Title: Multiproject Strategy, Design Transfer, and Project Performance

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Abstract: Compares and contrasts four ways to implement multiproject strategies. First, new design, second, Rapid Design Transfer, Third, Sequential Design Transfer and Fourth Design Modification.

Multiproject Strategy, Design Transfer and Project Performance

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INDIVIDUAL PROJECT

MULTIPROJECT STRATEGY, DESIGN TRANSFER, AND PROJECT PERFORMANCE

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I. INTRODUCTION

The new product development is the way for the companies to innovate new product in order to accomplish customer needs, market competition, and government regulations. One of many strategies which are completed the needs of the companies to develop new product is multiproject strategy. It is planed for the purpose of leveraging the financial and engineering resource investments in new product development. Furthermore, it can categorize into four major types: new design, rapid design transfer, sequential design transfer, and design modification [10]. The first one, new design, is the strategy to create new technology and design. The other types are the design transfer strategies which are concerned with the new technology or design and the past or existing products in both the aspects of technological and organizational. The interpretation of successful transfer means "the technology has moved from research to a development laboratory and then has become a product or a part of a product or an important enhancement of a production process" [3].

In this project, it is based the characteristics of technology transfer on [10] and is compared the ideas of the study among other articles. Therefore, it can be compared in strengths and weaknesses.

II. CONCEPTS

The concept stated in this project is that the condition of each method in design of new product development. The new product can be developed by two main ideas: First, the new project which is developed without any base design and the other is the new projects which is developed with the base project. In this project, it limited the area of the new product development only in the company. Nonetheless, it also emphasizes on the impact of each new product development method in project performance, lead time and productivity. There are four types of multiproject strategy: New Design, Rapid Design Transfer, Sequential Design Transfer, and Design Modification (figure 1).

1. New Design is different from others because it does not much relative with technological or interaction with other projects in the organization while others are the variations of the design transfer strategy. The coordination cost and design constraint for this type of project are quite low.

2&3. Rapid Design Transfer and Sequential Design Transfer are similar in idea of technology transfer. They rely on intensified internal R&D programs through increasing rewards for successful performance, organizing internal competition in research, and initiating simultaneous R&D on successive stages of innovation [1]. However, there is the difference between both of them. Rapid Design Transfer develops the new product while the base project does not completely finish the product but Sequential Design Transfer develops the new product after the base project is completely finished. Therefore, Rapid Design Transfer has an opportunity to mutual adjustment the new project with base project (figure 2).

4. Design Modification is one of the variations of the design transfer strategy. It likes Sequential Design Transfer but the difference is that it modifies the new product directly from the product of the base project while the base design and the new design of Sequential Design Transfer do not want the previous relationship of both product lines before.

III. METHODOLOGY

The methodology of this study was based on hypotheses, data collection, data analysis, and variables from [10].

Hypotheses:

- The new design strategy is radical innovation (figure 3). "Radical innovation changes a product's architecture but leaves the components, and the core design concepts that they embody, unchanged" [2]. Therefore, this strategy is the longest lead time and the largest amount of engineering hours.
- Rapid design transfer uses the least amount of engineering hours because the engineer can share their task and ideas in both the new project and core project (figure 1).
- Sequential design transfer and design modification are almost indifferent. The major difference between them is only the source of the base design and its application.

Data collection and Data analysis: From [10], it uses the data from 10 automobile in both US and Japan companies which have the results on 103 different new product projects. From the data, it shows that it is possible to separate between rapid design transfer and sequential design transfer by using average time lag to decide. Rapid design transfer has average time lag between base project and new project about 15.0 months while sequential design transfer has about 66.6 months so it has sufficiently different in both strategies. Moreover, from the data, it shows that design modification has the largest amount of average time lag which is about 81.2 months (figure 4).

Variables:

- The automobile design consists of three major component groups: body/interior, engine/transmission, and platform. Yet the project complexity which is required to accurately compare between lead time and productivity in different projects is measured only in both body/interior and engine/transmission.
- The innovativeness index of new product is measured by the component area which is brought new technical features to the company. It is range from 0 (not bring anything about technology to new product) to 1 (bring everything about technology to new product).
- Price in the market and the number of body types of each new project are measured because of the effect on project complexity.
- The type of the automobile has to be car or truck because other types of automobile can not cover in design and market characteristic similar to those of car and truck.

IV. SUPPORTIVE RESEARCHES

General

From [10], it shows the survey result on the new product development projects at 10 automobile companies in Japan and the US. It has the idea to do the research the same with the idea of Cordero which mention that "A great deal of interest has centered around comparison of Japanese, US, and European firms", and "The development of a product

like the automobile is a complex set of activities involving many people over long periods of time" [4]. Moreover, from [10], it also states that Nobeoka and Cusumano emphasize on the transfer of the project from the base project only in the company because it is easy to access the information for developing the new project. This idea is supported by the idea of Ettlie *et al.* which stated that "Concentrating at the level of the product family, and more specifically on the development and sharing of key components and assets within a product family, is the vital issue"[7].

Gupta and Wilmon state and categorize the essential reasons for accelerating the development of new product in the following table.

Reasons to Accelerate Product Development	**Reasons for Product Development Delays**
• Increased Competition • Rapid Technological Changes • Market Demands • To Meet Growth Objectives • Shortening of Product Life Cycle • Senior Management Pressure • Emergence of New Markets	• Poor Definition of Product Requirements • Technological Uncertainty • Lack of Senior Management Support • Lack of Resources • Poor Project Management
Team Members' Major Concerns During the New Product Development Process	**How Function Groups Delay the New Product Development Process**
• Management Style • Lack of Attention to Details • Limited Support for Innovation • Lack of Strategic Thinking • Poor Manufacturing Facilities	• Failure to Give New Product Development Priority • Continually Changing Requirements • Poor intergroup Relations • Slow Response

Cost, Time, and Performance

Time and cost are two of three important factors in transferring the project. Nobeoka and Cusumano mention the time as lead time and engineering hours which will directly effect the cost. Moreover, Cordero states about the interesting management and functional techniques which can help the organization to speed their strategies such as product policies for speed, simulated test markets, project planning and control techniques, resource-intensive techniques, and etc. The interesting technique is resource-intensive techniques which use the approach to save time by increasing cost. "A significant problem with these techniques is that cost increases very fast because the marginal time saved by additional resources begins to decline, and coordination loads, mistakes, and rework increase greatly" [5], (figure 5). In addition to time and cost, organization management (performance) is another important factor in transferring the project. The performance is directly effected to the time in new product development. The relationship between time and performance can be illustrated with the help of S-curve (figure 6), [5]. Moreover, the importance in the relationship of time, cost, and performance in new product development is also stated by Clark that "The time and cost required to complete a development project depend on the number of activities, their duration, and the way that different activities interact. These dimensions of a project are determined by the content of the product (features, performance, degree of innovation), and the scope of the project" [4].

Clark collects the data which is concerned about the product development in the world auto industry. These data cover the new vehicle development projects in 20 companies which are located in Japan, US, and Europe. Moreover, It also studies about lead time, engineering man-hours, product content (price and body size), and project scope. In the analysis of [4], Clark states that "In the terms of performance, the Japanese projects have a sizable advantage in both man-hours and lead time" and "the Japanese use one-third the man-hours and complete a vehicle about 18 months faster than their competitors in European and the US" [4].

Organization Management

From [10], Nobeoka and Cusumano state that the rapid design transfer strategy has to receive the supportive from the senior management. Furthermore, this strategy does not prevent companies from innovating with new design. Rather, it supports the organization to development new designs but it emphasizes on the basis of developing new product as effectively and as quickly as possible. McDonough and Barczak support in this idea. They state that "successful rapid development projects were highly visible within the firm and strongly supported by senior management; were kept on schedule through clear definition of product specifications; and had technical leaders who possessed not only technical skills but also general business skills" [6].

Leadership

McDonough and Barczak mention that "the project leader's style contributes more significantly to speed of development than does the source of the technology" [6]. This leadership style supports the idea of the paper that the leaders who control the multiproject strategy have to have the ability to increased interdependencies among projects, good communication, and coordination in design and scheduling.

V. UNSUPPORTED RESEARCHES

Time, Cost, and Performance

From [10], most of the analyses mention about the comparing among four types of new product development in the term of engineering hours and lead time while Clark always compares the new vehicle development among Japan, US, and European by using lead time and engineering man-hours. Although both two papers use the same standard to measure project performance, they are different in the targets that they want to measure. It means Clark wants to measure the difference of performance in each country while Nobeoka and Cusumano measure the difference in each of four types of new product development.

Nobeoka and Cusumano mention that rapid design transfer is the suitable strategy when compares among new design, rapid design transfer, sequential design transfer, and design modification. On the contrast, Kleinschmidt and Cooper demonstrate that the

success of the organization is depended on the level of innovativeness. It implicates that rapid design transfer does not habitually suitable strategy, but it depends on the degree in supporting the innovativeness in that organization. The organization which is low innovativeness (transfer technology) or high innovativeness will succeed more than the organization which has those in-between.

Meanwhile Nobeoka and Cusumano mention the difference between new design strategy and design transfer strategy in the aspect of cost, they do not mention about the hidden cost which is occurred when transfer technology to new product. Crawford studies about the sources of those hidden costs because an awareness of the costs, especially the hidden ones, will help to transfer the technology to its proper applications. For example, the hidden cost in transferring the technology can occur when necessary steps are skipped so the new product performs many mistakes.

Leadership & Sources of Technology

There are many factors which can contribute to faster new product development. One of this factor is studied by Barczak and McDonough III who mention the relationship between leadership style and the technological source on speed of development which comes from internal and external. These survey states that "a project's technological source moderates the relationship between leader style and speed of development in internally developed projects" and "there is no relationship between the leader's style and speed of development in projects where technological developments came from external sources" [6]. While Barczak and McDonough study about those relationships, Nobeoka and Cusumano emphasize only on the relationship between the new product development and the source of internal technology.

VI. STRENGTHS

From [10], it clearly illustrates the definition and the characteristics of each strategy in design transfer. They also superiorly present the research results by conducting surveys, making some hypothesizes about the results, analyzing each result by using standard measurements: lead time and engineering hours, and then performing analysis to accept or refute the hypothesizes. The paper is well structured and uses

ANOVA analysis which is an excellent statistical analysis tool for proving hypothesizes. Furthermore, it also discusses some implications of the survey results in the term of efficiency, strategic and organizational consideration, communication, and organization structure.

The sample data do not come from the variety of industries so it is very clear to compare each data with the same standard. Furthermore, the data are collected from many companies in the different countries, the data will be clearly identify and conclude.

One of the strengths of [10] is the difference in study about the sources of transfer technology. It emphasizes on the technology transfer in the same company which most of literature researches make the opposite way by analyzing the technology transfer between the company and the competitor. Additionally, it also clearly performs the types of new product development which use standard measurements, lead time and engineering hours, to categorize.

From [10], it shows that the appropriate strategy for transferring technology is rapid design transfer. It is the potential technology in the aspect of productivity advantages which are based on the experience of interviewees, the organizational requirements, and the advantages and disadvantages of this strategy.

VII. WEAKNESSES

From [10], it does not obviously separate between sequential design transfer strategy and design modification strategy. It does not state any measurement tool to separate the difference in each product line. They just mention that design modification strategy has the source from the same product line while sequential design transfer strategy has those from the other product lines. Moreover, both of the strategies also have not much different in both lead time and average time lag (figure 4).

In the analyzing the data on project content and project performance (figure 7), it does not mention much on the cause and effect which is depended on the nation of the companies, the cost in each strategy, and the vehicle types of the automobile: truck and van. They also do not notice any hidden cost which will affect in time and performance of the companies by each strategy. Moreover, the data which is collected from the companies in both countries, Japan and US, are totally different in size. It means that the

surveys from the Japan companies are much more than three times of those of US companies. In the regression analysis for lead time and engineering hours, from [10], it also does not emphasize much on the nation, product price, vehicle types, and innovativeness index.

VIII. IMPLICATIONS

The references are not quite adequate. Most of the references do not state much about the different in strategies of design transfer in the same companies. Most of them mention about the difficulties and reasons in design transfer. Moreover, most of the references do not state any idea in categorizing the transferring strategy like the paper. They always perform in form of accelerating the new product development.

IX. FUTURE RESEARCH

Given the results of this project, there are many potential reasons for the efficiency of the rapid design transfer strategy. Undoubtedly, it should have more research in the area of new product development especially in other industries or types of the projects more over than automobile industry. Furthermore, it should have more study in the field that what companies' characteristics should use which strategies.

X. CONCLUSIONS

In this project, the strategy which gives the most advantages, which is compared among new product development, rapid design transfer, sequential design transfer and design modification, is rapid design. The method of [10] for finding the conclusion of the best multiproject strategy is first they separate the multiproject strategy into two major parts. One is the new project which transfers the designs from the old projects in the company and the other is the new project development which has to create new design without any other idea from the old projects. From the results of the survey, it can identify the advantages and disadvantages of new project development.

The advantages of new project development (disadvantages of the transfer project)

- The transfer project will have the limitation on the difference between base design and new design because it may not properly target new market competition and new customer needs
- There will have many potential problems with respect to linking technologies between the base design and new design. These problems will obviously show up after the transfer project begins.

The disadvantages of new project development (advantages of the transfer project)

- It often develops in expensive products than for less expensive products because less expensive products may be more cost-constrained and may use more existing components.
- It tends to focus on technical innovation and design quality which is opposed to product costs.
- It requires both lead time and engineering hours more than those in the transfer strategy because it tends to develop in new technologies to the company which require the idea generation, producing prototypes, and testing.
- The transfer project seems to speed up development times, reduce engineering hours, and improve product quality and integrity.
- In the transfer project, the duty of functional managers and engineers are clearly distinguished so that they could focus on a limited number of technologically related projects. These can result in more effective multiproject management such as resource allocation and technology sharing.

It can conclude that the new project development strategy has many disadvantages more than advantage so it should have the study more in transfer project strategy. Next it show the separation of the transfer strategy into two types which one is composed of rapid design transfer and another type is composed of sequential design transfer and design modification. The reason that sequential design transfer and design modification are in the same type is the similarity in which both of them have long time lag between base project and new project. The followings are the advantages and disadvantages of

rapid design transfer when compares with sequential design transfer and transfer modification in the aspect of the efficiency in planning, mutual adjustment or task sharing, transferring, designing, management and organization structure and strategy.

The advantages of rapid design transfer (disadvantages of sequential design transfer and design modification)

1. The time lag between completion of the base project and that of a new project is much shorter in a rapid design transfer project than the other two types of transfer strategies. From this advantage of rapid design transfer, it can make many benefits for both the base design and new design such as
    - The new project manager has the ability to find and communicate with engineers who worked on the base design. It may be the convenient for new project engineers to ask some advice for the base design.
    - It is better to transfer the project by having the meeting between the new design and the base design engineers than to transfer through specifications and drawings.
    - The difference in management of leadership in the situation of long time lag may affect the efficiency of project transfer between the two designs.
    - It is difficult to have an accurate advance plan to modify the base design to transfer it to the new design when it has a long time lag.
    - It is difficult to develop the requirements of customer needs, market competition, or governmental regulations because all of these factors often change after the base design is completed, especially when the time lag between the completion of the base design and its transfer to the new design is long. These results may also increase the engineering hours of both sequential design transfer projects and the design modification.
2. There are overlapping and interactions between the base design and the new design only in the rapid design transfer strategy so they will have the mutual

adjustment. Moreover, both of them can share engineering tasks and resources so it may have contributed to the reduction in engineering hours required.

3. The rapid design transfer strategy does not prevent companies from innovating with new designs. However, it emphasizes in the objectives which purpose to take advantages of new designs as effectively and as quickly as possible.

The disadvantages of rapid design transfer (advantages of sequential design transfer and design modification)

1. The project which uses design modification to develop will have more variations and less technical innovation from the base design. In the contrast, the rapid design transfer tends to be small variations so the project of this strategy tends to be a derivative project.
2. The complexity of rapid design transfer strategy is the linkages and interdependencies between the base design and new design which can cause the constrains in the innovation of new project. Furthermore, it needs good communication and coordination in design and scheduling to ensure the timely delivery of shared components that meet the objectives of both the base design and the new design.
3. The rapid design transfer is not appropriate in the organization which has the management only in functional.
4. In rapid design transfer, there are some risks in transferring the technologies between the base design and the new design which these technologies are not proven in the marketplace or may have some technical flaws.
5. It is difficult to pose additional requirements in a planning process for new products in rapid design transfer because it requires a long-term plan which can clarify the project goals

6. The teams which implement rapid design transfer strategy may lose theirs focus and ability to create the distinctive product because they have to develop many projects at the same time.

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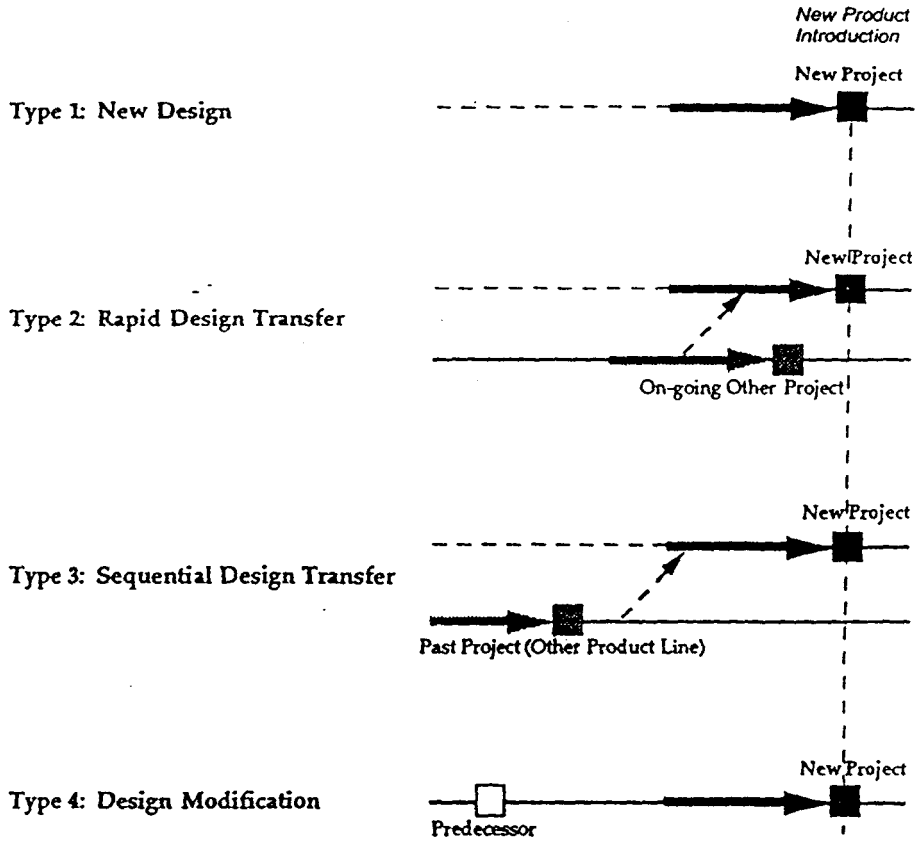

Fig 1. Typology of project strategies

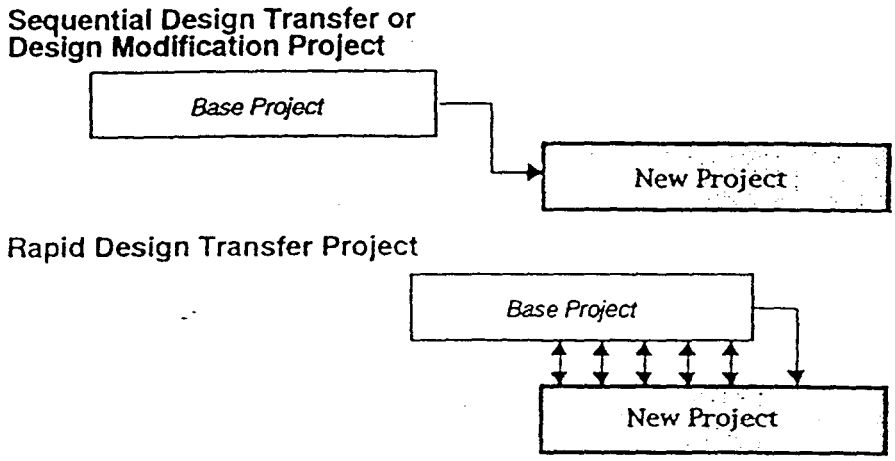

Fig 2. A framework for different modes of design transfer

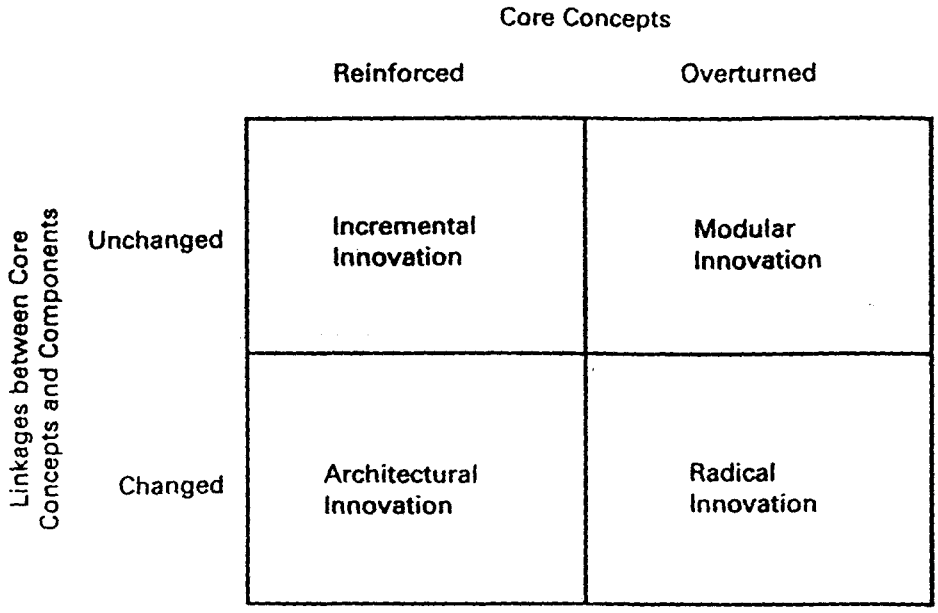

Fig 3. A framework for defining innovation

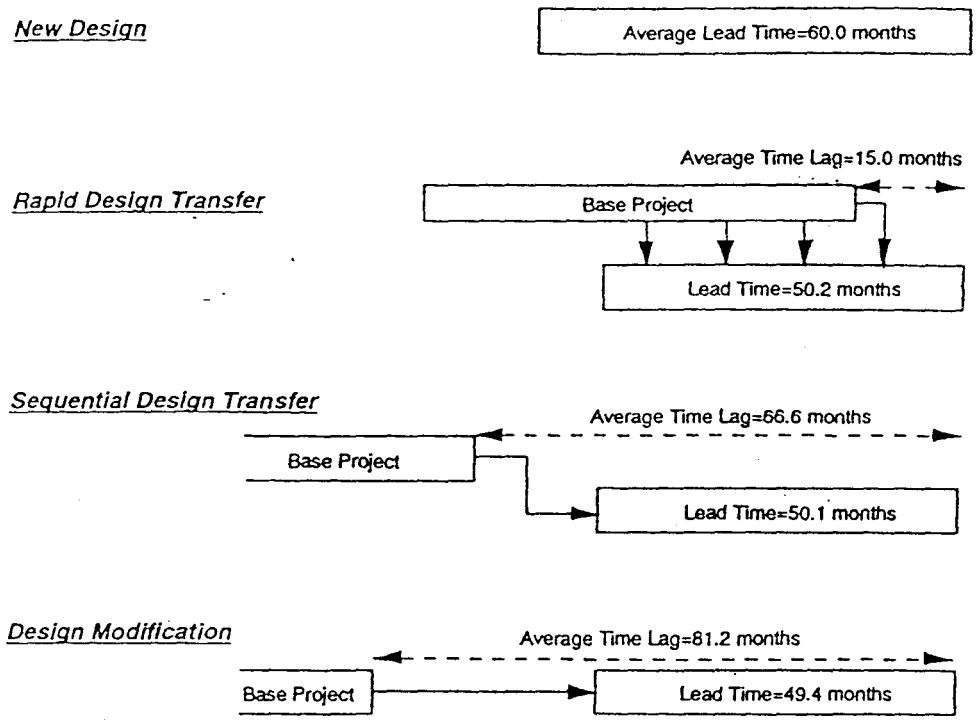

Fig 4. Multiproject strategy and average design transfer time lag

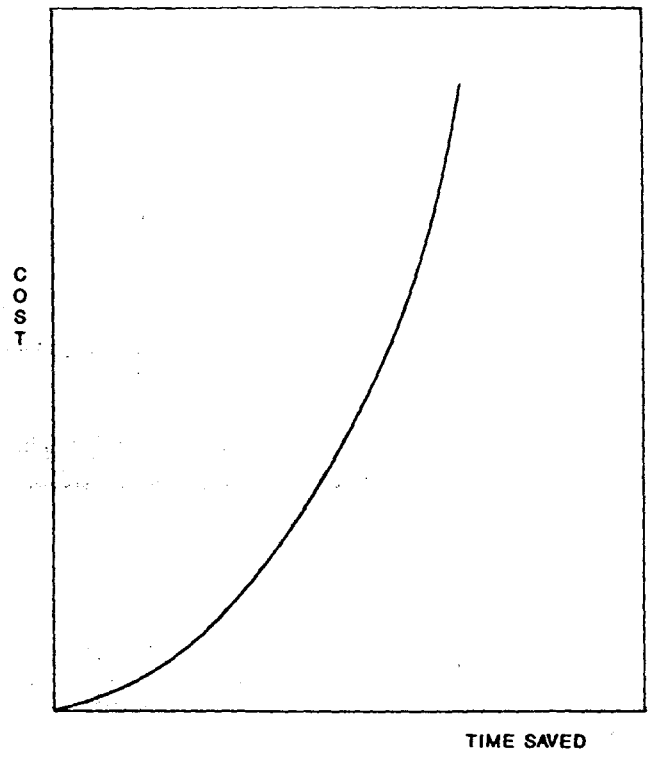

Fig 5. Cost of saving time with resource intensive techniques

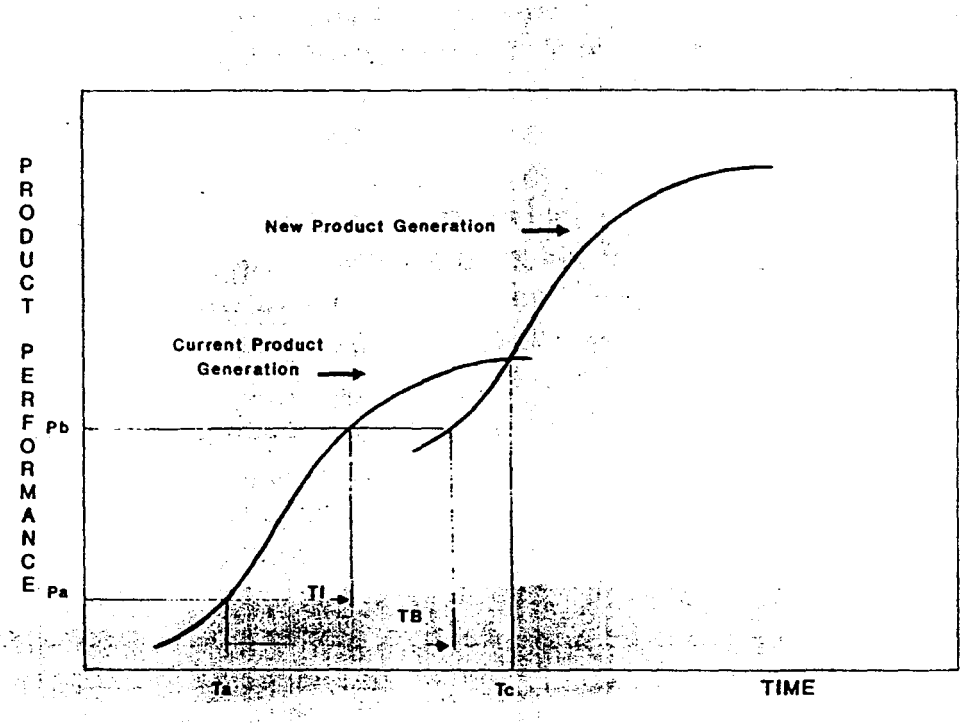

Fig 6. The S-curve: product performance vs. Time

Platform Design	New Design	Rapid Design Transfer	Sequential Design Transfer	Design Modification	Total
# of Projects	27	23	20	33	103
Japanese	19	20	13	26	78
US	8	3	7	7	25
Price ($)**	21200 (8860)	15540 (7610)	16380 (7720)	15920 (7220)	17090 (810
# of Body Types**	1.7 (0.6)	1.6 (0.5)	1.7 (0.8)	2.1 (0.9)	1.8 (0.7)
Truck/Van	7	5	3	8	23
New Design Ratio (%)					
Engine/Transmission	72 (32)	57 (40)	61 (35)	58 (36)	61 (36)
Body/Interior	92 (20)	91 (20)	95 (12)	82 (31)	89 (23)
Innovativeness Index (0-1)***	0.35 (0.33)	0.30 (0.36)	0.23 (0.30)	0.07 (0.18)	0.23 (0.31)
Lead Time (months)**	60.0 (15.6)	50.1 (11.9)	50.1 (12.4)	49.4 (14.9)	52.5 (14.5)
Engineering Hours (million hours)	1.89 (1.60)	0.72 (0.48)	2.02 (2.55)	1.95 (2.03)	1.66 (1.87)

Difference statistically significant at: ***1% Level, **5% Level, *10% Level (One-way ANOVA)
Standard deviaitons are in parentheses

Fig 7. Data on project content and project performance