UNIVERSITEIT GENT

FACULTEIT ECONOMIE EN BEDRIJFSKUNDE

HOVENIERSBERG 24
B-9000 GENT
Tel. : 32 - (0)9 – 264.34.61
Fax. : 32 - (0)9 – 264.35.92

WORKING PAPER

The Impact of Target Costing on Cost, Quality and Development Time of New Products: Conflicting Evidence from Lab Experiments

Patricia Everaert [1]

Research Assistant
Faculty of Economics and Business Administration, Ghent University (Belgium)

Germain Böer [2]

Professor of Management
Owen Graduate School of Management, Vanderbilt University

Werner Bruggeman [3]

Professor of Management Accounting
Faculty of Economics and Business Administration, Ghent University (Belgium)

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Correspondence: P. Everaert and W. Bruggeman: Faculty of Economics and Business Administration, Ghent University, Hoveniersberg 24, 9000 Gent, Belgium, E-mail: patricia.everaert@rug.ac.be, Phone/Fax: 32 9 26435 00; G. Boër, Owen Graduate School of Management, Vanderbilt University, 401, 21st Avenue South, Nashville, Tennessee 37203, E-mail: germain.boer@owen.vanderbilt.edu.

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Abstract

This paper investigates the favorable and unfavorable impact of using target costing during the development of a new product, under high and low time pressure. For both time conditions, the impact of target costing is compared to the so-called traditional Western approach (where design engineers are expected to minimize the cost level of the future product). This 2 by 2 design is tested by two lab experiments. The first lab experiment simulates the development of next generation new products, requiring a radical type of innovation. The second experiment simulates the development of derivative kind of new products, requiring an incremental type of innovation. Each time, the impact of target costing is measured on three variables: the product cost level, the quality level and the development time of the new product.

For the development of a *derivative new product*, the favorable impact of target costing on the cost level of a future product was supported by the data. We found a lower cost level under target costing. Though there was a significant interaction effect with time pressure as well. Only under low time pressure led target costing to a significantly lower cost, compared to the “minimizing cost” condition. Under high time pressure, target costing did not lead to significantly lower product costs, compared to the “minimizing cost” condition, but led to a significantly longer development time.

Contrary for the development of a *next generation new product*, target costing did not have an impact on the cost of new products, compared to the “minimizing cost” condition. In that NPD environment, the quality of new products was significantly worse than in the “minimizing cost” condition, although participants were taught that quality was the most important characteristic of the future product. Similar to derivatives, target costing had also a negative impact on the development time under high time pressure.

In sum, the results suggest that target costing is not without danger for all sorts of NPD projects. Based on our results, target costing is appropriate for derivative kind of new products, where designers do not face high time pressure.

1. Introduction

The present paper investigates by two lab experiments the impact of target costing on the cost level, the quality level and the development time of new products. Two time conditions are considered to determine if the impact of target costing interacts with time pressure during new product development. The first lab experiment simulates the development of a next generation new product, asking for a radical type of innovation to be developed in the new product. The second lab experiment simulates the development of a derivative kind of new product, asking for an incremental type of innovation in the new product.

Academic writers (e.g. Kato, 1993; Cooper & Slagmulder, 1997) stress the strategic importance of *cost management*, due to intense competition. This emphasis of actively searching for opportunities to decrease the total cost of a product has traditionally focused on reducing costs of *current* products at the factory level. Recently, the target costing system has been described in the literature as a way to reduce costs of *future* products; i.e. searching for cost reduction ideas while the new product is still in the new product development process. Because as Blanchard (1978) argues, a substantial portion of product costs becomes determined during that new product development process.

Current case study researchers (e.g. Kato, 1993; Cooper, 1995; Cooper & Slagmulder, 1997) suggest that providing target-costing-information to design engineers during new product development has a favorable impact on the cost level of new products. Cooper (1995) reports that *target costing* appears to lead to future products that cause lower product costs than when design engineers have no specific target cost to achieve and are expected to minimize the product cost of the future product, which is further abbreviated in this paper as the *non-target costing* environment. Though, this so-called favorable impact of target costing on the cost of future products has only been supported by anecdotal evidence. No empirical research has tested the effectiveness of target costing (compared to non-target costing) by controlling the many extraneous influences that may affect the cost level (e.g. reward structure, top management attention to cost reduction, organization structure, culture of the product development department, etc.). The present paper fills this gap by investigating empirically, **whether**

the cost level of a future product will be lower in a target costing than in a non-target costing environment, for the development of derivatives as well as next generation type of new products.

Furthermore, the cost element is not the one and only factor that design engineers need to consider when designing and developing future products. Cooper (1995) refers to the *survival triplet* with the elements cost, quality and functionality. The R&D management literature (e.g. Rosenthal, 1992; Ulrich & Eppinger 1995) refers to the *multiple objectives* "quality", "development time", "product cost" and "development cost". **In this study, we will include three objectives, i.e. product cost (abbreviated further as cost), quality and development time**[1]. The challenge, as Ray (1995) explains, is to balance these objectives, since they are all linked with each other in a *conflicting* sense. For instance, changing the type of material might have a favorable impact on the cost level, but might have an unfavorable impact on the quality level of that future product. Furthermore, *prioritization* among the multiple goals should be set, because design engineers need to know which objective should be relaxed first when things start to slip beyond the point of full recovery (Rosenthal, 1992; Cooper, 1995). **In this study, we investigate a NPD environment where quality is the most important objective, the cost objective comes on the second place and attaining the development time objective is least important.**

In current target costing literature, some of the case study researchers (e.g. Kato, 1993) mention that the easiest way to attain the target cost is to lower the quality level of the product. Others (e.g. Kato, Böer & Chow, 1995) suggest that the use of target costing can lead to longer development periods, because of the intense search for cost reduction ideas. Yet, there is no research to date that studies the impact of target costing on the three outcomes together. Furthermore Cooper (1995) and Rosenthal (1992) agree that it is the combination of the outcomes that determines the success of the future product. Consequently, we will also investigate in this study the differences in created new products between a target costing and a non-target costing environment, considering *simultaneously* the cost level, the quality level and the development time.

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[1] Remark that we do not consider the development costs in this study.

While many authors are stressing the strategic importance of cost management in highly competitive markets, another stream of literature is stressing the importance of *shortening the development time* of new products (e.g. Stalk & Hout, 1990; Smith & Reinertsen, 1991; Wheelwright & Clark, 1992). Being fast on the market with a new product is considered as essential in the current competitive environment. Current research on target costing, as far as we know, has not studied if time pressure (or difficulty of the development time objective) is weakening the impact of target costing on the cost level of a future product. Hence, we will investigate whether the difference in cost level between a target costing and a non-target-costing environment depends on the levels of time pressure. **In this study, we will consider two conditions of the development time objective, inducing respectively low time pressure and high time pressure.**

This paper contributes to different areas. First, the paper contributes to target costing literature by empirically testing the impact on the cost level as well as on the quality level and the development time. This contribution fits into Shields & Young's (1994, 191) general call for more research on determining how design engineers make decisions that affect product costs. By including the impact of target costing on the three elements, we also meet Cooper's (1995, 82) call for more research on the interlocking roles of the different NPD outcomes. Second, this study can be considered as a first attempt to detect the conditions under which target costing leads to effective cost management. Two factors are included here i.e. time pressure and type of innovation required for the new product (radical versus incremental). Third, the paper also contributes to goal setting literature by studying a goal situation with multiple, conflicting goals, a topic that is covered scarcely in the literature, as will be discussed further on. This last contribution fits into Locke & Latham's (1990) call for more research on multiple goal setting.

The remainder of the paper is organized as follows. In section two, we review the literature and develop research hypotheses. In section three, we will outline the research design and discuss the experimental settings and procedures. Section four describes the results of the experiments. In the final section, we discuss and summarize the research findings.

2. Literature Review and Research Hypotheses

2.1 Impact of Target Costing on the Cost Level of Future Products

Based on the definitions of target costing, one could reasonably expect a favorable impact of the use of target costing during NPD on the cost level of a future product (Sakurai, 1989, Horvath, 1993; Kato, 1993; Sakuari, 1995). For instance, Fisher (1995, 50) defines target costing as "the systematic process for reducing product costs that begins in the product planning stage". Monden & Hamada (1991, 16) define target costing as "the system to support the cost reduction process in the developing and designing phase of an entirely new model, a full model change or a minor model change". Based on field studies, Cooper (1995, 137) concludes that target costing leads to products with lower costs than when design engineers are expected to minimize the cost of future products. Anecdotal evidence is found in Cooper (1994), Cooper & Yoshikawa (1994), Monden & Hamada (1991) and Kato, Böer & Chow (1995). Hence, we can expect a lower cost level under target costing than under non-target costing.

Though, discussing the impact of target costing on the cost level, compared to non-target costing, where design engineers are expected to minimize the cost level, does not make sense unless we know something about the *difficulty* of the target cost set. Current research on target costing in Japan (Kato, 1993; Tani et al., 1994, Cooper & Slagmulder, 1997) suggests that the target cost is frequently set at a level that is *difficult-to-attain*, i.e. at a level that approaches more the allowable cost than the as-if cost. Sakurai (1989, 45) and Kato (1993, 36) use the following expression: "the established target cost should be attainable but only attainable with considerable effort." Consequently, when comparing target costing with non-target costing in this study, we will consider a difficult target cost setting (TCS), i.e. a target costing NPD environment where the target cost is set at a level that is difficult-to-attain. This leads to the following hypothesis:

<u>Hypothesis 1</u>: *In a three goal NPD situation, the cost level of a future product will be significantly lower under the difficult target cost setting (difficult TCS) than under the non-target cost setting (non-TCS).*

The second core finding of goal setting theory - a theory developed by the Psychologists Locke & Latham (1990) - also sustains this first hypothesis. Goal setting theory asserts that a specific and difficult goal leads to better performance than a vague goal such as "do your best" (Locke & Latham, 1990). The finding has been replicated in a large number of studies, both in lab and field studies, for all sorts of tasks and jobs (Latham & Lee, 1986). However, only few studies are available in a multiple goal situation with conflicting goals, like the NPD environment we are studying here (Austin & Bobko, 1985). Though the second core finding has been replicated in a multiple (conflicting) goal situation as well. For instance, Schmidt, Kleinbeck & Brockman (1984) found a significant, favorable impact of a specific-difficult goal over a vague "do-your best" goal, in a two-conflicting-goal situation.

2.2 Impact of Target Costing on Multidimensional NPD Performance

During the development of a new product, design engineers face different goals in terms of the development time, the product cost, the development cost and the quality level of the future product (such as performance, features, durability, reliability, aesthetics, etc. according to the definition of Garvin, 1987). In this study, we limit the NPD objectives to *three*, i.e. to the cost level, to the development time and to one aspect of quality (aesthetics, see further). We call the outcome on these three objectives *"the multidimensional NPD performance"*. In current target costing literature, few research findings are available on the impact of target costing on this multidimensional NPD performance. Some of the field study researchers (Kato, 1993; Cooper & Slagmulder, 1997) mention that sacrificing the quality may be one easy way to attain the difficult target cost. On the development time objective, conflicting anecdotal evidence is provided in current target costing literature. Kato, Böer & Chow (1995, 49) describe a new product introduction at Matsushita (Japanese electronics manufacturer), where the NPD team was charged with reducing the cost of a future product to a level of 30% below the cost of the existing product. The team succeeded in reaching this target cost, but did so by introducing the product late, which meant that the expected sales were never realized. Similarly, Ansari & Bell (1997, 169) report than an overemphasis on attaining the target cost can lead to longer product development cycles, and hence delay the product from reaching the market. Contrary, Cooper

& Slagmulder (1997, 181) found that introducing target costing at Olympus (Japanese camera manufacturer) did not introduce any significant delay into the NPD process.

In goal setting, Audia et al. (1996, 488) found in a two-goal setting on quantity and quality goals that changing the *quantity* goal from a do-best goal to a difficult *quantity* goal, had a negative impact on quality performance in an assembly task. Also Terborg & Miller (1978) found that the performance on quality decreased when changing from a do-best *quantity* goal condition to a difficult *quantity* goal condition. These studies show that assigning a difficult quantity goal, as compared to assigning a "do-best" quantity goal improves the performance of that goal, but deteriorates the performance of the other goal. However, these mentioned studies are all two-goal setting situations, supporting a negative impact of a difficult quantity goal on the quality performance. Locke & Latham (1990, 97) explain that lowering quality can be done *consciously* in an attempt to attain a difficult quantity goal or it can be done *unconsciously* as a by-product of increasing one's attention to attain the difficult quantity goal. Similarly, Bavelas & Lee (1978, 236) explain that improving performance on the one goal and lowering performance on the other goal is a result of the directing attention effect that comes from the more difficult goal. In our study, focussing the attention of design engineers on attaining the difficult target cost can have a negative impact on the quality level as well as on the development time. Focusing the attention of design engineers on the difficult target cost can lead to a (conscious or unconscious) lower quality level, as found in the earlier mentioned goal setting studies. Looking for additional cost reduction ideas in order to attain the difficult target cost is more likely to make the total development time longer, as found in Kato, Böer & Chow (1995). Hence, we expect that design engineers will design totally different new products in the difficult TCS than in the non-TCS, leading us to formulate the following hypothesis:

<u>*Hypothesis 2*</u>*:* *In a three-goal NPD situation, a combination of the three new product development measures cost level, quality level and development time will significantly differ between the difficult target cost setting (difficult TCS) and the non-target cost setting (non-TCS).*

2.3 Interaction of Target Costing and Time Pressure on the Cost Level

Shortening development time is considered as strategically important to survive, which might cause time pressure for design engineers during the NPD of future products (Wheelwright & Clark, 1992). In our study, we will consider *two* levels of time pressure: i.e. an easy-to-attain development time objective (corresponding with low time pressure) and a difficult-to-attain time objective (corresponding with high time pressure).

In target costing, very few is known about the moderating impact of time pressure on the relationship between target costing and the cost level of the future product. Though in literature, many cost reduction techniques are described, ranging from value engineering, value analysis to teardown and checklist methods (Sakurai, 1989; Monden & Hamada, 1991; Horvath, 1993; Kato, 1993; Tanaka, 1993; Cooper, 1995; Fisher, 1995). Hence, one can assume that more cost reduction ideas will be generated when design engineers have more time to perform the given cost reduction techniques than when few time is available to think about cost reduction ideas. This suggests that the favorable impact of target costing on the cost level of the future product, compared to non-TCS, will be more pronounced under low time pressure than under high time pressure.

In goal setting studies, we found two studies on this interaction effect in a two-goal situation[2]. Bassett (1979, 204) manipulated a quantity goal and a time goal simultaneously. He found a significant interaction effect between the easy and the difficulty quantity goal across the easy and the difficult time condition. Similarly, Gilliland & Landis (1992, 676) did a lab experiment while manipulating the difficulty on a quality goal and the difficulty on a quantity goal. For a complex task, a significant interaction effect between quantity and quality-goal difficulty was found. In particular, there was a significant difference in *quality* performance between the easy quality and difficult quality condition when the *quantity* goal was easy, while there was not a significant difference in *quality* performance when the *quantity* goal was difficult. Hence, only when participants had an easy quantity goal (i.e. had time enough to think about the quality) assigning a difficult quality goal resulted in improved

[2] Remark that these studies both compare a difficult goal with an easy goal, while we are here interested in comparing a **difficult** goal (i.e. the difficult TCS) with a **do-best** goal (i.e. the non-TCS).

performance for quality. Contrary, under the difficult quantity goal (i.e. when participants had hardly time to think about the quality) assigning a difficult quality goal did not result in improved quality performance.

Similarly, we expect in our study that under an *easy* time condition assigning a difficult target cost will result in a lower cost level, compared to the non-TCS. Contrary, we expect that under a *difficult* time condition assigning a difficult target cost will not result in a significantly lower cost level, compared to the non-TCS, since design engineers will have hardly time to think about cost reductions. Thus, we expect that the differences in cost level between the non-TCS and the difficult TCS will be larger under low time pressure than under high time pressure, resulting in a significant interaction effect. This hypothesis is formulated as follows:

<u>Hypothesis 3</u>: *In a three-goal NPD situation, the difference in cost level between a difficult TCS and a non-TCS will significantly differ across the levels of time pressure.*

2.4 Interaction of Target Costing and Time Pressure on Multidimensional NPD Performance

In target costing, just one case study researcher mentions a negative impact of target costing combined with time pressure on the total performance of new products. Kato (1993, 42) argues that since much of the creativity involved in developing new products is human-dependent, too much pressure for shortening development time under target costing creates tension and results in poor performance and management fatigue. None of the other English language cases on target costing, as far as we know, have included a discussion on an interaction effect of target costing and time pressure on the new products design engineers create.

Goal setting studies on multiple goals show that the quality goal is more readily sacrificed for attaining the quantity goal, when two goals are set at a level difficult-to-attain. One of the first studies on multiple goal setting is Stedry & Kay's field experiment (1966, 461) on foremen, receiving productivity goals (two levels) and rework goals (two levels). Support (not confirmation) was found for their hypothesis that if both goals are difficult, participants more often perceive them as impossible than if only one of the two goals is difficult. Consequently, for the two goals being difficult, performance was worse on at least one of the two measures than if only one of the two goals was difficult. Stedry & Kay (1966, 461) explain that people allocate effort to the different goals so as to maximize the expected number of goals attained. Their reasoning is that in the two-goal situation, increasing goal difficulty in an area already receiving effort will increase the effort allocated to the area as well as the expected performance in that area. Beyond a certain point however, further increase in difficulty would drive the area out of the set of those receiving effort. Similar results were found in a dual-task experiment by Erez, Gopher et al. (1990, 249), where *two quantity* goals are assigned. Though no analyses were provided on the performance of each goal separate, the dual task performance measure (calculated as a weighted sum) shows the lowest value when both tasks were set at a level difficult-to-attain. Also Gilliland & Landis (1992, 676) found that participants gave up the less achievable quality goal and allocated their efforts toward the more achievable quantity goal, when both goals were set at a level difficult-to-attain. They explain that for complex tasks, quality may be more easily sacrificed for quantity than the other way around (i.e. sacrifice quantity for quality) when difficult goals are set for both. In general, people are sacrificing the least attainable goal, when achieving both of them becomes very difficult. From the above mentioned studies, we expect that design engineers will more easily sacrifice the quality level of the future product in the difficult TCS, compared to the non-TCS, when the time objective is difficult than when the time objective is easy-to-attain. Hence we expect larger differences in quality level between the non-TCS and the difficult TCS under high time pressure than under low time pressure. Earlier we also expected larger differences in cost level between the non-TCS and the difficult TCS under low time pressure than under high time pressure. Similar to the Erez (1990) study, we do not expect differences in time spent between the non-TCS and the difficult TCS across the two levels of time pressure. Summing up, we hypothesize a significant difference in created products between the non-TCS and the difficult TCS, across the two levels of time pressure (because of the quality and cost differences). This leads to the following hypothesis:

Hypothesis 4: *In a three-goal NPD situation, the difference between the difficult TCS and the non-TCS on a combination of the three new product development measures cost level, quality level and development time will significantly differ across the levels of time pressure.*

3. Type of New Product Development Environment assumed in this Study

In target costing literature, very few is known on the type of new product development processes for which target costing is appropriate in generating cost reductions. We will study the effectiveness of target costing in a new product development environment, as assumed below.

1. We assume a NPD environment with **three** conflicting goals: i.e. for the cost level, for the quality level and for the development time.

2. In the NPD environment of our study, no objective is set for **development cost**. Development costs are not measured in this study.

3. This study assumes that design engineers have **knowledge of the results**, allowing them to track the progress towards attaining each of the three goals.

4. This study assumes a **reward** structure, contingent on the attainment of each of the three goals simultaneously. Furthermore, in this study no incentives are assumed for design engineers going further than the target cost or having finished the development of the new product earlier than specified in the development time objective.

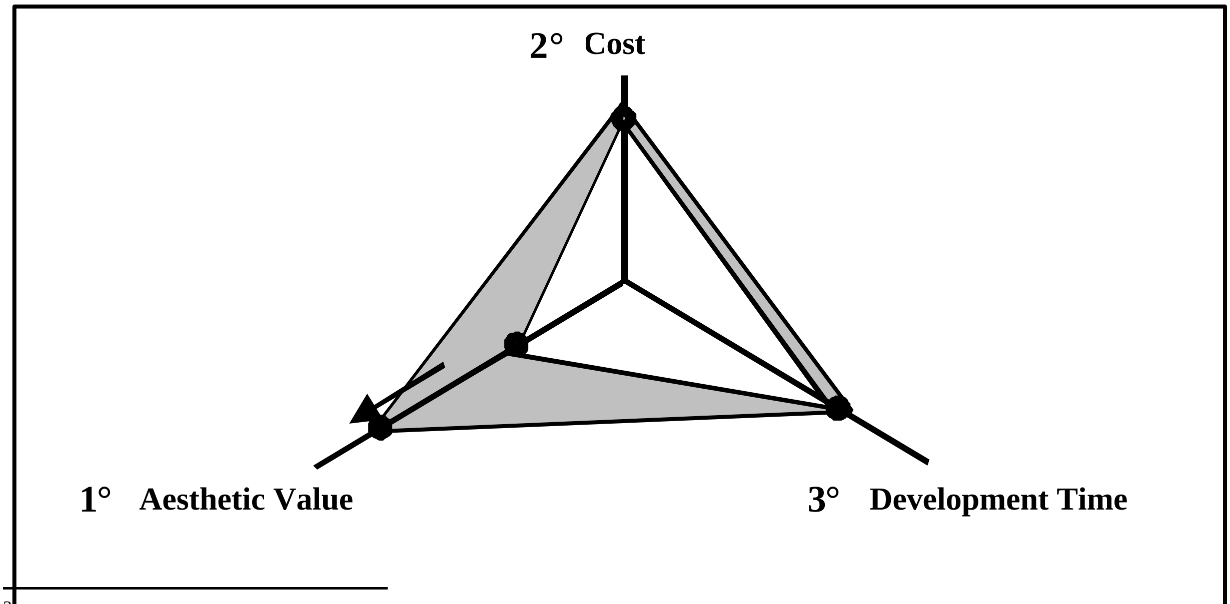
5. **Aesthetics** will be considered as aspect of quality in this study. To avoid the discussion that feedback on quality always lag feedback on cost performance because of the difficulty to notice a failure (for instance in reliability, durability or conformance), we use in this study a quality dimension which makes immediate feedback possible, i.e. design quality or aesthetics of the new product.

6. We assume in this study a survival triplet, as shown in Figure 1. **Priority** is given first to attaining the aesthetics objective, then to the cost objective and finally to the development time objective. Furthermore, in terms of **latitude** (i.e. the range between the minimum allowable and the maximum feasible value) on each of the three elements of Cooper's (1995) survival zone, we simulate an environment where some latitude on aesthetics is allowed, but few latitude is accepted

for the cost characteristic (because of a given market price) and few latitude is accepted for the development time objective (because of the risk being left behind by competitors). Finally, we simulate an environment of aggressive product design, asking for a do-best strategy for **aesthetics**.

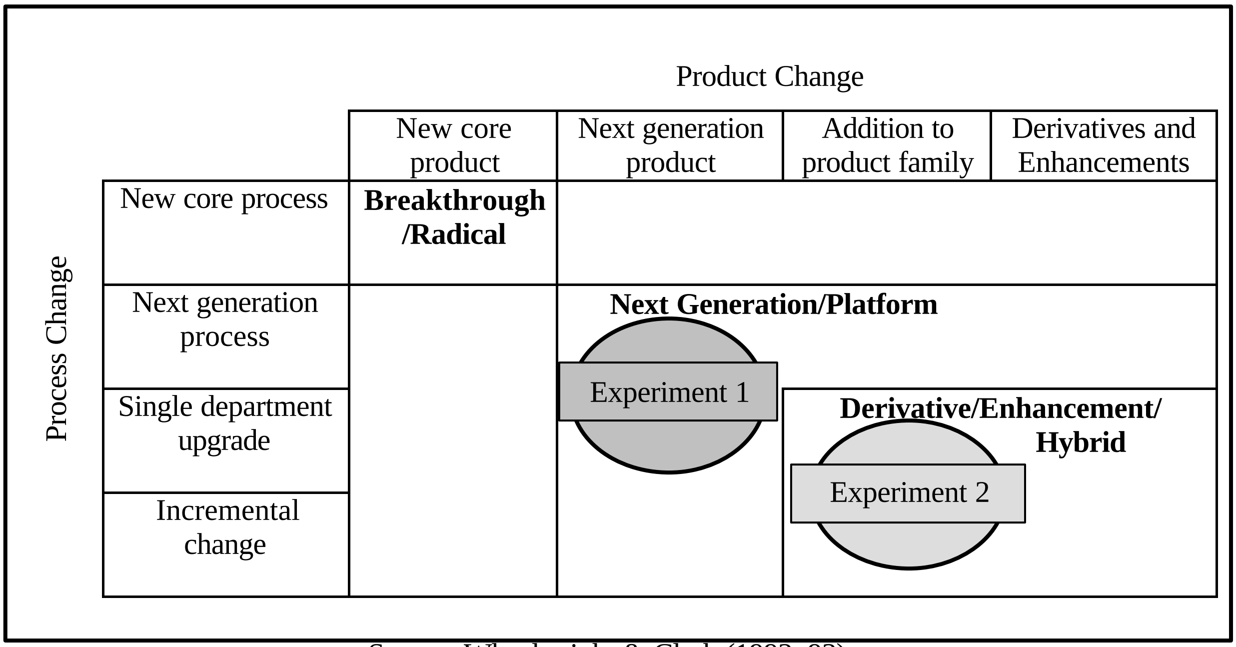
7. Following the framework of Wheelwright & Clark (1992), as shown in Figure 2, two different types of new products will be considered in this study. This two-dimensional framework defines individual NPD projects according to the degree of change in the product and the manufacturing process. *Derivatives* involve just incremental changes to existing products and thus require less creativity from design engineers. *Next generations* involve more radial changes to existing products and/or processes and thus ask for higher levels of creativity from design engineers. Breakthroughs require the most radical innovations, both in terms of product and processes, but will not be considered in this study. **Thus, in this study, we will investigate target costing for the development of *next generation* type of new products, as well as for the development of *derivative* kind of new products**. The earlier formulated hypotheses on the impact of target costing will be studied now under these mentioned assumptions.

Figure 1: The NPD Goals and the Survival Triplet of this Study[3]



[3] There exists some confusion on what is understood under "quality" in the definition of Cooper (1995, 15) when considering his survival triplet. Cooper (1995) would call the **aesthetic value** an aspect of *functionality*, because he limits in his definition quality to the conformity dimension. Under the general accepted definition of quality by Garvin (1987), aesthetic value is considered as one of the eight dimensions of *quality*. Furthermore Cooper (1995) considers "**development time**" also as an element of functionality. To keep only three axes in the survival triplet, we consider development time as the third axes, deleting quality (in the sense of conformance) which is not considered in our study here.

Figure 2: Types of New Product Development Projects



Source: Wheelwright & Clark (1992, 93)

4. Research Design

4.1 Lab Experiments

Lab experiments are used, because we want to test the developed hypotheses in a controlled environment and the lab provides the best opportunity to discover relations under "pure" and uncontaminated conditions (Birnberg & Nath, 1967; Kerlinger, 1973, Birnberg, Shields & Young, 1990). Hence, the artificiality of the laboratory (compared to the real environment of field research used before to study target costing) is here more an asset than a limitation. By isolating the situation from the life outside the lab, we can control the many extraneous influences that affect the new product development process. This artificiality also gives the unique opportunity to deliberately manipulate the variables of interest (target cost setting, time pressure and type of innovation) and to precisely measure the three dependent variables (cost, quality and development time). The obvious drawback of this artificiality is its reduced external validity. Though, discussion is provided in the literature on the many parallels between lab and field settings and between the similarity in behavior of student-actors in the lab and "real" employees in the field (Zelditch, 1969; Ashton & Kramer, 1980; Swieringa & Weick, 1982; Locke, 1986).

4.2 Experimental Design

We did two lab experiments. Experiment one simulates the development of a next generation kind of new product, while experiment two simulates a derivative kind of new product. Both experiments have a completely randomized factorial design (CRF-22), i.e. participants are assigned randomly to the treatment levels; all levels of the first treatment ("target cost setting") are considered in combination with all levels of the second treatment ("difficulty of the time objective"). In both experiments, "target cost setting" (TCS) has two levels (non-TCS and difficult TCS) and "time pressure" has two levels (easy TIME and difficult TIME), making four (2 x 2) cells in total, as shown in Figure 3. All effects are between-subjects effects and both experiments have a balanced cell design (n = 20, n = 16 respectively).

Figure 3: Experimental Designs in Experiment One (CRF-22) and Experiment Two (CRF-22)

	Experiment 1: CRF-22 Radical Innovation (next generation new product)		Experiment 2: CRF-22 Incremental Innovation (derivative new product)	
	Target Cost Setting		*Target Cost Setting*	
Time Pressure	**Non-TCS**	**Difficult TCS**	**Non-TCS**	**Difficult TCS**
Easy TIME	Cell 1 (n = 20)	Cell 2 (n = 20)	Cell 1 (n = 16)	Cell 2 (n = 16)
Difficult TIME	Cell 3 (n = 20)	Cell 4 (n = 20)	Cell 3 (n = 16)	Cell 4 (n = 16)

4.3 Experimental Task

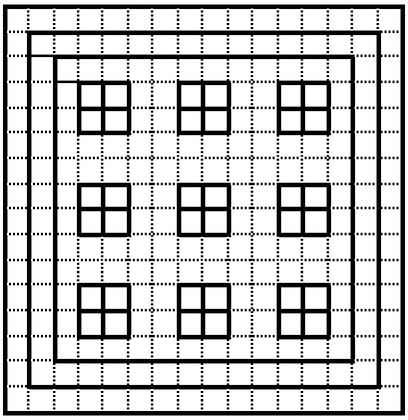
The idea for the task comes from the textile (carpet) industry. The textile sector is not a sector where target costing is extensively used in Japan (Tani et al., 1994), although Brausch (1994) reports on an American textile company, where target costing was well developed and very useful in developing new products. We quote: "*Because they are in the decorative fabric business, design is a major part of the firm's manufacturing process. The design staff constantly is developing new products with new applications for new markets. The design staff is good, but it never purposely designed for profitability. The target sales price was readily available because the product's perceived value is easily determined based on the "look" of the product*". (Brausch, 1994, 48)

Basically, the **task** is to design an attractive carpet that fits into a given living room interior, while considering cost and time instructions (i.e. the simultaneously attainment of the three conflicting goals). The interior with green sofa, blue curtains and a yellow ground perfectly fits with the darker (but expensive) colors. This induces a goal conflict between attractiveness and cost[4]. To impose some structure on the task, a basic pattern is given, as shown in Figure 4. Basically, participants need to select colors for each of the predefined 39 areas from a pallet of 10 different colors, represented by 9

[4] This is a major improvement compared to an earlier experiment (Everaert & Bruggeman, 1997) where there was no goal conflict perceived between cost and quality.

color pens and white. Only one design needs to be handed in at the end of the session, giving participants the opportunity to try for many designs and then to select the most appropriate one.

Figure 4: Pattern of the Carpet, used in the Experimental Task



Furthermore, participants are informed about the **cost system** of the company, including direct cost differences between yarn of different colors as well as higher indirect costs when using more than 5 different colors in one carpet, because of more material handling, higher set up costs, etc. The levels of direct and indirect costs are determined taking into account both realism and ease of calculation, as shown in Table 1.

Table 1: Cost Calculation System, used in the Experimental Task

	cost per small square *standard* color	Cost per small square *additional* color
	Class A:	Class A+:
White	3 BEF	6 BEF
Black	3 BEF	6 BEF
	Class B:	Class B+:
Yellow	10 BEF	13 BEF
Orange	10 BEF	13 BEF
Sky blue	10 BEF	13 BEF
Light green	10 BEF	13 BEF
	Class C:	Class C+:
Blue	15 BEF	18 BEF
Brown	15 BEF	18 BEF
Red	15 BEF	18 BEF
Green	15 BEF	18 BEF

4.4 Manipulation of the Independent Variables

The **target cost setting** manipulation was operationalized by the instructions in the instruction sheets. Participants in the non-TCS were instructed to *design an attractive carpet, trying to minimize the cost of the carpet.* Participants in the difficult TCS were instructed to *design an attractive carpet, taking into account a maximum cost of 2.750 BEF*.

The **degree of time pressure** was also introduced in the instruction sheets. The easy TIME objective (inducing low time pressure) was set at 1 hour and 45 minutes, the difficult TIME objective (inducting high time pressure) was set at 1 hour and 15 minutes. Participants could hand in their design earlier, or could take some extra time, though the instructions said that their boss wants them to be finished within the time limit.

The **type of innovation (radical versus incremental)** required in the development of new products is manipulated in the experiments by different examples of designs of last season. For the development of next generation new products in experiment one, the examples of the most attractive designs of last season contain all ten colors. In this first experiment (radical innovation), participants had many degrees of freedom in selecting the appropriate colors. The examples of last season did not help participants to quickly determine which colors the market really preferred in the given interior. Selecting the most appropriate colors for the design before combining them in an adequate way in the given pattern, requires much more creativity from participants than in the second experiment. Contrary, in the second experiment (incremental innovation) the number of colors used in the most attractive designs of last season was limited to 5. Though the basic pattern was totally different in the most attractive examples of last year, it was obvious from these examples of last year that the market only likes those five colors for a carpet within the given interior. Thus, participants in experiment two need to make only incremental changes (i.e. using another pattern, while using the same colors as in the most attractive designs of last year), requiring fewer creativity.

4.5 Measurement of the Dependent Variables

Cost level, attractiveness and time spent are the three main dependent variables in this experiment. Some more variables were measured afterwards in a post experimental questionnaire, but these are outside the scope of this paper. The **cost level** of the new product was measured as the *total cost* of the created pattern that each participant handed in at the end of the session. During the instructions, participants were taught how to calculate the cost level of the design.

Attractiveness was measured as the *mean score* from the judges. During the experimental task, nine judges scored the designs individually and independently from 1 to 5, considering the given living room interior. These judges were the same as the judges who did the scoring of the 10 (8) most and the 10 least attractive designs of the previous season. The Cronbach's Alpha coefficient for the scores of these 9 judges was .89 in experiment one and .92 in experiment two, which did not improve if one of the judges was deleted, indicating high internal consistency.

Time spent (the operationalization of real development time) was measured as the *time in minutes* between starting and finishing with the design task. All participants started at the same time. When participants were finished and decided which carpet to hand in, time stop was registered. The difference between the time stop and the time start gives the score for time spent in both experiments.

4.6 Feedback during the Task

Participants received immediate feedback on the **cost level** of their creations, because a cost calculation table was included on the second half of each pattern sheet. Participants completed this cost calculation table to determine the total cost level, as explained in detail in the instruction sheets. Furthermore, immediate feedback was also given on the **attractiveness** of the design. Nine judges were present in front of the room and scored the designs (from 1 to 5), placing it behind the given living room interior. Assistants brought back and forward the designs from participants to the jury. For the sake of practical arrangements, we limited the number of feedback possibilities to two. Participants could choose the moment of this feedback possibility: two designs at the same time or each at different time periods. Participants knew the mean score of the most attractive and the least attractive designs of last year, so they could compare the scores from the judges with these means to see if they were doing well or not. At the end of the exercise, participants handed in one of the scored designs or handed in a new design, which was then later scored during "down time" of the judges panel. Third, feedback on the progression of the **time** objective was possible as well, by tracking progress of time at the central clock.

4.7 Participants

The **first** experiment was administered on March 13, 1999 as an additional session for the class "introduction to industrial management" of Professor Dr. Ir. Hendrick Van Landeghem, for which 135 undergraduate students of the fifth year Bioengineering (University of Ghent) were enrolled. Of them, 120[5] participated voluntary in the first experiment and received extra credit. Students were informed of the experiment by a recruitment letter during the last official class of January 13, 1999 as well as by additional email messages. The **second** experiment was administered on April 28, 1999 during official class time of the course "cost accounting" of Professor Dr. W. Bruggeman to undergraduate students of the second year Applied Economics (University Ghent). In total, 180 students were enrolled, of which 64 participated voluntary. There were no advantages for those participating, since extra credit could not be given (due to a faculty rule), explaining the low response rate. Again students were informed of the experiment by a recruitment letter during an earlier class.

Each time it was stressed that participation was *voluntary*, that the task involved *no specific skills or risks of any kind* and that the purpose was to collect data for *research* purposes. For organizational reasons, students should hand in the reply form, attached to the recruitment letter.

4.8 Incentive System

As mentioned above, we assumed a product environment where quality (in the sense of aesthetics or attractiveness) is considered as the primary characteristic, before the price (or cost level) and the development time. We operationalized this given priority by the incentive system.

In general, the creators of only attractive carpets receive a bonus, with some extras if they created a low cost carpet as well, within the given time limit. Basically, a bonus of 300 BEF is given to the *five most attractive* designs in each of the four conditions. In the non-TCS conditions an additional bonus

[5] In this paper the results are only considered of the non-TCS and the difficult TCS, i.e. of 80 observations in total. Hence we do not discuss in this paper the results of the easy TCS (40 observations), because we want to compare here the results with the second experiment for which only a non-TCS and a difficult TCS could be manipulated (due to fewer participants than in the first experiment).

of 300 BEF is given to the *three lowest cost* designs, among those 5 most attractive ones. In the easy and difficult TCS an additional bonus of 300 BEF is given to participants *who attained* the target cost, among those 5 most attractive ones. For the time objective, the bonus is based on goal attainment. An additional bonus of 100 BEF is given to those 5 most attractive designs, finishing *within the given time* limit.

Summarizing, participants (25 % in experiment one and 31 % in experiment two) receive a bonus ranging from 300 to 700 Belgian Francs (approximately $ 9 to $ 21). Bonus determination occurred in each of the four groups separately, because it would be unfair to let participants compete with participants who received other instructions. Bonus pay occurred immediately after the task in experiment two (because of the last plenary meeting for this class), while bonus pay occurred at the beginning of the next class (i.e. two days later) in experiment two.

4.9 Pilot Study

The pilot study was set up to determine the levels of the difficult target cost. The pilot study was completely similar in setting and material as experiment one, except that just one condition was manipulated, i.e. the non-TCS easy TIME condition. In total 22 undergraduate students of the fourth year of Applied Economics (University of Ghent) participated voluntary, during official class time of an advanced course in management control. Of all 22 created designs, 40% had a cost level lower than 2.750 BEF. This level of 40% attainability has been used before in goal setting studies, when comparing a difficult goal with a “do-best” goal (Locke & Latham, 1990). Thus 2.750 BEF was set as the difficult target cost in both experiments.

4.10 Experimental Procedures

Students reported all **together** to the experimental session. The session took for no one longer than three hours, i.e. the regular class time. This time period was split up in **four blocks**: 30 minutes for instructions, 120 minutes (at most) for the task itself, 15 minutes to answer the post experimental questionnaire and 15 minutes for bonus pay (only in the first experiment). Each time the same experimenter, supported by the same nine judges, four assistants and two cashiers (only in the first experiment) guided the experiment. Each judge, assistant and cashier received beforehand written instructions on his/her duty during the experimental session. Basically judges had to score the designs, assistants brought back and forward designs from participants to the judges and kept track of the time spent, while the cashiers determined and paid the bonuses.

Participants were **randomly assigned** to the four treatment conditions, by choosing an ID number upon arrival. All the **material** was ready on the desk in a numbered A4-box. This material contained the folder with the instruction and pattern sheets, a set of 9 color pens, a brown envelope, the sealed questionnaire, a blue pen, 2 blue feedback cards, the interior, the color copies of the 10 (8) most attractive designs and color copies of the 10 least attractive designs. Each individual material was labeled with the ID number, assuring **anonymity**.

After a short welcome by the experimenter, participants went through the 17 page **instruction sheets**, page by page, as instructed by the researcher. These written instructions covered comments on practical issues such as the pattern, the colors, the cost of the colors, the cost calculation table, the objective of the task, information on last year's designs, the judges, the practical organization of the feedback by the judges, the bonus system and a one-page summary. In addition to these written instructions, six **overhead sheets** were presented to explain in detail how to use the cost calculation table on the second half of the pattern sheets. A **practice session** was included as well to familiarize participants with the colors and the cost calculation table.

Consequently, students **worked individually** on the task, during 120 minutes at most. They asked for scores of the jury by holding up one of the two blue cards. The assistant brought it to judge 1 in front of the room. The same assistant brought the scored designs back, guided by the ID number on the design and on the desk. When finished, participants handed in their selected design in the brown envelope. When holding up this brown envelope, the assistant picked it up and wrote the time on it. In that way, cashiers knew if the participant was finished within the given time limit or not.

Then participants unsealed the sealed **questionnaire** and completed it. Afterwards, they got a free drink and candy bar. Bonus numbers were posted on the bulletin board and the cashiers started **bonus pay** during the last 15 minutes of official class time (in experiment one) or 15 minutes before the next class (in experiment two).

5. Results

5.1 Manipulation Checks

Manipulation checks for target cost setting, difficulty of the time objective and priority among the NPD goals were done by self-reported measures, administered in the post experimental questionnaire.

For the **TCS manipulation** the perceived target cost *specificity* was checked. The developed measurement scales with answers on a 5-point Likert-type scale are shown in Table 2. The answers were averaged to form a global index. Conform the manipulation, the cost objective was perceived as much more specific in the difficult TCS than in the non-TCS ($t = 10.3$, 1-tailed $p = 0.000$, respectively $t = 7.1$, 1-tailed $p = 0.000$ for experiment two).

The perceived **difficulty of the time objective** was measured by two items (see Table 2). The time objective was perceived significantly more difficult under the difficult TIME condition than under the easy TIME condition ($t = 2.7$, 1-tailed $p = 0.004$, respectively $t = 2.4$, 1-tailed $p = .010$ for experiment two). Conform the manipulation the means on this time difficulty index are lower for the easy TIME ($m = 1.6$ and $m = 1.7$) than for the difficult TIME condition ($m = 2.1$ and $m = 2.3$), suggesting that the manipulation was successful.

To see if participants perceived the **priority among the attractiveness and cost goal** (manipulated by the bonus system) as intended, we included a three-item measure in the post experimental questionnaire asking for the self-reported energy towards the attractiveness and the cost goal individually, as shown in Table 2. In both experiments, the mean for energy on attractiveness (3.15 and 3.55) was higher than for energy on cost (2.23 and 2.60). The paired samples t-test reveals that participants reported significantly higher energy expended on attractiveness than on cost ($t = 8.7$, $p = .000$ for experiment one and $t = 6.9$, $p = .000$ for experiment two). Hence, priority among attractiveness and cost was understood in the way as intended.

Table 2: Measurement Scales for the Manipulation Checks on Target Cost Setting, Difficulty of the Time Objective and Priority among the NPD Goals

Target Cost Setting, Item 1 (COSTSPE1)

I knew exactly the acceptable cost of the carpet.

1	2	3	4	5
absolutely disagree		neutral		absolutely agree

Target Cost Setting, item 2 (COSTSPE2)

The instructions of my boss on the acceptable cost of the carpet were rather vague.

1	2	3	4	5
absolutely disagree		neutral		absolutely agree

Difficulty of Time Objective, item 1 (SHORTTIME):

The time limit was rather short to complete this task.

1	2	3	4	5
absolutely disagree		neutral		absolutely agree

Difficulty of Time Objective, item 2 (TIMEEASY):

The time limit of my boss was easy to attain.

1	2	3	4	5
absolutely disagree		neutral		absolutely agree

Energy to Attractiveness, item 1 (ATTREFFO) and Energy to Cost, item 1 (COSTEFFO)

How much effort did you provide to create an *attractive* carpet?
How much effort did you provide to bring the *cost* of the carpet down?

1	2	3	4	5
No or rather few	medium	many	high	extremely high

Energy to Attractiveness, item 2 (ATTRPERS) and Energy to Cost, item 2 (COSTPERS)

While I was creating the carpet, I worked with ____ persistence to make my design attractive.
I worked with _____ persistence to the *cost* of my design.

1	2	3	4	5
No or rather few	medium	many	high	extremely high

Energy to Attractiveness, item 3 (ATTRATTE) and Energy to Cost, item 3 (COSTATTE)

In general, I took much attention to improve the attractiveness of my design.
During the task, I thought that I took much attention to the *cost* of the carpet.

1	2	3	4	5
absolutely disagree		neutral		absolutely agree

5.2 Descriptive Statistics

Of the 80 participants in experiment one, 43 were male (54 %). Of the 64 participants in experiment two, 39 were male (61 %). In general participants were somewhat older in experiment one (mean 22) than in experiment two (mean 20). In both experiments, most of them had no experience with design tasks (90%, 84% respectively). In each of the two experiments manipulations were independent of gender, age or past experience, suggesting that the random assignment to treatments was successfully implemented. Less than half did a guess on the purpose of the task in experiment one (40%), somewhat more did a guess on the purpose in experiment two (58%). All 80 and 64 participants understood the task after reading the instruction pages. In general, participants found the experiment OK, rather fun or fun (88% in experiment one, 94% in experiment two). In both experiments, participants disagreed in the importance they took to the scores of the jury. The answers ranged between 1 and 5, though independent of the manipulations. Participants made on average 6 different designs (respectively 7 in experiment two), with a minimum of 2 and a maximum of 15 (14 respectively).

5.3 Testing Hypothesis 1

Hypothesis 1 in this study predicts a significant lower cost under the difficult TCS than under the non-TCS. This first hypothesis tests the so-called favorable impact of target costing on the cost level of future products.

In experiment one (next generation new products, radical innovation), the t-test does not find a significant lower cost level under the difficult TCS than under the non-TCS ($t = -.715$, 1-tailed $p = 0.238$), as shown in Table 3. The group mean on cost level, as displayed in Table 4, is lower (contrary to the expectations!) under the non-TCS (mean = 2574) than under the difficult TCS (mean = 2653), though not significant. **Hence, in this first experiment (next generation), the favorable impact of target costing on the cost level was not supported.**

Contrary in experiment two (derivative new products, incremental innovation), the t-test detects a significant lower cost level under the difficult TCS than under the non-TCS condition ($t = 3.286$, 1-tailed $p = 0.001$), as shown in Table 3. The group means on the cost level in Table 4 show indeed that the cost level is lower under the difficult TCS (group mean = 2584) than under the non-TCS (group mean = 2864), supporting hypothesis 1 and conform target costing literature. **Hence the favorable impact of target costing on the cost level was supported in experiment two (derivatives).**

Table 3: t-Tests to test Hypothesis 1
(Univariate Main Effect of Target Cost Setting on the Cost Level)

t-Test for Equality of Means between Non-TCS and Difficult TCS					
Radical Innovation	**t**	**Df**	**Sig. (1-tailed)**	**Mean Difference**	**Std. Error Difference**
Cost Level	-0.715	78	**0.238**	-79.150	110.670
Incremental Innovation	**t**	**Df**	**Sig. (1-tailed)**	**Mean Difference**	**Std. Error Difference**
Cost Level	3.286	62	**0.001**	280.313	85.314

Table 4: Group Means on Cost Level

Radical Innovation	**Non-TCS**	**Difficult TCS**	**Total**
Mean	**2574**	**2653**	2614
N	40	40	80
Std. Deviation	547.0	436.7	493.4
Incremental Innovation	**Non-TCS**	**Difficult TCS**	**Total**
Mean	**2864**	**2584**	2724
N	32	32	64
Std. Deviation	339.0	343.5	366.8

5.4 Testing Hypothesis 2

Hypothesis 2 in this study hypothesizes a significant *multivariate* main effect of target cost setting on the multidimensional NPD performance. We expect that the new products will significantly differ between the non-TCS and the difficult TCS on a combination of the cost level, quality level (i.e. attractiveness) and real development time (i.e. time spent).

In experiment one (next generation new products, radical innovation), there is a significant difference in group centroids detected (Hotelling's T^2 $p = .002$), as shown in Table 5. Hence, the data support hypothesis 2, suggesting that the created new products significantly differ between the difficult TCS and the non-TCS. The new dimension is accounting for 17.4 % of the total variance. This canonical variate is highly positive correlated with attractiveness ($r = .67$) and negatively correlated with time spent (r = -.44) and to a less degree with the cost level (r = -.18). We can label this first canonical variate as the "**creativity"** factor. Designs with a high score for attractiveness are scoring high on this "creativity" factor. Comparing the group means for TCS on this "creativity" factor, we find that designs created under the non-TCS are scoring on average high on this "creativity" factor (group mean = .454), while designs created under the difficult TCS are scoring on average low on this "creativity" factor (group mean = -.454).

Analyzing now further the multivariate group difference between the non-TCS and the difficult TCS in a univariate way (see Table 7), we find a significant difference for attractiveness (t = 2.7, 2-tailed p = .008) and a marginally significant difference for time spent (t = 1.7, 2-tailed p = .082). The group means of Table 8 learn that the carpet designs created under the non-TCS were perceived as much more attractive (group mean = 3.12) than the carpet designs created under the difficult TCS (group mean = 2.65). Furthermore, participants under the non-TCS (group mean = 66 minutes**)** spent on average less time to create the new design than participants under the difficult TCS (group mean = 71 minutes). As found earlier, there was no significant difference in cost level between those two groups. **In sum, the multivariate significant difference between the non-TCS and the difficult TCS can mainly be explained by the difference in attractiveness of the designs, and marginally by the difference in time spent.** This difference in time spent will be further explained when we will consider the two time conditions separate (see hypothesis 4).

In experiment two (derivative new products, incremental innovation), there was a significant multivariate difference detected as well between the non-TCS and the difficult TCS (Hotelling's T^2, p = .005), though the underlying dimension is totally different. The canonical variate that significantly separates the two groups on the three dependent variables (explaining 19.4% of total variance) is highly negatively correlated with the cost level (r = -.85) and positively correlated with time spent (r = .28) and to a less degree with attractiveness (r = .14), as shown in Table 6. We can label this canonical variate the "low **cost**" factor. A high score indicates that participants reduced extensively the cost level of the design. On average, designs made under the non-TCS are scoring low on this "low cost" factor (group mean = -.483), while designs made under the difficult TCS are scoring high on this "low cost" factor (group mean = .483), suggesting that participants went further in their cost reduction activities in the difficult TCS than in the non-TCS.

Analyzing further this multivariate group difference in a univariate way, we find only a significant group difference between the non-TCS and the difficult TCS on the cost level ($t = 3.2$, 2-tailed $p = .002$), as shown in Table 7. As discussed before under the first hypothesis, the cost level is significantly lower under the difficult TCS than under the non-TCS (see Table 8). Contrary to the first experiment, new products do **not** differ now in terms of attractiveness ($p = .58$) or time spent ($p = .28$), although this last conclusion on time spent will be revised later when we will consider the two time conditions separate (see hypothesis 4). **In sum, the multivariate significant difference between the two TCS groups can mainly be explained by the difference in cost level.**

Table 5: Hotelling's T^2 to test Hypothesis 2
(Multivariate Main Effect of Target Cost setting on Cost, Attractiveness and Time Spent)

Hotelling's T^2 for Equality in Group Centroids between the Non-TCS and the Difficult TCS					
Radical Innovation	**F**	**Hypothesis Df**	**Error Df**	**Sig.**	**Sq. Can. Correlation**
Hotelling's T^2	5.348	3	76	**0.002**	0.174
Incremental Innovation	**F**	**Hypothesis Df**	**Error Df**	**Sig.**	**Sq. Can. Correlation**
Hotelling's T^2	4.811	3	60	**0.005**	0.194

Table 6: More Multivariate Statistics to Interpret Hypothesis 2

<u>Radical</u> Innovation		
Structure Matrix: Correlation between Canonical Variate (Function) and D.V.		
	"Creativity" factor	
Attractiveness	**0.668**	
Time spent	**-0.435**	
Cost level	-0.176	
Functions at Group Centroids		
	"Creativity" factor	
Non-TCS	0.454	
Difficult TCS	-0.454	
<u>Incremental</u> Innovation		
Structure Matrix: Correlation between Canonical Variate (Function) and D.V.		
	Function 1	
	"Low Cost" Factor	
Cost Level	-0.851	
Time Spent	0.284	
Attractiveness	0.144	
Functions at Group Centroids		
	"Low Cost" Factor	
Non-TCS	-0.483	
Difficult TCS	0.483	

Table 7: Univariate t-Tests for Cost Level, Attractiveness and Time Spent to further Analyze the Supported Hypothesis 2

t-test for Equality of Means between Non-TCS and Difficult TCS					
<u>Radical</u> Innovation	**t**	**Df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**
Cost Level	-0.715	78	0.477	-79.150	110.670
Attractiveness	2.710	78	**0.008**	0.470	0.174
Time Spent	-1.764	78	**0.082**	-4.600	2.608
<u>Incremental</u> Innovation	**t**	**Df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**
Cost Level	3.286	62	**0.002**	280.313	85.314
Attractiveness	-0.555	62	0.581	-0.117	0.211
Time Spent	-1.096	62	0.277	-3.875	3.536

Table 8: Group Means for Cost Level, Attractiveness and Time Spent

<u>Radical</u> **Innovation**		**Non-TCS**	**Difficult TCS**	**Total**
Cost level	Mean	2574	2653	2614
	Std. Deviation	547	437	493
Attractiveness	Mean	**3.12**	**2.65**	2.88
	Std. Deviation	0.69	0.86	0.81
Time Spent	Mean	**66**	**71**	69
	Std. Deviation	13	10	12
<u>**Incremental**</u> **Innovation**		**Non-TCS**	**Difficult TCS**	**Total**
Cost level	Mean	**2864**	**2584**	2724
	Std. Deviation	339	343	367
Attractiveness	Mean	2.75	2.86	2.80
	Std. Deviation	0.87	0.81	0.84
Time Spent	Mean	**70**	**73**	72
	Std. Deviation	16	12	14

5.5 Testing Hypothesis 3

Hypothesis 3 in this study hypothesizes a significant interaction effect of target cost setting and time pressure on the cost level. We expect that the differences in cost level between the non-TCS and the difficult TCS will be larger in the easy TIME condition than in the difficult TIME condition.

In <u>experiment one</u> (next generation new products, radical innovation), the interaction effect on the cost level is significant ($F (1, 76) = 5.1$, $p = 0.027$), as shown in Table 9. Hence the data <u>support</u> hypothesis three. To see which specific groups are responsible for this significant interaction effect on the cost level, we compare now the cost level between the non-TCS and the difficult TCS in each TIME condition separate. The t-test in the *easy* TIME condition detects a significant difference in cost level between the non-TCS and the difficult TCS ($t = -2.07$, 2-tailed $p = .046$). Though, the t-test in the *difficult* TIME condition does not detect a significant difference in cost level between the non-TCS and the difficult TCS ($t = 1.1$, 2-tailed $p = .281$). Indeed, the group means on the cost level (see Table 11) indicate that the difference in cost level between the non-TCS and the difficult TCS is larger under the easy TIME than under the difficult TIME condition. Looking at the direction of the difference, we can conclude that participants in the easy TIME condition created a *lower* cost carpet under the non-TCS (group mean = 2400) than under the difficult TCS (group mean = 2722), which is totally unexpected from target costing literature. In the difficult TIME condition participants did not create significant lower cost carpets under the non-TCS than under the difficult TCS. The group means are in the direction as hypothesized in the target costing literature, i.e. with a lower group mean in the difficult TCS (group mean = 2585) than in the non-TCS (group mean = 2748). Though the difference is not significant. **Thus, our first hypothesis of no difference in cost level between the non-TCS and the difficult TCS for the development of a new product requiring a radical type of innovation should be revised. Contrary to what was expected, the cost level is even *lower* under the non-TCS than under the difficult TCS, but only under low time pressure (i.e. in the easy TIME condition), as shown in Figure 5.**

In experiment two (derivative new products, incremental innovation), the interaction effect on the cost level is marginally significant (F (1, 60) = 3.1, p = .081), as shown in Table 9. As expected, the group means (see Table 11) indicate that the difference in cost level between the non-TCS and the difficult TCS is larger under the easy TIME than under the difficult TIME condition. Indeed, the t-test in the *easy* TIME condition detects a significant difference in cost level between the non-TCS and the difficult TCS (t = 3.48, 2-tailed p = .002). The t-test in the *difficult* TIME condition does not detect a significant difference in cost level between the non-TCS and the difficult TCS (t = 1.1, 2-tailed p = .264), as displayed in Table 10. Contrary to the high innovative environment, participants in the easy TIME condition created a lower cost carpet under the difficult TCS (group mean = 2530) than under the non-TCS (group mean = 2960), as expected from target costing literature. Also under the difficult TIME condition, the direction of the difference in cost level between the non-TCS and the difficult TCS is in the hypothesized direction: a lower mean cost level under the difficult TCS (2637) than under the non-TCS (2768). Though this difference in mean cost level was not significant. **Thus, our first hypothesis of a significant lower cost level under the difficult TCS than under the non-TCS (for incremental innovation) should be revised now. The cost level is only lower in the difficult TCS than in the non-TCS when participants receive an easy TIME condition, as shown in Figure 5.**

Table 9: ANOVA F-test to test Hypothesis 3
(Interaction Effect of TCS by TIME Difficulty on the Cost Level)

Dependent Variable: Cost level						
Radical Innovation						
Source	**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**	**Eta Sq.**
Target Cost Setting (TCS)	125294.450	1	125294.450	0.538	0.466	0.007
Difficulty of Time Objective	223661.250	1	223661.250	0.960	0.330	0.012
TCS * Difficulty of Time Objective	1179036.800	1	1179036.800	5.061	**0.027**	0.062
Error	17704073.300	76	232948.333			
Total						
Incremental Innovation						
Source	**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**	**Eta Sq.**
Target Cost Setting (TCS)	1257201.563	1	1257202	11.039	0.002	0.155
Difficulty of Time Objective	28985.063	1	28985.06	0.255	0.616	0.004
TCS * Difficulty of Time Objective	357903.063	1	357903.1	3.143	**0.081**	0.050
Error	6833402.750	60	113890			
Total	483248908.000	64				

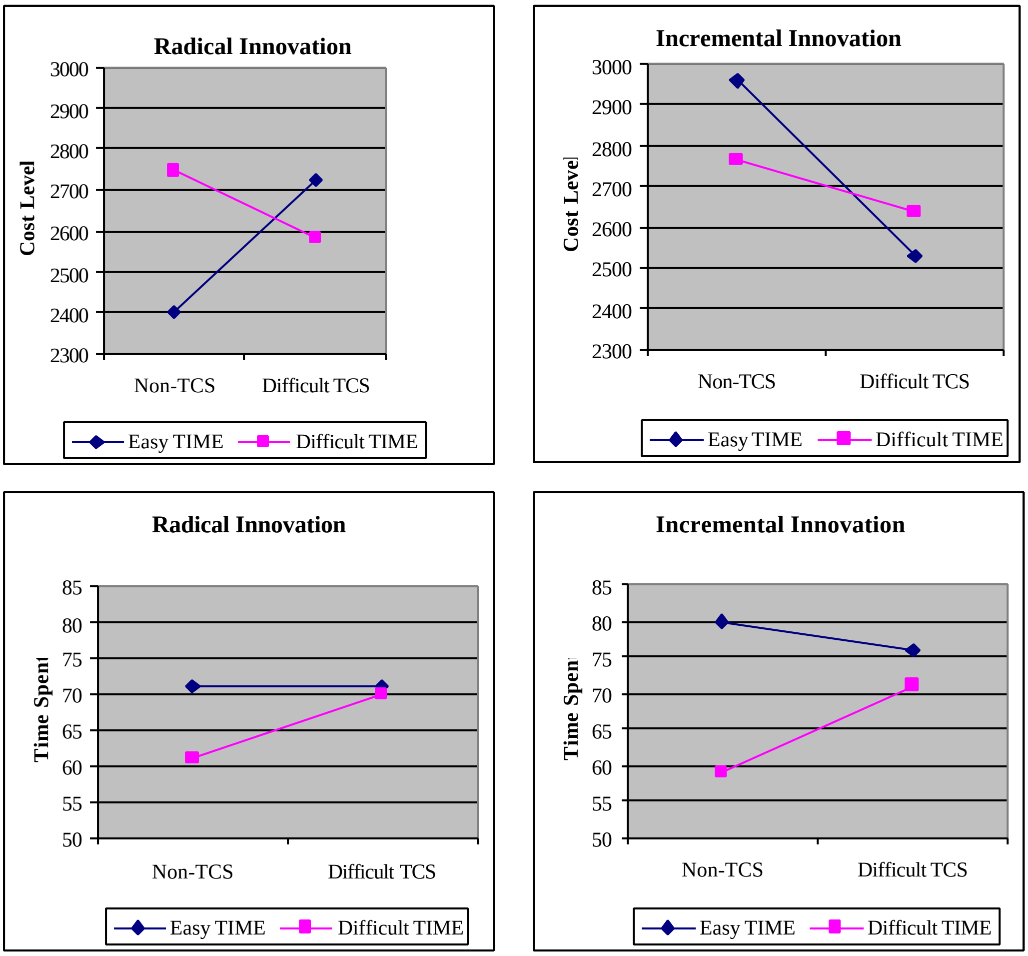
Table 10: Simple Main Effects by t-Tests to Further Analyze the Significant Interaction Effect of Hypothesis 3

t-Test for Equality of Means between Non-TCS and Difficult TCS						
Radical Innovation		**t**	**Df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**
Cost Level	in *Easy* TIME	-2.068	38	**0.046**	-321.950	155.703
	in *Difficult* TIME	1.095	38	0.281	163.650	149.487
Incremental Innovation		**t**	**Df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**
Cost Level	in *Easy* TIME	3.481	30	**0.002**	429.875	123.498
	in *Difficult* TIME	1.137	30	0.264	130.750	114.981

Table 11: Group Means on Cost Level for each Cell

Group Means on Cost Level			
Radical Innovation	**Non-TCS**	**Difficult TCS**	**Total**
Easy TIME condition	**2400**	**2722**	2561
Difficult TIME condition	**2748**	**2585**	2666
Total	2574	2653	2614
Incremental Innovation	**Non-TCS**	**Difficult TCS**	**Total**
Easy TIME condition	**2960**	**2530**	2745
Difficult TIME condition	**2768**	**2637**	2702
Total	2864	2584	2724

Figure 5: Interaction Effect between Target Cost Setting and Difficulty of Time Objective on the Cost Level and on Time Spent in Experiment One and in Experiment Two



5.6 Testing Hypothesis 4

Hypothesis 4 in this study hypothesizes a significant multivariate interaction effect of target cost setting and time pressure. We expect that the difference between the non-TCS and the difficult TCS on a combination of the cost level, quality level (attractiveness) and real development time (time spent) will differ as a function of time pressure.

In experiment one (next generation new products, radical innovation), the MANOVA for the interaction effect on the three dependent variables cost level, attractiveness and time spent is marginally significant (Hotelling's T^2, $p = .064$), as shown in Table 12. Thus the data marginally support the hypothesis of a multivariate interaction effect. The new dimension is accounting for 9,3 % of the total variance. This canonical variate is highly negatively correlated with cost ($r = -.807$), highly positively correlated with time spent ($r = .642$) and to a less degree correlated with attractiveness ($r = .293$). We can label this canonical variate as the "cost reduction activity" factor. Designs with a high score on the "cost reduction activity" factor are having a rather low cost, but designers used a rather long time to complete it. Comparing the group means on this "cost reduction activity" factor, as shown in Table 13, we find larger differences between the difficult TCS and the non-TCS under high time pressure than under low time pressure. To further analyze this marginally significant interaction effect, we need to consider the interaction effect on each dependent variable separate, as displayed in Table 14. The univariate F-tests show that the multivariate interaction effect can mainly be explained by a significant interaction effect on the cost level ($F(1, 76) = 5.061$, $p = .027$) and a marginally significant interaction effect on time spent ($F(1, 76) = 3.2$, $p = .077$). As discussed earlier under hypothesis three, in the easy TIME condition the cost level is significantly lower in the non-TCS than in the difficult TCS ($t = -2.068$, 1-tailed $p = .023$). Whereas in the difficult TIME condition the cost level does not differ between the non-TCS and the difficult TCS ($t = 1.1$, 1-tailed $p = .281$). For time spent, there is no difference in group mean between the non-TCS (group mean = 71) and the difficult TCS (group mean = 71) for the easy TIME condition ($t = .001$, 2-tailed $p = .980$), as displayed in Table 16. Contrary in the difficult TIME condition, there is a large difference in time spent between the non-TCS (group mean = 61) and the difficult TCS (group mean = 70), as shown in Table 15. Indeed, analyzing this univariate interaction effect by simple main effects, we find that time spent is significantly lower under the non-TCS than under the difficult TCS in the difficult TIME condition ($t = 8.215$, 1-tailed $p = .0035$). **In sum, the (marginally significant) multivariate interaction effect between target cost setting and time pressure can mainly be explained by the interaction effect of cost level and time spent. An favorable impact of target costing on the cost level was found only under low time pressure; whereas an unfavorable impact of target costing on the time spent was found only under high time pressure.**

In experiment two (derivative new products, incremental innovation), the multivariate interaction effect is significant (Hotelling's T^2 $p = .030$). The new dimension is accounting for 14 % of the total variance. This canonical variate is now highly negatively correlated with time spent ($r = -.862$), highly negatively correlated with cost ($r = -.564$) and to a less degree correlated with attractiveness ($r = .190$). We can label this canonical variate as the "efficiency" factor. Designs with a high score on the "efficiency" factor are having a rather low cost and designers used rather few time to complete it. Comparing the group means on this "efficiency" factor, we find larger differences between the difficult TCS and the non-TCS in the easy TIME condition than in the difficult TIME condition, as shown in Table 13. This significant interaction effect can mainly be explained by the significant univariate interaction effect on time spent ($F(1, 60) = 7.3$, $p = .009$) and in second instance by the marginally significant univariate interaction effect on cost level ($F(1, 60) = 3.1$, $p = .081$). Similar to the radical innovative environment, the group means on time spent show that the difference between the non-TCS and the difficult TCS is much larger under the easy TIME than under the difficult TIME condition (see Table 15). Indeed in the easy TIME condition, there is no significant difference in time spent ($t = .838$, 2-tailed $p =.409$) between the non-TCS and the difficult TCS. Though, for the difficult TIME condition, time spent significantly differs between the non-TCS and the difficult TCS ($t = -3.6$, 2-tailed $p = .001$). Similar to experiment one, the use of a difficult target cost had an unfavorable impact on time spent, but only under the difficult TIME condition. As discussed before, the marginally significant interaction effect on cost level is mainly caused by the lower cost level under the difficult TCS than under the non-TCS in the easy TIME condition. **In sum, the significant**

multivariate interaction effect between target cost setting and time pressure can mainly be explained by the univariate interaction effect on cost level and time spent. A favorable impact of target costing on the cost level was found only in the easy time condition, while an unfavorable impact of target costing was found on time spent only in the difficult TIME condition.

Table 12: MANOVA to test Hypothesis 4
(Multivariate Interaction Effect of TCS by TIME Difficulty on Cost, Quality and Time Spent)

Hotelling's T^2 on Cost level, Attractiveness and Time Spent					
Radical Innovation	**F**	**Hypothesis Df**	**Error Df**	**Sig.**	**Sq. Can. Correlation**
Target Cost Setting (TCS)	5.265	3	74	0.002	0.176
Difficulty in Time Objective	2.651	3	74	0.055	0.097
TCS * Difficulty of Time Objective	2.525	3	74	**0.064**	0.093
Incremental Innovation	**F**	**Hypothesis Df**	**Error Df**	**Sig.**	**Sq. Can. Correlation**
Target Cost Setting (TCS)	4.777	3	58	0.005	0.198
Difficulty in Time Objective	7.101	3	58	0.000	0.268
TCS * Difficulty of Time Objective	3.186	3	58	**0.030**	0.141

Table 13: More Multivariate Statistics to Interpret the Results of Hypothesis 4

Radical Innovation		
Structure Matrix: Correlation between Canonical Variate (Function) and D.V.		
	Function 1	
	"Cost Reduction Activity" Factor	
Cost Level	-0.807	
Attractiveness	-0.293	
Time Spent	0.642	
Functions at Group Centroids ("Cost Reduction Activity" Factor)		
	Non-TCS	Difficult TCS
Easy TIME	0.737	0.486
Difficult TIME	-0.115	0.654
Incremental Innovation		
Structure Matrix: Correlation between Canonical Variate (Function) and D.V.		
	Function 1	
	"Efficiency" Factor	
Time Spent	**-0.862**	
Cost Level	**-0.564**	
Attractiveness	0.190	
Function 1 ("Efficiency" Factor) at Group Centroids		
	Non-TCS	Difficult TCS
Easy Time	-0.851	-0.013
Difficult Time	.687	0.176

Table 14: Univariate Interaction to Further Analyze the Multivariate Interaction Effect of Hypothesis 4

Univariate F-tests						
Radical Innovation						
Source	**Dependent Variable**	**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
TCS	Cost Level	125294.450	1	125294.450	0.538	0.466
	Attractiveness	4.426	1	4.426	7.459	0.008
	Time spent	423.200	1	423.200	3.351	0.071
Difficulty of Time Objective	Cost Level	223661.250	1	223661.250	0.960	0.330
	Attractiveness	1.502	1	1.502	2.531	0.116
	Time spent	605.000	1	605.000	4.790	0.032
TCS * Difficulty of Time Objective	Cost Level	1179036.800	1	1179036.800	5.061	**0.027**
	Attractiveness	0.396	1	0.396	0.667	**0.417**
	Time spent	405.000	1	405.000	3.207	**0.077**
Error	Cost Level	17704073.300	76	232948.333		
	Attractiveness	45.093	76	0.593		
	Time spent	9598.600	76	126.297		
Incremental Innovation						
Source	**Dependent Variable**	**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
TCS	Cost Level	1257201.563	1	1257201.563	11.039	0.002
	Attractiveness	0.220	1	0.220	0.314	0.577
	Time spent	240.250	1	240.250	1.725	0.194
Difficulty of Time Objective	Cost Level	28985.063	1	28985.063	0.255	0.616
	Attractiveness	1.978	1	1.978	2.828	0.098
	Time spent	3025.000	1	3025.000	21.719	0.000
TCS * Difficulty of Time Objective	Cost Level	357903.063	1	357903.063	3.143	**0.081**
	Attractiveness	0.250	1	0.250	0.358	**0.552**
	Time spent	1024.000	1	1024.000	7.352	**0.009**
Error	Cost Level	6833402.750	60	113890.046		
	Attractiveness	41.955	60	0.699		
	Time spent	8356.750	60	139.279		

Table 15: Group Means on Cost Level, Attractiveness and Time Spent in each Cell of Experiment One and Experiment Two

	Radical Innovation			Incremental Innovation		
Cost Level	**Non-TCS**	**Difficult TCS**	**Total**	**Non-TCS**	**Difficult TCS**	**Total**
Easy TIME	**2400**	**2722**	2561	**2960**	**2530**	2745
Difficult TIME	**2748**	**2585**	2666	**2768**	**2637**	2702
Total	2574	2653	2614	2864	2584	2724
Attractiveness	**Non-TCS**	**Difficult TCS**	**Total**	**Non-TCS**	**Difficult TCS**	**Total**
Easy TIME	3.2	2.9	3.0	2.5	2.8	2.6
Difficult TIME	3.1	2.4	2.7	3.0	3.0	3.0
Total	3.1	2.6	2.9	2.7	2.9	2.8
Time Spent	**Non-TCS**	**Difficult TCS**	**Total**	**Non-TCS**	**Difficult TCS**	**Total**
Easy TIME	**71**	**71**	71	**80**	**76**	78
Difficult TIME	**61**	**70**	66	**59**	**71**	65
Total	66	71	69	70	73	72

Table 16: Simple Main Effects to further Analyze the Significant Univariate Interaction Effects

t-Test for Equality of Means between Non-TCS and Difficult TCS						
Radical Innovation		**t**	**Df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**
Cost Level	in *Easy* TIME	-2.068	38	**0.046**	-321.950	155.703
	In *Difficult* TIME	1.095	38	0.281	163.650	149.487
Time Spent	In *Easy* TIME	-0.026	38	0.980	-0.100	3.896
	In *Difficult* TIME	-2.866	38	**0.007**	-9.100	3.175
Incremental Innovation		**t**	**Df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**
Cost Level	In *Easy* TIME	3.481	30	**0.002**	429.875	123.498
	In *Difficult* TIME	1.137	30	0.264	130.750	114.981
Time Spent	In *Easy* TIME	0.838	30	0.409	4.125	4.924
	In difficult TIME	-3.652	30	**0.001**	-11.875	3.252

6. Discussion of the Results

Let's first discuss the impact of target costing **on the cost level alone**. Only in experiment two (incremental innovation) do the results of hypothesis 1 show that the cost level is significantly lower under target costing ("the difficult TCS") than under non-target costing ("the non-TCS"). Thus only for incremental type of innovations in new products, the so-called favorable impact of target costing on the cost level could be supported. In experiment one (radical innovation), setting a difficult target cost did not lead participants to design new products with a lower cost level. For the development of next generation new products, the cost level did not differ between the non-TCS and the difficult TCS. **These results suggest that target costing is only appropriate for incremental kind of innovations, such as for the development of derivative new products, where no radical changes need to be incorporated in the new product.** When going back to target costing literature, only Cooper & Slagmulder (1997) marginally address this problem. They argue that target costing is most difficult to apply to revolutionary products, like our study shows. Though they refer to different reasons. We quote: "Target selling prices are often difficult to establish because the value to the customer of the new product is difficult to estimate. Also, because the firm has never applied the technology in its products, historical cost information is not available. Finally, more new suppliers are typically involved." (Cooper & Slagmulder, 1997, 177) Though, in our study, a difference in type of innovation (radical versus incremental) was manipulated. No differences between the two environments were set in terms of "uncertainty of the cost estimates or sales prices". We induced "uncertainty on market preferences" in our experiments, resulting in a higher need of creativity for the development of next generation new products.

However, the picture becomes somewhat different for both environments when considering the impact of target costing **in combination with time pressure**. In both environments, the differences in cost level between the non-TCS and the difficult TCS are larger under low time pressure ("easy TIME condition" than under high time pressure ("difficult TIME condition). In experiment two (incremental innovation), the favorable impact of target costing on the cost level was statistically significant compared to the non-TCS, when time pressure was low. For high time pressure, the cost level was no longer significantly lower under the difficult TCS than under the non-TCS. This suggests that target costing is only favorable for the cost level, if design engineers receive plenty of time for the development of derivatives. **Hence for the development of new products, requiring only incremental changes to existing products, the favorable impact of setting a difficult target cost during new product development is resulting in a significant lower cost level, only when designers focus low time pressure as in our easy TIME condition.**

Similar, in <u>experiment one</u> (radical innovation) target costing is leading to a significant difference in cost level between the non-TCS and the difficult TCS, only when time pressure was low. Hence under high time pressure, cost levels did not significantly differ between the non-TCS and the difficult TCS. Though, totally unexpected is the direction of the cost difference for low time pressure. The cost level was found significantly *lower* under the non-TCS than under the difficult TCS. This suggests that target costing is very unfavorable for the cost level, if design engineers receive plenty of time in a high innovative environment. Why are participants under the non-TCS, easy TIME outperforming participants under the difficult TCS, easy TIME condition, both in terms of cost and attractiveness (see hypothesis 3)? A few papers in goal setting have thusfar tried to formulate the boundaries beyond which goal setting will not work or may even be harmful. Huber (1985) found that for a *heuristic task*, performance is *worse* when a difficult rather than do-your best goal is set, just as in our study. Individuals performing a maze task were less effective if they had a specific, difficult rather than a general goal for how quickly to find the way out of a computer maze. Similarly, Earley, Connolly & Ekegren (1989, 26) found that performance was consistently better in the “do-your best” condition than in a specific easy or specific difficult goal condition for a stock market prediction task, where a *large number of strategies* were available. The experimental task of our experiment one can be considered as a heuristic task, where a large number of strategies were available. Participants had to select first the most appropriate colors to fit within the interior and then allocate these colors to the right areas. No single best strategy and no single best carpet design was available. Many participants colored first a few designs, then calculated the cost of those designs that passed their own norms of attractiveness and finally consulted the jury. Others quickly created a few carpets without thinking on the cost issues to get an idea of the judges early in the process. Still others tried to copy some of the examples of successful designs of the previous year. Participants creating an attractive, but low cost carpet recognized afterwards that it was critical to choose the right color for the background area, since deciding on the background color (because of the highest number of small areas) essentially determined the total cost of the carpet. Though, it is unclear from the current goal setting studies why in our first experiment the non-TCS outperformed the difficult TCS only in the easy time condition and not in the difficult time condition. However, from the point of view of *innovation literature*, it is not surprising that in our study the least restrictive condition, i.e. the "non-TCS easy TIME" condition induced new products with the highest degree of innovation (i.e. the highest scores for attractiveness and the lowest scores for cost level). A condition of slack (no time and budget constraints such as in our non-TCS, easy time condition) is found more supportive in generating high innovative products than a situation of tight control (time constraints and cost constraints) (Abernathy, 1978; Quinn, 1985; Iansiti, 1995). Concluding, participants created lower cost products under the non-TCS than under the difficult TCS, probably because they received far less restrictions in being creative. This occurred only in the easy TIME condition, because only when much time was available participants found the appropriate strategy to create a low cost, high attractive carpet under this so-called less restrictive environment of the non-TCS. **Thus, for a radical type of innovation, setting no target cost during new product development is resulting in a significant lower cost level, when participants face low time pressure as in our easy TIME condition.**

Let's now discuss the impact of target costing **on the differences in created new products**, considered by the three NPD measures cost level, attractiveness and time spent together. In both NPD environments, the results of hypothesis two show that participants created a different new product under the difficult TCS than under the non-TCS. The new products differed mainly on what we called the "creativity" factor for radical type of innovations, while the new products differed mainly on what we called the performed "cost reduction activities" for incremental type of innovations in experiment two. In experiment one (radical innovation), the new products differed basically in terms of attractiveness. New products created in the non-TCS were perceived more attractive than new products created in the difficult TCS. This result is conform the Huber (1985) study in goal setting, where the poor performance of the difficult goal group was also associated with the use of a dysfunctional performance strategy. Being focused by the maximum allowable cost of the carpet, participants might have selected only the cheapest colors in their carpets (black, white, orange, sky blue, light green), though these colors did not fit into the given interior with blue curtains and a yellow ground. Once limiting the creativity to only these colors, participants could never find an attractive carpet. Hence the restriction of the target cost might have misdirected their attention in the strategy search. **Hence for the development of next generation new products, target costing had no favorable impact on the cost level, but had an unfavorable impact on the quality level. By focusing on the target cost, participants "forgot" to create attractive carpets. Though their cost-focusing behavior did not result in lower cost products, as discussed before.** In experiment two (incremental innovation), new products differed mainly on the cost level. Participants in the difficult TCS did more what we called cost reduction activities, resulting in a lower cost level than in the non-TCS. **Hence in this incremental NPD environment, the use of target costing had a favorable impact on the cost level and no unfavorable impact on the attractiveness of the designs.**

Again, the picture becomes somewhat different, when we combine the **multivariate impact of target costing with time pressure.** The significant multivariate interaction effect of hypothesis four learned that the difference in new products between the non-TCS and the difficult TCS was also dependent on time pressure. In both environments, this multivariate interaction effect could mainly be explained by cost differences and by differences in time spent. Cost differences were significant only for low time pressure, while time differences were significant only for high time pressure. In both environments, participants used significantly more time to create the new product under the difficult TCS than under the non-TCS, though only when time pressure was high. **Hence, when there was low time pressure, participants took no more time in the difficult TCS than in the non-TCS to create the new products. Contrary, when time pressure was high, participants in the difficult TCS needed more time to create their new products than participants in the non-TCS.** This last conclusion is consistent with previous research on multiple goal setting. When having a low time pressure, participants can successfully complete all conflicting goals. Though, when two goals are set at a level difficult-to-attain, like a difficult target cost under high time pressure in our study, completing the conflicting goals becomes harder and participants skip on one goal (Bavelas & Lee, 1978; Schmidt, Kleinbeck & Brockman, 1984; Erez, 1990; Gilliland & Landis, 1992). Here, participants skipped correctly on the time goal, since this goal was communicated as the least important goal. Combining the discussion on the interaction effect of time spent with the interaction effect on the cost level, we can state that for the development of derivatives participants created under low time pressure, lower-cost designs in the difficult TCS than in the non-TCS, without an increase in time spent. Contrary under high time pressure, participants did not create lower cost designs under the difficult TCS than in the non-TCS, though used more time to create the new product. Hence under low time pressure the cost reduction activities lead to a lower cost level, without spending more time. Under high time pressure, cost reduction activities did not result in lower cost designs, but in a significant increase in development time.

Combining now all conclusions for experiment one (radical innovation), we can state that target costing is not at all beneficial for the new products developed, compared to the non-TCS. Target costing is leading to less attractive products in all time conditions. Furthermore under high time pressure, target costing is leading to longer development times. Under low time pressure, target costing is leading to higher cost products. As shown in Figure 6, the use of target costing is not recommended for the development of next generation new products, based on the conclusions of experiment one. Combining now all conclusions for experiment two (incremental innovation), we can state that target costing is beneficial only when time pressure is low. Under high time pressure, target costing is not leading to lower cost products, but is enhancing the total development time. As shown in Figure 6, the use of target costing is recommended for the development of derivatives, only when being fast on the market is not an issue.

Figure 6: Impact of Target Costing, compared to a situation of non-Target Costing (minimizing the Cost Level) based on the Results of the Lab Experiments

	Target Cost is *difficult*-to-attain	
	Development of *Derivative* New Products	**Development of *Next Generation* New Products**
***Low* Time Pressure**	Target Costing is appropriate: No difference in quality Lower cost new products No difference in development time	Target Costing is not appropriate: Lower quality new products Higher cost new products No difference in development time
***High* Time Pressure**	Target Costing is not appropriate: No difference in quality No difference in cost level Delayed development time	Target Costing is not appropriate: Lower quality new products No difference in cost level Delayed development time

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