

Environmental Management, Structure, Networks and Information Exchange: The Case of a Tasmanian Pulp and Paper Mill

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ABSTRACT *Pulp and paper is a major impact industry, in which environmental impacts can be seen to be complex, diverse and characterised by uncertainty and interdependence. A greening process within this industry requires wide ranging environmental knowledge. Also fundamental are effective networks for information exchange and greening is therefore dependent on changes to such networks. This study investigates the issue of how greening occurs, focusing on the process at the Fletcher Challenge New Zealand integrated pulp and paper mill situated in Tasmania, Australia. It was seen that effective greening within this industry relies on information processing capabilities to access external and internal knowledge and skills, and that this is fundamentally dependent on structural arrangements. Appropriate organisational structure and external networks are therefore essential for accessing information and facilitating its dissemination and integration, thereby enhancing the firm's ability to address environmental concerns. The study highlights interaction between the formal change process, one which sought limited change, and an informal change process that continued greening the company beyond the official aims. The reasons for this are located in the power of informal information exchange.*

Keywords: greening, pulp and paper, information, structure, networks.

Introduction

The 'greening' of industry, where organisations change to become more environmentally responsive, has been a worldwide phenomenon, particularly since the late 1980s. This paper addresses such a process of environmental change as it occurred at the Fletcher Challenge New Zealand integrated pulp and paper mill, situated in Tasmania, Australia. Specifically, we focus on a vital background element in greening—changes to the information processing capacities of organisations. Our basic argument is that effective organisational greening relies on information processing capacities to develop appropriate knowledge and skills, and that these are directly influenced by organisation structure.

The argument is built on a case study and analysis of the process of change that occurred at the mill located in Boyer, Tasmania. Information was collected through interviews and site observations, as well as textual analysis of company documents and review of secondary information sources, including previous empirical work examining the environmental performance of the Australian industry, and the Boyer mill specifically. The research stands as an intrinsic single case study, but also as exploratory research that allows cautious theorising on a significant issue.

Discussion begins with an overview of the environmental concerns that gained considerable attention in Australia and Tasmania from the 1980s, focusing on the increasingly highlighted concerns of the pulp and paper industry. The case organisation will be detailed, outlining specifically the environmental concerns of the mill, and the pressure that came to bear as it began to be heavily scrutinised for its environmental impacts. The greening process that occurred at Boyer will then be described. This began as a response to external pressures. From the early to mid-1990s, however, the system of external pressures that had emerged shifted as environmental concerns in Australia and Tasmania became routinised. Within the industry, and at the Boyer mill specifically, an institutionalisation of environmental concern can be identified that is consistent with this shift. At Boyer, the emergence of a system of internal driving forces, combined with a stabilisation of external pressure over time, has resulted in an ongoing process of greening at the mill. After describing this important turning point in the greening process, discussion then turns to the internal drivers that sustained the change process in later years. This leads directly into discussion of the role, in the later change process, of information exchange and internal and external structural arrangements.

Background

Industry Overview

Industry and organisational responses to environmental concerns can be seen to vary by geographical location, media power and type of industry. Industries such as pulp and paper are often located in areas of high economic development where the media are relatively free and powerful. Due to this, and the highly visible nature of their environmental impacts, pulp and paper mills tend to be heavily scrutinised and subject to heavy pressures to better manage their environmental impacts.¹ For the pulp and paper industry in Australia, and specifically in Tasmania, such scrutiny peaked in the late 1980s. Since this time Australia has been widely regarded as a globally significant centre of environmental consciousness and activism, with Australian and particularly Tasmanian forest conservation campaigns becoming the attention of worldwide publicity. Widespread media coverage of environmental problems during the late 1980s coincided with a sharpened political salience to such issues in the lead up to the 1990 federal election.² Tasmania itself was a world cradle of green politics in the 1980s, with such issues as the Franklin River Dam dispute, and the Wesley Vale Pulp Mill affair gaining global attention. The Wesley Vale affair provides an example of such a campaign that served to increase public awareness during the 1980s. This key conflict in Australia's pulp and paper industry influenced many institutions in society. Subsequently, the national government launched a major research program, state governments tightened regulations, and industry reduced usage of elemental chlorine.³

Prior to this, industry and regulatory authorities generally paid little attention to the waste products being discharged by pulp mills, and environmental consequences of practices such as discharging effluence directly into the water were not understood, or were regarded as an acceptable cost of economic prosperity.⁴

The Boyer Mill

Fletcher Challenge New Zealand's Boyer mill stands alongside the Derwent River, 36 km upstream from the capital city of Hobart, in the Australian state of Tasmania. It is an integrated pulp and paper mill, operating 24 hours a day, every day of the year. The mill, built in 1941, was initially owned by Australian Newsprint Mill Limited (ANM), formed in 1938 by a consortium of Australian newspapers. ANM then became a joint venture between News Limited Corporation and Fletcher Challenge New Zealand until October 1998, when Fletcher Challenge New Zealand, the second largest newsprint producer in the world, took ownership. By this time ANM included both the Boyer Mill and the newsprint mill in Albury. The two Australian mills then combined with the Tasman mill, situated at Kkawerau in New Zealand, to form the Fletcher Challenge New Zealand Group.

The mill at Boyer has been heavily scrutinised for its environmental performance, particularly for its impact on the Derwent River Estuary. Liquid effluents, in particular the contaminants they contain, pose a concern as they can reduce oxygen levels in receiving waters and have adverse effects on aquatic life. In addition, such effluents can generate unpleasant odours, taint fish flesh, and encourage acidity, slime growth, scum and discolouration to the water. Being an older mill by world standards, air emissions present another challenge to environmental management. Air emissions from pulp and paper mills are often considered to be of relatively minor significance compared to waste water pollutants. Nevertheless, the industry does appear to be a significant contributor to air pollution when compared to other industrial sectors.⁵ Solid wastes have also been a concern for the Boyer mill. Landfill sites are required for this waste and problems can arise due to leaching of water containing organic matter from these sites. Additional considerations include difficulties in making efficient use of inputs, such as energy, water, and raw materials, and the environmental impact of many additives and fillers used in the pulp and paper making process. The use of 'old growth' (more than 25 years old) native Australian hardwoods, the associated chemical treatment procedures, and chemical bleaching practices in the past, have also placed the mill under considerable scrutiny.

During the late 1980s, a number of localised occurrences served to focus specific attention on the Boyer mill. The mill became part of a system of pressure for environmental change in the pulp and paper industry. Identified specifically in this research were the pressures from environmental activism, the local and wider community, media, competitors, customers, external (mainly government) bodies, and regulators. Most visible of these pressures was the media coverage of the mill's impact on the Derwent River Estuary. This highlighted the problem of sludge sediments rising to the river's surface (referred to in several media reports as 'pulp crocodiles') as well as the high levels of untreated effluent that continued to be discharged into the river. Prior to this, it is apparent that little consideration was given to the impact the mill was having on its natural environment. Process water

had for some time been discharged largely untreated into the Derwent River, with a ministerial exemption to the 1975 Tasmanian Environment Act allowing the discharge of solids and organics above permit levels.⁶ The 1989 Annual Review stated that 'The Boyer mill has had a somewhat chequered environmental record including the discharge of wood fibre residue into the Derwent River for a 48 year period'.

This localised attention on the mill was heightened by the broader attention of the conservation movement, and the involvement of local, national and international activists. Previous empirical studies of the Australian pulp and paper industry suggest that industry changes would not have occurred without pressure from such environmental forces who were recognised as being instrumental in 'drawing together local stakeholders . . . and middle class, urban nature lovers'.⁷ Activist campaigns, growing community pressure, and increased media attention on the industry interacted and contributed to the growing momentum of pressure on the mill. This further fuelled concerns from customers and consumers. In addition, others in the industry began to address these concerns; hence competitive pressures also became an influential factor.

The Greening Process at Boyer

Early Stages in the Process of Change

The initial response to the rising tide of pressure on the mill was the design and implementation of a primary effluent treatment plant in 1989. This action was a direct response to the high profile issue of contamination of the Derwent River Estuary. In this same year, the Annual Review included the mill's first Environmental Care Policy, and a new section was created specifically to address the environmental concerns of both the Boyer mill and the new mill at Albury. The 1989 Annual Review included statements by the new chief executive formalising 'the company's recognition of our obligation to meet reasonable community expectations of responsible environmental care'. It highlighted that '\$20 million has been committed to cleaning up liquid waste and cleaning up airborne pollution from Boyer', commenting also on the need to eliminate problems arising from 'antiquated equipment and operating procedures'. This year also saw formulation of the first Environmental Management Plan (EMP) by a number of key figures at the Boyer mill.

During 1990 and 1991 further research was conducted at Boyer, focusing mainly on those problems associated with the mill's impact on the Derwent River. A number of external consultants were brought in to examine these problems and recommend process improvements. By 1992 it was reported in the Annual Review that there had been a 'dramatic improvement in the mill's environmental performance'. This included reduction in water effluent discharge, and reports of an increase in animal and plant life in the Derwent Estuary. At this time effluent discharge levels were being maintained at less than 40% of the statutory limit (following voluntary surrender of the ministerial exemption to the 1975 Tasmanian Environment Act).

By 1993 'caring for the environment' was the second listed priority within the Annual Review's statement of 'Core Values'. The wording of this was extended from the previous year to address 'expectations' in addition to 'requirements' of the community. A formal environmental management system based on the British

Standard 7750 was introduced at Boyer during the later part of this year. This served to define employee responsibilities, and provided a mechanism for audit and review of environmental performance. Also during 1993 the caustic chlorine plant was closed, replaced with the more environmentally sound method of brightening pulp with hydrogen peroxide. This eliminated the problem of mercury emissions into the Derwent River.

A Shift from External to Internal Pressures for Change

By the early to mid-1990s the attention focused on the industry, and more specifically on the impacts of the Boyer mill, had waned. Broadly it has been recognised that a shift in patterns of environmental concern in Australia began to occur from the early 1990s. Such a shift is characterised by what at first appeared to be declining levels of environmental concern—they had lost urgency and been detached from the actions of increasingly marginalised environmental groups.⁸ The majority of interview respondents suggested that activist pressure, intense media coverage, and broader community attention were especially prominent only in the late 1980s and very early 1990s. After this, only regulations and local community inputs put direct pressure on the mill, and most respondents alluded to the fact that these pressures were of a more consistent and predictable nature. Regulatory pressure came about in the form of EMP revision every 3 years, inclusive of a 6 month approval and negotiation phase. Where there was to be an adjustment in standards, or the introduction of new operating requirements or treatment facilities, the window of time within which compliance was required could be negotiated with the Department of Primary Industry, Water & Environment. Community pressures on the mill were more localised and incident specific.

Such a declining level of environmental activism is symptomatic of a 'routinisation' of environmental concerns:

Routinisation marks absorption of social innovations into the established, and typically institutionalised ways of doing and experiencing things through repetition and habituation, and it is part of broader processes of social adjustment of change—the new becomes incorporated into a daily business regulated by established rules and procedures.⁹

The apparent waning of external pressure on the Boyer mill is consistent with this identified trend. The greening process, however, continued. The need to address the industry's range of environmental concerns had become a permanent issue on the mill's agenda. What had emerged by the mid-1990s was a system of internal forces that maintained ongoing environmental improvements. This shift from external to internal pressures, as the predominant driving force for change at Boyer, is best explained as an institutionalisation of environmental concerns, an 'emergence of orderly, stable, socially integrating patterns out of unstable, loosely organised, or narrowly technical activities'.¹⁰ A system of internal dynamics evolved to become the driving force behind an ongoing process of environmental change.

The Internal Driving Forces

The introduction of the Environmental Care Policy in 1989 marked the point for the move to internal pressures for change. After this, the company's core values,

vision and mission were formalised, and expectations were clearly set down for employees:

There is a written set of core values and that is a key thing that allows employees to say, 'OK, We are doing this in line with the company's policy'—we communicated that to employees with face to face sessions, we put things in writing (Interviewee 1).

The initial capital expenditure on environmental improvements, the Environmental Management Plan, the Environmental Care Policy, and the support for environmental improvements from the new managing director, were consistently cited by interviewees as the early internal drivers for change.

These (early) internal influences served to increase awareness. They were followed by a number of environmental education and training initiatives, as well as an increase in communications addressing environmental concerns. Such initiatives included, for example, the Environmental Care and Spill Training course, and a growing number of internal publications that covered environmental issues. Such initiatives sought to increase general environmental awareness and an understanding of environmental concerns, as well as encourage preventative activities. In reference to this it was highlighted during an interview that:

A lot of it are people actions now, not necessarily equipment actions (Interviewee 2).

Over time, these initiatives have met with some success, encouraging a positive change in attitudes and more environmentally sound work practices:

From an operational point of view, a lot more emphasis is now placed on environmental care, for example controlling spills and trying to prevent spills in the first place (Interviewee 7).

It was also recognised that in recent years a significant change in attitudes has resulted in a heightened perception of shared responsibility across the mill:

Previously production process workers believed that anything to do with the environment at best was the effluent treatment plant operators responsibility—they could just go on making paper, and if they needed to dump pulp or process water, they assumed others were there to catch it—they didn't take too much responsibility for their own actions really (Interviewee 4).

Inclusion of 'environment' within performance review measures, creation of the mills intranet, and restructuring that occurred at Boyer were also important internal drivers of the change process. Most prominent of these measures (to be discussed in more detail later) was the shift to a new team-based structure. As part of this structure at Boyer, several project teams and task forces were formed to deal specifically with environmental issues. These teams were implemented with the help of the newly appointed environment engineer who was instrumental in setting up a range of education, training and communication initiatives. These teams have been responsible for a range of environmental performance improvements,

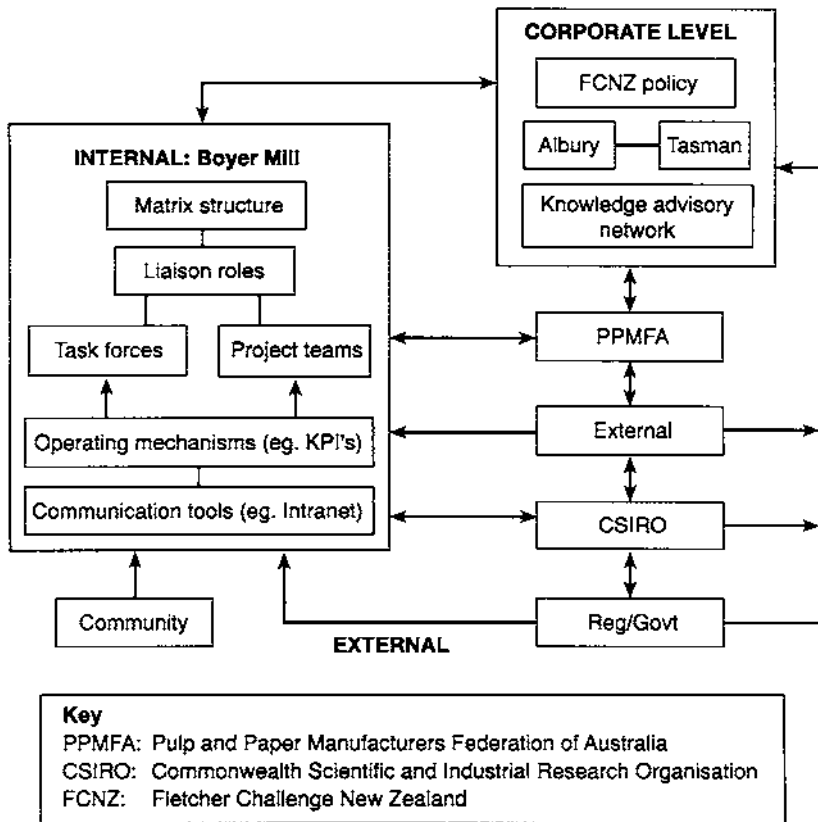


Figure 1. The system of information exchange at Boyer.

including, for example, innovative waste reduction and waste disposal initiatives. As a result, project teams and short-term task forces continue to represent an essential element in the ongoing greening process.

The initiatives described above provide an overview of the greening process that has occurred, and the institutionalisation of environmental concern at Boyer. The following analysis examines the internal driving forces for change, and the external networks that remain. We argue that information exchange is the key element in the greening process.

Information Exchange as a Key Element in the Greening Process

The study identified a web of interactions that combined as a system of information flow to influence environmental performance over time. Examination of this change process highlights the role of both intra-mill networks, intra-organisation networks and connections, and those external networks as part of a broad system comprising formal and informal information exchange. Figure 1 presents a model of this system of information exchanges. It makes clear that the Fletcher Challenge corporate level network interacts with both the internal Boyer network and external bodies. Some external bodies also interact with each other, and some, as well as influencing the corporate level directly, affect the Boyer internal system.

The Nature of Environmental Impacts and the Need for Information Processing Capabilities

Environmental strategy at Boyer has been consistent with the 'logical incrementalism'¹¹ view that one proceeds flexibly and experimentally, allowing the firm to benefit from the best available information. Consistent with this, the process benefited from an increase in information processing capacities that enabled people at the mill to collect, disseminate and integrate the best available environmental information. This is especially significant because the complex nature of Boyer's environmental impacts has meant that efforts to better manage these have required the supply and processing of vast amounts of information. Further discussion of these impacts highlights the high demand for information in high (environmental) impact industries such as pulp and paper.

Such a high demand for information stems from complexity and uncertainty, and interdependence of the impacts of the mill on the natural environment. Primarily, this notion of interdependency addresses the synergistic effects of pollutants on nature, in that the combined affects of pollution are greater than the sum of separate affects.¹² In an integrated pulp and paper mill, such effects are made even more complex by the interrelated nature of different work processes, and the potential for the combined contributions of mismanagement across departments to produce even greater impacts on the environment.

A specific example of this is wastewater effluent (the main source of discharge in paper mills) where the emissions that occur both before and after primary treatment result from a range of activities in the production process. In seeking to better manage wastewater, and ultimately reduce effluent levels, it is necessary that it becomes not only a concern of each operating area, but that each stage is conscious of the interdependency of their action with those of subsequent stages in the process. At the same time, each department needs to be aware both of their individual effect and the combined effect of the whole process on the environment.

This interdependency, and the complex nature of such environmental problems, obviously presents varying degrees of uncertainty and complexity to members of an organisation. This is particularly so when workers at various levels and within different departments may have little or no understanding of such problems. This highlights the need for accurate information and higher order information processing capabilities within the organisation. Environmental management within major impact industries therefore requires coordination in order to facilitate the necessary information flow. This is essentially a matter of organisational structure. Where information requirements increase as a function of increasing diversity, uncertainty, and interdependence within an organisation, structural modifications offer a means of adapting to increased demands for the processing of information. Thus, in order to be effective, organisations must develop an information processing capacity that matches the information processing requirements of its tasks.¹³ In the case of the Boyer mill, the requirements of an effective environmental management system placed high demands on the entire organisational structure. The response to this demand was gradual, with each structural change building information collection and processing capacity, and at the same time paving the way for further changes. Each of the networks and structural elements (as depicted in Figure 1) will be discussed in turn as examples of how information flow and enhanced information

processing capabilities have impacted on environmental management strategy and the change process that has occurred.

Structural Changes from an Information Perspective

Structural Changes at Boyer

Changes began initially with the introduction of internal liaison roles, introduced specifically to deal with environmental issues across multiple departments. The later introduction of a team-based structure at the mill has also contributed to greater information processing capabilities, while the change in 1998 to a more matrix style of organisation further impacted on the mill's capacity to handle environmental issues. Such lateral connections 'allow information to flow more directly among participants in interdependent departments or work groups, rather than up and over through hierarchical channels'.¹⁴ Each of these major changes will be discussed in turn.

The role of environmental engineer is an example of a formalised liaison role within the mill. This role was created in 1990 to facilitate interchange between interdependent departments. In particular, the role involves communicating with individuals and departments across the mill, overseeing the formulation of management plans, communicating procedural changes, performance reporting and ensuring that education, training, and other communication initiatives address environmental issues and promote performance improvements from an operational perspective. The role also involves coordination of project teams and task forces that work in environment-related areas. Such a role does not provide authority over the units, but rather over something important to that unit; in this case the 'something important' is environmental matters.¹⁵ The environmental engineer at Boyer has played a key role in spreading environmental information across the mill, and has been central to changes in environmental performance improvements.

An additional lateral coordination device, introduced on a mill-wide basis during the mid-1990s, was that of a team-based organisation structure. The move to a team-based structure included both project teams and task forces. Teams were introduced to address a variety of issues, one of which was environmental management. Included are permanent environment-related project teams, such as the Enviro Paper Team, as well as short-term focused task forces, such as the more recently formed Sludge and Flux Teams. The strength of focused task forces is that they allow multiple representatives to interact intensively over a short period of time to achieve specific objectives.¹⁶ At Boyer, such interactions have built environmental awareness and understanding across the plant, while at the same time solving specific environmental problems. Alternatively, the long-term project teams, whilst also made up of multi-departmental representatives, address a broader range of matters. For example, the Enviro Paper Team addresses environmental concerns on a broad level and conducts a range of activities, such as environmental monitoring of the river and general communication of activities across the mill. This team is also responsible for implementation of a range of process improvement initiatives. Both types of team-based structural arrangements enhance the coordination of processes, and help in addressing the uncertainty and complexity dimensions of the mill's environmental impacts. Such environmental issues require the interdisciplinary understandings that teams

facilitate through transfer of information across a wide range of areas within an organisation.¹⁷ The need for such interdisciplinary interactions is essential for addressing complex problem areas, such as environmental impact issues, that suffer from a fragmentation of knowledge.¹⁸ Team structure addresses this by bringing together individuals with differing insights, information and skills, and also overcomes fragmentation by removing boundaries that can create territoriality and impede the flow of information.¹⁹

Additional structural changes that enhanced information flow came in 1998 with the move towards a new matrix structure at Boyer. This is consistent with much of the early literature regarding organisational design which views matrix management as the final step in the utilisation of lateral coordinative mechanisms.²⁰ The stated rationale²¹ for this move at Boyer was a flattening of structure to reduce management levels and ultimately improve communication flow. This contributes to more direct relations with customers, team improvement, and enhanced long-term management perspectives. The shift away from hierarchical structure had been under way for some time, however the more recent formalisation sought to align the structure with the objectives and principles of the mill. These include 'decision making where knowledge is greatest', and 'ensuring all employees get a better understanding of the whole mill, not just the area in which they work'.²²

Beyond the formal structural arrangements that have played a fundamental role in increasing information processing capabilities are 'operating mechanisms'.²³ These mechanisms include control procedures, information systems, reward and appraisal systems and standardised rules and procedures. Such structural variables 'can be used to more clearly signal to organisational members what is expected of them, to motivate them toward their assigned part of the organisational goal, and, as necessary, to encourage them to take collaborative activity'.²⁴ Standardised rules and procedures to handle environmental matters are part of Environmental Management Plans and many are included within regulatory controls. An example of this is the mill's license to operate scheduled premises under the Environmental Protection Act 1975. Also, reward and appraisal systems, such as the team-based Key Performance Indicator (KPI) incentive scheme, represent an operating mechanism that has successfully reinforced the intent of structural design and served to increase awareness and consideration of environmental issues.

Structural changes, and the supporting operating mechanisms, provide a means of coordination and communication to better manage the interdependent nature of workflows and production processes. Together, they serve to highlight the interdependent nature of the production process to workers at the mill, and the need to consider not only actions taken within a particular area, but also how these contribute to an overall effort to better manage the impacts of the mill.²⁵ Such reciprocal interdependence requires 'the use of mutual adjustment or coordination by feedback, in which the interrelated parties must communicate their own requirements and respond to the needs of each other'.²⁶ The structural arrangements of liaison roles, teams, and a matrix structure, coupled with the supporting operating mechanisms, enhance the ability for interrelated parties to communicate and provide feedback. Further evidence suggests that over time this has increased the degree to which workers and departments at the mill have responded to the needs of each other with respect to environmental management practices.

Information Networks at the Corporate Level and Beyond

Whilst internal lateral connections have been an essential means of enhancing the mill's information processing capacity, other networks external to the mill have contributed to the greening process. Of these external elements, changes at both the Fletcher Challenge corporate level and the change in structure of external relations have shaped the identified change process. Where such a change process requires new information, such external connections are an integral part of this system of information exchange, as much of this new information is most likely to be found beyond the boundaries of the firm.²⁷ Whilst radical change and learning often requires the sudden incorporation of information very different to that which the firm already uses,²⁸ the gradual assimilation of information can facilitate more incremental change. Where such information cannot always be easily internalised, institutionalisation of external information can be a useful contribution to environmental change and improvement. Such formal institutional links have been established for Boyer, within the broader Fletcher Challenge organisation and outside of this with numerous industry groups and external bodies. These will be discussed in turn.

A move toward a higher degree of interaction between the three mills of the Fletcher Challenge New Zealand group, under the Fletcher Challenge Policy, has resulted in greater communication and information sharing about environmental issues. Such increased communications have led to collaborative design initiatives across the three sites, such as the sharing of ideas to handle effluent treatment. Activities such as this enable the Boyer mill to benefit from the capabilities of the Albury operation whilst being able to effectively tailor designs to the site at Boyer.

At the corporate level, structural links have also been created by the recent introduction of the Fletcher Challenge Knowledge Advisory Network (KAN). The KAN links individuals and groups across the organisation and seeks to provide 'connective tissue', with the goal being to share learning from one part of the organisation and one project to the next.²⁹ This has seen a sharing of skills and knowledge by means of a database, with environmental issues being a key element in this network.

Interactions with a number of external bodies are also important. These include both industry alliance groups and associations with several external government bodies. For example, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is a major contributor of environmental information, both to the industry as a whole and to the Boyer mill specifically. Through the establishment of industry-wide research programs and organisation of international conferences, CSIRO have enhanced the understanding of design complexities and provided a forum for the sharing of skills and experience. Such information has been an essential part of environmental improvements at Boyer. More directly, CSIRO have provided assistance specifically at Boyer through routine testing and contract research. As well as research and monitoring assistance from CSIRO, a number of other external consultants are used to provide expert knowledge regarding a range of problem areas. This includes the University of Tasmania and a number of local and overseas consulting groups.

Industry alliance groups, such as the Pulp and Paper Manufacturers Federation of Australia (PPMFA), are a further element in this communication network, and in this case, one specific to environmental issues in the industry. The main activities

of the PPMFA are the presentation of industry views and concerns to the Commonwealth Government, environmental research and development, the promotion of employee education and training, and public education (PPMFA 1999).

These alliances, both within the Fletcher Challenge organisation and beyond, enhance the ability of Boyer to benefit from the best available information regarding practices and procedures that minimise environmental impact. Such communicative action enables new practices to be adopted (and where necessary adapted) to the specifics of the Boyer site. Ultimately, such structural arrangements 'facilitate participation in a network that will provide visibility, exposure, and learning, and improve general prospects for advancement'.³⁰

The Role of Formal and Informal Information Exchange

Within the change process both formal and informal information exchanges have occurred. Both can be seen to contribute to this change process and ultimately, both formal and informal communications are an important tool for encouraging more environmentally sound work practices, and facilitating the successful transfer of environmental technology.

Formal Information Exchange

Highly codified, formal information exchange plays an important role in the change process at Boyer, both as a driving force and as a facilitator for positive environmental change, and, as such, formal mechanisms are an important element in this system. Codification implies the reduction and conversion of external knowledge into information that can be transmitted through information infrastructures. Such codification is important for integrating external information, storing this information once attained, then enabling the search and retrieval of such information when required by those within the firm.³¹ For both planning and problem resolution such codified information is arguably a necessity. From the construction of Environmental Management Plans every 3 years, to the more regular, periodical re-setting of environmental targets within operating areas, the availability of codified information is essential at Boyer. For problem resolution activities, such as spill treatment and accident recovery, the availability of easily accessible, codified information is seen as important for rapid and effective response. Further, where solutions to environmental problems exist, but are fragmented from the internal knowledge base and expertise, external inputs are often required. In many cases these need to be codified to ensure they can be internalised and are easily accessible by employees.

Examples of the formal exchange of information exist at all three levels of exchange identified within the system. External to the mill and the organisation, industry reports and other numerous documented research findings are examples of formal information exchange of a highly codified nature. This formal information exchange has been important for the planning of physical production changes such as design and implementation of the primary effluent treatment plant, as well as playing a key role in the closure of the mercury cell plant and the shift away from chlorine bleaching to hydrogen peroxide bleaching practices. The ongoing involvement of Fletcher Challenge in the Pulp and Paper Manufacturers Federation of Australia (PPMFA), as well as the ongoing interactions with bodies

such as CSIRO, will continue to represent formal information transactions which produce codified information within this broad system.

Within the Fletcher Challenge organisation, information exchange has been formalised under the Fletcher Challenge Policy, which sought to formalise linkages between the sites. Formalised information exchange is most clearly evident in the written publications circulated to employees throughout the organisation. The 'Paper Web' (previously the 'Newsprint Log' under ANM) serves as an example of formal environmental information exchange, reporting regularly on successful initiatives of each of the mills. This publication transfers information about solutions to environmental problems across sites, as well as providing an awareness-enhancing tool by, for example, reporting on environmental impact reductions and any environmental rewards received by individuals, groups and/or sites.

Formal information exchange within the Boyer site has also played a vital role in the broad change process and takes numerous forms. Environmental Management Plans, site-specific policies, and operating area guidelines are examples of the most formal, codified information exchanges within the plant. These serve to formalise environmental concern at the plant and provide a store of information that can be retrieved relatively easily by employees from all operating areas. Other formal information exchanges also occur within the Boyer mill, such as the reporting and feedback processes that occur under the KPI appraisal system. Under this system each operating area reports on performance levels on a range of criteria (of which environmental performance is one element). Results of these performance appraisals are then fed back to each team and/or operating area. This ongoing formal and codified information exchange process acts as a tool for measurement and long-term performance review, and seeks to motivate toward improvement.

Other means of formal information exchange include those which occur within the site's intranet. These are both one-way communications through information pages delivered on-line, as well as offering the opportunity for two-way exchanges through interactive sites, acting then as a substitute for informal communications where there is no personnel contact between these levels and/or operating areas within the site.

Informal Information Exchange

The barter of informal information is a common enough transaction in daily life, 'most obviously it is the basis of conversation'.³² This informal exchange has been a key element in information exchange at Boyer and a major contributor to the process of change that has occurred at the mill. This has direct links to structural changes at the mill. The transfer of more tacit forms of knowledge, in contrast with formal (codified) communications, is exemplified by face-to-face conversations, as well as by the transfer of skills. Where newly prescribed work practices require additional skills and understanding, transfer may be highly sensitive to social context and thus require an increase in physical propinquity and ultimately a structural flexibility that allows for ongoing informal information exchange.

The identified cultural shift at the mill, from the late 1990s, towards actively achieving environmental reduction goals by a greater contribution from 'people actions', is clearly attributable to the increase in informal information exchange. These include communications between employees at different levels within the organisation, and between the different operating areas and departments. This informal information exchange has contributed greatly to both the process of

learning that has occurred, and to the transfer and acceptance of new technologies and changes in work practices. It has been an essential tool for overcoming uncertainty, as well as highlighting the interdependence of actions and their synergistic effects between operating areas within the mill.

This informal information exchange, in the form of basic conversation, provides employees with the opportunity to question what is being explained, to highlight any misunderstandings, and to indicate resistance to changes being proposed. Much of this exchange is of a tacit, uncoded nature and is important for successful technology transfer. Such transfers are best facilitated through face-to-face contact, by those who have experience of the new technology, talking on site with those who do not.³³ The presence of liaison employees and teams at Boyer are examples of where informal information exchange has been encouraged. The richness typical of this type of communication is not attainable through the more formal exchange of information. Structural rearrangements at Boyer, that were conducive to informal information exchange, provide a social context suitable for the sharing of knowledge and skills between employees (from both the same and different functional and technological specialities).

Within the Boyer site, the increased presence of informal communications about environmental issues and work practices has helped in overcoming resistance to change that has occurred. The mill's shift workers and longer-term employees whose behaviours were entrenched, and therefore more difficult to change, were particularly significant centres of resistance. Informal information exchange, such as that encouraged by membership of teams and interactions with key liaison employees, has been an important tool for unfreezing these behaviours and encouraging a greater level of commitment to adopting new practices.

Between sites within the Fletcher Challenge organisation informal information exchange has also been encouraged as a result of structural changes, and as a flow on effect from those formal mechanisms in place. For example, the Fletcher Challenge policy initially implemented to formalise links between the three mills has also facilitated an increase in informal communications. Whilst predominantly occurring through more formal modes of information transfer, such as e-mail and telephone, the nature of the information itself is informal. Again, it is clearly exemplified by the transfer of skills and knowledge—the 'know how', 'know what' and 'know why'³⁴ that members of one site may possess that, once shared, may be adapted to the other sites, and ultimately contribute to their performance improvements. Such knowledge and skill transfer in this context includes, for example, improved operating procedures that reduce waste product amounts flowing between operating areas, innovative waste disposal ideas, and treatment and accident solutions. As each site increases its knowledge base through both internal and external information exchanges, of both a formal and informal nature, such informal communications between sites reduces the fragmentation of this knowledge. Where the transfer of more tacit forms of knowledge is not easily conducted through formal documentation and reporting, this informal interaction provides a social context that facilitates such exchanges.

Conclusion

This case highlights the importance of information exchange and the necessity for an organisation to consider structural arrangements that facilitate both formal and informal information exchanges. It has been argued that the environmental

impacts of an industry such as the pulp and paper industry and the Boyer mill specifically, are complex, diverse and characterised by uncertainty and interdependence. Such a change process can only be effective if a firm's ability to address these factors is enhanced. Information requirements increase as a function of increasing complexity, diversity and interdependence, and therefore structural arrangements must be in place to adapt to this increasing demand for information processing capacities.

We have examined the process of change that occurred at the Boyer mill from the latter part of the 1980s to the end of 1999, and in doing so identified the role of information exchange for environmental management at Boyer. The increase in information exchange has been a direct result of internal structural changes and the proliferation of external links. This information exchange has occurred at three levels—within the Boyer mill, between Boyer and the other sites in the organisation, and from numerous external information sources. Internally, structural changes such as the increased presence of teams and task forces, and the move toward a more matrix style organisation exemplify the relationship between structure and information flow. Internally, at a corporate level, an increase in interaction between key liaison personnel and the introduction of a knowledge management database demonstrate how structural arrangements have enhanced environmental information exchange. Externally, membership of industry networks, and the ongoing relationships with government bodies and environmental consultants, are examples of the structural arrangements within this system of information exchange. This exchange of information can be described as a multi-level system that has been both a driving force for environmental change, as well as an essential tool for facilitating this change process. Such a system increases access to environmental information and encourages the dissemination and integration of environmental knowledge and skill sharing within the organisation.

Formal means of information exchange were dominant in the earlier part of the change process, particularly where there was a high need for access to external knowledge and highly codified information. Formal, codified information exchange continues to play an important role, however more recently the power of informal information exchange can be seen to have a greater influence on the change process. Structural changes that provide a social context conducive to the richness of informal interactions therefore represent an important part of the greening process.

It is unlikely that only one form of information exchange would ever exist within such a context in isolation, and both formal and informal information exchange are both essential tools for such a change process to occur. However, the power of informal communication must be acknowledged as a tool for overcoming uncertainty, reducing complexity, and highlighting the interdependence of impacts on the natural environment as well as the interdependency of actions within a site that contribute to environmental performance. Whilst the most effective structural arrangements and external networks will ultimately differ across operations and industries, the system that has evolved to influence the Boyer mill provides an example of the positive influence of information exchanges on environmental performance.

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