

**CONFLICTS AND SOLUTIONS BETWEEN MATERIAL FLOW COST  
ACCOUNTING AND CONVENTIONAL MANAGEMNT THINKING**

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## **ABSTRACT**

Material flow cost accounting (MFCA), a major tool in environmental management accounting, has been developed worldwide. In Japan, the Ministry of Economy, Trade and Industry (METI) has been strongly supportive for promoting MFCA, and the number of companies introducing this tool has been steadily increasing. However, in order to apply MFCA in companies continuously, it is necessary to overcome the conflicts between MFCA and conventional management thinking. This paper indicates that the conflicts are likely to be caused by the essential feature of MFCA, and examines some possible solutions theoretically. Then, taking up three case examples that have succeeded in the continuous use of MFCA, specific countermeasures for dealing with the conflicts are investigated.

## INTRODUCTION

Environmental management accounting (EMA) has been rapidly expanding over the last decade. Indeed, the United Nations Division for Sustainable Development (UNSD) released two workbooks on EMA (UNSD, 2001 and 2002), and the International Federation of Accountants (IFAC) published its *International Guidance on EMA* (IFAC, 2005). In 2008, ISO/TC207 decided to publish a standard for material flow cost accounting (MFCA)<sup>1</sup>, which is a major tool in EMA, and launched “Working Group 8” for this purpose. An ISO standard for MFCA (ISO 14051) is expected to be released in 2011 (Kokubu, *et al.*, 2009). In Japan, the Ministry of Economy, Trade and Industry (METI) started its EMA project from 2000 and since then has been strongly supportive for promoting MFCA (METI, 2002; 2007), and the number of companies introducing this method in this country has been steadily increasing.

MFCA is a method that traces physical flows and stocks of materials in process, and then calculates their cost by multiplying material quantities by unit price. MFCA highlights the cost generated by and/or associated with material losses (along with products costs) as accurately as possible. It is therefore useful for improving material efficiency by identifying opportunities to reduce their relative consumption of materials. MFCA not only aims to reduce environmental impact, but also pursues cost reduction via reducing the use of raw materials and the generations of wastes. Most environmental management tools, including environmental management systems such as ISO 14001, while effective in reducing environmental impact, do not make a clear contribution to corporate profits, but instead tend to generate an additional cost for companies, at least in the short term. However, since MFCA addresses this problem by reconciling the environment and the economy, it has produced notable results for many companies (see, for example, Kokubu and Nakajima, 2004; Viere *et al.*, 2007; Wagner and Enzler, 2006 and Jasch, 2009).

However, analysing many examples where MFCA has been introduced, one finds that the skilful application of MFCA has enabled some companies to reduce their environmental impact and increase their productivity at the same time, while others have not managed to obtain such results, despite what they initially expected<sup>2</sup>. In order

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<sup>1</sup> MFCA was developed in Germany around the end of the 1990s. The German Federal Environmental Ministry and Federal Environmental Agency’s EMA guidebook positioned MFCA as the leading method of EMA (FEM/FEA, 2003).

<sup>2</sup> Kokubu (2008) examined 12 cases. Among these cases, five companies continue to apply

to see a successful and continuous introduction of MFCA into companies, it is necessary to adjust MFCA in the existing management system. Because MFCA provides new ideas to management, some conflicts may occur between MFCA and conventional management thinking. The purpose of this paper is to examine the conflicts and possible solutions between MFCA and conventional management thinking, first theoretically, and then by investigating the companies that have successfully and continuously applied MFCA in practice. Through these analyses, this paper aims to examine various countermeasures for dealing with such conflicts.

MFCA has been developed mainly in Germany and Japan (Strobel and Redmann, 2001; FEM/FEA, 2003; Wagner and Enzler, 2006; Kokubu and Nakajima, 2004; METI, 2007; Jasch, 2009). The importance of waste cost calculation has been also emphasized in many EMA studies in general (Rooney, 1993; Pojasek 1997; Loew, 2003; Burritt, 2004; IFAC, 2005). However, many previous studies explain the features of the method or future possibilities, but are not intended to solve practical problems that companies may encounter while introducing MFCA or EMA into companies. This paper will therefore attempt to address these issues.

This paper is structured as follows. First, the basic cost calculation method and features of MFCA is explained. Second, the possible conflicts and its solutions between MFCA and conventional management thinking are examined theoretically. Third, in view of three cases of companies that applied MFCA continuously, the countermeasures for resolving such conflicts are examined, and conclusions are drawn.

### **THE BASIC COST CALCULATION METHOD OF MFCA<sup>3</sup>**

MFCA quantifies material flows and stocks in process/processes in terms of both physical and monetary units. Here, a strict demarcation is required between material that forms part of the product, including intermediate product, and that portion of materials that ends up as waste to be discarded. In conventional cost accounting, it is of fundamental importance to determine whether or not the incurred cost in total is recovered from sales, and a strict determination of whether material is transformed into

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MFCA into their company at large, but the rest of the companies introduce MFCA only in particular lines processes and did not apply it to the entire company.

<sup>3</sup> The explanation of MFCA is based on basic MFCA texts including Nakajima and Kokubu (2008), ISO (2009) and METI (2007).

products, or thrown away as waste, is not generally required<sup>4</sup>.

MFCA is based on the principle of quantifying the flows of materials at the point in the manufacturing process at which any material losses (wastes) are generated. In this calculation not only is the cost of the input materials included, but also processing costs such as labour costs and depreciation costs are allocated, both to products and material loss. This is because MFCA assumes that even for waste materials, processing has been applied, and labour and equipment costs are thus involved. Waste is recognized as “another” product in this calculation. In addition to material costs and processing costs, waste disposal costs are therefore added to the cost of waste.

A simplified method for the calculation of MFCA is illustrated in Figure 1. In this example, one type of material (100kg) flows to both product (80kg) and waste (20kg). In a production process, which is a point for MFCA calculations, costs incurred are \$1,000 for the material and \$600 for processing. In conventional cost accounting, the cost of waste is generally not calculated. However, in MFCA the cost of the waste (material loss) is quantified as follows. First, the \$1000 cost of the material is divided, according to the weight ratio between product and waste, into \$800 and \$200. Second also based on the weight ratio, 20% of the processing cost (\$120) is allocated to the wastes. Thus, the total cost of the waste is \$320.

**Figure 1 An example of cost calculation using MFCA (Insert here)**

In Figure 1, the important information is that the waste actually costs \$320, to which waste management cost should be added in the final analysis of MFCA. In conventional cost accounting, the waste is understood simply as an object equivalent to 20kg, but MFCA clarifies that this object is also equivalent to \$320. This implies that, not including waste disposal costs, \$320 per product (20% of the total manufacturing cost) is wasted. MFCA provides such information to the management and motivates them to reduce waste substantially.

Since MFCA provides information on the basis of actual measurements, excluding the

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<sup>4</sup> The difference between MFCA and conventional cost accounting is explained in Kokubu *et al.*, (2009).

various premises involved in production processes, it sheds light on aspects that had been ignored by conventional management techniques where the management information provided was based on the premises of standard production processes. In practice, MFCA is expected to be effective in the following respects: investment appraisal in plant and equipment, modifications or substitution of raw materials, improvements in product design and production planning, and on-site improvement activities (Kokubu and Nakajima, 2004). For example, since MFCA makes it possible to accurately evaluate the cost of losses generated in manufacturing processes, this information can be used for the evaluation of new equipment or in substituting new raw materials in order to reduce losses. These are major aspects in which MFCA enables information to be used most efficiently.

## **THE ESSENCE OF MFCA AND CONFLICTS WITH CONVENTIONAL MANAGEMENT THINKING**

In order to introduce MFCA into companies and operate it effectively, it is necessary to adjust MFCA to existing management thinking. Since it is not the purpose of this paper to explore the nature of existing management thinking in general, some important examples of conventional management thinking are examined and compared with the basic concepts of MFCA. The controllability principle and the primary corporate objectives for profit seeking are discussed as examples of conventional management thinking, bearing in mind that in practical terms some conflicts with MFCA are likely to occur. If any conflict or friction is found, it is important to examine how to solve it in both theoretical and practical ways. Since the essential point of MFCA is located in the newly defined concept of loss, as discussed in the previous section, the analysis starts from this point, and possible conflicts between MFCA and conventional management thinking are examined. The purpose of this section is to examine these issues theoretically, and to offer an analytical viewpoint on the actual MFCA practices, which are discussed in the next section.

### ***The essence of MFCA: The concept of loss***

The basic idea of MFCA, which is explained in the previous section, is not so complicated. Many leading, highly competitive, Japanese companies have discovered plenty of room for improvement via MFCA<sup>5</sup>. This is because the concept of loss in

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<sup>5</sup> For actual examples of MFCA, many case studies appear in reports of projects commissioned

MFCA is different from the one generally followed in conventional business management. The value of MFCA-derived information is due to this difference in its concept of loss.

The committee draft for ISO 14051 standard provides an interesting case study of Company A, which is one of the world-class companies in lens manufacturing based in Japan. Before introducing MFCA, Company A believed that existing processes had a very high production yield ratio of 99% (99 of 100 pieces raw material inputs becoming finished products). However, MFCA calculations indicated that the material loss cost was approximately 32% in this process. This means that the yield ratio by MFCA was 68%. Most of the wastes (sludge) were actually generated by the grinding process of raw material. Company A did not recognize these wastes as “losses” in their conventional yield ratio management because such losses are uncontrollable for the manager of the factory, due to the design of the product and the processes that were already given. In Company A, defective products were only really conceived as losses generated from the production line. Ultimately, however, MFCA-based results led Company A to reduce these material losses and invent a new material with an 80% reduction in the shaved portion, in co-operation with the supplier. Because of the introduction of the new material, the amount of sludge and waste generated by both Company A and the supplier decreased significantly.

Another example is reported in IFAC (2005, p.61). In 2001, Ciba Specialty Chemicals in Germany undertook a case study to evaluate the potential of improving its information system by MFCA. The company focused on accurate tracing of the materials flows throughout a facility, as well as on the identification of all significant quantities and costs associated with those material flows. The MFCA project at Ciba revealed material discrepancies valued at about US \$2 million. These discrepancies were caused not only by actual material losses, but also by inaccurate data records in the ERP system.

These are typical MFCA success stories. However, companies do not always enjoy such benefits with this method. This is mainly because the losses indicated by MFCA are not, in most cases, incorporated into conventional production improvement activities, while companies always make considerable efforts to reduce various types of loss and slack.

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by METI (JMA Consultants, Inc.: <http://www.jmac.jp/mfca/> and Japan Productivity Center for Socio-Economic Development: [http://www.meti.go.jp/policy/eco\\_business/](http://www.meti.go.jp/policy/eco_business/))

For example, Toyota Production System (TPS), which is widely prevailed not only in Japan but all over the world, is designed to reduce “muda (waste)” in order to conduct “kaizen” (see Monden, 1994, Ch.13). Muda is defined as anything that does not add value, and TPS identifies seven main categories of muda: over-production, waiting, conveyance, processing, inventory, motion and correction (Kasul and Motwani, 1997, p.275). However, material loss is not included in the seven major categories of muda in TPS. The fact that TPS does not include material loss within its categories means that this type of loss is not considered to be dealt with in the factory operation.

MFCA, on the other hand, focuses on the relationship between inputs and outputs in production processes, where loss is defined as the difference between input and output based on weight (Nakajima and Kokubu, 2008). Of course, in conventional business management, the difference between input and output represents a loss at the stage of product design and development. However, if this loss cannot be reduced easily and is expected to be recovered from anticipated profits, it can be ignored as a target of management after the production has begun. Many standards and estimates in production management are established on this assumption. So long as the difference between material input and output falls within the permitted range of standards or estimates, and the estimated revenue can cover them, it can be considered that there is no problem, just as Company A thought so. Therefore, in conventional production management and cost management, the difference between input and output, which is permissible in terms of standard design, is necessary part of the input material, and is thus not considered as a loss. In other words, it can be deemed “an inevitable loss”. The most salient feature of MFCA is to quantify the “inevitable loss” that conventional production and cost management have overlooked.

The overlooking or inaccurate measurements of “material losses” in conventional management accounting can also be seen in the context of general environmental management accounting (IFAC, 2005, p.28).

In addition, conventional cost accounting systems often do not record data on material inputs to and from cost centre in production, but rely on general calculations provided by the production planning system, which may or may not reflect an organization’s real-world use and flow of materials. Many production-planning systems calculate materials loss by using inaccurate loss percentages. They may have little to do with the actual losses that occur during



production.

Hence, losses brought into focus by MFCA are losses that, while they comprise part of the manufacturing costs, were not always recognized as “losses” to be controlled in production management. The success or failure of the MFCA application depends on the possibility of developing ways of reducing them. However, if the loss provided by MFCA is not well known to the existing managers, some measures would be required to incorporate the new concept into the operation, before conducting any activities for improvements. For this purpose, it is necessary to examine whether any conflicts can be recognised between MFCA and existing management thinking.

### ***Conflicts between MFCA and conventional management thinking***

It is not the purpose of this paper to examine the whole area of conventional management thinking, but to examine some typical, but important, aspects of it, and analyse their relationship with MFCA as the first step in exploring this issue. One of the most important issues to be considered when MFCA is introduced into companies is how to control the new types of losses provided by MFCA. Because this aspect is inevitably related to the controllable range of managers, it may raise some conflicts with the conventional controllability principle, by which a manager should only be evaluated based on what they can control. This can underpin responsibility accounting (Choudbury, 1986). Following the traditional viewpoint on this issue, Solomons (1965, p.83) argued as follows:

It is almost a self-evident proposition that, in appraising the performance of divisional management, no account should be taken of matters outside the division’s control. These executives are to be judges on their conduct of control...

Based on the viewpoint of controllability, some conflicts may occur on-site when MFCA is introduced. This is because it is likely to be necessary to enlarge the span of accountability of managers in order to include the losses that have been newly “invented” by MFCA, which are often deemed to be out of the range of conventional production management. In the case of Company A, if the manager of the facility was evaluated by the result of the conventional yield ratio, which was 99%, when MFCA revealed that the “true” yield ratio was 68%, not 99%, this may cause friction within management. If the manager thinks that to manage the material loss costs lies out of his/her controllable range (in fact it was necessary to co-operate with the supplier in

order to reduce the losses in this case), it can be expected that the manager may resist including these losses in the evaluation. If “new losses” discovered via MFCA are not thought to be accountable to managers involved, improvements will stop. Consequently, in order to position MFCA as a means of both reducing environmental impact and increasing economic efficiency, the controllable range and/or associated accountability need to be reconsidered.

It has been discussed that in many cases managers have accountability over their controllable range (e.g., Vancil, 1979; Merchant, 1987, 1989; Dent, 1987; Rowe *et al.*, 2008; Simons, 2010). Some empirical studies suggest that it is not reasonable for managers to be accountable for beyond their controllable range, and that this can lead to dysfunctional decision-making, making managers feel they are being unfair (Merchant, 1987, 1989). However, much empirical research suggests that it would be reasonable for managers to be accountable for some aspects of uncontrollable factors (e.g., Dent, 1987; Giraud *et al.*, 2007; Frow *et al.*, 2005; Simons, 2010). For example, Frow *et al.*, (2005, pp.272-3) pointed out “managers are more rather than less likely to have accountability without controllability”, and Simons (2010, p.12) introduced the concept of the “entrepreneurial gap” to explain that the span of accountability is wider than the span of control.

Based on those recent arguments about the controllability principle, the idea of enlarging a manager’s accountability over the controllable range can be applied to the case of MFCA introduction. Therefore, valuable research could be carried out into examining what sorts of countermeasures could be incorporated in order to deal with this issue in practice. This is the topic to be examined in the context of Japanese corporate practices in the next section.

Before analysing MFCA practices, another possible conflict should be discussed, which is the conflicts between MFCA and the corporate primary objectives for profit seeking. There are various discussions that can be carried out with regard to corporate objectives (see Sundaram and Inkpen, 2004). For example, while the ultimate purpose of a firm is often assumed to be maximizing profits mainly in economics (e.g., Conner, 1991), issues such as “enlightened profit maximization” (Balboni, 2010) and “enlightened value maximization” (Jensen, 2002) should also be considered, reflecting recent CSR perspectives. Although there are various types of value and profit as corporate objectives or targets, it is not the purpose of this paper to examine what primary

corporate objectives should be. The aim here is to consider the relationship between MFCA and corporate primary objectives for profit-seeking in general. The economic objectives of companies are often considered to conflict with the environmental objectives. In the context of environmental management, Schaltegger *et al.*, (2008, p.4) has argued that “historically the usual (and apparently reasonable) assumption amongst most managers has been that improving environmental performance represents only extra costs for a firm.” This point needs to be examined in the context of MFCA as well.

MFCA is designed to link environmental objectives with economic objectives through reducing the cost of material inefficiency, as environmental management accounting tries to do, while recognising that sometimes conflicts between both objectives may occur. For example, let us suppose that a plan has been formulated to reduce material losses by \$1 million annually, as suggested by MFCA. If, on the other hand, a new sales opportunity that will increase profits by \$1 million presents itself, which will be the manager’s priority? From the viewpoint of profit seeking, it is natural for the manager to prioritise the future acquisition of profit, because managers tend to believe that opportunity loss is likely to be greater if profit-making opportunities are abandoned. If so, the adoption of improvement measures suggested by MFCA will be restricted to being within the range in which they do not compromise future opportunities for profit acquisition. The structure of this conflict lies between traditional economic objectives and environmental ambitions.

When comparing a plan that reduces costs and one which increases profits, managers will generally give priority to future growth, and will have a strong tendency to adopt means that increases profits. The problem that arises is that improvement proposals suggested on the basis of MFCA end up on the back burner. This is partly due to the structural features of MFCA, which do not include the cost of lost opportunities for future profits. However, if opportunity costs are incorporated into the system, then MFCA, which is based on actual quantified measurements, loses its most fundamental *raison d’être* (Nakajima and Kokubu, 2008). Therefore, it is considered that the best solution to this problem is not merely to improve MFCA’s calculation techniques, but to find a solution from the perspective of corporate management as a whole.

Finally, it is important to note that the controllability principle and the corporate profit-seeking objectives are mutually related. The controllability principle is a principle for controlling managers, but the corporate profit-seeking objectives are ultimately

related to the commitments of a CEO, which should be governed by stakeholders. This point is discussed by Simons (2010, p.10) in terms of controllability and accountability.

Following the controllability principle, span of control and span of accountability should align with an individual's position in the organizational hierarchy. For example, a CEO would have both wide span of control (responsibility for all the firm's resources) and wide span of accountability (accountability for broad measures such as stock price and competitive position). A shop floor supervisor, in contrast, would have narrow span of control and narrow span of accountability.

Although it is out of the scope of this paper to examine this issue more deeply, it is important to understand that these two aspects of conventional management thinking are related to each other in a broader context because countermeasures towards the associated conflicts with MFCA can also be related to each other.

### ***Solving these problems***

These possible conflicts concerning the controllability principle and the corporate primary objectives for profit seeking need to be systematically tackled, when MFCA is being continuously used at the company-wide level as part of a corporate management system. Regarding the conflict with controllability, one theoretical way of resolving this is to change the controllable range and/or level of associated accountability, although this is not generally easy to change. This problem cannot be solved on-site just by the department responsible for promoting MFCA. Therefore, in order to resolve this issue, commitment at the higher level of management is essential. It is necessary to appeal to managers to devise and implement relevant programmes to deal with the situation. In order to manage this situation effectively, it would be necessary to develop and employ some countermeasures for incorporating MFCA information into management activities.

While the issue of controllability can, therefore, be dealt with mainly within a company (albeit with some difficulty), conflicts between MFCA and corporate profit-seeking objectives need to be solved in a broader context involving the external stakeholders. If this problem could be solved within a company, one method would be to use MFCA within a range that does not conflict with corporate primary objectives for profit seeking. Many companies introducing MFCA have confined themselves to its use within this range (see Kokubu, 2008). However, if the reduction in environmental impact by MFCA could be pursued at the same time as an increase in economic efficiency, some

countermeasures involving external stakeholders would be necessary.

In this sense, the normative insistence on changing managers' minds will not necessarily be effective. Since managers are accountable for profits, they have a tendency to put the acquisition of profit opportunities before the reduction of material losses, and they will naturally give priority to alternative plans that further increase profits. However, when examined from the environmental point of view, the problem is the opposite. Rather than increasing production for the sake of future profit opportunities, it is better for the environment to reduce input. Consequently, to encourage managers to take an interest in MFCA, it is necessary that both society and market value companies that introduce MFCA to reduce their environmental impact. As Bruyn (1991) argues, this trend can be promoted by the "social market".

If an environmentally oriented manager decides to adopt MFCA in order to emphasize corporate environmental achievements, this problem can probably be solved to a certain extent. However, for such a manager to arise, social norms need to change, and some sort of policy to create such social conditions may also be required. MFCA is a technique in which both the environment and the economy coexist, and it can spread and penetrate through companies mainly as a means of improving production efficiency. However, in order to raise MFCA to the dimension of a corporate target, the purpose of environmental conservation needs to be brought into focus, again. To deal effectively with this issue, it will be critically important to incorporate some countermeasures involving external stakeholders.

In the next section, we will discuss three cases, in which MFCA was introduced into the whole company, exploring what sorts of countermeasures can be introduced in practice in order to overcome these conflicts.

### **COUNTERMEASURES FOR THE CONFLICTS: THREE CASE STUDIES**

The advantages of MFCA and the conflicts surrounding it are like the two sides of a coin. Since these problems are related to conventional management thinking, effective countermeasures would be needed to succeed in the continuing company-wide use of the MFCA technique. In this section, the cases of three companies (Tanabe Seiyaku,

Canon, Sekisui Chemical)<sup>6</sup>, which have continuously applied MFCA in a company-wide level, are analysed to explore how they have dealt with these problems in practice.

***Tanabe Seiyaku Co. Ltd.: Company-wide MFCA performance report meetings***

Tanabe Seiyaku, a pharmaceutical company, has participated in the EMA project of METI from 2001 to 2002. This company introduced MFCA into one production line as a trial in 2001, and applied the method throughout the company in 2003 (Kawano<sup>7</sup>, 2006). Tanabe Seiyaku applied MFCA to all its products (422 products, 12,310 processes) and as a result an annual cost reduction of JPY 230 million was achieved in 2006 (Tanabe Seiyaku, 2007, p.33). Tanabe Seiyaku was merged with Mitsubishi Welpharma, and became Tanabe Mitsubishi Seiyaku in 2008. However, the descriptions are based on documents before the merger<sup>8</sup>.

The most important feature of MFCA at Tanabe Seiyaku is the development of an MFCA system combined with ERP on a company-wide scale. In Japan, where most companies carry out MFCA calculations using MS Excel (Kokubu, 2008), Tanabe Seiyaku deserves special mention for being the first to succeed in its systemization. By combining MFCA with its ERP system, Tanabe has integrated MFCA data into the corporate financial information system and promoted improvement activities (Onishi *et al.*, 2008). Tanabe Seiyaku not only continuously collected MFCA data and used the information in activities at individual sites, but also conducted regular meetings to share information about improvement results based on MFCA data at the sites. These meetings, called as “MFCA performance report meetings”, in which top management participates, have been held every year from 2004 to 2007 before the merger.

These MFCA performance report meetings, which are held with the participation of representatives from all Tanabe Seiyaku’s principal sites, present cost reductions due to MFCA and the details of their environmental improvement activities. Therefore, in the case of Tanabe Seiyaku, information about improvement activities brought about by MFCA is shared throughout the company and material losses measured by MFCA are

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<sup>6</sup> The analysis in this section is based on a continuous cooperative relationship between the persons responsible for MFCA at these firms and the authors. However, specific information used here is limited to essays, environmental reports, and information publicized at seminars and lectures by the respective companies and persons in charge.

<sup>7</sup> Kawano was the main person at Tanabe Seiyaku introducing MFCA into the company.

<sup>8</sup> The consolidated sales before the merger in the fiscal year 2006 was JPY 177 billion.

perceived as an object of accountability by persons in charge. From the point of view of the controllability principle, Tanabe Seiyaku is an example that has adopted on a company-wide scale the extension of accountability as a method for dealing with the problems involved in MFCA.

Onishi *et al.*, (2008) evaluated the effects of these meetings based on their investigation through observations and interviewing as follows:

These meetings enable information-sharing on the achievements of factories and departments throughout the entire company. Since several executives take part in these reduction calculated using MFCA is more important than that calculated using conventional standard costing. Therefore, results reported at the performance evaluation meeting affect the performance evaluation of departments and employees. Moreover, since many participating department heads can understand what is going on in other departments, the sessions function as a forum in which issues can be shared with other department to encourage cross-functional improvement activities. (p.406)

In MFCA performance evaluation in Tanabe Seiyaku, managers at factories are not only evaluated by reduced manufacturing costs, but evaluated on their environmental performance by the amount of reduced wastes cost. The MFCA performance report meeting has been strongly supporting this evaluation activity. As Epstein (1996) indicated, the incorporation of environmental performance evaluation into the evaluation of individual performance is critically important to make the company more sustainable and environmental conscious. The case of Tanabe Seiyaku is one of such examples.

#### ***Canon Inc.: Applying MFCA information into on workplace PDCA cycle***

Canon is one of the leading precise machine companies in Japan, the consolidated sales in the fiscal year 2008 was JPY 4,094 billion. This company too, like Tanabe Seiyaku, has participated from 2001 to 2002 in the EMA project of METI, and has attempted the company-wide introduction of MFCA. Unlike Tanabe Seiyaku, however, Canon is not oriented towards constructing company-wide MFCA information systems as a combined ERP system. Instead, Canon introduced MFCA at individual manufacturing plants, on the basis of cooperation between the MFCA section in the Head Office environmental department and the plants. As of December 2007, Canon had introduced

MFCA at 17 sites in Japan and 9 overseas. The economic benefits by improvements based on MFCA analyses at major manufacturing sites worldwide were JPY 1.3 billion in 2007 (Canon, 2008, p. 47).

In order to implement MFCA throughout the company, Canon has linked MFCA to their “workplace-centred environmental assurance system”. Figure 2 indicates the basic mechanism of Canon’s workplace-centred environmental assurance system. The purpose of this mechanism is to enhance material efficiency by incorporating the use of MFCA information into the PDCA (plan-do-check-act) cycle of environmental conservation activities practiced on workplace (Anjo<sup>9</sup>, 2006).

**Figure 2 Canon’s workplace-centred environmental assurance system using MFCA (Insert here)**

The effects of this system were described under the heading “Devising workplace-centred environmental assurance system through MFCA” in Canon’s Sustainability Report (Canon, 2008, p.47) as follows:

At workplaces that have introduced MFCA, managers have led efforts to help employees recognise the amount and cost of the negative products<sup>10</sup> that are generated in the manufacturing process of each workplace and to analyse exactly how these losses occur. Improving the implementation of MFCA has enabled each workplace to devise an autonomous environmental assurance system that meet its specific needs.

After the above explanation, the report described two cases in their manufacturing subsidiaries.

After introducing MFCA in 2005, Nagahama Canon Inc. designated a person in charge of MFCA for the site. Workplaces producing key parts took the initiative for the company’s activities. By emphasizing MFCA’s effectiveness at regular meetings

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<sup>9</sup> Anjo was the main person in Canon for introducing MFCA into the company.

<sup>10</sup> “Negative products” means material losses valued by material costs, processing costs and waste management cost in MFCA. On the other hand, finished products are called as “positive products.”



and in internal reports, the company enhanced awareness and firmly established this approach.

Since the company introduced MFCA in 2003, individual workplaces at Canon Chemicals Inc. have worked to reduce waste and costs. The company has thoroughly adopted MFCA practices by sharing the results of analyses of workplaces. Employees' awareness and actions have changed positively, shifting from QCD to EQCD<sup>11</sup> activities. The company's processing, development, and technological divisions will be promoting MFCA in a concerted manner.

Incorporating MFCA into Canon's workplace-centred environmental assurance system is one possible way of overcoming the limitations of ISO14001, which tended to be restricted to mechanisms for general reductions in environmental impact, such as paper, waste and electricity. However, it is also expected to be a means of organically integrating factors such as environment, quality, costs and delivery on manufacturing sites. In this way, incorporating MFCA as regular information into on-site improvement activities means that the range of losses calculated by MFCA for a site is regarded as accountable. Therefore, it can be said that Canon's workplace-centred environmental assurance system deals with the possible conflicts between the conventional controllability principle and MFCA.

#### ***Sekisui Chemical Co. Ltd.: Establishing company-wide targets via MFCA***

Sekisui Chemical is one of the leading chemical and housing companies in Japan, the consolidated sales in the fiscal year 2008 was JPY 934 billion. Unlike the preceding two companies, Sekisui Chemical does not participate in METI's project. However, it began the introduction of MFCA in 2004, and in 2006 it set up a "manufacturing innovation centre" to support the company-wide introduction of MFCA<sup>12</sup>. Sekisui Chemical positioned introducing MFCA as part of its activities to strengthen environmental management, with the objective of becoming an "environmentally creative company", a goal which was elaborated in the mid-term corporate plan of the company. Sekisui Chemical has launched a plan to put it at the forefront of environmentally-aware

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<sup>11</sup> QCD and EQCD mean "quality, cost and delivery" and "environment, quality, cost and delivery" respectively.

<sup>12</sup> Okubo, the CEO of Sekisui Chemical, has shown in an interview with a member of the Sustainable Management Forum of Japan that 15 percent of input materials are not transformed into product and described how the company is making efforts to decrease this percentage based on the idea of material flows. This is evidence that top-level management can promote the introduction of MFCA (Okubo, 2006, p.72).

companies by 2010, and has established strict environmental targets. Introducing MFCA, which forms part of these efforts, is being pursued as an activity which combines environmental improvements and production innovations.

Since each company within the Sekisui Chemical Group incorporates reduction targets for loss costs discovered by MFCA in the mid-term action plan, and because each unit conducts its PDCA management cycle (Numata<sup>13</sup>, 2006), the possible conflict between MFCA and the controllability principle may have been avoided. On the other hand, it would seem that in achieving loss-cost reduction targets through MFCA on a company-by-company basis, the problem of conflict with the corporate profit-seeking objectives mentioned earlier can indeed arise. Although it is difficult for an outsider to examine how Sekisui Chemical actively deals with this problem, it should be important that it has set reduction targets through the use of MFCA. By introducing MFCA into all companies in the group, Sekisui Chemical set a target of achieving a reduction of waste-related costs of a total of JPY 5 billion from 2006 to 2008. This target was also publicly announced through its CSR report. As a result of promoting the theme of making improvements at 35 sites and across 106 products and processes, Sekisui Chemical has been able to reduce the total amount of material loss costs by JPY 7.2 billion on a cumulative basis, which was greatly exceeding its target (Sekisui Chemical, 2009, p. 28).

Sekisui Chemical evaluates the effects of MFCA in its CSR report (Sekisui Chemical, 2009, p.28) as follows:

While the second half of fiscal 2008 in particular was plagued by a large number of negative factors such as rising raw-material costs and decreasing production volumes due to the economic slowdown, the steady cost reductions that had continued since fiscal 2006 through the activities of Manufacturing Development Innovation utilizing the MFCA proved to be highly beneficial from a business standpoint.

This company decided to continue MFCA activities in fiscal 2009 and beyond. The new mid-term plan starting from 2009 of Sekisui Chemical includes a target of a cumulative reduction of JPY 5 billion in material loss costs over the five-year period from fiscal 2009 through fiscal 2013. The announcement and determination of targets for loss

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<sup>13</sup> Numata is the main person in Sekisui Chemical for introducing MFCA into the company.

reduction by MFCA are likely to be important within the company as a guideline when it comes to evaluating alternative management plans, and will no doubt help motivate managers to favour the adoption of improvements suggested by MFCA. Public announcements, as one of the environmental targets, are a particularly important strategy, which may relieve the tension between short-term profit objectives and MFCA. MFCA-based activities could be promoted even more energetically in the presence of a virtuous circle where society and the market appreciate the attitude of companies like Sekisui Chemical.

## **DISCUSSION AND CONCLUSION**

MFCA is different from most other means of environmental management in that it aims to reconcile the environment and the economy, and thereby to deeply penetrate manufacturing processes. The background behind the considerable progress that have achieved in introducing MFCA to companies is that MFCA has been perceived as a means of production management that supports specific targets, namely growth in material efficiency through cost reductions, beyond the framework of existing environmental management tools. Nevertheless, when MFCA moves on from the phase of its ephemeral use as a one-time calculation technique towards on-going, routine application, it is necessary to adjust MFCA to the existing management system. To this end, possible conflicts between MFCA and conventional management thinking need to be resolved.

It has been indicated in this paper that MFCA possibly conflicts with conventional management thinking because it provides a new concept of loss for a company. Such conflicts can often occur between the conventional controllability principle and the corporate primary objectives for profit seeking. Even though these conflicts are not exclusive, they can often occur when MFCA is introduced. If the continuing use of MFCA is to succeed, the resolution of these problems is essential. In the conflict with the principle of controllability, this paper has argued that it is essential to change the manager's level of accountability, and to ensure that top management are committed to bringing this about. Regarding the conflict with the corporate profit-seeking objectives, it has been shown that positioning targets by using MFCA as a high priority for top management can be effective and thus, social norms in the market should be changed to make companies more environmentally conscious.

From this analytical viewpoint, this paper examined three case examples, Tanabe Seiyaku, Canon and Sekisui Chemical, which have continuously applied MFCA at a company-wide level. It was also found that various means of resolving these problems have been devised and introduced in practice. Specifically, Tanabe Seiyaku's performance report meetings on MFCA and Canon's workplace-centred environmental assurance system by introducing MFCA are considered to function as a means of mitigating or dealing with conflicts between MFCA and the conventional controllability principle. In both companies, the accountability of managers can be extended to include the loss provided by MFCA. These findings are supportive of the previous literature suggesting that managers should be accountable for some aspects of uncontrollable factors, and can provide new evidences in this area. Sekisui Chemical's elaboration of targets for loss cost reduction by the use of MFCA and its publication is also considered to have the effect of motivating top management to make the reduction of material losses a higher priority. This is considered to mitigate conflicts between corporate profit-seeking objectives and environmental conservation.

This paper has also some limitations. First, the conflicts discussed in this paper are limited. For example, the integration of MFCA calculations with existing corporate information systems may create some conflicts. This issue can be another topic for future research. Second, the number of case studies is limited. Therefore, it is not possible to generalise these findings, but the contribution of this paper is to show that the companies which successfully introduced MFCA employed some sorts of countermeasures to mitigate or overcome the possible conflicts between MFCA and the conventional management thinking.

This paper is not suggesting that the initiatives seen in practice at these companies will completely resolve the problems involved in MFCA. Rather, the findings imply that in order to introduce MFCA throughout a company, it is important to use it in combination with some means of resolving or mitigating the conflicts between MFCA and conventional management thinking. Because the preparation of ISO new standards will promote the dissemination of MFCA, it is considered to be important to foresee the problems that will inevitably arise and to devise measures to deal with them. This paper has contributed to this end as the first step in exploring this issue.

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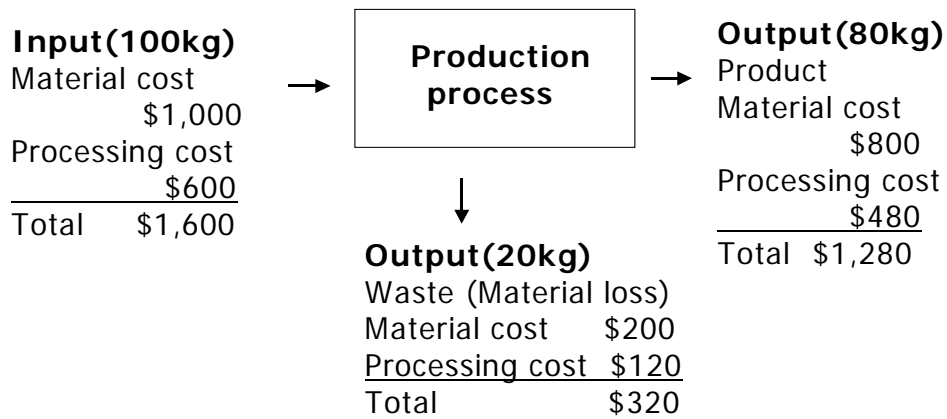
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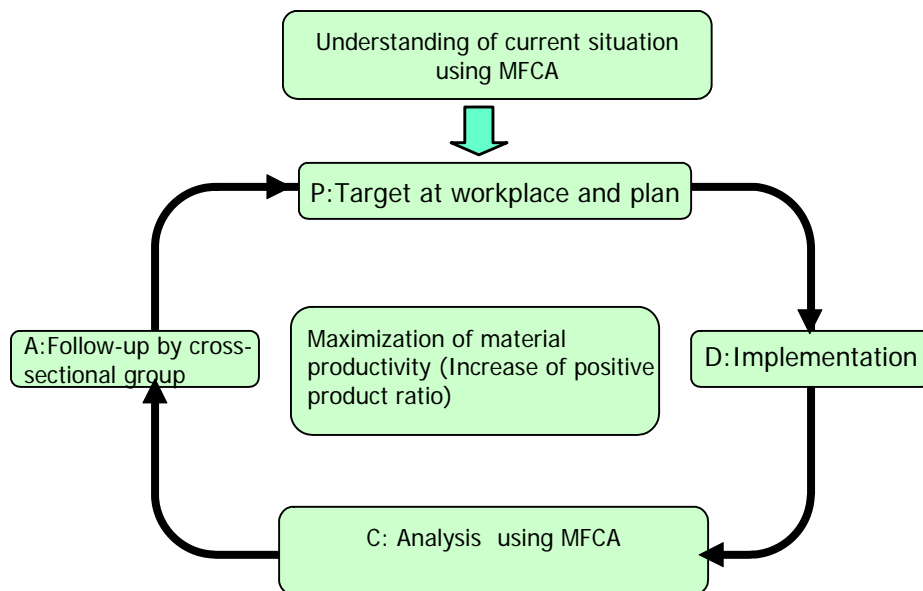


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**Figure 1 An example of cost calculation using MFCA**



**Figure 2 Canon's workplace-centred environmental assurance system using MFCA**

Source: Anjo (2006)