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From the Grave to the Cradle:
The Eco-Design Case for the Re-Evaluation of Hemp

Abstract

This paper argues that the story of hemp is one of mistaken identity and focuses on the potential of hemp (Cannabis sativa L.) in a social and economic context and how it can help to develop with modern technology into 'new' materials on a national level with reference to examples from abroad.

The current state of raw material shortages means that designers have an obligation to seek out new ways to source and process materials for a sustainable future. Designers are the "future creators" and should prescribe materials that are not only healthy in the cycle of production but also ensure an afterlife (recycling). Designers should also embrace the task of guiding the consumers in a new way of thinking, mainly concerning our environment and consumer patterns. Hemp is a zero-waste material; the whole plant can be used when harvested which makes it an ideal material to base such an eco-design system on.

The hemp fibre made from the outer bast yields 250% more raw material than cotton per acre while using considerably less pesticides. Spun hemp yarn can be transformed into rope or a rugged fabric as well as blended with silk or cotton as it absorbs natural dyes with ease. These fabrics can be used as upholstery, canvas covers, sails, clothing and even super-absorbent nappies. Hemp fibre is an ideal replacement for glass filament in fibreglass resin and is used in surf- and snowboards.

In spite of Hemp's impressive potential, it has been ignored for far too long. The main reason for the isolation of hemp is the mistaken assumption that Cannabis sativa L. is a drug whereas its vilified cousin, Cannabis indica carries the hallucinogenic properties thereby leading to a blanket ban on both. This paper argues the eco-design case for the re-evaluation of the assumptions about hemp and poses a challenge for design education to take a more holistic and proactive stance with respect to eco-design and issues of sustainability. In so doing, design would aid in eliminating some of the misconceptions that have dogged useful products like hemp thereby promoting creative product development in a socially responsible manner.

Key Words: *Eco-design, hemp, multi-diversity, socially responsible design, sustainability.*

Introduction

The choice of materials for new products is of major concern when the impact on the environment is taken in consideration, especially when the raw material is based on petrochemicals. This is particularly pertinent when viewed against the influential role that design plays in the world of product development and the resultant of global pollution and resource availability has become the main drive to reconsider if this was a healthy road for the future.

"From the grave to the cradle" concept has two significant contributions it can make. Firstly, it can inform more progressive legislation to reverse the demise of hemp production in the Western World as well as in South Africa. By using a consultative forum to engage, inform and educate future generations, government might be willing to re-evaluate their stand on hemp and alter relevant legislation to facilitate the reintroduction of viable hemp production and manufacturing industries. Secondly, hemp can help in the revitalization of our damaged planet, kindling it back to health thereby securing that future generations inherit a habitable Earth.

This concern is not as distant as it might sound at first as time is of the essence if we as inhabitants of this increasingly fragile planet are to stem the slide towards ecological disaster. We are witnessing a crisis of grave proportions and must act without delay. On a more positive note, the answer is within our grasp but will require concerted effort by all Earth's denizens and robust political goodwill and leadership from all leaders. The logical question then is why the hemp plant is not presently used as a sustainable design resource in South Africa.

Setting

In the dictionary cannabis is described as “a drug produced in various forms from the dried leaves and flowers of the hemp plant, smoked or chewed” (Hornby, 1997:162). The *Cannabis sativa L.* or hemp is a distant relative of the *marihuana “dagga”* plant we all know so well. Presently in South Africa there still appears to be misunderstanding of what exactly the hemp plant is. The stigma seems to revolve around the dangers of the hemp plant that is erroneously confused with the *dagga* plant; it is the tetrahydrocannabinol (THC) (Encarta, 1997) that causes the hallucinogen “high” found in the *dagga* – *Cannabis indica*, and it is mainly found in the flowers of the female plant which can be smoked. When we measure the THC value, dagga scores an easy 10% and beyond while that of Cannabis sativa L. can be controlled to reach a maximum of only 0.05% THC.

Currently there are three sides to the South African legislation that prohibit *Cannabis sativa L.* from being grown as a commercial crop, Firstly, the Department of Health has to issue permits, yet it only allows hemp to be grown for experimental purposes. It is reasonably easy to physically distinguish between hemp and *marihuana*, the leaves of the hemp plant are very narrow and the plant grows very tall whilst the *marihuana* plant grows to a short and wide plant. In South Africa the law stipulates that the THC value may not exceed the level of 1% (Brough, Sotana, & Mhlontlo, 2005:12) while the international drug potential threshold is 0.3% (Rosenthal, 1999:46). Secondly, the Department of Justice treats hemp as an equivalent to *dagga*, hence declaring it a drug. Thirdly, the Department of Agriculture classifies hemp under the Invaders Act 2 and bans it from being grown without supervision. There is need to first tackle the misconceptions people have regarding the plant before this potential “eco-savior” can be saved from total banishment from our agricultural fields. Further, there is a need for sustained “local consumer pressure” to be exerted to force the government to reassess its position on the hemp plant (Bethlehem & Goldblatt, 1997:219).

If we look at objects such as the canvas -“Dutch word derived from the Greek ‘Kannabis’ (Jamikorn, 2005)"- sail on wind powered ships and the ropes made from the fibre, it is not hard to understand how the Dutch reached their golden age. Hemp was already a profitable crop in 1555 in numerous regions of the Netherlands, where the government asked farmers to deliver set qualities (Fels, 2002:16).

The cannabis plant has been used through many parts of the world for cloth and fibre purposes as the found samples from a cave in Europe dating back to 6000 years. An excavation in Ankara revealed that China and Chinese Turkestan from 5000 years ago used hemp as thread and rope. The medicinal and hallucinogenic qualities were then part of the culture amongst healers and Shamans (Toit du, 1985:6). It was in the Han Dynasty starting at 207 B.C.E. until late 220 C.E. that the Chinese discovered the advantage of pounded hemp to create a light and inexpensive writing surface. The first Levi jeans made in California derived from fabric spun from the hemp plant (Robinson, 1996:105). The hemp fibre is not susceptible to moist and other weather influences, giving it a unique “non-rotting” strong characteristic and makes it very suitable for wet applications such as fire hoses, sails, tent linen and canopies (Dijkmeijer, 1947:61). The Western world had shown great interests in fibre capabilities centuries ago and the plant was even common to the local people of the Cape in Southern Africa when fleets were circumventing the coastline in the 15th and 16th century from the East with European navigators (du Toit, 1985:14).

Rudolf Diesel had his first prototype diesel engine running on natural based vegetable and seed oils such as hemp oil-fuel as they were more superior to petroleum before it was later turned into an automobile (Conrad, 1994:38). Henry Ford actually saw the world’s future evolve with the aid of hemp in the 1930’s as the core material for his newly developed plastics and fuel derived from the cellulose in the hemps stalk. Ford was convinced that one could make things as easily from Carbohydrates derived from plant matter as it was from the fossil based Hydrocarbons (Robinson, 1996:139). Besides Ford there are numerous futurists and organic based engineers today that are convinced that at least 90 percent of our fossil fuel based industry such as natural gas, crude oil and coal can be replaced by renewable biomass such as waste paper, hemp, sugarcane, and cornstalks. The time has come to replace the restrictive capitalistic model with the ecological consciousness that prescribes a cleaner future focusing on a “green planet” (Jamikorn, 2005).

Hemp seeds can be used to produce oil; it has a soothing and moisturizing effect on the skin while the residue meal from the nut is full of protein. Hemp has no waste materials, it alleviates waste carbon dioxide into oxygen and the whole plant can be used when harvested. Fabric made from hemp does not generate static electricity; it also creates electrically neutral surroundings of 30 meter around the root in the ground and has the potential to neutralize ultraviolet, radioactive and electromagnet waves (Unknown 3, 2006).

This impressive plant can help alleviate our global warming problems; hemp produces 600% more fibre than flax and 250% more fibre than cotton on an acre. Until recently the plant had a very industrial application with hard and course fibres. An enzyme was developed in the 1980's to easily remove the lignin from the outer bark without compromising its strength (Unknown 1, 2005). Since then *Cannabis sativa L.* seems to be a good sustainable candidate as source of high quality fine fibre yields just waiting to be used for numerous new options in manufacturing transformability. For example, hemp is a replacing equivalent of the glass filament used in current fibre glass resin blends. BMW and Daimler Chrysler are using more natural fibres such as flax and hemp for interior motor vehicle panels for sound proofing and protection; they concluded that the fibre in the panels break into compact reformed crushing shapes during impact in comparison to the sharp exposed edges after a motor vehicle accident created by plastics used up to date (Hanke, 2001:48).

Whereas the hemp plant can grow on virtually no fertilizer and pesticide, cotton is a crop that is very favourable due to its easy spinning. However the environmental impact seems to have been neglected. Cotton is grown on 3% of the most fertile soil while it is then sprayed with 26% of the global consumed pesticides which has led to the vast contamination of agricultural groundwater and runoffs; in the United States this has caused 15000 lakes unlivable (Guy, 2004).

Sustainability

In pre-industrial times people made products that were from the earth. The said products broke down easily into the eco-system at the end of their use-life, thus creating a natural cycle of nutrients returning to the earth. The human species has the unenviable reputation of being the only producer that removes vast quantities of nutrients from the rich soil without replacing them in a natural usable way (Braungart, 2002:96).

The state of the world is characterized by desire for extravagance which if unabated will accelerate society's impeding downfall. If the indulgence of possessions does not move from a personal gain to a spiritual awareness and reconnect to nature once more, then this fate is eminent (Fukuoka, 1978:110). Our reliance on science and imaginative the inventions that we have become so subservient to have left us with monstrous machines that evoke a sense of pride creating a false sense of security in the world of wholesale (Jung, 1964:101). The opposite would be true if we embrace an enduring ecological model, one that is so vitally important for our social and physical systems where sustainability is embedded ethical rather than economic domains (Stirling, 2004:13).

When raw materials are used to develop a new product, the lifespan versus material growth span has to be considered carefully. Frequently, the materials used to manufacture a wooden bookshelf take longer to grow than the actual length in use of the object after its produced state (Boy, 1994). The importance of re-assessing the value of the product in its entire lifespan can make the level of awareness amongst consumers and manufacturers shift to a new cooperation thereby sharing a human scale of understanding of the benefits of waste reduction (Stirling, 2004:13).

Sustainability is essentially a grassroots concept where the materials used, the people and their customs, energy flows, religions and needs as well as the water and soil use are analyzed. The chemicals that affect the up and down stream of the water supply as well as soil contamination is of crucial relevance as they have direct impact on the local flora and fauna, and by extension, the welfare of the local community.

The concept of designing products with unavoidable waste residues can be replaced with "form follows evolution" (Braungart, 2002:104). This results in a new lifecycle where the waste of production and the used product actually become a valuable nutrient material that will determine the shape of the design that can be fed back into the eco-system. Hemp can alleviate the dependence of small communities

on the monopoly of big corporations regarding the supply of energy as it can be turned into a sustainable biomass fuel that burns cleaner, creating a better economy and ecology (Jamikorn, 2005).

When sustainability is looked at on a local scale, the question as to what is best for that specific place or area needs to be interrogated subjectively and analyzed with an open-minded (Braungart, 2002:124). Current phosphate fertilizers are extracted from rock which is mined. This is extremely destructive to the environment whereas human waste (if not contaminated by disposed thinners, industrial wastes, cleaning chemicals and antibiotics) can be used to feed the soil with valuable phosphates as opposed to treating it as dumped waste (Braungart, 2002:102).

Ever since the Industrial Revolution, the source of fossil fuels took control of the energy supply and contact with nature and its resources has caused a gap between humans and its surroundings, giving people the feeling of having control over nature and the right to manipulate it according to their own free will (Braungart, 2002:128). Consequently, when a raw material is prescribed for a manufacturing process, its impact (or carbon footprint) on the environment should be carefully evaluated before the final choice is made, the easiest choice may not be the best outcome-based source. This raises the question of how our present choices will reflect on the future outcomes, resulting in a “feedforward” analysis (Braungart, 2002:145). The rapid rate of growth of the hemp plant can create a stable supply of seeds when locally grown and achieves self-sustaining viability within a year or two on a small scale industry, and in about five to ten years for large scale farming (Rosenthal, 1994:293). After all, God gave us "every seed-bearing plant on the face of the whole earth and every tree that has fruit with seed in it. They will be yours for food." (Genesis 1: 29-30) and we should treat this with mutual respect without wasting.

Processed hemp

Textiles

The bast (or outer side) of the hemp plant is the source for the fibre that does not require any complex machinery, it can be spun and woven on the same looms as being used for jute and flax, small alterations need to be made due to the thicker thread that the fibre of hemp possesses (Carter, 1907:106). Hemp is such a durable fabric with can be either used by itself or blends very well with cotton, silk or flax resulting in garments that can be worn for decades, are absorbent, cool, biodegradable, breathable natural fibre and is a good alternative for synthetic fibres based on petrochemicals. Up until the 1820’s numerous products made from hemp were available in America such as towels, quilts, bed sheets, rugs, drapes, tents, and clothing and were readily available around the world far into the 20th Century (Jamikorn, 2005). Cordage, twine and rope were produced using hemp as a source in 70-90% of most manufacturing cases up until 1937. Hemp has a lustrous strong fibre that can withstand moisture, insects, and heat and has a natural ultra-violet (UV) resistance. Used as a carpet backing for centuries hemp does not release toxic fumes after manufacturing for months or even years in comparison with synthetic products, which can also burn out into volatile poisonous gasses in case of home fires or in garbage dumps (Jamikorn, 2005). In Japan hemp was used for straps on sandals (geta) or as packaging rope, long-line fishing used for eels or even on their much longer bows never seen in Asia or Europe that could kill three men in line if the circumstances were ideal. Hemp is a durable fibre that was used for clothing suitable for all weather conditions and sailors even wore sandals manufactured completely from hemp in Japan (Paulhus, 2004).

The porous characteristics of the fibre insures a better bonding with dies and the fibre can absorb up to 30% of its own weight in moisture without feeling wet (Dijkmeijer, 1947:62) making it an ideal base for nappies. From an acre of full grown hemp about 25 to 50% of the plant can be turned into usable fibre, yielding an area of 500-1000 square metre fabric that is spun with a number 10 thickness; similar to jeans material. A hundred thousand jeans can be manufactured from between 200 to 400 acres of hemp (Rosenthal, 1994:71).

Fibreboards

A relatively inexpensive board can be made by heating up hurd (inner core of the hemp plant) and compressing it to produce a fire-resistant material, with excellent sound-insulating and thermal qualities suitable for construction purposes to replace dry wall and plywood manufactured from wood-based materials (Jamikorn, 2005). The hemp hurd can be processed on a conventional fibreboard production line without any alterations insuring no additional start up costs. Hurds are chopped into lengths of 25mm and shorter without compromising on its strength to prevent jamming the existing

wood mills (van Wyk & Gericke, 2000:300). Straw can be blended with hemp hurd to compensate for currently scarce hemp resources without reducing the quality of the comparable wood-type board whilst the 100% hemp board is two and a half stronger than the current wood medium density fibreboard (MDF) composite. The hemp board has an elasticity factor three times higher than the wood-based MDF, which enables the ease of nail penetration (Osburn & Osburn, 1994). There is great potential in creating structural building materials such as beams and posts out of the compressed hemp hurd with the same strength becoming the future competitor of the steel I-beam (Boy, 1994). Compared to concrete, hemp has the same strength factor yet is biodegradable, much lighter and is fire-resistant and as a board it can bend and curve easily (Unknown 3, 2006).

Oils

The possibility to reach a maximum of 82-kg/ha seed crop has an oil quantity of 30-40% that can be either used for soap as well as for food preparations such as margarine (Rosenthal, 1994:141). The base for paints and varnishes that were manufactured for thousands of years was usually hemp-linseed oil or a blend of the two which insured that deep penetration (due to its low viscosity) into the wood fibre and preserved it tremendously well. As a fuel for oil lamps, hemp was used extensively until about 1800 when it had to make way for the even cleaner burning whale oil that stayed around until the 1870's in America and the rest of the world (Jamikorn, 2005). Oil pressed from the hemp seed is rich in polyunsaturated essential fatty acids (EFA's) and can be easily be absorbed by sun damaged lipids and so replenishing the skin cells (Rosenthal, 1994:176). When processed in the same way as crude oil, hemp seeds have the ability to be transformed into a fuel with the same ignition qualities as diesel fuel and the high cellulose in the stem can be turned into a methanol or ethanol product without any heavy metals or sulfurs that can pollute the environment (Unknown 3, 2006).

Even though it is suggested that hemp should be cultivated in North American on 6% of its landmass to produce the demanding fuel at a wholesale price of $0.60 per gallon, an astounding $40-100 can be fetched for a gallon of hemp oil when it is sold for the cosmetic or food industry (Rosenthal, 1994:142).There have been numerous tests with hemp oil to prove to the world that it is possible to drive long distances such as the case with a vehicle that left Takigawa City, Northern Hokkaido, Japan on the 29th of April 2002 and covered 12500km in about four months using 2600 litres of fuel until September 11 (Unknown 3, 2006).

Paper

Hemp fibre can be an ideal supplement for wood-based pulp, which is currently mixed with other organic grown crops such as cotton, flax or even wheat straw to result in a required surface, opacity and weight. Hemp is a good non-wood fibre for cigarette paper, currency paper, and filter paper and is even used in the tea bag industry creating a viable ecologically-friendly product. These blending processes are still in an experimental/research stage bringing forth an initial high cost but producers are willing to pay for a higher quality and as products are developed, the cost may drop considerably (Unknown 2, 2006:13). As opposed to tree-based paper where great amounts chlorine are used to extract the lignin content that then converts into dioxins and other pollutants such as sulphur-based acids bleaching are used, paper made from hemp with a low level of lignin that can be dissolved with a nature friendly chlorine or hydrogen peroxide resulting in less contaminated residue returning into the water cycle (Boy, 1994**).** With hemp pulp yields of up to four times higher than its wood counterpart per hectare the final paper product also does not become brittle, decompose or yellow ensuring that the paper manufactured from hemp will outlive many of us by hundreds of years as opposed to wood-based paper that lasts about 50 years (Roulac, 1997:120).

Plastics

The plastics that can be derived from hemp can be processed into three different ways.

- The hurds make excellent cellophane that was commonly used up to 1930 and even presently as a plant-based packaging material.
- To emphasis the green aspect of hemp, a mixture of 50% hemp hurds and 50% recycled plastics can be used for production of injection-moulded parts.
- The oil obtained from pressing the seed can be "converted into a valuable plastic resin (Guy, 2004:1)."

At a conference held in Germany in November of 2006 by the European Industrial Hemp Association (EIHA) Canadians shared the great interest in a blend of hemp fibres and Polylactide (Carus, 2006:1). The plastic plumbing pipes currently made from polyvinyl chloride could be replaced by the renewable hemp made of a high concentration of cellulose ensuring that the currently used non-renewable chemical petroleum-based or coal feedstock can be eliminated in the manufacturing process (Jamikorn, 2005).

Building materials

Wheat and barley bale homes have been built for a while now but there seems to be a problem with the dampness that is collected by the straw which seems not to be occurring with hemp making it a viable replacement. Another positive point is the tougher and longer lasting characteristics of the hemp in comparison to the wheat bales. It is very difficult to work with hemp bales, as they are hard to pin down due to their toughness. However, hand-chopped hemp hurd is mixed with lime or earth that allows it to be either cast into wall structures moulds or the size of bricks. Chopped hemp hurds of about 2.5cm in length can be used for the casting process. Longer lengths can be used with the casting method as they seem to offer an additional strength (Kennedy & Michael, 2002:161). Hemp can be used in conjunction with wooden frame structures or as free standing walls. The walls can be built with a thickness of about 20cm with casting lifts of about 75 to 90cm in height (Kennedy *et al*, 2002:162).

Conclusion

Various design commentators including Whiteley (1993) and Papanek (1995) propose socially responsible design as a sustainable strategy to foster development in developing and majority world contexts. Whiteley (1993:119) further argues that *"a product or process which does not grow out of the habits and customs of a country or region is unlikely to be successfully integrated into the society's culture".* The *New Model of Socially Responsible Design* (Davey, Wooton, Thomas, Cooper, & Press, 2005) locates the design agenda at the core of all public sector engagement and includes the eight tenets of *Government, Economic policy*, *Fair Trade*, *Ecology*, *Social inclusion*, *Health*, *Education*, and *Crime*. The geopolitical realities in South Africa demand a more proactive homegrown approach to design advocacy. Locally pertinent concepts such as *ubuntu* (Mbigi, 2000; Bhengu, 2006) and *batho pele* (South Africa, 1997) lend themselves readily to the ethos of anthropocentricism which complements hemp production elegantly as the latter can be tailored to be labour-intensive, thereby creating sorely needed sustainable employment opportunities for a vast majority of rural and peri-urban denizens. The resultant economic empowerment and concomitant reduction in crime would benefit everyone.

The uses of hemp appear to be endless; the imagination seems to be the only limitation. The quest to design with the environment in mind as well as the long-term ecological impact any material has should inform all new product manufacturing ventures. Hopefully South Africa will capitalise on the opportunity to become a conscientious global champion in showcasing the immense potential of hemp. A program of education targeting policy makers in government on how to distinguish between the drug and agricultural plants would need to be developed, complimented by a pragmatic measure of design activism. Such interventions of *design for development* should be carried out "in the most effective ways" as Margolin (2007:115) advises. Finally, the design profession should challenge the state of mis-education and foster an environment in which, as Thomas (2006:65) puts it, "value-driven designers… can share their ideas and work more effectively in support of the ideals in which they believe".

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Education

1980-1985 Technical High School, Marais Viljoen, Alberton, SA
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1985-1990 College for Merchant Marines, Mechanical Engineering, Nijmegen, NL. Completed theoretical part, received diploma in 1992

2002-2004 Cape Technikon, Cape Town, SA
Completed National diploma Industrial Design

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Work experience

1991-1992 JO Tankers, Spykenisse, NL
Internship, worked in the engine room of chemical tanker controlling and maintaining the propulsion systems and machine park

1993-1994 Randstad (temp agency), 's-Hertogenbosch, NL
Numerous technical functions such as climate control, motherboard manufacturing and maintainence on forklifts

1995 Holland America Line, Rotterdam, NL
Functioned as mechanical engineer in engine room of passenger liner

1996-2001 Starren, Veghel, NL
Built and installed electrical controlling units for the logistics industry

2003 Cape Tecnikon, Cape Town, SA
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Miscellaneous

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Completed a course in process controlling in 1997
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Hobbies

Compile music video clips for underground bands in the Netherlands
Read Japanese fiction
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