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Multiple performance measures, causality and decision making – Exploring ostensive and performative aspects of causality: Evidence from a new product development process

Allan Hansen
Copenhagen Business School
Solbjerg Plads 3
DK-2000 Frederiksberg
Denmark
ah.om@cbs.dk

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Abstract:
The notion of causality is continuously being mobilized in discussions on the design of strategic performance measurement systems. So far, the debate on causality has primarily focused on general and abstract relationships among multiple organizational performance measures depicted in business models or strategy maps. These conceptualizations of causal relationships among multiple performance measures represent what in this paper is described as the ostensive aspect of causality. This type of causal knowledge is an important input for designing management control practice and facilitating decision making in many cases, however, it deflects attention away from the performative aspect of causality, which relates to how cause-and-effect relations among performance measures are performed in specific decision-making situations. In some situations, the ostensive aspects of causality outlined in business models do not represent the causal relationships at play in specific value creation processes that have implications for the extent to which the causal knowledge embedded in business models can be used for designing management control practices and facilitating decision making.

This paper illustrates the performative aspects of causality by means of an in-depth case study of a new product development process. The case study focuses on product design decisions and illustrates how the mobilization of and interrelations between four performance measures, each of which is embedded in a business model in the company (component sharing, product costs, product quality and flexibility), changed from one decision to another. This study reflects how the constituents of value creation in these decision-making situations were not given *ex ante,* but were mobilized and related *in situ*.

This paper concludes that the two perspectives (the ostensive and performative view) do not conflict, but rather supplement one another. The performative approach is well adapted to revealing the bidirectional and reciprocal causal relationships among performance measures at play in some value creation processes, but it cannot specify structural aspects of value creation in individual organizational settings. While both the ostensive and the performative view on causality have blind spots, a combination of the two might provide seeds for a more complete approach to understanding value creation in organizations and to understanding the limits of causal maps with regard to decision making and designing control practices.

This paper contributes to the discussion by expanding the conceptualization of the causality of importance to the design of a strategic performance measurement system by distinguishing between two different types of causality when it comes to understanding value creation in an organization. Second, this study documents the dynamics and complexities of causal relationships among performance measures in practice. Finally, this paper discusses the implications these dynamic aspects of causality have in terms of designing management control and facilitating decision-making in practice.

Key words: Case study, multiple performance measures, causality, decision making, new product development

I. Introduction

For decades, it has been recognized that diverse organizational objectives reflected in multi-dimensional performance measurement systems ensure that decision makers direct their attention towards a wider range of concerns important to value creation in organizations compared to one-dimensional performance measurement systems (Ridgway, 1956; Simon, 1964; Blau, 1965/1955). Furthermore, has it been argued that not only the *diversity* of but also the *causality* between performance measures is crucial when addressing the design of multi-dimensional performance measurement systems because knowledge of causality provides significant information for designing management control practice and for facilitating decision making (Eccles, 1991; Kaplan & Norton, 1996; Epstein & Manzoni, 1997; Ittner & Larcker, 1998a; Ittner & Larcker, 2003; Webb, 2004; Luft, 2004)

The causal relationships among performance measures are often conceptualized as 'profit chains' (Rucci et al., 1998), 'business models' (Magretta, 2002) and 'strategy maps' (Kaplan & Norton, 2004). The strategic performance measurement literature has emphasized that every objective and measure selected for the measurement system "should be an element of a chain of cause-and-effect relationships that communicate the meaning of the business unit's strategy to the organization" (Kaplan & Norton, 1996: 31). Furthermore, Eccles, in a manifesto on the design of performance measurement systems, asks the two following fundamental questions: "Given our strategy, what are the most important measures of performance?" and "How do these measures relate to one another?" (Eccles, 1991: 132).

The conceptualization of causality reflected in the Strategic Performance Measurement Systems (SPMS) literature is characterized by the ambition to trace general and abstract relationships among performance measures, which in combination, generate *a theory of value creation* within the individual organizational setting. In this paper, this type of conceptualization is called an ostensive conceptualization of causality. The aim of this paper is to explore another side of causality - namely the one that can be defined as performative. Following Feldham and Pentland's (2003) conceptualization of ostensive and performative aspects of organizational routines, this paper outlines the ostensive and performative aspects of cause-and-effect relationships among performance measures. The ostensive aspect of causality, which embodies what is typically thought of as the structure, is reflected in strategic business models. The performative aspect embodies specific actions, by specific people, at specific times and places that bring causality to life. The performative aspect of causality is important for strategic performance measurement system research, especially because it relates to the question of how

representative business models and causal links in strategic performance measurement systems are in terms of describing value creation in the specific decision-making situations in which value creation is performed. Understanding the performative aspect of causality might add to our understanding of how cause-and-effect relations and value creation are constituted in organizations, because it is primarily the ostensive aspect of causality that has been outlined in the literature so far. This paper intends to respond to the call for further research on the antecedents and effects of causal strength among performance measures (including the ways in which organizations cope with unavoidable causal weaknesses), which is considered to be able to add significantly to our understanding of performance measurement (Ittner & Larcker, 1998a; Luft, 2004).

This paper explores the causal relationships among four performance measures in an in-depth field study on a new product development process in a 'Global Electro Group' (pseudonym for the company's real name) subsidiary. The four performance measures, which represent four organizational objectives, component sharing, product quality, product cost and flexibility, are all considered crucial for value creation in the company's product development process. In addition, all four measures are elements in a business model that theorizes value creation in the company's product development process. Component sharing is considered to be an objective that leads to lower product costs and higher product quality whilst at the same time facilitating greater product variety and lower manufacturing costs. Thus, the business model reflects an ostensive aspect of causality, which is considered to play a significant role in terms of understanding value creation. At the same time, however, studying the specific product design decisions revealed another aspect of causality. The study in this paper illuminates how the mobilizations of and relationships between the four performance measures – their relevance, trade-offs and alliances – were in a constant state of flux, as well as contingent upon the heterogeneous entities related to the particular decision-making situations. The causal relationships expressed in the business model were not representative of the causal relationships performed in the specific product design decision making. This might have implications for the extent to which the business model can be used for designing management control practices and facilitating decision making for the project team.

This paper does not attempt to replace the ostensive view with the performative view, but rather suggests that the two aspects of causality seem to co-exist in organizations. Juxtaposing the two aspects of causality gives a more comprehensive picture of the meaning of value creation, and provides insight into the limits of using causal maps for designing management control practices and for facilitating

decision making. If a causal map is used for controlling value creation, then the mapping should also be representative of the causality at play in the particular value creation process that it is used to control. In order to examine the question of representativeness, this paper explores the performative aspect of causality.

The remainder of the paper is structured as follows. Section II characterizes the type of causality among performance measures included in strategic performance measurement systems, as well as the differences among ostensive and performative aspects of causality. Next, section III reflects upon specific methodological issues related to the design of the analysis and introduces the case study. Section IV presents six decisions related to value creation in a new product development process and portrays the interrelations among multiple performance measures. Section V then illustrates the absence of structural relationships among performance measures in regard to the specific decision-making situations related to the product development process and discusses the implications in regard to the design of management control systems. Finally, section VI offers concluding remarks on the quest for causality in multi-dimensional performance measurement research.

II. Conceptualizations of causality

The importance of clarifying causal relationships among nonfinancial and financial performance measures in multi-dimensional performance measurement systems has often been emphasized (Eccles, 1991; Kaplan & Norton, 1996; Epstein & Manzoni, 1997; Ittner & Larcker, 2003). Causal links are the crucial element in what is often called Strategic Performance Measurement Systems (SPMS) which are defined as "a set of causally linked financial and nonfinancial objectives, performance measures, and goals designed to align individual actions with strategy of the organizations"(Webb, 2004: 929). The intention of these measurement systems is for interlinked measures to represent a 'chain of profit' (Rucci et al., 1998), which ensures that performance measures included in the system – financial as well as nonfinancial – are aligned with the creation of shareholder value.

In order to better understand the way value creation is represented in SPMS, the type of causality put forward is examined more carefully in the following. Subsequently, the performative aspects of causality will be conceptualized.

A characterization of the conceptualization of causality outlined in the SPMS literature

In general terms, cause refers to explained relations between variables, where a variable is defined as a factor whose change or difference is studied (Simon & Burstein, 1985). In the business models or

causal maps outlined in the SPMS literature, it is the relations between multiple performance measures that are focused upon as well as how changes in one measure (variable) explain changes in another measure (variable). An illustration of the causal relationships pursued in the SPMS literature is given in the figure below, where Kaplan and Norton present the cause-and-effect relationships among performance measures/objectives in a balanced scorecard. According to Kaplan and Norton, strategy is a set if hypotheses about cause and effect, while the measurement system should make the relationships (hypotheses) among objectives (and measures) in the various perspectives explicit so that they can be managed and validated. The presumption in the causal map is that a change in, for instance, employee skills will lead to a change in the quality measure and the cycle time measure. In SPMS, causal relationships are among the measures in the measurement system that are considered to be the logic of value creation present in the individual organization – often conceptualized as the business model in the organization.

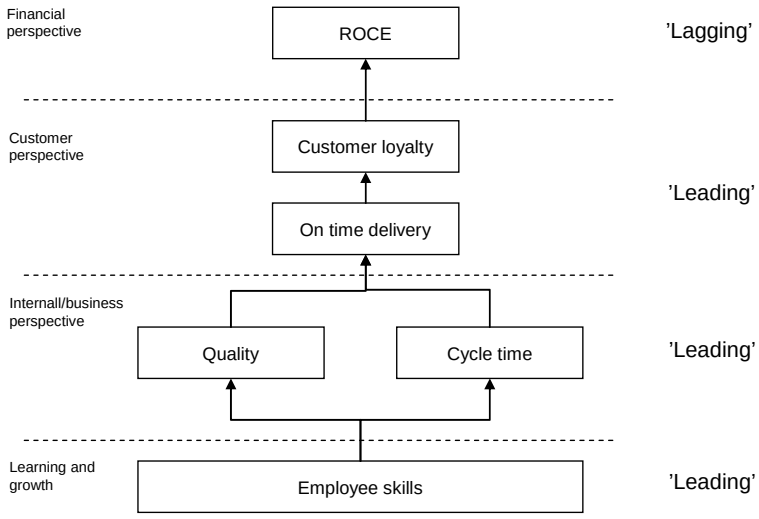

Figure 1: Cause-and-effect relationships in a balanced scorecard according to Kaplan and Norton (1996)

In order to characterize the form of causality that is used in business models or causal maps more carefully the two following types of causality as outlined by Shields and Luft can be used to further specify the causal relationships: The additive, intervening variable and the independent variable (Shields & Luft, 2003: 173). In the additive model, each independent variable (X_i) has an effect on the dependent variable (Y) that is not conditional on the value of any other X_i, and where the value of X_i itself is not conditional on Y or any other X_i. In the intervening variable model, in contrast, the effect

X_1 has on Y occurs on the condition that X_1 affects X_2, which in turn affects Y. However, X_2 does not affect X_1 and Y does not affect either of the X_is. Moreover, once the value of X_2 has been determined, its effect on Y does not depend on X_1. In the independent variable interaction model each X_i has a causal influence on Y. The additive, intervening and independent variable models that are graphically depicted in the figure 2 below are used in combination to build up the causal maps depicted by Kaplan and Norton above.

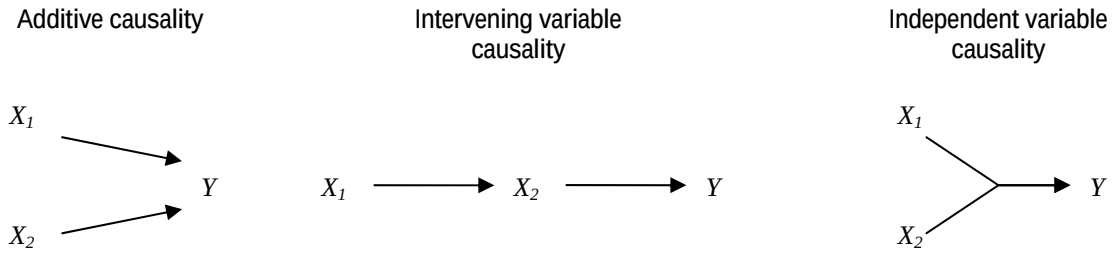

Figure 2: Three different forms of causality present in SPMS

Another characteristic of the form of causality outlined in business models and causal maps is the fact that it is a unidirectional causation that is at play, which means that X_1 is not conditional on any other variable in the model (Shields & Luft, 2003: 174); it is unidirectional from X_1 to other variables. The alternative to unidirectional causation is bidirectional causation where X_1 affects X_2 and X_2 affects X_1. Furthermore, yet another trait of the causality in the business models is that there is presumed to be a time delay between the change in one variable and the effect on another. Thus, X_1 is a leading indicator of X_2 in the intervening model and it is assumed to be able to predict the value of X_2 on the basis of X_1. Consequently, if designers of SPMS intend to test the hypothetical causal relationships among the performance measures, they need to design the test with time lags among the variables to be tested for causality.

Empirical research in accounting, marketing and operations management has examined the causal relationships among several nonfinancial performance measures in order to predict future financial performance, thereby outlining general relationships among multiple organizational goals, such as the causal relationships among customer satisfaction (Ittner & Larcker, 1998b), defect rates, on-time

deliveries (Nagar & Rajan, 2001) and financial performance. Causal relationships among nonfinancial measures such as internal process measures and customer measures (Jacobson & Aaker, 1987), and employee-related performance measures and customer measures (Hartline & Ferrell, 1996) have also been analyzed. Common to all these studies is the desire to outline statistical correlations among performance measures, thereby outlining general cause-and-effect relations among the measures that match the idea of causal relationships to be reflected in the business model related to SPMS.

The process of new product development has also been theorized in terms of value creation by searching for general relationships among performance measures. The four performance measures that are also addressed in the case study included in this paper, component sharing, product costs, quality and flexibility, have all been addressed in the research. Component sharing that uses the same version of a component in multiple products (Fisher et al., 1999) has often been designated as an indicator that leads to reduced product cost and increased product quality. Furthermore, it has been emphasized that component sharing is increasingly viewed by companies as a way of offering greater variety in the marketplace (flexibility), while retaining a lower variety in their operations (Ramdas, 2003; Ramdas et al., 2003). Fisher et al. (1999) propose that cost issues can usefully be thought of as the investment requirements for new products, the variable costs of production and the system costs of production, distribution and after-sale support. Fisher et al explain that "[t]he quality […] of a shared component may be higher than that of components designed and produced for unique applications. This enhanced quality […] may arise because of the learning and quality improvement associated with increased volume, and because increased production volume may justify higher levels of investment in component development and refinement (Fisher et al., 1999: 299).

Some business models and causal maps might be more complicated than the three characteristics outlined here; however, the three aspects outlined here often characterize causal linkages among the performance measures put forward in the SPMS literature. Because they also present the principles that the business model discussed in the case study are built upon, the discussion of causality in business models in this paper will not go any further.

A performative view on causality

Overall, the causality among performance measures outlined in SPMS can be characterized as the ostensive aspect of causality, which is what is typically thought of as structure (Feldman & Pentland, 2003). It is structural relationships among performance measures in SPMS that are hypothesized (and

perhaps tested statistically) that lead to unidirectional causal relationships (additive, intervening variable and independent variable interactions), which then explains the change on one measure as a consequence of a change in another measure.

The aim of this paper is to explore the representativeness of the causality represented in a business model when it comes to value creation. Taking the stance that if management control practices are based upon the causal knowledge represented by a business model, it is crucial that causal relationships also are representative of the causality at play for the particular aspect of value creation that the business model controls. This aspiration is pursued by focusing upon performative aspects of causality. Performances are the specific decisions and actions taken by specific people at specific times when they are engaged in organizational practices (Feldman & Pentland, 2003). An approach focusing upon the performative aspects of causality among performance measures is closely linked to ideas in social studies of accounting (Burchell et al., 1980; Miller, 1994). The point of departure from a Social Studies of Accounting perspective when studying organizational objectives is that they are "socially constructed, their meanings and roles stemming from the articulation of particular social concerns, interests and demands and the specific contexts in which [the criteria] operates" (Hopwood, 1979: 82). These ideas challenge the idea that value creation is something that can be totally grasped from an ostensive point of view. Hopwood (1979), for example, sheds light on the social construction of organizational performance and value creation, and stresses: "…by themselves criteria of [performance] of whatever variety, certainly have a potential to create particular meanings and understandings of corporate life and thereby influence action. But the realization of that potentiality is far from being unproblematic. It is dependent on the way in which the articulated criteria interlink with complex and ongoing *social and human processes, the functioning of which remains poorly understood in theory and practice*" (ibid.: 93 – *italics added*). In the social studies of accounting, the social processes within the particular organizational context affect the complexity and variability of the multiplicity of organizational performance. The focus on performative aspects of organizational life is also reflected in the practical turn in organizational analysis that has generated a number of studies drawing on ethnographic methods to study actors *in situ* (Schatzki et al., 2000), which promises to be relevant for management accounting research (Ahrens & Chapman, 2004) as well as strategy research (Whittington, 1996).

Latour (1986) argues that an analysis of the performative aspect of society is inspired by the fact that "it is impossible *in principle* to define the list of properties that would be typical of life in society although *in practice* it is possible to do so" (Latour, 1986: 273). The performative aspect of causality can be

understood as inherently improvisational (Feldman & Pentland, 2003), because the way that value is created in the specific decision-making situation differs from previous decisions. However, the idea is not that the performative and ostensive views of causality exclude each other, on the contrary, they co-exists in organizations, which implies that there are some areas in which the performative aspects of value creation have implications for the description of value creation in a business model.

III. Case study, introduction

This section presents the context for the case study. Firstly, there is a presentation of the organization and the new product development process in which the study of causal relationships between organizational objectives was carried out. Secondly, the business model theorizing value creation in the product development process and the four performance measures included in the model (component sharing, product quality, product cost, and flexibility) are introduced. This is then followed by a number of reflections about the design of the case study.

The new product development project

This paper addresses the question of value creation in new product development and the causal relationship among performance measures. The study presented in this paper was carried out in a product development process in a subsidiary of the Global Electro Group (a pseudonym for the company's real name). The Global Electro Group (GEG) is one of the world's largest producers of appliances and equipment for the kitchen, cleaning and outdoor use. The GEG subsidiary looked at in this study (hereafter referred to as Global Electro Subsidiary (GES)) develops and produces hot products for kitchens (cookers, ovens and exhaust fans). GES's production system is relatively small compared to other GEG factories, which means GES has fewer advantages in terms of economies of scale. GES, on the other hand, is considered to be more flexible and innovative, and enjoys its role as a developer and producer of niche products for the hot product segment within the GEG.

The new product was a freestanding cooker that was supposed to be marketed for a high-end segment. The development project was relatively small, as it was developed on a product platform for an existing product line in which the new product was considered to be the flagship. The distinguishing design features of the new product included an angled ceramic glass top, which gave it a completely new look and made a new user-interface possible. The new design also included a sunken front panel with a row of pop-out knobs, which, according to the designers, gave the cooker "an elegant, minimalist design"; a drawer with a 1.9" lift allowing for "the right balance in the horizontal dimensions"; and a long list of

new electronic functionalities such as cooking control and automatic oven thermometers. The new product was dubbed SMILE by the project group, as the sunken front panel and the angled ceramic top glass almost made it look as if it was smiling.

About 30 people were actively involved in the development of SMILE, and the number of coordination tasks and activities was significantly lower than in other development projects at GES, and in GEG in general. However, the project was still large enough to cause discussions concerning firm value. Several performance measures and organizational objectives were mobilized in order to guide the value creation process. The decisions that appear in the analysis all originate from issues of "design for manufacturability". This is, of course, only one of the numerous problems that were addressed during the product development process, but the issue of design for manufacturability was, for the purpose of this paper, as good as any other issue, as long as multiple performance measures and objectives were mobilized in order to guide the value creation process.

The manufacturing system at GES is organised in three departments: the plate works, the enamelling department and the assembly line. The highly automated *plate works* produces all the metal sheets for the cookers (the top, bottom and side sheets for the cookers). The *enamelling department* then treats the surface of these cooker sheets. The sheets that are enamelled are all processed in three different steps: in the first stage, the sheets are washed and dried. They are then fed through an electrostatic plant sheet, in which they are sprayed with enamel powder. Finally, they are burned in the oven at 800º C. The cookers are then assembled on the *assembly line,* and the various features are fitted. The cookers begin their journey on the assembly line at the 'skeleton line', they continue on the oven line, and then follow line 2, 3 or 4 (depending on which product line they are part of), finishing at the door line, where the door is mounted on the cookers.

Multiple performance measures, business modeling and value creation at Global Electro Subsidiary (GES)

During the discussions and reflections by the members of the product development project team, several performance measures were mobilized in order to signify the consequences of the product design in terms of firm value. Because the focus in this paper is on value creation and causal relationships among the performance measures and organizational objectives the issues related to measurement problems and strategic representativeness of the individual measures will be

deemphasized. The aim is primarily to address the question of cause-and-effect relationships among the performance measures already outlined in the business model which are presumed to be congruent.

In the study, four performance measures that were all part of a 'business model' for the product development processes in GES, were followed in the analysis, in order to reveal their significance in terms of expressing the multifaceted problem of value creation in specific decision situations. The four performance measures represented four organizational objectives: component sharing, product quality, product costs and flexibility which were all ingrained in a logic of value creation outlined in the business model below. The product development manager explained:

> "Component sharing is the key to successful product development in our organization. It leads to better quality, flexibility and lower cost and this again affects the profitability of our organization. That's what we say. I know it might be too simplistic. However, this is what we believe in".

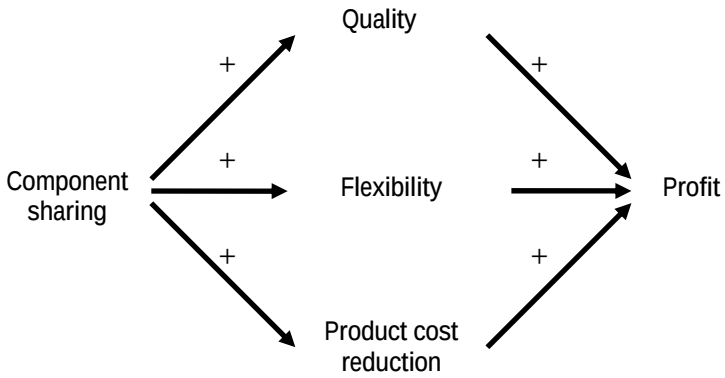

Figure 3: The product development business model in the Global Electro Subsidiary (GES)

Component sharing was the point of departure in the business model. The objective was about standardizing components/parts/modules for different product designs, in order to improve productivity in the manufacturing and purchasing processes, and hence lower manufacturing costs. In GES, component sharing was promoted as a performance measure within the central management program: standardization program. The standardization program was associated with a database in

which the components/parts/modules for each product were registered. The component sharing between products could then be measured from the records in the database. *Product quality* was another organizational objective included in the business model. Various aspects of quality were measured in GES, however, in terms of the business model it was the measure of "the service call rates" that was included. The service call rate was a measure of the number of service calls made by customers about a given product within a given period of time. *Product cost* was yet another organizational objective at stake in the development process at GES. Each product development process was confronted with a target product cost (the STK3 cost), which was the sum of direct and indirect product costs and investments estimated for each product. The achievement of the target cost objective was considered to be a cardinal point for each product development process. *Flexibility* was the fourth organizational objective included in the business model. It had various referents in the discussions of value creation in GES, however, the one included in the model was defined as product variety. The number of different products produced in the manufacturing system was considered as a success criterion because key competitive advantage could be obtained by GES within the Global Electro Group if it was able to offer a variety that other factories were not, because of their concern for economies of scale. Flexibility was considered as the company's core competence. Of course product variety should be compared with the cost and resources consumed, however, this was not included in the measure outlined in the model. In the first place it was about increasing product variety and the assumption is: at the same costs.

Development engineers and managers could easily describe the causal relationships among the multiple performance measures embedded in the model. The causal relationships among the measures could also be statistically supported. A design engineer explained:

> "We are actually able to validate these links from statistics. We have statistical evidence for the claim that products with a higher proportion of common parts have a higher product quality. It is also clear that if you use a higher number of common components in product design the product costs will decrease and we can increase the product variety. We have enough evidence to support these claims. You can take a look at the numbers. They all support these claims"

In GES component sharing seem to be "the way to breaking the codes of flexibility". Flexibility – meaning product variation – was a significant competitive advantage for the factory, however, this was

only possible through standardizing the components of new product design otherwise would the operations variety be too high and cause significant increase in manufacturing costs. Thus, being a flexible factory would never be possible without pursuing component sharing.

The data collection

The decision situations projected in this paper come from an in-depth case study of the new product development project over one and a half years at GES, focusing upon various performance management issues. Only a minor part of the data resources from the study was used for this paper. Nevertheless, the exhaustive case study was important, in order to get a detailed insight into the particularities that played significant roles in the debate of value creation and the mobilization and causal relationships among performance measures.

Data was collected by attending meetings, conducting interviews, studying formal documents, and informal discussions and observations. In total, the researcher attended 25 meetings, in which he played the role of "the fly on the wall". The meetings, which were all part of the new product development process, were formally called "project group meetings", "quality meetings", "steering group meetings," etc. Two thirds of the meetings were recorded and subsequently transcribed. In the remaining meetings, notes were taken and résumés were made after each meeting.

In addition, 45 semi-structured interviews were conducted with people from various functional groups involved in the product development project. The respondents had various departmental affiliations (production, sales/marketing, development, purchasing or general management) as well as differing positions in the hierarchy (CEO, manager, employee). The formal interviews were semi-structured, and focused upon issues of management control, strategy and the organization in relation to new product development, and to SMILE in particular. In addition, the interviews served to 'follow up' on the meetings - the issues discussed at the meetings were often quite technical or operational, and were sometimes hard to follow. In these cases, it was helpful to follow up on opaque discussions from the meetings in the interviews. All the interviews were based on a semi-structured questionnaire with open questions (Kvale, 1996) and lasted approximately 1 ½ - 2 hours. The interviews were all recorded and subsequently transcribed.

In addition to attending meetings and holding interviews, a wide variety of documents related to the product development process were studied (quality reports, standardization guidelines, accounting

reports, drawings, etc.). Furthermore, informal talks with personnel at GES played a significant role in getting insight into the product development process.

Although attending meetings obviously seem to be the major source of getting insight into the decision situations about the new product development processes, the formal interviews, informal conversations and document studies also played a significant role in this respect. Hence, all four data sources ended up being important resources for depicting decisions of value creation in the new product development process in GES.

Mapping decisions of value creation

Several different decision situations could have been portrayed on the basis of the data collected from the new development process in GES. Two factors were decisive for the selection of the six decision situations depicted in this study. First, the study aimed to challenge the ostensive view of causality. Secondly, the portrayal of the interrelations between performance measures was limited to those in which the four performance measures included in the business mode were mobilized, in order to make sense of how this specific decision was about value creation.

The decision situations that appear in the analysis are fairly simple in terms of the interrelations at stake. In the six decision situations included in this paper, only two design alternatives emerged, and organizational performance measures were mobilized in regard to each alternative, thus signifying the design alternatives in terms of value creation. For instance, a new feature of the design could be related to quality and flexibility on the one hand, but also to increased costs and component sharing on the other hand. Thus, these articulations often outlined trade-offs or mutual connections between performance measures from the business model. In the following, it is articulations in which the interrelation of the four performance measures emerged that are included, precisely because it presents issues of causality. Even though the decisions that are portrayed are fairly simple, they represent sufficient complexity to illustrate characteristics of causal relationships between performance measures and organizational objectives when it comes to value creation in practice and thereby illustrating the performative aspect of causality.

The decision situations described in the next section will be mapped. This is done in line with a tradition from social studies of science of 'mapping the dynamics of society' (Callon et al., 1986). The analysis maps the 'semiotic networks' – the heterogeneous elements mobilized in regard to each

decision situation, because the ramifications and mutual exclusivity that emerge within the decision situation illuminate how causality is performed in practice. The interrelations that are exposed in the network are the 'closing formation' in each decision situation, which reveals the relations among performance measures and the causal relationships in this particular decision of value creation.

Even though the project group at GES made choices between different design alternatives in each of the six decision situations that are portrayed, the aim of the analysis in this paper is not to describe how and why one alternative was picked in preference to another. Instead, the focus is upon the interrelations among performance measures that emerge in each decision situation. Consequently, the descriptions of the individual decision that follow in the next section will be oriented towards giving a 'snapshot' of the interrelation in each decision situation, rather than unfolding the process leading towards it. Thus, each description will end up with a map of 'the semiotics of each decision situation' revealing the relevance and meaning of each performance measure in regard to value creation.

IV. Multiple performance measures, causality and decision making – evidence from a new product development process

This section presents six decisions of product design that all deal with the question of value creation – more precisely the question of 'design for manufacturability'. In this section, the articulations of value creation within each decision situation will be presented one by one. In the next section (section V), the interrelations among the performance measures within each decision situation will be juxtaposed, and reflections will be made upon the insight of the causal relationships between multiple performance measures that the study has provided.

Decision I: 90° turn of the switch

The first decision deals with the 'pop-out knob' on the cooker - or more precisely, with the switch on the pop-out knob. The switch was meant to turn the various functions the pop-out knob was supposed to control on and off. From a manufacturing point of view, the switch was problematic, because it was difficult to assemble, and this difficulty initiated a process in which the project group tried to make sense of the switch's meaning in terms of firm value. Two design alternatives were hereby mobilized as solutions to the manufacturing issue, and multiple performance measures were mobilized in order to translate the significance of the alternatives in terms of value creation. Thus, two formations emerged from the process – one ascribing the meaning of a 90° turn of the switch (formation a or design

alternative a), and another signifying a pre-assembly of the switch in terms of firm value (formation b or design alternative b).

A 90° turn of the switch (formation a – design alternative a)

It was a production engineer who first problematized the switch at a project group meeting. He explained that the switch on the pop-out-knob was placed in such a way that there was little room for mounting the wires, due to a very compact design behind the front panel, where the input module only left a narrow space underneath the switch. Hence, there were three things causing the trouble: The placement of the switch 'taps' on which the wires were supposed to be fastened, the wires that were supposed to be fixed to the switch, and the lack of space between the input module and the switch taps. The production engineer suggested that one solution to this problem would be to turn the taps on the switch 90°. This kind of turn would make it much easier to mount the wires on the taps, but would also require some change in the construction. He continued:

> "The turn means that we have to change the construction a bit, because the axle and a number of other things have to be altered. The d-axle will have to be turned, otherwise the mark on the knob won't fit. However, all this means is that we have to change the tool that makes the pop-out knob, in order to realize this 90° turn."

The production engineer constructed meaning from the assembly problem in terms of firm value by mobilizing product cost as an organizational objective. The 90° turn of the switch was related to product cost in the sense that without a turn, the processing time on the assembly line would rise significantly, he explained. The difficulties with the assembly influenced not only the production cost, but also the cost related to reworking and service work involving the pop-out knobs. He pointed out:

> "It requires extra time, I expect it will take xx extra minutes per item. And more if there is a failure, because we will have to take it all apart again. We could make big savings if we turned it 90°."

The cost savings in the production system were high enough to more than offset the extra cost of reconstructing the pop-out knob, the production engineer emphasized. So all in all, a 90° turn would significantly lower the production costs.

Pre-assembly of the switch (formation b – design alternative b)

However, a development engineer confronted the product engineer's articulation of the assembly problem, and suggested an alternative to the 90° turn. The development engineer suggested that the switch be pre-assembled. Normally, the wires were mounted on the switch taps at the end of the assembly process, but they could also be mounted on the taps before the switch went to the assembly line, the development engineer argued. This would make it possible to avoid the problems of mounting the wires on the assembly line in the narrow space between the input module and the front panel.

A pre-assembly solution to the assembly problem meant that the existing pop-out-knob could be kept without any changes in its construction, which made sense in terms of organizational performance for two reasons. Firstly, because the pop-out knob was a standard component. If it was re-constructed and the taps were turned 90°, as the production engineer had suggested, it would be in opposition to the pursuance of component sharing. To ensure that organizational performance was not just a matter of production costs, a more holistic perspective of productivity at the factory as a whole ought to be taken into consideration, the development engineer emphasized.

Another aspect of pre-assembly was that it was closely related to customer flexibility, the development engineer argued. The ability to install new pre-assembly positions on the shop floor was important, because complicated assembly jobs were crucial to increasing the product variety. The factory was often confronted with complicated assembly jobs, not least due to the increasing number of electronic components with new features for the customer in the constructions. And it was precisely this challenge that the factory had to take up if it wanted to succeed at being flexible and increase it product variety at low costs.

The ability to integrate pre-assemblies in the existing production layout at GES was augmented by the fact that the factory had limited physical locations, because the factory was located in a protected area of the town, and it was impossible just to add a new wing to the factory, the development engineer explained. He underlined:

> "Space is something we don't have much of here. So we definitely have to learn how to handle these pre-assemblies. We can't just extend the factory; neither can we ignore the problem. We must address this problem seriously if we really want to be flexible. And the pre-assembly of the switch is a good way of learning this."

Causal relationships in regard to the 90º turn of the switch

In the articulation of the 90º turn of the switch, various performance measures were mobilized in order to navigate the product development process (please see figure 1). Formation a and b each represent two alternatives in terms of the problem of assembling the switch, which included concerns for component sharing, flexibility and production costs. The interrelations that emerged during the articulation are mapped in figure 1. The project group finally chose to set-up a pre-assembly rather than turn the switch 90º, although the reason for doing so will not be pursued in this paper. Here the focus is upon the relations among performance measures that emerge from articulations of firm value.

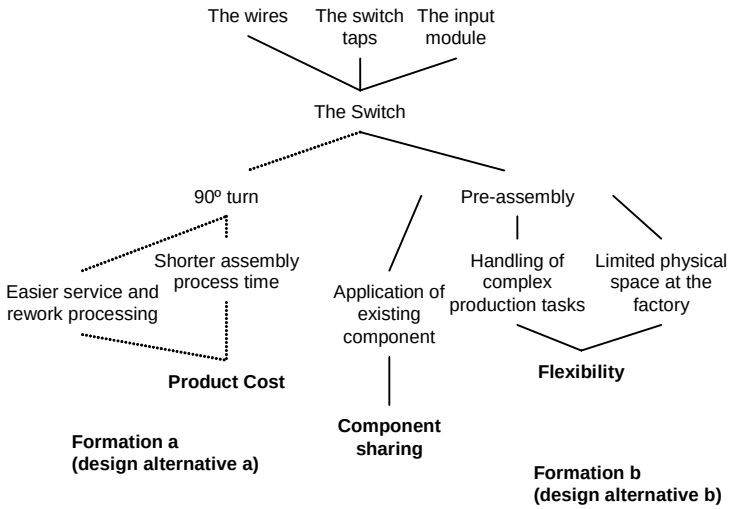

Figure 4: Decision I and cause-and-effect

Decision II: the fastening of the pop-out knob

Another aspect of the pop-out knob that was discussed in the project group was the way in which it was fastened to the front panel. Usually, the cooker knobs were simply screwed directly onto the front panel using a plain adaptor, which was an easy process to handle on the assembly line. However, it was different with the pop-out knob. It was not possible to use the normal knob adaptors, because the pop-out knob was too long, and therefore needed extra stabilization. Consequently, a special arrangement for fastening the knob was required in order to attach it to the front panel properly.

The discussion about the fastening of the pop-out knobs was centered on the significance of two solutions for fastening the pop-out knob. The first one was an aluminum construction in which the pop-out knob was supposed to be attached through two angle braces. The second one was a plastic housing for the pop-out knob. The translations of each piece of the construction for SMILE will be outlined below. Formation c represents the plastic housing translation, and formation d the aluminum construction translation.

The plastic housing (formation c – design alternative c)

The first attachments of the pop-out knob to the first physical models of the new cooker were carried out using an aluminum construction. However, these attempts to fasten the pop-out knob to the front panel revealed a number of difficulties. 'On paper, everything is easy' a production engineer commented, 'but in practice, it seems to be a lot more difficult to assemble and to manage this construction so as to ensure a smooth run for the pop-out knob.' Instead, the production engineer suggested a new solution: the plastic housing for the pop-out knob. The plastic housing was a cast barrel that was attached to the rear of the front panel, so the pop-out knob could be placed in the barrel, and thus fastened to the front panel. This construction was far less troublesome than the aluminum construction, and it was a competitive solution in many ways, the production engineer argued.

In order to make sense in terms of firm value, the production engineer first related the plastic housing to the product cost. A plastic housing would result in lower processing time on the assembly line, because it was much easier to handle a plastic housing than an aluminum construction. Accordingly, it would result in less direct labor for each product that was manufactured. The plastic housing would give rise to some extra cost, due to the spending on development, but this would be small compared to the savings it would bring about in terms of a lower production cost, the production engineer explained.

Secondly, the plastic housing solution was much safer in terms of lowering the risk of external failure. The pop-out knob could easily be given a run that was less than smooth with the aluminum construction. There was also a risk that it would get stuck when it 'popped out' at the customer, because the aluminum construction was so difficult to assemble accurately. In contrast, the plastic housing was a much safer construction in this respect. Thus, the risk of claims from the customer

would be much lower for the plastic housing than for the aluminum construction, the production engineer reasoned.

Thirdly, the plastic barrel fit into a strategy of isolating the components in terms of temperature, as more and more electronics were planned to be implemented in the cooker constructions. The aluminum construction did not have this quality, so a plastic barrel fit better into a strategy of offering the customers more electronic features, which was considered to be a main factor in winning "the flexibility war".

Finally, the production engineer raised an issue of trust and expertise. He argued that the sub-contractor who produced the plastic barrels for GES had a significant expertise in the field of casting, and that he was, in general, a trustworthy partner. Consequently, this was a safe solution, the production engineer contended.

The aluminum construction (formation d – design alternative d)

However, another translation of the aluminum construction, counter to the one made by the production engineer, emerged in the discussion of the question of fastening the pop-out knob. A development engineer pointed out that the aluminum construction actually ensured value creation in terms of component sharing. According to the development engineer, the aluminum construction was an important component in terms of standardizing, because it represented a fastening technology that could be applied almost everywhere within the cooker, and it could be applied for several types of components that had to be fastened. The development engineer explained:

> "The aluminum construction is flexible, and the aluminum profiles and angles can be used for fastening a lot of different sets of components to the cooker."

The aluminum construction may be difficult to handle in the beginning, but the results would come, the development engineer promised.

The causal relationships in regard to the fastening of the pop-out knob

The discussions about the fastening of the pop-out knob mobilized two different translations of what a competitive design might be (formation c and formation d) – please see figure 2. Multiple performance measures were mobilized in order to guide the decision. One translation underlined the role of the

aluminum construction, and its significance in terms of component sharing, while the other translation depicted the association between the plastic housing and product cost, quality and flexibility. The interrelations characterizing this process are mapped in the figure below. The project group decided to implement the plastic housing in the design.

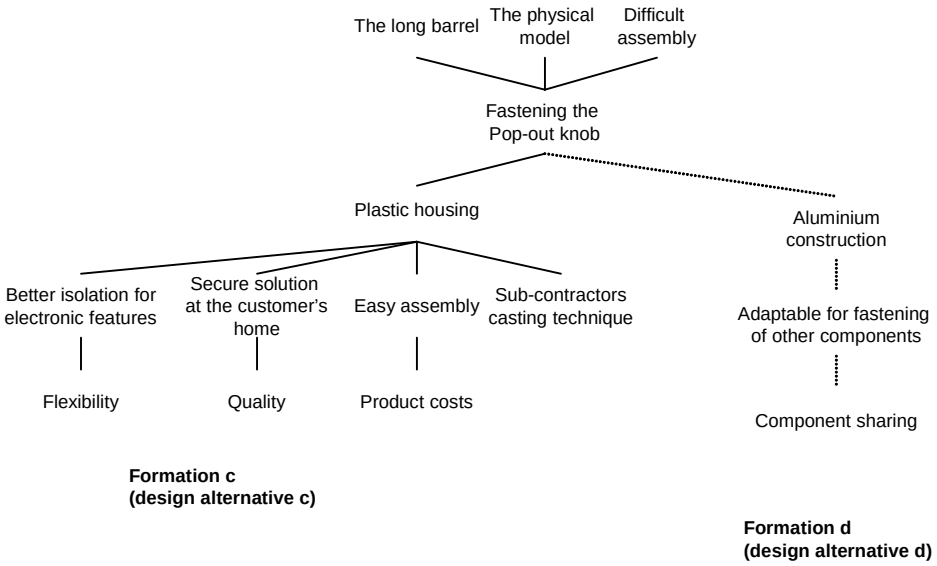

Figure 5: Decision II and cause-and-effect

Decision III: the black top frame

Another issue that was mobilized during the project group meetings was the top frame, or more precisely, the *black* top frame. It was problematized because the size of the item caused trouble in the enameling system. However, controversies about the meaning of the black variants emerged, as two translations of its significance appeared in discussions related to the design decision. One translation portrayed the black top frame as a problem, whereas another underlined its importance for firm value.

The black variant as a cost driver (formation e – design alternative e)

One of the characteristics of the new construction of SMILE was that the front panel and the top frame were welded into one item. As a result, this item was larger than the other top frames handled in the production system. This change had a particular effect on the enameling process, in which each item was passed through an electrostatic plant, a production engineer explained. Two things in the

electrostatic plant played a role in the problematization of the black variant: the spray guns and the catchers on the conveyor.

The electrostatic plant contained a closed automatic process in which a line of spray guns sprayed enamel powder onto the items passing by, fixed onto a conveyer by a catcher. The guns had to be adjusted very precisely in order to secure an even spread of the powder, which was vital for giving the items a bright surface. The reason why it was the black items rather than the white items that caused problems, was because there were two different electrostatic plants in the enameling department. The enameling processes for the white and the black items were kept distinctly separate, because it was technically impossible to process white and black items on the same plant without experiencing major problems with quality, with white spots on the black items, and vice versa. The black plant normally processed items such as baking sheets and oven sides. These items were significantly smaller than the top frame item for SMILE. Black sides and top frames were usually not processed in the black plant, because SMILE was the first black cooker the factory had produced.

In order to clarify what this meant in terms of firm value, the production engineer related it to the product cost and to component sharing. The product cost was influenced by the black variant, the production engineer explained, due to troublesome changes on the conveyor/catchers, and the setup of the spray guns in the electrostatic system every time a batch of black top frames was ready to be processed. All in all, this led to a substantial increase in the production cost in the enameling department, which in turn had an effect on the product cost.

Another association made by the production engineer was the black variant's relation to component sharing. A black variant was an extra item in the production system, and thus opposed the standardization program that endorsed the idea of reducing the number of components in the production system. Consequently, the black variant was not only a cost driver in terms of extra setup costs as ascribed by the product cost calculation, but also in terms of the complexity it produced in the production system as an extra variant. Thus, the production engineer proposed that the best thing to do would be to drop the black variant, because it triggered too many extra costs.

The black top frame – a value driver (formation f – design alternative f)

The translation of the black variant as a cost driver was opposed by another translation that turned the black variant into a value driver. The sales manager argued that black was an atypical color choice,

compared to white, which was the normal color for cookers. However, a black variant was an important element in sophisticated design that was to be launched with SMILE. Black was something special, and so was SMILE. The black variant was a substantial part of the idea of presenting a distinct product for the high-end consumer. The black variant was something that made people pay extra for SMILE, compared to other ordinary, freestanding cookers. Thus, the black variant should be seen as a value driver rather than a cost driver, the sales manager underlined.

Another point closely related to the idea of the sophisticated design, was that the black variant ensured customer flexibility. The black color was essential in the variety of colors (stainless steel, white and black) that were going to be presented to the customer, and which were considered to be essential to the value of SMILE as a product concept, according to the sales manager.

Causal relationships in regard to the black variant

The meaning of the black top frame in regard to firm value is embedded in the interrelations of performance measures outlined in the figure below. The first translation of the black top frame (formation e) relate it to increased product costs, and describes it as conflicting with component sharing. The second translation (formation f) proposes to keep the item, and links the black top frame with customer flexibility and a unique market value caused by a sophisticated color. The project group decided to continue with the black variant.

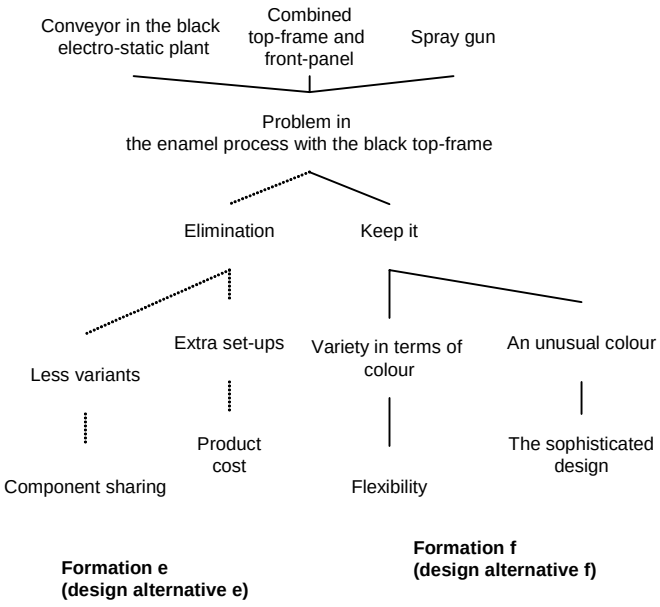

Figure 6: Decision III and cause-and-effect

Decision IV: The deformable decoration ring

Another problematization that emerged during the work in the project group concerned the appearance of the pop-out-knob. More specifically, it dealt with the decoration ring that was placed between the pop-out-knob and the hole in the front panel. This decoration ring was supposed to generate a smooth and full transition between the pop-out-knob housing and the front panel. However, the project group was discontent with the first decoration rings that were mounted on the first physical models. The hole seemed to be too small, which resulted in the ring bulging. Two solutions to this problem were discussed.

Two decoration rings (formation g – design alternative g)

It was a development engineer who problematized the appearance of the decoration ring on the front panel. He explained that the enameling process caused the problem. The enameled front panels had a hole that was 0.5 mm smaller than the stainless steel front panels. The difference was caused by a fine layer of enamel that settled in the edge of the hole, thus reducing the size of the hole slightly. The 0.5 mm was enough to make a difference when fitting the decoration ring. The decoration rings were made for the holes, regardless of their surface preparation, so this resulted in a misfit when the decoration ring was mounted in the enameled front panels.

The customers found the bulging decoration ring to be unacceptable, and the development engineer underlined; 'we have to do something. We simply can't accept this kind of bulge in our product, and the customer won't accept it. It is poor quality', he underlined. And the development engineer came up with quite a simple solution. He suggested that instead of only one decoration ring, two decoration rings could be produced; one for the stainless steel front panels, and another with a smaller diameter for the enameled front panel. The development engineer underlined the fact that this kind of solution would be low-cost. 'It won't cost much to design a new ring. We can just take the one we've got, and down-size it a bit - then we'll have decoration ring number two!', the development engineer explained.

The deformable decoration ring (formation h – design alternative h)

The development engineer's translation of the problem with the bulged decoration ring was challenged by another translation in the discussions in the project group; a production engineer mobilized an alternative. His solution was to construct a deformable decoration ring. A decoration ring that would diminish in size when it was mounted in an enameled front panel, and enlarge when it was mounted in

the stainless steel front panel. The production engineer explained the development of the new decoration ring: 'What we will try to do, is to incorporate four small channels in this ring. Channels that will deform when the ring is pushed into the enameled front panels. And on the contrary, if it is mounted on a stainless steel front panel, it'll dilate. We should be able to create this kind of solution with the knowledge we've got. Especially if we work together with our subcontractors.'

The production engineer mobilized two performance measures/objectives in relation to this alternative solution: component sharing and flexibility. Other concerns, such as better quality, were also enrolled. Firstly, the production engineer explained that two decoration rings instead of one would contradict with the aim of component sharing. Of course, it was just a matter 'one tiny component,' but everything that could be standardized should be standardized, the production engineer explained. He continued: 'It is exactly these kinds of decisions that determine whether or not we are able to control the hidden factory that they all talk about. We definitely have to reduce the length of the bill for materials'. The deformable decoration ring adapts nicely to the aspiration for standardized architecture.

Another concern related to the deformable decoration ring was that of quality. The one ring solution was less risky than the two ring solution, because two rings meant that there would be a risk that the employees on the shop floor would mount the wrong ring in the wrong hole. It would be fairly easy to detect a decoration ring that was too small, because there would be a gap, but it would be much more difficult to see if it was too big, because the bulge often appeared after some time. Consequently, a ring that was too big would often not be noticed in the production line. But sooner or later the decoration ring would start to bulge; not in front of the workers, but in front of the customer. Such a bulge would without doubt lead to a high Service Call Rate, the production engineer emphasized. He continued: 'It's so easy to make a mistake when you have two rings that only differ 0.5 mm in diameter. The production process is organized in such a way that this could easily be the case. If they mix up the rings, we'll see the problems later on – and they will be quite expensive to put right!'

Yet another aspect of the deformable decoration ring, which underlined the competitiveness and durability of this solution, was the expertise of the supplier. The suppliers were said to be very skilled in the field of plastic casting. This expertise was seen to justify the deformable ring as a realizable solution. It was realistic to set up such a solution, even though there was a great deal of uncertainty about this new item at the time when the decision had to be made. Would it be possible to integrate the four channels in the design? Which material was the most suitable? In conjunction with the aspects

mobilized by the production engineer, a formation was mobilized that translated the decoration ring into a competitive solution, in contrast with the 'two-ring' answer to the problem of the bulging decoration ring.

Causal relationships in regard to the bulging decoration ring

The translation of the decoration ring design in terms of firm value mobilized involved multiple performance measures (please see the figure above). The two decoration ring solution, aspiring to low production costs (formation g), whilst the deformable decoration ring would be a competitive solution, due to its associations with the lower service call rate, or quality and component sharing (formation h).

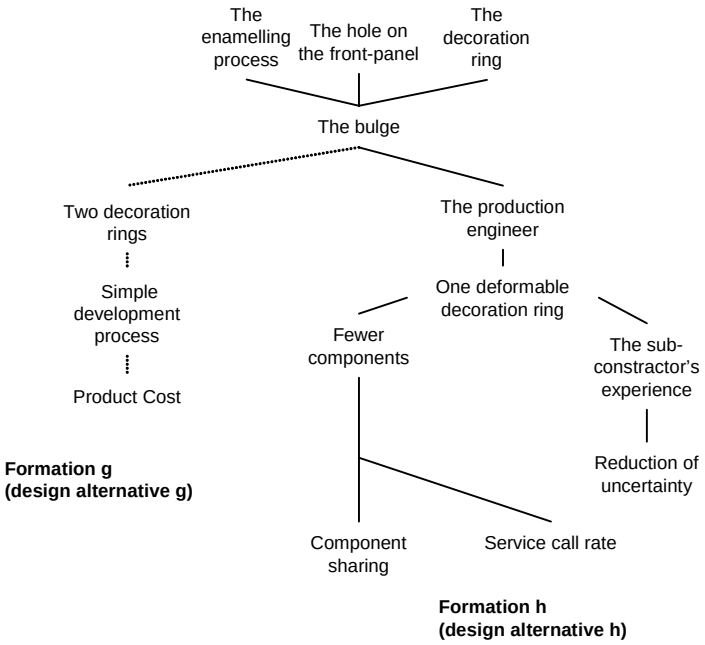

Figure 7: Decision IV and cause-and-effect

Decision V: The stay bolt for the top-frame

A stay bolt on the top-frame was another thing that was problematized during the meetings in the project group. The stay bolt was a little piece of thread which was welded onto the back of the top-frame. Electronic pieces fastened onto a nut were meant to be screwed onto the stay bolt. The project group had a long discussion about whether the stay was a feature that was value adding for the product or not. The discussions resulted in the formation of two alternatives, and multiple performance measures were mobilized in order to guide the decision concerning the stay bolt.

The stay bolt as a quality problem (formation i – design alternative i)

The stay was problematized by the production engineer, because it was a difficult component to deal with in the welding process. If the stay was welded too hard to the back side of the top-frame, it left marks on the front side of the top frame, and if the stay was welded too lightly on the back, it fell off very easily. The reason why it often left a mark was that the top-frame was relatively thin, and because the front side was enameled, which made it extremely sensitive to the changes in the metal structure caused by the welding. The welding marks could be impossible to spot by visual control before the top-frame was enameled, but after being processed they could very clearly be seen on the front. Hence, the welding mark was not necessarily visual, but a hard weld may change the structure in the metal, and these changes were enough to leave a mark after the enameling process. Even though the marks could be avoided by light welding, this was not a viable solution, because they would then fall off. Consequently, the stay left the group with a quality problem that would be discovered at a visual inspection at some stage in the process.

A mark on the front of the top-frame – even though it was just a small mark – was simply unacceptable for a GES product. The simplest solution would be to remove the stay bolt from the construction, thus eliminating the possibility of marks appearing on the front. The idea was to keep things simple. A production engineer explained: These fragile processes are what we have to eliminate, this is simply an implication of the quality program. The idea of having to eliminate risk is what we are all working on, for instance at the FMEA meetings".

The stay bolt as a way of achieving flexibility and technological adaptation (formation j – design alternative j)

In the discussions about the stay bolt, another translation of its effect on firm value emerged. The stay bolt was considered to be part of the aim of realizing the flexible firm, and to signify the importance of technological adaptation. Both of these were performance measures that re-installed the stay as a competitive feature of the new construction.

The development engineer explained that the primary role of the stay was to fasten new electronics features to the cookers. The welding of stays on the front frame was seen as one of the things that was of great importance in handling the electronic features in the cookers; new adapters had to be installed in the cooker all the time, in order to fasten new electronic components (not least because the new

cooling system would make it possible to fit new electronic features in out-of-the-way places in the cooker. The stay was a useful solution to this problem of fastening, which was all part of the placement of electronics, it was argued.

Even though it was argued from a quality-strategy point of view that the stay should be removed, it was something that should be left on if it was seen from a flexible firm perspective; the stay was a delicate piece to weld, but it was a part of the construction that GES ought to be able to deal with, if it wanted to increase variety at the same or even lower costs. The stay bolt was a challenge rather than a problem that should be removed from the construction. It was an opportunity to learn, and to be more flexible in terms of dealing with challenging pieces of the construction. A production engineer commented: "Everything can easily be too simple for the sake of quality, and it can ruin our ability to remain competitive – by which I mean flexible and innovative. It is very important for us to actually be able to handle a piece like the stay bolt – that's where all the flexibility and innovation are hidden!"

In order to explain that the stay bolt was not an "impracticable feature," it was related to a similar component on another cooker. By doing so, it became clear that a weld was not just a weld; there were hard welds and soft welds. It was the hard welds that obviously caused the problems on the enamelled surface of the top-frame. It was actually possible to successfully fit stays through a weld; this had been proved on another production line where the other cooker had had its stay bolts welded. The process was demanding, but possible. It was important to ascertain this, in order to present the stay on the new construction as being a 'realistic' demand. It all became a matter of a suitable welding technique – a challenge that ought to be taken up if the capability to be innovative and flexible was to be maintained, it was argued.

Causal relationships in regard to the stay bolt on the top-frame

The design decision in regard to the stay bolt was related to multiple performance measures. Quality and flexibility as well as innovation, were all linked to the problem of the marks on the front of the top-oven. Quality was here translated as being a threat to the capabilities of flexibility and innovation. Quality became a matter of visual appearance for the customer, flexibility became the ability to handle intractable features on the construction, and innovation became the consequences for the possibilities of cookers supporting electronics features by means of this fixture mechanism.

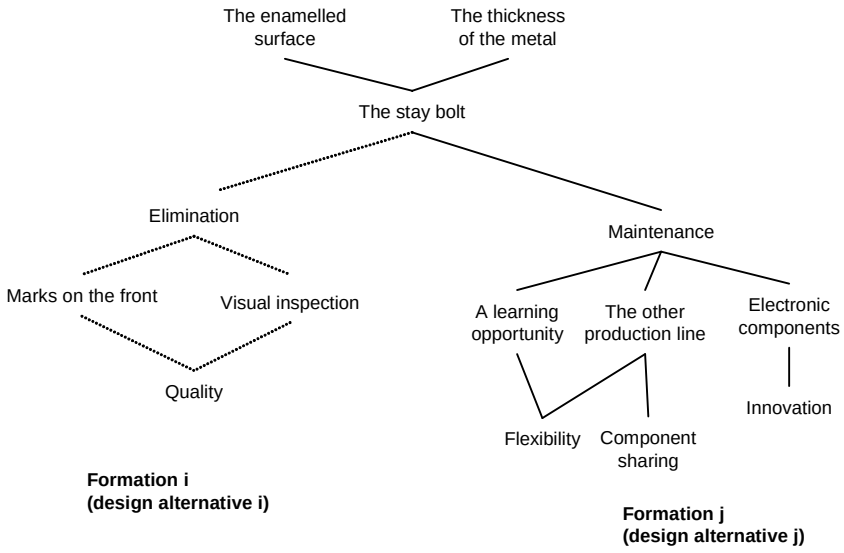

Figure 8: Decision V and cause-and-effects

Decision VI: Reconstructing the top-for-oven

Finally, the design decision about the reconstruction of the top-for-oven will be described shortly. Top-for-oven was the name given to a sheet of metal for the top of the SMILE oven. Initially, the SMILE oven was intended to be a standard oven, to be used in a wide range of products at GES. However, after some consideration, the project group discovered that the top-for-oven needed to be reconstructed, due to a special design of SMILE's drawer, which required the installation of a new cooling system in the construction. Thus, a translation process emerged concerning the value created by different design alternatives. The two formations that characterised the design debate about the reconstruction are portrayed below.

Reconstruction as a cost-driver (formation k – design alternative k)

It was a development engineer who initially problematized the top-for-oven construction. His problematization was based upon lifting the oven and drawer with the SMILE design 50 mm, and introducing a new cooling system for SMILE, and a new tool for the MSP-press. Lifting the oven and drawer 50 mm meant that there was no room for the standard cooling system. It was therefore necessary to implement a new cooling system in the SMILE construction. Moreover, the new cooling system would require a reconstruction of the top-for-oven, because the cooling systems had to be mounted in the top-for-oven construction, and it was impossible to find a cooling system that fitted the stamp that was already there for the standard cooling system. Consequently, a new stamp was needed, which in turn entailed a new tool for the MSP-press, because even a minor reconstruction of the top-for-oven required a new tool for the MSP-press.

However, these changes to the construction, and in particular the new tool for the MPS-press, turned out to be problematic in terms of the competitiveness and strategic considerations. A new tool would affect the product cost of SMILE, as it was put in the discussion in the product group. The new tool for the MSP-press was translated into an indirect cost in the GES costing system, and although the reconstruction was related to the new tool, it turned out that it would have a significant impact on the cost of the product. The reconstruction of the top-for-oven caused by the new stamp for the cooling system appeared to far exceed the cost budget for this part of the construction. It was inevitable that something had to be done, but reconstruction was not consistent with a competitive advantage.

Furthermore, SMILE's top-for-oven was initially thought to be a standard component, because SMILE was supposed to use the oven platform installed on all the other freestanding cookers by GES. The reconstruction of the top-for-oven would mean that a new component would appear in the production system. This would affect the production system in the normal way for new components, in terms of added complexity and lower productivity in the production system.

Reconstruction as a standardization (formation 1 – design alternative 1)

Fortunately, an alternative was mobilized. Ironically enough, it came from the concept of standardization. This time, the issue of standardization was related to the reconstruction of the top-for-oven, not by considering it as a standard *deviation*, but instead as a standard *creation*; where the reconstruction would constitute the new standard. This would mean that the existing top-for-oven standard used on several cooker models would become obsolete, and a new one defined. One that would re-install competitiveness and strategic advantages in the design, it was argued.

A new standard for the top-for-oven improved organizational performance at GES. *Firstly*, a new standard would affect the product cost for SMILE, in that it would make it possible to allocate the costs of the investment between four products, rather than just SMILE. This allocation led to a substantial decrease in SMILE's product cost for the reconstruction of the top-for-oven – enough to "meet the target cost" for the oven and the construction of the new product. *Secondly*, the new standard was related to technological adaptation – another management consideration. Reconstructing the top-for-oven with a *new cooling system* would make it possible to make use of more remote places for electronics inside the cooker, as well as more sensitive electronics. This was because a new cooling system would perform better than the old system, implying that the temperature could be kept low over

a wider space within the cooker, as well as keeping the temperature oscillations low. In general, electronics were considered to be sensitive to high temperatures, which definitely caused problems in a cooker. *Thirdly,* the new cooling system was also related to the possibility of installing *new cooling channels* in the front frame. This kind of feature could also be financed by allocating the cost of the investment among several models, and it would have a positive effect on the cooling on the front of the cooker, and probably decrease the number of service calls related to this matter. Consequently, the reconstruction and the new cooling channels would affect the quality of GES cookers as experienced by the customer.

Causal relationships in regard to the reconstruction

A significant observations from the translation process around the reconstruction of the top-for-oven, is how the same issue can be related to the performance meausre in two different ways. Component sharing was related to the issue, and in the first articulation component sharing made it look like the reconstruction would prevent a competitive advantage, whilst in the other articulation it made it look like a competitive solution. The figure below sums up the interrelations that appeared in this translation process, and translated the reconstruction in these two completely different ways. The project group ended up deciding to go for the translation of the reconstruction as a new standard, as illustrated by the full versus the dotted lines in the networks.

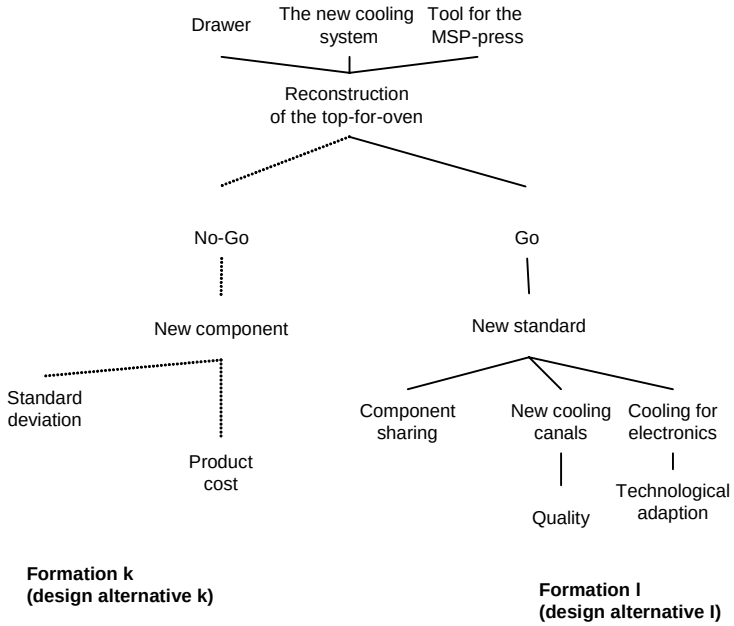

Figure 9: Decision VI and cause-and-effect

V. Understanding the causal relationships between multiple performance measures

To recapitulate, the decision situations described above illuminate how multiple performance measures and objectives were mobilized as a guidance to value creation in product design decisions. The mapping of the heterogeneous relations among particular design issues, elements of the production process and product technologies explains why and how performance measures were mobilized in the particular decision situation and the six decision situations together present an opportunity to explore the interrelations between multiple performance measures from decision to decision, and thereby bringing to light to the characteristics of causality when it comes to value creation in the product development process in the Global Electro Subsidiary (GES).

In the table below the *columns* outline the four performance measures/objectives and the *rows* summarize the decisions and the design alternatives discussed in each. The table indicates if and why the performance measures were mobilized in the decision situation. Furthermore, the 'alternative affiliation' for the individual performance measure/objective within each decision is indicated**:** the bold and the regular fonts, respectively, designate the two different formations/design alternatives.

In what follows, the comments of the table will be divided into three sections. The first section offers a discussion of the interrelations among the performance measures from the business model in each decision situation. The second section reflects on the 'nature' of the causality and presents a description of performance measures as signifiers of firm value. Thereafter, the implications for understanding of causality are discussed. In the final section, some reflections upon the performative view are given and the significance of supplementing the performative view of causality to the ostensive in regard to design of management control systems is outlined.

Decision \ Performance measure		Component sharing (Standardization)	Product cost (Direct + indirect costs)	Product quality (External failure)	Flexibility (Product variety)
Decision I	90º turn of the switch (formation a) or **new production layout – pre-assembly (formation b)**	**Formation b: Pre-assembly means maintenance of a standard component in the design – no changes in the switch construction.**	Formation a: a 90º-turn of the switch means a shorter process time for assembly. The savings in direct costs will far exceed the investment.		**Formation b: Pre-assembly represents a production capability that enables higher product variety.**
Decision II	**Plastic housing (formation c)** versus aluminum construction (formation d)	Formation d: The aluminum constructions could be standard components	**Formation c: Plastic housing is much easier to mount, giving lower product costs.**	**Formation c: Plastic housing is more stable than an aluminum frame, and the customer experiences fewer failures**	**Formation c: Plastic housing offers better insulation for components, which is considered to be essential with regards to implementing more electronic features (important to a wide product range)**
Decision III	Elimination of the black variant (formation e) versus **maintenance of the black variant (formation f)**	Formation e: An elimination of the black variant means there will be fewer components in the production system.	Formation e: An elimination of the black variant means fewer set-ups for the product, and consequently a lower product cost		**Formation f: A black variant is valuable for the customer. A flexible firm should be able to handle this**
Decision IV	Two decoration rings (formation g) versus **one deformable ring (formation h)**	**Formation h: Deformable ring reduces two components into one, and thus contributes to standardization.**	Formation g: Two decoration rings (one for each variant) – a low-cost solution.	**Formation h: Deformable ring reduces the risks of mounting the wrong ring on the assembly line, and hence the risk of a bulge appearing at the customer's home, giving rise to complaints**	
Decision V	**Stay (formation i)** versus no stay (formation j)	**Formation i: The stay is a part of the common component design.**		Formation j: No stay to reduce the risk of damaging the electronics	**Formation i: a stay will facilitate the adoption of new electronic features in new cookers of importance to the wider product range**
Decision VI	No reconstruction of top-for-oven (formation k) versus **reconstruction of top-for-oven (formation l)**	**Formation l: A reconstruction is a standardisation. The reconstruction will set a new standard**	Formation k: A reconstruction will significantly increase the product cost.	**Formation l: Reconstruction provides an opportunity to lower periodic heat zones on the front panel, by involving new cooling channels**	

Table 1: Organizational objectives and causality - the mobilization of, and relationship between, four organizational goals in six product design decisions.

Table text: The consecutive numbering of the decisions and formations/alternatives clarifies the point that the network constellation in each decision has an individual, and thus episodic, character. At the same time, there is repetition and change in the entities that are mobilized which constitute the decision situation related to value creation. The bold and the regular fonts given to the various formations/alternatives in the decision indicate the affiliation of the individual organizational objectives, and whether they are in contrast

The relevance of and interrelations between multiple performance measures in the design decisions

In this section, the relationships among the four different measures in the product design decisions are examined more carefully. The mobilized measures become constituent entities of firm value as they relate particular design issues to value creation and construct the meaning of the design alternatives in this respect. The attached performance measures/objective become the intermediaries that translate firm value.

In the following, the relationships between the multiple performance measures included in the model that emerged from the six product design decisions are depicted in three tables (table 2, 3, and 4). Although the tables replicate table 1, the relationships tabulated explicitly address the oppositional relationships or alliances between the different measures. The first table illustrates the relationship between component sharing and cost, quality and flexibility. The next table shows the relationship between cost, quality and flexibility, and the final depicts the relationship between quality and flexibility. Thus, it is an outline of the interrelations among the multiple performance measures in the design decision.

Whereas the horizontal axis in the table signifies the six different decisions, the vertical axis indicates the relationship between the cardinal measures of the table and the other measures appearing in decision situations. A minus (-) in the table indicates trade-off between the two measures, a plus (+) stands for an alliance between the two measures and zero (0) indicates that the measure to which the cardinal measure is related to is not present in the decision situation. The term "Not Applicable" (N.A.) refers to the fact that the cardinal measure is not present in the particular decision.

Table 2: The relationship between component sharing and cost, quality and flexibility

Translation process / Standardi-sation vs.	I	II	III	IV	V	VI
Cost	-	-	+	-	N.A.	-
Quality	0	-	0	+	N.A.	+
Flexibility	+	-	-	0	N.A.	0

Table 2 offers an outline of the relationship among component sharing and the three remaining performance measures. It illustrates how component sharing relates to product cost in five decisions, with the exception of decision V in which component sharing is not mobilized**.** Whereas component sharing in decision I, II, IV and VI stands in opposition to product cost concerns, the relationship among the two measures is in accordance in articulation III. Component sharing interacts with quality in decision II, IV and VI, revealing both a conflict and alliance of the relationship, recalling the component sharing-cost relationship. Finally, in decision I, II, and III, component sharing relates to flexibility in both convergent and non-convergent ways.

Table 3: The relationships between costs and quality and flexibility

Costs vs. / Translation process	I	II	III	IV	V	VI
Quality	0	+	0	-	N.A.	-
Flexibility	-	+	-	0	N.A.	0

Table text: The relationship between cost and component sharing is already depicted above thus is it not included in this table

Table 3 outlines the relationship between product cost and quality and flexibility. As in the case component sharing, the pursuance of lower product costs is related in multiple ways to quality and flexibility. Whereas cost efficiency in decision II is in alliance with quality improvement, in processes IV and VI the two are in an oppositional relationship. Moreover, while the cost objective interferes with flexibility in decision I and II, they correlate in decision II. The product cost measure is not mobilized in decision V.

Table 4: The relationship between quality and flexibility

Quality vs. / Translation process	I	II	III	IV	V	VI
Flexibility	N.A.	+	N.A.	0	-	0

Table text: The relationships between quality and component sharing and cost are already depicted above thus are they not included in this table

Table 4 recapitulates the final relationship that has not yet been depicted, namely the associations between quality and flexibility. In decision I and III, quality is not mobilized. In decision V, quality conflicts with flexibility. However, in decision II, the pursuance of quality and flexibility match.

These thorough studies of the relationships among the multiple performance measures (designated in table 2, 3 and 4) clearly reveal that the measures neither appear in regular relationships within the decisions nor have a constant relevance. These aspects transcend the idea that causality is a thing or a phenomenon with a regular character that can be defined *ex ante* in these decisions. The meaning of the multiple performance measures in regard to value creation is in a constant state of flux.

Causality – in a performative perspective

From the case study it is clear that the relationships between the four performance measures/objectives (component sharing, flexibility, quality and costs) change continuously from decision situation to decision situation, so does the meaning of value creation. Whereas the pursuance of lower product cost

in some decisions fits well with quality, there is a conflict between the two in others. Similarly, in some decisions the initiative to share component is in agreement with ensuring flexibility, whereas an opposition between the two occurs in others. Thus, each decision is unique and presents a new constellation of the performance measures.

In terms of the mobilization of the individual performance measure it is 'determined by' the heterogeneous materiality taking part of the problematizations within in the particular decision. The pop-out knob, input modules, protected areas of town, combined front and top panel, spray guns, etc. all play roles in the problematizations, constructing the possibilities of attaching various organizational objectives to the product design issue. Consequently, the heterogeneous materialities mobilized in the individual translation processes reveal a *difference* rather than contextual factors, such as technology, strategy, organizational structure or environment (from the contingency theory) or social interest (from social constructivism). These changing 'bits and pieces', constituting the problematization in the decision situations, seem to explain the meaning and relevance of the performance measure/organizational objective.

From a performative perspective value creation in terms of new product design neither has fixed referents nor has a regular character. Rather, it has different signifiers and an intermittent form. What firm value is all about, in other words, is constantly re-constructed from one decision to another, bringing to light that causality is an *effect* rather than a *cause* of organizational action. Metaphorically, the multiple dimensions of organizational performance can be described as a *kaleidoscope***:** practice becomes a "kind of kaleidoscope in which materiality is continually being organized and reorganized [in articulation, red.]" (Law & Mol, 1995). In the light of this metaphor, the glass pieces within the kaleidoscope might represent multiple performance measures, while the pattern emerging within the kaleidoscope presents the relationality between them. Whenever the kaleidoscope is turned (for every new translation or articulation), a new pattern (relationality) appears.

In order to understand value creation as a phenomenon in practice, yet another notion might be explored: organizational performance as a myth. Laclau defines a myth as "a space of representation which bears no relation of continuity with the dominant 'structural objectivity'. Myth is thus a principle of reading of a given situation, whose terms are external to what is representable in the objective spatiality constituted by the given structure" (Laclau, 1990: 61). Thus, firm value is not something in itself; rather, it is a room for representation colonized by performance measures, such as cost reduction,

component sharing, flexibility, quality. These signifiers construct the meaning of organizational performance in their mobilization and relationships within the particular decision situations. The articulation of a whole is considerable dependent upon its parts. However, it should be stressed that the relationship between the performance measures (part) and firm value (whole) is reciprocal. The articulations of firm value are not governed by an underlying rationality; rather, they are part of a whole which stands in reciprocal relation with its constitutive parts. The reciprocal conditioning of part and whole reveals a local, incomplete and precarious character (Laclau & Mouffe, 1985: 106).

Thus, in sense making processes, causality is characterized by a 'logic of contingency' rather than a 'logic of necessity' (Laclau & Mouffe, 1985: 25) and does not appear to have a contingent nature as pointed out in 'contingency studies' or social constructivism. Although firm value does have privileged signifiers, not one can be appointed as central and none of them enter into fixed relationships. The meaning of value is only partial, and it changes from decision to decision in the product development process.

Multiple performance measures from a performative perspective are open signifiers, which means that the meaning and relevance of performance measures change from one articulation to another, thus making it difficult to weigh up the importance of the various performance measures a priori, for them to form the basis of an enforceable contract. Their relevance and meaning are dependent upon the particular entities that are mobilized, and are related to the individual articulations. Design decisions are not repetitions: each has a unique heterogeneous materiality, affecting the meaning and relevance of the individual performance measure. Thus, the constraints to organizational decision making and courses of action constituted by multiple organizational objectives, as referred to by Simon (1964: 7) seem to be in constant flux, and illuminate something of "the precarious nature of the organizational order which accounting seeks to create" (Hopwood, 1983: 299).

Implications of the performative aspects of causality illustrated in the case study in regard to design of management control practices

A key question when it comes to understanding the managerial implications of the performative aspects of causality illustrated in the case study is: How are ostensive aspects of causality (e.g. causal knowledge outlined in the business model) used in the design of management control practices? Several commentators emphasize that causal knowledge is important as it play a role in performance evaluations (the choice and weight of performance measures), target setting, as well as decision

facilitation and goal commitment in organizations. For instance, Ittner and Larcker emphasize how resource allocation is dependent upon causal knowledge and argue: "If companies can't prove basic causality, they certainly can't determine the relative importance of the measures they select. And not being able to weigh these measures makes it hard to allocate resources according to their most beneficial uses or to create meaningful incentive plans" (Ittner & Larcker, 2003: 91). Zimmerman (2003: 739) also criticizes the balanced scorecard for not dealing with the issue of causal relationships and trade-offs among performance measures explicitly: "Balanced scorecards are not balanced in the sense of specifying how managers should make trade-offs between the various performance indicators. They do not tell managers when to stop producing more customer satisfaction because firm value falls beyond that point. Most balanced scorecards suggest that more of each performance indicator is preferred to less". Webb (2004) argues that there is some evidence that the process of outlining and communicating causal links will increase managers' understanding of the performance drivers in their business units, and increase their commitment to goals. Webb contends that if the causal links among the performance measures are strong, managers will estimate a greater probability of achieving their financial goals, and will be willing to exert more effort toward both these goals and the nonfinancial goals that indirectly lead to financial goal achievement.

The contribution of the case study outlined in this paper is that it illustrates decision-making situations where the causal relationships outlined in the business model are no longer representative because it is another type of causality that characterizes the relationships among the multiple performance measures. Whereas the business model outlines structural unidirectional relations among performance measures based upon stabile relations, the case study reveals how the causal relationships among the performance measures in the product development process were better characterized as dynamic, bidirectional and reciprocal. This implies that structural relationships among the performance measures are not representative for the logic of value creation and hence management control practices should no longer be based on assumptions that reflect this when it comes to controlling these processes.

The characteristics of the decision-making situations put forward in the case study are that multiple performance measures are simultaneously mobilized and their causal relationships change from one decision-making situation to another. The dynamic character of causality implies that in these types of decisions (product design decisions) and for these decision makers (the project team), it is not possible *ex ante* to specify the measures and weights that performance evaluation should be based upon. This is solely because the casual relationship among the performance measures is constantly changing. Thus,

the case study increases insight into why and when subjective performance evaluation should be applied. Empirical research on subjective performance evaluation primarily has focused on factors explaining who includes subjectivity in compensation contracts, whereas (Gibbs et al., 2004) and Ittner et al., (2003) focus on how subjectivity is incorporated into performance evaluations and bonus rewards. The study outlined in this paper contributes to the discussion with explanations that relate to the character of the decision-making situations that the person evaluated is involved with.

Nevertheless, the findings from the case study do not change the fact that business models and causal links among multiple performance measures reflected in strategic performance measurement systems still have an important role for designing management control practice and for facilitating decision making. There are numerous situations in which insight into structural relationships among multiple performance measures is helpful. For instance, when a decision maker has to decide whether or not to engage in a component sharing strategy, it might be helpful to refer to information about how component sharing has affected product costs and product quality in general. However, there are also other decision-making situations where the ostensive characterization of causality is not representative in terms of describing the logic of value creation. The limitations of business models in terms of representing the constituents at stake in the process of creating value have implications for their role as decision facilitating information. Business models are only a partial image of value creation in the individual organization. For specific decisions concerning the performance of value creation, the relevance of objectives and their relationships may differ from those described in the business model.

Furthermore, the (simple) theory of value creation depicted in business models seems to be helpful for decision makers, even if it is not fully representative in regard to what value creation is. The decision makers seem to be able to navigate easily between structural aspects of value creation and the processes behind them. The role of the business model from a performative perspective seems to be that it represents a list of performance drivers that may be of importance. The relationships among the performance measures are only suggestive, indicating a way in which they may be related and hence relevant to one another. These ideas are echoed in one engineer's reflections on the role of the business model in GES.

> The business model is, of course, a simplification of what it is like to design a new product. However, I think it is informative. At least a reminder of what we should think about when we design here in GES.

Very often, the engineers take component sharing into consideration because it has the potential to lead to lower product costs and higher product quality, a recipe that is outlined in the business model. Thus, the ostensive aspect seems to play a role, even in situations where things seem to be more complex and dynamic.

The table below summarizes the ostensive and performative aspects of causality discussed in this paper, and puts forward differences in terms of causality, the meaning of a performance measures, value creation and the role of the business model as decision facilitating information in regard to the two conceptualizations.

	Ostensive	Performative
Variable	A de-contextualized abstraction for which the same observable indicators are always associated with the same meaning, causes and effects.	A fact which in different settings could be associated with different meanings.
Cause	Unidirectional (additive, intervening variable, independent variable interaction), stability in terms of the variables and relations involved.	Bidirectional (reciprocal), dynamics in terms of variables involved and relations mobilized.
Value creation	The question of the elements of value creation is closed. A theory of value creation put forward the multiple organizational objectives and measures of importance and their causal relationships.	The question of the elements of value creation is open. The specific decision-making situation determines which organizational objectives, measures and causal relationships emerge.
Decision facilitation	The causal map (business model) predicts the extent to which the change in one measure affects another. Decision making is planned.	The causal map (business model) provides inspiration for organizational objectives of potential importance for value creation. Decision making improvisational.
Performance evaluation	Objective performance evaluation	Subjective performance evaluation

Table 5: The ostensive and performative aspects of causality and value creation

VI. Conclusions

When it comes to value creations in organizations at least two types of causality are at play in regard to the interrelations among the performance measures in strategic performance measurement systems (SPMS). The ostensive and performative aspects of causality are discussed in this paper. By illustrating the performative aspects of causality, this paper aims to describe some of the limitations of an ostensive view on causality, which is often reflected in the SPMS literature when it comes to representing value

creation in organizations, thereby clarifying restrictions in terms of using causal maps for designing management control practices (e.g. choice and weight of performance measures) and facilitating decision making in the organization.

By analyzing the role of four performance measures in decisions concerning value creation in a new product development process, this study has unmasked the dynamic and complex character of causality in practice. The case study revealed the two sides of causality in organizational practice. On the one hand, causality was 'a thing' – an outline of causal relationships among performance measures embedded in a business model (the ostensive aspect of causality). On the other hand, causality was an ongoing process in which the relevance of, and relationships among, performance measures was constantly reshuffled (the performative aspect of causality). From the latter perspective, then, value creation may be considered representation that bears no relation to continuity, with fixed relations among, and relevant to, specific performance measures.

This does not imply that the performative perspective should replace the ostensive perspective. On the contrary, the argument put forward in this paper is that the perspectives supplement one another. The performative approach is well adapted to revealing the multiplicity and richness of causality in specific contexts, but it has difficulty in specifying how general concerns may affect value creation in the individual organizational setting. While both the ostensive and the performative views of causality have blind spots, a combination of the two might provide seeds for a more complete approach to understanding value creation in organizations and for designing management control practices.

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