PRICEWATERHOUSECOOPERS

Cormack Manufacturing Pty Limited

Environmental Management Accounting
Case Study

June 2002

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Disclaimer

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Executive summary

This report presents the findings of a case study in how to apply Environmental Management Accounting (EMA) to achieve financial and environmental benefits. The subject of the study, Cormack Manufacturing Pty Limited (Cormack), manufactures plastic bottles and caps for the food, health and cosmetic industries. Cormack was keen to understand more about its environmental performance as failure to do so might jeopardise its long-term growth objectives.

In order to demonstrate the application of EMA at different levels of operation, and the various techniques that may be employed, the case study focused on several key areas of the business:

- the manufacturing business unit;
- a key manufacturing process; and
- an individual product.

Changes to the management accounting framework were made after a rigourous process of reviewing and analysing:

- the existing management accounting framework; and
- the significant environmental aspects and impacts of the business.

Only then was it possible to assess the estimated costs and benefits of any changes, and to understand the environmental costs and revenues of the business.

New account codes were created and other changes recommended in the reporting of quantitative and qualitative information. The economic and environmental impacts of the management decisions which flowed from those changes were recorded during a trial.

Cormack's environmental costs relate predominantly to waste, energy and packaging. The new structure separated many costs that were previously hidden within the general ledger, and ensured others, not captured by the accounting system, were brought into consideration.

The new cost and revenue information generated enabled management to identify a number of opportunities to save costs and improve its environmental performance. These included:

At the business unit level

- a reduction in packaging costs of $11,000 and elimination of associated packaging waste at the customer
- improved order forecasting and inventory control, projected to save the business 8% of the total manufacturing profit in reduced stock

obsolescence costs and 7% of the total manufacturing profit in reduced stock holding costs

- investment in a new, energy-efficient air compressor. While more expensive and initially unattractive, it is expected to result in cost savings of $50,000 and reduced CO_2 emissions of 773 tonnes over the life of the unit.

At the process level
An analysis was performed of two mutually exclusive methods of performing a key manufacturing process. The analysis identified significant and unexpected waste costs, and differences between the two processes in economic and environmental performance. This demonstrated the application of EMA at the process level, improving decision-making and integrating environmental performance considerations.

At the product level
The application of EMA at a product level showed that costs of waste are not currently being accounted for in determining standard costs. Incorporating the environmental costs at this level has implications for pricing, production mix and volume decisions and has direct impacts on margins.

Based on extrapolation of results for the trial period, initiatives already identified requiring a one-off investment of $37,000, will:

- save the business $41,400 per year over 15 years
- reduce their CO_2 emissions by 90 tonnes per year over 15 years

Going forward, the data provided by the new framework will ensure improved and more informed decision-making. Already a number of other potential strategies have been identified for consideration, once the data is available, to save costs and reduce CO_2 and waste emissions further.

The case study concludes that:

- organisations can tailor their own definition of what constitutes an environmental cost
- some environmental costs and benefits may be hard to identify. EMA can help separate hidden environmental costs and benefits and encourages consideration of those not captured by the accounting system
- EMA may be applied incrementally, in many cases using existing systems of data collection and accounting
- EMA can be employed at different levels, from the whole organisation down to the individual product
- each business will apply EMA differently according to their unique requirements. However, the focus should remain on key environmental performance priorities.

Cormack has found the case study to be very beneficial to its business and the outcomes have more than justified the investment in resources. The application of EMA has provided cost and revenue information on key areas of environmental performance. Improved capital and operational decision-making, for both the business and the environment, is the result.

Glossary

COGS is an acronym used for Cost of Goods Sold in this report.

Contingent costs are environmental costs that are not certain to occur – they depend on future events.

Direct costs are costs that are clearly and exclusively associated with a product or service and are treated as such in accounting systems.

Environmental aspect is the result of an activity, product or service that can interact with the environment.

Environmental impact is any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's activities, product or services.

Environmental liabilities is an umbrella term for different types of environmental costs, including costs for remediating existing contamination, costs of complying with new regulations, future environmental costs of current operations.

Externalities or **external costs** are the costs of an organisation's impact on the environment and society for which it is not currently financially responsible.

FG is an acronym used for finished goods in this report.

Full cost is the total cost of production, including direct and indirect costs. Unlike some other definitions it does not include external costs to society and the environment.

Hidden environmental costs are the results of assigning environmental costs to overhead pools or of overlooking future and contingent costs.

Hot runner and cold runner process refers to the mechanism in a plastic injection moulding machine for injecting the liquid plastic into the mould. In a hot runner mechanism, the plastic is molten in the flow channels between the moulds. In a cold runner mechanism, plastic freezes in the flow channels each time a batch of (six) products is moulded. This 'runner' waste must be separated, and in most cases can be reground and reused as raw material. Moulding machines can be converted to one mechanism or the other but at significant expense. Most of Cormack's products can be made using either a hot runner or a cold runner mechanism.

MP is an abbreviation for the manufacturing business unit profit. Confidential amounts in this report have been expressed as a % of this quantity.

Materials refers to raw materials of polypropylene, polystyrene and polyethylene.

Obsolete stock is stock of raw materials and finished goods that are reduced in value. Obsolescence occurs where product lines are discontinued or where demand is overstated and the stock expires before use or sale.

Recycled packaging is packaging sent for recycling after initial use. It is not re-used.

Recycled waste is waste from any source that is sold for recycling.

Re-grinding refers to the re-use of moulding waste in place of raw materials. In most cases, waste from moulding machines can be ground up on site and re-deposited in the machine in place of raw material. Special re-grinding machines are employed next to all moulding machines.

Returnable packaging is packaging that is returned by the customer and re-used in its existing form.

Re-used waste is waste that is re-used in the business in some form.

SEDA acronym for Sustainable Energy Development Authority, a NSW Government Agency.

The Packaging Covenant is a voluntary initiative designed to encourage organisations to identify strategies to reduce packaging waste. To join, organisations must develop and submit a plan for approval on how packaging will be reduced. Organisations who are not signatories to the Packaging Covenant will be subject to forthcoming regulations.

Waste from the moulding process is fairly homogenous, being different grades of polystyrene, polyethylene or polypropylene. It is either surplus raw material or rejected finished goods. All references to waste in the report refer to moulding waste unless otherwise stated.

Contents

1. Introduction

About the case study

This case study was conducted to explore the available techniques for Environmental Management Accounting (EMA) and develop a simple, repeatable methodology. The aim of EMA is to provide business managers with the information they require to facilitate operational and capital decisions which save costs, identify potential revenue opportunities and improve environmental performance.

Undertaking the study

The case study was undertaken over a period of nine months, involving the following approximate stages:

1. four months of preparation and understanding the business, involving discussions with management, investigation of the management accounts and identification of the environmental aspects and impacts of the business. This is documented in sections 2 and 3;
2. a further four months of trialling, involving testing, collection of data, and regular feedback and discussion meetings with management; and
3. one month analysing the data, interpreting results and agreeing actions, documented in section 4.

Focus of the case study

The study was undertaken for the manufacturing business unit. This business unit was selected because:

- management believed this was where the majority of environmental costs were being incurred and therefore where the greatest benefit would be achieved; and
- within the existing management accounting structure, the cost data was already available and being presented.

Other parts of the business were not considered in the study.

Limitations of the case study

Because of the size and nature of its operations, Cormack was able to make only limited resources available for the trial. As a result, the amount of testing we could undertake was limited. For the same reason, it was not possible to run a duplicate management accounting system to compare results. Individual results were therefore estimated and extrapolated.

To keep the analysis of the data simple, we did not consider tax implications or discount cashflows in our financial models.

Environmental costs

There is no standard definition of environmental costs. In this study, we defined environmental costs as "costs relating to the environmental aspects of the business". The environmental aspects of the manufacturing division are set out in Appendix A.

Other costs not normally embraced as environmental costs, such as materials and energy within finished goods, were also considered for management costing purposes.

Classification of environmental costs

The US EPA *Pollution Prevention Benefits Manual* (October 1989) presents a useful method for classifying environmental costs. Costs are classified into five tiers, as shown below:

Tier 0	Direct costs associated with capital expenditures, raw materials, other operating and maintenance costs, etc
Tier 1	Hidden regulatory costs from activities such as monitoring and reporting
Tier 2	Contingent liabilities arising from remediation of contaminated sites, fines and penalties for non-compliance, etc
Tier 3	Less tangible costs and benefits from consumer perceptions, employee and community relations, risk avoidance, etc
Tier 4	External costs to the environment, eg depletion of natural resources, reduced air quality

We have used this classification system in this report as it helps explain how and why different types of costs need to be considered in different ways in a management accounting framework.

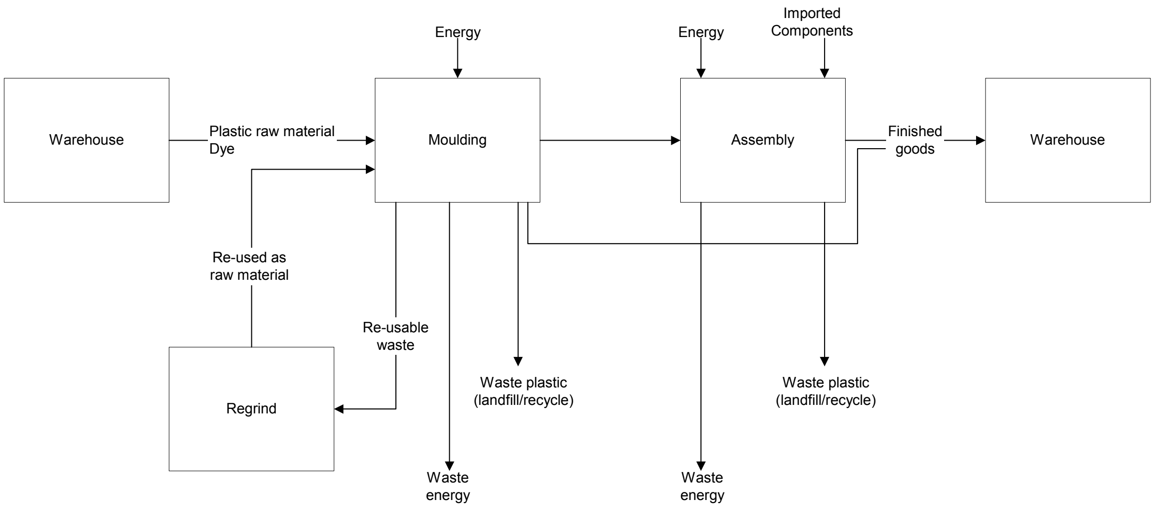
2. Cormack Manufacturing Pty Limited

Cormack Manufacturing Pty Limited is a plastic injection moulding business based in Western Sydney, New South Wales. They manufacture and assemble a range of polypropylene, polystyrene and polyethylene plastic caps and tops for the cosmetic, food, sports and pharmaceutical industries.

The business has a turnover of approaching $40 million and employs 90 staff. It is well run and controlled. Staff have continuously sought operational improvements and refinements; they recycle almost all waste and operate effective housekeeping and maintenance services around the workplace. The manufacturing process is certified to quality standard ISO 9002.

The manufacturing business unit undertakes two main processes: plastic injection moulding and assembly. The materials flow for the manufacturing business unit is shown in figure 1. The waste produced by these two processes is fairly homogenous, consisting of different grades of polypropylene, polystyrene and polyethylene (as there are little or no additives other than dye). Most of this is collected and ground up and can be re-used as raw material (re-grinding). There are no toxic chemicals used, no hazardous wastes generated, and limited environmental compliance requirements.

Figure 1: Materials flow in the manufacturing business unit



To the extent it is undertaken, environmental management is the shared responsibility of the quality manager and the chief engineer. There is no separate environmental management system.

Incentives to use EMA

Cormack's management believes that failure to consider its environmental performance will jeopardise long-term growth for the business.

In particular the following are issues for Cormack:

- focus by customers on the environmental performance of their suppliers, including Cormack;
- savings which could be generated by reducing/re-using waste;
- impact of becoming a voluntary signatory to the Packaging Covenant; and
- corporate goal to be a responsible corporate citizen.

Dealing with each of these requires Cormack to understand its environmental impact and make informed business decisions to achieve its sustainable growth goals.

The following section details how EMA was implemented at Cormack.

3. Implementing EMA

Implementation of environmental management accounting will ultimately result in changes to the existing management accounts to better show cost information. This may consist of a few simple changes within the existing framework or involve a full restructuring of cost centres and account codes.

Making changes to management accounting procedures will incur costs in:

- implementing the system changes, educating staff and initial inefficiencies; and
- collecting additional data and integrating it in the revised management accounting system.

These costs must be weighed against the anticipated benefits which would be yielded by more informed decision-making. The benefits may be economic, improved environmental performance, or both.

Before any changes were made to Cormack's management accounts, it was necessary to understand:

- the existing management accounting systems and procedures for the selected aspect of the business;
- the 'significant' environmental aspects of the business; and
- the increased revenue and/or reduced cost opportunities that are not captured by the existing accounting system.

Only then was it possible to assess the estimated costs and benefit of any changes, and to understand the environmental costs of the business (as defined) and how they are currently treated within the accounting system.

Management accounting in the manufacturing business unit

An understanding of the management accounting system and procedures was achieved by interviews with finance staff and analysis of the management accounts.

The management accounting system is segregated into:

- Manufacturing Business Unit (MBU)
- Sales and Administration Business Unit (SAU).

Both business units are then combined in the consolidated accounts (CA). For recording and reporting purposes the MBU (on which this case study is based) is a cost centre only. The costs in the MBU are absorbed into the CA COGS account on a standard cost per machine hour basis every month.

Table 1 presents a brief description of the costs recorded in the MBU.

Table 1: Cost centres of the Manufacturing Business Unit (MBU) and allocation of costs

MBU cost centre	**Description of allocated costs**
Product cost centres:	
- Pumps - Child resistant assembly - Sports closures - Twist closures - General	The only costs allocated to the product cost centres are labour and overhead costs (eg depreciation, light & power, engineering) relating to manufacturing. Labour costs are allocated to these cost centres when they are incurred using timesheet records. Overhead costs are allocated to these cost centres by predetermined journals. The journals have been determined at some prior date, based on management estimations of where the overhead costs are incurred. The costs are subsequently recharged or absorbed out of the cost centres into the CA COGS using a standard cost per machine hour of production. Waste costs are not separately accounted for and captured in overhead allocations.
Administration cost centres:	
- Finance admin - Manufacturing engineering - Manufacturing tooling - Admin manufacturing - Packaging warehouse	Factory administration expenses. These costs are allocated directly to the cost centre where they are incurred. They are also then recharged into the CA based on standard cost per machine hour of production.
CA consolidated	**Description of allocated costs**
	All direct product costs (materials, packaging, labels etc) are coded directly to the CA (and therefore do not hit the MBU product cost centres). The COGS is a one-line account (in the consolidated accounts) which incorporates all direct product costs and recharged MBU labour and overhead costs. There is no allocation by type of cost (eg materials, labour etc) or by product type (ie there are no product profit centres). All other non-manufacturing overheads (labour, communications, travel etc) are allocated directly to the CA.

The management accounting, done by Cormack's while functional, is imprecise. The allocations of some overheads between cost centres is based on assumed cost allocations, and there is no breakdown information on the cost of goods sold. Consequently, the detailed accounts are limited to reference use.

Senior management tends to use only the summary management accounts. These are produced every month from data in the detailed management accounts. Additional quantitative and qualitative information is included, covering, for example, debtors recoverability, inventory, sales, and KPIs such as debtor days. The summary accounts only show limited detailed information on costs. Costs are accumulated into categories; for example "Salaries & Wages", "Facilities Costs", "Repairs and Maintenance" and "Cost of Goods Sold".

Although other reports are used in conjunction with the management accounts, no additional cost information is readily available. There is limited data on product costs to make strategic decisions on price (driven by the market), product mix and volumes. The current structure provides no information on environmental costs, and middle management in particular has no information on the environmental aspects and impacts of the business activities.

Performing an environmental review and assessing changes

An environmental review and assessment was used to identify the significant environmental aspects and impacts of the business and the potential revenue and/or reduced cost opportunities that may not be captured by the existing accounting system. Although driven by PricewaterhouseCoopers, Cormack management were involved throughout, providing the necessary information and experience and ultimately making the decisions.
Our environmental review and assessment consisted of the following steps. The outcome of each step is set out in Appendix A unless otherwise stated.

Stage	Appendix A ref
1. Identification of key business operations	Column 1
2. Identification of the activities within each operation that has an environmental aspect	Column 2
3. Identification of the environmental aspects	Column 3
4. Identification of the environmental impacts	Column 4
5. Establishment of criteria for assessing the significance of the environmental impact. "Significance" is based on management judgement. The criteria established for assessment were:	
– the size of the environmental impact	Column 5
– the size or potential size of the financial impact to the business	Column 6/7
– the potential, future or intangible environmental impacts or financial costs	Column 8
– the risk of potential costs (using a quantitative matrix as per AS/NZS 4360)	Not supplied

Stage		Appendix A ref
6.	Each impact was then assessed against these criteria to determine its significance, and whether new account codes for cost and revenue data should be created. At this stage, consideration was also given to the following factors:	Column 9
	– is the impact within the boundaries of the business to control? Impacts outside of the business' control were excluded	Column 9
	– the practical feasibility and cost implications of collecting the data versus the expected benefit to be achieved from having the information available	Column 9
	– the feasibility of integrating the data within the existing accounting system.	Column 9
	At the time of assessment there were many unknowns where financial and environmental data was not available. In these instances, management judgement was used.	
7.	Based on the assessment of each impact against the criteria, a decision was made on whether to create a new account code	Column 10
8.	New account codes were then determined.	Column 11

Implementing the changes

Cormack decided to implement changes to the management accounts in two stages. Initially, Cormack agreed to implement the new account codes that could be accommodated within the existing accounting system. Information was collected for each of these new account codes during a trial period. The outcomes of this trial are detailed in Section 4.

More complex changes, requiring some restructuring of the management accounts to implement the remaining account codes, are to be made at a later date in Stage 2. These new account codes were not therefore subject to the trial.

Table 2 lists the environmental costs and revenues relevant to the new account codes (identified in Appendix A) created in stage 1, how these costs are currently treated within the accounting system, and the new accounting treatments proposed. This is shown diagrammatically in figure 2. Each current and proposed cost treatment is classified in accordance with the structure set out in Table 1.

In the case study, Tier 0 and Tier 1 costs are those recorded in the general ledger and within the control of the business. Many of these, for example costs relating to waste, were readily recognisable. Others are hidden and dispersed throughout the accounts; these costs, while not on the face of it environmental costs, become relevant due to their association with environmental aspects. Examples include the depreciation of specific machinery, indirect labour and maintenance.

Tiers 2 & 3 costs (contingent and intangible) were considered subjectively, but not quantified. Tier 4 costs (externalities) were not included. This reflects the current limitations of accounting systems in only recording financial costs which have been incurred.

Table 2: Cormack's environmental costs and their current and revised accounting treatment

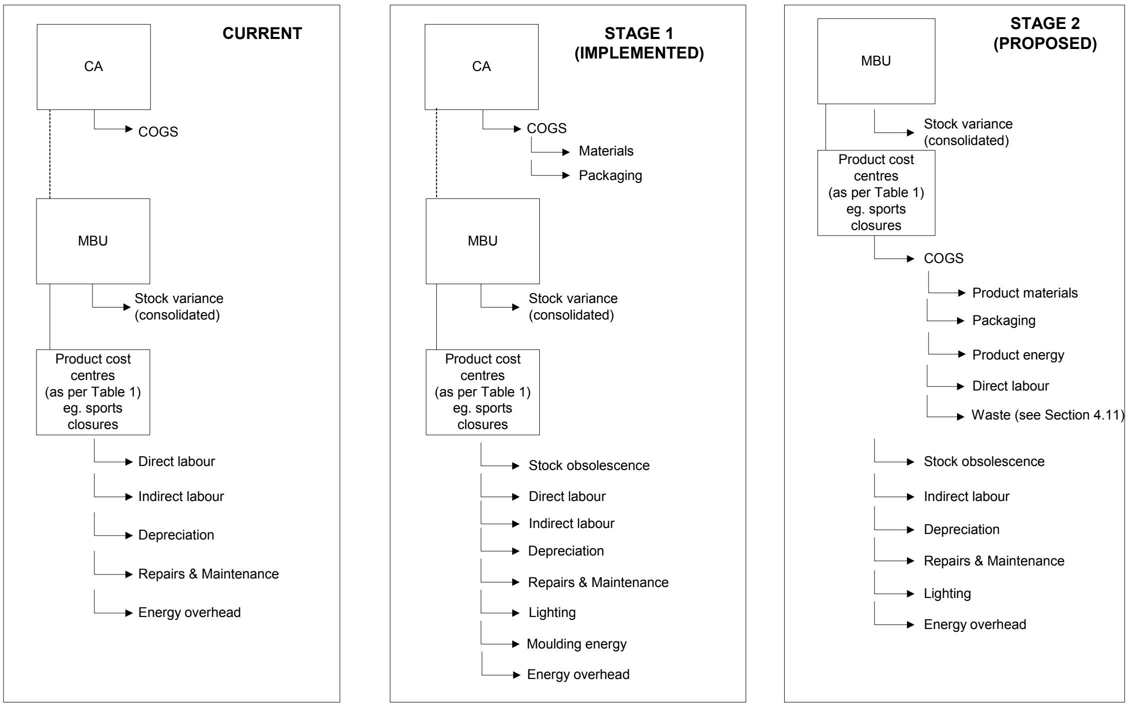
Relevant costs	Current accounting treatment	Revised treatment: stage 1
Tier 0:		
'Materials' 'Packaging'	Packaging and materials costs are hidden within COGS in the CA.	New account codes for "Materials" and "Packaging" to be created within COGS in the CA.
'Light and Power'	One account for each product cost centre is maintained in the MBU for all energy costs (lighting, machinery, office equipment etc). The allocation of costs between the product cost centres is fairly arbitrary, based on assumed management estimations of energy usage.	To be separated out into new account codes "Lighting" and "Moulding energy" for each product cost centre within the MBU. This will improve understanding of how the costs are generated. The remainder will remain in the "Energy overhead" account. The allocation basis between product cost centres will be updated and based on actual readings taken during the trial, replacing the previous management estimation basis.
'Stock variance'	All stock losses are accumulated in the MBU at a consolidated level. These include obsolete stock, spills, wastage on the production lines and misappropriation. There is no allocation between product cost centres.	"Obsolete stock" costs to be separated into a new MBU account code with costs allocated across the product cost centres. The remainder will stay within Stock variance account for the time being.
Tier 1:		
'Direct labour' 'Depreciation' 'External repairs and maintenance'	Separate account codes in the MBU already. Costs are allocated directly to product cost centres to which they relate.	No change requested. Current accounts and the bases of allocation appear reasonable.
'Waste'	No cost data recorded. The materials cost of waste is hidden within the Stock variance account in the MBU, as noted above. Energy and labour costs of waste are hidden in the energy and salaries accounts respectively in the MBU.	The weight of plastic waste produced (by product category) by the moulding and assembly operations is to be set-up as a KPI in summary management accounts. Although not separating the costs of waste at this stage, this KPI at least provides management with a measure for monitoring and controlling waste, and identifying where and why it is generated. Waste costs (including raw materials, labour, energy etc) will be separated out in the future; this is discussed in section 4.11.
'Compliance'	Minimal environmental compliance costs.	No change requested.
Tiers 2, 3 and 4	Not being captured by the accounting system.	Quantitative and qualitative data to be included in the summary management accounts and brought into decision making.

Implementing changes to Cormack's environmental costs - Proposed stage 2

Cormack has taken the decision to further restructure its detailed management accounts from 1 July 2002. In stage 2, the "Product materials" and "Product energy" account codes will be created. Direct materials costs (materials and packaging) will in future be recorded in the MBU, in separate accounts within a new MBU COGS (figure 2). The "Waste" account code will also be created in stage 2. This is discussed in section 4.11.

The existing product cost centres (by product type) will remain, but each will now show the full costs of production. The result will be clear and comprehensive cost profiles by product type within the existing management accounting framework. Although the costs shown will be at a generic product level, this will provide a useful starting point for understanding product costing (discussed in section 4.9).

Figure 2: The management accounting framework and treatment of environmental costs



4. The trial and outcomes

During the trial, data was collected to enable costs to be allocated to the new (Stage 1) account codes. Detailed monitoring of materials, labour and energy consumption was undertaken on a representative sample of moulding machines, to enable the management accountant to identify what the true costs were and where they were being incurred. In the case of packaging and stock variances costs, analysis of the financial data was sufficient to understand them and no physical monitoring was required.

Table 3 shows how the results of the trial have been used to better allocate costs within the management accounts, for the period 1 July 2001 to 30 June 2002 for each of the selected account codes. The final column (Management Response) references the various initiatives undertaken as part of the trial and being implemented by management as a result of improved cost information shown in column three (Revised %MP).

Table 3: Results of the trial under previous and revised management accounting

Account codes	Previous (%MP)	Revised (%MP)	Management response
Materials	Not known. Included in COGS.	485%	4.1, 4.2, 4.3
Stock variance	130%	110%	4.5
Obsolete stock	Not known. Included in stock variance account	20%	4.4
Packaging	Not known. Included in COGS.	48%	4.6
Moulding machine energy	Not known. Included in energy overhead account	36%	4.1, 4.2, 4.3, 4.7
Lighting	Not known. Included in energy overhead account	7%	4.8
Energy overhead	55%	12%	4.9
Waste	Not known	KPI in summary management accounts	4.1, 4.2, 4.3, 4.4, 4.5, 4.11
Compliance (Tiers 2 & 3)	Not known	Considered as part of a risk assessment	4.10

All figures expressed as % of manufacturing profit (%MP)

4.1 The hot runner versus cold runner process and associated environmental costs

This process was selected to demonstrate EMA at a process level. As one of the key processes, it is representative and takes in all the significant environmental aspects of plastic injection moulding identified in Appendix A.

Most of Cormack's products can be made using either a hot runner or cold runner mechanism within the moulding machines (all products are made using one or the other). The two methods generate different quantities of waste, and require different amounts of energy and labour. Management has little information on which is the most cost effective, or has the greatest environmental costs associated with it. Analysis would enable management to identify performance improvements at a process level.

Table 4 shows the estimated cost and environmental cost of moulding the same product using hot and cold runner moulds respectively. The costs have been grossed up to the annual production volume. The machines used in the trial were comparable (energy efficiency, depreciation, maintenance, labour etc) except for the hot and cold runner mechanisms.

Table 4: Comparison of the costs of using the hot and cold runner moulding process for a given product, based on machine production for one year

	Hot runner		Cold runner	
	Estimated cost ($)	**Waste cost ($)**	**Estimated cost ($)**	**Waste cost ($)**
Materials (in FG)	95,868	-	95,868	-
Energy (in FG)	2,899	-	3,049	-
Materials (in waste)	13,221	13,221	11,508	11,508
Labour (in waste)	2,216	2,216	6,216	6,216
Energy (in waste)	150	150	132	132
Total	114,354	15,587	116,773	17,856
		13.6%		15.3%

The different mechanisms of the two processes resulted in varying costs. The additional waste generated by the cold runner process during production resulted in a higher labour waste cost for sorting and processing the waste. For the hot runner, the large amount of unrecyclable waste generated during colour changes and purges, not necessary for a cold runner mechanism, resulted in a higher materials waste costs

This analysis showed that:

- the environmental costs of waste are far higher and more significant, at 13.6% and 15.3%, than management expected
- the hot runner method is slightly cheaper than the cold runner method, and has lower environmental costs. However quantification of the environmental impact of each method for the same period shows that other considerations may need to be taken into account in making any decision:

Table 5: Comparison of the environmental impacts of using the hot and cold runner moulding process for a given product, based on machine production for one year

	Hot runner	Cold runner
Waste sent to landfill	1,844kg	1,605kg
CO_2 emissions from production	47 tonnes	49 tonnes

A decision to use exclusively hot runners or cold runners has not yet been taken. The financial costs are comparable, but there are differences in the associated environmental impacts. Cormack is currently considering several ways to minimise the waste generation of each process.

4.2 Product costing and incorporating environmental costs

Product costing and margin analysis drives product pricing, production mix and volume decision-making. However, a review of the current management accounting identified that there is limited product cost information for decision-making. Standard costs have been determined, but are based on management estimations.

A specific product was selected during the trial to help understand:

- how environmental costs, particularly waste costs, are treated at a product level
- the appropriateness of the current standard cost of the product.

The product selected was unique at Cormack in that it was a simple, one-component product produced by one specific machine. This made collation and analysis of the data simple. The machine was also known to generate substantial waste.

Table 6: Standard direct costs and revised standard direct costs of production for a given product

	Current standard cost ($)*	Revised standard cost ($)*
Materials (in FG)	387,000	387,000
Labour (in FG)	95,300	60,000
Moulding energy (in FG)	14,700	7,000
Materials (in waste)	0	10,200
Labour (in waste)	0	5,800
Moulding Energy (in waste)	0	100
Total	497.000	470,100
Profit margin (including an allocation of other overheads**)	22.55%	23.79%

* based on annual production for FY02

** the other elements of standard cost relating to fixed overhead were not reviewed

The analysis showed that:

- existing standard costing for this product is imprecise
- the revised margin was 1.3% higher than the standard used in decision-making. Environmental costs account for 0.5% of the profit margin on this product
- this year alone the waste associated with the manufacture of this product cost the business $16,100, before disposal costs.

The inclusion of environmental costs impacts the profit margin being earned on products and the margin used for decision-making may be inaccurate. Failure to account for environmental costs at the product level raises issues of cross-subsidisation. For example, the materials waste costs are currently being hidden in the stock variance account (see section 4.5). Stock variance costs are included in the standard cost of products as an element of an overhead allocation (not shown in this analysis). The stock variance element of the standard cost allocated to this product is unlikely to equal $10,200 – it will probably be less as this product's production is known to generate significant waste. In other words, another product is being allocated a portion of this product's material waste costs.

Cross-subsidisation means that products with few environmental costs subsidise those with poor environmental performance and high environmental costs. The end result is that management may unknowingly make production decisions to produce more expensive products with higher environmental costs.

Ideally, more products would be analysed to properly identify cross-subsidisation, however this is not always feasible or may be complex. At Cormack, determining accurate individual product costing data is difficult. Within each product category there is a wide range of individual products of different sizes, shapes and colour, produced on different machines and which are sometimes assembled from a combination of manufactured and imported components. Initially at least, the environmental costs may be addressed at the product category level. This is discussed further in section 4.11.

4.3 Cost versus benefit of the re-grinding process

The re-grinding process was identified as worthy of further investigation during the environmental review process (Appendix A). Almost all production waste is re-ground at source for re-use as raw material. No cost information is known about the re-grinding process, but it is assumed to be the most cost-effective means of waste disposal and materials use.

From the cost and revenue data generated during the trial it was possible to analyse this "environmental" process to verify the economic and environmental credentials.

Costs and benefits per year[1]	**$**
Depreciation cost	(1,950)
Energy cost	(131)
Labour cost	(3,087)
Recycling revenue foregone	(3,175)
Raw materials saved	47,628
Net benefit per year:	39,285

In this case, the economic and environmental benefits of re-grinding moulding waste were obvious to management, although unproven. However, this example is a useful demonstration of how to consider the merits of other environmental processes.

4.4 Improved order forecasting to reduce obsolescence

As a result of identifying that obsolescence was costing the business 20% MP, management has reviewed its order forecasting process and significantly improved procedures. The new measures will improve the accuracy of forecasting sales, enabling better workflow scheduling and raw materials management. It is anticipated that this may reduce the current obsolescence

[1] based on the estimated operation of one re-grinder machine during a year

costs by 40% (saving 8% MP per year), and hence also reduce the quantities of waste produced.

Cormack is also paying a significant sum (48% MP) for third party storage. Their own warehouses are insufficient to accommodate all their raw materials and finished goods stock. Preliminary management estimates anticipate a 15% reduction in stock levels and hence a saving of 7% MP by allowing more stocks to be moved back into their own warehouses.

4.5 Improved stock control

As part of the trial, management reviewed the content of the remaining stock variance account. Analysis revealed the primary cause of the variance was losses of materials (as waste) during production which were not being reconciled to the stock holdings.

All waste from the production lines is now being weighed and recorded, and the data used for improved stock control and waste management by separating the materials waste costs from the stock variance account in the management accounts (see section 4.11). From initial estimates it appears this will account for 91% of the remaining stock variance account (100%MP out of 110%MP).

The final element of the stock variance of 10%MP is attributable to spills or misappropriation. Identifying and monitoring costs will enable management to improve control over these losses.

4.6 Reducing packaging costs

Identification and analysis of the packaging expense estimated that packaging to customers was costing the business over 50% MP per year. As a result management initiated a trial in conjunction with a key customer to test the cost effectiveness of returnable packaging on a specific product line. Using the data from this successful trial, and with agreement from the customer, the initiative is to be extended to three other product lines based on the following cost/benefit assessment:

Costs and benefits	$
One-off set-up costs for using returnable cartons: • purchase of new cutting equipment • design and print costs • additional cost of purchasing returnable cartons (compared to non-returnable cartons) Initial net outlay	(7,500)
Cost impacts to the business from using returnable cartons (which can be used 4 times) as compared to using disposable cartons (based on existing order quantities and lead times): • fewer cartons required (reduced purchase costs) • increased cartage (higher collection charges) • increased liner cost (more liners required for smaller cartons) • labour differences are negligible Net benefit per annum	4,790
Net benefit over expected life of returnable cartons:	11,660
Intangible benefits: • industry reputation • customer relationship • meeting obligations under the Packaging Covenant and avoiding future regulation • reduced packaging waste in the supply chain Net intangible benefit	Unquantifiable

Cormack is now looking to extend the initiative to other customers and reduce its packaging expense further. If successful, costs for returnable cartons in the above cost/benefit assessment may come down further with increased economies of scale.

4.7 Energy savings for the air compressor

The energy consumed by air compressors was suspected to be a significant part of the total energy cost of moulding. At the time of the trial, management was in the process of purchasing a new air compressor to cope with increased capacity, but little information was available on energy consumption. An energy-efficient alternative had not been seriously considered as it was perceived to be too costly.

Simple analysis of information generated during the trial showed that investment in the new style energy-efficient air compressors would repay the additional cost over conventional air compressors (the preferred choice) within 5 years. Over the estimated life of 15 years, this would result in an energy saving of $50,000 equivalent to 773 tonnes of CO_2.

Cost	Conventional[2] $	Variable cycle[3] $	Differential (cost)/benefit $
Capital outlay new compressor	(35,000)	(52,500)	(17,500)
Estimated energy cost per year	(14,500)	(10,000)	4,500
Total (cost)/benefit in year 1	(49,500)	(62,500)	(13,000)
Net (cost)/benefit after 15 years	(252,500)	(202,500)	50,000

4.8 Improving the efficiency of lighting

Identification of the lighting cost has provided management with the information they need to assess a number of energy-saving strategies:

Painting the interior factory walls white
Two of the factories currently have dark red brick interior walls. The third, a newer factory, has white. All are of similar size and shape. Comparison of the respective lighting costs during the trial showed how painting the factory would pay for itself within 9 years, as follows:

Costs and benefits	$
Estimated cost to paint the two unpainted factories	(12,000)
Reduced energy consumption per year	$1,400
Payback period	8.6 years

Investment in energy-efficient lighting
A lighting consultant is to be engaged to investigate the economic feasibility of investing in energy-efficient lighting, now that cost data for the existing lighting is known.

4.9 Managing the energy overhead

The original energy overhead cost has now been substantially allocated to lighting and moulding. The remainder relates to assembly operations, ancillary machinery and equipment usage around the offices and factory. This will be managed as follows:

- Cormack has signalled its intention to apply the EMA techniques learnt to the assembly operations. This will identify the energy costs of this process, which may then also be separately accounted for, and subsequently managed for efficiency
- Cormack is considering a full co-generation feasibility assessment for the factories to see if waste heat from the moulding process can be recycled to power ancillary machinery, reducing the overhead energy

[2] From data generated during the trial
[3] Estimated based on manufacturer specifications

cost. Cormack believe there may be a case for investment having now identified the heating costs (fuel, maintenance) and the energy costs of the moulding machines

- For more general office and surrounds energy overheads, Cormack has initiated a process of ongoing review to identify general energy efficiency measures. They intend to approach SEDA to discuss the possibility of joining its business energy-smart program.

4.10 Disaster prevention

Cormack has assessed that an environmental accident would be a significant risk for the organisation due to the potential associated costs. The main impact would be the loss of raw materials (small beads of polypropylene, polystyrene and polyethylene) offsite. Cormack is in the process of installing filters in the stormwater drain and a containment mesh around the southern perimeter of the site which receives the surface run-off.

Costs and benefits	**$**
Estimated (maximum) cost of implementing safety measures	(10,000)
Minimise risk and exposure to: – a potentially significant penalty from regulators – the costs of remediation (collection of raw materials from the river and stormwater drains) – possible loss of operating licence or, at least, increased scrutiny by regulators – possible loss of key customers due to poor environmental performance – damage to reputation with customers, regulators and in industry – bad feeling generated in local community	Not quantified*

* risks may be quantified by sophisticated risk assessment techniques (outside the scope of the study).

The link between the above assessment and the accounting system is tenuous. Tier 3 costs and potential benefits are not captured by an accounting system based on actual costs and revenues incurred. The application of EMA principles has ensured that these factors are considered, at least qualitatively.

4.11 Future changes to the management accounting to account for waste costs

Management intends to introduce a new "Waste" code into the MBU cost centre to record the combined materials, energy and labour costs of waste by product cost centre. This is illustrated in figure 2. The waste code could be split further into waste materials, energy and labour respectively, but this was not considered cost-effective at this stage.

A standard cost of waste per 1,000 units of product will be estimated for each product type (by further trials). For simplicity in accounting, waste costs will be limited to direct costs (materials, energy and direct labour). They should also incorporate elements of overheads such as maintenance, depreciation and indirect labour. At this stage of development of Cormack's EMA, this is considered too complex and unnecessary for current management purposes. These overhead allocations will be considered in the future, once the proposed changes have been successfully implemented.

Applying this standard cost will separate these hidden costs from the overhead accounts: stock variance (materials), overhead energy (energy), and salaries (labour).

For the first time, management will be able to integrate waste data into the management accounts and monitor where waste is being generated. This information will be valuable for controlling waste and for identifying future cost-effective initiatives to reduce or eliminate waste during production. The rules applying to the standard costs of waste are the same as for standard costing, and will be applied in the monthly management accounting. Management will determine the frequency of review based on operational developments and changes. Standard costs will be tested by obtaining actual readings in future trials.

5. Lessons learned

Experience at Cormack and on other similar projects has shown common themes in successful environmental management accounting. These are summarised below.

5.1 Defining environmental costs

It is not always clear what is an environmental cost. Adopting a recognised definition of environmental costs is not critical where EMA is being used as an internal analysis tool, and an organisation may tailor its own definition of environmental costs as appropriate. If environmental costs are reported externally however, the definition will then need to be explained and possibly justified.

Lessons learnt:

- The definition should be agreed upfront and applied consistently.

5.2 Identifying environmental costs

Some environmental cost and revenue opportunities are far harder to identify than others, as they are hidden or not captured by the accounting system. Analysing Cormack's management accounts alone would not have revealed all their environmental costs.

Lessons learnt:

- The simplest way to identify Tier 1 or "hidden" environmental costs is to first identify the significant environmental aspects and impacts that need to be managed, then work back through the accounting system. At Cormack, this facilitated the identification of the production waste, energy and stock obsolescence costs which were dispersed in different accounts.
- Tier 2 and 3 potential and future costs may be identified by considering environmental aspects and impacts during the environmental review. In this study, this highlighted to Cormack that the potential costs of an environmental accident were above their level of risk tolerance. In other cases, it may identify risks that could be managed to create a competitive advantage. Cormack also discovered that they were approaching a statutory production threshold and would be subject to regulation, and future costs, once the threshold had been exceeded.

5.3 Accounting for the different types of costs

Tier 0 & 1 costs
In the case of materials and packaging, the costs and environmental costs could be readily allocated to the cost centers where they were incurred as they are direct and separately identifiable.

In other cases, the way in which costs are incurred is more complex and the effort and expense required to accurately allocate them is prohibitive for the benefit achieved. At Cormack, energy costs are incurred across the business and recording the actual energy usage on an on-going basis would require substantial resources. The existing journal for allocating energy costs across the product cost centres was merely revised as a result of the data generated during the trial, and will be reviewed again in 6 months. This was considered sufficient for current decision-making information purposes.

Tier 2 & 3
It is difficult to see how potential or future Tier 2 and Tier 3 costs and revenues may be integrated into accounting systems (which record only actual costs). This may only happen in practice when these costs become internalised, for example through carbon taxes, fines or landfill levies, or revenues are realised. Management accounting, however, incorporates qualitative as well as quantitative information. Where financial accounting is not possible, these types of costs and benefits may be monitored using KPIs or reported qualitatively. Cormack have introduced the waste KPI into the summary management accounts, until the new waste account code is implemented.

Lessons learnt:

- Direct (Tier 0) and hidden (Tier 1) costs may be more cost-effectively treated using a predetermined journal, where the allocation basis is then subject to regular review.
- There are no rules as to how frequently these allocation journals should be reviewed or tested, but at a minimum they should be considered once a year during the budgeting process.
- Tier 2 & 3 costs and revenues identified in the environmental review should be reported at least qualitatively in the management accounts and incorporated into decision-making.
- Regular environmental reviews and assessments should be made to keep information on Tier 2 & 3 costs up to date. In the current climate of increased environmental awareness and regulation, these types of costs and the benefit opportunities are subject to rapid change. Given their intangible nature, there is a risk that they may otherwise go unnoticed.
- The accounting for the different types of costs and revenues may be developed over time, as more is understood about how costs are incurred or benefits realised and internal systems are developed to

record them. Quantitative or qualitative, the aim is to ensure the relevant costs and benefits that will assist environmental and financial decision-making are brought out in management information.

5.4 Focusing EMA on environmental performance priorities

EMA is a useful technique to address environmental performance. By generating cost and revenue data on waste, energy and packaging, the significant environmental aspects of the business, Cormack was immediately able to find cost-effective ways of minimising its most adverse environmental impacts. The primary focus on environmental aspects and impacts distinguishes EMA from other costing exercises.

Lessons learnt:

- Some knowledge of environmental aspects and impacts will be required to complete an environmental review.
- Many organisations will have already identified their environmental aspects and impacts as part of an EMS (such as ISO 14001).

5.5 Applying EMA at different levels of operations

EMA may be applied at different levels of an organisation. In this study it was used to understand the environmental costs and revenues for the manufacturing "business unit", the hot runner and cold runner "process", and to a specific "product".

Lessons learnt:

- Use the environmental review to identify business units, processes or products of the highest priority. This is how the target areas were identified in this study and where the greatest benefits will be achieved. Agree these target areas up-front.
- If individual product costing is complex, begin at a higher level as appropriate.
- This will require practitioners to have a thorough understanding of the standard costing basis and how standard costs are derived.

5.6 EMA can be implemented in stages

Success is not dependent on identifying and classifying all the environmental costs of the business straight away. EMA may be implemented incrementally, beginning with limited scale and scope.

Cormack intends to apply EMA next to analysing the assembly part of its operations within the manufacturing business unit as this study focused predominantly on moulding. This will separate further costs from the remaining energy overhead and stock variance accounts. It will also improve

Cormack's understanding of waste and product costs for its assembled products, and allow it to fully implement the additional stage 2 changes to the management accounts across the manufacturing business unit.

Similarly, a co-generation assessment was considered to be outside the scope of this study, even though heating and waste heat were identified as significant in the environmental review.

This approach is consistent with a strategy of continual improvement, a key element of any EMS and necessary if businesses are to achieve sustainable long-term growth.

Lessons learnt:

- Consult widely within the organisation, or within the target area, and educate staff. At Cormack this boosted morale and encouraged commitment to the objectives.
- Make someone who understands the business operations responsible for the EMA implementation process. Cormack has recently employed a management cost accountant to develop and project-manage a plan for further implementation of EMA, and to manage the process of continual improvement.
- Limit the scope at first to ensure adequate resources are available to fulfill the objectives.
- Start with what is known or high priority and work towards the more difficult costs and revenues later.

5.7 Introducing EMA into existing management accounting

As every company has a different management accounting system and different environmental aspects and impacts, there is no standard methodology for EMA.

The feasibility and complexity of introducing new account codes will vary between businesses. In Cormack's case this was determined by detailed consideration and review of current systems, and an analysis of the cost versus the expected benefit of having the information available.

- *Lessons learnt:* A thorough understanding of the existing management accounting system framework is required.
- Knowledge of the environmental aspects and impacts of the business and their significance is a critical first step.
- Ensure that the process of obtaining the data and having the resources available to do so is understood before commencing.

5.8 The EMA implementation process is an evolving one

The process of identifying changes to the management accounts and collecting information was an evolving one. The analysis has been simplified for the purposes of demonstration. Some of the initial accounting changes put forward were straightforward to implement. In other cases, it was simply impractical to collect the required information, given physical and resource limitations.

The focus of our trial also changed and evolved as we learnt more about the business and the environmental costs. Initially, for example, we intended to assess both the moulding and assembly processes, before realizing the work involved in analysing the moulding process alone. We then further narrowed the focus to the hot runner cold runner process, which was identified as being particularly representative of the moulding process as a whole.

As a result, at times during the trial the goalposts were moved and the logistics of the trial adapted accordingly, and fed back on our experience.

Lessons learnt:

- Be flexible and prepared to adapt as you gain experience.
- Participation of management in the process is a critical success factor to identifying and resolving issues and making implementation success
- Regular consultation with relevant management and staff should take place throughout the implementation process, rather than just at the start.
- Identify representative products or processes which may be used for extrapolation, gaining the maximum benefit from your limited resources

5.9 Using the existing framework

Creating new environmental cost account codes and allocating costs more accurately increases the complexity in the management accounting. Systems based on actual readings tend to require significantly more resources than do standard allocations. In some cases, concurrent systems of data collection may be required, which must then be integrated into the accounting system. Unless expensive automated systems are developed, this will have to be performed manually.

Lessons learnt:

- Where possible, integrate the environmental cost accounting into the existing structure of the management accounts and use data collection systems already in place. Waste generation data, for example, was already being collected at Cormack. By adding two extra steps to the existing system, the data is now being integrated into the management accounting and will be used to identify waste costs by product type.

6. The benefits of using EMA

The benefits and potential benefits to Cormack of using EMA, as a result of this exercise, can be summarised as follows:

At the business unit level

Identifying and separating the environmental costs for the business unit has already improved capital and operational decision-making and allowed management to identify a number of 'eco-efficient' strategies, as shown by:

- The assessment of the re-grinding process (operational), justifying the investment in the re-grinding machines (capital)
- Improved order forecasting and more efficient stock holding (operational)
- The investment in a new energy efficient air-compressor (capital)
- Savings in packaging waste and purchasing costs by investing in returnable cartons (capital).

At the process level

Although the analysis of the hot and cold runner process was inconclusive in this instance, in other cases one process may be identified as being financially and environmentally favourable. This would guide management in future operational decisions as to whether to use the hot or cold runners, and assess the case for investing in converting all machines to use one process or the other.

At the product level

Application at the product level showed standard costing may be imprecise, particularly if environmental costs are not included. Accounting for environmental costs at the product level is important as:

- pricing decisions are often based on standard costs (or compared to standard costs). To ensure the correct prices are set, all costs must be considered. This is particularly important in high volume, low margin industries
- product mix decisions may be taken based on the relative profit margins of products. Inclusion of environmental costs will impact decision-making by making products with poor environmental performance more expensive
- understanding where environmental costs are being generated (ie which products) and what causes them (predominantly the cost of waste materials) will aid Cormack to identify minimisation strategies.

Additional benefits of EMA

Applying EMA has provided additional benefits to Cormack as follows:

- Cormack is currently considering writing its first environmental report, based on the environmental analysis performed by PricewaterhouseCoopers and the information generated by the trial and the findings of the study.
- Environmental performance indictors are being developed in the summary management accounts to facilitate monitoring by senior management of key environmental performance criteria. These may be linked to employee remuneration in the future.
- As a result of the exercise, Cormack was presented with a register of environmental aspects and impacts and a documented summary of applicable legislation, both key ingredients of an EMS.
- The analysis has resulted in improved cost accounting overall, by generating additional cost information for minimal additional effort.
- This process may provide Cormack with a useful platform for internalising externalities such as energy costs, life-cycle, greenhouse gases, future costs and liabilities, in the future.

7. Conclusion

Overall, Cormack management has acknowledged that the study has been very beneficial to their business. It has helped them understand their environmental performance better, improve their management accounting and flow of information, and, most importantly, linked the two together. This has resulted in improved and more informed decision-making and the identification of strategies with the following projected outcomes over the next 15 years of:

Financial savings per year	$41,400
Reduction in CO_2 emissions per year	90 tonnes
Reduced waste to landfill per year	Not quantified
Required investment	$37,000

The benefits of applying EMA have been described in detail; they will vary depending on the techniques employed and the nature of the business. The costs however, are more straightforward. They are simply the direct and opportunity cost of resources.

The barrier to widespread uptake of EMA has been that, in the majority of cases, management perceive the costs to be greater than the expected benefits. Experience at Cormack has shown that this assumption may not necessarily be valid. Furthermore, current global trends are seeing external costs increasingly being internalised and growing pressure on companies to be responsible corporate citizens and improve their environmental performance to achieve sustainable growth. The equation is therefore changing and, as this study suggests, those organisations who embrace EMA early stand to gain the competitive advantage.

Appendix A: Cormack environmental review and assessment

Business Operation	Activity	Environmental Aspect	Environmental Impact	Environmental Quantification	Recurring price/cost	Financial Quantification (price earned or cost to business over last 12 months)	Future or potential costs, intangibles and opportunities	Assessment of impacts	New account code to be created?	Account code
Production	Operation of moulding machinery	Use of electricity	Increased emissions of Greenhouse Gases from Power Stations; use of finite, natural resources which require environmentally damaging mining and extraction	Not currently known as no identification of individual energy costs, but extremely energy intensive process so likely to be significant. Based on NSW conversion factor, calculated at 0.928kg per kWh	6.3c/kWh	Unable to determine as no identification of individual energy costs, but significant cost	Possible future taxes on CO2 emissions. Opportunity to join Greenhouse Gas Challenge - intangible benefits	Significant financial cost; significant environmental impact; potential future costs and intangible benefits of reduction	Y	"Product energy"; "Waste"
		Noise	Complaints from locals, badwill generated	Not quantifiable but minimal environmental impact as on industrial estate and factory well sound proofed	n/a - no financial cost of pollution yet	n/a	Noise disturbances will generate badwill from local community	No financial cost; minimal environmental impact. No history of complaints or risk of badwill	N	
	Refrigeration units used to chill water for cooling of moulds	Use of electricity	Increased emissions of Greenhouse Gases from Power Stations; use of finite, natural resources which require environmentally damaging mining and extraction	Not currently known as no identification of individual energy costs but estimated to require significant energy usage. Based on NSW conversion factor, calculated at 0.928kg per kWh	6.3c/kWh	Unable to determine as no identification of individual energy costs	Possible future taxes on CO2 emissions. Opportunity to join Greenhouse Gas Challenge - intangible benefits	Significant financial cost; significant environmental impact as contribution to GHG; potential future costs and intangible benefits of reduction	Y	"Product energy"; "Waste"
	Input of raw materials	Use of non-biodegradable polymer raw materials: (polyethylene, polypropylene and polystyrene)	Manufacture pollutes environment. Non-biodegradable in environment causing long-term degradation of the environment	55T polymers/month	$1,300-$1,500 per tonne	Not possible to determine from management accounts, but significant expense	Manufacture of amounts >2000T per year subject to regulation	Significant financial cost and will provide useful management accounting information. Efficient use can only improve overall environmental performance	Y	"Product materials"; "Waste"
	Spillage and disposal of contaminated materials	Generation of non-biodegradable waste; unnecessary use of resources	Land degradation and release of non-biodegradable materials into the environment	Impractical to record but generally insignificant	n/a -one-off costs only	$25K but also includes obsolete stock disposal		Minimal financial and environmental impact; impractical to record	N	
	Set-up for coloured production run	Consumption of raw materials and generation of useless waste to landfill	Land degradation and release of non-biodegradable materials into the environment	Waste plastic generated of 0-75kg per set-up change. Up to 5 colour changes per week. Exact amounts unknown but significant quantity as in most cases it can't be recycled	Cost per tonne of waste unknown but includes materials, labour, energy and disposal/recycling cost	Cost and weight produced unknown, but potentially substantial	Landfill levies being introduced which will increase price of disposal. Likely to be more significant in long term	Potentially significant financial cost (materials, labour, waste disposal) never previously considered. Significant environmental impacts of waste. Cost of waste disposal will increase in long term	Y	"Waste"
Assembly	Operation of assembly machinery	Use of electricity	Increased emissions of Greenhouse Gases from Power Stations; use of finite, natural resources which require environmentally damaging mining and extraction	Not currently known as no identification of individual energy costs but estimated to require significant energy usage. Based on NSW conversion factor, calculated at 0.928kg per kWh	6.3c/kWh	Unable to determine as no identification of individual energy costs, but significant cost of production	Possible future taxes on CO2 emissions. Opportunity to join Greenhouse Gas Challenge - intangible benefits	Significant financial cost; significant environmental impact; potential future costs and intangible benefits of reduction	Y	"Product energy"; "Waste"
		Noise	Complaints from locals, badwill generated	Not quantifiable	n/a - no financial cost of pollution yet	n/a		No financial cost; minimal environmental impact. No history of complaints or risk of badwill	N	
	Compressors used to aid in assembly	Use of electricity	Increased emissions of Greenhouse Gases from Power Stations; use of finite, natural resources which require environmentally damaging mining and extraction	Not currently known as no identification of individual energy costs but estimated to require significant energy usage. Based on NSW conversion factor, calculated at 0.928kg per kWh	6.3c/kWh	Unable to determine as no identification of individual energy costs, but known to be energy intensive and therefore expensive	Possible future taxes on CO2 emissions. Opportunity to join Greenhouse Gas Challenge - intangible benefits	Significant financial cost; significant environmental impact; potential future costs and intangible benefits of reduction	Y	"Product energy"; "Waste"
Packaging	Packaging of finished goods (not returned from customers)	Waste of resources as disposal by customers of non-returnable packaging	Waste of resources; land degradation at landfills; if recycling undertaken, could be further impacts	Over 80,000 cartons used per year (not returned)	Average $1.16 per carton	Over $100,000 per annum	Packaging covenant offers major intangible benefits of improved relationship with key customer and reputation in industry. Non signatories liable to increased regulatory costs in near future	Significant financial cost to business, not currently separately identified. Would provide useful management information. Significant environmental issues concerning unnecessary disposal. Future costs of regulation likely and major intangible benefits to be gained by managing	Y	"Packaging"
	Processing supplier packaging (not returned)	Packaging needlessly discarded	Plastic sheeting non-biodegradable and involves non-environmentally friendly manufacturing; degradation of land; recycling may have environmental impacts	Average 853 plastic liners per month sent to landfill	n/a - included in price of raw materials and would be minimal	n/a	Would come into packaging covenant obligations. Potential revenue could be obtained if recyclable material used	Minimal financial cost, primarily environmental performance consideration	Y	Environmental consideration only - no cost object required

Business Operation	Activity	Environmental Aspect	Environmental Impact	Environmental Quantification	Recurring price/cost	Financial Quantification (price earned or cost to business over last 12 months)	Future or potential costs, intangibles and opportunities	Assessment of impacts	New account code to be created?	Account code
Waste Management	Use of regrinding machines	Use of electricity	Increased emissions of Greenhouse Gases from Power Stations; use of finite, natural resources which require environmentally damaging mining and extraction	Not currently known as no identification of individual energy costs. Not anticipated to require significant energy usage, but in constant use. Based on NSW conversion factor, calculated at 0.928kg per kWh	6.3c/kWh	Unable to determine as no identification of individual energy costs		Significant environmental impact; potential future costs and intangible benefits of reduction	Y	"Product energy"
		Reduction in raw material usage and minimising waste	Conserving resources and reducing environmental impacts associated with waste	20-30% of each mould output is waste, of which on average 80% is reground and reused. Unknown amounts reground		Not currently known, but financial benefit equals materials costs saved		Apparently significant financial and environmental benefits to business. Useful management accounting information to prove this	Y	Process to be tested by separate cost benefit analysis
	Waste disposal	Disposal of general skip waste to landfill	Degradation of land; more waste means more transportation	22 skip bins/month ($2m^3$ waste) = $44m^3$ waste sent to landfill per month	$26.62 per collection + $24 bin rental (3 bins @ $2/week)	Over $7,000 per annum	Future landfill taxes. Waste disposed is wasted resources	Minimal financial cost and environmental impact as most waste is recycled at source. Not considered significant at this stage	N	
		Disposal of recyclable plastic waste and cardboard to recycling companies	Reduced degradation of land; requires transportation	2730kg plastic caps, 580kg plastic bags. 1430kg plastic tubes /month	$0.2/kg plastic caps, $0.1/kg plastic bags, $0.15/kg plastic tubes	Approximately $10,000 per annum		Significant efforts made at recycling, but minimal revenue impact. Recycling considered elsewhere	N	
		Noise from trucks	Complaints from locals, badwill generated	Not quantifiable	n/a - no financial cost of pollution yet	n/a		No EH&S issues arising as staff protected, and no complaints received	N	
		Use of fuel and oil	Use of finite, natural resources which require environmentally damaging mining and extraction	Unable to calculate currently as deliveries performed by third parties. Local collections only, so likely to be insignificant	Unable to determine - included in price of deliveries	n/a		Outside boundary of business making it impractical to manage specifically. Minimal financial and environmental impact and no future, potential or intangible costs	N	
			Air emissions from delivery trucks; CO2, NOx etc. contributing to local air pollution	Unable to calculate currently as deliveries performed by third parties. Would be estimated based on fuel consumed x conversion factor	n/a - no financial cost of pollution yet	n/a	Future tax on CO2 emissions will be passed on by provider	No financial impact and outside control of the business	N	
Factory/ warehouse	Lighting 24 hrs a day for 5 days a week	Use of electricity	Increased emissions of Greenhouse Gases from Power Stations; use of finite, natural resources which require environmentally damaging mining and extraction	Not currently known - but likely to be significant usage as factory artificially lit 24hrs per day	6.3c/kWh	Unable to determine as no identification of individual energy costs	Possible future taxes on CO2 emissions. Opportunity to join Greenhouse Gas Challenge - intangible benefits	Significant financial cost; significant environmental impact; potential future costs and intangible benefits of reduction	Y	"Lighting"
	Heating 24 hrs a day for 5 days a week	Use of diesel oil	Use of finite, natural resources which require environmentally damaging mining and extraction	6000L diesel consumed per year	n/a	$8,000 per annum	Possible future taxes on CO2 emissions. Opportunity to join Greenhouse Gas Challenge - intangible benefits	Financial cost is relatively minor, but potentially unnecessary given the waste heat given off machines. Significant environmental impacts from use	Y	Options for co-generation considered outside the scope of this study
			Air emissions from delivery trucks; CO2, NOx etc. contributing to local air pollution	Estimate based on fuel consumed x NSW CO2e factor 0.928kg per kWh	Currently no cost of externality	Nil	Possible future taxes on CO2 emissions. Opportunity to join Greenhouse Gas Challenge - intangible benefits	Minimal future financial costs and minimal environmental impact	N	
		Seepage of oil	Local organic pollution	Unable to determine amounts lost to environment, but small. Storage area bunded to prevent leakage into stormwater	n/a	Impractical to measure as insignificant		Insignificant financial cost, minimal environmental impact and low risk of financial or environmental cost in future; impractical to measure	N	
		Odours	Badwill generated in community	Insignificant and cannot be quantified	n/a - environmental aspect only	n/a		Minimal environmental impact; no previous complaints. Risk to business very low	N	
	Storage of oil	Up to 480L of oil stored on site	Local organic pollution	Impractical to determine	Insignificant	Insignificant		Minimal spillage and insignificant volumes	N	
	Operation of water cooling towers	Use of electricity	Increased emissions of Greenhouse Gases from Power Stations; use of finite, natural resources which require environmentally damaging mining and extraction	Not currently known as no identification of individual energy costs but estimated to require significant energy usage. Based on NSW conversion factor, calculated at 0.928kg per kWh	6.3c/kWh	Unable to determine as no identification of individual energy costs	Possible future taxes on CO2 emissions. Opportunity to join Greenhouse Gas Challenge - intangible benefits	Significant financial cost; significant environmental impact as contribution to GHG; potential future costs and intangible benefits of reduction	Y	"Energy overhead"
		Use of biocide chemicals (which/harmful), discharged into sewer every 3 months	Risk of local water pollution; breach of environmental legislation?	Quantities of biocides being released per year	n/a - no financial cost of release as yet	n/a	Possible breach of legislation; increased compliance costs for using chemicals	No financial cost; minimal environmental impact and low risk of future costs given quantities used	N	

Business Operation	Activity	Environmental Aspect	Environmental Impact	Environmental Quantification	Recurring price/cost	Financial Quantification (price earned or cost to business over last 12 months)	Future or potential costs, intangibles and opportunities	Assessment of impacts	New account code to be created?	Account code
	Storage of materials in silos	Risk of spillage into local stream, sewage system and groundwater	Risk of local water pollution; breach of environmental legislation?	Cannot be quantified	n/a - environmental aspect only	n/a	Potential cost of clean up and fines	Low risk as stored in strong silos, bunded and protected. No current financial cost or environmental impact	N	
	Disposal of obsolete or contaminated raw materials and FG stock	Waste of raw materials; disposal to landfill	Degradation of land, introduction of non-biodegradable materials into environment	Unknown quantities wasted	n/a - one-off costs	Unable to determine form management accounts		Significant financial cost and environmental impacts associated with waste disposal. Management estimate potentially significant quantities may be involved	Y	"Obsolete stock"
	Cleaning	Use of chemical cleaning agent trichloroethylene, washed into drainage after use	Local water pollution	Minimal environmental impact as quantities of cleaning agents used minimal	Insignificant	Insignificant	Future compliance cost	Insignificant financial cost, minimal environmental impact and low risk of financial or environmental cost in future	N	
	Deliveries of raw materials	Noise from trucks	Complaints from locals, badwill generated	Impractical to determine	n/a - no financial cost of pollution yet	n/a		No complaints. Industrial park so reduced sensitivity	N	
		Use of fuel and oil	Use of finite, natural resources which require environmentally damaging mining and extraction	Unable to calculate currently as deliveries performed by third parties	Unable to determine - included in price of deliveries	Unable to determine but general transport and associated environmental costs may be potentially significant part of the current raw materials cost		Frequent deliveries each day from Melbourne but outside scope of control. Financial costs considered as part of raw materials	N	
			Air emissions from delivery trucks; CO2, NOx etc. contributing to local air pollution	Unable to calculate currently as deliveries performed by third parties. Would be estimated based on fuel consumed x conversion factor	n/a - no financial cost of pollution yet	n/a	Future tax on CO2 emissions will be passed on by supplier. Arguably considered as contributing to the businesses GHG emissions	Frequent deliveries each day from Melbourne but outside scope of control. Financial costs considered as part of raw materials	N	
		Offsite spills of load due to traffic accident	Risk of pollution, damage to environment	Unable to determine as responsibility of third party	Impossible to determine - deliveries performed by third parties	n/a		Very rare and outside scope of control	N	
	Transporting stock and goods using forklifts	Noise	Complaints from locals, badwill generated	Impractical to determine	n/a - no financial cost of pollution yet	n/a		No EH&S issues arising as staff protected, and no complaints received	N	
		Use of electricity and gas	Increased emissions of Greenhouse Gases from Power Stations; use of finite, natural resources which require environmentally damaging mining and extraction	Impractical to determine	Insignificant	Insignificant		Clean fuel and minor fuel consumption	N	
	Dispatch of finished goods	Noise from trucks	Complaints from locals, badwill generated	Impractical to determine	n/a - no financial cost of pollution yet	n/a		No complaints. Industrial park so reduced sensitivity	N	
		Use of fuel and oil	Use of finite, natural resources which require environmentally damaging mining and extraction	Unable to calculate currently as deliveries performed by third parties	Unable to determine - included in price of deliveries	n/a		Impractical to determine, minimal financial cost and environmental impacts outside scope of business	N	
			Air emissions from delivery trucks; CO2, NOx etc. contributing to local air pollution	Unable to calculate currently as deliveries performed by third parties. Would be estimated based on fuel consumed x CO2e conversion factor	n/a - no financial cost of pollution yet	n/a	Future tax on CO2 emissions will be passed on by provider	Future costs may be passed on, but minimal in foreseeable future. No current financial cost and environmental impacts are outside boundary of business	N	
Compliance	Disaster prevention	Avoidance of pollution	Prevention of damage to local environment	Incalculable but one-off impact into water system	n/a	No current disaster plan implemented	Potentially significant fines and clean up costs. Damage to business and reputation potentially significant, may affect key customer relationships	Serious threat is disaster were to occur	N	Considered by risk assessment
	Insure against environmental liabilities	n/a	n/a	n/a	No specific premium in insurance for environmental accidents	None	Directors cannot get insurance for pollution incidents. Costs fo an environmental accident would be borne by the business directly	Significant cost to business and important in risk management	N	Considered by risk assessment
	Meeting licence conditions and legal requirements	Avoidance of environmental damage	Prevention of damage to local environment	Prevention of damage to local environment	n/a	Current estimate based on % time of indirect salaries	Avoidance of fines and litigation; maintain reputation with regulatory authorities, damage to reputation and business if breach, and possibly key customer relationships	Few licence requirements. Subcontractors ensure compliance for most applications. No previous fines or contravention history	N	