SUSTAINABILITY, MENSTRUAL PRODUCTS AND SPHAGNUM MOSS: AN INVESTIGATION

Presented in partial fulfilment of the requirements for the
Degree of Master of Science
in Resource Management

by
Tracy E. Roe

Centre for Resource Management
Lincoln University
1992

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ABSTRACT

The concept of sustainable development has become widely adopted as a management objective in New Zealand. Its application to industrial situations is often problematic, since industrial production is based upon objectives that are not always compatible with sustainability. For example, there are a number of environmental problems associated with the commercial manufacture of sanitary products. In this report, a product that may overcome many of these problems is investigated. The study explores the feasibility of commercially producing a sphagnum moss menstrual product in New Zealand.

Despite uncertainty, findings suggest that the production of a sphagnum moss menstrual pad is provisionally workable with regards to ecological sustainability, meeting the needs of women, and technical capability. However, a number of restrictive institutional structures are identified, that make the development of a sustainable menstrual product industry in New Zealand unlikely. Legal and economic structures are found to operate in such a way so as to effectively prevent newcomers to the industry, especially if small. The contradictions that these structures provide for sustainable development is discussed.

ACKNOWLEDGEMENTS

Many thanks to Roy Montgomery for reading drafts and giving much appreciated guidance.

Thanks to John Hayward for having me on-board.

Thanks to Peter Espie, Phillipa Horne and Peter Jarvis for advice with experiments, John Chamberlain for supplying moss, and Maurice and Melva Nutira for their time.

And thanks to my friends for seeing me through it all.

Author's Note

In academic discourse the general practice has been to refrain from bringing personal viewpoints into the presentation of findings, since these are thought to cloud the "objectivity" of the research. However, I believe that whether biases are openly stated or not, they are an inevitable element of any academic endeavour. In choosing what to study, how to approach the study, and what to emphasise, the author brings subjectivity to the research.

Although I have refrained from bringing my personal beliefs into the presentation of this report, I believe the objectivity of research can be increased through being explicit about methods and assumptions. By stating my subjective position, my intention is to help explain any biases the reader may find in my approach. I began this project by analysing my own experience of menstrual products. I felt concerned about what I perceived as negative implications for the environment that resulted from their production. I also became intrigued with the realisation that I hadn't connected these issues before, when I had in many other aspects of my life. Eventually I began to ask why there wasn't a product like the one I wanted/needed on the market.

Around the same time, I read a book describing the past use of moss for menstrual protection by Canadian Indian women (Anne Cameron, 1981). I thought that moss may offer a solution to the problems that I perceived with the current menstrual product industry, and decided to investigate the use and management of sphagnum moss in Aotearoa/New Zealand. Indeed, sphagnum moss seemed to offer the potential of an industry in fitting with the concept of sustainability. From these initial investigations I began to ask questions about product development. It is to these questions that this study is addressed.

CHAPTER 1. Introduction

1.1 General Introduction

The concept of sustainable development has become widely adopted as a management objective in New Zealand. It is a goal that has arisen with the recognition that present patterns of development cannot be sustained by the environment. Sustainable development is has been defined by the World Commission on the Environment and Development as "development that meets the needs of the present without compromising the ability of future generations to meet their needs"(1987: 8).

The application of the concept of sustainability to industrial situations is often problematic, since industrial production is based upon an ideology that resources are limitless and the earth infinitely forgiving. For example, there are a number of environmental problems associated with the commercial manufacture of sanitary products. One approach to "greening" the sanitary product industry may be to develop a product incorporating sphagnum moss. While a sphagnum moss sanitary product does not automatically imply a sustainable industry, the utilisation of this resource may be an improvement upon existing manufacturing processes. Sustainable development may best regarded as a process that can probably never be fully achieved, but provides a general framework for change in our social and economic institutions.

This study investigates the feasibility of commercially producing sphagnum moss menstrual pads in New Zealand. It is hoped that by describing some of the barriers to producing a sphagnum moss menstrual product, not only will some insight be offered into why more environmentally benign menstrual products are not for sale in our supermarkets, but also that some light will be shed on the obstacles to improving the sustainability of industries in general.

1.2 Problem Statement

Disposable menstrual products[1] have only become available in the last fifty or so years, and have been associated with a number of problems. These include risks to women's health, risks to the environment, and certain disadvantages to do with comfort, protection, and perceptions (Consumers' Association Ltd., 1991). These problems have the potential to be overcome, and research into methods for dealing with them could result in an improved product.

Sphagnum moss[2] has been used for centuries in absorbent bandages because of its ability to retain fluid and its mild antiseptic properties (Thieret, 1956). It occurs extensively on the West Coast of the South Island of New Zealand, and recently an export industry has developed. The industry is primarily based on sending moss to Japan for use in the propagation of orchids, and appears to be sustainable in terms of rates of renewal of the resource base (Buxton, Johnson and Espie, 1990). However, reliance on essentially a single market has made the industry vulnerable to price fluctuations. Diversification through product development may increase stability.

The commercial production of menstrual products results in environmental exploitation and degradation. This is in conflict with the objective of sustainability. Because menstrual products are a necessity for women, there is a need to find a way to make them that minimises these negative impacts on the environment. One approach may be to use sphagnum moss as a raw material.

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[1]While sanitary products include all common household paper products, such as toilet paper, facial tissue, paper napkins and kitchen towels, as well as diapers and sanitary napkins, menstrual products are commonly called sanitary products. They are also referred to as "feminine hygiene products", "personal hygiene products" and "personal care products". In this report the terms will be used interchangeably, and unless otherwise stated will refer specifically to menstrual products.

[2]Sphagnum is also known as peat moss or bog moss, but on the West Coast the generic or latin name is used as the common name, as will be done throughout this report.

The production of a sphagnum moss menstrual pad has the potential to overcome problems associated with sanitary products currently available, and may also, by diversifying and "adding value" to the resource, benefit the New Zealand sphagnum moss industry.

1.3 Objectives

This study attempts to shed some light as to why the commercial production of menstrual products seems to imply environmental problems. My intention is to identify some of the factors that may prevent the manufacture of an environmentally friendly menstrual product that is also acceptable to women in terms of concerns relating to health, comfort and convenience.

More specifically, the aim of this study is to research the overall feasibility of producing a sphagnum moss sanitary pad, that:

* is environmentally benign;
* is equal (if not superior) to other sanitary pads in terms of protection, comfort, and aesthetic appeal;
* has a place on the commercial New Zealand market;
* is economically viable to produce; and
* is appropriate in terms of New Zealand legal and health standards.

1.4 Methodological considerations

A case study approach is used to investigate the obstacles to developing a sustainable menstrual product industry in New Zealand. The benefit of the case study is that it has

real world character. In examining the feasibility of producing a sphagnum moss menstrual pad, specific obstacles facing those involved in menstrual product development will be considered.

However, such an approach to research is by its very nature limiting. While it may offer some insight into the barriers to "greening" the sanitary products industry, and industries in general, caution needs to be exercised about drawing general conclusions.

In order to investigate the potential of the envisaged product adequately, the consideration of many factors is necessary. It is difficult to place levels of priority on any of these aspects, and what I choose to do first is a reflection of my own values, preferences and biases. I stress that I am not attempting to be fully comprehensive. The factors I have chosen to place under closer scrutiny are not the only ones, but are the issues that seem most obvious to me.

For example I have chosen not to investigate the implications of producing a sphagnum moss menstrual product for West Coast communities. The question of whether industrial development is desired in the region, especially when applied to menstrual products, would require an in depth investigation into attitudes towards development which is beyond the scope of my research. Poverty, low productivity and unemployment are often regarded as "problems of underdevelopment". In contrast, they may be viewed as problems for our present economic and political system which requires continued growth and development. For this reason, I am opposed to the export of what may be misguided priorities to the West Coast.

Several approaches to information gathering were used, and the study is based on both primary research and secondary sources. The research is exploratory and does

not propose to prove any theory. Rather, the study investigates some of the issues that need to be addressed in order to make sustainable development an achievable objective.

1.5 Outline of the report

The paper begins with a brief description of the development of the sanitary product industry, and the problems it implies for the women's health and the environment in Chapter 2.

In Chapter 3, further background material is given by way of an overview of the sphagnum moss industry on the West Coast of the South Island. These two chapters serve to acquaint the reader with the issues, since there is very little published material concerning menstrual products or New Zealand sphagnum moss. A proposal for a sphagnum moss menstrual product is then outlined.

In Chapter 4 the feasibility of producing a sphagnum moss menstrual product is explored in terms its implications for the environment and women's health, and technical, legal and economic barriers. Findings and implications of the feasibility study are discussed.

Finally, in Chapter 5, the broader implications of the outcomes of the feasibility study are discussed.

CHAPTER 2. Menstrual Products

Menstrual bleeding results when an unfertilised egg is shed along with the lining of the womb of a fertile woman. Menstrual fluid consists of tissue and mucus as well as blood. A period lasts about five days, and is usually heaviest in the first few days. On average, women lose 35 mls of fluid during a period, but both the quantity and duration of menstrual bleeding are highly variable.

Women in different cultures have handled their menstrual flow in many ways. Since earliest times, women have made their own tampons and pads from available materials, often washing and reusing special cloths or rags. Fifty years ago most western women used pieces of cloth to catch their menstrual fluid. Today the majority use commercial sanitary napkins and tampons[1]. A woman with a regular menstrual cycle is going to use on average 6000 to 7000 tampons from menarche to menopause (Women's Environmental Network, 1989).

2.1 Development of the sanitary product industry

The basic human needs for absorbent personal care products are unchanged from prehistoric times but how adequately these needs have been met and the materials used have changed significantly. In past times people have had access to absorbent materials such as dry grasses, peat moss, plant fibres, animal hair and fur, feathers, and

[1]Statistics for New Zealand are unavailable. However, a World Health Organisation survey conducted in 1983 found that only one percent of British women surveyed used home-made protection. This compares with somewhere like Egypt where 57 percent of women used home-made towels (Barbara Christian and Robert Snowden, (eds.), Patterns and Perceptions of Menstruation: A World Health Organisation International Collaborative Study, p. 249, in Treneman, 1989).

spiderwebs. With the development of yarn spinning and weaving, it was possible to make more comfortable and more efficient absorbent products, so that the chore of gathering clean absorbent materials was replaced with the task of laundering reusable articles.

The first disposable article of commercial significance was the sanitary napkin introduced in 1921. This product followed the development of the creping process whereby wet-laid paper (cellulose fibre) could be made soft yet strong (Gross, 1990). The first menstrual tampon was introduced by Tampax Corporation in 1933. The original Tampax brand tampon was made of cotton fibre wrapped in a nonwoven rayon coversheet. Today the absorbent medium used in most modern tampons is wood fibre (cellulose fluff). Fluff is also the principal absorbent material used in sanitary napkins, disposable diapers and incontinence devices (ibid.).

Another development in absorbent technology occurred in the 1960s with the advent of polymeric aqueous gelling agents, now popularly known as absorbent polymers or superabsorbents. These synthetic and modified natural polymers absorb many times their own weight in fluids and allow the fabrication of smaller yet more absorbent articles[1]. Superabsorbent diapers were introduced in Japan in 1979, but have only become widely used in the West since 1984 (Gross, 1990). Most menstrual napkins sold in Japan also contain superabsorbent materials. In New Zealand napkins containing superabsorbents are becoming increasingly popular and are replacing the more conventional cellulose fluff products. This is because the superabsorbent

[1]Superabsorbents minimise leakage since the fluid is held tightly within the material as a gel. With a sanitary napkin, the coverstock (or bodyside lining) of the absorbent structure receives and transmits the fluid. Because superabsorbents are many times more absorbent than the cellulose nonwoven covering fabric, they effectively draw the fluid away from the skin which results in a dry feeling.

technology allows the production of thinner, more efficient, and thus more comfortable and discreet pads.

The sanpro industry is characterised by large multi-national corporations, that have rapidly generated a highly profitable market for their increasingly sophisticated products. Many women who began managing their periods with washable sanitary towels now use disposable products. However, alternatives to commercially manufactured products are still used by some New Zealand women. These include washable towels, sea sponges and diaphragms. It is said that Tuhoe women continue to use certain mosses for menstrual protection to the present day.

2.2 How satisfactory are menstrual products?

Generally women choose tampons for convenience, although for some they are not practical because insertion is difficult and/or painful, discomfort may occur due to dislodging, and for some risks of infection or ulceration of the vagina may be a problem. Disabled women and women who have had many children may find tampons unsuited to their needs, while in some cultures it is not acceptable to use tampons.

Some women choose pads because they find that they suit their needs better than tampons. The disadvantages of pads are that they may chafe or stick, they are bulky and they don't always stay in place. 'Slim' pads (using superabsorbent technology and a plastic shield backing) are less bulky.

For the comfort and well-being of users of absorbent items, modern disposable articles have become increasingly reliable. The incidence of menstruating women having to change their garments because of premature product failure is decreasing. Yet "[e]ven when applied to personal care devices designed for mundane bodily functions,

absorbency is a complex matter. There exists no single, perfect, universal absorbent" (Gross, 1990: 20). Product developers continue to search for more reliable absorbent structures. Additionally, environmental and health concerns complicate the picture as new materials are discovered, developed, proven and implemented.

2.3 Risks to women's health

Toxic Shock Syndrome is a rare disease which can affect anyone, but it is most common in women who are menstruating. It is thought that tampons can sometimes alter the environment of the vagina, so that the normally harmless bacteria *Staphylococcus aureus* starts to produce a toxin. The toxin can be absorbed through vaginal walls into the bloodstream leading rapidly to Toxic Shock Syndrome (Schousboe, 1990). The use of high absorbency tampons has been closely associated with Toxic Shock Syndrome, particularly in the United States.

There are a number of other less well researched medical concerns with menstrual products. Ulcers or sores in the vagina have been associated with tampons, especially if used continuously for long periods of time (Consumers' Association, 1991). This may be intensified with the use of high absorbency tampons.

Some production processes (eg. chlorine bleaching, rayon production) may give rise to dioxins in sanitary products, but they have been found only at very low levels. Exposure to large amounts of some dioxins produces a skin condition called *chloracne,* and many years of exposure to dioxin has also been linked to risk of cancer. In addition to the enormous toxicity of dioxins, they are highly bioaccumulative, being fat-soluble. The cautious consumer may choose unbleached or non-chlorine bleached products.

2.4 Risks to the environment

While there is no doubt that we need sanitary protection, the production of disposable menstrual products has profound implications for the environment because of the number of women using these products. The "feminine hygiene products" industry is presently undergoing a dynamic phase of growth[1].

Chemical pulp-mill effluent contains many carcinogens and pollutants. Chemo Thermo Mechanical Pulp (CTMP) is an environmentally safer and more efficient alternative to the chemical pulping process. The process is cheaper and utilises 90 percent of the tree compared to the conventional pulping's 45 percent. However, it requires a high energy input, and sulphur (which is difficult to degrade) is released in the effluent.

Chlorine bleaching acts to form toxic chlorine based compounds as by-products. Since dioxins are bioaccumulative, they may be passed through the food chain.

Menstrual products need to effectively absorb fluid. Unbleached pulp contains resin acids and other natural wood chemicals that prevent the fibres from absorbing water, and this fact is often used by the paper industry as an argument for continuing to use chlorine in the bleaching process.

But the pulp does not need to be bleached bright white in order to become absorbent. Hydrogen peroxide, for example, removes the resin acids efficiently without having all the negative side-effects of chlorine bleaching. Other methods (sometimes

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[1]Sales of feminine hygiene products are predicted to rise from $2.4 billion in 1989 to over $3 billion by 1995. Compared to previous years, the increase represents a slowing down due to the decline in the growth rate of the 18 to 44 year old female population, the major users of feminine hygiene products (Rosendahl, 1990). However, the paper products sector is set for future growth because of demographic trends, such as women starting to menstruate earlier and women reaching menopause later (Britt, 1990). Sanitary product companies are also expanding their markets, both by creating new markets in less developed countries and by offering a greater range of products such as panty liners 'for those in between days' (Dagnioli, 1988).

called oxygen bleaching) involve chlorine dioxide which contains a residual amount of chlorine gas, so that organochlorine pollution is reduced, but not eliminated (Cook, 1989).

While dioxin-producing processes are not essential for sanitary products and some companies in the industry are no longer using chlorine bleaching, the majority of menstrual products are still made from polluting chemical pulping and bleaching processes.

Sanitary products, due to the numbers used and their bulk, are also problematic for disposal. Many sanitary products go down the toilet. Our sewage systems weren't designed to deal with the "disposable" products we use today. Plastic wrappings and backing shields have to be collected because our sewage works can only cope with paper and human wastes. Pads can also choke drains.

Those products that reach landfills take many years to degrade, and overpackaging adds to this problem. Also, incineration of products containing chlorine based compounds including plastics, has been associated with dioxin emission (Oakland, 1988). This is important, as there is a trend towards using combustion as a means of reducing the need for land filling, while at the same time allowing useful energy to be recovered.

With the recent expansion of production incorporating superabsorbent gelling agents, there is much uncertainty regarding the environmental impact of manufacturing processes and the degradation of the products. While superabsorbent technology has reduced the volume of cellulose pulp required in each pad, there is evidence that these chemicals may release very toxic substances as they degrade.

2.5 Hiding menstrual products

A major part of the discourse surrounding menstruation in Western societies describes it as dirty and unpleasant. Menstrual products are sold on the strength of their discretion and secrecy, and concealment has become the predominant virtue. The emphasis is on maintaining the silence, not letting anyone know that you are menstruating[1].

While menstrual products are a necessary part of life for women, we are expected to buy, store and use them without drawing attention to them. Disposable products have become more acceptable than washable products (which are more obvious since they have to be washed and dried).

Disposable products have also made it easier for women to manage menstruation. Many women choose disposable products for reasons of convenience, and may perceive the health and environmental concerns as negligible or of no interest to them. However, while the convenience of not having to wash the products is real, convenience is closely linked to the perceptions of freedom that we experience when we use disposable menstrual products. Not only have disposable products made dealing with the monthly flow simple and uncomplicated, they have also made it easier to hide our bleeding. The emphasis that we place on convenience with respect to menstrual wear may be exaggerated because of this connection.

The rules of silence that surround menstruation have implications for the menstrual requirements of women. While, for the sake of the environment it may be preferable for women to stop using one-use-only disposable products, this would be

[1]Adolescent girls report that their greatest concern about menstruation is to conceal their sanitary products from others, thus disguising the very fact of menstruation (Ussher, 1989: 32).

oppressive for many women today. Unless attitudes to menstruation change, many women will continue to prefer to use disposable products. However, every woman's experience of menstruation is different, and our needs are diverse. For this reason, it is important that alternatives (ie. both more environmentally friendly disposable products and washable products) should be made available to those women who feel dissatisfied with the range of products presently on the market.

2.6 Conclusions

A researcher for a large sanitary product company regards technological advance as important for adequately providing for women's needs and those of the environment:

> The growing public awareness of the environmental aspects of our throw-away society offers new opportunities for the technologists responsible for creating and improving absorbent products... New materials are sought which are more amenable to recycling, are readily biodegraded, or are environmentally compatible.
>
> The absorbency needs of people are a fact of life and will be met. If the future is a reflection of the past, the absorbent products yet to come will be more convenient and more reliable. This will happen as the fundamental understanding of absorbent processes is transformed into new and genuinely improved products on the shelves of the supermarket (Gross, 1990: 20).

As long as women have been menstruating there has been a need for a safe, convenient, and comfortable way of managing menstrual flow. Regardless of shape, size, or composition, menstrual hygiene products have for centuries been one of two

varieties: internal or external. It has only been within the last 60 years that these products have been made commercially, and only since 1980 with their reported association with Toxic Shock Syndrome that they have come under medical, political and public scrutiny.

With this scrutiny has come the realisation that very little research (outside of the closely guarded in-house studies by the tampon industry) has been focused on the physiology of menstruation, the dynamics of menstrual flow and product absorbency, and health problems associated with menstrual hygiene.

Similarly there has been very little research into the environmental impacts of the production and disposal of menstrual products. Limited investigations imply that waste production is in excess of the assimilative capacity of the environment. There is growing acceptance that the control of wastes at the end of their production is a difficult and expensive process. Emphasis is now being placed on eliminating or reducing waste at the source rather than controlling it once it is produced.

"Disposable sanitary products ('sanpro') have brought convenience and discretion. But with them came increased risks to women's health - and threats to the environment" (Consumers Association Limited, 1991: 176). There is an apparent need to change our approach to the production of menstrual products.

One option is to stop using disposable products, and re-use washable towels instead. Yet for those who prefer a disposable item for convenience and discretion, sanitary protection that combines adequate protection, comfort, safety, while not harming the environment, may not be available.

For this reason, it is important to investigate ways of improving disposable products. One approach may be to change the raw materials used in production, so that

those that are difficult to recycle, treat or dispose of are replaced by more easily managed materials.

In the following section I will investigate the potential of New Zealand sphagnum moss as a raw material for enhancing menstrual products.

CHAPTER 3. Sphagnum moss

Sphagnum species occur throughout the world in a wide range of habitats, and account for at least one per cent of the world's land surface (Malcolm and Malcolm, 1989). In New Zealand, *S. cristatum* is easily the most common of the New Zealand sphagnums, which grow most extensively on the West Coast of the South Island.

This chapter describes the general properties and uses associated with sphagnum mosses. It then gives a brief overview of the present sphagnum moss industry on the West Coast of the South Island of New Zealand. The intention is to provide background information with which to ascertain whether further research into the feasibility of producing a sphagnum moss menstrual product is desirable.

3.1 Properties

Sphagnum has been a useful plant to human beings for thousands of years, due to its great absorbent power, its sterility, its slightly acidic nature, and the antiseptic properties of some species.

(i) Liquid Retention

The considerable absorptive powers of sphagnum are related to the anatomy of the plant. The leaves and branches of sphagnum are composed of small green living photosynthetic cells which surround large empty "hyaline" cells. These are dead cells which have large pores and internal wall thickenings. They will readily fill with water so that the holding capacity of the moss may be as much as fourteen to twenty times the dry weight of the plant. The hyaline cells of sphagnum leaves and branches are

strengthened so that they maintain their shape and consequently water holding capacity, even when the plant is dried and dead. The ability to retain water is enhanced by the dense arrangement of branches and leaves (Denne, 1983).

(ii) Antiseptic properties

Some species of sphagnum moss have an historical association with medical hygiene. Dried sphagnum is offered for sale in various herb shops in parts of China, and is used in the treatment of acute haemorrhage and eye diseases. Sphagnol, a distillate of peat tar, is supposed to be useful for the treatment of several skin diseases and has also been recommended to relieve the itching of insect bites and even to prevent them. The Alaskan Indians make a salve for cuts, by mixing sphagnum leaves with tallow or other grease (Thieret, 1956).

Microbiological examination shows the presence of a few harmless organisms. The presence of *Penicillium* might well account for sphagnum's healing properties (Williams, 1982). Unfortunately there has been no published research into the microbiology of New Zealand species.

(iii) Mildly acidic

Sphagnum is able to accumulate the ions necessary for growth from extremely dilute solutions, showing selectivity in the ions it absorbs. By exchanging hydrogen ions for other cations, sphagnum creates an acidic environment in which it flourishes and the plant itself is mildly acidic (Crum, 1972).

(iv) Compressibility

The ability to compress sphagnum, makes it economical to package and transport, and allows thin absorbent pads to be made.

3.2 Use in absorbent bandages

Plants belonging to several species of the moss genus *Sphagnum* can hold large amounts of water. This feature has made sphagnum useful to humans for thousands of years. Many of its former uses have been gradually replaced, with technological advances in synthetic materials providing alternatives.

Traditional cultures throughout the world have used sphagnum in lieu of socks, diapers for babies, and sanitary pads for menstruating women. Maori women used the absorbent and insulating properties of sphagnum to line baskets for babies. These were changed regularly to keep the baby clean and warm (Macdonald, 1974).

Historically sphagnum has been used for making absorbent bandages, because of its antiseptic properties and its ability to retain liquids. During the First World War, sphagnum was used extensively for surgical dressings, thus freeing cotton for the manufacture of gunpowder. In 1916 the British War Office accepted them as "official" dressings, and by the end of the war the total British output was estimated to have been about one million pounds per month (Nichols, 1918). Moss dressings were made in most European countries at the time, and also in the United States and Canada. Construction of the dressings varied over time and from country to country, but they were generally a flat bag of muslin with a fine enough weave, so that the particles of the moss would not sift through. This bag, which varied in size according to need, was filled with the appropriate amount of moss and sewn up. This large scale use and the

concurrent scientific investigations into the properties of sphagnum moss, proved that the traditional beliefs in its virtues were well justified (Williams, 1982: 714).

"For use in absorbent pads, the sphagnum is not merely equal to absorbent cotton - it is superior to it" (Nichols, 1918: 53). Apparently sphagnum has the following advantages over cotton for surgical use:

(1) moss absorbs liquids much more rapidly, about three times as fast and in amounts three to four times as great as cotton;

(2) sphagnum retains liquids much better, thus reducing the number of times the dressing needs to be changed;

(3) Sphagnum distributes absorbed liquids more uniformly throughout its mass;

(4) sphagnum dressings are cooler, softer and less irritating than those made with cotton; and

(5) these dressings can be produced at much less expense (Nichols, 1918).

"As a dressing, the moss is de-odourising and does not allow discharges to pass through as does cotton wool" (Williams, 1982: 713).

Hotson noted that there seemed "every reason for believing that it (the practice of making surgical dressings from sphagnum moss) is not going to be discarded after the war ends" due to its inexpensiveness, high absorbency, its abundance, and in its undoubted superiority over gauze and absorbent cotton for some purposes (1918: 208). During World War II, attention was again called to peat moss as a suitable material for surgical dressings, but apparently the need for a cotton substitute never became critical (Thieret, 1956).

There is no doubt that sphagnum moss is effective in wound treatment. However, "recent research into wound dressings is conspicuous for its lack of interest

in moss and its advantages. The emphasis nowadays is on the search for new synthetic substances" (Williams, 1982).

3.3 The sphagnum moss industry on the West Coast

Although many of its former uses have been discontinued, sphagnum is still used in horticulture as a sterile medium for water retention in mulching plants. Almost ninety percent of New Zealand's moss is exported to Japan, where it is used by orchid growers. Home hobbyists and commercial growers wrap the moss around the roots of orchid plants, and require each strand to be of a certain length and quality. Some variability is acceptable, since moss is a natural product.

(i) Development of the industry

Before the export market for sphagnum was realised, moss was gathered on a small scale and sold within New Zealand for horticultural use.

The first exports to Japan were made in the early 1970s. Trade has grown rapidly in the last 15 years, to an industry involving numerous individuals and several large companies. With the increase in demand for New Zealand moss, exporters have increased production from around 10 tonnes in 1977 to an estimated 1000 tonnes in 1990. The industry returned around $14 million in 1990, and probably 70-80% was returned to the West Coast.

New Zealand moss is considered high quality, and only first grade moss is sent (long, good colour and low contamination). Second grade moss (shorter, dark brown and more impurities) constitutes the local New Zealand supply. However, much of this moss is dumped, along with third grade moss. This is especially the case when gluts

in the market cause moss prices to drop.

The market may have reached its ceiling at around 800 tonnes per annum. During the 1990-91 season, nearly 1000 tonnes was exported, which was about 200 tonnes more than in the previous year. There was a downturn in the market, suggesting that the extra 200 tonnes was an oversupply (Buxton, 1991). This has probably resulted from a combination of the effects of new entrants to the export market falsely inflating demand, large export companies taking over the market by driving prices down, and importers playing off exporters against each other (New Zealand Trade and Development Board, 1989).

This flooding of the market has caused prices to drop by around 5%, and has implications, not only for exporters, but also for those who have lost their jobs as a consequence. Oversupply is not a new phenomenon in this youthful industry. Observations indicate that the industry would benefit from a coordinated marketing approach.

Although the industry is beginning to coalesce after ad hoc development during the boom period in the 1980s, it is still fragmented and those involved are attempting to assess the sustainability of the resource and develop strategies for effective marketing. Reliance on virtually a single market leaves the industry vulnerable, and many are eager to diversify (New Zealand Trade and Development Board, 1989).

(ii) Implications for West Coast Communities

The sphagnum moss industry has numerous positive effects on West Coast communities in terms of employment and flow of capital. It is difficult to accurately assess how many are involved in the industry. A conservative estimate is probably around 250

people involved on a full time basis and 350 on a part time basis (Buxton, Johnson and Espie, 1990). Export earnings are high and the present production provides substantial financial input into a relatively depressed regional economy. For these reasons, it is in the interests of the community to manage the resource wisely, so that the supply of moss is not exhausted through exploitation.

Sphagnum moss (*rimurimu*) was used in the past and was a valued resource of the tangata whenua. While Maori people are involved in the industry, traditional values are not incorporated into the management of the moss (Jimmy Russell, 1992), and some perceive that the moss is being exploited in a similar manner to the abuse of the forests in Westland.

(iii) Environmental implications

There is relatively little potentially productive land on the West Coast and the way land is utilised is an important issue for the people of the region. Sphagnum moss harvesting compares favourably with sheep and cattle farming, and forestry on similar lands in economic efficiency, sustainable use of natural resources and environmental quality (Denne, 1983). The intensity of extraction has only been at the present level for the last five or so years, and there is much uncertainty as to the effects this has on the environment. However, growth rate experiments appear to indicate that the present productivity can be maintained, and that long term "moss farming" has future potential (Buxton, Johnson and Espie, 1990).

(iv) Is diversification a good thing?

The sphagnum moss industry is beneficial to West Coast communities and appears to

be sustainable. However, rapid and disjointed expansion has resulted in a fragmented and unstable industry, without a secure future. Diversification through an "adding value" approach is one possible approach to increasing the resilience of the industry. Because the bulk of the lower grade moss is effectively a waste product of the present industry, it may be an ideal raw material for the production of sanitary pads in New Zealand.

3.4 A new market for sphagnum moss?

The West Coast sphagnum moss industry has a number of problems associated with it, as does the production of sanitary products. A sphagnum moss menstrual product industry appears to have the potential to overcome these problems. This is because sphagnum moss is a potentially sustainable resource, the extraction of which causes minimal damage to the ecosystem. It does not require pulping and bleaching processes that produce polluting effluent. It also has absorbency properties which will allow the construction of a much thinner and more comfortable and more absorbent pad, without relying on superabsorbent technologies. Its natural deodorising properties and sterility give it added appeal. Production in New Zealand would minimise energy costs of transportation and make us self-sufficient in terms of a basic human need.

The hypothetical product

An inexpensive, effective, totally biodegradable, disposable sanitary pad which is able to be produced in New Zealand is envisaged.

The pad is constructed from an absorbent core of compressed sphagnum moss, contained within a nonwoven covering material (produced so as to cause the minimum

of damage to the environment in terms of production processes and disposal), and is to be worn inside standard women's underwear, being attached by an adhesive strip. It would be ideally suited for disposal by incineration, burial, or composting.

The moss used in its construction is a by-product of the sphagnum moss industry, being sorted Grade III moss (that which is presently dumped).

The presence of a sphagnum moss pad on the Canadian market

It is important to note that when my research on the potential of using sphagnum moss in sanitary pads was begun, I was not aware of other research in this field. However, the sanitary product giant, Johnson & Johnson, has recently released a new line of thin sanitary napkins in New Zealand, with an absorbent core of processed peat moss: "Sure and Natural Prima" (New Zealand Business Review, 1991). The product appears superior to many other pads in terms of absorbency and comfort, although it relies on a plastic backing shield, and the pads are also individually wrapped in plastic.

The presence of Johnson and Johnson 'Prima' demonstrates that it is technically and economically possible to produce a moss pad on a commercial scale.

3.5 Conclusion

From this brief analysis of menstrual products and the sphagnum moss resource, the development of a sphagnum moss menstrual product industry in New Zealand appears to offer positive solutions to a number of problems. Why then hasn't an industry emerged? In the following section, the feasibility of producing a sphagnum moss menstrual pad in New Zealand is assessed. The aim is to determine, what barriers, if any, prevent such development.

CHAPTER 4. Evaluating the feasibility of producing a sphagnum moss menstrual pad in New Zealand

4.1 A framework for evaluation

In this section closer scrutiny is given to the feasibility of producing a sphagnum moss menstrual pad in New Zealand. There are a number of issues that require clarification in order to determine whether or not it is possible to produce a sphagnum moss sanitary pad that is environmentally friendly, equal (if not superior) to other sanitary pads in terms of protective efficiency, comfort and disposability, that has a place in the market, is economically viable, and fits in with health and legal standards. Those issues which are to be addressed are divided into the following set of hypotheses:

(i) environmental implications

That a sphagnum moss menstrual product is feasible to produce in terms of the sustainability of the sphagnum resource, the processing outputs of production, and the biodegradability of the product.

(ii) health implications

That a sphagnum moss menstrual product is feasible to produce in terms of issues of women's health.

(iii) technical implications

That a sphagnum moss menstrual product is feasible to produce in terms of the materials used in production, the design of a suitable product, and in terms of the manufacturing process.

(iv) legal implications

That a sphagnum moss menstrual product is feasible to produce in terms of

health regulations and patent law.

(v) economic implications

That a sphagnum moss menstrual product is feasible to produce in terms of economic viability, and that there is a market for the pads.

While the division of the feasibility study into these categories is useful for analysis, these aspects are interdependent, and as the analysis proceeds, many overlaps will become apparent to the reader.

4.2 Environmental implications

> It is of considerable concern that harvesting is being carried out without knowledge of the biological and hydrological importance of sphagnum wetlands, and without the information necessary to ensure that the resource is managed for sustainable yield (Johnson, 1988: 2-3).

Research into New Zealand species of sphagnum is limited, and very little is known about its ecological and physiological characteristics. For this reason much of the information given here comes from studies made in other countries. For more detail on New Zealand sphagnum moss see Denne (1983) and Sainsbury (1955).

(i) Ecological significance

Sphagnums are large robust mosses, and often form deep hummocks of luxuriant

growth. The adult plants reach over 30 cm in length and vary in colour from pale green to brown. Mosses do not have an outer protective layer (the cuticle which occurs in most higher plants), so that the exchange of water takes place directly through the cell walls. For this reason mosses are restricted to humid or aquatic habitats, where water balance can be maintained. Sphagnums generally grow in swampy areas which are called peat bogs. These are habitats of low nutrient status to which the plants are well adapted, and occur as a result of natural succession, or in some instances, the clearing of forest. This modified land is known on the West Coast by its Maori name, *pakahi.*

A number of rare plants are found in some West Coast swamps. Bogs do not usually support large numbers of animals, but may provide a habitat for some mudfishes and the uncommon South Island fernbirds. It is likely that they also support invertebrates, eels, freshwater crayfish, frogs, skinks and geckos. Most animals are dependent on the vegetation at the edge of the wetland (Denne, 1983).

There is a need to ascertain whether moss can be harvested without significant detraction from the ecological value of the biological community, especially with regard to sites on conservancy land. Investigations to assess the environmental implications of moss harvesting are beginning, but understanding the impacts of harvesting on bog ecosystems, natural succession and forest regeneration, awaits the results of long-term research. International studies show the importance of mosses in general in soil conservation and the succession of vegetation (Thieret, 1956). Sphagnum probably plays an important role in controlling drainage on the West Coast. Wetlands may attenuate flood peaks and sustain low flows. However, harvesting of sphagnum moss is likely to have a negligible impact on the hydrology of large rivers, since only a small

area of a catchment is affected by the gathering process[1] (Duncan, 1991).

It appears that moss harvesting does result in some loss of ecological integrity and the removal of sensitive elements. However, it can be harvested while still retaining the basic ecosystem structure, and in most instances will regenerate relatively quickly. The protection of bogs in conservation areas is vital in order to retain unmodified natural ecosystems. These are the "untouched baselines and remnants in our extensively modified country" (Buxton, Johnson and Espie, 1990: 26).

(ii) Sustainability of the sphagnum resource

The West Coast relies heavily on extractive industries such as gold and coal mining, and logging. This has influenced the way the people of the region perceive resource use. If sphagnum moss is regarded as a "boom and bust" industry, then sustainable management is not an issue. However, the management of this renewable resource on a long-term basis is not only in the interests of those who earn a livelihood from moss, but of benefit to the whole community, including future generations.

An investigation into the growth rates and regeneration of sphagnum on the West Coast has been initiated by the Department of Conservation, in order to determine the impact of moss harvesting on the sustainability of the resource and on other vegetation (Buxton, Johnson and Espie, 1990). Growth rates of *S. cristatum* appear to be extremely high in comparison with other countries, probably due to the unique climatic conditions on the West Coast. Observations by harvesters suggest that regeneration to

[1]Also presumably most harvesting occurs in lowland areas, while the highest rainfall on the West Coast is in the mountains (greater that 10 mm per annum in contrast with 2-3 mm in lowland areas). Upland areas are therefore most important for hydrology. At a situational level, peat bogs soak up water from rainfall and thus control flows to some extent by releasing it slowly to the environment. However, if the moss is already saturated from an underground water supply, water will flow over the moss as it would over open ground (Duncan, 1991).

a harvestable length takes between three and seven years, and growth rate observations appear to confirm this (ibid.).

The rate of moss regeneration is dependent upon a number of environmental factors, such as climate, nutrients, shade and support, and therefore varies from site to site. Generally, sphagnum will reestablish if some live material is left after harvesting. This usually requires no special effort from the picker as it will grow from small branches which drop off during handling. However, methods used to pick the moss and remove it from the harvest site have a major effect on its regrowth. Water tables are vulnerable to change if disturbed, which can result in loss of regenerative capacity. To enhance regeneration moss must be removed in a way that minimises damage while maximising yield. Each individual site will require a different management strategy, based on the observations of the picker. Because sphagnum obtains nutrients from precipitation, repeated harvests are unlikely to reduce future productivity. However, some harvesters note that it is not as easy to find sphagnum as it was in the early days.

Some people in the industry are looking towards moss "farming" because of a desire to establish reliable and non-exhaustible supplies of moss. Limited farming techniques and harvesting in an environmentally sensitive manner have resulted in some of the best moss on the Coast (Yarwood, 1990). Farming moss to encourage higher growth rates is yet to be practised on a wide scale. It may have future potential, but little is known about optimal commercial conditions.

The bulk of the moss is found on land owned by the Department of Conservation, Timberlands Ltd. and Landcorp, and is protected under a number of legislative acts including the Conservation Act 1987; National Parks Act 1980; Reserves

Act 1977; Environment Act 1986; Resource Management Act 1991 and State-Owned Enterprises Act 1987. There is no overall management policy for the sphagnum resource. At present most moss is administered on a more or less open access basis, by means of licences. The terms and conditions of the licenses vary with each agency. Because short-term licenses appear to encourage the exploitation of the resource, there is a trend towards longer-term renewable licenses to encourage sustainable harvesting.

Sphagnum is a renewable resource and sustainable yield harvesting is possible. Growth rate experiments indicate that the present productivity can be maintained, and that long-term moss "farming" has future potential. However, there is much uncertainty with regards to the long-term effects of the present industry on the sphagnum moss resource. The history of resource exploitation on the West Coast suggests that predictions for the future may be rather optimistic, and that resource exploitation could easily occur unless strict management rules are put in place.

In addition, the potential effects of the development of other products on the sphagnum moss resource is also a consideration for sustainability. While it can be assumed that sphagnum moss menstrual products would be based on the by-product of the present industry (the discarded low-grade moss), the expansion into new products may have unintended consequences. For example, such an industry may encourage increased levels of harvesting and perhaps more intense harvesting methods that may result in fewer fragments being left behind for regeneration.

(iii) Processing outputs of production

The existing approach to environmental protection allows for the use of harmful raw materials and products, and the discharge of polluting substances. "Cleaner production"

is a concept concerned with the efficient use of raw materials, energy, and the minimisation of waste (Haskell, 1992).

Externalities of production of a sphagnum moss menstrual product are dependent upon the method of manufacture, which is at present unknown. In searching for ways to produce a moss pad, the question of whether or not the process is polluting or harmful to the environment should be a major factor in making choices.

The advantage of sphagnum is that it requires relatively little processing compared with pulp products, so that many of the harmful environmental side effects are avoided. Non-renewable inputs for providing the raw product are minimal (fuel for transportation and kilns, materials for packaging). However, the manufacturing process would be material and energy intensive, and some sort of chemical or sterilising treatment may be required. Research into the outputs of production would need to be undertaken concurrently with research into an economically viable manufacturing process.

(iv) Biodegradability

Last year the Ministry for the Environment released a discussion paper on conserving resources and reducing rubbish and pollution: "Producing Less Waste" (Bailey, 1991). The ultimate goal of production is seen to be the prevention of waste at its source rather than the control or management of it after it has been produced.

While the "garbage crisis" requires that we focus on waste reduction rather than waste treatment and disposal, disposable menstrual products are, by definition, commodities that must be disposed of. Because the management of waste from sanitary products is problematic, rates of degradation should influence the choice of materials

used in the final product.

Biodegradability is dependent upon the both the composition of the final product and the method of disposal. There do not appear to be studies into the rate of decomposition of *S. cristatum*, and how this compares with other products, and further investigation would be required.

On a cautionary note, swamps are renowned for their powers of preservation. For example, centuries old wooden Maori artifacts have been found intact in peat bogs. However, this characteristic results primarily from the anaerobic conditions of swamps, which causes decomposition processes to be arrested. Similar conditions prevail in landfills (rubbish dumps). The decomposition of menstrual products (or any material for that matter) is significantly retarded and in some cases suspended in landfills where anaerobic conditions are created by piling rubbish under layers of dirt.

Sewage systems work by creating an aerobic environment to speed up the decomposition process, and may be able to deal with a sphagnum moss product. However, menstrual pads are not designed for disposal in this manner since they are bulky and would block drains, so that this is not a feasible option unless our sewage systems are completely redesigned. Also, menstrual fluid is proportionally rich in nitrogen, which is difficult and expensive to treat.

An alternative approach to disposal is composting. Sphagnum moss would be ideal for this purpose, as it is a valuable horticultural product because of its moisture retention properties. Similarly the addition of blood (menstrual fluid) would provide valuable sources of nitrogen to the compost medium. This is, however, a long-term proposition requiring re-education on how to dispose of rubbish in general. It is also complicated by attitudes to menstruation, which would make it unacceptable option for

many people.

The chemical properties of sphagnum moss during decomposition are also unknown. However, it seems safe to predict that it would compare well with other products, especially those of comparable thinness which contain superabsorbent gels. Sphagnum moss is unlikely to contain harmful toxins that would be released to the environment upon decomposition. However, if antimicrobial agents are used, as is probably the case with Johnson & Johnson Prima, decomposition would be retarded.

(v) Conclusions

Studies initiated by the Department of Conservation on the West Coast into the growth rate and factors affecting regeneration are showing positive results (Buxton, Johnson and Espie, 1990). Market indicators suggest that current demand for moss is reaching its upper limit. This combined with the apparent biological sustainability of present harvesting rates implies the potential of the development of a long term industry. However, "[t]he economic viability of sphagnum harvesting can only be properly assessed if it includes research and management costs of ensuring the operation is sustainable and does not have adverse effects on land and water systems" (Johnson, 1988: 12).

Thus the feasibility of producing a sphagnum moss menstrual product in terms of ecological sustainability appears positive although much uncertainty remains. Research into sustainable levels of harvest and ecological impacts of harvesting is desirable to ascertain the risks associated with such an industry. Research would be also be required to determine the suitability of *S. cristatum* in terms of outputs of production, rates of degradation, and chemical properties during decomposition.

4.3 Implications for women's health

While environmental and human health are ultimately linked, potential risks for women's health associated with the use of menstrual products need to be considered. An understanding of the medical aspects of female anatomy and physiology is necessary in order to determine the suitability of constructing sanitary pads from sphagnum moss. This understanding would determine whether or not a microbiological study of *S. cristatum* would be required. It is important to obtain this information in order to determine what processes related to hygiene must be incorporated into the technical production process.

(i) Infections of the genital tract

The following is a brief description of those aspects of the biology of the genital tract that are relevant to menstrual protection. For more detailed information see Barnes and Chamberlain (1988), Llewellyn-Jones (1990), and Reame (1983).

The genital tract forms a continuous open pathway from exterior to the peritoneal cavity, and a natural defense system against ascending infections is therefore necessary. Infections to the genital tract concern the vulva, the vagina, the cervix and the uterus. However, generalised infection is more common than infection specific to an organ (Barnes and Chamberlain, 1988).

Protection against infection is achieved by both physical and chemical means. The entrance to the genital tract is effectively closed by the apposition of the labia and the walls of the vagina. The vagina is also protected by vaginal acidity. Bacteriolytic mucus at the cervix serves as a functional closure, preventing the entry of bacteria to the uterus.

The normal secretion of the vagina is acid (pH between 3.5 and 4.5), and is made up of made up of epithelial cells containing glycogen and bacteria. At menstruation these conditions are somewhat changed. The cervical plug is absent, and vaginal acidity may lowered by the alkaline menstrual discharge[1]. This lowering of natural defense through loss of acidity is somewhat balanced by the secretion of menstrual fluid, effectively cleaning the vagina.

In summary, pelvic infections would be more serious and frequent if it were not that: (i) the vaginal cleft is normally closed and the vaginal walls in apposition; (ii) vaginal acidity is a barrier to bacterial growth; and (iii) the endometrium is shed during menstruation each month (Llewellyn-Jones, 1990).

(ii) Implications of menstrual products for women's health

Generally the vagina is able to look after itself very well. However, internal menstrual tampons can alter conditions of the vagina and increase risk of infection. For example, while staphylococcal toxaemia (Toxic Shock Syndrome) is uncommon, tampons have been implicated in a high proportion of cases. Gynaecological texts now recommend that women take care when using tampons:

> Risk is reduced considerably if women chose tampons made of cotton or non-enhanced rayon, and of low absorbency. It is also recommended that tampons should be changed every 4 hours and avoided at night when a pad should be used" (Llewellyn-Jones, 1990: 58).

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[1]Investigations by Reame (1983) showed that for her survey the mean pH of menstrual fluid was 6.3, but was subject to wide variation, ranging from 4.7 (acid) to 7.3 (neutral). Findings suggest that women with typically acid flows may be at less risk for invasion by organisms requiring an alkaline environment.

External menstrual protection is thus required by women who are vulnerable to infections and/or unable to use tampons (for example physically disabled women). Many women may choose to use external protection to minimise risks of infection, or because they find that tampons are uncomfortable and perhaps provoke cramping.

Generally, external menstrual protection should not be problematic, provided it is hygienic and non-irritating. The vulva is subject to diseases which may affect skin in general, and also to certain specific conditions. Irritation may be caused by allergies to drugs and chemicals, dietary deficiencies, parasites, or due to vaginal discharges associated with infection (Barnes and Chamberlain, 1988). However, the vulva is remarkably resistant to infection. The secretion of the apocrine glands is rich in undecylenic acid which is fungicidal.

(iii) Health Regulations

There is no specific legislation for sanitary pads and tampons in New Zealand. They are all treated by the Department of Health as if they were medical devices and are therefore controlled by the Medicines Act 1981 and Medicines Regulations 1984. This legislation states that a medical device cannot be sold if it is unsafe or if it is injurious to the health of a person. It also refers to misleading advertising. There is no requirement for registration or for products to have the consent of the Minister prior to distribution, as is the case with products classified as medicines.

The Department of Health has on-going testing programmes for medicines and medical devices, which are carried out by the Department of Scientific and Industrial Research (DSIR) and the New Zealand Communicable Disease Centre (NZCDC). In this programme groups of products are tested for their microbial content and safety.

Products referred to the Department as complaints are assessed on an individual basis. If a product is found to be unsafe or injurious the Department is able to require the distributer to recall it or withdraw it from circulation (Cavanagh, 1991).

In the USA, standard absorbency testing and labelling for tampons has been required by law since March 1990[1] (Consumers' Association Ltd., 1991: 179). This labelling also allows a tampon with the same absorbency to be selected when different brands are used. In New Zealand it has been recommended that companies distributing tampons introduce a similar system (Cavanagh, 1991).

Following the association of Toxic Shock Syndrome with tampons, the Department obtained an agreement with the industry that all tampons sold in New Zealand would contain specific warnings on this problem and would comply with a number of other requirements: enclosing a pamphlet on Toxic Shock Syndrome; submitting the formulation of any new brand of tampon; monitoring levels of dioxins; protecting the products with adequate packaging; and being sourced from a country that imposes Good Manufacturing Practices on tampon manufacturers.

In contrast, the rules concerning menstrual pads have not been formalised by agreement, and are therefore less stringent. This seems to be a logical approach, since menstrual pads have not generally been associated with health risks. The Medicines Act

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[1] In 1980 the Food and Drug Administration (FDA) adopted a rule classifying menstrual tampons under the Medical Device Amendments of 1976 as class II medical devices. For thirty years, tampons had been classified as cosmetics and had only recently been upgraded to the general category of "devices". An effect of this legislation was to provide for the development of a national performance standard for the safety and efficacy of menstrual tampons. (Menstrual pads are classified as class I medical devices being in the same category as tongue depressors and therefore not subject to performance standards). In 1989 the FDA released a final rule to amend its menstrual tampon labelling regulation to standardise each of the terms currently used to describe tampon absorbency, junior, regular, super and super plus, so that each term represents a 3-gram range of absorbency. The rule requires that the manufacturers describe the absorbency using the term that corresponds to the absorbency of their tampons as determined by a test method specified in the final rule. The purpose of the final rule is to enable consumer to compare the absorbency of one brand and style of tampons with the absorbency of all other brands and styles (Reame, 1983).

functions as a safety net for products that are found to be unsafe or injurious. However, because there is no liability involved, producers are free to experiment with new technologies and materials, and this may not always be in the interests of women's health. For example, there is no requirement for pre-market testing and research into the effects of new products such as pads containing superabsorbent polymers. Women must therefore rely on the integrity of manufacturers, who may also be interested in preserving reputations for quality products.

(iv) A sphagnum moss menstrual pad and women's health

Because risks of Toxic Shock Syndrome are closely associated with high absorbency tampons, and because of the absorbency properties of *S. cristatum*, moss is unlikely to be a suitable raw material for the production of a menstrual tampon.

Because menstrual pads are used externally, requirements are less stringent, and high absorbency is advantageous. Pads need to be hygenic but not sterile. In fact no menstrual products sold in the supermarket are sterile.

Health regulations do not create barriers for manufacture of sphagnum moss pads. Rather, they provide a set of logical rules which function to guide manufacturers to take care to produce a safe product.

Of concern would be allergenic reactions to sphagnum moss because of its mild acidic properties. This might present a problem for some women, but is unlikely to affect the majority, especially if enclosed within a paper coverstock.

Another concern would be the possibility of introducing pathogenic organisms to the vagina. The potential of this could be increased because of the acid nature of the moss. Acid-loving and acid-tolerant microorganisms are likely to be contained within

untreated moss. For this reason microbial investigations would need to be carried out in order to ascertain risk, and the raw product may need to be treated in some way so as to make it hygienic. While risks with contamination are probably minimal, these should be explored to ensure that the product is safe.

4.4 Technical feasibility

In meeting the needs of women, a menstrual pad must fulfil a number of requirements, including comfort, convenience, effectiveness, and hygiene. A manufacturing process that is economically viable and appropriate in terms of the environment must also be developed.

The existence of Johnson & Johnson "Prima" indicates that it is technically possible to produce an effective and comfortable pad, and also that health concerns have been addressed. Patent literature, which will be discussed in the following section, provides a wealth of information on production processes. However, before extensive research is undertaken, it is necessary to determine if New Zealand moss is useful for this purpose, since it is a different species to that used in Canada.

For this reason, a number of experiments to assess the suitability of New Zealand sphagnum moss for use in a menstrual pad were conducted. Experiments were restricted to *S. cristatum* because, although at least five species of *Sphagnum* occur on the West Coast, *S. cristatum* is the only species useful to the Japanese horticultural market and is therefore the basis of the moss industry[1]. Sterility, water holding

[1]Sphagnum australe resembles S. cristatum and is sometimes harvested and sent to Japan. However, it occurs much less extensively than S. cristatum and is proportionally insignificant to the industry.

capacity and acidity, were investigated. The experiments are written in full in Appendix One.

(i) Sterility

While menstrual products are not sterile, in order to minimise the risk of infection by pathogenic organisms, "sanitary"[1] products should be made from "hygienic" raw materials. In other words, "contamination should be minimal and at 'safe' levels" (Schousboe, 1992). For example, wood pulp products have been subjected to a bleaching process, so that presumably they contain only air-borne flora. Strict adherence to hygienic practices in sanitary product manufacture is vital in minimising both the type and number of microorganisms.

Because sphagnum mosses have been used medicinally for thousands of years and are purported to have a natural sterility and antiseptic properties, it was thought important to investigate whether or not these claims were applicable to *S. cristatum.* Because the identification of microorganisms is a time-consuming and difficult exercise, determining the microbial flora of *S. cristatum* was an unrealistic goal for research, and instead *S. cristatum* was investigated for any bacteriostatic properties.

Few raw materials used in making pharmaceutical products are sterile as received, and special treatment may be required to render them microbially acceptable for use. Grown, collected, processed and packaged in open conditions, moss harbours a number of soil and air-borne microorganisms. For this reason, the effectiveness of

[1]Sanitization refers to the reduction of microbial contaminants to safe levels as determined by public health requirements.

a number of sterilisation processes was investigated[1].

(ii) Absorbency

While there is no published data on the water holding capacity of *S. cristatum*, New Zealand moss is regarded as highly absorbent compared to other sphagnum species throughout the world. The ability to rapidly absorb and retain menstrual fluids is vital for the effective performance of menstrual products. Experiments to determine the water holding capacity[2] of *S. cristatum* are useful indicators of the ability of sphagnum moss to absorb menstrual fluids[3]. For this reason, a standard method for determining water holding capacity of *S. cristatum* that could be used in comparative experiments was devised.

Water holding capacity varies in different parts of the same plant, seasonally, and from plant to plant, depending upon environmental history and genetic make up,

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[1]It is assumed from scanning patents, that Johnson & Johnson have dealt with the issue of hygiene by incorporating an antimicrobial chemical, "Dowacil 200" into the Prima moss board (EU 0 171 932/A1). Presumably the moss has been sanitised in some way prior to the addition of the chemical, as "[a]ntimicrobial substances should not be used solely to reduce the viable microbial count as a substitute for good manufacturing practice" (United States Pharmacopeial Convention, Inc., 1985). All useful antimicrobial agents are toxic substances, and the presence of dead microorganisms or the metabolic by-products of living microorganisms may cause adverse reactions in sensitised persons. For maximum protection for the consumer, the concentration of the preservative shown to be effective in the final packaged product should be considerably below the concentrations of the preservative that may be toxic to human beings. Thus the use of antimicrobial substances should be used primarily to inhibit the growth of microorganisms that may be introduced inadvertently during or subsequent to the manufacturing process.

[2]The term 'water holding capacity' is used because it is considered more accurate and less subject to interpretation than the term 'absorbency'. 'Absorbency' can be both a qualitative term describing a property (ie. a pad absorbs water) and a quantitative term describing capacity (ie. a pad absorbs 10g of water). In contrast, 'water holding capacity' can only be interpreted as a quantitative term encompassing the characteristic to be measured.

[3]There are no standard procedures for measuring the fluid capacity of menstrual pads. Menses, blood, and synthetic fluids were used in the development of a test method for determining the absorbency of tampons, but it was concluded that "there was a good correlation with saline which is easily acquire and not as messy" (Weigle, 1992). Syngyna fluid is a saline solution consisting of 10g sodium chloride in 1000 ml of purified water and 0.5 g of acid fuschin dye.

so that it is not possible to determine an absolute water holding capacity value for sphagnum moss. As well as the natural variability of the moss, measuring water holding capacity is problematic because of potentially excessive adherent water after immersion, and the ready exchange of moisture with the atmosphere exhibited by *S. cristatum.*

The standard method was used to measure changes in absorbency of *S. cristatum* after being subjected to a number of sterilisation and grinding treatments, since the production of sphagnum moss menstrual products would involve such processes[1].

(iii) Acidity

The acid nature of *S. cristatum* is of interest when investigating its potential for use in a sanitary pad, since acidity has implications for the type of microbial flora it contains, as well as potential for the moss to cause skin sensitivity and irritability.

(iv) Conclusions

S. cristatum is highly absorbent compared to other raw materials used in the production of menstrual products (surpassed only by superabsorbent gels). It has a "saturation water content" of about 25 times its dry weight, and is likely to be a suitable raw material for the production of sanitary products in terms of its water holding properties.

Because it is not sterile and does not appear to exhibit antimicrobial properties,

[1]Johnson & Johnson used screened milled moss to produce absorbent moss boards, in order to remove the smallest particle which would block manufacturing machinery. Also the by-product of the West Coast sphagnum moss industry, which would be used in the pads, is primarily composed of smaller sized pieces.

some sort of sanitising or sterilising process would be required for commercial sanitary wear production.

Heat sterilisation processes were effective, but some loss of structural integrity was observed. This corresponded to a reduction in water holding capacity. However, the moss was still highly absorbent when compared to other absorbent substances.

While it is likely that sanitization would involve some sort of heat treatment, the treatment is unlikely to be as radical as sterilisation, so that greater absorbency would be retained than indicated by these experiments. Indeed current drying practices may be sufficient, but further research would be required to determine the health risks.

At pH 4.5, the acidity of *S. cristatum* is similar to that of the vagina, which typically exhibits a pH in the range of 3.5 - 5.5, depending on the individual woman, the phase of the menstrual cycle, health etc. This pH is only slightly more acidic than skin, which is generally around pH 5, indicating that is unlikely to cause irritation in most women, especially if overlaid with a paper nonwoven coverstock. However, some women may show sensitivity to *S. cristatum.*

These experiments are merely preliminary indicators of the likely potential if *S. cristatum* as a filling material for menstrual products. They indicate that *S. cristatum* is an ideal raw material in terms of its absorbency. Much uncertainty remains concerning issues such as level of hygiene required, and the implications of the acidity of *S. cristatum* for microbial growth and skin sensitivity, and further experimentation would be required to determine its suitability of *S. cristatum* for a menstrual pad.

A method of manufacture has not been investigated. Other materials with which to make a comfortable cover layer and an underlying shield, and design considerations must also be addressed. Research and product development is a major hurdle, and

involves financial risk since there is no guarantee of commercial success.

Successful processes for the manufacture of peat moss pads have been patented by Johnson & Johnson. The patent literature provides useful information regarding construction of a moss pad, but it also places restrictions on useable processes.

4.5 Legal obstacles

Almost without exception, important innovations derived from research are first disclosed publicly in the patent literature, which is one of the largest and most comprehensive sources of technical information in the world. However, in New Zealand, patent literature is not frequently used as a source of information in the context of technology transfer (Department of Trade and Industry, 1987).

Patents relating to processes for the manufacture of a sphagnum moss menstrual product provide insights into potential methods of manufacture. However, the existence of patents may severely restrict the development of the envisaged product in New Zealand. For this reason, it is important to determine where the research fits into the legal framework. Intellectual property rights are investigated in order to clarify their implications for the feasibility of producing a sphagnum moss menstrual product in New Zealand.

(i) Patent Rights

Patents are defined by the Patents Act 1953 and are part of a system of intellectual property rights, the essence of which is to reinforce incentives to undertake research and development. New Zealand legislation relating to patents, trademarks, designs and

copyrights is presently in the midst of review, and wholesale reform is anticipated (Sumpter, 1991).

A patent is a legal monopoly which is granted for a limited time to the owner of a new invention that is capable of industrial application. In practice a patent is concerned with new technology, in the form of novel machines, processes and substances. In New Zealand a patent is granted by the Crown founded upon the concept that in return for an inventor making a full disclosure of his or her invention, the Crown will grant a monopoly for a 16 year period. In general terms an invention must be novel and relate to a commercially useful product or process (Sumpter, 1990).

The patent is in law a property right and it can be given away, inherited, sold, license and can even be abandoned like other property. The owner of a validly granted patent may prevent others from using the patented invention without his or her permission for the duration of the monopoly and seek damages if they are proved to do so.

The protection of the products of intellectual endeavour (intellectual or industrial property) is a factor of major significance in the world economy. Patents are of a national character, and there is no such thing as a world patent. However, New Zealand is a member of the World Intellectual Property Organisation and the International Convention for the Protection of Industrial Property (The Paris Convention, 1883). The Convention holds that each participating country grant nationals from other countries the same rights as nationals from their own. It is not intended to harmonise patent systems in different countries.

The patent system in New Zealand is broadly modelled on the British system.

In England the practice of granting monopolies in certain products and processes can be traced as far back as 1449. Legal patents were legal documents issued by the monarch and sealed in such a way as to be open for public inspection. With the increasing power of Parliament, this royal prerogative was gradually diminished, and in 1623 the Statute of Monopolies imposed a general prohibition on monopolies. The Statute did, however, recognise the special characteristics of invention monopolies, which made them desirable so long as they were kept within reasonable limits (Hodkinson, 1987).

(ii) Purpose of Patent legislation

The English origins of intellectual law have an underlying theme of fairness, of preventing those who would "reap what they have not sown". A more modern rationale for justifying intellectual property lies in the belief that society stands to benefit from the efforts of creative people, and whether artistic or commercial, they should be given some form of exclusivity as an incentive to use and exploit what they create. On the other hand, the public interest can be served by limiting the duration and scope of what rights are granted. In practice, establishing the demarcation between the monopoly rights given to the creators, and the right of the general public to benefit from the fruits of their labour, has been subject to considerable variation, and it is not always easy to define where the balance should be struck (Sumpter, 1991).

While monopolies are generally considered unfavourably by the state, it is prepared to grant patents for inventions as it is a condition of the grant that (i) the patent will be of limited duration, and (ii) that the patentee must explain in the patent specification precisely how the invention is made to work, so that when the patent

expires any citizen can make use of it for the general well-being of the community. In other words, a patent is a kind of social contract in which citizens are encouraged by the community to be inventive.

(ii) How well defined are monopoly property rights?

Patent applications go through an administrative process, and once the complete specification is filed, it is formally examined at the Patent Office to see if the claims in the application have been anticipated. If accepted, the patent is advertised in the Patent Office Journal. If there is no opposition, the patent may after a period of time be sealed (Brown and Grant, 1989: 485). The price that an owner of an invention has to pay for the grant of a patent monopoly is to register the invention, to prove it to be novel and inventive and of a type which is patentable in law and to disclose it in an official journal in sufficient detail to enable any suitably skilled person in the same technical field to reproduce it. Other costs include maintaining and enforcing the patent, a process that generally involves the courts.

In general terms the patent holder has the exclusive right to make, use and sell the invention. Thus the patentee may sue any person who makes, imports or sells a product, or employs a process contained within the patent (Sumpter, 1991: 35).

The approach of the Courts in assessing whether an infringement has occurred, is to interpret the features of the claimed invention as set out in the specification to decide which are the essential "integers" of each claim. It is then determined whether the allegedly offending article includes all the essential integers of one or more of the patentee's claims. Remedies include injunctions and damages for losses resulting from the infringement (Sumpter, 1991).

The onus of proof of an invalid patent lies with the opponent. Grounds for opposition are wide and include the following: anticipation (prior publication); prior use in New Zealand; the invention is obvious and does not involve any inventive step; the subject of any claim of the complete specification is not an invention; the complete specification does not sufficiently and fairly describe the invention (Brown and Grant, 1989). The benefit of doubt is given to the applicant, so that the opponent must have a genuine commercial interest and is likely to suffer real prejudice by the existence of the patent. The decision to bring an action against a patent would thus depend on factors such as the prospects of success, the cost of the action, the financial strength of the opposition, the risks of a trade secret being exposed in court, and the availability of other alternatives such as negotiated settlements.

There is a caveat in the legislation (section 48[1])that allows the Commissioner of Patents to take away exclusive property rights granted by patents, if such an action is required to serve the public interest. However, it is unlikely to be enforced except in extreme situations, and Brown and Grant suggest that it is unwise to read too much into this provision (1989: 487).

An existing patent may be seen as an obstacle to development or as a possible complementary piece of technology. There are a number of possible responses to an obstructive patent: ignore the patent; seek a licence from the patentee; design around it; or challenge the patent. This is invariably a business decision, dependent upon the strength of the patent, and the willingness of the other party to fight or deal. Ignoring the patent is a calculated risk, and would depend on factors such as how long the patent has to run before expiry, the strength of the patent, the cost of the alternatives and the power of the patentee. Designing around the patent is a skilled job, involving a search

for alternative means of achieving the same technical result without infringing on the scope of the existing patent. Most patent specifications are drafted as broadly as possible so as to minimise the possibilities of this happening, and the practicable alternatives outside the scope if these claims may be few and far between. Challenging the patent if there is an arguable case, can be a costly exercise in the short term but can save a lot of money in the longer term (Hodkinson, 1987).

While patent rights are not absolute, due to the possibility of enforcement, they sharply restrict the range of appropriable information. If carefully drafted, a patent can in some cases protect even an underlying inventive concept which forms the basis of the patented invention itself, and not just the particular example of that concept which the inventor came upon (Hodkinson, 1987). While in theory patents do not monopolise ideas, this may effectively result from the granting of a patent or portfolio of patents.

(iii) Sphagnum moss menstrual pad and patents

The concept of using sphagnum moss (or peat moss as it is referred to in the patent literature) in a sanitary or other absorbent product cannot be patented. Moss has been used by women around the world for thousands of years as an absorbent structure for dealing with their menses. For this reason, the idea is not novel. However, to some extent the idea has been effectively monopolised by Johnson & Johnson.

Since the late 1970s a number of patents have appeared which protect manufacturing processes that incorporate peat moss into sanitary and other absorbent products. These have all been lodged by Johnson & Johnson or subsidiaries, and have priority dates from applications lodged a year earlier in the USA. The patents include a process for bleaching peat moss (1979); an absorbent product containing peat moss

(1979); a low-density peat moss board (1981); a calendered peat moss board (1983); an air laid peat moss board (1986); a process for forming an air laid fibrous pad (1988); and an apparatus for layered flanged air laid pad formation (1990). (See Appendix Two for a summary of each invention.)

Presumably the processes patented by Johnson & Johnson represent the most economical methods established to date. The patents provide a wealth of information about why older methods are not suitable and show how the idea developed until finally a product was released in 1990 in Canada and late 1991 in New Zealand.

Although the patents cover "the state of the art" in peat moss sanitary production, they do not exclude different production processes, or for that matter a similar process. For example, the method of extracting the peat moss in the Canadian patent is different from the method of obtaining moss in New Zealand (NZ Patent 217692).

The concept of making a sphagnum moss board is simple, being closely related to the art of paper making. The challenge is to find a process sufficiently different to the Johnson & Johnson process that is economically viable. The existence of the patents could conceivably stimulate the invention of a radically new process for the manufacture of sphagnum pads.

Another option is to contest the claims made in the Johnson & Johnson patents. However, this would be a costly and difficult exercise, assuming that Johnson & Johnson have drawn up the patents with requisite care in order to prevent such actions.

Yet another alternative is to wait for the patents to expire. Some of the patents will lapse within the next two to four years and those processes relating specifically to

refining the process of manufacture of a peat moss board will terminate in 2002.

In summary, within the patent system there is some flexibility for a potential manufacturer to appropriate or develop a manufacturing process that is viable in terms of technology and profitability. However, the restrictions are real, and would be difficult and costly to overcome.

(iv) Conclusions

Intellectual property rights are important for encouraging innovation and development, since few companies could afford to embark on expensive programmes of research and development without the assurance that ownership of the fruits of this labour will be safeguarded. Creative individuals may find a way around patents, but this is a costly and time-consuming exercise, and the patent holder (in this case a large corporation) retains the advantage of "getting in on the ground floor". From the point of view of the individual, unless she or he commands adequate resources, it is difficult to either derive benefit from an invention or get around existing patents, without obtaining financial backing or without having the idea taken up by an industrial firm.

Because Johnson & Johnson is a large corporation, the challenge is intensified by the financial advantage that they would have over most challengers, since a corporation like Johnson & Johnson would include in its organisation and budget the means with which to monitor and enforce its patent rights. The existence of patents for processes related to the production of a sphagnum moss sanitary pad, thus severely restricts the feasibility of producing a sphagnum moss sanitary pad in New Zealand. Legally, the processes contained within the Johnson & Johnson patents cannot be imitated, unless some course of action is first taken. Conceivably, a financier

could support such actions, or an inventor could develop a radically new process, or alternatively an entrepreneur could wait for the patents to expire. In the final analysis, although restrictive, patents do not rule out the possibility of producing a sphagnum moss menstrual product in New Zealand. The constraints they imply are closely related to market structure barriers that prevent innovation by new entrants. This is discussed in the following section.

4.6 Economic implications

The presence of "Sure and Natural Prima" in our supermarkets indicates that it is economically feasible to produce a sphagnum moss menstrual pad. However, this does not answer the question of whether or not it is economically feasible to produce such a pad in New Zealand.

Economic considerations are dependent upon a number of factors, and it is difficult to discuss them specifically without first having determined a method of manufacture and strategy for marketing. For this reason the implications of economic structures for the development of a sphagnum moss menstrual product in NZ will be discussed on a more theoretical level than the previous sections.

(i) An opportunity for moss exporters?

Early last year an article appeared in the New Zealand Business Review announcing a 'startling' new market for sphagnum moss:

> When one door closes another opens. Johnson & Johnson closed down production in New Zealand last year to consolidate operations in Australia, but

> developments in the company's Canadian market may open interesting future export opportunities for this country's sphagnum moss industry... After 15 years of hush-hush research, Johnson & Johnson is launching a new line of thin sanitary napkins with an absorbent core of processed peat moss (Beavis and Goad, 1991: 12).

A number of New Zealand sphagnum moss export companies have approached Johnson & Johnson regarding sales of New Zealand moss for use in Prima, although "regrettably no business resulted from these discussions" (Chamberlain, 1991).

It seems that the sustainable output of New Zealand sphagnum moss has been a limiting factor on the potential availability for diversification of use[1] (Chamberlain, 1991; Owens, 1992). Also, because clean, graded New Zealand moss has a relatively high value in Japan, it could not compete with the Canadian raw material, which is probably available at a lower cost[2] (Owens, 1992). This view was echoed in a letter from the Vice President of Research and Development Division of Johnson & Johnson (Canada): "We have samples of *S. cristatum* from New Zealand which showed excellent absorption properties but was far too costly to be of practical interest" (Ruffo, 1992).

Barriers to further research seem to be related to the assumptions concerning the appropriate scale of operation for a viable industry. Indeed the West Coast sphagnum moss resource may only be able to support a relatively small manufacturing process.

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[1]A Sphagnum Exports representative, said that when they approached Johnson & Johnson, the volume of moss they required was twice that of the total New Zealand export industry.

[2]Neither the potential of using grade three moss (the waste product of the present industry), nor opportunities for local production appear to have been discussed.

However, output could be increased by developing moss farming, or alternatively looking to other sources (such as Australia or South America) as a means to increase the supply. Similarly, investigating the suitability of the waste product of the present sphagnum moss industry may provide a low-cost alternative to high quality moss. Local manufacture would also overcome the significant costs of transporting sphagnum moss.

(ii) How important are economies of scale?

Even if the quantity of supply could be sustainably increased, and the costs of supplying the raw product could be reduced, the scale of operations may be a significant obstacle for the development of a sphagnum moss menstrual product industry in New Zealand. The opportunity to raise money for innovation[1] and to realise a profit depends importantly on the economic environment in which it is performed.

Market structure, by which I mean the configuration of sellers (of which pure competition and monopoly are extremes) is an important determining factor for innovation (Kamien and Schwartz, 1982). The sanitary product (sanpro) industry consists of a few large multinational corporations. The oligopolistic market structure of the sanpro industry appears to obstruct the entrance of new competitors, especially if small.

Theories of technical advance shed some light on this phenomenon, which has come to characterise many international markets. The course of technical advance has influenced market structure through altering the methods of production.

[1]Here innovation is taken to include the basic research, invention, development and commercialisation, that give rise to a new product or means of production (Kamien and Schwartz, 1992).

Schumpeter hypothesised that there is a positive relationship between innovation and monopoly power (Kamien and Schwartz, 1982). Firstly, the possibility of realising extraordinary profits is an important motive for developing an innovation. The ability to make above normal profits depends on the power to prevent or at least retard imitation of the innovation and can be achieved by means of a patent, trademark or copyright. It can also be achieved through buying up raw products, gaining control of the channels of distribution, or developing a reputation and identity through advertising. Also by being first, the innovator may achieve substantial economies of scale relative to the size of the market. Secondly, the possession of monopoly power allows the firm to finance further innovation, and hire the most innovative people.

Galbraith developed the idea that large firms are more than proportionally innovative than small firms (Kamien and Schwartz, 1982). This hypothesis is independent of that of Schumpeter, because possession of monopoly power does not necessarily imply large size, except in relative terms (of course, large firm size and monopoly power do sometimes occur together). According to Galbraith innovation is becoming increasingly expensive and therefore large firm size is becoming increasingly advantageous. Large firms have an advantage over small ones because of economies of scale in research and development. Monopolists and oligopolists can typically appropriate a higher degree of their R&D output as a result of entry barriers into the industry - such as economies of scale, high capital costs, or well-established distribution channels (Bollard, Harper and Theron, 1987). Firms like Johnson & Johnson have large research divisions in which numerous employees work together. Researchers are able to develop expertise in a particular area and are supplied with equipment necessary for specialised investigations. Large firms are also better able to exploit the results of

research efforts, especially if they have an established name and reputation. Also lead-time and learning curve advantages, secrecy, market leadership and brand-names are methods of appropriating the benefits of an invention.

The structure of the market for sanitary products seems to provide significant barriers to the entry of newcomers, especially if working on a comparatively small scale. Research and development has become increasingly institutionalised, making it difficult for independent innovation to occur. It is possible that some large New Zealand company or the government could finance research and development of a sphagnum moss menstrual product, but the risks for large-scale sponsorship are great because of the competitive advantage held by Johnson & Johnson.

However, smaller scale R&D is never completely ruled out. Large firms are also characterised by retarded innovation due to internal bureaucracies and lowered motivation, so that opportunities for small players exist, and examples of innovation from small firms are plentiful.

(iii) "Economics" as if women mattered

Innovation is driven both by developments in scientific knowledge, and by economic opportunity. Inventions often respond to market opportunities (are demand-pulled). It is therefore important to ascertain whether or not there is a market for a sphagnum moss menstrual product in NZ.

It has been argued above that economies of scale advantage the large firm not only in terms of costs of research and development, but also in terms of marketing products.

Over the years competition within the sanpro industry has increased. Brand

loyalty is low and price considerations are high in purchase decisions on sanitary products (Rosendhal, 1990). In spite of these trends women are understood to be cautious about trying new products. In fact trying to get consumers to try any new product is difficult. To establish a market for a new menstrual product, extensive marketing is now required.

For example, there were predictions that Johnson & Johnson could have a difficult time marketing "Sure and Natural Prima", because the moss core is visible through the pad's white outer linings as a dark, rectangular middle layer. "This is the kind of product women just don't want to take a risk on" (Beavis and Goad, 1991: 12).

Acknowledging that it is not easy to get women to try a new pad and to convince them that a thin pad will work, Johnson & Johnson planned extensive free sampling. The marketing plan included selling points such as "so thin, so close to nothing" and "incredible protection". However, "Sure and Natural Prima's" most innovative feature is not part of the sales pitch. The package does not mention peat moss. The enclosed pamphlet says only that the "unique, highly absorbent core [is] from nature" (Beavis and Goad, 1992).

However, the presence of the pads in our supermarkets shows that a moss pad can be successfully marketed, and that women are willing to try new products. While initially the moss core was down-played, recent advertisements are mentioning the moss and its absorbent properties, stressing its effectiveness and that it is a natural product. Part of the success is derived from the reputation Johnson & Johnson have for quality menstrual products, and also from the huge spendings on advertising, which has included give-aways, and magazine and television coverage.

This focus on the effectiveness and construction of menstrual products is a relatively new phenomenon in advertising. Generally, advertisers play on the shame that women feel around menstruation and the need to hide it[1]. Paradoxically, through advertising and also the increased visibility of menstrual products on the supermarket shelves, menstrual protection is becoming more visible, and to some extent the rules of silence may be breaking down. This may in turn be influencing the marketers to focus more on the effectiveness, and less on "protective" qualities of their products. Even the brand name "Sure and Natural" is a break from traditional names such as "Carefree", "Libra", and "Whisper".

Another effect of the new sales pitch is that women are becoming more informed about methods of production. With the commercialisation of sanitary products, women have lost information about alternative approaches to dealing with menstruation. As means of production have been progressively expropriated from the household, and as commodities become more economic to buy than make, the sphere of the market expands and the necessity of finding things we need there expands (Weinbaum and Bridges, 1979: 134). A consequence of expanding consumerism is the potential for change. "These values inculcated by education are likely to boomerang... By an ironic twist the mental values we stimulate can be the death-knell of their own exploitation" (Mitchell, 1971: 30). Ultimately, such strategies may undermine the industry, if women become so connected with the productive process, so that production is returned to the original "experts" in the home. If women returned to the use of

[1]The irony of menstrual advertising is that by marrying images of the modern liberated woman with the ancient menstrual taboo, women are seduced into buying products to hide the burden of their femininity (Treneman, 1989). The advertisers rely on women to grasp the "hidden message": that menstruation is to be concealed.

washable napkins, this would have major implications in terms of sustainability.

While producers control demand to some extent through limitations on supply and advertising, consumers obviously play a part in demand for products. Consumption has a high degree of autonomy from production and an ability in turn to influence it. In the late 1980s a major "green revolution" took place, defined mainly through a rising public concern and media coverage of environmental issues. A large number of consumers began to use consumer choice to voice their opinions.

Lobby groups in Europe and the United States have been asking the sanpro industry for products that meet the needs of consumers with environmental and health concerns (Women's Environmental Network, 1991). In response to these campaigns, eco-labelling, in the form of "environmentally friendly" messages, has become commonplace on menstrual product packaging. This labelling is voluntary and has been self-imposed by companies. With the exception of a few smaller companies that have changed to non-chlorine bleaching and mechanical pulping processes, most of these claims are without foundation. A new phenomenon has emerged: the "green con", indicating that may be unwise to overestimate the power of consumer choice.

Yet, the labelling is increasing consumer awareness, and may have implications for the industry in years to come. As women become more skilled at interpreting environmental claims (or alternatively if compulsory and standardised labelling rules are introduced) the companies will have to respond. "Expanding the consciousness of many (for the sake of expanding consumerism) **does** mean expanding their consciousness. And the products of this expanded consciousness are more elusive than those of the factory conveyor belt. The ideologies cultivated in order to achieve ultimate control of the market are ones that can rebel **in their own terms"** (Mitchell,

1971: 30-31).

(iv) Conclusions

The modest scale of sustainable moss extraction operations in NZ appears to be a severe limitation to establishing a competitive industry, in terms of a viable scale of operation, costs of research and development, and cultivating a market.

This indicates that economic barriers are real, and in some way related to industrial law, so that the production of a sphagnum moss menstrual product on a commercial scale is unlikely to be possible. Of course, all hurdles can conceivably be overcome. It seems that economic barriers are such that their overturn would require the activities of risk-taking and industrious entrepreneurs with substantial financial backing. However, there are indications that the market is moving towards more environmentally friendly products, so that innovators could comfortably assume that a commodities based on sustainable production would have a place in the markets of the future.

4.7 Findings and Implications

After placing the concept of developing a sustainable sphagnum moss menstrual product industry in New Zealand under closer scrutiny, a number of issues have emerged. In this section, findings are summarised and their implications discussed.

(i)Summary of findings

The general outcome of examining what seemed like a "good idea", is that there is much uncertainty about the feasibility of the implementing the idea, both in physical terms and institutional terms. In other words, considerably more research is required to clarify these uncertainties.

In particular, uncertainties concerning the feasibility of the industry in terms of ecological sustainability, implications for women's health, and the method of manufacture require clarification. However, despite these uncertainties, findings suggest that the production of a sphagnum moss menstrual product is likely to be acceptable in terms of environmental and health concerns, and that it is technically possible to put the idea into practice.

In summary, the production of a sphagnum moss menstrual product is provisionally feasible in physical terms, and there seems to be no real reason to say that it would not be possible to establish a manufacturing industry in New Zealand. However, the research and development required to overcome the uncertainties that arose, necessarily entails costs. Costs are an important factor in constraining innovation.

In testing the institutional (legal and economic) hypotheses, obstacles that would require more than research effort emerged.

Patent law obstructs the appropriation of economically viable processes that have been patented by Johnson & Johnson. Although it is often said that it is easy to invent around one patent or a few, circumvention can be quite difficult if it is a technological field that is blanketed by a whole patent portfolio held by a single firm or closely-coordinated cartel. While patent law does not give absolute intellectual property rights, the existence of the Johnson & Johnson patents may effectively prevent the development of an industry in New Zealand, at least until that time when patents run out.

In waiting for the patent to expire, Johnson & Johnson will have in the meantime exploited the advantage of monopoly power to gain a market lead in process of manufacture. As well as the advantages appropriated through market power, the size of Johnson & Johnson operations also provide barriers to a new entrant. Furthermore, when legal monopoly runs out, effective economic barriers still exist.

(ii) Inefficiency of the patent system

The philosophy behind patents is intended to cultivate a balance between incentives for innovation and the protection of collective interests. However, because of market power, collective interests may not be served. This is because monopolies are economically inefficient[1], and have distributional implications that favour industrial development over other social objectives.

They result in misallocations of resources relative to the most efficient systems. Imperfections in the patent system can also lead to both over-investment and under-

[1]Inefficient system because power structures lead to less than pareto-optimal situations (deadweight loss to society).

investment occurring simultaneously and not necessarily in a mutually cancelling manner (Kaufer, 1989).

(iii) Historical trends in research and development

In principle, patents are granted to the individual or individuals who invent some new product or process. This approach can be traced back to the fact that when patent systems first emerged, nearly all inventive activity was carried out by individual inventors working more or less alone, without formalised organisational attachments. But over the years radical changes have occurred with respect to inventive activity:

1. Invention has come to depend more closely on a base of advancing knowledge.
2. Inventive activity has moved from the realm of the independent, individual inventor, to corporate organisations.
3. Technology and the scope of business firm's operations have become increasingly internationalised.

These changes are reflected in the statistics on the origin of patents within diverse national patenting jurisdictions. In New Zealand 75% of patent applications come from overseas (Probine, 1987). In comparison, the United States has remained relatively self sufficient in terms of patent origination.

In other words, the era of the cheap invention is over. With the movement of inventive activity from the individual to the corporate research and development laboratory, it has been questioned whether the logic of patents still holds (Kaufer, 1989).

However, patents are far from perfect as a means of appropriating benefits. Rarely is a patent so strong that it is immune to a determined effort to get around it or

challenge its validity in the courts. Indeed the patent system embodies a kind of paradox in that its disclosure often helps would be imitators in their circumventive efforts.

Neither are patents necessary for appropriating benefits to motivate research and development. Alternative tools of appropriation include secrecy, and other barriers to entry resulting from things such as economies of scale, and reputations of established oligopolistic industries. Similarly, product differentiation and "image" advantages may accrue to firms successfully introducing new inventions. Given such advantages, the firm may be able to hold substantial market shares and sell at prices exceeding production costs, even without patent protection.

This implies that patents are not the pivotal factor in preventing imitation activity today. Market structures work to maintain monopolistic power. Patent law and economic systems appear to have directed or have been directed by an ideology that encouraged innovative development above other social and economic goals.

(iv) Theories of technological advance

Historically, technological advance was not viewed as a deliberate economic process. Adam Smith, while recognising the importance of the role of technology in economic progress for the Industrial Revolution, saw that the major advances came from "men of independent means, seeking truth for its own sake" (Kamien and Schwartz, 1982: 4). The economic system was seen as a stationary state by classical economists, and at this time invention generally occurred independently of commercial development.

In the late nineteenth century, technical advance came to be institutionalised as part of the quest for profits, and early this century Marx replaced the vision of the

economic system in a stationary state, with one of continual evolution. He argued that capitalists' profits were reinvested in capital equipment, not only to offset depreciation, but also to keep pace with its continuous improvement (Kamien and Schwartz, 1992).

Schumpeter subsequently developed a theory of competition through innovation. Schumpeter differentiated between the act of invention and the act of entrepreneurship, and described the role of active economic agents in technological advance. Innovation is rewarded by extraordinary profit, through the granting of monopolies. Eventually the successful new product or method of production is imitated and these profits are eroded. If imitation is immediate, then entrepreneurial profit does not exist and there is no incentive to engage in this activity. This means that there is a basic incompatibility between entrepreneurial activity and perfect competition. The main theme of Schumpeter's theory is that in conflict between entrepreneurial activity and perfect competition, the latter should be sacrificed (Kamien and Schwartz, 1982: 8).

In other words Schumpeter argued that monopolies, that are inefficient in terms of price competition, be sanctioned for the sake of innovative competition. He justifies monopolistic practices designed to retard innovation, since he views them as temporary. However, the movement of innovation from the individual to the corporation may imply that market power is not "eroded".

(v) Limits to growth

Schumpeter's rationale is based on the assumption that non-static economies are inevitable and desirable. His theory justifies innovation and thus corporations. The result is that market structures and patent law effectively promote growth for the sake

of growth. What are the costs of this?

Goodland (1987) describes the problems for sustainability in traditional assumptions that there are no limits to growth in the physical scale of production and consumption. This approach to economics neglects the environmental and social costs of growth for the sake of growth. The non-static economy model does not take account of the fact that growth in natural resource consumption is ultimately constrained by the physical laws of thermodynamics, and the finite size of the planet.

Steady-state economies do not imply no economic growth. "Growth in economic output may not be similarly constrained, since innovation may continue to squeeze more "value-added" from a natural resource bundle" (ibid.: 38). Growth in economic output need not be limited, so long as we seek to stabilise resource consumption.

In other words, growth, innovation, and technological advance, are not necessarily in conflict with long term development. The nature of these activities however must change if the objective of sustainability is to be achieved.

> The many influences that have been at work over the past century have tended towards increasing the scale of operation in almost every sector. The finance and investment system has had a very big influence, but the main justification has been that so-called economies of scale make it inevitable. Nevertheless, managers of these big organisations are well aware of the difficulties that size and complexity can create. One of the most serious problems for any company that has to be intensely innovative, is the inertia a large organisation experiences in making rapid responses to the need for frequent change" (Davis, 1991).

However, because management and control are in different hands in the modern corporation, it is possible to bring in motives besides the maximisation of profits. The

"owner" (the shareholder) has little control over the large corporation's activities, which are controlled by salaried managers. Such a corporation may have motives besides the maximisation of profits. For example, managers may be concerned to earn a reputation for innovation or dependability, or to encourage growth in the industry. These goals, not the expansion of returns, may be what motivates managers. Innovation need not be solely profit motivated. By incorporating the goal of sustainability, a new definition of "wealth" may emerge.

Many corporations display that they are indeed motivated by goals other than profit. Davis describes his experience with Johnson & Johnson's management working to bring a corporate vision of stewardship into practice: "the dry bones of a seemingly pretentious creed came to life in changed company behaviour" (1991: 47). (For the Johnson & Johnson Credo see Appendix Three.)

However, large trans-national firms may disadvantage smaller firms, and even smaller or less developed nations. New Zealand will have to compete in international markets with products processes and services that are competitive in price, quality and design. For this reason, international transfers of technology are clearly important to small countries like NZ, especially in manufacturing technology. In policy terms, the international transfer of technology becomes a strategic instrument of industry policy.

Other disadvantages include the loss of diversity that big corporations often imply, and the inability to respond to local needs, so that incorporating broad social objectives into their functioning may not in itself be enough. It may be that we need to encourage diversity in our market structure: firms large,small and middle-sized; in order to balance the trade-off between specialised innovation and competitiveness.

Diversity can come through policies that encourage new entrants, and those which encourage the devolution of large organisations into more responsive and efficient units.

CHAPTER 5. Conclusions

The possibility of producing a sphagnum moss menstrual product in New Zealand that meets the specific needs of women and at the same time comes some way toward fulfilling the objective of sustainable development has been investigated. The results of these investigations indicate that it is provisionally possible to commercialise this idea, with regards to satisfying a basic human need within the constraints of the environment. However, institutional barriers function to prevent the research and development required to realise such an industry.

These institutional barriers include legal and market structures which operate to privilege large corporations and firms with market power. Existing market structures generate inefficiencies and misallocation of resources, and work to foster economic growth through technological advance without taking account of the impacts of such development for people and the environment. Although ecological and technical limitations are important issues, the real obstacles to the development of a sustainable menstrual product industry are institutional and ideological.

Institutional barriers reflect the contradictions that are contained within the concept of sustainable development. They indicate that the limits to sustainability have structural as well as natural origins. Approaching product development from the point of view of sustainability provides explanations that differ substantially from those made from traditional economic theory. The economic system has been isolated from understandings of scientific principles underlying environmental change, so that it is the environment, rather than our social practices, that is viewed as an obstacle to continued growth. The ideology and technology of our economic system involves a representation of the body, society, and nature, as machines which are manipulable and which require

control and domination. As nature has come to be dominated, so the control of women through the appropriation of production has also occurred.

Recognition of the necessity of a form of development that is sustainable demands a fundamental break from some of the assumptions and beliefs that have underpinned traditional economic development since the beginning of the Industrial Revolution.

The concept of sustainable development draws on two frequently opposed intellectual traditions: one concerned with the limits which nature presents to human beings, the other the potential for human development based on nature. It seeks to find a compromise between natural environment and the pursuit of economic growth. However, attempts to bring new values to our economic imperatives are restricted by the very structures that must change.

Nevertheless, understanding the conflict between sustainable development and our institutional inheritance is empowering. Recognising the contradictions for sustainable development helps us to understand why a sphagnum moss menstrual product is not presently being produced on the West Coast. It also compels us to question the adequacy of attitudes, institutions, and laws that have grown out of the Industrial Revolution.

There is an emphasis on competition through innovation in the market structure of sanitary product industry. In recent years there has been a rapid diversification of the products available for menstrual protection, indicating that firms are competing by with new products, rather than allowing new entrants to bring price competition to the market. This is different to the emphasis placed on price competition that is prevalent in most economic theory. If markets have moved in this direction, then economic

theory may need to change.

Sustainable development raises questions about the nature of business operations, not least about size. It challenges the industrial and commercial system to restructure itself, to base itself on a new set of assumptions and beliefs about the way we conduct our economic affairs. Reconciling economic and environmental goals will be possible only through a massive transformation in the production process. And not only the technologies must change: attitudes, values, capital markets and public policies must also evolve towards more sustainable patterns of production and consumption.

There is a need a more inclusive economics, that incorporates goals other than growth. We need to recognise the role of changing technology in our relationship with the environment and be aware of the dangers that it alone holds the solutions. We also need a redirected model of development, based on understandings of environmental change and our history, and we need to "unlearn the lessons of the development process" (Redclift, 1987: 204).

Achieving sustainable development is related to transcending structures of the international economic system that result in the exploitation of natural resources, and which frequently operate to deter long-term sustainable practices. We cannot rely on the market forces to sustain our environment, we need more international agreement and planning.

The contradictions within sustainable development imply important tensions for our future development. While there are tensions we must continue to question and debate. We must employ communication and analysis, and attempt to clarify our situation, in order to incorporate the goals of sustainability into research and development. Industrial research plays an important role in this process. It is in this

field of research that ideas are put into practice and tested. Innovative risk-taking may be essential for the creation of a radically different economy, and may be discouraged by slow-moving, excessively bureaucratic businesses. This raises a number of questions about our present structures: Are patents, as they stand, obsolete and inhibitors of sustainability? Will monopolies on innovation, and economies of scale become outmoded? Can we incorporate broader social goals than profit making into the modern corporation? This kind of research is where real change can occur.

I began this study by taking a technological approach (developing a new product) to solving the problems that I perceived in the manufacture of menstrual products. My investigations highlight the limitations of this strategy for generating sustainable industries. In so far as redesigning technology may be positive, redesigning at the level of the individual products is limited by social and economic structures. There is a need to construct technology according to a completely different set of socially desirable values.

Investigating the potential of sphagnum moss as a raw material for menstrual products is not the only approach to improving menstrual products, nor to enhancing the New Zealand sphagnum moss industry. Other strategies may include producing reusable (washable) menstrual products. Alternatively, other raw materials could be used such as recycled pulp, or processes for improving the manufacture of paper pulp could be investigated.

Similarly, considering the production of menstrual products as a means to improving the New Zealand sphagnum moss industry is only one of a number of tactics. For example, sphagnum moss could be used in a variety of value-added products that require absorbent raw materials. Alternatively, the industry could focus on improving

its marketing strategies as a means to increase its resilience. Ultimately, what we decide is the appropriate use of resources is a matter for the community to decide.

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APPENDIX ONE: Experiments into properties of *Sphagnum cristatum*

I. Bacteriostatic properties of Sphagnum cristatum

Aim

To investigate the existence of bacteriostatic properties in *S. cristatum* by "zone of no growth" technique.

Materials and methods

Petri dishes were prepared with sterile standard methods Plate Count Agar (5 g tryptone, 2.5 g yeast extract, 1 g glucose, 15 g agar per litre).

Plates were seeded with reference cultures of the following organisms:

Enterococcus spp.
Salmonella spp.
Staphylococcus aureus
Escherichia coli
Pseudomonas aeruginosa

Pieces of *S. cristatum* (10 mm sections) were placed at quadrants on the surface of each of the prepared plates. The plates were incubated at 22° C and 37° C and examined after 24 and 48 hours.

Results

Normal growth was observed from each of the inoculums at both temperatures. Growth was not inhibited at or around the pieces of sphagnum.

Conclusion

S. cristatum does not exhibit bacteriostatic properties.

II. Sterilisation of *Sphagnum cristatum*

Aim

To investigate the effectiveness of steam, dry heat and chemical (janola) sterilisation processes on *S. cristatum.*

Materials and methods

1. Sterilisation procedures

Moisture content of sphagnum moss was standardised by placing in a controlled environment room (20° C and 65% RH). Representative samples of the moss were sterilised using the following procedures:

A) autoclave, 121° C, 15 minutes

50 g moss autoclaved in autoclave plastic bag

B) heat, 160° C, 2 hours

15 g moss in 2 litre (l) coffee tin with seal lid

C) heat, 140° C, 3 hours

15 g moss in 2 l coffee tin with seal lid

D) heat, 121° C, 16 hours

15 g moss in 2 l coffee tin with seal lid

E) janola 10%, 15 minutes

0.5 g moss placed in a 0.25 l solution of janola and distilled water, soaked for 15 minutes, rinsed under aseptic conditions in 0.25 l sterile distilled water for 5 minutes, and drained.

F) janola 20%, 15 minutes

0.5 g moss placed in a 0.25 l solution of janola and distilled water, soaked for 15 minutes, rinsed under aseptic conditions in 0.25 l sterile distilled water for 5 minutes, and drained.

2. Observations

After treatment, the moss was examined for changes in colour, texture, flexibility and structural integrity. Wettability was observed by placing in distilled water and visually comparing the ability to take up water with that of untreated moss.

3. Test for sterility

Samples of moss were randomly selected from each of the six sterilisation treatment, untreated moss (control) and Johnson & Johnson "Prima". Under aseptic conditions, small leaf-size fragments of moss (approximately 5 mm in length) were transferred onto Oxoid PDA plates (4 g potato extract, 20 g dextrose, 15 g agar per litre).

For each sterility test, 3 petri dishes were inoculated with 5 pieces of moss (15 replicates per treatment). Plates were incubated at 25° C (Test 1 and Test 2) and 37° C (Test 3) and examined at 48 hour intervals for 14 days.

Results

Observations

The following is a summary of changes observed after the sterilisation process. The results are comparative, based upon the observable characteristics of the untreated moss: creamy brown colour with green tips; soft to touch; flexible leaves, slightly brittle stems; springs back when compressed; holds together; absorbs water readily and rapidly.

A) autoclave, 121° C, 15 minutes

fawn, darker tips; soft; flexible leaves, stems more brittle; doesn't spring back when compressed; holds together; absorption slowed.

B) heat, 160° C, 2 hours

dark chocolate brown; hard; leaves and stems very brittle; shrunken; falls apart; repels water.

C) heat, 140° C, 3 hours

yellow brown, darker tips; harsh; stems more brittle; shrunken; falls apart; repels water.

D) heat, 121° C, 16 hours

yellowed, some greenness remains; soft; stems more brittle; shrunken; falls apart; repels water.

E) janola 10%, 15 minutes

bright pale yellow; harsh; flexibility retained; looks more 'open'; holds together; readily absorbs water.

F) janola 20%, 15 minutes

Same as above.

Test for sterility

The presence or absence of microbial contamination on each replicate was noted at 48 hour intervals. The percentage of specimens in which viable aerobic microorganisms were observed after 14 days are given in the table below.

	% of fragments with contamination		
	TEST 1	TEST 2	TEST 3
TREATMENT	25° C	25° C	37° C
A	0	0	0
B	0	0	0
C	0	0	0
D	0	0	0
E	87	100	80
F	100	93	80
G	100	100	80
H	-	68	-

Key to Treatments:

A = autoclave, 121° C, 15 minutes

B = heat, 160° C, 2 hours

C = heat, 140° C, 3 hourS

D = heat, 121° C, 16 hours

E = 10% janola, 15 minutes

F = 20% janola, 15 minutes

G = control, air-dried

H = Johnson & Johnson "Prima"

The control (no sterilisation treatment) displayed 100% contamination at 25° C and 80% contamination at 37° C. Generally, it took 2 days for microbial presence to be observed.

No contamination was observed in the autoclave and heat treatments (A,B,C and D) over the two week period.

High levels of contamination were observed in the chemical treatments, E (10% janola) and F (20% janola), indicating that the sterilisation procedure had been ineffective. After 10 days there was up to 100% contamination when incubated at 25° C, and 80% contamination when incubated at 37° C. However, rate of growth was slower than the control. Only limited contamination was observed at day 2 and 3, indicating temporary inhibition of microbial growth.

Johnson & Johnson "Prima" initially displayed relatively low levels of contamination. By day 4, 28% of the replicates were contaminated. By day 7, 52% of replicates were contaminated. The presence of microorganisms was not observed in 32% of the specimens.

Conclusions

Structural change was observed in all treatments. Physical treatments resulted in general darkening, shrinking, fragmentation and decreased wettability. Autoclaving appeared to produce less change than dry heat treatments. While bleaching did not decrease wettability, a loss of organic matter was observed.

All heat treatments sterilised sphagnum moss. Chemical treatment (janola) did not sterilise the moss, but some samples exhibited temporary inhibition of growth (2 days). Prima was not sterile. 32% of specimens were free from microbial contamination, another 40% of specimens displayed temporary inhibition of growth (4-10 days), while 28% of specimens exhibited normal microbial growth.

III. Effects of sterilisation and grinding processes on the water holding capacity of *Sphagnum cristatum*

Aim

To investigate:

1. the water holding capacity of *S. cristatum*;
2. the effect of steam, dry heat and chemical sterilisation processes on water holding capacity; and
3. the effect of grinding and particle size on water holding capacity.

Materials and methods

1. Standard procedure for measuring water holding capacity

Random 15 g samples of air-dried *S. cristatum* at 20° C and 65% RH were used in all water holding capacity experiments. Because determining a standard procedure involved working with the two variables, time to soak and time to drain, determining the optimal times was necessarily done by trial and error. Although interconnected these have been written up separately.

Moisture content in 15 g samples of *S. cristatum* was compared after soaking in 680 ml plastic containers (Lily 680) for various time periods. Initial water uptake was rapid, and slowed significantly after 5 minutes. However, water continued to be absorbed at a diminishing rate, even after 12 hours. In order to obtain maximum water holding capacity an overnight (16-24 hours) procedure was used.

Moss was drained by inverting Lily 680 containers fitted with a 1.5 mm aluminium mesh lid. Experimentation was necessary to determine the optimal method and time to drain the moss that had been soaked overnight. Water retention outcomes that visually resembled the moss

that had taken up water by capillary conduction were considered most appropriate[1]. To deal with the problem of excessive adherent water after soaking, specimens, in their draining containers, were placed on absorbent blotting paper for 5 minutes. The moss was then drained for one hour in a controlled environment room (temperature 20-25° C and 55-65% RH). One hour was chosen as a suitable standard, since most adherent water had drained away, while little water held within the cells had evaporated.

To determine dry weight, the moss was placed in a drying oven at 80° C for 24 hours. Repeated weighing experiments showed that 15 g of soaked and drained had reached a constant weight after 8 hours.

2. Sterilisation and water holding capacity

The standard procedure (see 1 above) was used to determine the water holding capacity of air-dried *S. cristatum* after six sterilisation treatments. Untreated air-dried moss was used as a standard with which to compare the water holding capacity. The water holding capacity of untreated kiln-dried moss was also measured.

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[1]**Note on capillary conduction investigations**

In order to estimate "saturation water content" of *S. cristatum*, the following investigations were performed. To avoid potentially excessive adherent water resulting from complete immersion, 50 mm long individual shoots of air-dried *S. cristatum* were placed with lower stems in distilled water. The stems were supported within a plastic mesh tray, so that only the lower 20 mm were immersed in the water. Shoots were left for 24 hours, substantially longer than the time required for several other species to attain a constant mass (Titus and Wagner, 1984). The moss was observed periodically, and after 24 hours the 'saturated' mass of the upper 30 mm of the shoots was determined by weighing. "Saturation water content" was calculated after drying plants at 80° C for 24 hours using the following equation:

saturation water content = (SM -DM)/DM;
where SM = saturated mass (g), and DM = dry mass (g).

After 30 minutes, the moss had taken up water and looked wet. After 24 hours, when constant mass had been attained, the cells looked expanded and full, and slightly wet on the surface.

I also performed these investigation for the six sterilisation treatments (see Experiment II). After 24 hours capillary conduction was only visually obvious in the bleaching treatments. No apparent conduction took place in the autoclaved and heat sterilised moss indicating that capillary conduction faculty had been destroyed.

From these investigations I had a visual and numerical reference with which to determine an appropriate immersion and draining procedure for measuring "saturation water content".

The treatments were:

A) Control (no treatment)

B) autoclave, 121° C, 15 minutes

C) heat, 160° C, 2 hours

D) heat, 140° C, 3 hours

E) heat, 121° C, 16 hours

F) janola 10%, 15 minutes

G) janola 20%, 15 minutes

H) Kiln-dried moss (no treatment)

See Experiment II for further details about the sterilisation processes. In all treatments, except No. 8, air-dried moss was used. In all cases moss had been placed in a controlled environment room (20° C, 65% RH) for at least 48 hours.

The "saturation water content" was determined concurrently for one replicate of each of the 8 treatments (8 observations). The experiment was repeated 10 times, giving 10 replicates for each of the 8 treatments (a total of 80 observations).

3. Particle size and water holding capacity

Moss was ground in a Retschmuhle Grinder with a 4 mm square mesh grinding plate. The following particle size categories and their approximate proportions were obtained by sieving:

65% larger than 1.7 mm.

20% between 1.0mm and 1.7mm

15% less than 1.0 mm.

Water holding capacity was estimated for 4 particle size categories using the standard procedure (see 1 above). Unground moss was used as a standard.

The treatments were:

A) Control (unground)

B) Ground moss

C) Ground moss particles between 1.7 and 3 mm

D) Ground moss particles between 1 and 1.7 mm

Water holding capacity was determined concurrently for 1 replicate of each of the 4 treatments (4 observations). The experiment was repeated 9 times (a total of 36 observations).

Results

1. Water holding capacity of air-dried moss

Natural variability in the water holding capacity of sphagnum moss samples served to complicate the determination of a standard procedure. Replicates were found to vary, but results showed that this did not significantly affect the outcome of comparative water holding capacity experiments.

The following standard procedure for determining "saturation water content" was devised:

> 15 g of randomly selected sphagnum moss (20 C, RH 65%) is immersed in distilled water for 16-24 hours, drained on blotting paper for 5 minutes, then drained in a controlled environment (20-25° C, 55-65% RH) for 1 hour. The "saturation water content" of the sample is determined by weighing the sample, then drying at 80° C for 24 hours, and reweighing. Saturation water content[1] is expressed as a fraction of dry mass by the following equation:
>
> MC = (SM - DM) / DM;
>
> where MC = saturated moisture content; SM = saturated mass; and DM = dry mass.

In this analysis, saturated moisture content (MC) was expressed as a % of dry weight:

> % MC = 100(SM - DM) / DM

---

[1]Saturation water content can also be expressed as a ratio, SM/DM. This ratio can be obtained from the fraction of dry mass expression (SM-DM)/DM, simply by adding DM/DM or 1.0. The ratio is what is referred to in expressions such as "the moisture content is *x* times the dry weight of..."

2. Sterilisation and water holding capacity

Mean % saturated water content (% MC) for the 8 sterilisation treatments are shown in the table below.

TREAT	MEAN % MC	SD	SIG	SM/DM
A	2384	165		25
B	1064	199	***	12
C	730	123	***	8
D	882	168	***	10
E	1073	241	***	12
F	3003	265	***	31
G	2960	106	***	31
H	2265	163		24

n = 10

$LSD_{(0.05)}$ = 140.5

CV = 8.9

*** = significantly differs from control (A), T-test, $P < 0.05$

Key to Treatments:

A = Control (no treatment)

B = autoclave, 121° C, 15 minutes

C = heat, 160° C, 2 hours

D = heat, 140° C, 3 hours

E = heat, 121° C, 16 hours

F = janola 10%, 15 minutes

G = janola 20%, 15 minutes

H = Kiln-dried moss (no treatment)

Mean water holding capacity of air-dried and kiln-dried moss were not significantly different, being 25 times the dry weight of moss and 24 times the dry weight of moss respectively. All sterilisation treatments resulted in a significant change in water holding capacity.

Physical sterilisation treatments reduced water holding capacity. Autoclaving and heat sterilising at 121° C, resulted in the water holding capacity being approximately halved (retaining around 12 times the dry weight of moss in both cases). Water holding capacity after treatment with dry heat at 140° C and at 160° C was reduced to approximately a third of the untreated moss (retaining approximately 10 times and 8 times the dry weight of the moss respectively).

Bleaching with janola resulted in an apparent increase in water holding capacity, retaining about 31 times its own weight in water. However, weighing experiments showed that dry matter had been lost as a result of the sterilisation process. This caused the % moisture content figure to be higher than the control, although the weight of water retained was equivalent to that of the control (untreated moss).

3. Particle size and water holding capacity

Mean % saturated water content (% MC) for the 4 treatments is shown in the table below.

TREATMENT	MEAN % MC	SD	SIG	SM/DM
A) Control (no grinding)	2463	200		26
B) Ground (all)	2522	151		26
C) Ground (1.7 - 3 mm)	2133	144	***	22
D) Ground (1 - 1.7 mm)	2937	43	***	31

n = 9

$LSD_{(0.05)}$ = 135

CV = 5.6

*** = differs significantly from control (A), T-test, $P < 0.05$

The saturated water content of the ground moss did not vary significantly from that of the unground moss (control), both having a mean saturated moisture content of approximately 26

times the dry weight of the moss. However, water content of the larger of the ground particles (1.7 - 3 mm fragments) was significantly reduced to approximately 22 times dry weight (84% of the control). In contrast the water content of the smaller ground particles (1.0 - 1.7 mm) significantly increased to 31 times the dry weight (116% of the control).

Conclusions

S. cristatum absorbs and retains around 25 times its own weight in water. Heat treatment reduces the water holding capacity of the moss. Higher temperatures resulted in greater reductions in water holding capacity. Decreased water holding capacity was probably caused by oxidation during the heating process destroying cellular structure and capillary action. Chemical (janola) treatment resulted in an apparent increase in water holding capacity, due to a loss of organic matter. In fact water holding capacity approximated that of the untreated moss.

Grinding did not significantly alter the water holding capacity of the moss. However, the water holding capacity of ground *S. cristatum* appears to be inversely related to particle size. This suggests that a reduction in water holding capacity resulted from cell destruction while an increase in water holding capacity resulted from the increase in surface area. It happened that the grinding and sieving procedure used in this experiment balanced these two opposing factors in such proportions that overall no change in water holding capacity took place.

IV. Effects of sterilisation on the pH of *Sphagnum cristatum*

Aim

To measure the pH of *S. cristatum* and to investigate the effect of steam, dry heat and chemical (janola) sterilisation treatments on the pH of *S. cristatum.*

Materials and methods

Random 2 g samples of treated air-dried moss were placed in 500 ml containers with 150 ml distilled water, and left in a controlled environment room (20° C, 65% RH) for 60 minutes[1].

The treatments were:

A) Control (no treatment)

B) autoclave, 121° C, 15 minutes

C) heat, 160° C, 2 hours

D) heat, 140° C, 3 hours

E) heat, 121° C, 16 hours

F) janola 10%, 15 minutes

G) janola 20%, 15 minutes

H) Kiln-dried moss (no treatment)

See Experiment II for more information on the sterilisation procedures.

The pH of 3 replicates of each of the 8 treatments was measured at 25° C with a pH meter.

The procedure was repeated, resulting in 48 observations.

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[1]Experimentation was undertaken to determine the optimum time to soak the moss. It was demonstrated that one hour was a suitable time to allow the water to be fully absorbed and a pH equilibrium to be reached, while not too long as to allow the effects of CO_2 to alter the pH.

Results

Mean pH for the 8 treatments are shown in the table below.

TREATMENT	MEAN PH	SD	SIG
A) Control (no treatment)	4.51	0.05	
B) autoclave, 121° C, 15 min	4.63	0.18	
C) heat, 160° C, 2 hours	5.00	0.13	***
D) heat, 140° C, 3 hours	4.49	0.04	
E) heat, 121° C, 16 hours	4.57	0.05	
F) janola 10%, 15 min	8.18	0.22	***
G) janola 20%, 15 min	8.07	0.30	***
H) Kiln-dried moss	4.58	0.11	

n = 6

$LSD_{(0.05)} = 0.16$

CV = 3.

*** = significantly differs from control (A), T-test $P < 0.05$

Conclusion

The mean pH of untreated moss at 25° C was 4.5. pH did not change significantly for most treatments. Heat at 160° C for 2 hours increased pH to 5. Chemical bleaching raised the pH to very alkaline levels, pH 8.

APPENDIX TWO: New Zealand Patents relating to Peat Moss Boards

(11) 189717. (22) 21 Feb 1979.
(54) ABSORBENT PRODUCT COMPRISING BLEACHED PEAT MOSS AND FINELY DIVIDED WOOD PULP. (52) 87.3.
(71) Johnson & Johnson.
(72) Levesque, Y.
(31) 879832; (32) 21 Feb 1978; (33) US.
(31) 007280; (32) 30 Jan 1979; (33) US.

Fig.1

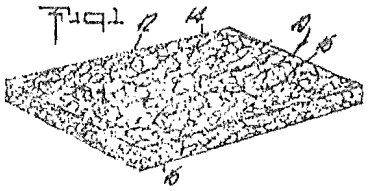
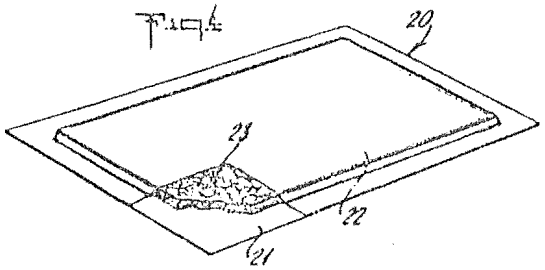


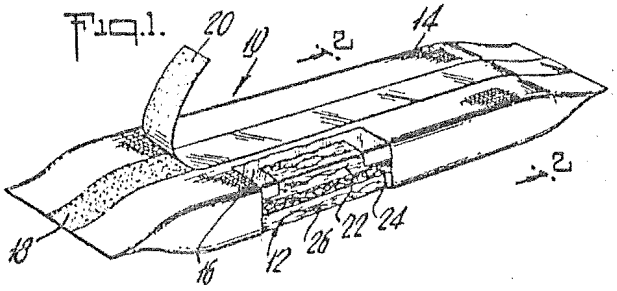
Fig.4

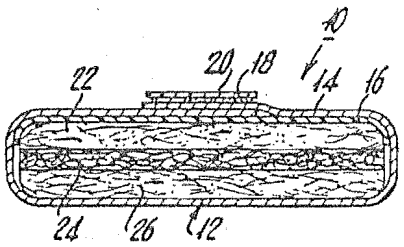


(57) The product 10 comprises bleached peat moss 12 and finely divided mechanical wood pulp 14 having a Canadian Standard Freeness Value of from 30 to 600 and present in a ratio, by weight of the wood pulp to the peat moss, of more than 0.35. The product may include long-fibered absorbent material 16 such as rayon fibres. The product may be used as an absorbent core 23 disposed between a fluid impervious backing sheet 21 and a fluid pervious facing sheet 22 of a disposable diaper 20.

(11) 189716. (22) 21 Feb 1979.
(54) ABSORBENT PRODUCT INCLUDES LAYER OF PEAT MOSS AND FINELY GROUND WOOD PULP. (52) 87.3.
(71) Johnson & Johnson.
(72) Levesque, Y.
(31) 7,279; (32) 30 Jan 1979; (33) US.

Fig.1.





(57) Element 12 of an absorbent product e.g., sanitary napkin 10, consists of a plurality of layers including at least first and second adjacent absorbent layers 22, 24. The first layer 22 comprises cellulose fibres. The second layer 24 comprises in admixture, peat moss and finely divided ground mechanical wood pulp in a weight ratio of at least 0.35 gms wood pulp per gram peat moss. The wood pulp has a Canadian standard Freeness Value of from 30 to 600.

(11) 197753. (22) 17 Jul 1981.
(54) PEAT MOSS/WOOD PULP BODY-FLUID-ABSORBENT BOARD.
(51) D21H5/12; D21J1/00; A61F13/16,20; A41B13/02.
(71) Johnson & Johnson.
(72) Levesque, Y.
(31) 06174403; (32) 1 Aug 1980; (33) US.

(57) This absorbent board comprises a mixture of (a) peat moss having a particle size such that it is retained on a screen of about 100 mesh (Tyler) and (b) mechanical wood pulp fines having a Canadian Standard Freeness of from 60 to 500, the board having a dry density of from 0.03 to 0.09 gm/cc. Preferably at least 5 percent by weight of the board is mechanical wood pulp and optionally at least one surface layer of Kraft pulp is laminated to the board to change the surface appearance. The board may be made more flexible by slitting or by dry compressing to a density of 0.2 to 0.8 gm/cc, such as by embossing, and in the compressed state it is still highly absorbent and upon wetting it returns to about its original thickness and to full absorbency. The board is made by screening the peat moss and discarding the peat moss fines, forming a slurry of the peat moss fraction with mechanical woodpulp fines having a CSF of 60 to 500 and then forming the board from the slurry at a rate to give the desired final dry density, this suitably being obtained by laying the slurry on to a Fourdrinier wire in a weight of 15 to 35 grams of solid per square foot. The absorbent board may be used in absorbent products like diapers, sanitary napkins, or tampons.

(11) 205584. (22) 13 Sep 1983.
(54) CALENDERED PEAT MOSS BOARD.
(51) C10F7/00; D21J1/08; A61F13/18.
(71) Johnson & Johnson Inc.
(72) Ovans, K.J.
(31) 423387; (32) 24 Sep 1982; (33) US.
(74) WWM

(57) A peat moss board with enhanced absorbency is manufactured by producing a board from a wet slurry of peat moss and wood pulp and then conditioning it to contain a prescribed water content before calendering. The water content of the conditioned board must range in value according to the equation: $W = 0.10795P + 8.048 + 7.180$ where: W is the percentage of water by weight and P is the percentage of peat by weight of the dry board. After the board has been conditioned to the prescribed water content it is calendered to compress it and produce a board of enhanced absorbency. The resulting board is then dried to ambient water content.

(11) 217692. (22) 25 Sep 1986. Time extended under s.93A. See Journal No. 1290.

(54) PRODUCING ABSORBENT BOARD FROM PEAT MOSS BY AIR-LAYING.

(51) D21J1/16; D21H5/00.

(71) Johnson & Johnson.

(72) Cadieux, S.M.; Lemay, M.

(31) 770549; (32) 29 Aug 1985; (33) US.

(74) WWM

(57) A process for producing absorbent board from peat moss comprises (a) harvesting peat moss having a degree of decomposition of H-1 value as measured by the modified Von Post scale with no more than 33 percent by weight of the harvested peat moss having a degree of decomposition of H-2 value or more; (b) individualising the harvested peat moss; (c) drying the individualised peat moss; (d) entraining the dried peat moss in a gas stream; and (e) condensing the entrained peat moss to form a low density board. Preferably the low density board is calendered to produce a higher density board useful in the manufacture of sanitary napkins, diapers and dressings. It may also be used as an horticultural mulch.

4,170,515

PROCESS FOR BLEACHING PEAT MOSS AND RESULTING PRODUCT

Jean-Marc Lalancette, and Bernard Coupal, both of Sherbrooke, Canada, assignors to Johnson & Johnson, New Brunswick, N.J.

Filed Feb. 21, 1978, Ser. No. 879,833

Int. Cl.[2] D01B 1/50

U.S. Cl. 162—92 70 Claims

1. A process for bleaching peat moss comprising; (a) forming a slurry of peat moss of a pumpable consistency, (b) treating said slurry with active chlorine in combination with a material selected from the group consisting of alkali carbonates, alkali hydroxides, alkaline earth carbonates and alkaline earth hydroxides while maintaining the pH of said slurry at 7 or less, (c) dewatering said slurry to a solids content of at least 5%, and (d) washing said dewatered slurry with acid to produce a bleached peat moss.

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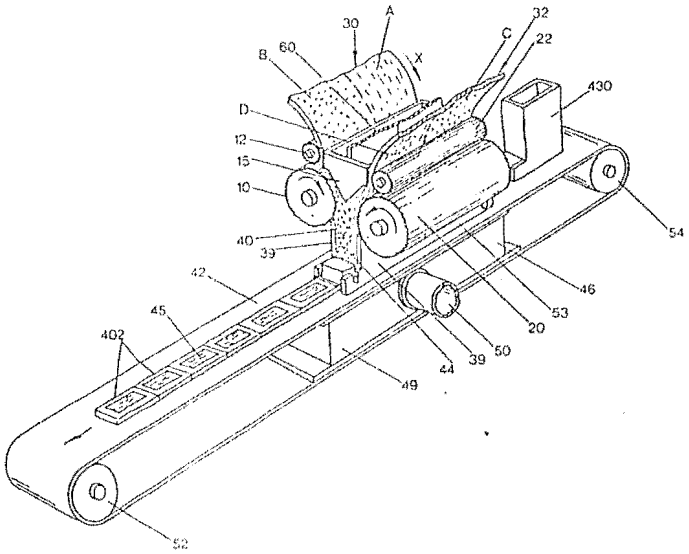
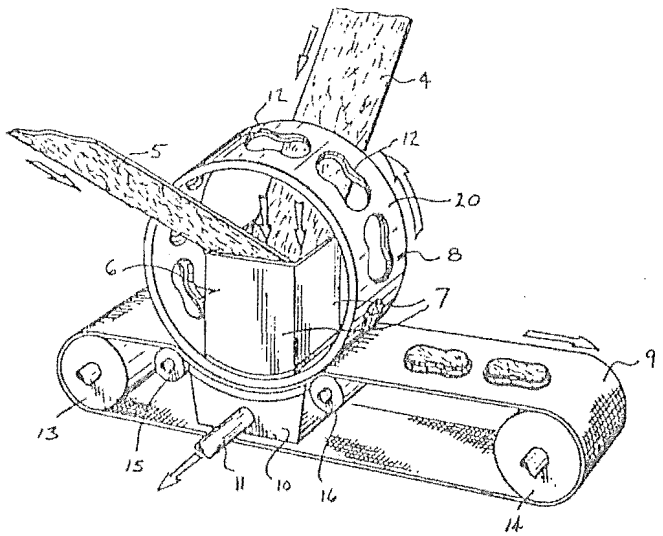
(11) 226286. (22) 21 Sep 1988.
(54) FORMING AIR LAID FIBROUS PAD.
(51) D01G25/00; D04H1/70; A61F13/16.
(71) Johnson & Johnson.
(72) Marshall, Gerald M; Farrington, Allan P; Wereson, Nicholas.
(31) 99874; (32) 22 Sep 1987; (33) US.
(74) WWM

(57) An air laid fibrous product 45 is made by fiberising two fibrous materials 30,32 in lickerins 10,20. The resulting loose fibres are drawn by an air current 44 into molds 402 carried on conveyor 42. The molds have their bottom part formed as a screen, while the conveyor is also formed from screen material, so that air may be drawn through the mold and conveyer. By moving a separator into mixing duct 40 the relative distributions of the two types of fibres in the mold may be varied.



(11) 232414. (22) 7 Feb 1990.
(54) APPARATUS FOR LAYERED FLANGED FIBROUS PAD PORMATION.
(51) IPC5: A61F13/15; D04H1/00,70.
(71) Johnson & Johnson.
(72) Farrington, Allan P; Marshall, Gerald M.
(31) 89 311544; (32) 16 Feb 1989; (33) US.
(74) WWM

(57) An apparatus for the formation of a flanged fibrous product such as a sanitary napkin is arranged so the wider flanged portion of the product is in contact with a foraminous belt 9. The apparatus has a mould wheel 8 in which stepped moulds 12 have a flange forming portion which is adjacent to the foraminous belt 9 and is separated therefrom after pad formation leaving the formed pad behind on the belt 9.



APPENDIX THREE: The Johnson & Johnson Credo

We believe our first responsibility is to the doctors, nurses and patients, to mothers and all others who use our products and services.
In meeting their needs everything we do must be of high quality.
We must constantly strive to reduce our costs in order to maintain reasonable prices.
Customers' orders must be serviced promptly and accurately.
Our suppliers and distributors must have an opportunity to make a fair profit.

We are responsible to our employees, the men and women who work with us throughout the world.
Everyone must be considered as an individual.
We must respect their dignity and recognise their merit.
They must have a sense of security in their jobs.
Compensation must be fair and adequate, and working conditions clean, orderly and safe.
Employees must feel free to make suggestions and complaints.
There must be equal opportunity for employment, development and advancement for those qualified.
We must provide competent management, and their actions must be just and ethical.

We are responsible to the communities in which we live and work, and to the world community as well.
We must be good citizens - support good works and charities and bear our fair of taxes.
We must encourage civic improvements and better health and education.
We must maintain in good order the property we are privileged to use, protecting the environment and natural resources.
Our final responsibility is to our stockholders.
Business must make a sound profit.
We must experiment with new ideas.
Research must be carried on, innovative programs developed and mistakes paid for.
Reserves must be created to provide for adverse times.
When we operate according to these principles the stockholders should realize a fair return.