



The development of accounting calculations as chronological network effects

Growth rings of accounting calculations

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Abstract

Purpose – This paper aims to examine the processes through which accounting calculations are formed and developed in a Japanese manufacturing company.

Design/methodology/approach – The paper is based on an in-depth longitudinal case study. Actor network theory is used to analyze the empirics and to trace the historical translation process where the calculations were formed and developed as inscriptions.

Findings – The empirics show that an accounting calculation (called PPH) was formed and developed as a flag to rally around to involve different interests at different times. It translated changing external social and economic contexts as well as internal managerial and shop-floor interests into its calculations at different stages of the company's development. The processes were inscribed in the form of an accounting calculation and these inscriptions were accumulated, rather than replaced or abandoned, to create growth rings of accounting calculations as chronological network effects.

Originality/value – The case in this paper demonstrates that *keiei-rinen* (management philosophy) control can be more bottom-up than implied in the extant literature. Shop-floor workers and non-accounting experts participate in (re)shaping processes of accounting calculations. In these processes, “stability” is the key for the calculations to remain at the centre of translation attracting various interests and linking different demands over time.

Keywords Actor network theory, Amoeba management, Inscription, Japanese management and accounting, *Keiei-rinen* (management philosophy)

Paper type Case study

1. Introduction

In recent years, many contemporary and historical studies of management accounting have described the development of accounting in its social context (Hopwood, 1978, 1987; Baxter and Chua, 2003, 2006, 2009; Ahrens and Chapman, 2007; Chapman *et al.*, 2009). A central theme of these studies is that accounting cannot be understood simply with reference to its functional properties because it is implicated in the shaping of its

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own context. Accounting and organizational objectives are interdependent in the sense that objectives may be continuously reformulated in the light of new information and revised calculations (Preston *et al.*, 1992; Ahrens and Chapman, 2007).

Sharing the broad concern of these studies, this paper examines the formation and development process of accounting calculations in a Japanese manufacturing company, focusing on how accounting calculations reflect the visions and values within a company, social and economic conditions, as well as the historical context over time. As MacIntosh and Scapens (1990, p. 460) state, accounting systems embody norms of organizational activity and provide a set of values and ideas about what is approved and disapproved. They not only enable action at a distance and enact that action locally, but also reinforce or justify action when things go wrong (Preston, 2006, p. 560).

Simons (1990, 1995, 2000) proposed the levers of control (LOC) framework in which the vision and values of management for judging good or bad are conceptualized as a belief system and a boundary system. Together with other two control systems – a diagnostic system and an interactive system – he argues that control of business strategy is achieved. This line of research posits complementary but independent roles for each system under the name of “control package” or “control mix” (Abernethy and Chua, 1996; Otley, 1999; Marginson, 2002; Henri, 2006; Widener, 2007).

Kaplan and Norton (1996, 2001) explore ordering properties between corporate vision and other numerical control systems including non-financial numbers. They state that the balanced scorecard (BSC), as a strategic management system, helps managers translate their vision into operational terms that provide useful guidelines for employees at the local level to take action (Kaplan and Norton, 1996, p. 152). This line of argument suggests that accounting and non-accounting calculations can be designed in a manner consistent with organizational vision and objectives for the purpose of performance measurement (Otley, 1999, 2006; Gates, 2000; Ittner *et al.*, 2003). Therefore, the success or failure of management accounting systems is influenced by their users’ cultural values (Dent, 1987; Bhimani, 2003).

The general finding of these studies is that accounting is no longer the remote and top-down system that Johnson (1992) criticized. Instead, these studies show that accounting facilitates communications and organizational learning among managers and employees in line with corporate vision, values, and norms. However, as typically shown in Simmons’ framework, vision and values are expected to be set by top management even though those controls are supplemented with other bottom-up controls, such as an interactive system. Thus, it is implied that bottom-up controls and communications take place only in the limited area which top managers define, and their daily operations are signified and justified by the accounting systems which top management designs. In other words, a well-defined vision and set of values may end up making employees just the loyal servants of management by constraining the opportunity to explore new frontiers to enhance their learning.

The flat ontology of “actor network theory” (ANT) gives further insights into the roles of accounting. Using ANT Mouritsen *et al.* (2009, p. 738) show that accounting calculations are not only mobilized by others, but also mobilize others. They produce knowledge, create visibility, mediate between complementary resources, and identify objects and objectives to be managed. Dechow and Mouritsen (2005) investigate two cases of enterprise resource planning (ERP) systems and demonstrate the collective aspects of accounting calculations by showing how local control issues in different

parts of an organization are used to create concepts of global management. Briers and Chua (2001) demonstrate how an activity-based costing (ABC) system functions as a vehicle for communication through which various people, such as industrial engineering experts, cost accountants and business analysts, reach agreement on their decisions. Hansen and Mouritsen (2005) argue that the BSC is an imagery that provides a form in which management practices can be placed and which combines what may be shorthand for any conceivable concern that a company's management may have. They show the plastic yet robust aspect of management accounting as a "boundary object" (Star and Griesemer, 1989) and argue that accounting calculations serve as an interface between different organizational communities with diverse goals and interests.

In the context of Japanese management and accounting, the importance of corporate values is a common theme. The values and norms of management, or *keiei-rinen* (management philosophy)[1], are considered key elements of the fundamental framework for understanding management accounting practices in Japan (Hiromoto, 2009). Bottom-up control is another prominent theme in the Japanese management and accounting literature (Kagano *et al.*, 1983; Tani, 1999; Okano and Suzuki, 2007). An emerging question here is how the seemingly top-down *rinen* (philosophy) controls occur in a bottom-up and group-based context and how they are balanced or mitigated through management accounting practices. The literature review in Section 2 describes the possibility that the sense-making or signification process of accounting calculations could also be bottom-up and dynamic in that the values and norms of shop-floor workers may affect the (re)shaping processes of accounting calculations.

The arguments in the subsequent sections are based on an in-depth longitudinal case study at a manufacturing company in Japan, called Kyocera Corporation Ltd (Kyocera). Section 3 presents the methodological issues in examining the case data. We use the concepts of translation and inscription from ANT (Callon, 1986; Latour, 1987, 2005; Robson, 1992; Callon and Law, 1997) as a heuristic device to follow the steps in the development of accounting calculation. Section 4 describes the research design with data collection largely based on archives covering the 20 years after the company's founding. A series of interviews was also conducted to develop an understanding of the company and its management and accounting systems. Section 5 presents the case analysis, Section 6 discusses the empirics while Section 7 concludes the paper and presents some future research opportunities. Based on the analysis, this paper will demonstrate how *keiri-rinen* (management philosophy) control can be bottom-up in the sense that shop-floor workers affect the value system by participating in the (re)shaping processes of accounting calculations.

2. Literature review

Okano and Suzuki (2007) explain that one feature of Japanese management accounting is that it emphasises communication between top management and shop-floor workers, rather than central control. They state that top managers in Japanese companies tend to encourage wider participation of shop-floor workers in continuous improvement processes such as Kaizen costing (p. 1133). Kagano *et al.* (1983, pp. 115-116) also describe a feature of Japanese management as "group dynamics", in which "decision making and its implementation are executed on a group basis through direct interactions between people".

Referring to Japanese management and accounting practices such as those of Toyota, Johnson (1992) criticizes top-down controls via accounting information and emphasizes the importance of bottom-up empowerment. Cooper (1995) also investigates 20 companies in Japan and introduces the concept of a micro profit centre (MPC) as a style of lean cost management. In line with Johnson's studies, Tani (1997, 1999) explores the roles of accounting in MPC systems and finds that accounting information enhances empowerment as a common language. His findings are supported by other researchers (Yoshida and Matsugi, 2001; Watanabe, 2004; Matsugi, 2005) in various Japanese companies.

To enhance wider communication in an organization, earlier studies (Weingartner, 1969; Brealey and Myers, 1988; Remer *et al.*, 1993; Kazusa, 2003) argue for the importance of simplicity in accounting calculations as a way of enhancing wider communication in an organization. Based on a case study of a Japanese steel company describing its capital budgeting process, Horii (2009) concludes that the simplicity and comprehensibility of accounting calculations enhance the participation of non-accounting experts and shop-floor workers.

However, the meaning of shop-floor workers' participation must be carefully defined: do they participate only in the implementation of management's plan under a centralized management control and accounting system, or, more dynamically, in designing and re-designing the processes which make up the accounting system? During the 1980s, the usefulness of corporate culture was promoted (Peters and Waterman, 1982) with the intention of enhancing organizational performance by securing greater commitment and flexibility from employees. On another front, Willmott (1993, pp. 535-542) argued that there is a dark side to a strong corporate culture that systematically constrains opportunities to deal with competing values and their associated projects. This issue requires careful consideration if the participation of shop-floor workers ends up being only that of a loyal servant, or "happy slavery" as Willmott (1993) warned. If not, research should examine how shop-floor workers can proactively participate in the management process, including decision making and (re)designing management control and accounting systems.

The importance of values and norms is also discussed in the context of Japanese management and accounting. Hiromoto (2009, pp. 4 and 36) states that *keiei-rinen* (management philosophy) plays an important role in Japanese management and argues that it requires each employee to understand corporate philosophy thoroughly for organizational learning and creativity to take place. Sawabe and Tobita (2008) examine the relationship between management philosophy and corporate performance quantitatively. Based on responses to questionnaires from 167 companies in Japan, they find that the penetration of philosophy within the company has a positive impact on employee motivation and satisfaction, both of which also have a positive relationship with these companies' return on equity (ROE).

Sawabe and Ushio (2009) explore the dialectical relationship between and within accounting and management credos. They show that management credos may not necessarily be internally consistent but may have conflicts, which are then reflected in accounting systems. These contradictions are manifested in daily practices and facilitate the learning of shop-floor workers by providing opportunities for them to demonstrate their creativity to mitigate the conflicted situation. Hiki (2007) also identifies the intertwined relationship between management philosophy and

accounting practices. She conducts two longitudinal case studies of Japanese companies and finds that management accounting systems do not necessarily work as originally intended, which have both positive and negative consequences. She states that only rules and principles that produce desirable effects will survive to advance the entire accounting system (Hiki, 2007, p. 83).

The implication of these studies is that accounting calculations are related to and embody values and norms within the organization as previous research has revealed (Dent, 1987; Macintosh and Scapens, 1990; Bhimani, 2003). These studies further demonstrate the possibility that belief and boundary controls may occur in a non-linear and intertwined relationship involving shop-floor workers via accounting calculations. Extending these arguments, the present study empirically examines how accounting calculations are formed and developed reflecting the visions and values within a company and the social and economic conditions, in the context of group dynamics and bottom-up management. In particular, this study focuses on how shop-floor workers participate in and affect the (re)shaping processes of management accounting within a company.

3. Methodological issues

3.1 *Networks of translations with human and non-human actors*

This paper employs aspects of ANT to examine the process of translations surrounding accounting calculations as inscriptions. ANT is concerned with investigating how society is held together by a heterogeneous set of elements. With the goal of comprehending complex social situations, it rejects any dichotomy of human and non-human, as well as social and technical factors. It is based on the realization that something unusual has happened in the history and sociology of scientific hard facts, something so unusual that social theory could not penetrate it (Latour, 2005, p. 106). The main purpose of ANT is to trace a relationship that does not transport causality but induces two mediators into coexisting, which is called "translation". It is assumed that:

[...] a concatenation of mediators does not trace the same connections and does not require the same type of explanations [...] If some causality appears to be transported in a predictable and routine way, then it is the proof that other mediators have been put in place to render such a displacement smooth and predictable [...] there is no society, no social realm, and no social ties, *but there exist translations between mediators that may generate traceable associations* (Latour, 2005, pp. 107-108, italics in original).

Callon (1986) provides an expatiation of the concept of translation based on a description of a scientific and economic controversy about the causes for the decline in the population of scallops in St Brieuc Bay and the attempts by three marine biologists to develop a conservation strategy for them by negotiating with other actors: fishermen, scientific colleagues and the scallops. He proposes four intertwined processes of translation that interact with each other: "problematization", "interessment", "enrolment" and "mobilization". Problematization refers to actors' efforts to convince others to subscribe to their own view by showing they have the correct solutions. Problematization calls on external elements such as cultural and discursive resources (Ezzamel, 1994; Alcouffe *et al.*, 2008). Interessment corresponds to actions by which an entity (here the three researchers) attempts to impose and stabilize

the identity of the other actors whom it defines through its problematization. Enrolment is the creation of alliance networks that aim to build up agreement among the stakeholders concerning their interests. It designates the device by which a set of interrelated roles is defined and attributed to actors who accept them (Alcouffe *et al.*, 2008). Finally, mobilization is to render entities mobile by materializing them through a series of displacements and reassembly. The association of actors formed through these processes becomes closer if it is successfully mobilized and enrolled in the larger chain of associations as a taken-for-granted assumption, called a black box (Latour, 1987).

This perspective helps us examine the development process of accounting calculations where a variety of elements are enrolled by human and non-human actors in relation to historical and social situations to avoid the “perils of managerialism” (Law, 1991, p. 13) or hero sociology. The present study seeks to treat the seemingly powerful, such as managers and accounting system designers, as one of many network members and effects following the spirit of ANT.

3.2 Accounting calculations as inscriptions

Robson (1992) argues that the development of accounting should be considered in terms of a continuing refinement of mobile, stable and combinable inscriptions that expedite long distance control. An inscription is a material translation of unfamiliar events, places and people to be acted on Latour (1987, p. 1988). In an accounting context, inscription refers to numbering and calculating the details of transactions, manufacturing plants, materials, debts, shares, productive equipment, labour and so on (Robson, 1992, p. 698).

Morgan (1988) called numbers the dominant metaphor of accounting. Quantity, which is expressed in numbers, is inseparably related to quality as Alonso (1987, p. 14) argues “there is no counting without concepts”. Once the object of quantification is defined, the numbers then come to stand for the conceptual entities. Robson (1992, p. 688) claims:

[...] the content of a number statement, that is, a sentence which assigns a definite number to a set of objects, is an assertion about a concept rather than an object [...] if, for example, I state “I have nine cars”, this can firstly be restated as “the number of my cars is nine [...]” in this form the cars now fall under the concepts “car” and “has nine instances”, both of which are concepts in identity with themselves.

In this example, what is actively suppressed by the process of quantification is that “my cars” may differ in design, capacity, colour, top speed, and so on, because once particular concepts or properties of objects have been defined and counted, differing or distinguishing attributes are no longer visible. Ezzamel *et al.* (2004), for example, examined the role of accounting calculations as an inscription to transform and promote the new commercial agenda in a high-tech division of a major British manufacturer. They focused on the increased and changing use of performance measures at this site, interpreting them as moves to signify and facilitate an increasingly commercial orientation towards activities.

Latour (1987, 1988) states there are three major and interrelated components for inscription as the means of acting on unfamiliar events, places and people at a distance. Inscriptions need to:

- (1) render them mobile so that they can be brought back;
- (2) keep them stable so that they can be moved back and forth without additional distortion, corruption or decay; and
- (3) be combinable so that regardless of the stuff they are made of, they can be accumulated, aggregated or shuffled like a pack of cards.

He represents the necessity of these three interrelated components based on rhetoric of cartography as follows:

There is no way to bring the lands themselves to Europe, nor is it possible to gather in Lisbon or at Versailles thousands of native pilots telling navigators where to go and what to do in their many languages [...] One of the “extraordinary means” that have to be devised is to use travelling ships as so many instruments, that is as tracers that draw on a piece of paper the shape of the encountered land [...] In consequence, many more elements have to be put on board the ships so that they can calibrate and discipline the extraction of latitudes and longitudes (marine clocks, quadrants, sextants, experts, preprinted log books, earlier maps). The travelling ships become costly instruments but what they bring or send back can be transcribed on the chart almost immediately. By coding every sighting of any land in longitude and latitude (two figures) and by sending this code back, the shape of the sighted lands may be redrawn by those who have not sighted them (Latour, 1987, pp. 223-224).

Robson (1992) argues that these three elements are the qualities that numerical inscriptions also need to possess. In an accounting context, the mobility of accounting reports is strongly attached to the use of writing. Company accounts inscribe productive processes, labour, transactions, machines, buildings, cash flows and loans dispersed spatially and temporally but given a common form by the text. By the quality of stability, he means that inscriptions must be recognizable to their users, implying the stability of the relationship between the inscription and the context to which it refers. Combinability is defined as what allows the actor to accumulate inscriptions, aggregate them, tabulate them and recombine them to establish new relationships and calculate norms to compare the settings to be influenced in accordance with his or her specific objectives, aims or ideals. He contends that accounting statements apply the characteristic of combinable inscriptions by giving us a chance to appreciate the process of translation through which this combinability is achieved. He further posits that accounts numbering the details of transactions, productive equipment, labour, and so on do not discriminate the differences between these entities but assert that they have identical qualities, in this case, a concept of economic cost or values.

4. Research design

The analysis in this study is based on an in-depth, longitudinal retrospective case study at a manufacturing company in Japan, called Kyocera Corporation Ltd (Kyocera). Its sales volume is 1,267 billion yen (or US\$15 billion) for the fiscal year ending March 2011. Within the Kyocera group, there are 197 companies, primarily based in Japan, the USA, Europe and Asian countries. Our aim is to trace the formulation process of its unique performance measure called “profit per hour (PPH)”, focusing on the 20 years (from 1959 to 1979) immediately following the company’s establishment.

The data collection is primarily based on archives. We copied all the pages of the internal company magazine from 1964 to 1979 (Vols 1-67, 1,420 pages)[2], all internal

documents showing managerial decisions (*ringi-sho*, in Japanese) from 1971 to 1988 (Nos 1-171, 311 pages), and a memoir written by the second president and published for internal use in 1987 (613 pages) as well as a company history book internally published by the company in 2000 (598 pages). The analysis of archival data enables us to follow Latour's (1987, p. 21) suggestion, "be there before the box closes and becomes black". All documents were electronically recorded with an optical character reader (OCR) for the purpose of data processing. Finally we conducted a series of interviews between May 2004 and April 2008 to build our understanding about the company and its management and accounting systems.

In the process of data collection and its analysis, we attempted to follow the actors to understand their innovations in order to learn how their collective existence had evolved, which methods they had applied or adapted to fit their collective existence and which accounts best defined the new associations that they had been forced to establish, as Latour (2005, p. 12) suggests. To do so, we tried to note the:

[...] queerest, baroque, and most idiosyncratic terms offered by the actor [...], [resisting] the idea that there exists somewhere a dictionary where all the variegated words of the actors can be translated into the few words of the social vocabulary (Latour, 2005, pp. 47-48).

In Section 5, we present field materials that illustrate the formulation and development process of PPH where all the actors, including both humans and non-humans, act as mediators rather than passive recipients of action.

5. Case analysis

5.1 *The origin of PPH as an index for production efficiency: inscribing the shop floor production situation*

Kyocera was founded by Mr Inamori and his colleagues in April 1959 in Kyoto. He left another company with them and started a venture company to demonstrate his technological competence, with the financial support of Mr Miyagi, a friend of his colleague Mr Aoyama (later, the second president). Mr Inamori (27 years old, at the time) essentially managed the company as the technical director, and Mr Miyagi formally, if temporarily, became the first president while also running his own company.

Kyocera began with nine directors and 26 employees with capital of three million yen (about US\$8,300 at the time). The head office/factory (office-cum-factory), equipped with the minimum facilities for the order volume at the time, consisted of two production teams. Its main product was a U-shaped ceramic component for cathode ray tubes (CRT) used in televisions.

In the second year (1960), Kyocera set up a marketing branch in Tokyo (about 500 km away from their head office/factory). Since then, a monthly Product-Marketing Meeting started to be held at the head office/factory. The marketing branch was just a set of desks and chairs in a borrowed space in the first president's own company. Mr Aoyama (1987, p. 204) writes:

The most important thing [at the time] was for the company to increase orders. After the marketing branch was set up in April of 1960, we started holding a Product-Marketing Meeting at the head office every month.

The main topic of the very first meeting was how to improve the production teams' operations. The two leaders of the production teams at the head office/factory

submitted seven sets of data to show their production efficiency to the directors and the leader of the marketing branch:

- (1) order forecasts;
- (2) orders received and the ratio of orders produced;
- (3) production plans;
- (4) actual production and the ratio against the original plan;
- (5) orders remaining at the end of the month;
- (6) delivery-delays; and
- (7) production yield reports.

Since Kyocera was a technology-oriented company, they devoted most of their time to examining the production data in detail with the directors. At this time, no official set of data was required to be submitted in the meetings, and each leader chose what to submit based on his/her own ideas, rather than on the management demands.

In May 1963, a second factory was built in Shiga Prefecture (the Shiga Factory was about 50 km from the head office/factory). Two months later, the leader of the production team in the Shiga Factory submitted five additional sets of data to demonstrate that factory's production efficiency at the Product-Marketing Meeting:

- (1) operation days;
- (2) number of workers;
- (3) gross labour hours;
- (4) production output per capita; and
- (5) production output per (labour) hour.

At the April 1964 Product-Marketing Meeting, the leader of production team one at head office/factory followed suit and began submitting data concerning production output per hour for comparison between the physically distant production teams. However, the other leaders of head office/factory production teams complained that it was not fair to compare only the production output. Masaji Aoyoma recalls:

The Head Office/Factory was always lower (than the newly built Shiga Factory, in production output per capita and hour) at that time. They complained about comparison based simply on outputs. Therefore, they devised "Deducted Sales" which is calculated as production output deducted by the cost of materials, supplies and utilities. They submitted Deducted Sales Per Capita and Deducted Sales Per Hour (to the Product-Marketing Meeting) in January 1965 (Aoyama, 1987, p. 205).

They continued to submit these numbers for the next two months. In April 1965, production teams at the Shiga Factory followed suit and began calculating the same numbers. In the course of time, they found that deducted sales per capita was not useful as a comparison. Instead, deducted sales per hour was calculated and submitted at the monthly meeting by each team. Table I shows the calculation of deducted sales per hour' with the numbers at the time, which is the very first prototype of PPH. To keep the metric simple, cost was calculated on a cash basis, rather than by accruals. Around this time, the performance measure began to be called PPH, or simply "per hour".

(Head office/factory) production team one		Production team two	
Gross sales	4,123,000 yen	Gross sales	2,931,000 yen
Materials	125	Materials	2,057
Factory supplies	255	Purchase of magnet pipe	250
Charges			
Electricity	166	Purchase of attachment and jig	254
Gas	68	Factory supplies	31
Outsourcing costs	270	Outsourcing costs	75
Total	884	Total	2,667
Deducted sales	3,239	Deducted sales	265
Members	36 (people)	Members	22 (people)
Total hours	7,787 hours	Total hours	4,542 hours
Deducted sales per capita	89,972 yen	Deducted sales per capita	12,045 yen
Deducted sales per hour	416 yen	Deducted sales per hour	58 yen

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Table I.
“Deducted sales per
capita and hour” in
January 1965

Source: Aoyama (1987, p. 205)

This calculation was devised and suggested primarily by the leaders of the shop-floor workers in the course of their daily operations. One of the purposes of the calculation was to render mobile the local reality each production team faced every day. The production of one team was inscribed in deducted sales per hour and mobilized to be compared with another located in a physically distant place. Because this calculation originated at the shop-floor, it was equipped with some stability; that is, it was recognizable and comprehensible to other production teams. However, the stability of the calculation was not acquired in a straightforward manner. They added, deducted, discarded, and combined different types of numbers to devise a calculation with could be mobile and stable to retain the various interests of different factories.

5.2 Expanding the scope of evaluation based on PPH by the top management: constructing the PPH network

In May 1966, Mr Inamori formally became the president and accelerated the mobility of PPH. Soon after taking up his position, he proposed a corporate target based on PPH for the year ending March 1968: a “monthly target of 200 million yen for turnover, and 1,500 yen for PPH for each team in the company” (in-company magazine, 1967, September). It was the first time that PPH was officially set as a target for the entire company. In fact, it was also the first time that the word “per hour” appeared in the in-company magazine since it was first published in February 1964. By this time, PPH was now used at the corporate level by the top management, rather than being merely an index for operational efficiency at the shop-floor level.

During the same period, the scope of PPH-based evaluations spread to the marketing teams. The revenue for marketing teams was the commission paid by production teams, whose accounts retained the booking of sales, with ten percent of the sales amount being allocated to marketing teams. Mr Inamori recalls this as follows:

Since the establishment, I have managed the company on my belief, “customers rule price”. Therefore, you shouldn’t set the price of products on the basis of accumulated costs. You need to take the market price as a starting point, and then make best efforts to reduce costs to squeeze enough profits within the limit of the amount [...] I reckon that it is production

groups which generate profit. For that reason, they should receive market information directly and take immediate action on their daily operations. For that purpose, I made the scheme where sales to customers were booked directly to production groups so that the fluctuation of market prices directly influences the revenue of production groups. Meanwhile, marketing groups, which intermediate production groups with their customers, receive commissions on the basis of sales volume from production groups as revenue. I stuck with the idea, "the source of profits lies in production groups" (Inamori, 2006, pp. 176-177).

By booking the sales in production team accounts, Mr Inamori inscribed his belief that "customers rule price" and that "the source of profits lies in production groups" in the calculation of PPH. Mr Aoyama recalls as follows:

You may find that it is nothing special to calculate deducted sales or value added per hour, which seems too common among other companies. But what is significant is that Mr Inamori made the best use of this (Aoyama, 1987, p. 206).

In 1967, he began awarding the teams that achieved the designated amount of PPH every month. Certificates and simple gifts, such as pencils, were given as prizes. The company magazine occasionally reported the ceremony with photos. Concurrently, the term "per hour" became frequently used in the magazine as shown in Table II.

Whereas the term "per hour" did not appear at all until Mr Inamori became the president, it occasionally appeared after his succession. By doing so, he attempted to stabilize PPH company-wide.

At the end of March 1968, the number of teams evaluated based on "per hour" had increased to 14. They were called "amoebas" and were expected to be autonomous and independent in their decision making. For that purpose, their size was kept small. Each amoeba consisted of five to 15 members and was expected to survive on its own, earning enough profit to feed the members. It was also allowed to expand or shrink its size by receiving and transferring additional/redundant members with other amoebas, which is the derivation of the name "amoeba". By this time, a network among management, shop-floor workers and PPH calculations had begun to be constructed.

5.3 Positioning PPH as the source of compensation: making the network stronger during economic growth

In the late 1960s, Japan was in the middle of an era of rapid economic growth. After a number of stark confrontations between organized labour and management in the 1950s to early 1960s, in-house unions and a cooperative relationship between employees and managers were formed. The basic understanding among them was to participate in increasing corporate performance which results in higher wages (Dore, 1973).

Kyocera was no exception. Pay raises had been an important issue for both managers and shop-floor workers. In 1968, the company thoroughly revised internal labour regulations, and a labour union was established requiring a five-day week in 1969. In the in-company magazine, the topic was frequently mentioned by both the shop-floor workers and top management:

The trash area was so messed up. I used to work for a metal factory before coming here. An incredible amount of defective products are discarded in this workplace. Without reducing them, we would not deserve as much salary as in Western countries (Mr Moriguchi, a worker in a firing chamber, in-company magazine, 1967, November).

	1964	1965	1966	1967 ^a	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Publication no.	1-4	5-9	10-11	12-15	16-19	20-25	26-30	31-34	35-39	40-45	46-50	51-53	54-56	57-61	62-64	65-67
Total pages (a)	16	24	14	16	24	50	50	28	46	128	148	144	116	260	156	188
Frequency (b)	0	0	0	9	6	20	26	11	23	24	25	27	16	12	36	24
Frequency/page (b/a)	0.00	0.00	0.00	0.56	0.25	0.40	0.52	0.39	0.50	0.19	0.17	0.19	0.14	0.05	0.23	0.13

Note: ^aMr Inamori became the president in May 1966 (the term "per hour" is picked up only when it is used as the abbreviation of "PPH")

Table II.
Frequency of appearance
of the term "per hour" in
the company magazine

The salary increases year by year and everyone hopes for high wage for a cultural life. It is our responsibility to respond to their expectations. We need to earn enough profits to pay that high a wage (Inamori, in-company magazine, 1968, December).

By this time, a further expectation was made of PPH regarding pay raises, which had been a company-wide performance measure. It began to be used also as an index for the source of wages. Mr Inamori stated as follows:

I would like to refer to raising the payment [...] We have occasionally talked about raising the payment up to the level of United States. Although this should be the national target, rather than just Kyocera's, we would like to do so, ahead of other companies. To catch up with the level of United States in wage scale, we need to increase the production efficiency by 50 to 100 %. Managers need to make the best effort to accomplish the higher target continuously. Therefore, we have decided to set the target as 2000 yen for Per Hour as a minimum requirement (in-company magazine, 1968, September).

In 1971, he also states:

Considering it is obvious that pay levels in Japan will catch up with the one in Europe and United States in the future, [...] we should take it in advance, and then grow the company to absorb the gap. To do so, what we have to do is to increase Per Hour, which means: 1) increase of orders, 2) rationalization, 3) increase productivity, 4) improvement of yield ratio, and 5) eliminating loss from waste.

Referring to PPH in relation to pay raises during the wave of economic growth with continuous pay increases, he tried to strengthen the PPH network where all members including top management and shop-floor workers participated in the growth of the company and shared the fruits in the form of pay raises. However, PPH was originally devised to quantify production efficiency by production leaders. It was just a simple index for leaner production, not a calculation for management purposes. This was where Callon's (1986) translation process became important.

In the social context of rapid economic growth, Mr Inamori problematised the issue of a pay raise for the shop-floor workers. He aroused their interest by proposing a program to grow the company in which they could share the profits. By doing so, he enrolled and locked the actors into an alliance: shop-floor workers, economic and social context, where PPH calculations stand at the centre of the translations. Nevertheless, further negotiation between the management and the PPH calculation was necessary; that is, the PPH calculation had to be consistent with the program in which the higher PPH would be shared among all workers, including management and shop-floor workers. The negotiation was successful because labour costs did not appear in the calculation of PPH, which was originally devised to quantify labour productivity rather than financial profitability. Therefore, the PPH could be interpreted as the source of pay raises for shop-floor workers in the same manner as management compensation.

The construction of the PPH network was also sustained by another non-human actor, the company's management philosophy of "management based on grand-familism". In 1960 (the second year after its establishment), Kyocera was in imminent danger because newly recruited teenage employees were about to go on strike. Although the founders started the company to demonstrate their technological competence, the newly recruited employees did not share the same ambition. They were concerned about labour rights and their own welfare, demanding annual wage

increases and a guarantee of lifelong job security. For the managers still struggling to maintain operating cash flow, their demands were incomprehensible. They negotiated for three days and reached an agreement when the managers promised to do their best to keep the company alive at the risk of their own lives. Mr Inamori recollects as follows:

After thinking for weeks in a gloomy atmosphere, I started to think like this: "I started the company to show my technological competence to society. However, employees devote their lives to the company. Therefore, there is something more important than my own dream. It is more important to protect the lives and well-being of the employees and their families. It is my destiny to strive for their well-being" (Inamori, 2006, pp. 25-27).

Pursuing the ideal relationship between management and employees, I found the answer in the model of the traditional family in Japan, where grand-parents, parents and their children live together and work hard for the entire family. Everyone feels happiness in the growth of the entire family and each member shares the same destiny [...] That is what I mean by "grand-familism" (Inamori, 2006, pp. 51-52).

Negotiating with these values and interests of managers and shop-floor workers, and economic and social context, PPH further embraced these actors in its calculation. It was at the centre of translation, constructing a robust actor network during a period of rapid economic growth in Japan.

5.4 Tribulations during economic turmoil: keeping the interests of shop-floor workers in the PPH network

Kyocera continued to grow riding on the upswing of market demand. Table III shows the performance transition of Kyocera.

By fiscal 1970-1971, the sales volume had grown to 269 times that of the first year. The third and fourth factories (Sendai Factory in 1969 and Kokubu Factory in 1972) were built in Kagoshima Prefecture, which boosted Kyocera's production capacity. The number of amoebas had increased to 80 by the end of fiscal 1970-1971 (ending March 1971). However, Kyocera suffered from an economic turmoil soon thereafter. Mr Aoyama recalls:

The amount of order receipts decreased by half in the second half of 1970 because of monetary constraints (by the central bank), and recession and import restrictions in the United States (Aoyama, 1987, p. 375).

Although the economy recovered after a while, Kyocera encountered another economic depression in 1973. He states:

Because of the oil shock which started in October of Showa 48th year [1973 CE], [Kyocera's] sales volume dropped from the first half of the fiscal year Showa 49th [1974 CE] [...] It was really a tough time during the fifteen months [from April 1974 to June 1975]. We had to find [a way] to survive immediately in the situation with the order receipts rapidly decreasing. To be honest, we needed to be in a hurry [to deal with the situation], but we had to stay calm at the same time (Aoyama, 1987, pp. 481-483).

Indeed, the sales volume decreased in those two years despite the expansion of productive capacity. The performance had been improving until fiscal 1971-1972. Although it stayed in the black, the sales volume declined by two percent in that

Table III.
Kyocera performance
transition

Fiscal year	Term	Sales		Growth rate (%)	Net income		Profit ratio (%)	PPH (yen)	Number of employees (a)	Number of amoebas (b)	(a)/(b)	Remarks
		Million yen	Million yen		Million yen	Million yen						
1959-1960	1	26	2		7.1	212	36	2	18.0	Establishment		
1960-1961	2	50	4	90	7.7	235	56	2	28.0			
1961-1962	3	81	5	62	5.9	260	87	2	43.5			
1962-1963	4	119	11	48	9.5	300	105	2	52.5			
1963-1964	5	161	11	35	6.5	340	160	2	80.0	Launch of Shiga Factory Deducted sales per capita (and hour) was calculated in Shiga Factory		
1964-1965	6	248	17	53	6.9	386	185	2	92.5	Deducted sales per hour was calculated in head office/ factory		
1965-1966	7	298	20	20	6.6	446	223	5	44.6	Deducted sales per hour was calculated in Shiga Factory		
1966-1967	8	644	102	116	15.9	499	341	8	42.6			
1967-1968	9	1,044	114	62	10.9	690	462	14	33.0	PPH started to be applied to marketing teams		
1968-1969	10	1,921	302	84	15.7	1,073	535	17	31.5			

(continued)

Fiscal year	Term	Sales		Growth rate (%)	Net income		Profit ratio (%)	PPH (yen)	Number of employees (a)	Number of amoebas (b)	(a)/(b)	Remarks
		Million yen	Million yen		Million yen	Million yen						
1969-1970	11	4,419	1,061	130	1,061	24.0	1,238	855	21	40.7	Launch of Sendai Factory	
1970-1971	12	7,002	1,353	58	1,353	19.3	1,268	1,265	80	15.8		
1971-1972	13	6,852	1,142	- 2	1,142	16.7	1,105	1,303	78	16.7		
1972-1973	14	11,256	1,949	64	1,949	17.3	1,488	2,073	115	18.0	Launch of Sendai Factory	
1973-1974	15	23,882	4,359	112	4,359	18.3	2,335	2,670	130	20.5		
1974-1975	16	20,805	3,228	- 13	3,228	15.5	1,433	2,316	126	18.4		
1975-1976	17	29,633	5,225	42	5,225	17.6	2,379	2,785	137	20.3		
1976-1977	18	40,190	7,461	36	7,461	17.8	2,802	3,033	151	20.1		
1977-1978	19	38,683	6,563	- 4	6,563	17.0	2,817	3,144	175	18.0		
1978-1979	20	50,343	6,865	30	6,865	13.6	3,168	3,712	216	17.2		
1979-1980	21	81,905	12,035	63	12,035	14.7	3,436	4,554	269	16.9		

Source: Aoyama (1987, p. 214)

Table III.

fiscal year. It recorded negative growth again in fiscal 1974-1975, decreasing 13 per cent in sales volume.

The fatal issue was how to deal with an overabundance of workers stemming from the rapid decrease in sales volume. Figure 1 shows the sales volume and number of employees on a monthly basis during the second recession. Even though the sales volume decreased by more than 60 per cent in January 1975 compared with April 1974, Kyocera did not downsize the number of employees except through natural attrition.

In November 1974, the president, Mr Inamori, promised the following to all members of the company:

I tell you that we will overcome this hardship only by partial pay cutbacks of sectional managers and higher positions, including me [...] Whereas it is common to lay off employees in an economic downturn in Europe and the United States, the climate rooted in Japanese society does not necessarily accept that option [...] I believe that the relationship between managers and employees, in a good sense, prevents the job-freeze option in Japan [...] We intend to share this hardship among all the members of the company. In other words, we need patience to bear the burden and to sacrifice ourselves equally, hand in hand. Otherwise, the Japanese economy and companies will face even worse problems [...] I believe that only a company in which every member goes in the same direction sharing one vision will flourish in the future (in-company magazine, 1974 November).

Despite excess labour within the company because of the economic downturn, a layoff was not an option under the philosophy of “grand-familism”. Facing the crisis, Mr Inamori further negotiated with the metric of PPH and shop-floor workers to keep the PPH alliance. This was done in two ways: the first was to count the hours based on “substantial members”; and the second was to book the capital cost based on a nominal

1974	April	May	June	July	August	September	October	November	December
Sales volume (million yen)	2,822	2,577	1,800	1,770	1,529	1,578	1,387	1,227	1,120
Number of employees	2,671	2,676	2,656	2,595	2,535	2,490	2,455	2,429	2,407

1975	January	February	March	April	May	June	July	August	September
Sales volume (million yen)	1,098	1,167	2,731	1,476	1,684	1,824	2,329	2,262	3,948
Number of employees	2,369	2,347	2,321	2,309	2,290	2,289	2,319	2,342	2,386

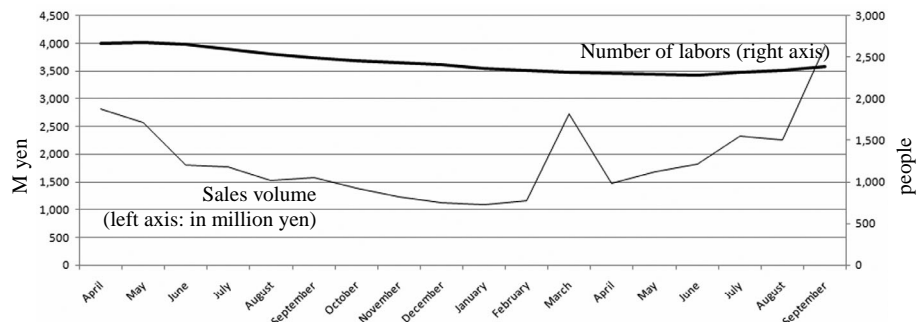


Figure 1. Transition of sales volume and number of employees during the economic downturn

Source: Aoyama (1987, p. 481)

basis in the PPH calculation. By doing so, he remained committed to achieving the PPH target set in the previous year without lowering it. In February 1975, Mr Inamori stated the following:

I think that it is necessary to accomplish the Per Hour target of 2,700 yen this year, which was last year's target. At present, sales volume is decreasing while this company does not have lay-offs, which makes the goal of 2,700 yen Per Hour harder to accomplish. Therefore, I decided to separate the excess members from the members who are necessary to the operations from this January (in 1975) [...] so that the excess members can prepare to transfer to new production areas.

We have a consensus that we don't want to lose them, and we do not want to lay them off. Therefore, the total Per Hour of the company might be lower than 2,700 yen [...] However, it is important to make it clear that we can earn 2,700 yen Per Hour, if only with the minimum number of members (in-company magazine, February in 1975).

"The minimum number of members" was called "substantial members", which was calculated based on previous years' average per capita production output. Each amoeba was operated only by those members. The remaining workers were not allowed to support the operation. Instead, they engaged in cleaning the factory and office, or attended training workshops under the control of the head office. They were called the Development Division, and their labour hours were excluded from the PPH calculation (Declaration Paper No. 53-54, 1975).

By this time, "internal interest" had been introduced into the PPH calculation. It was akin to capital costs imposed on the amount of each amoeba's equipment in addition to depreciation. It had been calculated based on purchase price to cope with that period's high inflation. However, it was changed to a book value basis, which inevitably reduced the amount of each amoeba's internal interest as the amount of depreciation increased. Mr Inamori explained the reason as follows:

As is commonly believed in the Japanese economic community, we need to pay three or four times more to buy the same equipment in five years' time. Therefore, it is necessary to depreciate three or four times the purchase price. We need to make a profit after absorbing such a burden, or the business becomes meaningless. By doing so [booking internal interest on a purchase price basis], I intended to keep this company lean. I think, theoretically, this is correct, but I now find that it is a critical mistake. It is effective only as long as employees find it challenging, whereas I have been feeling that they take it as too great a burden that prevents them from accomplishing higher Per Hour. In other words, it might be logical, but it makes no sense if they lose their motivation (In-company magazine, 1975, February).

At this stage, the amount of "2,700 yen" was as important an actor as the PPH calculation itself. In fact, the amount was occasionally mentioned by shop-floor workers in the in-company magazine that year:

In this era of low growth economy, we need to improve productive efficiency with thorough rationalization to obtain more than 2700 yen Per Hour (a worker with no title at the administration office in Kokubu Factory, 1975, September).

I will do my best to obtain 2700 yen Per Hour with other members of Film Pressing [Division] by improving yield ratio (a worker with no title at Film Pressing Division at the Kokubu Factory, 1975, September).

It was originally the target for the previous year[3] which was set just after accomplishing 2,335 yen in fiscal 1973-1974. However, the actual PPH in fiscal 1974-1975 decreased to 1,433 (Table III) in the economic crisis, falling short of the target. However, Mr Inamori could not lower the target lest he decrease his employees' motivation: lower PPH implied lower payment in the PPH network. To maintain their interest, he negotiated with the shop-floor workers and the PPH calculation to find a way to achieve the target.

5.5 After the recessions: mobilizing the PPH network as "Amoeba Management" to external organizations

Kyocera's performance recovered in the latter half of fiscal 1975-1976 (ending March 1976). The company-wide PPH for the year recovered to 2,379 yen, and increased to 2,803 yen in the next fiscal year. It continued to grow, and the PPH network began to be mobilized to other companies by enrolling the business community under the name of Amoeba Management; business articles and books on Amoeba Management began to be published (Kunitomo, 1985; Hamada and Monden, 1989); and Kyocera's Management Planning Office was spun off as an internal venture company in 1986 to consult on Amoeba Management for external organizations including the non-profit[4].

Tables IV and V show the basic format of the PPH for production and marketing amoebas in 1985. The basic calculation did not change since it was first set in 1965. Since then, only "(internal) interest and depreciation" and "marketing costs" (commission) were added in the components of expenses which inscribed the managerial and economic context of the past in the calculations. The calculation format has been common to all amoebas regardless of size.

However, understandings of PPH were not necessarily unanimous within the company. For example, the reason for the calculation where payment to employees are

Total sales	$A = B + C$
External sales	B
Internal sales	C
Internal purchases	D
Expenses	$E = a + b + \dots + j$
Materials	a
Elec/gas charges	b
Outsourcing cost	c
.....	...
.....	...
Interest and depreciation	h
Overhead costs	i
Marketing costs	j
Deducted sales	$F = A - D - E$
Total hours	$G = x + y + z$
Fixed hours	x
Additional hours	y
Transferred hours	z
Profit per hour	$H = F/G$

Table IV.
PPH format
for production
amoebas in 1985

Source: Kunitomo (1985, p. 97)

Table V.
PPH format for
marketing amoebas
in 1985

External sales	A
Revenue	$B = A \times 10\%$
Expenses	$C = a + b + \dots + i$
Tel/post costs	a
Travel costs	b
Elec/gas charges	c
.....	...
.....	...
Rental costs	g
Overhead costs	h
Deducted revenue	$D = B - C$
Total hours	$E = x + y + z$
Fixed hours	x
Additional hours	y
Transferred hours	z
Profit per hour	$F = D/E$

Sources: Kunitomo (1985, pp. 92-102); Inamori (2006, pp. 40-41)

not included in costs, but counted as (labour) hours to divide the deducted sales (akin to value added) is explained in a variety ways: “for the comparison of (operational) efficiency between amoebas” (interview with a consulting manager of KCCS, 27 July 2004), “to raise consciousness of self-sustenance to every worker” (interview with an associate-manager of management laboratory of Kyocera, September 2004, Inamori, 2006, p. 200), “to enforce flexible transferring of workers between teams and divisions” (Inamori, 2006, pp. 109-111) and “Labor expenditure is not to be minimized. We also intend to increase labour expenditure by improving turnover” (interview with a consultant of KCCS, 27 July 2004).

PPH was created and developed to deal with the various demands of changing social, economic, managerial and shop-floor contexts. It was originally devised by a production team leader in the Shiga Factory physically distant from head office/factory to mobilize the local reality. The production situation was inscribed in the calculation and mobilized to be compared with others in the head office/factory. After Mr Inamori became president, PPH’s scope had grown company-wide, whereas the size of teams remained small. The revenue for marketing teams was booked on a commission basis, and sales of products remained in production’s accounts, thus inscribing his management credo “customer rules price” and “production generates profit” in its calculation. To bridge the hierarchical gaps between management and shop-floor employees, and the physical gap among remote factories, PPH stood in the centre of translations. During the company’s rapid growth, Mr Inamori strengthened the PPH network by negotiating with the calculations and shop-floor workers, referring to PPH in relation to pay raises. In a series of economic crises, the network was sustained by changes to the calculations and its use, which remained inscribed and has survived in the current PPH calculation.

Each of these understandings of PPH comes from its historical background. Yes, PPH was used to compare the amoebas’ operational efficiency. Yes, each amoeba is expected be conscious of self-sustenance, earning enough profits to feed itself making

decisions on its own. Yes, PPH is calculated on a value-added basis in which labour expenditure is a form of profit sharing, rather than a target of minimization. The diversity of understandings comes from the fact that PPH was created and developed by inscribing various historical purposes in it. These historical purposes are all inscribed in PPH as growth rings of accounting calculations.

6. Discussion

6.1 *The importance of stability for development of accounting calculations*

This paper has demonstrated the intertwined and continuously reformulated relationship among management philosophy, accounting calculations, various interests within the company and the economic and social context over time. Robson (1992) contends that the development of accounting is considered in terms of a continuing refinement of mobile, stable and combinable inscriptions that expedite long distance control. The PPH generation process was a set of event chains of mobilizing local contexts from the shop-floor level to the top management level. Initially, it was invented by production team leaders by recombining operational data as a result of trial and error. They tried to show how much their teams contributed to the company, rather than to production volume alone, in ways more recognizable for them in the context of their daily operations.

This shows that inscriptions must be recognizable to their users. In Robson's (1992) words, they must be equipped with stability. Who, then, are the users? Management must be one category. Who else? Shop-floor workers in charge of daily operations are another. The shop-floor workers are under management's control, and so they need to understand management's evaluation criteria so they can tell whether they are on the right track which is communicated through the managerial vision. The inscription thus becomes one way of legitimizing their work. That purpose is better served by accounting numbers and calculations that are recognizable or understandable to those that they affect, including those who are not experts on them. What is important in this case is that PPH was originally devised by shop-floor workers who were not accounting experts, which inevitably resulted in equipping the calculations with the ability to be recognized by them.

"Stability" performed a central role in the development process of the PPH calculation to expedite long distance control while responding to the various demands of changing social, economic, managerial and shop-floor contexts over time. The third president, Mr Inamori, made the best use of PPH in this regard. Negotiating with PPH calculations, shop-floor workers, economic and social conditions, and the existing philosophy, credos and visions, he constructed a strong actor-network where PPH calculations formed the centre of translations during the growth stage of the company. In this network, it was the source for both management and shop-floor worker compensation. Greater PPH meant more payment. It began to represent the fruits to be shared among all members of the company. The stability and simplicity of the calculation enhanced wider communications among all members, including non-accounting experts (Weingartner, 1969; Brealey and Myers, 1988; Remer *et al.*, 1993; Kazusa, 2003; Horii, 2009). Thus, it became a flag to rally around to involve different interests in the company.

6.2 Robustness of accounting calculations over time

Mouritsen *et al.* (2009) argue that accounting calculations in their case studies developed as mobilizing changing and diverse interests as well as being mobilized by others. In this paper we have shown that the stability of PPH opened up the space to adapt to the various demands of different parties maintaining a common identity across sites. It supports the debate about the plastic yet robust nature of accounting calculations (Briers and Chua, 2001; Hansen and Mouritsen, 2005; Dechow and Mouritsen, 2005), and further shows that it can withstand the changing needs of a heterogeneous network over time. Briers and Chua (2001) demonstrated how an ABC system superseded the existing standard costing system to become a vehicle through which various people, such as industrial engineering experts, cost accountants and business analysts, reached consensus on their decisions. However, once they had agreed, they no longer needed the ABC system. Eventually, it was superseded by another system. As Law (1991) states, these cases show that powerful heroes or machines are built out of fragile, heterogeneous networks, and triumphant technology might only be king for a relatively short time. In contrast, the empirics of this paper demonstrate that the same metric was retained through successive waves of meaning, playing different roles each time.

Alonso (1987) argues that counting cannot be separated from concepts. Once the object of quantification is defined, the number then comes to stand for the conceptual entities. In the process of spreading PPH to marketing teams, management credos and vision, such as “customers rule price” and “the source of profits lies in production groups”, were inscribed into the calculation. However, if the concepts are not accepted by the audience, the inscription may fail to bring them into the program.

Dore (1973) also demonstrates how consensus between managers and their subordinates was considered important in British factories in the 1960s, referring to the statement by productivity manager in the UK’s Employment and Productivity Bureau:

[The] mandate to manage comes primarily from his subordinates; only if they co-operate or at least acquiesce will he achieve his purpose [...] Consent [...] has to be sought. It requires the creation of confidence by a frank disclosure of full information concerning of future objectives, a continuous joint review of overall performance and the predetermined extent to which all interests will participate in success – the slicing and share-out of the cake (Dore, 1973, p. 150).

However, the consensus in PPH is not necessarily related to “fairness” (Libby, 2001; Lindquist, 1995) or attainability of the numerical target. For example, the corporate target of 2,000 yen set for fiscal 1968-1969 was not attained until fiscal 1973-1974. The target of 2,700 yen set for fiscal 1974-1975 was not attained until fiscal 1976-1977 (Table III). Rather, it was the acceptance of the management narrative and scenario (Mouritsen *et al.*, 2001) that linked the company’s growth and future expectations proposed by these numbers. In other words, PPH survived over time by providing the opportunity for continuous negotiation between management and shop-floor workers via its calculation.

6.3 Rinen control in the bottom-up context via continuous refinement in accounting calculations

A further implication of the present case is that *rinen* control or belief/boundary control, in Simons’ (1995) words, can be more bottom-up than earlier studies expected,

in the sense that shop-floor workers may affect the value systems of the company via participating in the (re)shaping processes of accounting calculations. The designing and re-designing process of management accounting systems at Kyocera was not unidirectional. Rather, PPH embraced a wide range of people in the company, including shop-floor workers who translated their interests into its calculation as it was refined.

Nevertheless, refinement is not merely a change. To be refined, the inscription and its calculation need to improve in some sense. In the present study, additional roles and expectations were provided to PPH as its calculation changed over time. However, these changes had to negotiate with the calculation. Once PPH became the predominant calculation at the case company, changes had to be consistent with the existing calculations and value systems inscribed in them. In other words, PPH had a right to refuse a change. At the stage of economic growth, for example, the negotiation for positioning the PPH as the source of pay raises was successful because labour costs did not appear in its calculation, which was originally devised to quantify labour productivity rather than financial profitability. By accumulating additional roles and signification, PPH was refined over time without being abandoned or superseded by another calculation.

In the management context, those who are designing, reading and interpreting management and control systems are in fact a priori privileged (Ahrens and Chapman, 2007, p. 103). However, the development process of the accounting calculation described in this case was rather anti-heroic. Without being a loyal servant or happy slave (Willmott, 1993), shop-floor workers were directly and indirectly involved with repeated (re)shaping processes of PPH in changing and diverse contexts. These processes were inscribed in the form of the calculations, and these inscriptions were accumulated to create growth rings of accounting calculations as chronological network effects.

7. Conclusions and future research opportunities

Accounting calculations are not only mobilized by others, but also mobilize others (Mouritsen *et al.*, 2009, p. 738). The flat ontology and the notion of translation in ANT has helped us investigate the processes in which an accounting number and its calculations were formed and developed as a flag to rally around to involve different interests at different times. It translated changing social and economic contexts and managerial and shop-floor interests into its calculations at different stages of the company's development.

Whereas most ANT papers (Briers and Chua, 2001; Hansen and Mouritsen, 2005; Dechow and Mouritsen, 2005) investigate cases where externally developed accounting systems, such as ABC, BSC and ERP, are introduced, this paper focused on the historical development process of an internally developed calculation PPH within a company. By investigating these processes, this paper has shown that *keiei-rinen* (management philosophy) control can be more bottom-up than implied in the extant literature (Simons, 1995, 2000; Kaplan and Norton, 1996, 2001; Otley, 1999, 2006). In other words, shop-floor workers and non-accounting experts affect the value system by participating in (re)shaping processes of accounting calculations.

However, once the network is mobilized to other companies, it inevitably becomes an established or a black-boxed system for both Kyocera and the company introducing the new system. As described in Section 5.5, the PPH network started to be mobilized

outside of the company under the name of Amoeba Management. By 2010, the number of companies which had introduced the Amoeba Management System numbered more than 400, according to its consulting arm, KCMC. However, the companies which introduced Amoeba Management did not necessarily share the same historical development processes of the PPH calculation. If the managers or/and consultants impose the values behind PPH on the employees as taken-for-granted assumptions, the shop-floor-rooted calculations may ironically end up being seen as top-down and coercive control systems. In that sense, future research opportunities lie in exploring how the mobilized system can be opened up to problematise, interest and enroll shop-floor workers in (re)designing the processes again. Combined with the findings in this paper, investigating these processes will give us further understandings on accounting calculations as inscriptions and expand the possibility of applying ANT in management accounting research.

Notes

1. *Keiei-rinen* (management philosophy) includes both Simon's (1995) belief and boundary systems.
2. This magazine was not published during the company's first five years.
3. Based on a calendar year (January to December 1975), rather than a Kyocera fiscal year (April to March). At this time, calendar year seemed to be more commonly used in the company.
4. It became an independent legal entity called Kyocera Communication Systems Ltd (KCCS) in 1995 to run the consulting and related information technology businesses. KCMC further spun off the consulting division to establish KCCS Management Consulting Ltd (KCMC) in 2006. It had consulted at approximately 300 external companies by the end of 2010.

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