The effect of cost goal specificity and new product development process on cost reduction performance

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A B S T R A C T

Many firms that compete based on the development of new and innovative products have begun to adopt concurrent new product development (NPD) processes in which product design phases occur in a non-linear and iterative manner. While concurrent NPD processes increase flexibility and reduce time-to-market as compared to traditional sequential processes, concurrency increases task uncertainty since the product design process begins before all important product features and specifications have been established. Such changes can result in costly redesign and rework. Prior research suggests target costing, where product design teams are assigned specific cost goals, is an effective method of controlling costs in sequential NPD. Even so, it is unclear whether target costing will improve cost reduction performance when combined with a concurrent NPD process due to increased task uncertainty. We examine experimentally the ability of product design groups to achieve specific or general cost reduction goals under simulated sequential or concurrent NPD. We predict and find that the nature of the NPD process moderates the effect of specific cost reduction goals on actual cost reduction performance. While specific cost goals result in higher reductions in product cost than general cost goals under a sequential NPD process, specific goals are no better than general goals in motivating design groups to reduce product cost under a concurrent NPD process; thus, we demonstrate boundary conditions on the usefulness of target costing as a cost control method.

Introduction

New product development (NPD) processes comprise several phases that typically include planning, concept design, product design and testing, and production start-up (Davila, 2000). These phases have traditionally been performed sequentially and in lock-step (Kalyaraman & Krishnan, 1997; Valle & Vazquez-Bustelo, 2009). Decisions about product features and specifications are identified and “frozen” before the actual design process begins (Hertenstein & Platt, 2000). In contrast, under concurrent NPD, design phases occur simultaneously and in a non-linear manner. Product specifications may unexpectedly change due to upstream decisions about product features that continue to occur even though downstream product design activity has already begun (Loch & Terwiesch, 1998; Mitchell & Nault, 2007). Thus, task uncertainty, defined by the number of exceptions and degree of improvisation required to complete internal tasks (Perrow, 1970), is higher under concurrent than under traditional sequential NPD (Mitchell & Nault, 2007).

An important and relatively unexplored issue is how firms control NPD costs when task uncertainty is high.
Prior research suggests target costing is an effective cost management tool firms use during the NPD process (Booker, Drake, & Heitger, 2007; Cooper, 2002; Davila & Wouters, 2004; Dekker & Smidt, 2003; Everaert & Bruggeman, 2002). Target costs are specific cost goals calculated by subtracting a target profit from the product’s market-driven sales price (Ax, Greve, & Nilsson, 2008). Setting and working toward target costs can provide significant cost savings in sequential NPD processes (Anderson & Sedatole, 1998; Cooper, 2002; Cooper & Slagmulder, 1999).

Concurrent processes, on the other hand, are inherently more uncertain than traditional sequential processes (Mitchell & Nault, 2007) and thus, we examine whether assigning specific cost goals (as would be the case under target costing) will also be effective in controlling costs under concurrent NPD. This issue is important given the recent widespread adoption of concurrent NPD processes in practice (Mitchell & Nault, 2007; Valle & Vazquez-Bustelo, 2009).

Hirst (1987) develops a theoretical proposition that task uncertainty will limit the effectiveness of specific cost goals (such as target costs) in directing effort and performance, although he does not test this proposition empirically. Essentially, Hirst (1987) argues that as task knowledge becomes less complete, task uncertainty increases and individuals are less able to identify the most effective ways to direct their effort towards improved performance when presented with specific goals. This effect is much less severe (or even nonexistent) under general (“do your best”) goals. Therefore, based on the theory developed in Hirst (1987), we hypothesize that the nature of the design process (sequential or concurrent) will moderate the effectiveness of specific cost goals in motivating increased cost reduction by new product design groups. In particular, due to higher task uncertainty under a concurrent NPD process, specific cost reduction goals will be less effective in reducing product cost under concurrent relative to sequential NPD.

In our experiment, 186 participants are assigned to three-person product design groups and are required to redesign a small truck to meet new product specifications. The group’s objective is to lower the truck’s cost while achieving the stated functional/technical specifications. Participants are students enrolled in MBA or other postgraduate executive education programs. To operationalize variations in specificity of cost goals, we assign a specific goal (“achieve a final product cost of $16,500”) to half of the design groups and a general goal (“reduce costs as much as you can”) to the others. We operationalize the sequential and concurrent design processes by varying the timing of information delivered to design groups regarding new product specifications. We simulate a more certain sequential process by informing design groups of all product specifications before they begin to redesign the product. To simulate a relatively less certain concurrent process, the design groups receive the same information in total as under the sequential process, but one third of the product specifications are provided at each of three different intervals during the work period and the design groups do not know when or if this new information will be received.

We find that the nature of the design process (concurrent or sequential NPD) moderates the relation between cost goal specificity and cost reduction performance. Groups assigned a specific cost goal reduced costs more than those assigned a general cost goal in the sequential NPD (low uncertainty) condition while cost reduction performance is no better under specific cost goals than under general (“do your best”) cost goals in the concurrent NPD (high uncertainty) condition.

This paper makes several contributions to both research and practice. First, we answer the call by Davila and Wouters (2004) for additional research to better understand how cost management tools like target costing can help or hinder innovation given recent changes in the manufacturing environment and the management of the NPD process. Second, our findings suggest cost goal specificity and the firm’s approach to the NPD process may jointly influence design teams’ ability to reduce the cost of new and redesigned products. These results are important given recent popularity of concurrent NPD (Mitchell & Nault, 2007; Valle & Vazquez-Bustelo, 2009) in many organizations looking to reduce time-to-market for new products. As more firms adopt concurrent processes, it will be important to recognize that high task uncertainty may be a boundary condition on the effectiveness of target costing; hence developing alternate cost management tools that are effective in the uncertain concurrent NPD environment should be a priority for these organizations (Davila & Wouters, 2004).

The remainder of this paper is organized as follows. The next section reviews the literature and develops our hypothesis. We then describe the research design and results of hypothesis tests and finish with a discussion and suggestions for further research.

Literature review and hypothesis development

Target costing

Target costing is defined as a profit planning and cost management tool used to support the development of new and redesigned products (Kee & Matherly, 2013). Cost targets are derived by deducting required profit margins from market prices and typically serve to control costs during the design stage of NPD (Ansari, Bell, & Okano, 2007). In practice, once a product’s cost target is established, a team works to design a product that satisfies customer requirements at no higher than the target cost (Cooper & Slagmulder, 1999). In a target costing environment, design teams are instructed to not just “design a good component,” but to instead “design the best component for a given amount of money” (Mihm, 2010, 1334).

Conditions under which target costing is adopted and reasons for its use have been examined extensively using

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1 While most prior research fails to distinguish sequential and concurrent NPD processes, Exhibit 2 in the review article of Hertenstein and Platt (2000) provides an example of a traditional sequential NPD process map studied in most of the prior accounting literature.

2 The experimental task is modeled after a target costing exercise used internally by the Boeing Company (also described in detail in Everaert & Swenson, 2014). The truck’s initial product cost was set at $20,000 for all design groups.
survey and field data. Results indicate that target costing is adopted most frequently by firms operating in uncertain external environments (Dekker & Smidt, 2003; Tani et al., 1994), although Ax et al. (2008) find the relation between intensity of competition and adoption of target costing to be indirect through perceived environmental uncertainty in their sample firms. Most respondents to prior surveys on the adoption of target costing indicate it is perceived as a useful cost control technique that can result in improved product quality, more cost effective product designs and timely new product introductions (Dekker & Smidt, 2003; Ellram, 2000; Tani et al., 1994). Conditions under which target costing is more or less effective in reducing product cost have also been examined. For example, Ibusuki and Kaminski (2007), in their field study of an automotive manufacturer’s NPD process, found that target costing was most effective when paired with value engineering methodologies while Filomena, Neto, and Duffey (2009) examine a field site in Brazil where managers believed target costing should extend beyond careful tracking of product-development costs to also include setting a target cost for the NPD process itself. No prior studies of which we are aware have examined the usefulness of target costing under concurrent NPD.

In the target costing literature, Everaert and Bruggeman (2002) experimentally examine the effect of specific, difficult cost goals and time pressure on cost reduction in NPD. While they do not specify the nature of the NPD process (i.e., sequential or concurrent), the description of their experimental task implies very little uncertainty in the NPD process. Their results indicate specific difficult cost reduction goals result in greater cost reduction than general (“do your best”) goals, although this effect is diminished when time pressure is high. Everaert, Boër, and Bruggeman (2000) use a similar experimental design to examine the effects of cost goals and time pressure for a “derivative” new product, defined as requiring an incremental change to an existing product, and for a “next generation” new product, defined as involving a more radical change requiring significant creativity from design engineers. Results indicate significantly higher cost reduction in the presence of a specific cost goal for the derivative, but not the next generation product implying that specific cost goals improve cost reduction performance when task complexity is low rather than high. Even so, task uncertainty has not previously been examined in this context.

Task uncertainty and NPD

In the current study, we focus on the product design phase of NPD characterized by the development of the physical product. In traditional sequential NPD, the product design phase does not begin until all product specifications and features are confirmed. Thus, sequential NPD is described as linear and “lock-step” (Hertenstein & Platt, 2000). In concurrent NPD, the specifications and product features coming out of the concept design phase are considered preliminary and may change even though the product designers have begun to work on the next phase in the NPD process (Krishnan & Ulrich, 2001). For this reason, concurrent NPD has been described as non-linear and iterative (Mitchell & Nault, 2007). Some managers prefer to implement concurrent NPD processes because they can reduce time-to-market for new products, although concurrency can also mean that product designers’ work becomes inherently more uncertain (Mitchell & Nault, 2007).

Task uncertainty in concurrent NPD is driven by variability and lack of analyzability of the work that is performed (Perrow, 1970). Variability refers to the degree of routineness of the work performed while analyzability refers to the degree to which exceptions to routine work require workers to improvise a solution (often referred to as degree of task knowledge). Concurrent NPD is characterized by more variability and lack of routine in the product designer’s work than would be experienced under sequential NPD. In addition, concurrent NPD processes are inherently less analyzable since, by design, they include more “exceptions” to work routines requiring designers to improvise solutions more often than under sequential NPD. Thus we characterize the product design phase carried out under concurrent NPD as higher on task uncertainty than the product design phase that is carried out under sequential NPD processes.

Task uncertainty, goal specificity and cost reduction performance

According to Locke and Latham (2002), goals lead to improved performance by directing attention and effort toward goal-relevant activities. In addition, goals play an energizing role with specific, difficult goals motivating higher effort than easy goals or “do your best” goals. Goals also affect persistence with specific, difficult goals motivating greater persistence at a task than easy or general (“do your best”) goals. Finally, goals affect motivation indirectly by leading to discovery and use of task-relevant knowledge.

In a theoretical analysis based on goal-setting theory, Hirst (1987) considers the effect of task uncertainty on the link between budget goal difficulty and performance. Hirst (1987) argues that specific, difficult budget goals focus attention on goal interpretation, strategy search and selection. In effect, goal specificity makes behavior selective and this can improve performance if the selective behavior reduces effort expended on irrelevant activities. However, as task knowledge becomes less complete, task uncertainty increases and individuals are less likely to easily identify the activities required to improve performance. Thus, Hirst (1987) proposes therefore, that task uncertainty will moderate the relation between goal specificity and performance; specific, difficult goals will lead to improved performance when task uncertainty is low, but not when task uncertainty is high.

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3 Results for time pressure and the interaction of time pressure and cost goal are not reported by the authors for either the derivative or next generation products.

4 In fact, Mitchell and Nault (2007, 375) call uncertainty “the engineering design problem most often examined in the literature on concurrency.”

5 Budgets are a particular type of cost, profit or return-on-investment goal against which performance can be evaluated (Kren, 1990).
Empirical evidence based on Hirst (1987) is scarce. More recent empirical papers citing Hirst (1987) tend to study the effects of environmental uncertainty on the adoption of goals rather than the effect of task uncertainty on the effectiveness of goals (Hartmann, 2000, 2007). Thus, we examine theory and empirical evidence beyond Hirst (1987) of a relation among task uncertainty, performance measures/targets and actual performance. For example, Chenhall (2003) provides a review of the survey-based literature from the early 1980s until 2002 using a contingency framework to study issues of management control. Based on his review of theory and empirical results, Chenhall (2003) forwards the proposition, similar to that of Hirst (1987), that as task uncertainty increases, controls become less formal including less reliance on planning and on pre-established accounting performance measures.

One study reviewed by Chenhall (2003) of particular importance to our work is Davila (2000) that uses four case studies of NPD processes and prior literature to develop a set of testable hypotheses concerning conditions under which management control systems would be more and less useful in NPD. Davila (2000) hypothesizes and finds that management control systems are used less intensively in NPD when technological uncertainty is high. Similar results are found by Abernethy and Brownell (1997) for R&D organizations. While neither Davila (2000) nor Abernethy and Brownell (1997) address target costing or cost goal specificity directly, Dekker, Groot, and Schoute (2012) examine the effect of task uncertainty on the specificity of divisional performance targets. They find that firms with lower task uncertainty are more likely to use specific performance targets.

In the NPD context, product design groups can be assigned specific or general cost goals (Cooper, 2002; Tornberg, Jamsen, & Paranko, 2002) to motivate them to reduce product costs. Groups that operate under a sequential NPD process receive finalized design information at the outset; therefore, they are more easily able to focus their efforts on achieving a specific cost target. Under a concurrent NPD process, there is much uncertainty and variability in the timing and type of product specification information that is available to design groups once the design process has begun (Loch & Terwiesch, 1998; Roemer, Ahmadi, & Wang, 2000). Furthermore, groups must periodically redirect their cost reduction efforts to incorporate new specifications as they are received. In essence, the concurrent NPD process, when paired with a specific cost reduction target, can actually place additional cognitive demands on group members which can reduce the specific cost goal’s potential effectiveness in motivating effort to reduce costs compared to those groups assigned a general cost goal (Byron, Khazanchi, & Nazarian, 2010). These arguments imply assigning specific cost reduction goals will improve performance more under a sequential than a concurrent NPD process leading to the following hypothesis:

**Hypothesis.** The nature of the product design process will moderate the relation between cost goal specificity and cost reduction performance: groups assigned a specific cost goal will reduce product cost more than groups assigned a general cost goal under a sequential, but not a concurrent NPD process.

**Experimental design and method**

The experiment employs a 2 (specific/general cost reduction goal) × 2 (sequential/concurrent NPD process) between-subjects design. Participants include 186 students enrolled in executive education and MBA programs at large universities in the US, Europe and India. Participants are randomly assigned to an experimental condition and then to one of 62 three-person groups. The objective of the group was to redesign a truck made of LEGO™ parts in order to meet new product specifications while reducing cost. The trucks produced by six groups did not meet the required product specifications, stability or safety tests and were disqualified. In addition, one group did not answer the post-experimental questionnaire including our “understanding of the cost workshop” covariate (described in detail below). Therefore, 55 groups are included in the ANCOVA used to test our hypothesis.

Participants completed the task as part of a classroom exercise. They were told they would be working on a group activity to learn more about product design and cost management techniques. Completion of the truck redesign task was followed by debriefing by the instructor concerning the learning objectives of the activity. Participation in the activity was a required element of the course and results of the exercise (e.g., which groups were able to reduce costs the most) were revealed to the participants once complete.

Participants’ mean age was 28.9 years (standard deviation = 5.63) and their full-time work experience averaged 6.8 years (standard deviation = 6.2 years). Seventy percent of participants were male. Nineteen percent of participants reported working in accounting/finance, 28 percent were engineers and the remaining participants reported their functional area as “other.”

**Task overview**

Groups engaged in an exercise to redesign a LEGO™ model truck subject to certain design specifications, quality requirements and cost constraints (see Appendix A). The truck’s cost was determined by summing its direct material, direct labor, and overhead costs. Material and labor costs were assigned based on the size and quantity of LEGO™ parts used. Overhead costs were assigned based on the number of different types of parts used in the truck’s design (see the product costing worksheet in Appendix B). To develop the experimental task, two of the authors participated in internal training workshops on target costing conducted at The Boeing Company. Similar to our experiment, Boeing’s workshop included a “hands-on” target costing exercise using an advertising display wagon as the product. We also received feedback on the degree of

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Program of enrollment was not a significant covariate in our hypothesis tests described below.

While many firms that implement target costing employ cross-functional design teams (Swenson, Ansari, Bell, & Kim, 2003), we chose not to attempt to simulate a cross functional team in the lab to limit potential noise in our results.

Specifically, the trucks redesigned by three groups failed to meet one of the design specifications, one group failed the minor crash test, and two groups failed the lift test. Failures were distributed across experimental conditions.
realism in our experimental task from members of the Consortium for Advanced Management—International’s (CAM-I) Target Costing Group. We then conducted several pilot tests to refine and standardize the experimental task.

The experiment lasted two hours and 45 min and, for consistency, administrators followed a script throughout. For the initial instructional phase, all participants received a set of written materials and viewed a presentation by the administrator describing the truck’s building blocks and components. Next, each participant received a set of parts with written instructions about how to build the truck according to its original design. Participants then spent 20 min learning how to build the original truck.

For the next step, the administrator explained how to calculate the truck’s product cost using the product costing worksheet. Participants used this worksheet to calculate the product cost for the truck they had just built. At this point in the exercise, all participants had handled the truck parts, built the truck according to its original design, and used the product costing worksheet to calculate its cost. Participants were then randomly assigned to a three-person design group.

Groups next received information describing their task along with a specific or a general cost goal. Each group member completed a pre-experimental questionnaire that assessed their understanding of the goal, their self-efficacy and commitment to achieving the goal. Each group then received two completed trucks in the original design (one to be redesigned and the other as a reference of the original design) and a standardized set of additional LEGO™ parts to use when redesigning their truck. The groups also received several blank product costing worksheets.

All groups had 60 minutes to complete their truck redesigns. Each workstation was partitioned off to prevent participants from observing other groups’ work. When time ran out, groups were told to stop working and each participant completed a post-experimental questionnaire with demographic and process-related questions. Following the experiment, all trucks were examined by the administrator to ensure they met quality and design specifications.9

Independent variables

Specificity of the cost goal

The first between-subjects variable manipulated the cost goal at two levels, a specific cost goal and a general cost goal. All groups started with a truck that had a product cost of $20,000. The written instructions for the specific cost goal condition stated: “Your group’s objective is to redesign your truck and achieve a cost goal of $16,500.” The written instructions for the general cost goal condition stated: “Your objective is to redesign your truck and reduce costs as much as you can.”

The specific cost goal was developed after reviewing the goal setting literature and conducting several pilot tests. While the literature reveals that the presence of specific, difficult goals improves performance (Locke & Latham, 1990), it also emphasizes the importance of setting achievable goals (Webb, 2004). Similar to Everaert and Bruggeman (2002), we set the specific cost goal at a level of cost reduction that was achieved 40% of the time by the groups with no specific cost goal in our pilot tests of the experiment.

Sequential and concurrent NPD process

The second between-subjects variable manipulated task uncertainty via a sequential and a concurrent NPD process by varying the point at which revised product specifications were provided to the design groups. The revised specifications were divided into three segments and were presented using both video clips and handouts. Details are provided in Appendix C.

In the sequential condition, all revised specifications were received by the design groups before the product redesign process began while in the concurrent condition, groups received the first piece of information at the beginning of the exercise, the second piece 20 min into the exercise, and the third piece 40 min into the exercise. Thus, concurrent design groups did not know if or when new information would be received once the product redesign process began. All groups were also informed of the amount of time remaining until the end of the work period at 20-min intervals. Groups in the sequential condition learned how much time was remaining only while groups in the concurrent condition also received the new pieces of information at each 20-min interval.

Dependent variable

Our dependent variable is the dollar value of cost reduction achieved by each group measured as the difference between the truck’s original design cost ($20,000) and the cost of the redesigned truck. The truck’s original and redesigned costs were calculated using an activity-based costing (ABC) approach.10 Our study included the number of different types of parts utilized as an activity-based cost driver. We did not tell the groups how to lower costs or redesign their truck; however, they could reduce the truck’s cost by eliminating unnecessary parts, by using less expensive parts, and by reducing part variety.11 The amount by which cost was reduced was recalculated and verified by the administrator at the end of the session.

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9 The practitioner literature expresses concern that quality standards could be relaxed as companies pursue aggressive cost goals (Cooper & Slagmulder, 1999; Kato, 1993). Therefore we used pilot tests to determine how and if participants’ would cut corners while they redesigned their trucks. We then controlled this potential behavior by developing Appendix A to clarify the truck’s design specifications and other quality requirements including stability and safety tests.

10 Prior research has suggested that the method of cost reporting can influence behavior (Buchheit, 2004; Dearman & Shields, 2005). Thus, we utilize a simple activity-based costing method in all conditions to minimize potential cost reporting format confounds. While accounting/finance participants may have better understood the costing method, functional background when entered as a covariate in our analysis was statistically insignificant (p-value > 0.70).

11 Although using part variety as a cost driver added complexity to the product costing exercise, it also made the experiment more robust by having the participants consider an often overlooked cost driver that can significantly affect product costs.
Results

Manipulation checks

To test participants’ understanding of the nature of their cost goals, each participant responded to the question “What was your group’s objective?” The question was open-ended and two of the researchers read through the responses and coded them as follows: (1) cost reduction was not mentioned at all; (2) general reduction of costs was mentioned or (3) the specific cost goal was mentioned. Seventy-two of the 81 participants in the general cost goal condition completed the questionnaire and of these, four failed to write an objective which mentioned cost reduction. Seventy-seven of the 87 participants in the specific cost goal condition condition completed the questionnaire. Twelve of these participants mentioned cost reduction, but did not state the specific cost reduction goal in their response while only one did not mention a cost goal at all. Given our manipulation check question was qualitative and open ended and no groups had more than one participant that failed to mention the correct cost reduction goal, we retain all groups in the sample for purpose of hypothesis testing in the results section below. Even so, for completeness, we also disclose results of our hypothesis tests for the reduced sample in the tests of hypotheses section below.

Covariate

On our post-experimental questionnaire, we asked participants to indicate the degree to which they understood how to use the product costing worksheet on a scale of 1 (not at all) to 5 (completely). We then calculated the group mean degree of understanding by averaging responses to this question provided by each of the three members of each group. The mean group response was 4.71 (std. dev. = 0.43) or design process (p = 0.91) and no other potential covariates were identified.

Descriptive statistics

Descriptive statistics concerning dollars of cost reduction by experimental condition are presented in Table 1. All means are adjusted for the effect of the covariate, that is, participants’ understanding of the cost worksheet. In the sequential condition, the adjusted mean dollars of cost reduction per truck is $3786 (std. dev. = $814) when there is a specific cost goal and $2819 (std. dev. = $855) when there is a general cost goal. In the concurrent condition, adjusted mean dollars of cost reduction is higher under a general cost goal (mean = $3737; std. dev. = $787) than under a specific cost goal (mean = $3507; std. dev. = $483).12

Tests of hypothesis

We hypothesized that the nature of the NPD process would moderate the relation between goal cost specificity and cost reduction performance such that groups assigned a specific cost goal would reduce costs more than groups assigned a general cost goal under the sequential, but not the concurrent NPD process. We perform an analysis of covariance (ANCOVA) to test this prediction. The results of our ANCOVA are presented in Table 2 (Panel A).

The significant interaction between cost goal specificity and NPD process (F = 10.04, p < 0.01) indicates initial support for our contention that the nature of the NPD process moderates the relation between cost goal specificity and cost reduction performance.13 Next we perform an ANCOVA within each of the sequential and concurrent conditions (see Table 2, Panel B). Consistent with our hypotheses, results indicate a significant main effect of cost goal specificity in the sequential condition, the adjusted mean dollars of cost reduction

Note: Means are adjusted for the effect of the covariate (evaluated at mean = 4.67) measured as the mean rating for each group of participants’ understanding of the costing worksheet (1 = not at all and 5 = completely). We lose one group in our analysis as they did not answer the question about understanding of the cost worksheet used as our covariate. Dollars of cost reduction is measured as the difference in cost between the original and the redesigned truck.

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12 The covariate was not significantly correlated with cost goal type (p = 0.43) or design process (p = 0.91) and no other potential covariates were identified.

13 We note the standard deviation of cost reduction dollars varies greatly among cells. Even so, the Levene test for homogeneity of variance was not significant (F = 1.46, p = 0.24). Second, to examine whether outliers influence our results, we create simple pass/fail categories based on whether the group achieved the $3500 cost reduction goal. In the sequential condition, 80% of groups assigned specific cost goals achieved the cost reduction goal while only 21% of groups assigned general cost goals achieved the goal. In the concurrent condition, 50% of groups assigned specific cost goals met the goal while 69% of groups assigned general cost goals achieved the goal. These proportions follow the same pattern as results of our main hypothesis tests reported in the next section of the paper and differences in proportion are significant based on a chi-square test (p-value <0.01). Thus, outliers do not appear to have a major influence on our results.

14 When we exclude the 17 groups that include one group member who failed to mention the appropriate cost goal on the manipulation check question, the interaction between cost goal and NPD process is marginally significant (p = 0.07) and the covariate is no longer significant (p = 0.29).
the sequential ($F = 11.48, p < 0.01$), but not in the concurrent NPD condition ($F = 1.15, p = 0.29$). Our results provide support for our hypothesis.

**Supplemental analysis**

To supplement our main analyses, we examine various process measures obtained as part of the post-experimental questionnaire to see if they are associated with differences in cost reduction performance. First, we analyzed the number of times that group members self-reported redesign attempts on the truck as a whole during the 60-min exercise. This statistic could be a potential explanation for greater cost reduction by groups in the sequential condition. We did not, however, find a significant difference in the number of redesign attempts depending on cost goal, NPD process or the interaction between goal and NPD process (all $p > 0.24$).

In the concurrent condition, groups are required to modify their design several times to incorporate new product specifications. Thus, it is possible that the nature of the concurrent NPD process will naturally increase participants’ frustration with the process. Frustration has been identified as a stressor that can place additional cognitive demands on design groups (Byron et al., 2010). To examine whether frustration affects our participants’ cost reduction performance, we asked participants to respond to the following question: “To what extent did the timing of when you received your design change information affect your truck building experience?” Participants responded on a scale of 1 (caused no frustration) to 5 (caused a lot of frustration). Results of an ANOVA with frustration as the dependent variable and cost goal and NPD process as independent variables indicates a significant difference depending on NPD process ($p < 0.01$) with those in the concurrent condition indicating significantly more frustration (mean = 2.64, std. dev. = 0.85) than those in the sequential condition (mean = 1.79, std. dev. = 0.57). Neither the main effect of cost goal specificity ($p = 0.94$) nor the interaction between cost goal specificity and NPD process ($p = 0.71$) were significant predictors of frustration with the task.

Everaert and Bruggeman (2002) find that time pressure diminishes the beneficial effects of specific goals on cost reduction performance for incremental design changes. In our study, all groups operate under similar time constraints and pilot testing indicates that the 60 min allowed was viewed by most participants as sufficient to complete the redesign. Even so, it is possible that some participants perceived that time pressure limited their ability to achieve cost goals. Therefore, as part of our post-experimental questionnaire we asked participants about the extent to which they perceived time pressure limited their effectiveness. Results of an ANOVA with perceived time pressure as a dependent variable and cost goal type and design process as independent variables indicated neither of the independent variables nor the interaction between them were significant (all $p > 0.24$). In addition, we ran the same ANCOVA reported in Table 2, but with the addition of perceived time pressure as a covariate. Results were qualitatively similar to those presented in Table 2 although the perceived time pressure covariate was not significant ($p = 0.58$). Thus, time pressure does not appear to be an alternative explanation for our experimental results.

Finally, we examined whether participants perceive the task to be more difficult depending on experimental condition by asking “How difficult was it to achieve your group’s objective?” Responses were given on a scale of 1 (not at all difficult) to 5 (extremely difficult). Results of an ANOVA with perceived difficulty as the dependent variable and cost goal type and design process as independent variables indicates perceived difficulty is significantly higher under specific cost goals (mean = 3.17, std. dev. = 0.68) than general cost goals (mean = 2.60, std. dev. = 0.50). Perceived

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15 When we exclude the 17 groups that include one group member who failed to mention the appropriate cost goal on the manipulation check question, the main effect of cost goal type in the sequential condition continues to be significant ($p = 0.03$) while the covariate is no longer significant ($p = 0.41$). Similar to the full sample results, neither cost goal type ($p = 0.69$) nor the covariate ($p = 0.54$) are significant in the concurrent condition.
difficulty did not vary significantly depending on design process or the interaction between design process and cost goal type \( (p > .23) \). Thus, specific cost goals were perhaps not surprisingly perceived to be more difficult to achieve than general cost goals regardless of NPD process.¹⁶

Discussion

This study provides evidence that the type of NPD process moderates the effectiveness of cost goals in motivating cost reduction performance. Specific cost goals result in higher cost reduction performance under a sequential, but not a concurrent NPD process. These results are important given the operations management literature recommends that concurrent NPD processes be implemented to reduce time-to-market in response to increasing global competition (Afonso, Nunes, Paisana, & Braga, 2008; Roemer et al., 2000). Similarly, target costing has been recommended in the cost management literature as an important tool to ensure newly designed products can be introduced at a competitive market price (Cooper, Swenson et al., 2003). Our results indicate that specific cost goals as used in target costing result in significantly reduced new product costs under sequential, but not concurrent NPD processes. While the arguments made by Anderson and Sedatole (1998) suggest this may be the case, we are not aware of prior studies that have empirically tested these relations.

In addition, we note reports that target costing has not achieved the widespread application that might be expected given the benefits identified in the literature (Dekker & Smidt, 2003; Guilding, Cravens, & Tayles, 2000). Our results suggest that these benefits might be overstated in the presence of uncertainty inherent in concurrent as compared to more traditional sequential design processes. Given there are many other potential sources of uncertainty in the NPD process, our results provide additional insight into the finding that target costing is not as popular in practice as might be expected given its touted benefits.

Finally, an alternative interpretation of our results might be that firms should always use specific cost targets because they perform better than general cost targets under sequential NPD and not significantly worse under a concurrent NPD process. However, future research is required that considers the increased costs that may accompany the development and implementation of specific cost targets and target costing programs against the potential benefits that might be achieved under concurrent NPD.

Certain factors limit this study’s generalizability. First, we chose to examine incremental rather than radical product design changes to keep task complexity constant and relatively low across conditions. Everaert et al. (2000) find that a specific cost goal leads to greater cost reduction for incremental rather than radical product design changes and attribute this effect to incremental changes being less complex than radical changes. Our experiment examines the effect of cost goals and NPD processes on incremental design changes only (i.e., where task complexity is relatively low); hence, the relative effectiveness of specific cost goals for radical design changes and under different NPD processes is left for future research.

Our choice to examine incremental rather than radical design changes also informed our decision not to tie financial incentives to the achievement of cost reduction goals. Specifically, Locke and Latham (2002) argue goals motivate performance independent of monetary incentives to achieve the goal and are only expected to have differential effects on performance when the task is complex (see also Bonner, Hastie, Sprinkle, & Young, 2000). Given we hold task complexity constant and relatively low across conditions, we did not expect to observe differential effects of financial incentives depending on cost goal specificity or NPD process. The effect of financial incentives on motivation and effort in NPD when task complexity is high is therefore an open question.

Second, we examine only two different information flow possibilities; that is, where all new information is received at the beginning of the design process, or where it is received at three equally spaced time intervals throughout the design process. In reality, the timing of receipt of new product specifications can range across the spectrum. Future research is needed to investigate how different patterns of information flow may affect the design groups’ ability to achieve cost goals.

Third, the groups in both our sequential and concurrent conditions had the same amount of time, in total, to complete their designs. However, given that companies adopt a concurrent approach to bring new products to market sooner, there may be time pressures in practice that were not present in our concurrent condition. Future research is needed to consider how time pressure influences the effectiveness of cost goals under concurrent NPD.

Notwithstanding its limitations, this paper makes several contributions to the literature by considering the joint effect of a concurrent NPD process and the implementation of cost goals to improve the timeliness and efficiency of the NPD process. While the operations management literature has considered how a concurrent NPD process can be used to reduce time-to-market given significant numbers of firms have moved to concurrent NPD in practice, our study is one of the first to shed light on the impact of target costing, a popular cost reduction technique in NPD, on cost reduction under a concurrent process.

Acknowledgments

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administering the experiment. Dan Swenson would like to thank the Nordic Council, the Copenhagen Business School, and Arizona State University for their financial support.

Appendix A. Information sheet for truck redesign given to participants

☐ Your group’s objective is to redesign your truck and achieve a cost goal of $16,500. *(This was the objective for the specific cost goal condition. For the general cost goal condition it read: “...and reduce costs as much as you can.”)*

☐ Your group must also satisfy the following design specifications and quality requirements:

**Design Specifications**

1. The redesigned truck must contain all of the special parts (4 wheels, 2 axles, a grille, windshield, steering wheel and roll bar).

2. The truck’s components must adhere to the following standards:
   - ☐ A light and a roll bar are required and must be placed on top of the cab.
   - ☐ The dimensions of the space inside the cab must not change.
   - ☐ Doors are required on both sides of the cab.
   - ☐ The dimensions of the engine must not change and it must remain in front of the cab.
   - ☐ The dimensions of the truck’s bed must not change.
   - ☐ For hauling cargo, the truck bed must have sides and a tailgate at their current height.
   - ☐ The undercarriage provides legroom for the driver and is required.
   - ☐ The distance between the two axles must not change.

**Quality Requirements**

1. The truck must maintain its integrity during a minor crash test (hitting a wall after traveling 18 inches at a 20 percent grade).

2. The truck must maintain its integrity while being lifted off the table two times, for five seconds each time.
   - ☐ For one lift, the facilitator will only hold on to the cab.
   - ☐ For the second lift, the facilitator will only hold on to the truck bed.

*Note: For the crash test we set up a ramp in a corner of the room that could not be viewed by the other groups. Individual groups could then self-test their own designs.*
Appendix B. Activity-based product costing worksheet provided to participants

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<th>End Inv</th>
<th>Qty Used</th>
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\# of Unique Plates Subtotal

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\# of Unique Bricks Subtotal

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</table>

\# of Unique Special Parts Subtotal

Total material & labor

Overhead cost (Total # of unique parts X $200) $200

Total Cost

Appendix C. Pieces of redesign information provided to participants

1. The National Traffic Safety Administration has discovered that this truck becomes a fire hazard when it is hit from behind. Therefore, the gas tank that is located behind the rear axle must be moved.
2. A consumer focus group has found that this truck has insufficient leg room. This problem can be corrected by extending the undercarriage to the front axle.
3. A second consumer focus group recommends two additional changes for this truck. The first recommendation is to remove the indentation from inside the truck bed. The second recommendation is to make the truck a four-wheel drive vehicle. These requirements can be met by designing a flat truck bed and extending the undercarriage to the rear axle.

References


