87.79%
Total Sales ('000)		0	0	0	869	918	992	925	910	910	910	910	910	910
Lost Sales					5372	7943	10881	12380	14091	14091	14091	14091	14091	14091
Sales Revenues (Mils)		$ -	$ -	$ -	$ 15,289	$ 16,112	$ 16,319	$ 16,151	$ 16,010	$ 16,010	$ 16,010	$ 16,010	$ 16,010	$ 16,010
Total Variable Costs (Mils)		$ -	$ -	$ -	$ (9,051)	$ (9,571)	$ (9,689)	$ (9,604)	$ (9,505)	$ (9,505)	$ (9,505)	$ (9,505)	$ (9,505)	$ (9,505)
Total Fixed Costs (Mils)		$ -	$ -	$ -	$ (1,899)	$ (1,899)	$ (1,899)	$ (1,828)	$ (1,828)	$ (1,828)	$ (1,828)	$ (1,828)	$ (1,828)	$ (1,828)
Profits Before Tax		$ -	$ -	$ -	$ 4,339	$ 4,713	$ 4,792	$ 4,719	$ 4,677	$ 4,677	$ 4,677	$ 4,677	$ 4,677	$ 4,677
Adjustment for Inflation		$ -	$ -	$ -	$ 4,688	$ 5,162	$ 5,389	$ 5,409	$ 5,484	$ 5,610	$ 5,739	$ 5,871	$ 6,006	$ 6,145
Depreciation														
Plant		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Equipment (Total)		$ -	$ -	$ (381)	$ (825)	$ (317)	$ (223)	$ (151)	$ (141)	$ (347)	$ (308)	$ (109)	$ (41)	$ -
Earnings Before Taxes		$ -	$ -	$ (381)	$ 4,063	$ 4,845	$ 5,146	$ 5,258	$ 5,343	$ 5,263	$ 5,431	$ 5,763	$ 5,965	$ 6,145
Rate =	40%													
Taxes		$ -	$ -	$ -	$ 1,625	$ 1,938	$ 2,058	$ 2,103	$ 2,137	$ 2,105	$ 2,173	$ 2,305	$ 2,386	$ 2,458
Earnings After Tax		$ -	$ -	$ (381)	$ 2,438	$ 2,907	$ 3,088	$ 3,155	$ 3,206	$ 3,158	$ 3,259	$ 3,458	$ 3,579	$ 3,687
Add Depreciation		$ -	$ -	$ 381	$ 825	$ 317	$ 223	$ 151	$ 141	$ 347	$ 308	$ 109	$ 41	$ -
Operating Cash Flow		$ -	$ -	$ -	$ 3,263	$ 3,224	$ 3,311	$ 3,306	$ 3,347	$ 3,505	$ 3,567	$ 3,566	$ 3,620	$ 3,687
Net Cash Flows		$ (250)	$ (746)	$ (1,779)	$ 2,793	$ 3,094	$ 2,997	$ 2,973	$ 2,961	$ 3,505	$ 3,567	$ 3,566	$ 3,620	$ 3,687
Inflation Factor, Rate=	2.3%	1.0000	1.0230	1.0465	1.0706	1.0952	1.1204	1.1462	1.1725	1.1995	1.2271	1.2553	1.2842	1.3137
NPV	$12,580													
Cost of Capital	10.0%													
Pre-Tax ROS	28.05%	-	-	-	27.09%	28.52%	27.65%	27.42%	27.16%	25.94%	29.21%	29.21%	29.21%	29.21%

Table 30: North American Truck Platform Financial Analysis Spreadsheet

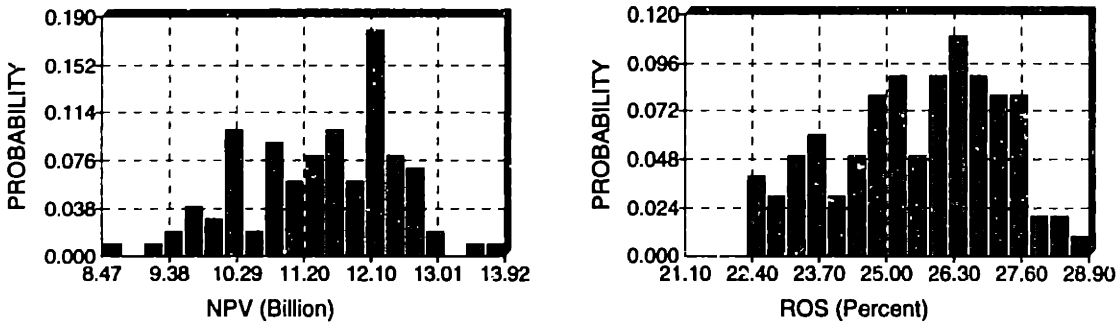


Figure 47: Individual Platform NPV and ROS Distribution

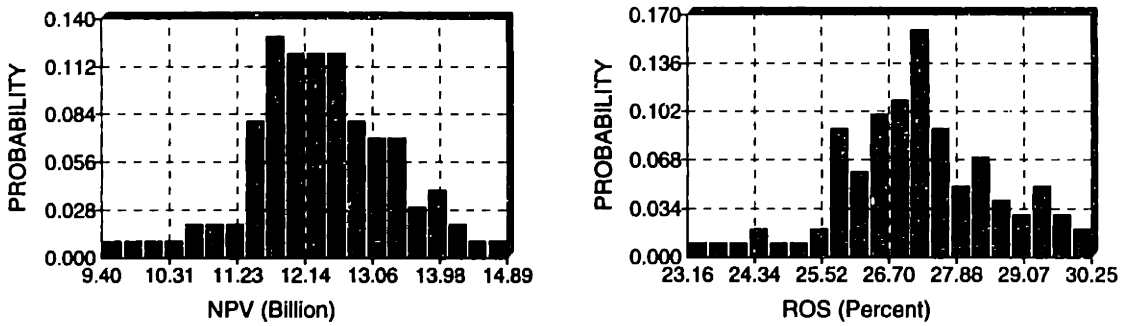


Figure 48: Global Pickup Platform NPV and ROS Distribution

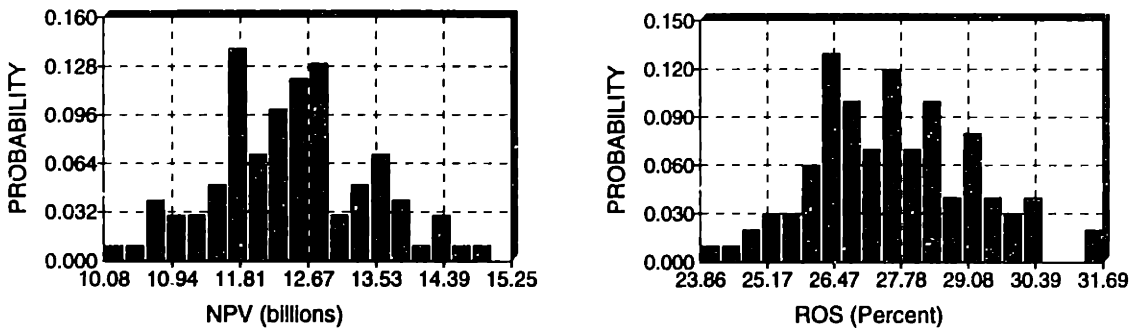


Figure 49: North American Truck Platform NPV and ROS Distribution

Step 4 - Evaluate and Compare Platform Strategies

The scenario analysis, simulation and linear programming process yields an database from which platform strategies can be evaluated and compared. Table 31 summarizes the performance metrics results. It can be seen in Table 31 that all platform strategies have a positive NPV and ROS. However, both the global pickup and North American truck have NPV's and ROS's which are higher than the individual platform strategy, with the North American platform strategies having the highest NPV and ROS.

The risk associated with each strategy is captured by the standard deviation value. Based on the strategies and scenarios evaluated, there doesn't appear to be much of a difference in platform risk. In all cases, the standard deviation is approximately 10% of the mean.

	Individual		Global Pickup		NA Truck	
	NPV	ROS	NPV	ROS	NPV	ROS
min	$8,468	21.10%	$9,396	23.16%	$10,082	23.86%
max	$13,923	28.90%	$14,893	30.25%	$15,251	31.69%
mean	$11,433	25.57%	$12,331	27.20%	$12,433	27.60%
std dev	1060	1.65%	978	1.41%	1015	1.55%

Table 31: Summary of Platform Performance Metrics

Figure 51 - Figure 55 provide an explanation for why the North American truck platform strategy has high value in terms of NPV and ROS. It can be seen from the graphs that the North American truck platform has a cost advantage. For a slightly higher investment initially (Figure 50), the North American truck platform strategy has a slightly lower average variable cost (Figure 50) and significantly lower fixed cost (Figure 54). These North American truck cost advantages throughout the analysis period yield a high NPV and ROS.

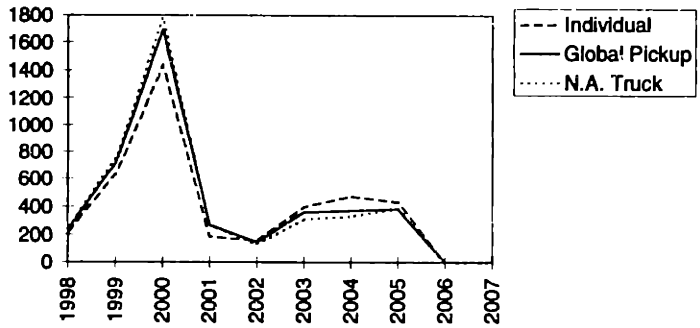


Figure 50: Engineering and Manufacturing Investment

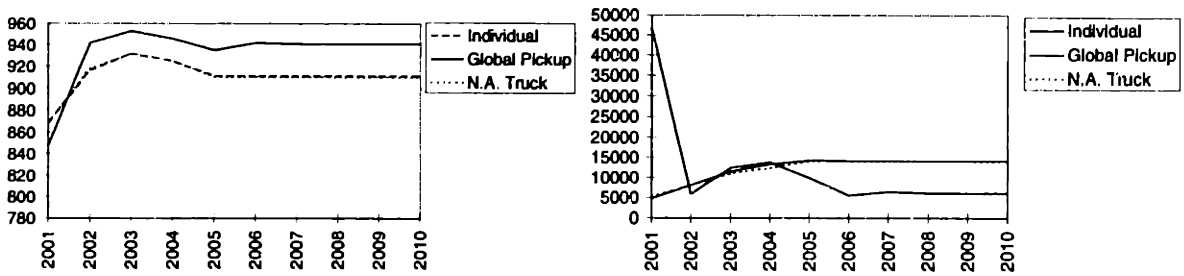


Figure 51: Expected Sales ('000) and Lost Sales

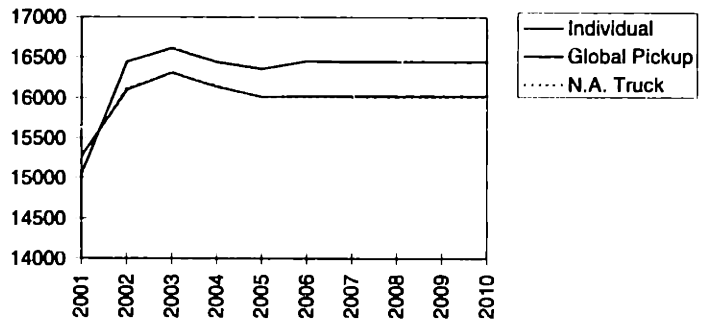


Figure 52: Expected Revenue

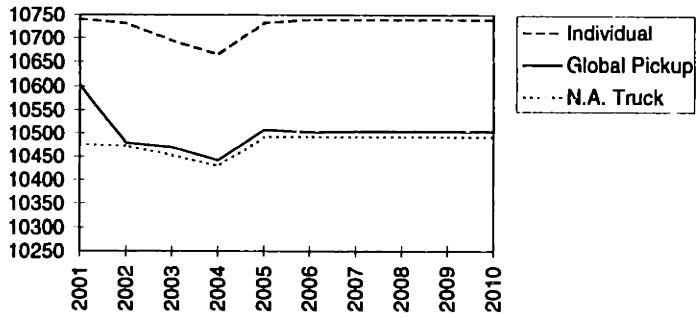


Figure 53: Average Variable Cost Per Vehicle

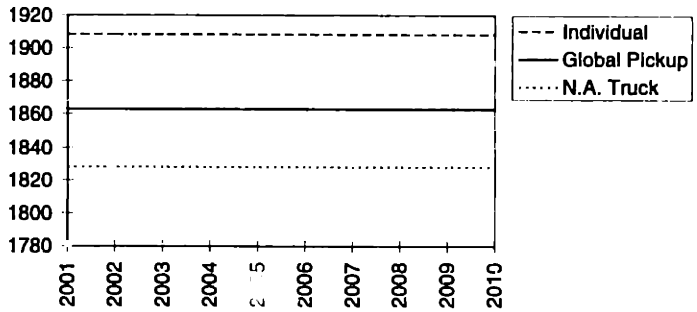


Figure 54: Fixed Cost

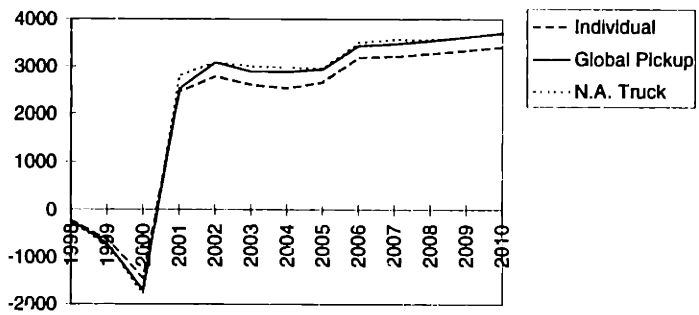


Figure 55: Net Cashflow

At this point in the platform analysis, better strategies can be identified and uncertainties in terms of scenarios and/or volatility, may be added or dropped. Additional analysis can then be performed, until the range of strategies evaluated constitutes a set of scenarios for which confidence is high and significant improvements are unlikely.

Trade-off graphs are useful for assessing many platform scenarios. The multiplicative effect of combining different strategies and plausible cost-benefit assumptions can yield a large number of scenarios. Trade-off graphs effectively communicate the cost-benefit interactions of many different platform scenarios.

An example of the use trade-off graphs is shown in Figure 56. Each plotted point corresponds to a different scenario, where the light shaded points are plotted to represent other plausible compact truck platform scenarios not included in the previous section. The scenarios closest to the optimal results for one cost-benefit implication can be traded-off against another.

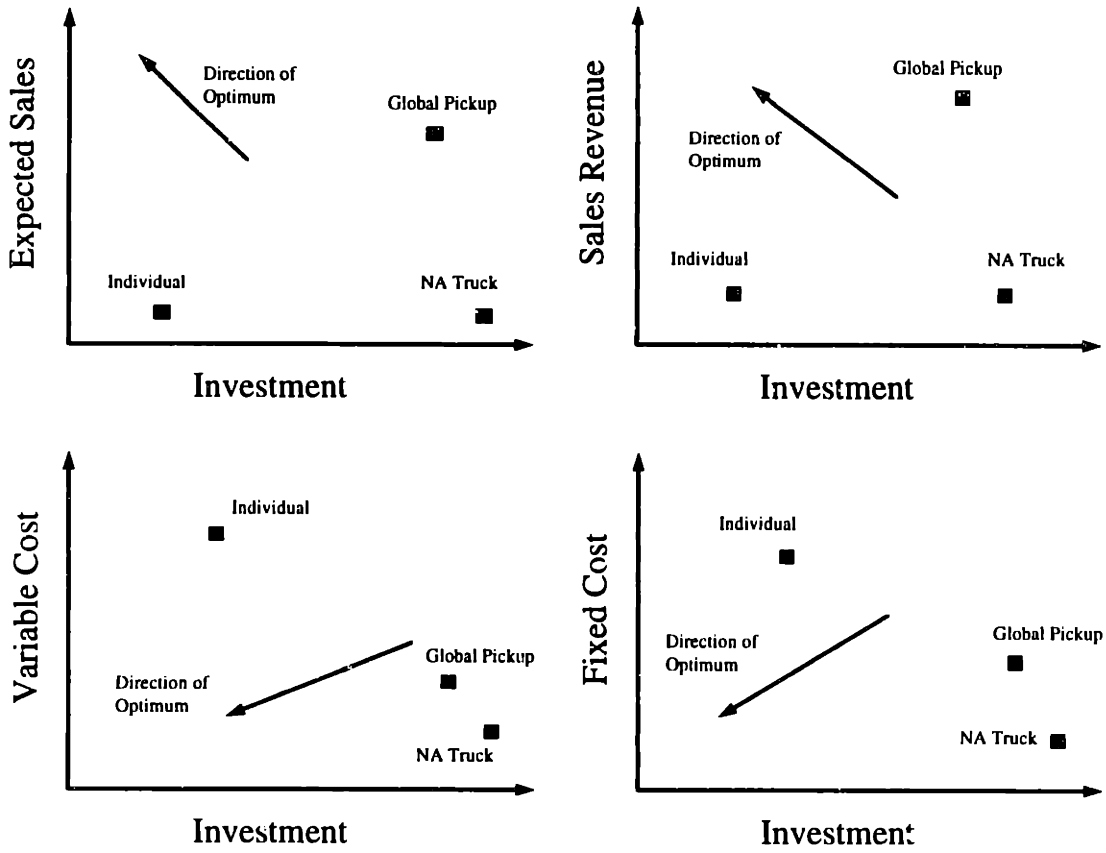


Figure 56: Cost-Benefit Trade-Off Graphs

Step 5 - Identify Preferred Platform

Once the scenario analysis process is completed, all of the important impacts associated with the choice of strategy have been identified. The risks associated with the strategy's choice, in addition to its performance have been quantified. At this time, the analysis' audience of stakeholders and decision-makers can identify a preferred strategy, or class of strategies from the population of scenarios. Fine tuning of the strategy can then commence.

5.0 CONCLUSION

The importance of this method is its ability to systematically model the complex interrelationship between cost-benefit attributes (business issues) and product platforms and to provide useful data for product platform assessment. The 5-step process has several advantages when it comes to providing quantitative information in a joint decision-making environment.

Since it begins with the identification of important performance metrics and attributes, it automatically addresses the range of concerns held by the group responsible for making product platform decisions. A clear identification of issues and attributes serves to divorce discussions of acceptable performance criteria from the platform strategy's underlying technology. This is important for politically charged areas within a company. In such areas, participants enter the discussions with firmly held views often comprised of an idealized technology which, in their qualitative opinion, represents the correct strategy.

In analyzing the performance of platform strategies, scenario analysis and simulation are used to assess platform value under uncertainty. Scenario analysis and simulation are less controversial than more traditional analysis methods which either ignore uncertainty all together or incorporate uncertainty through a single discount rate. Data analysis capability with commercially available software identifies the risk associated with strategy choice, and the range over which performance may vary. This is advantageous to approaches which look at single optimal solutions alone. Mathematical modeling of the product platform strategy using linear programming methods provides specificity when the details of one platform scenario warrant closer examination.

Although the multiplicative effect of combining all available strategies and uncertainties can yield a very large number of scenarios, the process is capable at dealing with a high level of complexity. Trade-off graphs are used to capture the cost-benefit attributes of each platform scenario of interest to stakeholders. Trade-off graphs allow the audience to perform a visual comparison of all scenarios under consideration. This accelerates

decision-making and enables a focused implementation of platform initiatives. Platform parameters which are shown to have a strong impact on performance are understood and managed carefully.

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