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Towards & Beyond 2020

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Oral Session

Special Session 6 (Room D) November 12, 2010 10:00-12:00

International Standardization of Environmental Management Accounting

Chair : Michiyasu NAKAJIMA, Bernd WAGNER

D3-1000 (Invited) 10:00-10:20

The Role of MFCA in Coping with the Challenges of 2020

Bernd WAGNER

D3-1020 10:20-10:40

The Impacts of MFCA Management to Corporate Financial Performances

Michiyasu NAKAJIMA, Asako KIMURA

D3-1040 10:40-11:00

MFCA Management in OMRON

Toshiaki HARADA

D3-1100 11:00-11:20

MFCA Management in Sekisui Chemical

Masashi NUMATA

D3-1120 11:20-11:40

International Standardization of MFCA (ISO 14051)

Yoshikuni FURUKAWA, Hiroshi TACHIKAWA

D3-1140 11:40-12:00

Modeling of an Environmental and Economic Sustainable Business Concept

Markus MAU, Nicole MAU

General Session (Room D) November 12, 2010 13:30-15:10

Risk Assessment and Management

Chair : Masahiko HIRAO

D3-1330 13:30-13:50

Sustainable Use of Contaminated Land in Taiwan-building a Risk Assessment Foundation and Lesson Learned

Hung-The TSAI, Chih HUANG, Chih-Hsiu SHEN, Su-Shin HUNG, Yu-Jen CHUNG

D3-1350 13:50-14:10

Decision Support Tool in Design of Metal Cleaning Process Based on Life Cycle and Risk Assessments

Hiroki MATOBA, Yasunori KIKUCHI, Masahiko HIRAO

D3-1410 14:10-14:30

Risk Trade-offs between Brominated Flame Retardants and GHG Emissions from Life Cycle Perspective; Toward Sustainable Chemicals Assessment

Satoshi MANAGAKI, Yasukazu YOKOYAMA, Shigeki MASUNAGA, Yuichi MIYAKE, Takeshi KOBAYASHI, Atsumi MIYAKE, Hiroki HONDO

D3-1430 14:30-14:50

Human Exposure Assessment to Pesticides in Developing Countries: Pesticide Flow Analysis During Handed- and Motor-Pressurized Application

Camilo LESMES FABIÁN, Glenda GARCÍA-SANTOS, Claudia BINDER

D3-1450 14:50-15:10

PAHs Accumulation in the Life Cycle of Corn

Shiyong DU, Guolan FAN

The Role of MFCA in coping with the challenges of 2020

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Abstract

The vision is to gain transparency of all man-made material flows. In 2020 we want to know the physical amounts, the economic values and costs, the significant environmental and social effects of all material flows. This knowledge helps us to keep worldwide material flows at a sustainable carrying capacity, ensuring the adequate supply of the world population with necessary goods and services. MFCA is a tool to control material flows starting at the corporate or production level. MFCA will be applied at all levels of product life cycles along the supply chains, from the extraction of raw materials to the final disposal of the remnants of product use or consumption. Controlling material flows means measuring and reporting. But it also means initiating actions and evaluating results in order to keep resource consumption, emissions and entropy at a level that enables sustainable life on earth. The future can not be predicted. But ideas how we wish the future to be can be developed. And prerequisites for this desired future can be defined. If we wish a sustainable existence of mankind on earth we can define prerequisites.

Keywords: "Material Flow Cost Accounting (MFCA)", "material efficiency", "eco-balance", "mass balance", "dematerialization of growth", "sustainable growth"

1. Why Concern About Material Flows

In the past 150 years world population has grown from 1 billion to almost 7 billion. In the same time, since the advent of industrialization, world **economic growth** has risen from estimated 500 to 6500, measured in GDP per capita and international dollars [1].

Basis of this economic growth is the increasing industrial mass production of material goods. The corresponding material flows from extraction of natural resources to the diffuse disposal of the remnants of product use have numerous **effects** on human life style, on global economic developments, on climate and on the natural environment.

Governance and control of these material flows and their effects have become an essential condition of human existence.

2. Early Stages

With the end of the 19th century a **public awareness of the effects of industrial production on the environment slowly develops**, an awareness of the scarce availability of natural resources and of nature as prerequisite of human life. Only since the 1970ties, marked with global discussion of topics like "Limits of Growth" [2] or "Environmental Protection" public awareness differentiates further effects like climate change, melting of polar ice, loss of biodiversity, global water scarcities and their respective political, social and economic consequences. First systematic estimates of **economic effects** on a macro level (Stern 2006, Sukhdev 2008 [3]) met public alert only three decades later, even though reinsurance companies had started quantifying costs of climate change and steadily increasing natural catastrophes many years before that [4]. Only in the past two decades has industry started to employ significant end of pipe technologies for "Environmental Protection" on a micro level in order to reduce harmful effects. Only in the late 80ties did management science start to measure environmental effects of industrial material

flows, developing first instruments as LCA or Eco-Balances, allowing to define indicators for the assessment, the reporting and the management of industrial environmental effects. Environmental Management Systems (EMAS - 1993, ISO 14001 - 1996) and Environmental Management Accounting (EMA) started to integrate the **management of environmental effects** into corporate awareness, corporate management and corporate decision making.

The **challenges** of the present are to further develop these instruments in order

- to enhance the transparency of material flows firstly within but also between companies, from extraction to final disposal, along complex product life cycles,
- to further develop the awareness of economic, environmental and social aspects of industrial material flows in corporate and political leadership,
- to widen the awareness of interdependencies between economic, environmental and social aspects, of direct and indirect effects of material flows,
- to support commonly shared tools for measuring, reporting and controlling,
- to therefore back up the conscious management of material flows and their effects in order to insure long term sustainable development as well on a corporate as on a global level.

3. Transparency of Material Flows

Transparency of material flows on a corporate level means: **knowledge, documentation and control of all ingoing, stored and outgoing materials** across and within the borders of the defined corporate system. This system might be a production site, a warehouse, an entire company or various production sites or companies along a supply chain. A comprehensive material flow is described not only by the **movement** of material from A to B, but also includes the

material **stocks** at A and B - at the beginning and at the end of the regarded period (changes of stocks). The material flow also includes transformation processes: we need to know what happens when material is treated in various ways, cut, assembled, burned, melted etc., what inputs and outputs (mass balance) we assess for these transformation processes.

The knowledge should include all input materials, being raw or auxiliary materials, being purchased or free (e.g. natural resources: oil, water, air), and all output materials, going into the product or leaving the system as waste by air, into water or soil or in solid form.

In general **energy flows** (oil, gas, wood) are material flows, like other auxiliary material flows. As auxiliary material their purpose in production processes usually is to produce heat or work. Electricity differs as we commonly do not measure in mass units. The thermodynamic laws of input-output-balance and entropy apply to all flows (or currents), material and energetic, and are fundamental for the understanding of the physical nature of material flows. Material and energy as such can not be destroyed or generated, just transformed. Material and energy in a system might be "lost" or "consumed" or might "disappear" to air or soil according to a common understanding. Their physical amount (measured in mass or energy units) stays constant though, even after transformation into emissions or off-heat. When energy is "consumed" for production it has not vanished, as commonly perceived, it has just been transformed to work and off-heat. Transparency of material and energy flows implies mass balancing.

4. Triple Transparency

We need to gain simultaneous knowledge of all three sustainability aspects of material flows: the economic, the ecological and the social dimension. We need to know the physical amounts of the regarded flows, if possible in mass units, their value or costs in monetary units, and their actual or potential environmental and social effects in physical or descriptive units.

Today parts of these flows and their various aspects are recorded in detail on the corporate level mainly in monetary units. For ingoing material if purchased or outgoing material if sold (products, waste, recycling material) we quite often have exact data on physical amounts (in differing units though) and on prices stated on bills and therefore featured in the accounting system. But on material without bills, e.g. going as emissions into the air or as effluents into water or soil, we often know little, neither on total physical amounts, nor on monetary values or on environmental or social effects. Sometimes punctual information exists when limit values, e.g. for emissions, are controlled. In 2020 we will know a lot more about these flows, their economic, environmental or social values or costs, their input-output-balance and their direct and indirect effects, - with the help of MFCA.

5. A Global Perspective

At the present stage of development MFCA focusses on the internal corporate scope. It starts with the compilation of internal material flow charts and the tracking of quantities and costs, especially waste costs. This method, as standardized in the recent ISO 14051 endeavours, will be a globally used tool by 2020. As

many companies profit from this tool it will be possible to link MFCA data of one company to the next one, along entire supply chains and networks to a common supply chain/life cycle MFCA exercise. The material output in MFCA of one company will become the input for MFCA of another. It will be possible to trace material flows globally, 'from cradle to grave'. The present emphasis on physical quantities and costs will be enriched by an increasing accentuation of environmental and social information. Standardized tools for the measurement and control of environmental and social aspects, some of which are already in development (e.g. GRI), will be applied world wide.

If governance and control of material flows will not be established world wide, e.g. via the UN organizations, material flows will move to areas of lowest production costs and least control of harmful effects. If monetary markets as economic steering institutions are still in function the pricing of material flows in 2020 will be linked also to their environmental and social effects, as shown symptomatically in upcoming CO2 emissions trading.

6. Controlling Material Flows

Controlling material flows firstly means **measuring, recording and reporting material movements and stocks**. This is today's MFCA. In the next years it will be necessary to elaborate and further standardize these processes of measuring, recording and reporting in order to ensure that every time

- the same subject is measured. E.g. if we measure "waste" we have to make sure we measure the same type of waste, not different fractions of different mixture, density or toxicity.

- we measure with consistent measuring units, measuring points, time frames etc.

- consistent reporting units, reference units, indicators etc. are being used.

In conventional cost accounting it took decades to arrive at fairly consistent international accounting and reporting methods. The International Financial Reporting Standards (IFRS) are still far from being globally well established. MFCA in analogy is at its very beginning. Through the present ISO process it only starts to be recognized internationally and spread beyond the present pioneers' applications.

This also suggests that MFCA already in its early consolidation stage today has to strive for a **harmonized docking to established and approved accounting systems**. In the long run it will not be feasible to run separate parallel accounting systems. In 2020 we need one comprehensive accounting and reporting system based as well on financial data as on material flow data. This comprehensive accounting system offers reports for multiple purposes, for investor decisions, for strategic planning, purchasing, quality control, environmental management etc.. The report data has to be available at **any time at the push of a button**. As for accounting this applies equally to closely linked Enterprise Resources Planning Systems (ERPs). Considerable material flow information is contained in conventional cost accounting and ERP systems already today, but not adequately accessible, extractable or reportable. In 2020 **annual business reports** will contain monetary/financial data as well as environmental and social

data, derived -not only but substantially- from material flow analysis. Most larger companies today already report on sustainability matters, but separated from financial reporting and by random standards. Investors and taxation decisions in 2020 will be based on an integrated processing of financial, environmental and social indicators. CO2 taxation is one signal pointing to this direction.

Controlling material flows through MFCA means not only pure data accounting in terms of measuring, posting and reporting. Controlling also means **initiating action**: making use of accounting data to set measurable objectives to induce implementation and steering action within Plan-Do-Check-Act (PDCA) management cycles [5]:

7. From Accounting to Action

Internal accounting data are senseless if they don't lead to improvement action. MFCA only becomes worthwhile when it leads to actual improvements. In the past accountants were not involved in improvement, in change management. Accountants, even controllers, delivered data sheets. Drawing consequences from the data was left to other functional units. Nevertheless, the concept of controlling includes the idea of setting targets. But also from setting targets to real innovation, to structural or behavioural changes there is still a long way. In order to serve more than the filling of data sheets modern MFCA should be **part of a consequent controlling and management cycle**: setting up targets based on a thorough MFCA analysis, breaking down targets into operational programs, implementing programs by means of a functioning organization, checking results, initiating corrective action. MFCA should be directly integrated into this typical PDCA cycle. Targets derived from MFCA data should cover economic, environmental and social aspects. The results of the target implementation again should be checked and then steer the future search, compilation and reporting of MFCA data for the next cycle.

In 2020 the functioning of such PDCA cycles, that are meeting the MFCA based targets, will be enhanced by **incentives and sanctions**. Managers salaries and promotion will depend on criteria like resource efficiency, CO2 reduction (Carbon Footprint), percentage of renewable or recycled materials or energies, substitution of toxic material, material efficiency and waste reduction etc.; but also on criteria for health or qualification of employees, gender equality, etc.. Sanctions will be taken if such sustainability targets are violated. Also companies are going to be taxed and governed more consequently by sustainability targets and criteria. This in many respects has already started, differing from country to country. But in general it happens on an accidental basis. Thus CO2 emissions, as presently most widely perceived and discussed indicator, might be taxed, other emissions to air soil, water, are not, some countries or states do, others do not. Presently existing mechanisms for reward or sanction are not based on a comprehensive analysis of input-output-relations of material flows on a corporate or a national level. Many statistical figures, macro or micro, on resource consumption or resulting emissions are vague estimates or projections, not exact material flow measurements or recordings. Most modern "Enterprise Resource Planning" Systems (ERPs) are exact in balancing monetary units. They are ignorant in balancing input-output flows in mass units,- even though

technically they are capable to do so .

PDCA cycles as well as sanction and reward systems are formal approaches to induce implementation and improvement. Human systems function quite often not according to formal rules but to informal regulations, according to emotions and prejudices, to sympathies or antipathies etc.. Effective MFCA in 2020 therefore is part of a systematic PDCA implementation cycle, globally regulated by acknowledged sanction and reward systems. But this implementation cycle works consciously in consideration of differing perception and awareness levels of process participants, of emotional and behavioural dynamics, of communication barriers, of personal and interpersonal conflicts.

The German experience of 20 MFCA projects [6] in 1999-2003 showed, that MFCA in many cases was properly installed, resulting data were transferred to realistic, highly promising targets and programs, integrated into officially installed PDCA management systems, but ... implementation did not take place.

Necessary and economically highly promising innovations did not take place, not because of a lack of accounting data or targets or formal systems, but because of emotional or communication barriers, because of differing perceptions and attitudes etc., because of human behavioural factors.

A comprehensive MFCA approach includes actual implementation and innovation processes taking into "account" the emotional nature of social change processes. In real corporate life MFCA will be incorporated in processes of organizational development, change or innovation management. [7]

8. From Efficiency to Effectiveness

MFCA allows an increase in resource or material efficiency. **Material efficiency** means less material for the same good or benefit. This also means less waste, less pollution etc.

But if efficient goods are produced in high numbers, the overall amount of resource or material consumption and of environmental burden will still increase. So, in terms of sustainability, such a production might be **efficient but not effective**. The overall target of reducing the total amount of environmental burden might not be reached by efficient production. In view of sustainable development **the growth of material based production is limited**. Through MFCA and material efficiency it might take longer to reach the limit. But a limit is there nonetheless, though discussed where exactly. Resources are limited, as are carrying capacities. As less industrialized countries, China, India etc., approach western consumption patterns, - and industrialized countries are not in a position to criticise this -, the limit is reached or crossed quickly.

On the other hand the functioning of our money economy, established since the beginning of industrialization and mass production, depends on economic growth. It needs growth to secure interest payments, to keep up the spirit of investment and employment, to keep up with innovation and competition, to maintain social security and peace etc.: a man-made self dynamic vicious circle.

One way out of this circle lies in the **dematerialization of economic growth**. Dematerialization of growth in parts can be reached through higher material efficiency. But primarily through replacement of material growth by

service growth. People buy and consume less material goods but more services. This would not demand the often proclaimed but unrealistic waiving of consumption for materialized societies. It would mean a change in consumption patterns: "More wellness, less shopping". In the words of the OECD Council on Resource Productivity: "We have to break the linkage between economic growth and resource use." [8]

9. The Global Challenge

If dematerialization of growth by any means should be possible we still face the challenge of supplying non-materialized countries on a material consumption level (food, water, housing, health care, but also basics -for industrialized countries- like cars, television, refrigerators, mobile phones etc.) that **prevents critical inequalities between materialized and non-materialized countries**. History has shown that significant inequalities have always been forcefully equalized, emerging as migrant movements, religiously covered, class or civil conflicts etc..

Securing an **adequate global supply of material goods** and controlling the corresponding **material flows within the limits of a sustainable carrying capacity** will be the vital global task in the upcoming decade. Not only environmental or climate sustainability but also global social peace will depend on this. This challenge is becoming more and more exigent in regard of today's spiralling globalization dynamics of information and material flows and mobility.

Transparency of global material flows, their costs, their environmental and social effects will be the first condition to cope with this vital challenge. Governing and controlling man-made material flows on a global level will be and already is today existential for the human condition.

MFCA, elaborated as a globally applicable and therefore standardized global tool, as developed presently with the international ISO standard 140051 therefore is an essential contribution to cope with this challenge. MFCA has to be implemented globally, but it has to start this implementation on an atomic corporate level.

On the one hand, MFCA is a tool to increase corporate material efficiency and therefore competitiveness on a micro level. MFCA, established internationally by ISO processes, on the other hand is positioned within the scope of a global sustainability strategy on a macro level. It thus serves to govern global material flows providing an integrated economic, environmental and social perspective.

We will not be able to forecast our future, but we can identify conditions under which a future is possible - or not.

6. Acknowledgement

The above considerations are based on the early MFCA experiments and experiences during the Eco-Efficiency Project in 1999 to 2003 (sponsored by the State of Bavaria, Germany) [6]. Without the dedicated engagement of the young staff members of imu augsburg, especially the conceptual inspirations by Markus Strobel, this development would not have happened.

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[4] see e.g. regular reports by Munich RE on natural hazards and catastrophes and their economic costs, www.munire.com

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