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Integrating product mix and technology adoption decisions: a portfolio approach for evaluating advanced technologies in the automobile industry

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Abstract

Interactions with managers in the automobile industry indicate that efforts to bring potentially profitable new technologies into production are often frustrated by the traditional unit cost-based approach that is used for evaluating new technologies. Opportunities for timely introduction of valuable or even preemptive technologies can be missed because unit cost comparisons, typically applied to a limited set of vehicle configurations with volumes based on current demand figures, invariably favor incumbent over new technologies. In this research, we develop a more complete technology adoption decision model that integrates product mix and technology adoption decisions. Specifically, we recognize that product mix and volume are important variables in determining the cost effectiveness of new technologies, and include in the model customer demand projections that reflect market trends (e.g. growing demand for increasingly sophisticated features and functions in vehicles). Anticipated experience benefits are then applied to the appropriate production volumes to more accurately predict the profit impact of adopting new technologies. The introduction of automotive multiplexing, a technology that is characteristic of current technological advances in the industry, provides a context for considering insights that can be derived from the decision model. Our interaction with a global Tier I automotive systems supplier allowed us to obtain representative cost data and other information relevant to the technology adoption decision.

Keywords: Operations strategy; Marketing/operations interface; Technology management; Advanced technology; Automobile industry

1. Introduction — the technology adoption decision problem

Technology strategy is an increasingly integral component of enterprise decision making. In high-tech industries, resource commitment to and adoption of the right product and process technologies are critical to sustaining competitive advantage. In more traditional manufacturing and service industries, technology adoption decisions affecting product architecture and process technology are no less significant. While the end product itself may not be perceived as high-tech, advanced technology solutions can provide superior manufacturing capability and the improved product performance and customization that are required for long-term competitiveness. As firms across industries witness an unprecedented rate of technological advance in both product functionality and productive capability, executive level decision makers face the critical

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issue of whether any given technological advance should be adopted for their firms' products or processes. All too often, the response to opportunities for technological change is centered on an incremental evaluation of new versus incumbent technologies, a process that typically favors the incumbent technology.

Many researchers have studied and documented leading firms' failures to embrace technologies that become critical to survival in their industries (for example, Hayes and Abernathy, 1980; Baldwin and Clark, 1994; Bower and Christensen, 1995). Several factors that complicate the technology adoption decision-making process are worth noting. First, executive decision makers, particularly those in long-established product and service industries, often lack the background to fully comprehend the implications of an advanced technology. The result is a certain technology-aversion, i.e. a bias toward product and manufacturing technologies that have historically proven lucrative for the firm. Decision makers also do not tend to appreciate that critical developing technologies are often initially less cost effective than incumbent technologies, and instead focus on short-term financial measures that favor the incumbent technology. Even executives who appreciate the importance of embracing the right technologies cannot possibly gain the level of understanding required to make informed technology adoption decisions for each new opportunity. Bower and Christensen (1995) note that while the analysis techniques employed by many well-managed companies are sufficient for evaluation of incremental technology advances (i.e. those that build on current product or process architecture), new technologies that involve a significant shift in product architecture or manufacturing capability (i.e. "disruptive" technologies) will almost always appear financially unattractive when evaluated by the same measures. It is this failure to embrace disruptive technologies in a timely manner that has eroded the competitive position of many well established companies in a variety of industries, including computers, copiers, automobiles, and construction equipment.

In this research, we develop a broader decision framework for evaluating new technologies. A key element that differentiates this framework from traditional technology adoption decision models is explicit consideration of the interrelationships between the product line decisions that ultimately dictate the portfolio of products offered by the firm, and the technology decisions that drive both functionality and manufacturability of the firm's product mix. We extend the criteria used to make technology adoption decisions beyond standard unit cost comparisons by simultaneously determining the firm's optimal product portfolio and the technology that should be used for each product in the mix. Mathematical programming is used here as a language for capturing, highlighting, and communicating the important trade-offs involved in technology choice. Integrating strategic marketing and manufacturing elements into a model that seeks to maximize profits over an appropriate time frame allows for more realistic identification of the impact on profit of adopting an advanced technology. For example, the setup costs associated with alternative technologies can vary significantly depending on the mix of products produced. Similarly, the mix and volume of products offered by the firm affect unit costs for a new technology due to volume-based experience effects. By focusing the adoption decision on overall firm performance, short-term, functionally-focused incentives no longer play a role in determining the technology strategy of the firm. Application of this broader approach to a specific decision environment illustrates the benefits of integrating product mix and technology choice decisions.

In Section 2, we describe a new technology considered by firms in the automobile industry, adoption of which involves a significant change in vehicle system architecture and associated production processes. The difficulties encountered in the process of evaluating the new technology described in Section 2 motivate the integrated technology adoption/product selection decision model formulated in Section 3. Section 4 presents a case study based on the specific technology adoption decision in the automobile industry. We first outline one firm's approach for evaluating alternative technologies that is based on standard unit cost analysis, and then motivate the need for broader analysis using an integrative decision model like that presented in Section 3. In Section 5, results of our analysis are provided along with some general insights into technology adoption decision processes. Finally, Section 6 concludes with directions for continuing research.