CHAPTER 2

CHALLENGES FOR ENVIRONMENTAL MANAGEMENT ACCOUNTING

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Abstract Environmental management accounting (EMA) is concerned about the accounting needs of managers in relation to corporate activities that affect the environment as well as environment-related impacts on the organization. This paper provides an overview of a range of challenges faced by EMA.

1 INTRODUCTION

Various reasons are given as to why an increasing number of managers are becoming interested in EMA information (Ansari, 1997 pp. 4-5, Gray and Bebbington, 2001). These include that:

- *Environmental regulations* impose requirements on companies. For example, Superfund liabilities for site cleanups (remediation) in the USA and take-back (extended producer responsibility) provisions in the European Union. These regulations, when enforced, can lead to environmental costs that, if significant, need to be *controlled* and *reduced* by management;

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- *An increase in voluntary acceptance* (self regulation) by managers of the importance of managing business environmental impacts. Managers are beginning to recognise the growing importance of the monetary consequences of corporate environmental impacts to the prosperity of their corporations. If managers wish to lower their costs (to improve income or profitability) or environmental impacts (to reduce penalties, e.g. cessation of business, for non-compliance or the outrage of different stakeholders), then EMA information is necessary. Voluntary acceptance leads to commitment, assessment, monitoring and elimination of the causes of adverse environmental impacts and costs, as well as *control* in order to maintain corporate legitimacy in the eyes of customers, society and other stakeholders (Deegan, 2002);
- *Promotion of EMA* is being undertaken by international, national and local government bodies and some educational institutions, although little is known about how educational institutions are embracing the area. EMA is being promoted by groups such as the United Nations Division for Sustainable Development (UN DSD), United Nations Environment Programme (UNEP) and the Tellus Institute (through The Environemntal Management Accounting Research and Information Center (eMARIC) – because of potential social and environmental benefits from widespread use of environmental management tools related to the need for organisations to include all environmental costs in operating decisions and investment project analysis and to invest in clean technology. Academic investigation into EMA practices is gathering momentum and is being organised through networks such as EMAN in Europe, Asia Pacific and the Americas. Promoters of EMA tend to encourage organizations to accept the win-win logic behind the adoption of EMA practices (UN DSD, 2003, Schaltegger and Burritt, 2000 p. 53). From this perspective, environmental performance and financial performance of the organization are promoted on the basis that organizations can take actions that improve both types of performance. Some success in the promotion and dissemination of EMA ideas has already been noted (Osborn et al., 2002).
- *EMA tools are increasingly available* to help in the management process (see Figure 1 for some practical examples of such tools). Each tool, for example full cost accounting or life cycle costing, has been defined in a number of ways, thereby adding complexity for successful implementation to be achieved. The range of tools is typified by experience in Japan, where the Ministry of Economy, Trade and Industry (METI, 2002) established an EMA project in which the use of various tools – environmental cost management, material flow cost accounting, life cycle costing, environmental capital appraisal, and environmental corporate performance evaluation – is being researched.

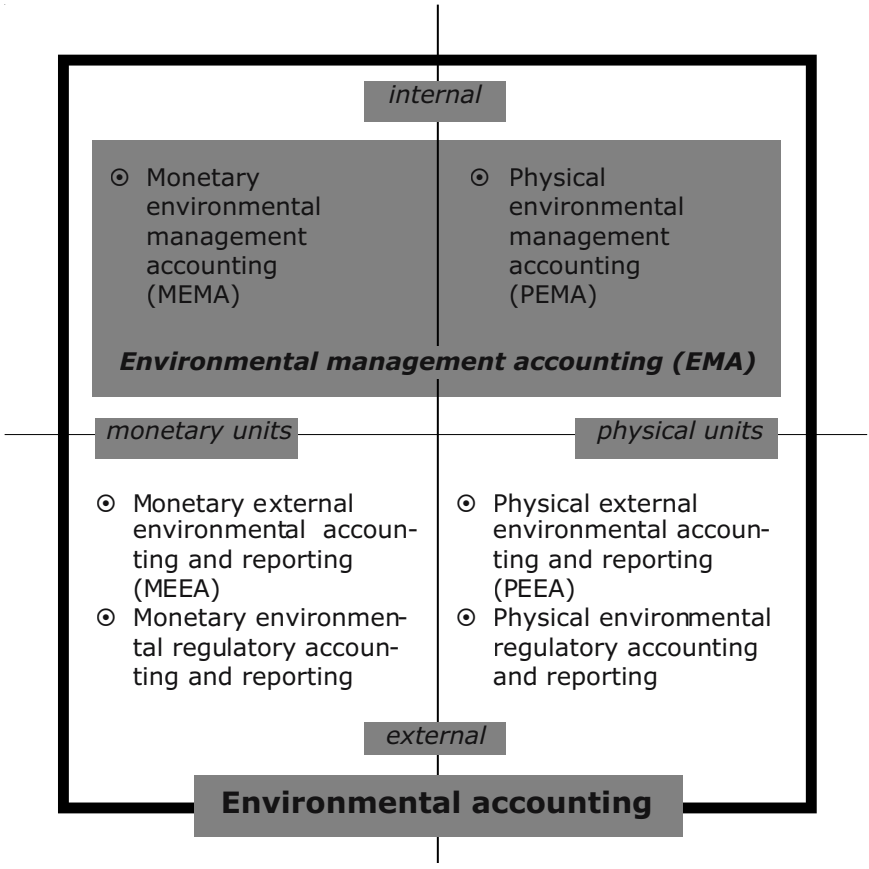

Figure 1. *Categories of Environmental Accounting (modified from Bartolomeo et al., 2000 p. 33)*

Given these incentives for the development of EMA, the paper proceeds as follows. Section 2 considers the meaning and development of EMA. Section 3 identifies some key problems with conventional management accounting along with academic and practitioner responses. Section 4 reveals challenges for EMA to address. The paper concludes that relevant, reliable, low cost EMA information is needed if the impetus already started is to continue to gather pace.

It should be noted that EMA literature is growing at a rapid rate and, in consequence, only a selective review of the literature on EMA is considered here. For a comprehensive review, a useful starting point is provided by Mathews (1997 and, 2003) and Bennett and James (1998c). No attempt is made here to provide detailed discussion of particular EMA tools, or environment-related performance indicators.

A wide repository of published information on these is located on the EMA Research and Information Center (EMARIC) web site[1]. Another diverse set of information can be found in Bennett et al.'s (2002a and 2003) papers from conferences and workshops of EMAN Europe. Finally, a recent critique of EMA is provided by Bennett, Bouma and Wolters (2002a).

2 WHAT IS ENVIRONMENTAL MANAGEMENT ACCOUNTING?

2.1 What is environmental management accounting?

Taken literally there are six possible words or phrases in the term 'environmental management accounting'. These are environmental, management, accounting, environmental management, management accounting, and EMA. Examining each in turn leads to some appreciation of discussions about the whole:

- *Environment* – does the definition include social and economic aspects as subsets? If so, the closer environmental and sustainability considerations become.
- *Management* – is this represented by functions (specific life cycle activities – from research and development, through production to product take-back), roles (the subject that manages – top, middle, production supervision, environmental, product manager, accountant, logistics, etc.), or object to be managed (people, physical objects, reputation).
- *Accounting* – the systematic gathering and use of monetary and non-monetary information about the organization that can be used by others – internally by managers and, if disclosed, externally by other stakeholders. Reporting of accounting information to stakeholders outside the organization in non-monetary terms is typified by an environmental report, and in monetary terms by a financial report.
- *Environmental Management* – a process view of management involving the continuous (continual) improvement cycle. Assumptions are made about: whether a narrow or wide view is taken of the environment; the management functions to be included; the managers that are included in environmental management; the objects being managed (people, physical objects, reputation).
- *Management Accounting* – conventionally concentrates on measurement in monetary and non-monetary terms to help managers make decisions that achieve the organization's goals. Management accounting and cost accounting are often distinguished because cost accounting is a source of information for both internal use and external reporting (Horngren et al., 2003).

- *Environmental Accounting* (see Figure 2) – various perceptions of the concept and practices of environmental accounting have emerged (for example, Adams, 2000, Bennett and James, 1998, Gray et al., 1993, Gray et al., 1996, Gray and Bebbington, 2001, Hamner and Stinson, 1995, Howes, 2002, Parker, 2000, Schaltegger, 1996, Schaltegger and Burritt, 2000, US EPA, 1995, White and Savage, 1995). Some convergence has taken place in the definition of environmental accounting, for example:
  - MEEA monetary external environmental accounting
  - PEEA physical external environmental accounting
  - MEMA monetary environmental management accounting
  - PEMA physical environmental management accounting (see Figure 2).

These classifications rely on the perceived usefulness of, and ability to distinguish between, internal and external stakeholders and the need for environmental accounting to provide monetary and physical units of measurement.

What, then, is environmental management accounting?
There has been movement towards the development of a comprehensive framework of EMA with the following characteristics:

- A focus on internal rather than external users of accounting information (e.g. Schaltegger and Burritt, 2000), and
- Separate identification of the need for monetary and non-monetary information to be gathered and tracked (Bennett and James, 1998a, Burritt et al., 2002, ECOMAC, 1996, IFAC, 1998, UN DSD, 2001 p. 39).

Figure 2 provides several contrasting definitions of EMA. Graff et al. (1998) combine material use and costs in their definition. It is a flow-orientated definition. They provide a fundamental distinction between monetary and non-monetary environment-related information. IFAC (1998) considers the combined management of environmental and economic performance and includes in their definition reference to a range of tools associated with EMA, including life-cycle costing, full cost accounting, benefits assessment, and strategic planning for environmental management. Full cost accounting addresses the range of impacts being managed (it internalises the costs of what conventionally are considered to be external impacts); while life cycle costing focuses the impacts of all functions of the business rather than a narrow group such as production, which was the special preserve of conventional cost accounting. The UN (2002) focuses on flows of environmental costs and economic (in monetary and non-monetary terms) benefits. Schaltegger and Burritt (2000) specifically identified EMA with monetary measures, but have since suggested the inclusion of monetary and non-monetary information (Burritt et al., 2002). Finally,

Bennett and James (1998a p. 33) provide a definition that incorporates financial and non-financial information about environmental and economic performance, with sustainable business being a goal.

Bennett et al. (2002b p. 2) later emphasise that EMA provides a close link between environmental management and management accounting, which raises the question as to how this link occurs. Is it through supplements to existing environmental management, or supplements to conventional management accounting, through reinvention of conventional management accounting and environmental management, or through the introduction of a new system that reflects a change in management philosophy towards concern for the environment as an ongoing issue for business. Considerable emphasis seems to be placed on the reinvention of conventional management accounting as the basis for considering environmental issues (see Howes, 2002). Hence, a closer examination of conventional management accounting in the context of corporate environmental issues is merited.

2.2 Is EMA just conventional management accounting with an environmental twist?

Conventional management accounting has a number of characteristics; it has a focus on internal decision-making about the business, it looks at past information to guide future decisions, cost receives the greatest attention, manufacturing is the value chain function most widely considered, and the emphasis is on control (Otley, 2001 p. 244).

Hansen and Mowen (2003 p. 7) provide a representative definition of conventional management accounting: "…management accounting identifies, collects, measures, classifies and reports information that is useful to internal users in planning, controlling, and decision-making." Not only is management accounting seen as being relevant to internal decision makers such as managers, it also strongly emphasises providing information about the future as a basis for decision-making and management control.

In a well-established source of information about management accounting, Horngren et al. (1997 p. 2) identify several specific purposes for conventional management accounting information:

1. Formulating strategies and long-range plans (sometimes called strategic management accounting or strategic business management) – including new product development and investment in tangible and intangible assets;
2. Physical resource allocation decisions involving profitability of specific products, brands, distribution channels and customers;
3. Cost planning and cost control of operations and activities relating to different responsibility centres; and
4. Performance measurement and evaluation of people – comparing expected and actual performance.

Source	*Definition*
Graff et al. 1998 pp. 3-4 (Tellus Institute)	Environmental management accounting is the way that businesses account for the material use and environmental costs of their business. Materials accounting is a means of tracking material flows through a facility in order to characterize inputs and outputs for purposes of evaluating both resource efficiency and environmental improvement opportunities. Environmental cost accounting is how environmental costs…are identified and allocated to the material flows or other physical aspects of a firm's operations.
International Federation of Accountants (IFAC) (1998, para. 1):	[Environmental management accounting is…] the management of environmental and economic performance through the development and implementation of appropriate environment-related accounting systems and practices. While this may include reporting and auditing in some companies, environmental management accounting typically involves life-cycle costing, full cost accounting, benefits assessment, and strategic planning for environmental management.
UN DSD EMA Initiative	Environmental management accounting serves as a mechanism to identify and measure the full spectrum of environmental costs of current production processes and the economic benefits of pollution prevention or cleaner processes, and to integrate these costs and benefits into day-to-day business decision-making.
Schaltegger and Burritt (2000 p. 89)	…environmental management accounting is defined in a narrower sense to include only the environmentally induced financial aspects of accounting that help managers to make decisions and be accountable for the outcome of their decisions.
Bennett and James (1998 p. 33)	The generation, analysis and use of financial and non-financial information in order to optimise corporate environmental and economic performance and to achieve sustainable business.

Figure 2. *What is Environmental Management Accounting?*

Whereas regular, periodic information is needed to fulfil purposes 3 and 4, information for purposes 1 and 2 are often ad hoc, project based and require special reports to managers as particular opportunities arise.

One implication of the greening of management accounting is that, potentially, all of the characteristics of conventional management accounting can be reconsidered in the light of physical and monetary environmental considerations. Bennett and James (1997 p. 34) identify six areas of environment-related management accounting:

- Identifying cost reductions and improvements;
- Prioritising environmental actions;
- Guiding product pricing, mix and development decisions;
- Enhancing customer value;
- Future-proofing investment and other decisions with long term consequences; and
- Assessing the eco-efficiency and/or sustainability of a company's activities.

Wilmshurst and Frost (2001 p. 138) succinctly summarise these purposes as follows "At the core of environment-related management accounting is…the development of environmental performance indicators that provide management with both financial and non-financial information relevant for decision-making purposes".

Bennett and James (1997 p. 34) recognise that environment-related management accounting has the potential to include energy and materials accounting, environment-related financial management, life cycle assessment and costing, environmental impact assessment and environmental externalities costing, even though in practice financial data and financial management has been the prime concern.

However, management accounting is undergoing rapid change, so much that Pierce (2001) argues "There seems no doubt now that managers will take over management accounting….Relevance and timeliness are of far greater importance than who supplies the information." He observes that, based on UK, US and Irish research (Pierce, 2001), conventional management accounting techniques will continue to be widely used, will be adapted to reflect non-financial indicators of performance, and will be closely linked to strategy, but decentralized managers, not management accountants, will dominate. Otley (2001 p. 244) considers that additional changes to conventional management accounting have occurred with management accounting becoming more strategic being forward looking, concerned about planning, externally focused, value focused and with an eye on other aspects of the value chain. Support for the growing importance of non-monetary information as part of management accounting comes from Bennett and James (1998d p. 371) who examined the cost of waste at Zeneca and found that accountants are not essential to environment-related management accounting where an understanding of physical processes was the primary concern for data gathering.

Whoever does assume responsibility for management accounting information, and EMA, a number of problems with conventional management accounting remain to be addressed. These are considered in the next section.

3 GREEN ISSUES – KEY PROBLEMS WITH CONVENTIONAL MANAGEMENT ACCOUNTING

3.1 Context

Some of the key problems for EMA stem from problems with conventional management accounting, while others are related to the lack of recognition of environmental impacts. These problems and the ways that they are being addressed in theory and practice in the context of environmental issues, are examined below:

Problems with conventional management accounting:
1. Performance appraisal techniques are too narrow and short term in their focus;
2. Lack of attention to articulation of stocks and flows; and
3. A narrow focus on manufacturing.

Problems with the lack of recognition of environmental impacts in conventional management accounting:
1. Environmental costs are assumed not to be important;
2. Certain types of environmental costs are not identified or tracked;
3. Indirect environmental costs are included with general business overheads;
4. Investment appraisal excludes environmental considerations;
5. Little accounting for externalities and sustainability issues.

3.2 Problems with conventional management accounting

1. Performance appraisal techniques are too narrow and short term in their focus
The academic response: introduce a balanced scorecard that includes non-financial measurement sets relating to customer satisfaction, learning in and growth of the business, internal business processes, as well as financial measures. Physical environmental performance is one of the measurement sets that could be adopted, emphasising long-term physical and monetary environmental performance of the organization (Kaplan and Norton, 1992, 1993, 1996a, and 1996b).
The response from practice: Empirical evidence gathered about practice in Germany, Japan and Australia indicates that little attention is given to the use of EMA data in performance appraisal, either for environmental managers, or for other managers in the sample of companies examined (Burritt et al., 2003).

Also, practical implementation of material flow cost accounting illustrates the ways in which cost centres material costs are manipulated (e.g. by renaming high value materials and misposting, the volume used appears to decline in the cost centre costs) (Eco-Effizienz, 2002 p. 2).

2. Lack of attention to the articulation of stocks and flows

A focus on flows means that stocks receive less attention. This is equivalent to stressing the income statement in accounting, while ignoring the fact that income represents the difference between opening and closing balance sheets (the stock positions) (Chambers, 1986 p. 179). Both are critical for a full understanding of position and performance.

The academic response: recognition of the need to integrate financial accounts to articulate stock and flow information (Chambers, 1986, Schaltegger and Burritt, 2000), but emphasis is placed upon the flows (UN DSD, 2001).

The response from practice: in financial accounting the need for articulation is widely accepted but in conventional management accounting it is not. In EMA, however, environmental assets are largely ignored (for one exception see Burritt and Cummings, 2002). Valuation of environmental liabilities in monetary terms for management decision-making is examined by the US EPA (1996 13) but is only recommended for situations when they might make a difference to the investment appraisal. The emphasis on articulated information about environmental liabilities in the management accounts is not stressed. Articulation between stock and flow information in physical environmental terms receives less attention.

3. A narrow focus on manufacturing

The academic response: Life cycle analysis and *life cycle costing* (cradle to grave) should be adopted (Bennett and James, 1998e). Integrated Product Policy (EC, 2001 Green Paper, White Paper forthcoming from the EC. Supply chain management is required (Tellus Institute, 2003).

The response from practice: Cases explore this wider focus. For example, Yakima-Olympia Corporation, a vertically integrated but non logging forests product company has choosing between clear cutting with feller/skidder/buncher technology or harvester/forwarder technology (Shank and Govindarajan, 1992). Integrated Product Policy (IPP) is being introduced in The European Union to link business and other stakeholders and supply chain management is being introduced. For example, the European Information and Communications Technology Industry Association encourages producers to supply key data along the product chain in the electronics industry and the European Union End of Life Vehicles Directive encourages strategic alliances to gather information about materials (International Material Data System, 2003).

3.3 Problems with the lack of recognition of environmental impacts in conventional management accounting

1. Environmental costs – not important

A key criticism of conventional management accounting is that it largely considers environmental costs to be immaterial in proportion to the organization's total costs. One reason suggested is that environmental costs are not separately identified (US EPA, 1995).

The academic response: case studies have been undertaken to separately identify environmental costs as a proportion of total costs (Ditz et al., 1995). The implication is that where such costs are material they need to be separately identified and managed.

A second strand of academic work has explored the notion of what is an environmental cost. In particular, materials flow cost accounting recognises all non-product costs associated with the generation of waste, both direct costs such as materials and overheads, as being environmental (Stroebel and Redman, 2002).

The response from practice: a large number of cases identify whether environmental costs form a material part of total costs (see some major recent sources in Figure 3).

2. Some environmental costs are not identified or tracked

Given the tendency for environmental costs not to be separately identified the need to do so became apparent.

The academic response: studies tried to establish what are environmental costs (e.g. UN DSD EMA, 2001); which environmental costs are potentially important (Bennett and James, 1997); and how best to classify such costs (US EPA, 1995).

Environmental costs have been classified in several different ways. Five classifications seem to have received particular attention based on:

a) *conventional cost accounting* (Horngren et al., 2003, Schaltegger and Burritt, 2000) – job and process; direct and indirect; historical and standard; fixed and variable; ordinary and extraordinary;
b) *measurability* (US EPA, 1995 p. 14) – five tiers conventional (0), indirect hidden (1), less tangible (2), contingent (3); and societal (externalities) (4). Measurability has been the focus of many case studies in EMA;
c) *quality* (Ansari, 1997 p. 5) – prevention, assessment (appraisal), control (internal failure) and external failure;
d) *life cycle and activity* (Kreuze and Newell, 1994); life cycle – research and development, design, production, etc.; activity based – unit, batch, product sustaining and facility level costs; and
e) t*arget audience* (Schaltegger and Burritt, 2000, Burritt et al., 2002) – internal (managers and employees); external (shareholders, tax agencies, environment agencies, suppliers, creditors, general public, local communities, NGOs, etc.).

The response from practice: the majority of cases only consider internal private environmental Tier 0 (conventional) and Tier 1 (hidden) environmental costs (see Graff et al., 1998 p. 11 for analysis of 39 cases across a range of industries).

3. Indirect environmental costs are lumped in with general business overheads
The academic response: identify and measure direct environmental costs (US EPA, 1995). Revise allocation bases separating out indirect environmental costs using activity-based costing (resources consumed by activities) to reduce cross subsidisation of 'dirty' products, processes, sites and departments.
The response from practice: the focus of most EMA cases (see Figure 3).

4. Investment appraisal excludes environmental considerations
The academic response: suggests change cash flows, discount rate and include option values to reflect environmental considerations in discounted cash flow calculations (Schaltegger and Burritt, 2000, section 6.5).
The response from practice: according to Graff et al. (1998 p.12) almost all of the projects included in their snapshot of 24 capital investment projects calculate a n Net Present Value (NPV), but most ignore option values. Graff et al. (1998 p. 12) found the lowest NPV of their 24 cases was minus USD 1.4m, the highest USD 11.6m, and typical was NPV USD 10,000 to USD 100,000.

5. Little accounting for externalities and sustainability issues (Tier 4 social costs (US EPA, 1995))
The academic response: Encourage a 'full cost accounting' EMA system (Bebbington, 2001). Extend the regulatory mix of policy instruments to include voluntary initiatives, such as the adoption of full cost accounting, with a sliding scale of enforcement penalties if business does not demonstrate voluntary commitment (Li, 2001).
The response from practice: Most case studies ignore externalities associated with business environmental impacts (see cases in Figure 3). Where externalities are calculated (e.g. ex post values – travel cost, hedonic pricing, averting behaviour – ex-ante values – contingent valuation, etc) the quality of information is poor but this is considered to be better than an estimate of zero (Graff et al., 1998 p. 12).

Each of these problems has a bearing on the characteristics needed for development of a pragmatic comprehensive management accounting system (see Schaltegger and Burritt, 2000 p. 44).

Source	*Number of EMA Cases Presented*	*Sector/Industry/Name (if available)*
ICAA, EA, VicEPA, Sydney, October 2002[2]	• 4 Australia	• Private/ Education/ Methodist Ladies College, Perth • Private/ Plastic Injection/ Cormack Manufacturing • Private/ Internal services to divisions/ AMP Services • Private/ Wool manufacturing – carbonising/ Michell Group
UN DSD EMA, Lund Sweden, December 2002[3]	• 12 Austria • 1 Zimbabwe • 1 South Africa • 5 Costa Rica • 1 Romania • 1 Hungary • 1 Slovakia • 2 South Korea	• Private/ Banking, Brewery, Energy, Pulp and Paper, Galvanising, Skiing, Water Treatment • Private/ Particle and fibreboard/ Zimboard Mutare • Private/ Mining, – 4 sectors • Private/ Poultry, Labels, PVC products, coffee mill, pasta/Pipasa, Etipres, Resintech, Coopronarango, Roma Prince • Public sector/ Water authority • Private/ Chemicals/ Nitrokemia • Private/ Cardboard production • Private/ Steel, health care/POSCO, Yuhan-Kimberley
UN DSD EMA, Bristol UK, February (UN DSD2002)	• 1 Canada • 3 Slovakia	• Private/ Pulp and paper mill/ Mackenzie paper Division, Abitibi-Consolidated Corporation • Private/ Pulp and paper; railway carriage repair; cardboard manufacturer
EMAN Europe, Bristol, UK, February 2002	• 11 Austria • 14 UK	• Private/ Pilot projects • Private/ Survey
Kokubu and Nakajima (2002) /IMU	• 6 Japan	• Private/ Various / Material flow costing in: Nitto Denko, Canon, Tanabe Seiyaku, Takiron, Nippon Paint, Shionogi
Gago (2002)	• 11 Spain	• Private/ Wood boards, bricks, wood pulp, oil refining / Co-generation of energy supply in unnamed companies
EMAN Asia Pacific, Kobe, Japan September 2001	• 3 Korea • 1 Philippines	• Private/steel, electronics, chemicals/ POSCO, Samsung, LG Chemicals • Private/ conglomerate/ Lopez Group

Figure 3. continued

Source	*Number of EMA Cases Presented*	*Sector/Industry/Name (if available)*
Graff et al. (1998)	• 39 Cases	• Private/ Chemicals; metal finishing, fabrication; printing; electronics; paper; electrical utilities, other./ 24 capital investments; 9 product/process costing; 6 strategic planning
Bennett and James (1998b) The Green Bottom Line (pp. 294-372) – various authors	• USA	• Private/ medical products and technologies (Cost-benefit analysis)/ Baxter International
	• Canada	• Public sector/ Ontario Hydro
	• Switzerland	• Private/ Electric utility (Full cost accounting), machinery and engineering (Identification of environmental costs)/ Sultzer Hydro
	• USA	• Private/ (Xerox Ltd/ Packaging use by document company (Product life cycle costing)
	• UK	• Private/ waste disposal in agrochemicals division (Conventional tracking and allocation)/ Zeneca
Ditz et al. (1995) Green ledgers	• 9 USA	• Private/ 9 companies in-depth (includes pollution prevention in four small companies). *General Comment*: '…the casework presented here avoids an explicit accounting of social costs.'

Figure 3. *Some available case studies in environmental management accounting*

4 ADDITIONAL CHALLENGES FOR THE FUTURE

Given the growing academic and practitioner interest in EMA, the availability of EMA tools and the promotion activities of various institutions, consideration needs to be given to the challenges that lie ahead. Nine of these are examined briefly below:

1. Inductive theory and the direction of case studies

A range of case studies in EMA are gradually being built up, based on experiences of organisations in practice in a number of countries (see Figure 5). Further case studies are being undertaken in each of the main categories – physical and monetary aspects of environmental cost analysis, investment appraisal, and performance management (including planning and control) in a range of countries and cultures. In time, the number should provide a sufficient base from which some generalisations can be drawn in relation to the observations of management practice in building up sustainable relationships and practices in situations of conflict, competition, cooperation and power differentials. With UN DSD cases "…the focus … is on actual company costs rather than on externalities…" (UN DSD, 2001 p. 8), and there is no inten-

tion at this stage to try and include externalities in new case studies being encouraged.

Bouma and van der Veen (2002 p. 279) observe that "Most research in EMA is prescriptive, contributing to the further development of tools, and often based on a limited number of case studies. Empirical research in EMA (e.g. Bouma and Wolters, 1998) is scarce and is focused more on describing the current state of implementation than on analysing or critically evaluating the effectiveness of the new tools." Their recommendation is to gain insight into the spread of EMA practices and to apply EMA theory to the adoption and effectiveness of EMA practices (Bouma and Wolters (1998 p. 279). As a starting point, Bouma and Wolters (1998 p. 289) attempt this in the context of environmental costs using contingency theory and institutional theory at operational, model, coalition and value levels. The analysis could be extended to each of the tools of EMA embodied in a comprehensive system (Burritt et al., 2002).

2. Small and Medium Enterprises (SMEs) and enterprises in developing countries

Case studies tend to focus on self-selecting organisations (but notice exceptions e.g. Ditz et al., 1995), usually large or environmentally sensitive organisations, or multinationals looking to improve their legitimacy with stakeholders. In larger companies divisional organisational structures can be used to educate and train managers in environmental awareness and, later having internalised this awareness, they will be equipped to run the total business.

Existing case studies in EMA are useful for understanding environmental costs, material flows and the potential for EMA. However, if the vast majority of (small and medium enterprises and developing country) businesses are not engaged in the process an holistic approach to addressing corporate environmental issues will not result, one that is essential if environmental problems are to be enthusiastically and successfully addressed. Diffusion of EMA (e.g. Osborn et al., 2002) requires the 'succession' factor with SMEs and developing countries to be taken into account.

3. Beyond win-win

Theoretical developments are needed to help guide practice and policy makers beyond win-win outcomes. The conventional view that many environmental impacts of business lead to net costs to business, and will not lead to win-win outcomes has not gone away. Case studies look for the win-win outcome, without considering how to choose when there is a net cost to the business. Case studies where there is a trade-off between environmental and economic, or environmental and social, outcomes would be invaluable because they would help generate a new mental set for managers where it is permitted for the environment to be seen as the key pillar of sustainability on some occasions.

4. Is pure physical information environmental management accounting information? Balanced scorecards can be relevant for particular purposes, for example calculation of various eco-efficiency, eco-effectiveness and eco-equity measures. However, engendering a philosophy of corporate conservation of environmental resources may require periodic, sequential focus solely on environmental indicators. In these circumstances relevant scorecards will be more important than balanced scorecards. For example, through ecological footprints[4] (Barrett and Scott, 2001, Chambers and Lewis, 2001, Wagekernagel and Rees, 1996) and rucksacks[5] (Chambers and Lewis, 2001) business may wish to empower its employees with the thought that their actions can help conserve the environment at work, or make customers aware of their environmental footprint when for example, they take a flight (e.g. the SAS emission calculator[6]). See also, in Australia, VictoriaEPA (2002) has established a series of pilot partnerships to investigate the potential development and application of eco-footprints to business, and to develop a robust method as a tool to measure and communicate the progress of business towards sustainability[7].

The implication is that pure physical information can be regarded as EMA, but that a comprehensive system may not be required to provide such information. Effort has been put into establishing whether information for accountants and environmental managers is systematically gathered and used. Using a narrow definition of EMA relating to internal decision support provided by financial data, Bartolomeo et al. (2000 p. 39) summarised the situation in Germany, Italy, the Netherlands and Great Britain and compared this with the USA. They found from a series of case studies in Europe that the financial benefits of introducing comprehensive EMA systems are not usually justified. Instead, they suggest that business piggy-back environment management accounting on other systematic changes, such as the introduction of activity-based costing.

It was also noted that in the UK and US business tends to look for short-term monetary gains from environmental projects, whereas in Germany, Italy and the Netherlands longer term benefits of eco-balancing and broad stakeholder responsibility are to the fore (Bartolomeo et al., 2000 p. 47), although there is some evidence of convergence. In contrast, evidence in Australia (Wilmshurst and Frost, 2001 p. 143) indicates that the basic structure for recording monetary environmental information already exists, even though environmental costs are not separately recorded in practice. But there is little active involvement by accountants in corporate environmental management either individually, or as a members of the environmental management team.

What remains as an issue is identification of the circumstances in which a comprehensive EMA system is or should be of benefit to the business (see Solomons (1965) for an early insight, and Johnson and Kaplan (1987) and Kaplan and Norton (1996) for recent views).

5. Software systems
Development of cheap but reliable and high-quality software systems will be one aid to the take up of EMA by smaller businesses. In a useful survey, the following questions were addressed (US EPA, 1995b).

- What tools and software systems encourage and allow a comprehensive coverage of environmental costs?
- What tools and software systems support life-cycle costing (LCC)?
- What directions might software and tool developers explore to critically evaluate and modify their products in light of new information and needs?
- What are appropriate research directions based on the current state and limitations of the available tools and software? (US EPA, 1995b)

An up-to-date summary of developments since 1995 is overdue. Current packages such as the PT Laser Systems Dynamics Model can be used to integrate: environmental and materials balance analysis; full cost accounting; life cycle economic evaluation of options; and sensitivity/influence analysis[8]. Another program, TCAce currently under revision[9], makes provision for all tiers of environmental costs, including societal costs. Software packages are only as good as the quality of the information that they produce and the links between quality of data and available software need to be synthesised for practitioners (e.g. the practice of using averaging of data is a criticism of life cycle assessment packages) (Schaltegger and Burritt, 2000 p. 249). Studies providing practical guidance with and lessons of implementation of software would be invaluable for the acceptance of EMA by business, and of the role of the internet in EMA could be examined.

6. Is the distinction between internal and external stakeholders useful?
The contention that EMA has a focus on internal uses of information is complicated when it is recognised that as part of the management process detailed internal information is sometimes shared with management of some parties conventionally considered to be outside the organisation. For example, provision of information to suppliers and customers as part of the business process.

For example, studies of environmental supply chain management explore this relationship. McDaniel (2000) provides practical guidance for managers of environmental issues through establishing partnerships, alliances and cooperations with upstream and downstream activities (suppliers, distributors, shippers, customers, etc.). The study observes that most supply chain managers do not focus on environmental concerns, one reason being that the frequency and magnitude of environmental costs are hidden by cost accounting systems (McDaniel, 2000, p. iv). Without information about these environmental costs management decisions related to converting suppliers into service providers are unlikely to occur. For example, a chemi-

cal service provider might purchase and deliver chemicals, change out drums, repackage chemicals and deliver chemicals to the point of use, provide data for some environmental reports, undertake research for chemical substitutes, process efficiency improvements, and manage waste disposal (Votta et al., 1998, Whaley and Johnson, 2001). Perceived environmental advantages from converting supplies into services, and growing take-back requirements in Europe and elsewhere encourage further studies in the cross over between internal and external relationships (Lippman, 2001 p. 14).

Internal and external stakeholder issues also arise in the context of understanding the difference between environmental management accounting and environmental cost accounting. For example, Howes (2002 p. 3) provides an introduction and practical guide to ECA divided into two parts – internal ECA and external ECA. Analysis is not based on the conventional distinction between accounting information for internal and external stakeholders. Internal is taken to mean actual environment-related expenditure, while external is taken to mean calculated estimates of externalities that would be needed to reduce business environmental impacts to a socially acceptable level (Howes, 2002 p. 27).

Another example also illustrates the problems that exist with basic terminological issues. UN DSD (2001 p. 5) suggests that cost accounting is also called management accounting, is the central tool for internal management decisions, yet is based on data obtained from financial accounting and the UN DSD acknowledges that financial accounting is mainly designed for meeting the needs of external rather than internal stakeholders. In contrast, Ansari et al. (1997 p. 19) suggest that environmental costs should be measured from the perspective of quality management – based on prevention, appraisal, internal and external failure categories. No recognition is given to the possible impact of financial accounting, through external cost accounting rules (or standards), on the resulting figures. Finally, Schaltegger and Burritt (2000 pp. 107/109) suggest that ECA should be a core component of EMA, while recognising that financial accounting practice, through the imposition of arbitrary rules in cost accounting, can adversely influence management accounting information.

In summary, there is progress in understanding the links between EMA, management accounting and financial accounting. However, links between ECA and EMA remain confusing and open to further clarification through research into the internal/external classification of EMA information use.

7. Performance management

Performance measurement and appraisal systems are described by Gray and Bebbington (2001 p. 59) as the point at which, if the organisation is serious about environmental impact environment, flow into all procedures and policies of a business:

Most critically environmental issues must become a core factor in the design and operation of the financial system and the system of performance appraisal, incentives and rewards.

Gray and Bebbington (2001 p. 59) observe that there has been a great deal of empty rhetoric in this area.

Performance appraisal that does not include environment-related impacts of individuals and organisational units (profit centres or cost objects) is unlikely to produce the behaviour desired by a committed top management. This area clearly deserves further research work. Use of environmental indicators in performance appraisal systems remains at an early stage of development.

8. Should business try to assess externalities?

A gap continues to exist between the theory of full cost accounting (e.g. Bebbington et al., 2001) and the practice whereby business does not commit to identifying externalities.

Slow adoption of full cost accounting for externalities is linked to the competitive process. For example, Ontario Hydro, an energy provider, was cited as an exemplar of an organisation that identified and accounted for externalities in its planning and investment decisions (Boone and Howes, 1996, Epstein, 1996, Mathews and Lockhart, 2001). These full costs were seen as the cost of doing business, but corporatisation and competition mean that consideration of externalities becomes a luxury.

A number of ways of encouraging business to include externalities in their decision-making have been suggested (Bebbington et al., 2001 p. 16, Gray, 2001 pp. 12-14), but lack of adoption in a competitive situation means that non-voluntary approaches are likely to be needed.

One question raised is whether EMA is a voluntary management tool designed to help managers, or a tool of social policy where government imposes its sway. In the USA cost accounting standards, specific measurement rules, were introduced to stop adverse payouts to companies that used accounting fiction when claiming money for government contracts – yet management accounting was still portrayed as a voluntary initiative. Involvement of various groups in the promotion of EMA could be because of the desire for externalities to be internalised when they otherwise would not, hence, if voluntary suasion does not work, full cost accounting rules of engagement for corporations are likely to be introduced as part of the fluid regulatory mix and enforcement pyramid. Interplay between the various stakeholders in the drive for socially desirable outcomes from corporate existence is another challenge for EMA. The debate between those who feel corporations should operate free of government intervention once market rules have been established (e.g. the establishment of tradable property rights), and those who recognise the environmental damage already perpetrated on society by this system will continue.

Tier 4 'societal' costs appear to be assessed by only a very small number of organisations. The lack of voluntary interest in externalities costing (Tier 4 societal costs) by business has received renewed academic attention and a call for action and further government initiatives (Mathews and Lockhart, 2001, Bebbington et al., 2001). The argument put forward is that the internalisation of externalities and its reflection in environmental accounts is too important to be left to managers. Their focus is on what EMA information is of use only to themselves – increased productivity, profitability and continuing legitimacy of the business (Ditz et al., 1995 p. 21).

9. Costing

Academics have long considered the problems of cost allocation. Direct costs are traced to cost objects, whereas indirect costs have to be allocated. Thomas (1974) terms allocations 'incorrigible', that is to say, no theoretical justification can be provided for dividing the common cost of a single input to two outputs. For example, linking the cost of electricity for powering the production of joint products with individual units of output can only be based on an arbitrary rule of thumb. Zimmerman (1979), in contrast, suggests that cost allocations can usefully serve as a proxy for such costs, and that cost allocation helps make managers aware that such costs exist when they might otherwise be ignored in decision-making. Burritt (1997) argues for the use of cost allocation to make managers aware of indirect environmental costs, with the intention that such costs will be better managed as a result of the allocation.

The US General Accounting Office (1992) recognised the problem that conventional management accounting systems did not allocate indirect environmental costs to specific production processes, instead including them as part of general overhead to be absorbed by all production.

When environmental costs are large and such costs are allocated through a general absorption rate to all production processes, the result can be under-costing (and cross-subsidization) of relatively dirty production processes (Hamner and Stinson, 1995). Allocation, or preferably direct tracing through improved measurement, of environmental costs to processes, rather than hiding them in general overhead charges is one way of encouraging cleaner production. Kreuze and Newell (1994 p. 38) applied similar thinking to the encouragement of 'cleaner' products. Revised cost allocation procedures are seen as one way to promote clean products and reduce the sale of dirty products. Kreutze and Newell (1994) illustrate their argument using activitybased costing and life cycle costing.

Although separation of a common indirect cost (e.g. depreciation of integrated production technology) into environmental and commercial elements will always be arbitrary it is becoming the norm that where environmental costs form a significant part of total operating costs an attempt should be made to separate them from general overheads and trace or allocate them to products (US EPA, 1995). Activity-based costing is often suggested as a way of avoiding arbitrary cost allocations, but, in

practice, because costs directly traced to activities are then linked with units of product, allocation remains a part of the costing process. The introduction of Integrated Product Policy is likely to exacerbate this tendency as a larger number of costs from upstream are linked to final output.

5 COMMENT

To achieve broad dissemination to a wide range of organizations EMA systems need to be relevant to the issues at hand, available at low cost, provide simple integration with existing management accounting systems, or environmental management systems and be reliable. Some challenges with EMA can be linked directly back to problems of conventional management accounting, for example the pervasive nature of cost allocation in a situation of joint products, over-costing of certain products, etc. Other challenges are added through the incremental adaptation of conventional EMA for environmental issues, for example, the issue of how environmental costs should be defined. Progress in addressing these challenges continues.

NOTES

1 http://www.emawebsite.org/about_emaric.htm.
2 Available at the Department of Environment and Heritage web site http://www.deh.gov.au/industry/finance/publications/project.html.
3 Available by contacting the United Nations Expert Working Group through http://www.un.org/esa/sustdev/sdissues/technology/estema1.htm.
4 The ecological footprint of a business represents the impact or "load" imposed by the business on the Earth measured in terms of bio-productive area (Chambers and Lewis, 2001, Wackernagel and Rees, 1996). Footprints are useful because they: provide a single measure of environmental performance; represent a bottom-up indicator of sustainability; and can be linked with other performance measures, such as eco-efficiency. However, as with all indicators of environmental performance: poor data quality is a problem; boundaries to life cycle analysis are arbitrary; the focus is on resource consumption rather than pollution.
Disaggregate information may be more useful (e.g. when assessing a renewable energy proposal).
5 Recall that an ecological rucksack is the material input used to obtain a product (service) minus the weight of the product itself. The material input is defined as the life cycle wide total quantity (in kg) of natural material moved (physically displaced) by humans in order to generate a product or service (EEA, 1999). The rucksack identifies hidden material movement. For example, in order to make one ton of aluminium it takes about 4.8 tons of bauxite. In order to extract one ton of bauxite, however, some 0.6 tons of topsoil must typically be removed. So far, this makes for a "rucksack" of (4.8 x 1.6) -1 = 6.8 tons of moved material per ton of aluminium. To make the aluminium, however, various other materials are also required as auxiliary inputs. The total "rucksack", counting these materials but not the materials moved to provide energy for the processes, has been estimated by Wuppertal Institute researchers at some 8.6 tons per ton of aluminium. The rucksack must be identified prior to any costing process or competitive advantage.
6 http://sasems.port.se
7 http://www.epa.vic.gov.au/eco-footprint/paint_factory.asp
8 http://www.sylvatica.com/ptlaser.htm
9 http://www.earthshift.com/tcace.htm

REFERENCES

Adams, C.A. (2000), Ethical Reporting Past and Future, *Management Accounting*, February: 48-51.

Adams, R. (2002), *Management accounting and the environment Student Accountant*, ACCA, 4 April (at http://www.accaglobal.com/publications/studentaccountant/405369).

Ansari, S., Bell, J., Klammer, T. and Lawrence, C. (1997), *Management Accounting. A Strategic Focus: Measuring and Managing Environmental Costs*. Columbus (OH): McGraw-Hill.

Barrett, J. and Scott, A. (2001), The Ecological Footprint: A Metric for Corporate Sustainability. *Corporate Environmental Strategy* 8 (4): 316-325.

Bartolomeo, M., Bennett, M., Bouma, J.J., Heydkamp, P., James, P. and Wolters, T. (2000), Environmental Management in Europe: Current Practice and Further Potential, *The European Accounting Review*, 9 (1): 31-52.

Bebbington, J. (2001), *An overview of accounting for environmental externalities*, Advances in Environmental Accounting. Proceedings of the ACCA/Environment Agency Seminar, May. London: Certified Accountants Educational Trust.

Bebbington, J., Gray, R., Hibbitt, C. and Kirk, E. (2001), *Full Cost Accounting: An Agenda for Action*. London: Certified Accountants Educational Trust.

Bennett, M., Bouma, J.J. and Wolters, T. (eds.) (2002a), *Environmental Management Accounting: Informational and Institutional Developments*. Dordrecht/Boston/London: Kluwer Academic Publishers.

Bennett, M., Bouma, J.J. and Wolters, T. (2002b), The Development of Environmental Management Accounting: General Introduction and Critical Review. In: Bennett, M., Bouma, J.J. and Wolters, T. (eds.) *Environmental Management Accounting: Informational and Institutional Developments*. Dordrecht/Boston/London: Kluwer Academic Publishers, pp. 1-18.

Bennett, M. and James, P. (1997), Environment Related Management Accounting: Current Practice and Future Trends *Greener Management International*, 17, Spring 33-51.

Bennett, M. and James, P. (1998), Environment Related Management Accounting: Current Practice and Future Trends. In: Bennett, M. and James, P. (eds.) *The Green Bottom Line: Current Practice and Future Trends in Environmental Management Accountin*g. Sheffield: Greenleaf Publishing, pp. 30-60.

Bennett, M. and James, P. (eds.) (1998b), *The Green Bottom Line: Current Practice and Future Trends in Environmental Management Accounting*. Sheffield: Greenleaf Publishing.

Bennett, M. and James, P. (1998c), *Environment Under the Spotlight – Current Practice and Future Trends in Environment-Related Performance Measurement for Business*, Research Report 55, London: Association of Chartered Certified Accountants.

Bennett, M. and James, P. (1998d), The Cost of Waste at Zeneca. In: Bennett, M. and James, P. (eds.) *The Green Bottom Line: Current Practice and Future Trends in Environmental Management Accounting*. Sheffield: Greenleaf Publishing, pp. 362-373.

Bennett, M. and James, P. (1998e), Life-cycle costing and Packaging at Xerox Ltd. In: Bennett, M. and James, P. (eds.) *The Green Bottom Line: Current Practice and Future Trends in Environmental Management Accountin*g. Sheffield: Greenleaf Publishing.

Bennett, M., Rikhardsson, P.M and Schaltegger, S. (eds.) (2003), *Environmental Management Accounting – Purpose and Progress*. Dordrecht/Boston/London: Kluwer Academic Publishers.

Bouma, J.J. and van der Veen, M. (2002), Wanted: A Theory for Environmental Management Accounting. In Bennett, M., Bouma, J.J. and Wolters, T. (eds.) *Environmental Management Accounting: Informational and Institutional Developments*. Dordrecht/Boston/London: Kluwer Academic Publishers, pp. 279-290.

Bouma, J.J. and Wolters, T. (1998), *Management Accounting and Environmental Management: A Survey among 84 European Companies*, Zoetermeer: EIM and Erasmus University.

Boone, C. and Howes, H. (1996), Accounting for the Environment. *CMA Magazine*, June.

Burritt, R.L. (1997), Corporate Environmental Performance Indicators: Cost Allocation — Boon or Bane? *Greener Management International*, 17, (Spring): 89-100.

Burritt, R.L. and Cummings, L. (2002), Accounting for Biological Assets – The Experience of an Australian Conservation Company'. *Asian Review of Accounting* 10 (2): 17-42.

Burritt, R.L., Hahn, T. and Schaltegger, S. (2002), Towards a Comprehensive Framework for Environmental Management Accounting – Links Between Business Actors and EMA Tools, *Australian Accounting Review* 12 (2): 39-50.

Burritt, R.L., Schaltegger, S., Kokubu, K. and Wagner, M. (2003), Environmental Management Accounting for Staff Appraisal: Evidence from Australia, Germany and Japan. In: Bennett, M., Rikhardsson, P.M. and Schaltegger, S. (eds.) *Environmental Management Accounting – Purpose and Progress*. Dordrecht/Boston/London: Kluwer Academic Publishers, pp. 151-188.

Chambers, N. and Lewis, K. (2001), *Ecological Footprint Analysis: Towards a Sustainability Indicator for Business*. London: Certified Accountants Educational Trust.

Chambers, R. (1986), *Financial Management*. Sydney, Australia: The Law Book Company.

Deegan, C. (2002), Introduction. The Legitimising Effect of Social and Environmental Disclosures – a Theoretical Foundation. *Accounting, Auditing and Accountability Journal,* 15 (39): 282-311.

Ditz, D., Ranganathan, J. and Banks, R.D. (1995), *Green Ledgers: Case Studies in Corporate Environmental Accounting*. Washington, DC: World Resources Institute.

EC (2001) *Green Paper on Integrated Product Policy*. Brussels: Commission of the European Communities. COM(2001)68 final.

Eco-effizienz (2002), *Why material reporting?* Eco-effizienz Newsletter 05-02.

ECOMAC, (1996), *Synreport: Eco-Management Accounting as a Tool of Environmental Management (the Ecomac project)*, EIM Small Business Research and Consultancy, http://www.eim.nl/uk/nl/ecomac.html.

EEA (1999), *Making Sustainability Accountable: Eco-Efficiency, Resource Productivity and Innovation*. Topic report. European Environment Agency. No 11/1999.

Epstein, M.J. (1996), *Measuring Corporate Environmental performance. Best Practices for Costing and Managing and Effective Environmental Strategy*, Chicago: Irwin Professional Publishing.

Gago, S. (2002), Management Information for Ecologically-Oriented Decision-Making. A Case Study of the Introduction of Co-Generation in Eleven Spanish Companies, *Accounting Forum* 26 (2): 191-218.

GEMI (1994), *Finding Cost-Effective Pollution Prevention Initiatives: Incorporating Environmental Costs into Business decision making. A Primer.* Washington DC: Global Environmental Management Initiative.

Graff, R.G., Reiskin, E.D. White, A.L. and Bidwell, K. (1998), *Snapshots of Environmental Cost Accounting. A Report to: US EPA Environmental Accounting Project*, May. Boston: Tellus Institute.

Gray, R.H. (2001), *Environmental Accounting: Setting the Scene Advances in Environmental Accounting*, Proceedings of the ACCA/Environment Agency Seminar, May, pp. 9-16.

Gray, R. (2002), Of Messiness, Systems and Sustainability: Towards a more Social and Environmental Finance and Accounting, *British Accounting Review*, 34: 357-386.

Gray, R.H. and Bebbington, J. (2001), *Accounting for the Environment*, 2nd ed. London: Sage Publications.

Gray, R.H., Bebbington, J. and Wolters, D. (1993), *Accounting for the Environment*, London: Chapman Publishing.

Gray, R., Owen, D. and Adams, C. (1996), *Accounting and Accountability. Changes and Challenges in Corporate Social and Environmental Reporting*, London: Prentice-Hall.

Hamner, B. and Stinson, C.H. (1995), Managerial Accounting and Environmental Compliance Costs. *Journal of Cost Management*. (Summer): 4-10.

Hansen, D.R and Mowen, M.M. (2003), *Management Accounting*, 6th ed. Mason, OH: South-Western.

Haveman, M. and Foecke, T. (1998), Applying Environmental Accounting to Electroplating Operations. An in depth analysis. In: Bennett, M. and James. P. (eds.) *The Green Bottom Line: Current Practice and Future Trends in Environmental Management Accounting*. Sheffield: Greenleaf Publishing, pp. 212-236.

Horngren, C.T., Foster, G. and Datar, S.M. (1997), *Cost Accounting – A Managerial Emphasis*, 9th ed. New Jersey: Prentice Hall.

Horngren, C., Datar S.M. and Foster, G. (2003), *Cost Accounting: A Managerial Emphasis,* 11th ed., Upper Saddle River, NJ: Pearson Education.

Howes, J. (2002), *Environmental Cost Accounting. An Introduction and Practical Guide*. London: Chartered Institute of Management Accountants.

IFAC (1998), *Environmental Management in Organizations. The Role of Management Accounting,* Financial and Management Accounting Committee, International Federation of Accountants, Study #6, New York, March.

International Material Data System (IMDS) (2003), http://www.freund-dirks.de/imds/eng/startimds.html accessed on 28 November 2003.

Johnson, H. and Kaplan, R. (1987), *Relevance Lost: The Rise and Fall of Management Accounting*, Cambridge, MA: Harvard Business School Press.

Kaplan, R.S. (1984), The Evolution of Management accounting, *The Accounting Review*, LIX (3): 390-418.

Kaplan, R.S. and Norton, D.P. (1992), The Balanced Scorecard – Measures that Drive Performance, *Harvard Business Review* (January-February): 71-79.

Kaplan, R.S. and Norton, D.P. (1993), Putting the Balanced Scorecard to Work, *Harvard Business Review* (September-October): 134-147.

Kaplan, R.S. and Norton, D. (1996a), *The Balanced Scorecard,* Cambridge, MA: Harvard Business School Press.

Kaplan, R.S. and Norton, D.P. (1996b), *The Balanced Scorecard – Translating Strategy into Action*, Boston, MA: Harvard Business School Press.

Kokubu, K. and Nakajima, M. (2003), The Position of Material Flow Cost Accounting in Environmental Management Accounting, *Kaikei* 2 (164): 123-136, (in Japanese).

Kreuze, J.G. and Newell, G.E. (1994), ABC and Life Cycle Costing for Environmental Expenditures. *Management Accounting*, (February): 38-42.

Lee, B.-W., Jung, S.-E. and Chun, Y.-O. (2002), Environmental Accounting in Korea: Cases and Policy Recommendations. In: Bennett, M., Bouma, J.J. and Wolters, T. (eds.) *Environmental Manage-ment Accounting: Informational and Institutional Developments*. Dordrecht/Boston/London: Kluwer Academic Publishers, pp. 175-186.

Li, L. (2001), Encouraging Environmental Accounting: A Survey of Government Policies and Instruments. *Corporate Environmental Strategy* 8 (1): 55-64.

Lippmann, S. (2001), Supply Chain Environmental Management. *Environmental Quality Management* 11 (2): 11-14.

Mathews, M.R. (1997), Twenty-five Years of Social and Environmental Accounting Research: Is there a Silver Jubilee to Celebrate? *Accounting Auditing and Accountability Journal,* 10(4): 481-531.

Mathews, M.R. (2003), *A History of Social and Environmental Accounting Through the Research Literature*, paper presented at the Accounting and Finance Association of Australia and New Zealand Annual Conference, Brisbane, Australia, July.

Mathews, M.R. and Lockhart, J.A. (2001), *The Use of an Environmental Equity Account to Internalise Externalities*. RP0104. Birmingham, UK: Aston Business School Research Institute.

McDaniel, J.S. (2000), *The Lean and Green Supply Chain: A Practical Guide for Material Managers and Supply Chain Managers to Reduce Costs and Improve Environmental Performance*, EPA 742-R-00-001 US EPA Washington, DC.

METI (2002), *Environmental Management Accounting Tools Workbook*, Ministry of Economy, Trade and Industry, Japan.

Miakisz, J. (1992), *Developing a Composite Index for Measuring and Communicating Environmental Performance*. GEMI Conference Proceedings on Corporate Quality/ Environmental Management II, pp.189-193.

Osborn, D., Savage, D., Reyes, M.F. and Muradyan, T. (2002), *Images of Effectiveness, Equity and Efficiency in the Diffusion of Environmental Management Accounting*. Green Measures: Hawker, Australia: Green Measures, pp. 56.

Otley, D.T, (2001), Extending the Boundaries of Management Accounting Research: Developing Systems for Management Performance, *British Accounting Review* 33: 243-261.

Parker, L. (2000), *Environmental Costing. An Exploratory Examination,* Australian Society of Certified Practising Accountants, Melbourne, February.

Pierce, B. (2001), Management Accounting Without Accountants, *Accountancy Ireland* 33(3).

PwC (2002), End of Life Vehicle Directive, *PricewaterhouseCoopers*, September, 1-14.

Schaltegger, S. (1996), *Corporate Environmental Accounting*, London: John Wiley, with contribution by K. Müller and H. Hindrichsen.

Schaltegger, S. and Burritt, R.L. (2000), *Contemporary Environmental Accounting — Issues, Concepts and Practice*, Sheffield, UK: Greenleaf Publishing.

Schaltegger, S. and Muller, K. (1998), Calculating the True Profitability of Pollution Prevention. In: Bennett, M. and James, P. (eds.) *The Green Bottom Line: Current Practice and Future Trends in Environmental Management Accounting*. Sheffield: Greenleaf Publishing, pp. 86-100.

Schaltegger, S., Hahn, T. and Burritt, R.L, (2002), EMA: Links to Management Systems and Stakeholders' Part II. In: *Environmental Management Accounting, Policies and Linkages*. New York: United Nations, pp. 87-274.

Shank, J.K. and Govindarajan, V. (1992), Strategic Cost Analysis of Technological Investments. *Sloan Management Review* (Fall): 39-51.

Solomons, D. (1965), *Divisional Performance. Measurement and Control*. Homewood, IL: Richard D. Irwin.

Stone, D. (1995), No Longer at the End of the Pipe, but still a Long Way from Sustainability: A Look at Management Accounting for the Environment and Sustainable Development in the United States. *Accounting Forum* 19 (2/3): 95-110.

Stroebel, S. and Redman, C. (2002), Flow Cost Accounting, an Accounting Approach Based on the Actual Flow of Materials. In: Bennett, M., Bouma, J.J. and Wolters, T. (eds.) *Environmental Management Accounting: Informational and Institutional Developments*. Dordrecht/ Boston/ London: Kluwer Academic Publishers, pp. 67-82.

Tellus Institute (2003), EMA for supply chain management details of a current project at http://www.tellus.org/b&s/EMA_sp.html, accessed 28 November 2003.

Thomas, A. (1974), *The Allocation Problem. Part II. Studies in Accounting Research*. Sarasota, FL: American Accounting Association.

UN DSD (2001), *Environmental Management Accounting. Procedures and Principles*. Department of Social and Economic Affairs. New York: United Nations Division for Sustainable Development.

UN DSD (2003), United Nations Division on Sustainable Development. Technology Initiatives at http://www.un.org/esa/sustdev/estema1.htm (accessed on 17 December 2002).

UN DSD (2002), *Proceedings of the United Nations Experts Working Group on Environmental Management Accounting* held in Bristol, UK 13-15 February 2002.

US EPA (1989), *Pollution Prevention Benefits Manual*, Washington DC: United States Environmental Protection Agency.

US EPA (1995), *An Introduction to Environmental Accounting as a Business Tool: Key Concepts and Terms*. Office of Pollution Prevention and Toxics. Washington DC: United States Environmental Protection Agency.

US EPA (1995b), *Incorporating Environmental Costs and Considerations into decision making: Review of Available Tools and Software*, September, Washington DC: United States Environmental Protection Agency.

US EPA (1995c), *Case Studies in Environmental Accounting: Green Accounting at AT&T*. Washington DC: United States Environmental Protection Agency.

US EPA (1996), *Valuing Potential Environmental Liabilities for Managerial decision making: A Review of Available Techniques*. Washington DC: US EPA, December.

US General Accounting Office (1992), *Waste Minimization: Major problems of Data Reliability and Validity Identified*. Washington DC: United States General Accounting Office.

VictoriaEPA (2002) EPA Victoria and eco-footprint (at http://www.epa.vic.gov.au/eco-footprint/default.asp).

Votta, T., Broe, R., Johnson, J.K. and White, A. (1998), Using Environmental Accounting to Green Chemical Supplier Contracts, *Pollution Prevention Review*, Spring, pp. 67-78.

Wackernagel, M. and Rees, W.E. (1996), *Our Ecological Footprint: Reducing Human Impact on the Earth*, New Society, Gabriola Island, BC, Canada.

Whaley, D. and Johnson, J.K. (2001), Optimising the Chemical Supply Chain: the Trend Towards Chemical management Services, EnviroNews: http://www.environews.com/Features/chemical_supply_chain.htm. Accessed 2. July. 2004 New England's Environment, 7 (3).

White, A.L, and Savage, D.E. (1995), Budgeting for Environmental Projects: A Survey, *Management Accounting*, October: 48-54.

Wilmshurst, T and Frost, G. (2001), The Role of Accounting and the Accountant in the Environmental Management System. *Business Strategy and the Environment* 10: 135-147.

Zimmerman, J.L. (1979), The Costs and Benefits of Cost Allocations *The Accounting Review*, (July): 504-521.