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INTEGRATED COST MANAGEMENT THROUGHOUT THE PRODUCT LIFE CYCLE

by

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Integrated Cost Management Throughout the Product Life Cycle

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Abstract

The assumed high level of designed-in costs is frequently used to suggest that the dominant focus of cost management should be in the design, not the manufacturing, phase of the product life cycle. Yet, many firms expend considerable energy on cost reduction during the manufacturing phase. This paper demonstrates that this paradox partly derives from an incorrect interpretation of the concept of designed-in costs and partly from erroneous assumptions about firms' cost management practices. Based upon in-depth field research, the paper explores how a lean manufacturing enterprise distributes its cost management resources across the product life cycle. The research findings indicate that intensive and systematic cost management occurs in both phases of the product life cycle and that the majority of cost management in the manufacturing phase is not related to product redesign. Furthermore, the cost management practices in the two phases have been integrated to increase their overall effectiveness. These findings suggest that a significant portion of a product's costs is not locked in by its design as commonly assumed.

Keywords: cost management, designed-in costs, product life cycle, target costing

1. Introduction

A commonly quoted statistic in cost management states that 80-95% of a product's costs are determined by its design and are therefore committed before the product enters the manufacturing phase. The origin of this statistic is difficult to identify because it is widely used without attribution, but it appears to derive from Blanchard (1978). Since then, the proposed high value of this statistic, hereafter referred to as the Blanchard statistic, has been quoted extensively to justify the importance of cost management in product design (Berliner and Brimson 1991; Kaplan and Atkinson 1998; Cooper and Chew 1996). In addition, it has been used to support the adoption of target costing, a feedforward cost management technique applied in the design stage of the product lifecycle (Cooper and Slagmulder 1997; Ansari and Bell 1997; Tanaka 1989). More specifically for the purpose of this paper, the proposed high value of the Blanchard statistic has been used to suggest that the dominant focus of cost management should be in the product development phase of the product life cycle and not in the manufacturing phase. For example, Kaplan and Atkinson (1998, 223) state that

> *"Effective cost control is exercised during the product's planning and design phase not when the product and process have already been designed and the product is being made. During the product manufacturing phase, most of the product costs have been committed and the focus is cost containment."*

Garrison and Noreen (2000, 881) go even further and explain the rationale behind the proposition:

> *"Once a product has been designed and gone into production, not much can be done to significantly reduce its cost. Most of the opportunities to reduce*

> *cost come from designing the product so that it is simple to make, uses inexpensive parts, and is robust and reliable."*

Horngren *et al.* (2000, 430-431) communicate the proposition in a subtler manner. By inference they suggest that little can be done to reduce the cost of products with a high Blanchard statistic:

> *"Locked-in costs (designed-in costs) are those costs that have not yet been incurred but which, based on decisions that have already been made, will be incurred in the future. ... If costs are not locked in early, cost reduction can be achieved right up to the time when costs are incurred."*

Thus, the authors of these major accounting textbooks clearly have accepted the proposition that the appropriate primary focus of cost management is in the design, not the manufacturing phase of the product life cycle. The same assumptions also often appear in the practitioner literature (see, for example, Brausch 1994; Henkoff 1995; Böer and Ettlie 1999; Schmelze et al. 1996).

Paradoxically, the above statements are at odds with firms' cost management practices as described in the literature. The western academic and practitioner literatures on cost management are replete with descriptions of cost systems designed to focus the firm's cost reduction efforts on the manufacturing phase (Kaplan and Cooper 1999; Cooper and Kaplan 1999). In contrast, the western literature on cost management during the product development phase is much smaller and relatively recent in origin. For example, the majority of the English-language literature on target costing was written after 1990 despite the long history of the technique (Yoshikawa et al. 1993; Cooper 1995; Cooper and

Slagmulder 1997; Ansari and Bell 1997). Furthermore, the majority of examples are Japanese in origin. The relative size of the two literatures appears to reflect practice and thus further challenges the proposition that the majority of cost management occurs in the design phase. Consequently, there appears to be a paradox between the generally accepted proposition that the primary savings from cost management are achieved during product design, and observed practice, where the majority of cost management efforts are expended during the manufacturing phase. This paradox has yet to be discussed in the literature, a gap that this paper sets out to fill.

The paradox derives from two commonly held assumptions, that together we will call the Blanchard proposition, one about the level of designed-in costs, and the other about the relative effectiveness of cost management across the product life cycle. The first assumption is that some – if not all – manufactured products have a high Blanchard statistic[1]. Second, it is commonly assumed that for those products cost reduction occurs primarily during the design phase, whereas only cost containment can be achieved during the manufacturing phase. Since these two assumptions are logically independent, even if the first assumption can be discredited, it is still necessary to explore the validity of the second assumption (i.e., the majority of cost reduction occurs during the design phase).

The paper is structured as follows. The next section describes the field research method. Section 3 discusses the need to correctly interpret the Blanchard statistic. Section 4 defines the research questions regarding the distribution of cost management resources across the product lifecycle that were used to guide the field research. In the fifth section,

the field observations are documented to provide insights into the cost management practices of the firm selected for this study. Section 6 contains an analysis of those field observations. In particular, it explores the perceived value of undertaking cost management in the different phases of the product life cycle. The final section provides the conclusions of the paper and suggests some directions for future research.

2. Research Method

To explore the validity of the Blanchard proposition (i.e., the proposition that products have a high level of designed-in costs and therefore most cost reduction occurs during the design phase), we studied the cost management practices of the consumer products division of Olympus Optical Company. An in-depth field research approach was adopted because a detailed understanding of the firms' entire product cost management program was required to adequately explore the validity of the Blanchard proposition. Moreover, the lack of extant knowledge about this topic made it virtually impossible to develop structured questionnaires to explore the issue effectively at a large sample of firms. A single research site was considered adequate since the objective of the research was to examine for the existence of cost management programs that do not comply with the Blanchard proposition, not to demonstrate a central tendency in firm behavior. The widespread acceptance of the Blanchard proposition enables a single counter example to provide adequate disconfirming evidence, especially since the research site was purposely chosen to maximize the likelihood that the findings would support the theory (Popper 1959).

We chose the consumer products division for four reasons. First, it was part of a firm that had a reputation for having a mature and sophisticated cost management program that included the application of target costing (Cooper 1995). A firm that undertook aggressive systematic cost reduction in the design phase (such as through the application of target costing) was selected to offset a potential bias in experimental design. A firm that performed little or no cost reduction during the design phase might be forced by competitive pressure to undertake it by default during the manufacturing phase. In contrast, a firm that aggressively reduced costs in the design phase would only undertake cost reduction in the manufacturing phase if it considered such action effective in its own right. Second, the division was known to be a lean enterprise. A lean enterprise was chosen because the adoption of lean design principles increases the effectiveness of cost management during the product development process (Womack and Jones 1996). For example, target costing is more frequently practiced by lean enterprises than mass producers (Cooper and Slagmulder 1997). Consequently, lean enterprises that are undertaking target costing represent environments in which the implications of a high Blanchard statistic can be observed as managers typically will have identified the relative opportunities for cost reduction in both phases of the product life cycle. Third, Olympus Optical division produced products with a short life cycle. Short life cycle products were selected to enable the cost reduction history of a product to be followed over its life cycle. In addition, a short life cycle favors a high Blanchard statistic because it implies that there are reduced opportunities for cost management during the manufacturing phase. Finally, Olympus Optical was known to operate in a highly competitive environment that demanded

sophisticated cost management. A highly competitive environment was chosen to ensure that the cost management systems documented were a critical aspect of firm survival (Khandwalla 1972; Cooper 1995).

The specific product development project chosen for the research, the new Stylus Zoom camera, was selected based upon two criteria. First, Olympus Optical management viewed the project as creating significant technical and cost reduction challenges for their product engineers. The new Stylus Zoom camera was the first "mother" camera, i.e. it contained components that were going to be used in a family of cameras and for several generations of those cameras. Previously, all camera components were only used in a single model. Second, the new Stylus Zoom camera was being developed during a period of yen appreciation that was placing considerable pressure on Olympus Optical to reduce costs even more aggressively than usual. The effective world-wide selling prices of the division's products, when specified in yen, were dropping. This effective price reduction caused the target costs of new products to fall and the firm was having trouble meeting them for some products, including the Stylus Zoom. These two selection criteria were designed to ensure that we could observe and document the full spectrum of Olympus Optical's cost management practices in action.

The field research was based on ten days of interviews with general managers, design and manufacturing engineers, and blue-collar workers both at divisional headquarters and Tatsuno, the firm's primary manufacturing facility. These observations were carried out over a six-year period during six separate visits to the firm. The individuals

interviewed were actively involved in designing, implementing, and applying the various cost management techniques used by the firm. The interviews were held in English with translator support as appropriate. Typically, between three to five persons were interviewed at a time (though sometimes, there was only one person in the room and at others over ten).

3. Interpreting the Level of Designed-In Costs

The first assumption that underlies the Blanchard proposition is based upon a common misperception about the meaning of the Blanchard curve, a graphical illustration introduced by Blanchard (1978, 14) as "reflecting a characteristic life cycle cost trend curve as related to actions occurring during the various phases of the life cycle" (see Figure 1).

[Insert Figure 1 about here]

The Blanchard curve identifies the extent to which the costs of a product, *when measured at the end of its production life*, are locked in at different stages of the life cycle. Thus, while it may be correct to state that 95% of a product's final costs are locked in by its design, that is not the same as stating that 95% of its launch costs are locked in. The Blanchard statistic with its retrospective orientation cannot identify the magnitude of the costs that can be avoided by improving product design or through increasing the efficiency of the manufacturing process.

Since the level of effort expended on cost management in the two phases of the product life cycle is presumably a function of the level of avoidable costs, the Blanchard

statistic does not provide any insights into the appropriate distribution of cost management effort across the product lifecycle. Thus, disposing of the first of the two assumptions was a somewhat trivial undertaking. The second assumption is more difficult to explore and is the focus of the rest of the paper.

4. Distribution and Nature of Cost Management Throughout the Product Life Cycle

According to the Blanchard proposition, the division's approach to cost management is expected to have the following general properties. First, the majority of cost reduction is undertaken in the design phase and second, cost containment is the predominant cost management activity during the manufacturing phase. The pattern of cost management anticipated is summarized in Table 1.

[Insert Table 1 about here]

To test whether these predictions are valid, it is necessary to answer five interrelated questions that cover the necessary and sufficient conditions required for the Blanchard proposition to be operative.

Q1. If significant cost management activities occur during the product design phase, do such activities also occur during the manufacturing phase?

The first question explores the distribution of cost management efforts throughout the product lifecycle. In particular, it explores whether if the division expends

significant resources on cost management in product design, it also expends significant efforts on cost management during the manufacturing phase of the product lifecycle. The Blanchard proposition suggests that the greatest intensity of effort should be in the product design phase. If high levels of effort are expended in both phases, then the next step is to identify the nature of the activities in the manufacturing phase.

Q2. If cost management is applied in both phases of the product lifecycle, are the cost management activities that take place during the manufacturing phase designed to reduce, rather than contain, costs?

The second question explores the nature of the cost management activities in the two phases of the product lifecycle. The Blanchard proposition does not state that cost management should not occur in the manufacturing phase, only that it should be predominantly limited to cost containment. Therefore, it is important to identify the nature of the cost management activities in the manufacturing phase at the firm. If a significant portion of the activities in the manufacturing phase are related to cost reduction, then the focus of those activities needs to be further explored.

Q3. If cost management is applied in both phases of the product lifecycle, do the cost reduction activities that take place during the manufacturing phase focus on sources of savings other than product redesign?

The third question explores the focus of the cost management activities in each phase of the product lifecycle. The Blanchard proposition assumes that once a

product enters production, no further design-related cost management activities are undertaken. However, even if significant cost reduction activities in the manufacturing phase were observed, that would still not necessarily violate the Blanchard proposition. Instead, a modified version (the weak form) of the Blanchard proposition could be in effect; where design-related cost management activities that focus on product (re)design continue into the manufacturing phase, but other than that only cost containment is possible. In contrast, if significant cost reduction activities were observed that are not design-related but instead focus on rendering the production process more efficient, then even the weak form of the Blanchard proposition is called into question. Under those conditions, it is important to determine if the cost reduction activities are applied to products that have already been subjected to significant cost reduction in the product design phase.

Q4. If cost management is applied during the manufacturing phase and it is non design-related in nature, is it systematically applied to products that have already been subjected to systematic cost management during the product design phase?

The fourth question explores whether a significant portion of individual products are subjected to intense cost management in both the design and manufacturing phases of the product life cycle. In particular, it tests whether the cost management activities applied in the design phase include design improvement and in the manufacturing phase include process efficiency. The critical issue is whether these cost management activities are applied to essentially all products in both phases, or to just a few of them in only one of the phases. If they are applied to essentially all

products in both phases, then a significant violation of the Blanchard proposition has been identified. However, if only a few products are subjected to intense cost reduction in one of the phases, then the violation is not significant. To determine the level of violation, the various techniques were coded as being either systematic, that is applied to all or nearly all products or *ad hoc*, that is applied to only a few special case products. If both phases of the lifecycle appear to be subjected to systematic cost reduction for the majority of the products, then it is important to determine if these activities are integrated or stand-alone.

Q5. If cost management is applied to products during both phases of the product lifecycle, are the programs integrated or applied in a stand-alone manner?

The final question explores whether there are sufficient benefits from integrating the cost management techniques across the two phases of the product lifecycle to justify the effort. Such integration would suggest that the benefits in both phases are considered significant and that integration provides additional savings in its own right. Thus, integration of systematic cost reduction activities across the entire product lifecycle provides substantial evidence against the validity of the Blanchard proposition.

These five questions capture key attributes of the cost management environment observed at the research site. If the answer to all five questions is negative, then Olympus Optical management has developed a cost management program that is in keeping with the Blanchard proposition. However, if the answer to all questions is positive, then cost

management at Olympus Optical is not in keeping with the predictions of the Blanchard proposition.

5. Field Observations

The field observations at Olympus Optical revealed the use of five major cost management techniques; target costing, product-specific kaizen costing, general kaizen costing, functional group management, and standard costing. Each of these techniques had a specific orientation to cost management with respect to the five research questions in terms of the timing of the intervention (product design phase versus manufacturing phase), the objective (cost reduction versus cost containment), the focus of cost management (product design versus production process), the level of formality (systematic versus *ad hoc*), and the level of integration with other cost management techniques (stand-alone versus integrated).

Target Costing[2]

At Olympus Optical, target costing was applied as a feedforward cost reduction technique during the design stage for all new products. Thus, target costing is treated as a systematic cost management technique. The first step in setting target costs at Olympus Optical was to identify the price point at which a new camera model would sell. Once the price point of a new camera was identified, the free on board (FOB) price was calculated by subtracting the appropriate margin of the dealers and the U.S. subsidiary plus any import costs, such as freight and import duty. Target costs were established by subtracting the product's desired target profit margin from its FOB price. To achieve the target cost

reduction objective, established by comparing the product's target cost to its current estimated cost, Olympus Optical product engineers tried to find creative ways to realize the desired level of functionality and quality at the target costs. Aggressive cost reduction was achieved at Olympus Optical by applying value engineering in three different areas. First, the number of parts in each unit was targeted for reduction. Second, expensive, labor-intensive, and mechanical adjustment processes were eliminated wherever possible. Finally, metal and glass components were replaced with less expensive plastic ones where appropriate.

Approximately 20% of the time, the current estimated cost was equal to or less than the target cost and the product design was immediately released to the production group at Tatsuno. The other 80% of the time, further analysis by the research and development group was required. First, marketing was asked if the price point could be increased sufficiently so that the target cost was equal to the estimated cost. If the price could be increased by an appropriate amount, the product was released to the production group. If the market price could not be increased sufficiently, then the effect of reducing the functionality of the product was explored. Reducing the product's functionality decreased its estimated cost to manufacture. If these reductions were sufficient and did not cause the target selling price to fall, the product was released to production. If it was not possible to increase the price or decrease the production cost sufficiently to reduce the estimated cost below the target cost, then a life cycle profitability analysis was performed. In this analysis, the effect of potential cost reductions over the production life of the product was included in the financial analysis of the product's profitability. The product was released if these life cycle savings were

sufficient to make the product's overall profitability acceptable. If, even with these additional cost savings included, the estimated costs were still too high, the product was abandoned unless some strategic reason for keeping the product could be identified.

Target costing was considered of particular importance by Olympus Optical's senior management because the manufacturing phase of the life cycle of modern point and shoot compact cameras was short, with the typical compact camera only being on the market for between 12 and 18 months. This short manufacturing phase made it difficult for Olympus Optical's product engineers to correct any design problems that led to high manufacturing costs, after the product had entered production. Thus, the short life cycle encouraged the firm to solve any cost problems during the design, as opposed to the manufacturing, phase.

Product Specific Kaizen Costing

The importance attached to achieving the cost reduction objective established by the target costing system was highlighted by the existence of product specific kaizen costing. Like target costing, the unit of analysis for product specific kaizen costing was the product and its objective was specified in financial terms. However, it was a feedback cost management technique as opposed to a feedforward one. Product specific kaizen costing activities were initiated to correct any cost overruns incurred during the manufacturing phase that were caused by design issues. Thus, it extended the product development process into the early stages of manufacturing.[3] At Olympus Optical, product specific kaizen costing was used as an *ad hoc* cost management technique, not a systematic one. It was only

applied to strategic products that had significant cost overruns in the earliest stages of the manufacturing phase.

The product specific kaizen costing process was initiated when a new product at Olympus Optical failed to meet its target cost. Such products were rapidly redesigned during the early stages of the manufacturing phase to bring their costs in line with their target costs. The willingness of the firm to take such corrective actions was dependent upon three factors. First, the magnitude of the expected volume of product sales: the higher the sales volume, the more willing the firm was to take corrective actions. The second factor was the anticipated magnitude of the investment required to reduce costs: as the magnitude of the investment increased, the firm was less likely to approve the cost reduction project. Finally, the potential savings had to be sufficient to justify undertaking a special cost reduction program.

The practice of product specific kaizen costing at Olympus Optical was observed during the new Stylus Zoom camera project. Problems with the cost of the new product surfaced during trial production when its costs were found to be about 10% above target. Furthermore, when the product entered mass production at Tatsuno, its costs were found to be even higher and furthermore did not fall as much as expected. Overall, the production costs were 5% higher than the trial production costs making the total cost overrun 15%. Under normal conditions, the 10% cost overrun at the trial production stage would have led to the postponement of the launch of the new Stylus or complete cancellation of the product. However, the new Stylus was viewed as a “flagship” product and was therefore

protected from postponement or cancellation. In addition, the new Stylus was the first of a new family of products designed to increase parts commonality. Delaying the launch of the new Stylus would have meant that the evaluation of the parts commonality program would have to be postponed. Given the strategic importance attached to this program, postponement was considered unacceptable.

The window of opportunity for cost reduction for the new Stylus was shorter than might first be anticipated for such a high volume product with a multi-year manufacturing life. Olympus Optical management believed that the product specific kaizen window closed only 11 months after product launch. The cost of the new Stylus was reduced in four primary ways. The first was to reduce the number of parts in the product, the second was to replace more expensive materials with less expensive ones, the third was to manage supplier costs, and the final approach was to transfer production overseas where overall costs were lower. The primary rule applied to post launch cost reduction was that the product's functionality and quality were not allowed to change. From the customer's perspective, the last Stylus Zoom off the production line would be identical to the first one.

The unwillingness of Olympus Optical management to launch products that had not attained their target costs reflects management's belief that the discipline of target costing would be lost if too many products were launched which exceeded their target costs. In particular, they were concerned that the workforce would begin to accept that it did not matter if target costs were not achieved, since they could be achieved later during the manufacturing phase. However, for strategic products the cost of not launching was

considered higher than the cost associated with any loss of discipline in the target costing process. Thus, the existence of product-specific kaizen costing and the way it is used at Olympus Optical indicates a sophisticated cost-benefit tradeoff with respect to cost management across the life of the firm's products.

General Kaizen Costing

General kaizen costing, or production cost control and reduction as it was called at Olympus Optical, was applied as a feedforward cost management technique during the manufacturing stage of the product's life. However, unlike target costing and product-specific kaizen costing, the design of the product was treated as given and the cost reduction process focused on the way the product was manufactured. Thus, the unit of analysis for general kaizen costing was the production process, not the product per se. Reducing the cost of production processes was an effective way to reduce costs because many production processes were used across several generations of products. Therefore, savings achieved during the manufacturing cycle of a particular product could continue to be replicated long after that product had been withdrawn.

General kaizen costing consisted of setting cost reduction targets for production processes and empowering the workforce to find ways to achieve them. Olympus Optical's production cost control and reduction approach focused primarily on removing material, labor, and some overhead costs from products; for example, selling, general, and administrative costs associated with the control and procurement departments were

included in the cost reduction objectives. The general kaizen costing system at Olympus Optical was mature and had been in operation for many years. At Tatsuno, individual cost reduction objectives were set for each assembly line and thus, each internally produced component. These objectives were designed to be challenging, but attainable. Its widespread application at Olympus Optical makes general kaizen costing a systematic cost management technique.

Functional Group Management

Functional group management was a feedforward cost management technique that focused on making Olympus Optical's production processes more efficient. Like general kaizen costing, the design of the firm's products were assumed to be given and it was the efficiency and yield of the production processes that were the focus of improvement. However, the primary difference between general kaizen costing and functional group management was the ability to reduce costs through increased output as well as through increased efficiency of manufacturing. Like general kaizen costing, the savings were non-design in nature. The emergence of a new cost management technique focusing on the manufacturing phase indicated that Olympus Optical management perceived that there were further savings that could be achieved in that phase of the product life cycle.

Functional group management consisted of breaking the production process at Tatsuno into ten autonomous groups and treating them as profit centers instead of cost centers.[4] Functional group management was introduced at Olympus Optical for two

reasons. First, the switch to profit as opposed to cost centers enabled the groups to include ways to increase the throughput of the production processes under their control into their improvement activities. In addition, actions that increased both costs and profits by increasing revenues were supported by the functional group management system, whereas they were not supported by the general kaizen system, which focused solely on reducing costs. The second motivation for the functional group management system was the change in mindset that it induced. Converting the production lines to profit centers allowed the groups to better understand their contribution to the firm's overall profitability. The motivation for inducing the mindset change was primarily driven by the observation that general kaizen costing systems tend to lose their effectiveness over time. By switching from a cost to a profit perspective and by operating in a bottom-up as opposed to a top-down manner, the functional group management system revitalized Olympus Optical's general kaizen costing system.

By finding ways to increase their output levels, the groups increased their ability to generate "revenues" and hence profit. As the groups increased their revenues, the capacity of the factory also increased leading to real performance improvements. For example, in the first three years of functional group management, approximately 80% of the profit improvements were from changes that increased output; the remaining 20% of improvements were from cost reduction initiatives, such as increased use of unmanned processing and improvements in shortening processing time. Since all production processes were subjected to functional group management, it was viewed as a systematic cost management technique at Olympus Optical.

Standard Costing

Olympus Optical used its standard cost system primarily as a systematic cost management technique to achieve cost containment or cost maintenance. The standard cost system operated as a passive feedback technique to help identify cost problems, which were subsequently resolved by the other techniques. Product costs, as reported by the standard costing system, were mainly used for three purposes. The first was to determine if three months into production, new products were indeed being manufactured at their target costs. There was little use of the reported product costs for strategic decision making purposes as the target costing process primarily helped determine the firm's product mix and its profitability. Second, reported product costs were used to ensure that production processes were operating at the expected level of efficiency. Actual performance was compared to standard performance and variances computed. These variances were used to create cost containment pressures on the work groups. Third, standard product costs were used to identify ways to make unprofitable products profitable. If an existing product became unprofitable, Olympus Optical had three options. First, it could do nothing and wait until a new model replaced the existing one. Second, it could accelerate the replacement of the product. Finally, it could cause a more aggressive general kaizen costing objective to be established.

6. Data Analysis

To determine whether the field observations were in keeping with the Blanchard proposition, the cost management practices at Olympus Optical were coded in four ways. First, the cost management techniques were coded with respect to when they were applied in the product life cycle. The coding states were the product design and manufacturing phases, and whether the techniques were applied throughout the phase or only for a portion of it (Question 1). Second, the techniques were coded according to their objective as either cost reduction if the primary objective was to reduce the cost of the product to a lower level, or cost containment if the objective was to maintain the cost of the product at a previously achieved level (Question 2). Third, the cost management techniques were coded with respect to their focus, which was either product design or the production process (Question 3). A technique was categorized as being focused on product design if the primary outcome was a change in the design of the product, even if product functionality remained constant. Alternatively, it was coded as being focused on the production process if the primary outcome was a change in the way the product was manufactured and its design was essentially unchanged. Fourth, the techniques were coded based upon their degree of formality (Question 4). A cost management technique was coded as systematic when it was applied to essentially all products, and *ad hoc* when it was applied to only a limited number of 'special-case' products. Finally, the techniques were coded with respect to their level of integration with the other cost management techniques (Question 5).

Distribution of Cost Management Efforts Throughout the Product Lifecycle

The total amount of resources dedicated to cost reduction by Olympus Optical management appears to be high, as anticipated for a firm in an intensely competitive environment (Khandwalla 1972). However, the observations showed that only one cost management technique was applied during the product design phase (target costing), whereas four distinct techniques were applied during the manufacturing phase (product-specific kaizen costing, general kaizen costing, functional group management, and standard costing). The distribution of cost reduction efforts across the product life cycle is illustrated in Figure 2.

[Insert Figure 2 about here]

Thus, the first set of observations showed that the distribution of cost management activities across the product lifecycle was not in keeping with the predictions of the Blanchard proposition. However, the four cost management techniques observed in the manufacturing phase might all be designed to achieve cost containment and thus still support the Blanchard proposition. Consequently, the next step is to determine the nature of the cost management activities to determine whether they are designed to achieve cost reduction or cost containment.

Nature of Cost Management Undertaken During the Manufacturing Phase

The cost management technique observed in the product design phase, target costing has the objective of cost reduction not cost containment, as anticipated by the Blanchard proposition. Of the four techniques applied in the manufacturing phase, three were designed to actively reduce costs (product-specific kaizen costing, general kaizen costing, and functional group management) and only one (standard costing) was designed to contain costs. Thus, the nature of cost management observed in the manufacturing phase did not support the Blanchard proposition. However, if all of these cost reduction techniques were dedicated to identifying cost savings through product redesign then, while the strong form of the Blanchard proposition would not be supported, the weak form might still be in effect. To determine if the weak form was operative, we now address the focus of the cost reduction activities.

Focus of Cost Management Undertaken During the Manufacturing Phase

Cost reduction in the manufacturing phase at Olympus Optical can be decomposed into techniques that focus on product redesign and techniques that focus on rendering the production processes more efficient. Of the four techniques observed in the manufacturing phase only one, product-specific kaizen costing, is focused on product redesign. Of the other three techniques, two, general kaizen costing and functional group management, are focused on rendering the production processes more efficient. The final technique, standard costing focuses on cost containment.

The extension of product design activities to the manufacturing phase weakens the significance of the Blanchard proposition; therefore gaining an understanding of how the Olympus Optical division managed product redesign in the manufacturing phase is deemed worthy of additional analysis. At Olympus Optical, when the target cost for a strategic product was not achieved, additional pressure to reduce its costs was exerted by applying product-specific kaizen costing. Olympus Optical management viewed target costing and product-specific kaizen costing as part of a continuous process with the objective of achieving the target cost through innovative product design. Olympus Optical management had accepted that, from time to time, the product engineers would fail to achieve the cost reduction objective set by the target costing system, but strategic imperatives would force some of those products to be launched anyway. For example, the strategic nature of the new Stylus Zoom camera (specifically, its role as the first mother camera) required that the product be launched into the market even though it had failed to achieve its target cost. The firm would immediately subject such products to product specific kaizen costing activities to bring their costs down to their target levels. This practice suggests that the savings from improvements in manufacturing only (excluding design changes) are typically not sufficient to bring the cost of such products back into line with their target costs within a reasonable time frame. Thus, the purpose of product specific kaizen costing was to access design-related savings that were missed, due to competitive time pressure, by the target costing system during the manufacturing phase of the product life cycle. The existence of the product-specific kaizen program demonstrates that Olympus Optical was able to shift some of the cost management efforts it dedicates to design-related savings to the manufacturing phase.

However, Olympus Optical management stated clearly that product-specific kaizen was only used for those products that failed to achieve their target costs, but were launched for strategic reasons. Their rationale was that changing a product's design and hence the production process during the manufacturing phase was highly disruptive and, in most cases, the savings anticipated for products that had achieved their target costs were not sufficient to justify the effort. Consequently, the technique was only used for high volume products early in their manufacturing phase to ensure that an adequate number of units were likely to be sold to justify the up front investment.

Thus, at Olympus Optical, essentially all products (or more accurately, their production processes) were subjected to cost reduction through the application of general kaizen costing and functional group management, which is at adds with the Blanchard proposition.[5] There is still one possible scenario that would enable at least the weak form of the Blanchard proposition to be in effect and that is if there are two types of products at Olympus Optical. The first type of product is subjected to intense cost reduction in the design phase and only cost containment in the manufacturing phase. These products would comply with the Blanchard proposition. The other type of products is only subjected to intense cost reduction in the manufacturing phase, therefore they violate the predictions derived from Blanchard proposition. To determine if the various cost reduction techniques were indeed applied to different sets of products, the range of applicability of the various techniques was analyzed.

Range of Applicability of Cost Management Applied in Both Phases of the Product Life Cycle

The previous findings did not rule out the possibility that Olympus Optical produced two types of products, products that benefited primarily from systematic cost reduction in the design phase and products that benefited primarily from cost reduction in the manufacturing phase. However, the application of target costing, kaizen costing, and functional group management was considered binding by Olympus Optical management. The Stylus Zoom project was unusual in that it concerned a strategic product launched above its target cost and therefore required the application of product-specific kaizen costing. According to Olympus Optical management, essentially all products were subjected to systematic cost reduction in both phases of the product life cycle, which is in direct conflict with the predictions of the Blanchard proposition.

Of particular importance is the observation that the functional group management technique, a systematic cost reduction technique applied in the manufacturing phase, was only recently introduced with the aim of revitalizing the general kaizen costing program in two ways. First, it adopted a profitability perspective that created incentives for the workforce to identify ways to increase output levels and second, it increased the bottom-up aspect of goal setting so that the workforce was more committed to achieving their cost reduction targets. The shift in orientation to profits focused the workforce on findings ways to increase the rate of output of the firm's production processes. As the processing speed increased, the overall cost of the product decreased as it consumed fewer resources and therefore decreasing costs. The increased commitment caused the workforce to identify cost

reduction goals that were more aggressive than those previously set by management. Despite their aggressiveness, these self-established goals were frequently exceeded. In the past, the management set goals were rarely exceeded and sometimes not even achieved. Thus, the introduction of functional group management indicates that Olympus Optical management believes that increased cost reduction in the manufacturing phase is cost justified.

The first four sets of findings indicate that the cost management program at Olympus Optical is not designed to comply with the Blanchard proposition. Further evidence was available that indicated even more strongly that the proposition was not applicable. That evidence derived from the integration of the various cost management techniques at Olympus Optical.

Integration of Cost Management Techniques Across the Product Life Cycle

Olympus Optical has not just developed and implemented five independent cost management techniques, instead it has created an integrated product cost management program. The program is integrated in that the five techniques are specifically implemented so that they mutually reinforce each other. This observation provides important insights in its own right as little is known in general about the integration of cost management techniques. While considerable literature has been published in recent years about various cost management techniques, most of the literature focuses on a single technique. For example, there are numerous articles and books on topics such as target costing (Cooper

and Slagmulder 1997; Sakurai 1989; Cooper and Chew 1996), kaizen costing (Imai 1986; Monden and Hamada 1991), product costing (Cooper et al. 1992; Kaplan and Cooper 1999), operational control (Kaplan 1990), and micro profit centers (Cooper and Kaplan 1999; Cooper 1995). However, few – if any – of these writings illustrate whether and how the various techniques are used in concert to reduce costs in different phases of the product life cycle or are applied separately. A few writings discuss multiple techniques, but they do not discuss integration to any significant extent (Monden 1995; Cooper 1995).

The mutual reinforcement process at Olympus Optical started with the target costing system and ended with the standard costing system. Target costing reinforced the effectiveness of the product specific kaizen costing system by identifying products that had cost overrun problems before they entered production. Thus, the target costing system provided an early warning of the need to initiate a product specific kaizen costing intervention.[6] Target costing also reinforced the general kaizen costing and functional group management techniques because it helped identify the savings that should be achieved during the manufacturing phase and isolated them from the cost reductions that could reasonably be anticipated during the product development phase. If the target costs of new products were appropriately established, then only achievable cost reduction objectives would be set for the general kaizen and functional group management systems. Thus, an effective, well-designed target costing system helps ensure that excessive cost reduction pressures are neither required nor applied during the manufacturing phase.

The interaction between target costing and standard costing was subtler. In firms that do not have sophisticated target-costing systems, the role of the standard cost system includes determining whether new products (as well as existing ones) are profitable. This role often conflicts with the other primary purpose of the standard cost system, which is operational control (Kaplan and Cooper 1999). By reducing the importance of the product-costing role through the use of target costing, Olympus Optical management enabled the standard cost system to be primarily focused on cost maintenance (as per Monden 1995 and Kaplan and Atkinson 1998). Thus, the standard cost system is not seen as a source of significant cost savings at Olympus Optical. Its primary role is to support the other systems and ensure that cost savings achieved by those programs are maintained, rather than achieve savings in its own right.

The integration of the cost management techniques that are used to reduce costs through changes in product design (target costing and product-specific kaizen costing) and those used to reduce costs through changes in manufacturing (general kaizen costing, functional group management, and standard costing) indicates that Olympus Optical management believes that cost reduction is effective across both phases of the product life cycle. Integration of the five cost management techniques provides important evidence regarding the lack of validity of the Blanchard proposition on three fronts. First, it demonstrates that a significant number of products are subjected to cost management in both the design and manufacturing phases. Second, it suggests that Olympus Optical's overall cost management program is both carefully designed and kept up to date. Consequently, it is difficult to argue that the systems used to reduce costs during the

manufacturing phase are legacy systems that are no longer effective. Finally, the observed integration of the cost management techniques at Olympus Optical indicates that the additional savings from integration are considered sufficient to offset the incremental costs associated with achieving them. If the total feasible cost savings during the manufacturing phase were small, as suggested by the Blanchard proposition, then it is unlikely that the additional savings from integration would be considered sufficient by Olympus Optical management.

Summary of Observations

The observations show that the firm uses one systematic cost management technique, target costing, and one *ad hoc* applied technique, product-specific kaizen costing, to obtain design-related savings. Target costing is applied in the product design phase and product-specific kaizen costing in the manufacturing phase. In addition, Olympus Optical uses two systematically applied techniques, general kaizen costing and functional group management, to achieve process-related cost reduction during the manufacturing phase. Finally, it uses standard costing to ensure cost containment in the manufacturing phase. The pattern of cost management techniques observed in action at the research site is represented in Table 2.

[Insert Table 2 about here]

This pattern of cost management observed at Olympus Optical is significantly different from the one predicted by the Blanchard proposition (cf. Table 1). The answer to

all five research questions derived from our field observations was positive, which strongly suggests that the Blanchard proposition does not apply in the observed setting.

7. Conclusion

Careful analysis of the Blanchard statistic indicates that the paradox between the generally accepted proposition that the primary savings from cost management are achieved during the product design phase, and descriptions of practice where most cost management efforts are expended during the manufacturing phase, is the outcome of a misconception about the level of designed-in costs. The Blanchard statistic is a retrospective measure of when the costs of a product are locked in. It does not capture the costs that can be avoided through product redesign or increased manufacturing efficiency. As such, it provides no insights into the appropriate distribution of cost management efforts across the product lifecycle. However, discrediting the Blanchard statistic does not automatically invalidate the commonly accepted Blanchard proposition about the concentration of cost management efforts in product design.

Through careful observation of the cost management practices at Olympus Optical, we provide empirical evidence that the second assumption of the Blanchard proposition does not hold either. The proposition predicts that we should only observe design-related cost management techniques such as target costing in the design phase and only cost containment techniques such as standard costing in the manufacturing phase. Furthermore, for products that have excessive manufacturing costs, we might expect to observe an

extension of the design process into the manufacturing phase, such as the application of product-specific kaizen costing, but no other attempts to reduce costs during manufacturing. Thus, if we had observed systematic target costing, systematic or *ad hoc* product-specific kaizen costing, and standard costing at the research site, then we would argue that our observations were in keeping with the (weak form of the) Blanchard proposition.

However, what we observed was a pattern of cost management techniques in the manufacturing phase that was completely at odds with the Blanchard proposition. The systematic cost reduction during the manufacturing phase was not design-related as predicted, but instead focused on rendering the production processes more efficient. Even more telling was that the various forms of systematic cost reduction were applied to the same products in both phases of the product life cycle. Finally, the entire cost management system was integrated, with the various techniques operating in concert as opposed to isolation. It is the observation of two additional techniques, general kaizen costing and functional group management, and the way they are used and integrated into the entire cost management program that allows the rejection of the Blanchard proposition.

At Olympus Optical Co. the magnitude of the savings directly attributable to standard costing was small compared to the savings achieved by the other cost management techniques. This observation may help explain the widespread acceptance of the Blanchard proposition. Many western firms rely solely upon their standard cost system for reducing costs during the manufacturing phase, therefore, if these savings are quite small (as suggested by the observations at Olympus Optical), managers may come to conclude

erroneously that only modest savings are possible in the manufacturing phase. Thus, the widespread acceptance of the Blanchard proposition may be an outcome of western practice, and not of an underlying economic reality.

It is obviously dangerous to generalize from a single observation. However, as Popper (1959) suggested, a single disconfirming observation is sufficient to call a commonly held belief into question. Since many firms that compete in today's global economy face equivalent competitive forces to the ones that led Olympus Optical to develop its integrated product cost management program, it is likely that such programs are quite common. Thus, an important extension of this research is first, to determine if other firms have implemented similar integrated cost management programs and second, to identify the conditions which favor (or hinder) their adoption. Furthermore, the factors that determine the ratio of avoidable costs in the design phase and in the manufacturing phase of a product's life cycle need to be identified. The value of these factors could then be used to estimate the potential savings available to the firm and help managers determine the level of cost management resources they expend on each of the two phases of the product life cycle. Finally, more research is needed on the way cost management techniques can be integrated so that they reinforce each other.

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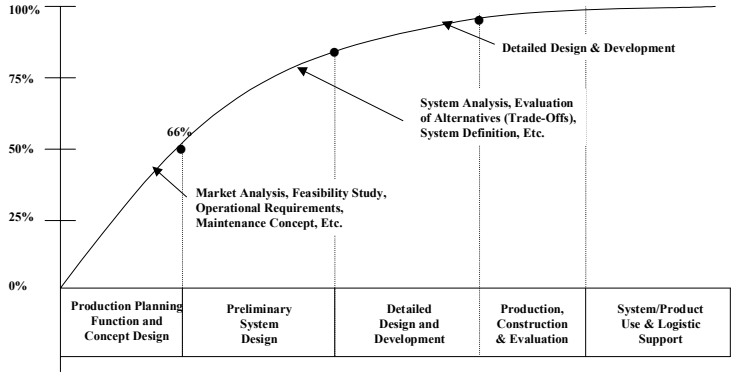
Figure 1: Actions Affecting Life Cycle Costs



Source: Blanchard (1978), p. 15.

Figure 2: Distribution of Cost Management Techniques Across the Product Life Cycle

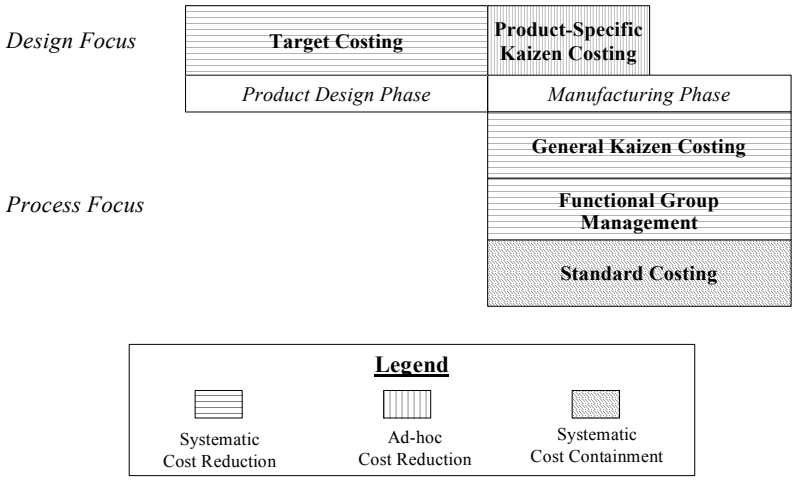


Table 1: Anticipated Pattern of Cost Management

Phase in the Product Life Cycle	Formality	Focus	Objective
Product Design	Systematic	Product Design	Cost Reduction
Manufacturing	Systematic	Production Process	Cost Containment

Table 2: Cost Management Techniques Observed at Olympus Optical Co.

Phase in the Product Life Cycle	Cost Management Technique	Formality	Focus	Objective
Product Design	Target Costing	Systematic	Product Design	Cost Reduction
Manufacturing	Product-Specific Kaizen Costing	Ad hoc	Product Design	Cost Reduction
Manufacturing	General Kaizen Costing	Systematic	Production Process	Cost Reduction
Manufacturing	Functional Group Management	Systematic	Production Process	Cost Reduction
Manufacturing	Standard Costing	Systematic	Production Process	Cost Containment

[1] It is possible that this assumption breaks down for extremely simple manufactured products. The products analyzed in this paper fall towards the middle range of product design complexity.

[2] For a thorough description of target costing, see Cooper R. and R. Slagmulder, 1997, *Target Costing and Value Engineering*, Portland, OR: Productivity Press.

[3] From the literature it is not clear whether the Blanchard statistic for a product should include or exclude any cost savings achieved through product redesign in the manufacturing phase. In this paper, we have adopted the conservative assumption that such savings are included.

[4] Other firms have introduced similar systems for the same reason. For example, Kirin Breweries used its Kyoto Brewery System and Higashimaru Shoyu introduced its Price Control System to motivate cost reductions in their production processes (Cooper 1995).

[5] This observation has to be interpreted carefully as there is some degree of product design in the general kaizen program: for example, metal parts might be substituted for plastic ones and separate integrated circuits might be combined into a single one. However, the bulk of the savings are achieved by reducing the labor and overhead content of the production processes.

[6] Since product specific kaizen costing is an *ad hoc*, as opposed to a systematic, cost management approach at Olympus Optical, its integration sheds little light on the validity of the Blanchard proposition. However, we included a description of its integration with target costing to provide the reader with a more complete understanding of how carefully all of the elements of Olympus Optical' cost management program have been designed.