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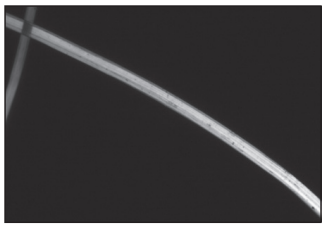

Eco-tech Fashion: Rationalizing Technology in Sustainable Fashion

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Abstract

At first thought, technology and sustainable fashion might appear to hold contrasting ideals; however, an investigation into technology and sustainable fashion yields complex symbiotic relationships between the two areas. Technology is essentially the prime enabler that allows sustainable fashion to thrive and develop today. The role of technology within the sustainable fashion realm is broken into two main areas: the physical manifestation of sustainable fashion garments, including textiles, and the digital domain. The effects of technology in sustainable fashion are best understood through looking at the work of a

technology theoretician, Andrew Feenberg, who advocates for small, but effective, "democratic rationalizations" of technology to achieve positive change.

KEYWORDS: bamboo, technology, textiles, fast fashion, sustainable fashion

> The dilemma of virtue and prosperity is not absolute, but can be mediated in the course of technological development … As it sinks down into the structure of technology itself, through advances that adapt technical systems to the natural environment, it will become obvious that environmentalism represents progress.
>
> Andrew Feenberg (1999)

> The sewing machine is a tool for liberation.
>
> Otto von Busch (2007)

Introduction

One day last year I was wearing a new bamboo fiber sweater at work. I enjoyed feeling the smoothness of the lustrous fabric against my skin and, as a textile conservator, I was pleased to experience a fiber that was relatively unknown to me. On a whim, I pulled a few fibers from a stray yarn and mounted them to a microscope slide. I was curious to see how this natural fiber compared with those I usually encountered in my work with historical textiles—would it have the same rugged branch-like form as linen or the smooth, rhythmic twists of cotton? As I gently eased the fiber into view through the lens of the polarized light microscope, it was with great shock that I registered a morphology akin to a synthetic fiber (Figures 1–4). Visually, this striated polymer stippled with small amounts of delusterant had more in common with the regenerated fiber rayon than it did with a natural cellulose fiber—gone were any indications that it was derived from bamboo. It was at that moment that I realized this supple fabric marketed as environmental and natural was really created through technology using chemistry and energy in a process similar for that of viscose rayon, ironically one of the most polluting fibers to manufacture.

At first glance it seems incongruous that a "natural" fiber marketed as an ecological alternative to petrochemical-derived synthetics would be created through chemical manufacturing; however, a deeper investigation into the role of technology in the realm of sustainable fashion reveals a picture that is far removed from oversimplified nature-versus-machine arguments. Hiding behind bamboo's facade of "naturalness" is a back-story worthy of consideration—why is its manufactured

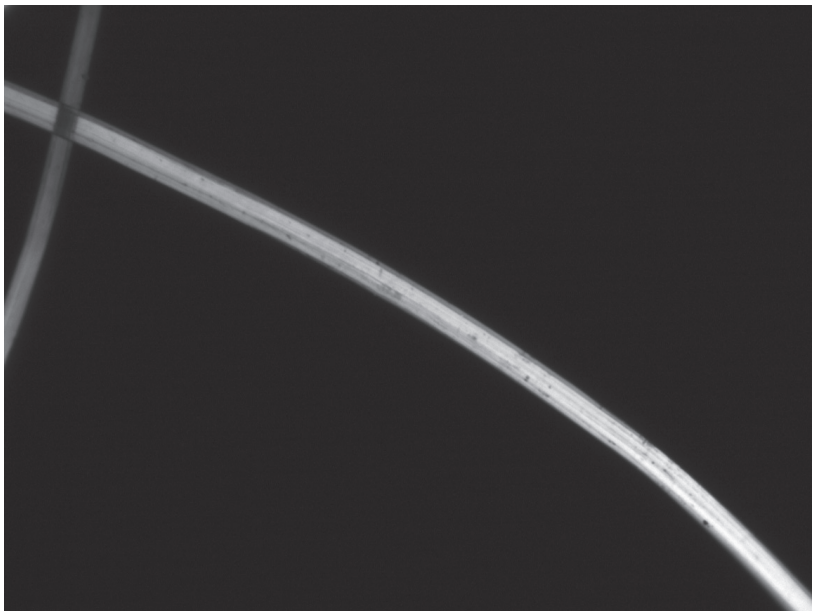

Figure 1
Regenerated bamboo fiber as seen magnified 20× by a polarized-light microscope.

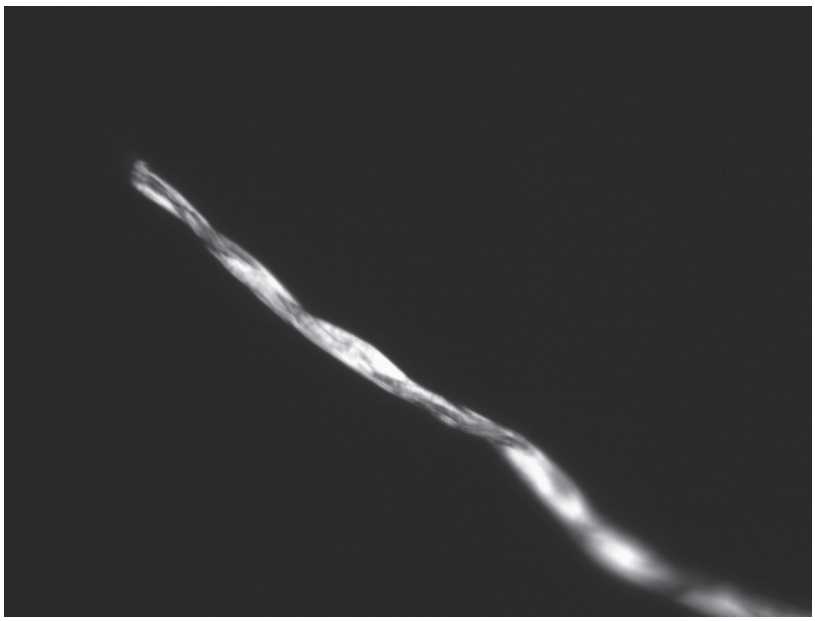

Figure 2
Cotton fiber as seen magnified 10× by a polarized-light microscope.

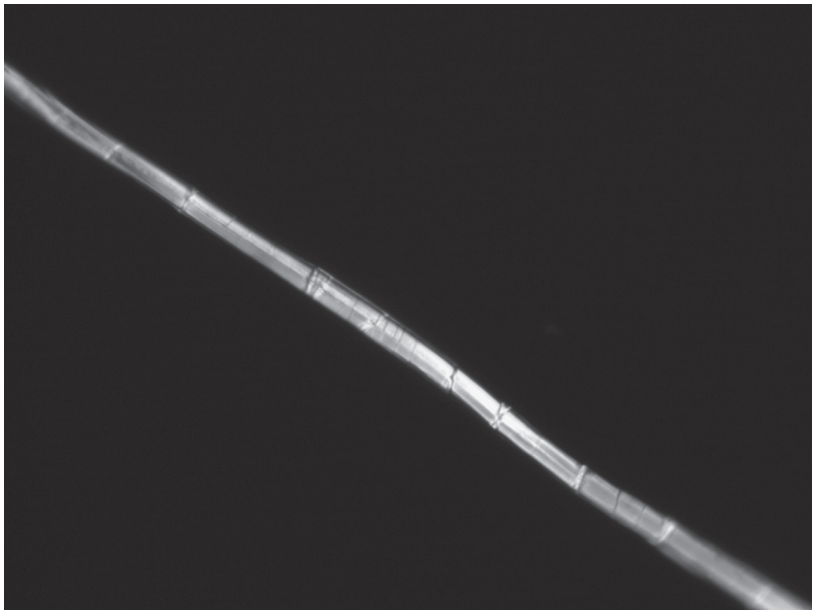

Figure 3
Linen fiber as seen magnified 20× by a polarized-light microscope.

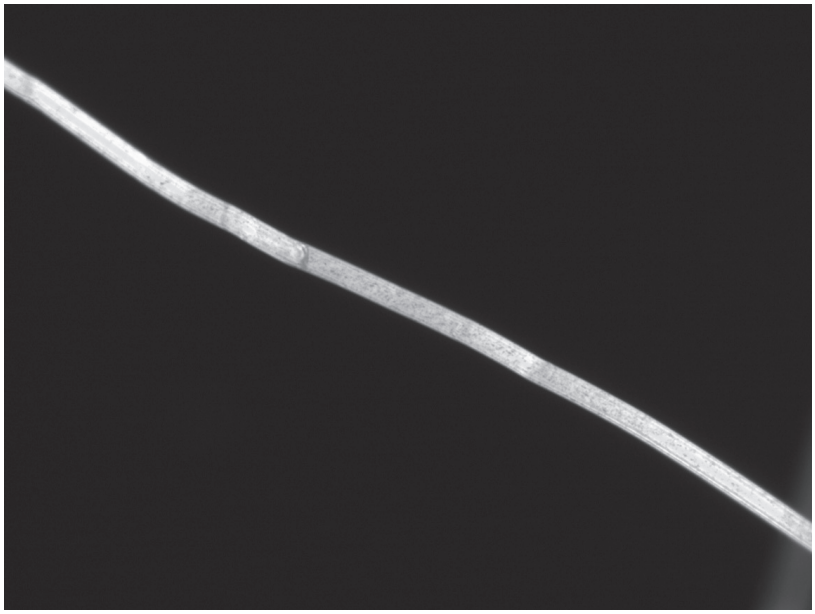

Figure 4
Viscose rayon fiber as seen magnified 20× by a polarized-light microscope.

provenance overlooked? What would happen if its technological manifestation was embraced, rather than brushed away?

The back-to-nature philosophy evident in much of the ecofashion movement either is ambivalent about the role of technology, or worse, serves to position technology as a destructive force acting upon society, leading the way to an ever-dimmer future. I would like to recontextualize

this view of technology as a merely functionalist and hierarchical machination of society into one that affirms its role as a multidimensional cultural force with great democratizing possibilities, especially within the realm of fashion. In essence, I believe that ecofashion is expressed most successfully when technology's role as facilitator is acknowledged. A close investigation reveals that the blending of technology with fashion is not merely the application of devices or circuits to clothing, but rather the enabling role that it plays. While technology is by no means the only lens through which to view ecofashion, it is imperative that its role not be diminished. As I will show, many areas pertaining to ecofashion already rely on some type of technological aspect. If selectively and rationally embraced, technology can continue to serve the sustainable and ethical requirements of modern society, enabling ever sophisticated methods of clothing creation, consumption, and disposal.[1]

Eco-tech Fashion

The relationship between fashion and technology is not new. An inquiry into fashion today uncovers an undercurrent of techno-fashion, whether conceptually practiced by designers such as Hussein Chalayan or as seen in the prevalence of garments with embedded circuitry or high-performance fabrics. The phrase "wearable technology" is often used to describe this physicality of technological fashion, and specifically indicates garments with some sort of attached electrical device or component; however, this definition is inherently limiting and imprecise, as fashion has always been a wearable expression of the technological state of society. Contextualizing technology within fashion history reveals a system that has always enabled the development of fashion; i.e. technical improvements in looms led the way to ever sophisticated weave structures; the invention of synthetic dyes in the mid-1800s created a demand for shockingly bright colors; and the production of synthetic polymers in the twentieth century satisfied the public's hunger for novelty.

Technically mediated fashion was particularly strong during the mid-twentieth century, especially with the advancement of machinery and manufacturing processes leading to the development of innovative fibers and plastics. Fashion designers like Paco Rabanne, Pierre Cardin, and Diana Dew created modular, streamlined, and space-age clothing, whilst fashion magazines and their advertisers told customers to celebrate the development of synthetic fibers as excitingly futuristic. Concurrently, fiber manufacturers were looking towards technology as the answer to future consumption needs based on expected population growth. *American Fabrics* magazine strongly encouraged the development of synthetic fiber and fabric technologies since "natural fibers alone will be unable to fill this vast future need" (de Cizancourt and Segal 1961–2: 40). This argument recognized the limitations of the earth's environment

to produce enough natural fibers in the face of growing clothing consumption, yet failed entirely in acknowledging the dangers of turning towards a nonrenewable resource like petroleum.

During the mid-twentieth century, there also was a recognition of the sociological impact of merging fashion with technology, as evidenced through the 1968 exhibition "Body Covering" at the Museum of Contemporary Crafts (now called the Museum of Arts and Design) in New York City. Besides showing garments by fashion designers like Dew and Rabanne, the exhibition contained conceptual drawings of a dress that could expand into a portable seat for the wearer and an environmental garment structure that fully enclosed the wearer's nude body, delivering meditational vibrations or warning notifications of approaching unpleasantness (Museum of Contemporary Crafts 1968). Thus, fashion in the mid-twentieth century emphasized a positive view of technology as a promising solution to primary physical and social needs.

This optimistic belief of technological fashion has not wholly persisted. A standard of cheap, fast, and disposable clothing has arisen with the perfection of networked technological systems streamlining the design, manufacturing, and consumption of clothing. Mediocre products combined with suspect and possibly harmful methodologies and materials are all hallmarks of a "fast fashion" system containing the ideals of novelty and profit. Technology is in part to blame for the environmental and ethical fallout of fast fashion consumption; there is now biotechnological interference with the environment, a profusion of detrimental textile manufacturing byproducts and waste entering the ecosystem, and of course, a vast amount of energy needed both to make and to take care of all the clothing produced. Conventional fashion's built-in system of redundancy thrives today because of the ongoing perfection of technological production and consumption techniques catering to fashion's need for change. In many ways, technology is a prime enabler to society's fashion consumption addiction and at the root of many of its negative consequences.

This tension between technology as a positive or negative factor in the sustainable reality of a culture's resources is at the core of any discussion on technology and environmentalism. Thinkers as early as Karl Marx noted the possibilities of technical interaction to alter society and the environment at large. Technology can be envisaged negatively as a hierarchical deterministic force driving consumption and commoditization, thus leading our environment into an inequitable stasis. As we become increasingly disembodied from our natural world, we become more likely to question the authentic qualities of living in a technocratic society. We find that "much of the environmental disparity or environmental injustice in the world today emanates from non-sustainable technological systems, whether in terms of consumption, or unequal distribution of pollution burdens" (Veak 2005: 2).

This pessimistic and determinist view of the technological world is classified in environmental terms as "ecocentric," and is a view that strives for "a low-impact technology … concerned with the environmental impact of rampant growth and large-scale industrial development" (Madge 1997: 46). The opposing environmental mode is termed "technocentric" and "is characterized by an unswerving belief in the human ability of science and high technology to manage the environment" (Madge 1997: 46). However, neither technocentrism nor ecocentrism accurately describe the complex attitudes and activities occurring at present within the sustainable fashion realm. Balancing the dismay regarding the role current technologies play in the fast fashion system is an alternate belief that the right technologies, when selectively developed and applied, can play an integral role in the growth of sustainable fashion. This concept is best called eco-tech fashion, and is an idea that insists upon the emergence of a sustainable fashion system through an innovative technological framework containing thoughtful manufacturing processes and consumption patterns. Eco-tech fashion emphasizes technological systems that are more democratic and sustainable than the current prevailing technologies. "Eco-tech" is a phrase borrowed from the architectural lexicon that refers to the use of sophisticated technologies to promote and develop social and ecological practices and awareness.[2]

While it is not the goal of this article to posit ecofashion into the arguments of technological theoreticians, viewing it through the lens of social and cultural technology thinking, rather than strict ecological or fashion theories, does prove to be effective. In particular, the provocative technology philosopher Andrew Feenberg has crafted a positive, flexible argument pushing for contextual, rather than functional, readings of the technology-society relationship. His concept of a "democratic rationalization" of technology reveals a cultural horizon that promotes participation and initiative in technologies that "can also be used to undermine the existing social hierarchy or to force it to meet needs it has ignored" (Feenberg 1999: 76). He states that:

> legal forms may eventually routinize claims that are asserted informally at first, but the forms will remain hollow unless they emerge from the experience and needs of individuals resisting a specifically technological hegemony … These movements alert us to the need to take technological externalities into account and demand design changes responsive to the enlarged context revealed in that accounting (Feenberg 2003).

Essentially, he promotes an adaptable, democratic and horizontal technology system that can best respond to the sustainable needs of society.

> Technical democratization cannot proceed primarily through … formal means. The state and its administrations are products of

> centuries of centralization of power in bureaucratic structures that are congruent with a specific technical code. To the extent that the code is inherently authoritarian, it must be changed from below, not from above, and that requires active citizen involvement (Feenberg 1999: 106).

To that end, Feenberg states that "the environmental movement … [is] arguably, the single most important domain of democratic intervention into technology" (Feenberg 1999: 93).

It is easy to extend Feenberg's assertion of the importance of technology within the environmental movement to sustainable fashion. The viability of an ever-sustainable fashion system is the ideal reason to investigate the possibilities of democratic rationalizations of technology. Already there is evidence that fashion is renegotiating its relationship with environmentalism on individual and societal terms through contextual, rather than hierarchical, applications of technology. This synergy between technology, sustainability, and fashion is evident in the life cycle of eco-tech fashion, from production through post-consumption. In large part, these alternative technological mediations are broken into two realms: material and digital. The term material refers to the physical creation of ethical fashion, covering areas such as design choices, the manufacturing of fiber and the recycling of old clothing. The digital category emphasizes the tremendous impact of the internet on sustainable fashion through the enabling of socially conscious consumption and information dispersion.

As recently as a decade ago, the term "ecofashion" conjured up images of unsophisticated clothing of low quality and little design. However, this description is no longer valid as this type of fashion evolves into a design methodology that is forward-thinking, style-driven, and fundamentally technology-focused. By emphasizing the importance of technology in achieving sustainable goals, eco-tech fashion becomes a distinctly modern movement looking forward to the future of all fashion.

Material Manifestation

Technology is a basic necessity for crafting the physical form of fashion. It is inherently expressed through all stages in the development of fashionable garments, from the manufacturing of fibers to the production of the final garment. In eco-tech fashion, sustainable theories meld with smarter manufacturing and production techniques. Oftentimes these newer sustainable processes derive from the conventional technology realm, and have been tweaked to achieve specific ecological goals.

While there are many aspects of a garment's life that affect its environmental footprint (such as how it is sewn, sold, maintained, and

disposed of), it is easiest to understand how ecological technology applications encourage sustainable fashion by looking at the production and use of polymers—the most fundamental requirement (besides design) for clothing the human form. Achieving an absolute ecological ideal in fiber production is difficult, especially when one realizes that technology can be both a detrimental and beneficial force. However, with the general increase in awareness regarding the need for a better sustainable fashion system, more attention and work has gone into producing more ecological fibers and textiles. Whether a fiber is grown organically or produced synthetically, there are significant technologies involved, each with their own discrete anthropogenic effects.

The technological struggle of organic fibers against conventionally grown ones is translated in theoretical terms as a "democratic rationalization" of technology versus the "conservation of hierarchy" (Feenberg 1999: 76). For example, small organizations and farmers struggle to stimulate the growth of the organic cotton market against larger, technology-driven proponents of conventionally grown fiber, like Cotton, Inc. Even though the amount of organic fiber composes a small percentage of the total fiber grown in the world, its production is growing steadily, with more cotton farmers turning away from conventional farming methods that are heavily dependent on insecticide and herbicide usage. New agents, such as the organic fiber advocate organization Organic Exchange, are actively seeking to gain ground against the conventional cotton market. Organic Exchange is committed to growing the amount of organic cotton production by as much as 50% a year, and has largely been successful.

While organic cotton in ecological terms is superior in that it is less toxic to produce (requiring fewer inputs), it does not necessarily have the ability to produce the same yields per acre of arable land that conventional cotton can. As well, since the designation of organic in the United States ends with harvest, it is possible that the entire life cycle of cotton, including textile manufacturing and dyeing, is not any more sustainable than conventionally grown fiber. In acknowledgement of this disconnect, there has recently been a push for creating standardized international organic trade measures, which has led to the creation of an accreditation program for organic fiber processing called the Global Organic Textile Standard. In order to keep driving organic cotton farming forward, environmentalists and organic advocates should continue to push for the development of alternative cotton farming and manufacturing technologies that coincide with the adoption of standards forcing disclosures on the environmental footprint of the entire production cycle of cotton yarns.

The marketing and sale of organic cotton is so potent that it is has actually forced a response from conventional cotton producers, most notably Cotton, Inc. Traditional cotton farming in the United States uses technology in streamlined farming methodologies that include targeted

applications of pesticides and irrigation that take into account the best timing, placement, and quantity. Cotton, Inc. is keen to note that while not necessarily conceived with an ecological intent, these integrated pesticide and water management techniques ironically lead conventional cotton farmers towards a more efficient and sustainable system requiring fewer and less-toxic inputs (Barnes and O'Leary 2006).

The most polarizing controversy in cotton agriculture is the growing use of bioengineered (often called transgenic, genetically modified, or GM) cotton. By the 2004–5 growing season, as much as 80% of the cotton growing areas in the United States was under biotech varieties (International Cotton Advisory Committee (ICAC) 2005: 4). Much of the GM cotton today is Bt (*Bacillus thuringiensis*) cotton, a strain that is engineered to thrive while resisting the attacks of certain insects. Advocates of biotechnology reinforce it as the solution to dwindling arable land and resources (with the effect of agricultural intensification), while opponents stress the uncertainty of its effect on ecosystems and biodiversity. Cotton, Inc. claims that if natural fiber production (aided by technology) cannot meet the textile needs of a growing population, then synthetic and manufactured fibers will (Cantrell 2006). This echoes the 1960s, when the *American Fabrics* editors stated that the unsustainable quantity of natural fibers grown could not clothe a growing world population, a projection which thus merited the development of synthetic polymers.

The apprehension and controversy over GM cotton reveals the hierarchical nature of the current prevailing technological system inherent in cotton agriculture. This top-down technocratic development of GM crops proves that "sustainable technology" and "ethical technology" are not really the same thing. The practice of using streamlined applications of inputs and GM cotton seed results in a cotton system that is more sustainable because it tries to meet current and future clothing needs. The problem with current cotton technologies is not necessarily their sustainable character (in terms of being able to produce enough fiber to meet demand), but rather how ethical they are in terms of harming the environment.

Questions exist regarding the safety of GM crops with regards to the possible destabilization of ecosystems and threats to biodiversity. Since the use of Bt cotton is relatively new, there have not been long-term studies conducted evaluating the threats of Bt cotton to biodiversity, although a two-year study published in 2006 in the United States found that bioengineered cotton posed no more threat to certain beetle and ant varieties than did growing non-transgenic cotton (Cattaneo *et al.* 2006: 7571–6). The same study underscored the fact that the yields between transgenic and non-transgenic cotton were the same, with transgenic cotton trumping conventional cotton due to its lower insecticide requirements. Conversely, an analysis that same year by the environmental group Friends of the Earth concluded that the current practice

of producing GM crops failed to deliver any of their supposed benefits, in large part due to the hierarchical nature in the way technology is implemented (Friends of the Earth International (FOEI) 2007). The technology as it stands now is limited to a few proprietary biotech varieties, which means that large companies like Monsanto reap the economic benefits of GM crop production, while smaller farmers do not. Unlike the bottom-up structure of organic cotton farming which meant to "produce more food and alleviate poverty … the private sector views biotechnology mainly as a source of income and a way to compete with other companies, and only secondly as a tool to solve problems" (International Cotton Advisory Committee (ICAC) 2005: 6).

While there are many flaws in current conventional cotton farming techniques, reversing away from the implementation and study of advanced technological methods is not the answer. The reality is that, while organic farming works in local markets on a small scale, its current niche status simply cannot sustain the global demand for cotton. Conventional cotton growers have a point—if all cotton production were to become organic, then would the system be economically viable, and would there be enough fiber to satisfy demand? Technology has proven that it can help make enough cotton to meet demand (even if it does so at great environmental and social defect). Unfortunately, there is no real dialectical discussion about the creative possibilities of bioengineered fibers from an environmental standpoint. Before Bt cotton became commercialized, it was conceived of as a possible asset to organic cotton production. However, its lack of organic certification from the National Organic Standards Board in the United States made it ineligible to be used, and ultimately its spread negatively affected the quantity of organic cotton produced in the United States (International Cotton Advisory Committee (ICAC) 2005: 4). Environmentalists, public figures, and fair-trade advocates need to seek ways to appropriate and subvert the current technological practices for maximum positive and ethical impact. This means the development of trusting, synergistic, and interdisciplinary relationships between designers, independent scientists, engineers, manufacturers, and the public and private sectors with the goal of creating effective technologies that minimize the negative human and environmental impact of producing cotton and other fibers.

The debate over cotton exemplifies the ways in which technology is interpreted and applied to achieve certain ends. Demonstrating this further are fibers manufactured from renewable sources. Touted as natural and sustainable due to their biological derivation, these fibers are regenerated from materials like bamboo, seaweed, corn, soy, eucalyptus, milk, and beech wood. Still, as revealed through a microscope, a great deal of energy, chemistry, and research goes into the creation of polymers from renewable sources. Typically, regenerated cellulose fibers are created through a process similar to that originally developed in the

early twentieth century for viscose rayon. The primary cellulosic source is pulverized and then mixed with chemicals to extract raw cellulose, which is then dissolved into a solvent, and eventually forced through a spinneret as a filament into a coagulating agent. To aid in the dissolution of plant structures protecting the cellulose, these regenerative manufacturing processes required chemicals like carbon disulfide, which were unfortunately harmful to workers and disposed of into the environment. Today, most bamboo fiber is manufactured using this method, and thus in reality the production of regenerated bamboo fiber is no less polluting than rayon.[3]

Addressing the detrimental aspects of rayon manufacturing, a new regenerated cellulose fiber called lyocell is made in a closed-loop system that ensures nearly all of the water and chemicals (like the amine oxide NMMO) used to dissolve and extract the cellulose (obtained from beech wood) are reclaimed for use again. This adaptation of the traditional rayon system into one that addresses key environmental problems (like the disposal of chemicals) is a significant achievement in eco-tech fashion. The lyocell process is slowly gaining ground against other regenerated cellulose manufacturing techniques—unfortunately, at the present time much of the lyocell process remains proprietary and inaccessible to smaller manufacturers. Open-source access to this technology would not only allow smaller manufacturers to use this less-polluting process, but would ideally spur the development and adaptation of it for the regeneration of other biological sources, such as the aforementioned bamboo.

Yet another fiber made through the regeneration of plant resources is PLA (polylactide), a recently developed polymer derived from fermented corn sugars. NatureWorks (a joint venture between Cargill and Teijin) manufactures PLA as an extruded fiber under the patented name of Ingeo. In true eco-tech style, the language NatureWorks uses on its website to describe the PLA fiber emphasizes both its high-technology roots, while insisting that the resulting manufactured fiber is ecological and has a "natural feel." Besides bearing compostable characteristics (under certain conditions) like other biological fibers, Ingeo is also chemically recyclable. Unlike bamboo and lyocell, Ingeo has yet to make a significant dent into the ecofashion sphere.

Manufactured fibers like Ingeo, bamboo, and lyocell rely on their derivation from renewable and compostable biological sources as an automatic qualifier that they are an ecological or natural fiber. However, the reality is that they are created through chemistry, using vast amounts of energy, chemicals, and processes that are not necessarily environmentally conscious. These biologically derived fibers could play a significant role in the creation of a truly sustainable fashion system, but technology must be precisely applied to limit pollution and energy expenditures, while the manufacturing processes must become open source and accessible rather than remain proprietary.

Unlike fibers manufactured from biological sources, technical fibers are derived from nonrenewable chemical resources like petroleum. On the surface these synthetic fibers might appear to be inherently less sustainable when compared with biological fibers, mainly because they stem from limited resources and are incapable of being fully biodegradable; however, these technical fibers have a definite place in ecofashion, especially given that they can be chemically recycled and often outperform natural fibers in terms of usage and care requirements (since they require less washing and drying and at lower temperatures). As well, the fibers themselves are usually less prone to staining, oxidation and degradation, and therefore, soundly constructed garments can last a very long time.

Disposability is one of the most important technically mediated factors in the design process of all fibers. Whereas natural fibers like linen and cotton, and even most regenerated fibers like bamboo and lyocell are eventually composted into their base biological components after disposal, technical fibers remain in the waste system indefinitely. Recycling addresses the two main perceived drawbacks of synthetic fibers—it reclaims resources and alleviates waste issues. Recycling is still active only on a small scale, although there are influential chemistry companies like Teijin and Wellman that are pursuing the perfection of synthetic fiber recycling systems. An early leader in synthetic recycling, Wellman's website states that they were the first to introduce a polyester textile fiber made from post-consumer polyethylene terephthalate (PET) packaging in 1993. Teijin has developed a polyester-recycling technology scheme called Eco-Circle that efficiently reclaims polyester at a high quality. The company has implemented recycling drops where its products are sold and has a successful partnership with the outdoor gear manufacturer Patagonia. Teijin's and Wellman's ability to convert used polyester into polymers with nearly the same quality as virgin polyester speaks to the sustainable possibilities of synthetics. Ideally more research on the technology of recycling chemical fibers will continue, along with the education of consumers regarding these recycling opportunities.

The performance and look of a fabric, including how it handles, its care, and its disposal, are design choices achieved best through technology. While synthetic fibers are harder wearing and easier to care for than natural fibers, their sterility and lab derivation lacks the emotional connotation that natural fibers carry. As well, natural fibers have aesthetic and tactile qualities that synthetic fibers often lack. Blending synthetic, natural, and regenerated fibers together increases a textile's performance by combining the desirable qualities of each type. For example, cotton and polyester are often blended together in ratios like 50/50 or 70/30, creating fabrics that breathe and drape naturally, yet require little attention to care. While blending increases performance, unfortunately it complicates the disposal stage. The main environmental detriment of blending fibers is the difficulty in effectively separating out the base

materials for recycling or disposal. Whereas efficient recycling schemes exist for returning old polyester into another fiber of virtually the same quality, there are really no successful technologies yet that can reclaim in full the base materials of a blended fiber, especially one that combines synthetic with natural polymers.

The creation of fibers that enhance the sustainability of the fashion system is currently primarily dependent upon the actions of the established technocratic structures that have larger R&D capabilities. Chemical and fiber science companies like Cotton, Inc., Cargill-Dow, and Teijin are now employing discriminate manipulations of technology towards a specific end goal of realizing innovative and cutting-edge sustainable solutions. Large companies comprehend the added value of going green through technological solutions in terms of efficiencies and marketing. Even Cotton, Inc. agrees that most ecological practices inevitably mean fewer inputs, thus translating into a more efficient business model (Cantrell 2006). More research needs to be invested in developing tighter closed-loop manufacturing systems and seeking ways to control the amount of inputs while optimizing the quality of the product. Sustainable techniques will hopefully diffuse through the entire textile manufacturing system, allowing smaller manufacturing companies to access them.

This top-down vertical filtering of sustainable fiber and textile production seems at odds with Feenberg's concept of democratic rationalization, yet these perspectives of technological mediation need not be mutually exclusive. Fashion, with its inherent aspects of consumption through the generation of trends is arguably the cultural system with the most democratic potential in existence today. Consumer demand has forced the prevailing technocratic structures to reexamine their sustainability quotient. It is through a demand for eco-tech fashion that our culture will "shift patterns of investment and consumption … to open up the imagination of technical advances that transform the horizon of economic action" (Feenberg 1999: 98). Sustainable fashion advocates should aim "to steer the system from within through subtle hybridizations, not mass revolution" (Veak 2000: 228). Fashion's existence on the street, in the stores, and in the media ensure that there are ample opportunities for participants to stipulate a democratic rationalization of the prevailing wasteful and polluting clothing manufacturing systems.

Digital and Democratic

Besides the physical production of ecologically sensitive fibers and garments, the digital domain is the most important, technically mediated aspect of sustainable fashion. Digital technologies, including cameras,

home computers, and Internet access, are tools for subverting the conventional fashion system, as seen with the rise in eco-consumption, networking, and information distribution. It is through the Internet that Feenberg's concept of a democratic rationalization of technology is most authentically played out. The Internet is an actualization of technology in daily life, and can be politicized (or de-politicized) by those who use it. Commerce sites, blogs, editorial magazines, networking platforms—each portal allows individuals to participate in a techno-fashion system that, more times than not, has real-world results. Sustainable fashion, as a subset of the larger fashion system, is particularly suited to the horizontal diffusion capabilities and subversions of the internet. Nodes within the Internet operated by agents seeking change push for the dispersion of sustainable ideologies combined with ethical consumption options. This "survival of agency … [and] the ability of modern men and women to act as agents in the technical sphere from which the technocracy draws its force" (Feenberg 2000: 241) is one of the greatest validations of the Internet and its democratizing capabilities.

Within the past ten years there has been an explosion of online vending options that allow any person to clothe themselves in recycled clothing or garments made from sustainable fabrics. Fulfilling a void, websites like www.fashion-conscience.com or greenisblack.ca operate vending portals offering garments containing some kind of ethical or ecological feature. The operators behind www.fashion-conscience.com acknowledge that it is difficult to define what type of fashion exactly is considered ethical. Their "ethical statement" on the site claims "many people have different interpretations of what is one hundred per cent ethical fashion. We believe if you are making an honest move in the right direction to less harmful, exploitative practices, that is better than no move at all."

Other digital options for purchasing ethical clothing besides online boutiques include real-time exchange venues. The easiest, and most authentic, way to make ethical consumption choices is by purchasing recycled clothing, a process made simple through websites like eBay.com. This portal contains millions of vendors and consumers who are able to connect directly with each other. Either through a bidding system or "buy it now" options, vendors set the pricing for their unique products, hoping to attract consumers searching for specific styles, sizes or brands. Many recycled clothing vendors operate small stores within the site, selling vintage or used wares sourced in their local area. This peer-to-peer system facilitates the global distribution of old clothing, eliminates waste, and contributes to the rise of a smaller economic market separate from the traditional fashion system.

The online marketplace, Etsy.com best embodies a site where consumers and makers practice small, but effective democratic rationalizations

against the prevailing, large-corporation market economy. Etsy is a radical and successful experiment that allows the consumer to understand intimately where and how their clothing was made, and by whom. The website states their vision "is to build a new economy and present a better choice: buy, sell, and live handmade." This strong "do-it-yourself" (DIY) ethic directly counters the conventional fashion system. Since opening in June 2005, over 100,000 independent sellers, many selling handcrafted garments, have opened up shops within the site. Even though the accumulative effect of Etsy is still on a micro-scale, it has successfully switched a small part of a vertically based economy into a horizontally fluid one. Without a doubt, this small victory over the prevailing economic hegemony would be impossible without this rationalization of the democratic possibilities of the Internet.

Besides making consumption possible, the Internet's most progressive characteristic is its use as a communication tool. Democratic rationalizations "usually involve innovative communication strategies, necessary to thematizing these concerns as public issues in a technocratic society" (Feenberg 1999: 108). Seizing upon this easy, effective, and cheap way to diffuse information, activists, including sustainable fashion advocates, use the Internet to recruit like-minded thinkers to create change. Many of these nodes promote a lifestyle concerned with ethical issues, especially environmental ones. Usually, fashion is presented as just one aspect of a sustainable lifestyle. The online presence of the Sustainable Style Foundation (SSF), SustainableStyle.org offers access to a sourcebook of sustainable vendors, education awareness tools, their free in-house magazine *SASS,* and a weblog containing news updates. Similarly, another site, Inhabitat.com, features fashion on their regularly updated weblog, even though their mission is concerned mainly with sustainable home design. The best known website pushing for eco-conscious living is Treehugger.com. This website is comprehensive and international, featuring the latest content, news, and products about sustainable living. All of these sites focus on fashion as a significant issue in environmentalism. Ironically, the writers usually focus on the consumption aspects of fashion, pushing for the acquisition of "greener" products, rather than suggesting more radical ideologies of ecofashion, like buying less clothing or wearing garments longer.

The most subversive democratic rationalizations of fashion address this disconnect between fashion's inherent consumerism and a perceived sustainable ideal. In these rationalizations, individuals carry out specific actions while performing for their cyber-audience. These actors reflect on the actual act of consumption—they chronicle what they wear and how they obtain their clothes. FiftyR×3.com was a highly successful and timely project undertaken by an independent designer and child therapist Jill Danyelle. She documented her wardrobe every day, with the goal of at least 50% of her clothing choices being recycled, reworked

into new designs, or made in a process with a reduced carbon footprint. An even more radical example of sustainable fashion brought to the fore by an individual is Alex Martin and her "Brown Dress" project at www.littlebrowndress.com. For one year, Martin wore the same self-made dress every day. Her daily online documentation and journal authentically captured her struggles in denying the consumption aspect of fashion, revealing that it was just her "messy attempt to stand up to an element in my life that I was ready to challenge." Unfortunately, both projects ended after a year, revealing the difficulties that arise when one tries to challenge the *status quo,* especially on a permanent basis. Yet even though these projects were only temporary, their actions, spurred on by the faceless observations of their audience, speak to anyone wondering just how and why to consume less clothing. These two individuals purposely exploited the ultimate technological system by advocating for effective low-tech methods. Essentially, anyone can subvert the traditional fashion system by consuming less and intentionally wearing clothing that is not newly manufactured.

Sometimes, agents of change create projects with no overt ecological purpose, only to find these projects containing unintended sustainable principles. An individual might be looking to the Internet as the launch field for a project aimed at subverting the entire fashion system, only to come up with solutions that, significantly, are ecologically sensitive. Illustrating this result is Otto von Busch's theoretical studies on hacking into the fashion system[4] that are found on his website www.selfpassage.org. Using terminology referential to the influence of hackers and coders in the development of the Internet, actors like von Busch bend the standards of fashion to reveal alternate and progressive system possibilities. von Busch views his Recyclopedia (Figure 5) as "an attempt to create open-source methods for fashion, to open the 'code' and flows of re-purposing and recycling methods."[5] His ReForm cookbooks offer "an open source empowerment through [the] reengagement with our consumer goods" by disclosing how to refashion one's existing clothing into a new wardrobe. This methodology pushes "open source [as] a technology for enabling a radical participatory refashioning." To von Busch, and many other individuals out there, "The sewing machine is a tool for liberation."

The Recyclopedia, Brown Dress Project, and FiftyR×3 are just a few examples of active citizen involvement within the digital domain attacking the fashion *status quo*. Other similar actions that are documented online include street-style weblogs and wardrobe remixing groups. The personalization of fashion and the public implications of user agency stand against traditional fast fashion consumption patterns. These instances are examples of democratic rationalizations of technology which "signify user interventions … [to] challenge undemocratic power structures rooted in modern technology" (Feenberg 1999: 108).

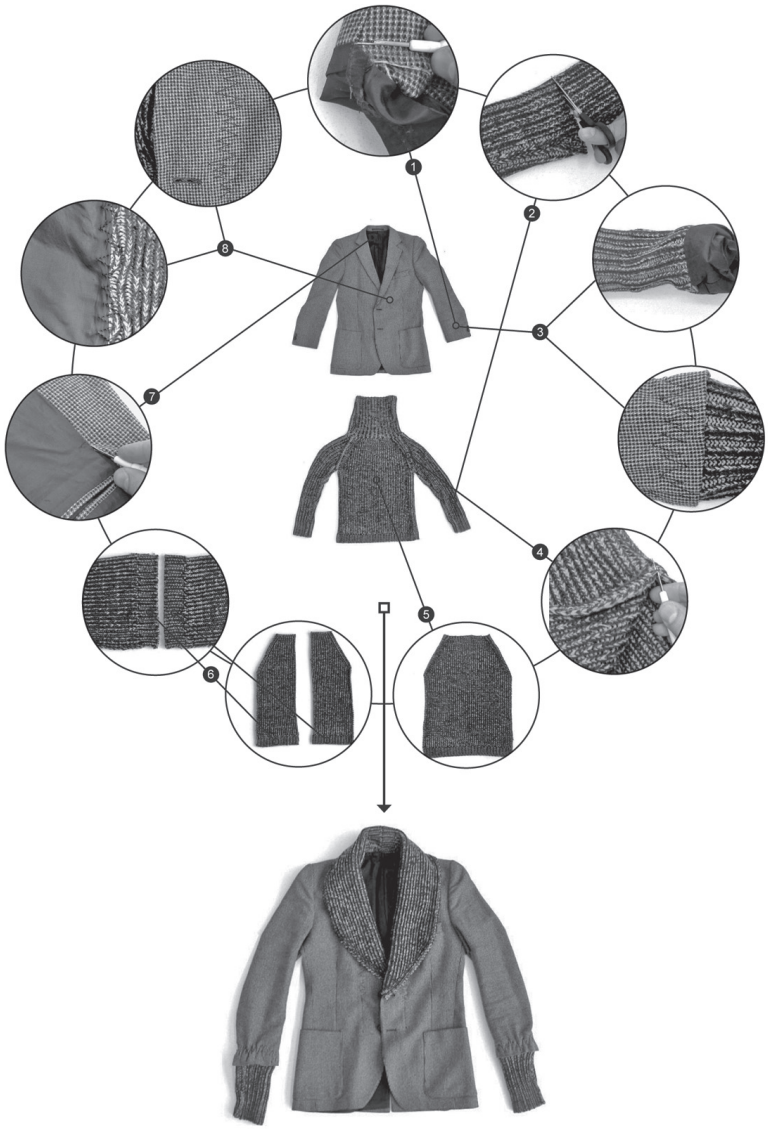

Figure 5
Otto von Busch's Recyclopedia, which shows how to convert an old jacket and sweater into the JackSweat, can be downloaded from the Internet. Diagram and photographs by Otto von Busch.

Conclusion

Technocratic structures both reinforce cultural norms and force society to adapt to technological changes. Many of the advanced technologies today strengthen a cultural set of values based on consumption. Concurrently, newer and more efficient technologies emerge to meet these perceived consumption needs. In a clear example of this symbiosis between a culture and its technology, we find that the optimization of technological capabilities within the design, manufacturing, and retailing

realms facilitates fast fashion clothing consumption. The goal of sustainable fashion advocates should not be to reject the current values of a technological society, but rather to alter and subvert the meanings and manifestations of technology from within. There must be a widespread recognition of the significance of technology's role in the evolution towards a more sustainable fashion system.

Eco-tech fashion will hopefully one day replace traditional fashion structures, insofar as effective sustainable collaborations develop between all players in fashion—the designers, manufacturers, scientists, retailers, and consumers. Interjecting democratic rationalizations of technology into the fashion system will inevitably force the emergence of more sustainable and ethical solutions. By rationally exploiting both the material and digital manifestations of technology to achieve an ethical and sustainable ideal, eco-tech fashion succeeds in pushing the entire fashion system forward towards a promising future.

Notes

1. This article is not an effort to engage in technological positivism, nor does it aim for the creation of a techno-utopia within the fashion system. Neither does it attempt to determine the superiority of either the technological constructivist or determinist points of view. The determinist point of view states that technology acts upon society, thus forcing social institutions to adapt to technical innovations. Alternately, technological constructivism insists that it is ultimately humankind that determines the progress of technology through selecting any number of workable technical solutions to a problem. Rather, this article is a hermeneutic exercise of the technically mediated domain of ecological fashion.
2. Fashion, in its quest for evolution, has historically looked at architectural theory for design cues, creating a design parallelism of tectonic forms and strategies, abstract geometries, and body/spatial relationships. See Hodge (2006) and Quinn (2004). See Slessor (1997) for a full discussion on eco-tech theory in architecture.
3. Although not commonly manufactured, bamboo fiber can be created in a less-polluting process, similar to that of linen, through labor-intensive steps such as combing, retting, scutching, and spinning. This type of bamboo "linen" fiber does not have the sheen and soft hand that bamboo "rayon" does, nor is it produced and sold as widely.
4. See www.selfpassage.org for the complete Recyclopedia and other projects, like Hackers and Heretics. See also another fashion hacker, Giana Gonzalez at www.hacking-couture.com.
5. Personal e-mail with the author, November 13 2007.

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