

Erasing Environment: The Soldier of the Future and Utopian Smart Textiles

by Kirsty Robertson
pg. 17 illustration by Femke Herregraven and Henrik van Leeuwen



1 Invitation in hand, I made my way to the blue “Wedgewood” conference rooms at the Chateau Laurier in Ottawa for the Soldier of the Future workshop to which I had (accidentally) been invited.¹ I had dressed carefully, a scholar of contemporary art camouflaged as a civil servant. As it turned out, my cotton shirt, pleated skirt, and flat shoes were all wrong. The workshop was all polyester, rayon, microfiber, cheap suits, cotton, and wool army uniforms. I stood out, first drawing curiosity: “Who did you say you were?” To which I vaguely replied “an academic,” and then the dismissal as I sat at tables with representatives from Lockheed Martin, Rheinmetall, General Dynamics, and numerous Canadian start-ups. They were there to get in on the generous funding the government was investing in promoting an integrated system of communication technology and support for the needs of Canadian soldiers.²

Participants volunteered to try on Canadian field uniforms and describe the experience of standing in the gear for ten minutes: “The weight! I can’t believe how heavy this is,” “imagine wearing this in the heat of Afghanistan.” The exercises, brainstorming sessions, and presentations all emphasized a need for lighter and more efficient uniforms and backpacks. They also demonstrated the vast gulf between the focus of critical humanities scholars, activists, and journalists covering the military, and the great sums of money pouring into that sector. It was not so much that perspectives critical of such investment were erased or suppressed, as they were completely irrelevant to the flow of materials from laboratory to procurement to conflict. Any space for critical interruption was relegated decisively outside of that seamless system.

This is not to suggest that the participants in the workshop didn’t have very real concerns. They did, clustering around how to protect soldiers from heat stroke, injury, permanent maiming—and from death. Throughout, troops were treated with reverence and respect. Meanwhile, “the enemy,” whether Taliban or otherwise, was constructed as a threat to “Canadian values,” manifested through the vulnerable bodies of Canadian soldiers. A series of presentations contrasted Taliban soldiers—young men in white robes and sandals holding outdated automatic guns—with Canadian personnel kitted out in the latest high-tech equipment. One might expect an advantage for Canadian soldiers. But instead, one presenter asked, “How can we compete?”

The presenter continued, illustrating his argument with an image showing a Canadian soldier carrying an enormous backpack, bent over on the side of the road, exhausted and very hot. “The Taliban have such an advantage,” he said, “they are mobile, they don’t overheat, and they can move quickly.” The question of the workshop was thus: How can we create smarter textiles, technologies, and equipment that can outdo guerilla soldiers who wear cotton robes and sandals?³ In other words: how can we create a militarized and shielded human-architecture hybrid with the ability to both survive in and be protected from a hostile environment. There was no discussion of reducing the amount of clothing or equipment that the soldiers would carry.

Soldiers, while treated with reverence, were also clearly sources of profit. A laboratory that could find a way to ease the burden of weight while providing everything from bullet-proof underclothing to an integrated system of video

cameras, food, water, bedding, ammunition, changes of clothing, and power source stood to secure a lucrative government contract. The Future Warrior needed to be both walled-in and able to interface with the outside world. Thus, the terminology of the workshop narrowed in focus: “how can we erase environment?” The term ‘environment’ was used to cover everything from weather to IUDs, from suicide bombers to overbearing civilians. Answers lay in smart textiles and advances in nanotechnology, exterior skeletons, and integrated soft communication systems. What was being asked for was the creation of the ultimate, arm(our)ed nomad.

Though answers could have come from farther afield—for example, more drone aircraft or long-distance intelligence—at the Integrated Soldier System Project, the focus was on how bodies could be protected and become weaponized entities by communicating remotely, seeing at night, filming, and remaining cool while doing so. Participants listened to presentations on innovative processes of electrifying cloth by weaving electrical circuits directly in to cotton, wool, and polyester; the use of solar power to alleviate battery weight; shoes complete with GPS devices that could “find their way home”; and uniforms equipped with thin tubes through which cold water could pass, creating microclimates to cool down overheated infantry. The proposals stretched from projects already used in war to the highly speculative, but the ultimate goal was for one proposal: an integrated system, the contract for which would be undertaken by a single bidder.

At the time of the 2010 workshop, the Canadian government was part of NATO operations in Afghanistan and fond of referring to military procurement as an important part of the national economy. Thus, hundreds of millions of dollars had been made available for the innovation of the Future Warrior.⁴ The workshop imagined conflict in terms of a kind of soft escalation: the Taliban had greater mobility, therefore Canadian soldiers required a more flexible and better integrated armour system. In turn, the production of this system required public investment and private enterprise that together would allow Canadian soldiers to “bring peace” to troubled environments (from which they would be utterly protected). Canadian companies would profit not only from designing the integrated systems of the Future Warrior but also from intellectual property rights and patents.⁵ In these equations, the material and immaterial were tightly interwoven.

The Canadian Integrated Soldier System Project is something of a latecomer to the Future Force Warrior strategy. The strategy originated in the United States in the 1990s and is now heavily funded and operational in more than 20 NATO and allied countries.⁶ The goal of this program, as noted on the MIT Institute for Soldier Nanotechnology’s website, is “to help the Army create a 21st-century battle suit that combines high-tech protection and survivability capabilities with low weight and increased comfort.”⁷ The project crosses boundaries, bringing together multinational corporations and military personnel with the work of engineers, artists, designers, and architects, such as Neri Oxman. Her work at

MIT’s Material Ecology Lab to produce bio-inspired armour functions at the imaginative limits of the project.⁸ By the 2030s, it is hoped that the Future Soldier will be introduced, using the latest technologies, pushing the limits of smart textiles and other integrated systems. And, of course, a soldier system needs a war.

2 Apparently far removed from front-line war zones, smart textiles are cast in much more utopian projections and are often renamed: electronic textiles, wearable technologies, fashionable technologies. They are seldom directly supported by military investments, though materially they are deeply connected. If the integrated soldier systems are focused on “erasing environment,” many research-creation projects appear to do the opposite. Consider, for example, the well-known “Hug Shirt” developed by CuteCircuit (London), which allows wearers to “send hugs over distance.”⁹ The garment, embedded with sensors, measures strength of the touch, skin temperature, and the heartbeat of the sender, and then recreates those sensations (and emotions) using actuators to translate them to the wearer of another Bluetooth-enabled shirt.¹⁰

The prize-winning Hug Shirt is just one example among many, but it clearly demonstrates the way that “civilian” smart textiles are often not about protection and erasing environment but about creating connections in a world that is perceived to be individualistic and anti-social. Seemingly different from the concerns of the Integrated Soldier Systems, wearable textile technologies sometimes delve into the connected histories of textiles and computing,¹¹ or the comforting properties of fabric, material, and the intimacy of clothing.¹² They draw on the metaphorical possibilities of textiles, on an etymology of networking built directly into the language of textiles—the material, the interwoven, the connective, the tissue.

One finds projects that capture both the imagination and the headlines: Fabrican’s spray-on fabric clothing, Maggie Orth’s playful soft light dimmers and musical jackets, Hussein Chalayan’s technology-enhanced fashion designs.¹³ One finds similar aims and goals in responsive environments that make use of smart or technologically enhanced textiles. In the introduction of one typical text on responsive textile environments, the authors write of the artists, scientists, and engineers involved: “Whether their focus is clothing or immersive environments, their aim is to make textiles that interact with their users not only in visual or tactile terms, or even by being mobile, but which use digital interfaces to respond in all of these ways.”¹⁴ According to Lucy Bullivant, the impact of these textiles “is phenomenological, meaning that the body is able to directly experience its environment in a very direct and personal way.”¹⁵ High-tech membranes, skins and tensile architectures create mobile or static structures that interact with their visitors and inhabitants to create new communities and affects. These textiles are spoken about with great reverence—it is not a question

of if they will lead to new communities and social benefits, but when.

There are a number of examples that illustrate this reverence. Surface Kinetic Integral Membrane (SKIM), for example, is a responsive textile composite that monitors the mood of human occupants in a room and adapts accordingly. Though the material was never manufactured, the work re-imagines architectural and domestic space as deeply and emotionally imbricated in the lives of its inhabitants and occupants.¹⁶ The London-based design firm Loop.pH provides a second example of this in their ephemeral textile and living environments: delicate walls woven with living plants, light-reactive photosynthesizing window blinds, and glowing, flocked wallpaper that responds to ambient sound by changing colour.¹⁷ Sweaterlodge, a tent made from fleece manufactured from recycled plastic bottles designed by the architecture firm Pechet and Robb, is another example. Here the environment created is both claustrophobic and womb-like, as diffuse light filters through the orange fleece into an open space where visitors can ride bicycles to power films and lights. Though relatively low-tech in comparison to some of its counterparts, Sweaterlodge raises issues of resource use and community-building, suggesting the two cannot be separated. There are hundreds of examples that use new and smart fabrics to encourage interaction and celebrate the “virtues of the transitory,” the ease with which fabric structures can be dismantled and moved.¹⁸ SKIM, the Loop.pH pieces and Sweaterlodge, along with the work of a number of other architects and designers, suggest ambient spaces with untapped possibilities for creating communities of sentiment that might offer the radical potential for rethinking both space and social connections.

These high-tech and often mobile structures are part of a much wider application that Bradley Quinn calls “textile futures”—faster, lighter, stronger textiles that can stop bullets, hoist satellites into orbit, and withstand temperatures hot enough to melt steel.¹⁹ Tiny fibres, writes Quinn, will rebuild the world. Truly exciting projects are currently being imagined that cross the boundaries between art, experimentation, and architecture, and offer endless unfettered possibilities. A September 2009 issue of the magazine *Fabric Architecture*, for example, showcased flexible and provisional housing proposals that can be easily transported and quickly assembled in post-disaster scenarios.²⁰ Another issue from September 2011 focused on the application of high-tech fabric solutions to environmental catastrophe and questions of sustainability (for example, sophisticated, technologically enhanced awnings that provide natural shade instead of air conditioning).²¹ Quinn also points to the numerous advances in medical textiles, high-tech solutions to problems of mobility, communications, and, again, post-disaster relief. In these scenarios, the infinite potential of smart textiles is writ large.²² But at the same time “textile futures” remain essentially that: imaginative propositions that may change the future, but largely exist only in theory. Is it possible that the speculative nature of many of these projects allows them to push the limits of imagination, but forecloses their actual critical potential?

At first glance, this appears not to be the case, although closer examination suggests otherwise. The emphasis of civilian projects is quite different from that of the Integrated Soldier System workshop, where smart textiles rarely venture to the limits of the imagination but are immediately slotted into existing frameworks for funding, invention, and distribution. Nevertheless, outside of the workshops and defense industry exhibitions, Future Warrior projects are recycled as fascinating, science fiction-like developments. Recently, the Future Warrior was shown in the Bruce Mau-curved exhibition *Massive Change*, which looked at how design could improve the welfare of humanity. According to Mau, the Future Warrior was included because it has led to decreases in soldier casualties, at least on one side of the conflicts.²³ Similarly, a project from Nexia Technologies (Montreal) to create bullet-proof undergarments from spider silk collected from transgenic goats, can be read in terms of this kind of fascination.²⁴ The Nexia project (which ultimately proved too expensive) was picked up by Margaret Atwood in the post-apocalyptic genetic modification novel *Oryx and Crake* (where it appears as the spout-gider), and also by artist Jalila Essaïdi, who, collaborating with the Forensic Genomics Consortium Netherlands, transplanted transgenic spider silk into human skin to create bulletproof skin (for artistic consumption only).²⁵

Essaïdi's work and the Future Soldier's appearance in *Massive Change* at the Vancouver Art Gallery and the Art Gallery of Ontario, appear to blur boundaries between art, design, and military R&D in a manner that was simply not present at the Integrated Soldier System Project. These artistic contributions make this research appear imaginative and exciting. However, in many projects commenting on conflict and safety, the proposed solutions aestheticize the problem, creating visibly powerful answers that elide the underlying causes. Thus high-tech textiles are often proposed as housing solutions for the millions displaced by war, conflict, and resultant famine. In 2006, the United Nations High Commission for Refugees released a report on “humanitarian design,” which argued that high-tech textiles had a significant role to play in the protection of refugees, including anti-malaria blankets and tents that use nano-technology and micro-encapsulation to prevent mosquito bites, and tents and fabrics fitted with solar cells and intelligent polymers that provide an electrical circuit. The UN report imagines a future in which tent cities are not associated with exceptional circumstances, squalor, and protracted waiting, but with small ecological footprints, comfort, and community.²⁶

But the UN's call for an idyllic tent city won't come to fruition—the report notes that it is too expensive. Paradoxically, refugee camps are also produced by the same

logic that demands better soldier systems and the soft or hard escalation of conflict. Theorists have, over the past decade, talked about the globalization of war—showing how war is no longer a “state of exception” but everyday reality, diffused through both discursive and material registers in a series of apparently unending and un-stoppable conflicts: the War Against Terrorism, the War Against Drugs, the War Against Poverty.²⁷ Conflict is the new norm, inexorably changing the political economy of the social.

As noted above, there is a deep chasm between the way textile futures are imagined and the number of projects actually brought into being. Smart textile projects remain in large part imaginary, prototypes for what the world could be. Such projects are occasionally the innovative public face of companies that make their profits in much more mundane ways—such as through the collection of IP rights and technology transfer—and are thus much more about publicity than projects to be realized.²⁸ Though some projects, such as the Hug Shirt, Maggie Orth's work, and Sweaterlodge, make it beyond the prototype, many come into being through the sort of military-led cooperation seen at the Soldier of the Future workshop. Thus, if textiles are to rebuild the world, they will do so in a very particular order—from military design down.

3

Walking in to the workshop, I should not have been surprised by the microfibre and polyester-blend suits. Polyester remains one of the most popular textiles used and worn around the world, and it was vital in the development of nanotechnology and smart textiles. Often described as the textile equivalent of fast food, polyester was invented during the Second World War as an alternative to natural fibres; it didn't wrinkle and could be easily washed and cared for. But polyester, like most synthetic fabrics, is a petroleum-based product. Ethylene, which is derived from petroleum, is the principle ingredient of polyester.²⁹ As Luz Claudio writes in an article on waste and the fashion industry, the demand for polyester doubled between 1992 and 2007. She investigates the energy-intensive manufacturing of polyester and other synthetic fabrics, taking note of the large amounts of crude oil used in the process, not to mention the release of emissions including volatile organic compounds, particulate matter, and acid gases such as hydrogen chloride.³⁰

This is true of the textiles discussed here, from nanotechnology and the carbon used in fire-retardant textiles to, on a seemingly opposite scale, the quantities of pesticides, fuel, and waste water used in making cotton. As ‘fast fashion,’ or over-buying cheap clothing, becomes increasingly the norm, secondary and tertiary markets for textiles and apparel have also blossomed as clothing is “recycled” and donated, thus destroying smaller localized production operations (in Africa and elsewhere) and increasing the consumption of fossil fuels through the global transportation of huge amounts of used clothing.³¹ The environmental impact of textiles has been well documented.³² Less so the overlapping systems at work—for instance, the relationship between polyester production, extraction method patents, and conflict in oil-rich regions. Conflict, in turn, begets the need for new, higher-tech soldiers to combat cotton-wearing guerrillas. In the meantime, the environmental destruction wrought by the textile industry leads to more conflict, climate change, and increasingly unsustainable life-styles. The polyester suits at the workshop told a story of their own.

4

In a recent art intervention, designer Christien Meindertsma created *One Sheep Cardigan*, a project that followed a single, named sheep from birth to sweater. Each finished sweater came with the information about the sheep, a merino breed raised on an organic farm.³³ The *One Sheep Cardigan* and *One Sheep Sweater* projects followed from Meindertsma's work *Pig 05049*, where she traced each part of a particular Dutch pig (no. 05049) after it had been slaughtered. Though *Pig 05049* might seem far removed from the Integrated Soldier System workshop, they have much to say to one another. The integrated system planned for Future Warriors is based on a model that brings various components together into a seamless whole—a process that, as I argue above, needs to be carefully unraveled and revealed as a strategy of critical inquiry. It is this process of unraveling that underlies *Pig 05049*. In a write-up on the project, it is noted:

After slaughter, bits and pieces of the Dutch pig travel around the world. Gelatin from its skin ends up in liquorices and gums, and even cheesecake and tiramisu. In the weapon industry the gelatin is used as conductor for bullets. Pork fat is one of the ingredients of, amongst others, anti-wrinkle cream and shampoo, information that producers are not too keen on admitting. The glue made from pig bones makes matches sturdier and porcelain is manufactured from its ashes. Protein from pigs' hair contributes to making bread soft. Every part of a pig is either eaten or processed. Should anything be left over, it is converted into green electric power.³⁴

All of a sudden, the pig is no longer a pig, but a mapped and quantified package of commodities. The *One Sheep Cardigan*, in response, does the opposite—refuses the process of division and instead creates a cardigan, socks, and other knitted goods from a single, well-cared for, and (most importantly) known living entity. In doing so, Meindertsma's work provides a model for critiquing the military projects described above. Textiles, clothing, and apparel are almost always thought of as cut off from their processes of production.

Bruce Robbins suggests we focus on the opposite—the shocking moment when one realizes that one's clothes have been made by people, cultivated from the soil to become the finished garment in one's hands through hundreds of

others and systems of manufacture, transportation, and commodification.³⁵ Robbins calls this moment of realization the ‘sweatshop sublime,’ the moment, for example, where the whole system exposed by Meindertsma in *Pig05049* is revealed and made accessible. The *Pig05049* project refuses to consider that environment could be erased, presupposing instead that this is an impossibility. Read in this way, what the Future Warrior project's integrated systems attempt to do is not erase environment, but refuse to understand it in all but the most superficial terms. Despite thermal performance, light-weight technology, and all the rest, integrated systems cannot escape their own evasiveness, their own weightiness, their own anchoring in new and old formations of capital.

At the Integrated Soldier Systems workshop, and in the utopian smart textiles laboratories run by artists, designers, and engineers, high-tech textiles are drawn upon to solve pressing problems: death and injury to soldiers in the field, as well as questions of sustainability, community-building, and caring. Often they are successful. But just as often such projects and workshops refuse or erase critique. At this workshop, critical engagement was unimaginable in the closed circuit of military procurement. In the civilian examples, the utopian impulse of the projects often forecloses further questioning. Textiles can't solve what the humans making, inventing, distributing, and profiting from them also can't solve—that the very materiality of new fabrics depends on the same exhaustible commodities. Ignoring these links means making projects that offer only surface or symbolic solutions. On the other hand, applying a kind of material criticism to smart textiles means admitting that what on the surface may appear utopian is layered, fallible, and compromised, but nevertheless still laden with potential and possibility.

Kirsty Robertson is a professor of contemporary art and museum studies at the University of Western Ontario in Canada. Robertson's work focuses on the study of textiles, wearable technologies, and immersive environments. She considers textiles within the framework of globalization, activism, and creative industries. At present, she is working on her book *Tear Gas Epiphanies: New Economies of Protest, Vision and Culture in Canada*.

Femke Herregraven is a graphic designer based in Amsterdam. Her work deals with issues where design, (information) politics and economy collide. Through research and speculative design projects she aims at deconstructing the role of design in maintaining power structures and reflecting on possible alternatives.

Henrik van Leeuwen is a graphic designer/researcher and media artist with an interest in global phenomena where technology, design and power structures intersect. Henrik currently works as a freelance designer and media artist in Utrecht and Amsterdam, and is always interested in meeting and working with (inter)national partners and clients.

Notes

- I say accidentally because I certainly did not fit the bill of most academic participants. All of them that I met worked in laboratories developing textiles and applications. I spent some time trying to figure out how I was invited and eventually decided that the workshop must have required a quota of academics and someone did an Internet search, found an abstract I had written which may have had key words (such as military and textile) and invited me without actually looking into my research.
- The program set aside CDN \$310 million. See David Pugliese, “Firms battle to build future warrior,” *Ottawa Citizen*, 21 July 2008, A1.
- As a note of clarification, I use “we” here because it was repeatedly used in the workshop, creating a self-contained system where there was simply no room for critical engagement.
- Mike Blanchfield, “\$60B in Defence Spending Rolls on Despite Recession: New Equipment Purchases Good for Economy, Defence Minister Says,” *Edmonton Journal*, May 28, 2009, A4.
- See the WIPO (a UK company who were present at the Ottawa workshop) webpage on Intelligent Textiles to see how this works: “Digitize Your Clothes: Look Smart in Intelligent Textiles,” World Intellectual Property Organization, accessed on 1 October, 2011, www.wipo.int/ipadvantage/en/details.jsp?id=2610.
- Mike Hanlon, “Future Warrior Suit 2020,” *gizmag*, accessed on 15 May, 2010, www.gizmag.com/go/3062.
- See “Enhancing Soldier Survivability,” Institute for Soldier Nanotechnologies, accessed on 1 October, 2011, web.mit.edu/isn/about/index.html.
- Neri Oxman, “Home Page,” accessed on 13 September, 2011, web.media.mit.edu/~neri/site/projects/armour/armour.html.
- CuteCircuit, “Hug Shirt,” accessed on 15 May, 2010, www.cutecircuit.com/products/thehugshirt.
- Ibid.
- See Sadie Plant, *Zeros and Ones* (London: Double Day, 1997).
- See the work of Joanna Berzowska, <http://www.berzowska.com>
- For descriptions of many of these projects see Sabine Seymour, *Fashionable Technology: The Intersection of Design, Fashion, Science and Technology* (Vienna: Springer Vienna Architecture, 2008) and *Functional Aesthetics: Visions in Fashionable Technology* (Vienna: Springer Vienna Architecture, 2011).
- Sarah Bonnemaison and Christine Macy, “Introduction,” in *Responsive Textile Environments*, eds. Sarah Bonnemaison and Christine Macy (Halifax: Tuns Press, 2007), 7.
- Quoted in Ibid.
- Nimish Biloria, “Adaptive Corporate Environments,” (2007), accessed on 12 May, 2010, repository.tudelft.nl/assets/uuid...de3e.../arc_biloria_20071009.pdf.
- Loop.pH, “Home Page,” accessed on 2 October, 2011, loop.ph/bin/view/Loop/WebHome.
- Christopher MacDonald, “SweaterLodge: Curatorial Essay,” www.pechetandrobb.com/sweaterlodge/curator_essay.html.
- Bradley Quinn, *Textile Futures: Fashion, Design and Technology* (London: Berg Publishing, 2010).
- See *Fabric Architecture Magazine* fabricarchitecturemag.com.
- Ibid.
- There are projects that do investigate the juncture of military with smart textiles, playfully reworking armour into aesthetically pleasing technologically enhanced shells. For example, see Amy Thompson's Plastic Analogue collection or XS Lab's Sticky, Stiff and Itchy dresses, which draw on urban paranoia and security, but do so in a lighthearted way (and also function as a way to convert human kinetic energy into electric energy): captain-electric.net/site/dresses.php; Seymour, *Functional Aesthetics*, 29.
- Bruce Mau Design and the Institute Without Boundaries, “Massive Change,” accessed on 15 October, 2011, www.massivechange.com.
- “GM Goat Spins Web-based Future,” *BBC News*, accessed on 14 June 2008, news.bbc.co.uk/2/hi/sci/tech/889951.stm
- Jalila Essaïdi, “2.6g 329m/s,” jalilaessaïdi.com/2-6g-329ms.
- Bradley Quinn, “UN report on Future Refugee Camps” United Nations High Commission on Refugees, 2006, cited in Quinn, 2010, pp. 1-10.
- See, for example, Giorgio Agamben, *Homo Sacer: Sovereign Power and Bare Life* (Stanford: Stanford University Press, 1998); Michael Hardt and Antonio Negri, *Multitude* (London: Penguin Press, 2004).
- See, for example, Bill Gates's recent ventures into hurricane prevention: “Bill Gates' Hurricane Stopper Would Be ‘Plan C’ for Humanity,” accessed on 15 October, 2011, www.techflash.com/seattle/2009/07/Bill_Gates_hurricane_stopper_would_be_Plan_C_for_humanity_50544257.html.
- Geno Jezek, *What is Polyester?*, accessed on 10 August, 2011, www.whatispolyester.com.
- Claudio Luz, “Waste Couture: Environmental Impact of the Clothing Industry,” *Environmental Health Perspectives* 115, no. 9 (September 2007): 450.
- Ibid.
- Keith Slater, *Environmental Impact of Textiles* (CRC Press, 2003).
- Christien Meindertsma, “Home Page,” accessed on 12 August, 2011, christienmeindertsma.com.
- Regine Debatty, “PIG 05049. A Conversation With Christien Meindertsma,” *We Make Money Not Art*, accessed on 12 August, 2011, www.we-make-money-not-art.com/archives/2008/08/christien-meindertsma-what-is.php.
- Bruce Robbins, “The Sweatshop Sublime,” *PMLA* 117 no. 1 (January 2002): 84-97.

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SPIDER ADAPT

Google Labs



UN Research
Institute for
Textile
Development

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TECH TEX

Business Coordination House,
TechTex India magazine



Teijin Group,
Osaka, Japan

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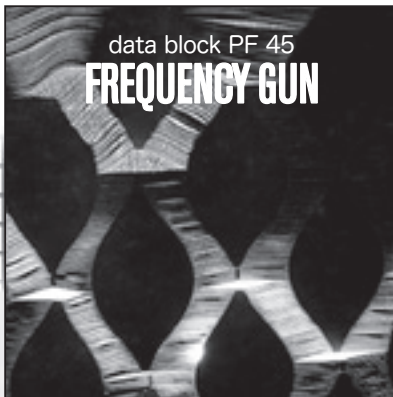
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Berlin Zoological Garden,
Vogue



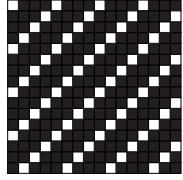
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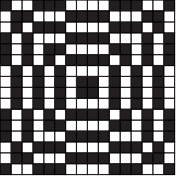
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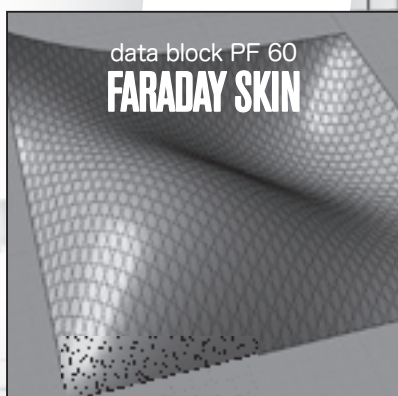
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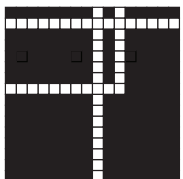
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