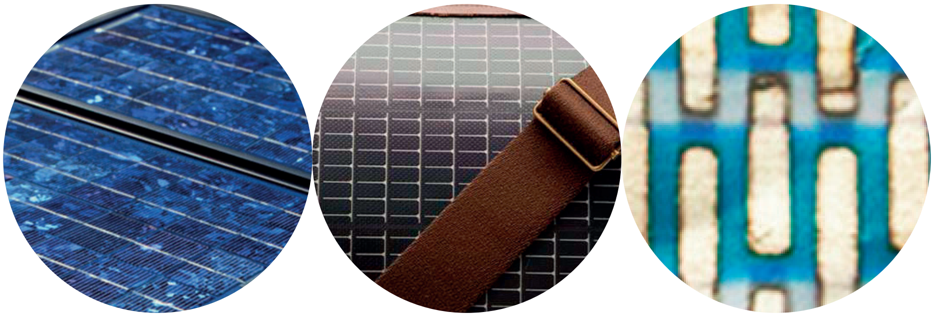
MARIANNE FAIRBANKS
UNIVERSITY OF WISCONSIN-MADISON

SOLAR TEXTILES: SOMETHING NEW UNDER THE SUN

COLLABORATION | SOLAR POWER | PHOTOVOLTAIC POWER | PORTABLE POWER
ENERGY HARVESTING | CHEMISTRY | WEAVING | PATTERN



ABSTRACT

AS AN ARTIST TRAINED IN FIBERS AND MATERIAL STUDIES, I FIRST EXPLORED THE IDEA OF ALTERNATIVE ENERGY IN A COLLABORATIVE INSTALLATION THAT CONVERTED PEOPLE POWERED BICYCLE ENERGY INTO ELECTRIC ENERGY TO CHARGE LIGHTS.

Looking back at some of these early projects provides the groundwork for how I have come to explore the current research, collaborating to create a solar textile.

In graduate school I started to collaborate with Jane Palmer under the moniker, JAM. We came together at a point when we were both looking to get beyond the boundaries of our studios and connect our work with people in the community. Once we decided to collaborate, it changed our entire approach to art-making. To collaborate, we had to let go of the notion of sole authorship and the myth of the genius of the individual artist. This inspired us to seek out the kinds of interactions that could help us feel more connected to our Chicago community, and gave us confidence to go out and meet people with whom we might collaborate. Collaborating with each other was essential in prompting us to start asking others for help and to start making projects more ambitious than we could achieve alone – projects for spaces other than our studios and for audiences beyond the art community.

A SUCCESSFUL SOLAR-HARVESTING TEXTILE WOULD SERVE AS A FOUNDATION FOR WEARABLE TECHNOLOGY, CAPABLE OF PROVIDING RENEWABLE ENERGY FOR THE UBIQUITOUS AND EVER-EXPANDING ARRAY OF PERSONAL ELECTRONICS.

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FIBERS AND MATERIAL STUDIES

As an artist trained in Fibers and Material Studies, I explore intersections between the materiality and processes associated with textiles, sustainable design, and collaboration. My formal training is in textile-based processes, but my conceptual understanding of materials and their meanings has led me to more interactive and politically based work. I currently teach at the University of Wisconsin-Madison, where I have partnered with a chemist to develop a textile capable of harvesting solar energy. While I have been a part of many collaborations, this has been my first time working with a scientist on an interdisciplinary project. Working with others has allowed me to realise projects more ambitious than I could have achieved alone, and has enabled me to develop projects for spaces outside of my studio and for audiences beyond the art community. Looking back at some of my early projects and collaborations provides critical context for how a solar textile project that marries sustainable energy, chemistry, and textiles has become the focus of my current research.

EARLY COLLABORATIONS INCORPORATING ENERGY

My first exploration of alternative energy was transform/transport II (figure 1), an installation produced with Jane Palmer under the moniker, JAM (2002). The project was conceived and created collaboratively, and required the active participation of audience members to fully realise the work. With this project, we looked to get beyond the boundaries of our studios and connect our work with people in the community.

transform/transport II (JAM 2002) was installed in a gallery in Chicago's West Loop, a neighborhood with a deep and rich history of union labour. With this in mind, we became interested in how we could translate the collective labour of people power into something immediate, visual, and poetic. To do this, we adapted six bicycles to become a single, stationary light-production unit. We rigged each bike with several electric generators that were wired to strings of small lights suspended above and around them. When one bike was ridden, many lights twinkled, and if all six bikes were ridden simultaneously, the collective work of the riders created a shimmering and brilliant constellation.

JAM continued to investigate alternative energy for *Dispensing with Formalities*, a public art exhibition in Columbus, Ohio. We were asked to use newspaper dispenser bins as a space to locate distributable art and our contribution, *Sun/light* (JAM 2003) (figures 2 and 3), sought specifically to distribute light. In order to make this light dispenser self-contained, capable of both collecting energy and distributing light, we reached out to a local solar engineer who helped us rig the dispenser with solar panels and batteries. We mounted the panels atop of the dispenser to collect sunlight to be stored in a sealed lead acid battery that, in turn, powered light-emitting diode (LED) bulbs to be illuminated during the dark hours of the night. Our hope was to distribute the immaterial and perhaps provide light to spaces like unlit sidewalks that may be overlooked by the city.

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After working with the solar engineer who not only helped us to create *Sun/light* (JAM 2003) but also taught us the basics of how to use and collect solar energy, we felt empowered to continue working with solar energy and found that flexible, thin film solar panels were on the market. This lead us to create personal power (figures 4 and 5) in 2003, a project in which we embedded flexible solar panels into garments and bags capable of charging small electronics.

personal power JAM (2003/4) was politically motivated and was developed around the time of the run-up to the second Iraq War. We felt the war was driven by the United States' greed for oil, and we felt an acute powerless in our country's decision-making process. We subsequently started talking about ways to bring power back to the individual and wondered about ways to use solar power on a scale that could enable each one of us to be independent from the grid. Our goal thus became to literally empower people: to give them a personal power source enabling them to disconnect from conventional power sources while allowing them to use their electronic devices to remain connected to a larger information network. We looked to integrate flexible solar panels into garments, backpacks, and handbags to create mobile power units for devices such as cell phones and, in some cases, small gaming devices. It was our hope that by integrating solar power into items that people already use every day, they might become more interested in the potentials of solar power on a larger scale.

From our initial conceptual and political project came the goal of making wearable, portable, alternative energy widely available. By crafting the project beyond the conceptual realm, beyond a single piece of art or a single prototype and making it a viable consumer product, we aimed to have a measurable effect on our culture's dependency on non-renewable energy sources. To make the transition from art project to manufactured product we partnered with an MBA student at the University of Chicago School of Business, crafted a business plan, and formally incorporated as a business called *Noon Solar*.

With *Noon Solar*, we sought to bridge the gap between technology and fashion. Given the relatively high costs of the technology and materials, we set our sights on making this a high-end product for an urban consumer. We had competitors addressing the sporting market, but were looking for a different kind of trendsetter: an early adopter of technology, a fashionista, and an eco-conscious consumer who could use his or her apparel to collect power.

To collect the sun's light energy we used a flexible thin film photovoltaic panel (figure 6 and 7) that was sewn

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into the exterior of the bags. Wires connected the solar panels to a lithium-ion battery inside an interior pocket. The battery stored the energy, which could be used to charge devices through multiple adapter tips provided with the bag.

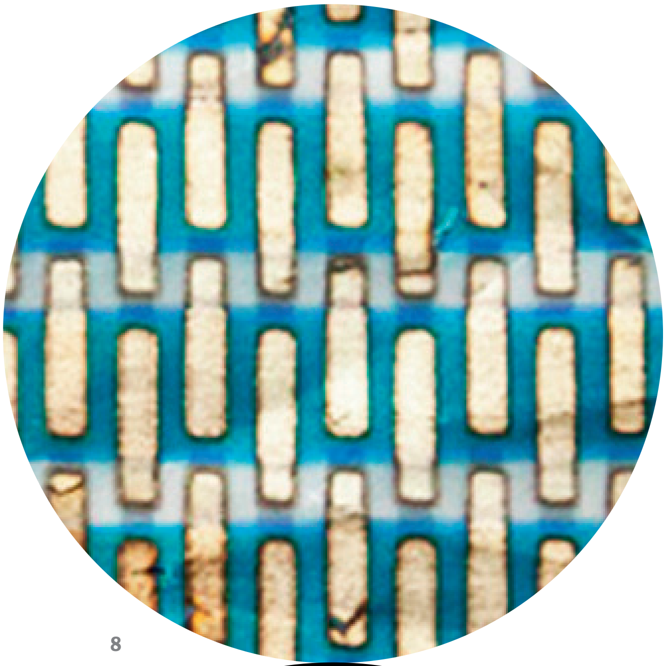
By 2008, *Noon Solar* had distribution in over 30 stores across the US and Canada. Though we disbanded the company in 2010, our design for incorporating the solar panel into the handbag and capturing the energy was awarded U.S. Patent in 2013.

People were clearly interested in having portable power but cell phone technology was still relatively new and we faced many challenges, including sourcing the portable batteries we sold with our bags and providing the correct cell phone charging adapter tips. More than this, as the thin film panels that we integrated into the *Noon Solar* bags were at the cutting edge of commercially available solar technology in the early 2000s, they were the most expensive component of our bags (further driving up our price point). Aesthetically, it was always a challenge to figure out how to integrate the rigid, rectangular, and thin film into the design of the bags. I always dreamed of a solar conductive surface that would cost less, offered more flexibility, and would not have size limitations. What if fabric *itself* could collect the sun's energy and be seamlessly integrated into the bags?

TEXTILE TECHNOLOGIES

As I began pursuing this idea of a solar fabric, I recognised that it had the potential to be a new entry in a long tradition of revolutionary textiles. In her book *Women's Work: The First 20,000 Years*, Elizabeth Wayland Barber (1995:45) writes that, during the Upper Paleolithic, string was the '…unseen weapon that allowed the human race to conquer the earth'. The invention of fish lines, tethers, nets, and leashes represented a 'string revolution' that was every bit as pivotal for humankind as the harnessing of steam during the Industrial Revolution (Barber 1995). In the 21st century, the challenge is no longer to conquer the earth, but to sustain it, and the revolutionary power of textile technology is as necessary as ever.

Though we rarely recognise the humble string for its contributions, it has been and remains the catalyst for countless innovations and efficiencies, and serves as a nexus of collaboration between many disciplines (McQuaid 2005). From architecture to agriculture, medicine to manufacturing, advances in technical textiles touch nearly every aspect of our lives. For centuries, ships were powered by nothing more than sails, yoking the wind to move massive vessels across vast oceans. While the power of the wind is substantial, consider that the sun provides more energy in one hour than all of humanity consumes in an entire year. Imagine a world in which ships' sails, campers' tents, and even our very clothes could capture the sun's abundance of energy. I believe that this is the next frontier for textiles.



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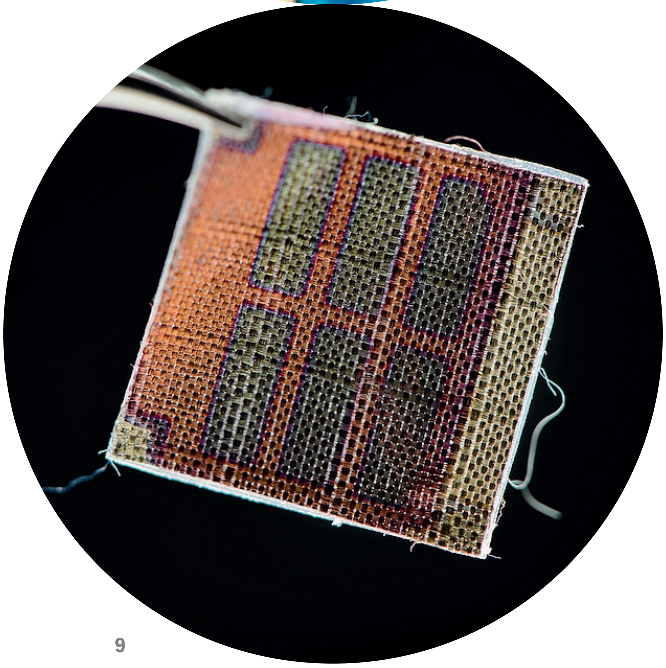

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CHEMISTRY/TEXTILE COLLABORATION TO CREATE A NEW ENERGY HARVESTING FABRIC

One year ago, I arrived on campus at the University of Wisconsin-Madison. Being part of such a big, Research 1 institution, I started to investigate existing types of solar research. I quickly found Chemistry Professor Trisha Andrew, who had successfully made an organic dye-based solar cell on paper (2015) (figure 8).

Andrew (Tenenbaum 2014) uses dyes because photovoltaics (PV), the process of converting solar power to energy, depends on materials such as paper that are excellent at absorbing light, and, as she explains, '…there is no material that absorbs light as well as dye, not even the silicon used in commercial solar cells.' As a chemist and a fibers artist, our processes of working with dyes are very different. Andrew uses a stencil resist to create a pattern of nano-layered chemicals to create solar cells. In my world, we think of this as stencil screen-printing or as the Japanese rice paste stencil process of Katazome. Andrew cuts the stencil and then applies it to the substrate that is suspended in a gravity-free chamber where the vaporized dyes adhere to the cloth. No solvents or liquids are involved. The dye is able to make a completely even or conformal coating that is critical to building the solar device.

As a dyer, I am fascinated by the idea that the pigment can capture the right wavelength of light and convert it to electricity. As a weaver, I am excited to investigate the possible structural potential of building the layers of the cell into the woven cloth itself. What if, instead of printing the chemical nano-layers on the surface of the cloth, we could coat each thread and then create a solar textile using specific weave structures?

To be sure, Andrew originally built the solar cell on paper to prove that these cells could be lightweight and inexpensive. She was stuck, however, because paper is not sturdy enough to have many practical applications. After discussing my previous work and posing my questions about whether her process would work on a textile substrate, she was excited and intrigued and our collaboration to make a solar textile was born. I assembled dozens of fabric swatches and we did our first test on a conductive copper cloth (figure 9). This initial test was able to collect light energy but at low efficiency. We are now conducting tests on a variety of fabric substrates to see which one will be most efficient, including, baste, protein and cellulose woven textiles.

In the field of energy, function is often elevated over form, but in the case of developing wearable solar power, I am driven to understand if the pattern design and flexible solar collector can work in unison, being both highly efficient but also highly appealing. A key question I am asking is whether the solar textile could be woven instead of printed? Following this, a couple of questions I am asking are:

Can the patterns that we use to create a solar textile on the surface look high-tech or tell the story of how the textile is functioning? How will consumers come to know the look of solar power and then choose it as their style and their energy source? Our research includes two approaches to making a solar textile, one is to create the solar device on a textile substrate and the other is coating individual threads to be fully integrated into a woven cloth. While I am excited to think of all of the possibly end use applications of a solar textile I am most interested in creating a textile based solution to our energy needs that could be used in a magnitude of contexts.

Textiles are lightweight, pliable and durable. A successful solar-harvesting textile would serve as a foundation for wearable technology, capable of providing renewable energy for the ubiquitous and ever-expanding array of personal electronics. From my early collaborations with Jane Palmer to my innovative research with Trisha Andrew, my work within Fiber and Material Studies has always pressed the boundaries of both art and technology – insisting on the intersections and impressions of politics on both. My collaborative work to develop a textile capable of generating energy would have revolutionary implications for a range of fields including satellite technology, sporting goods, and a variety of consumer products; from everyday garments and accessories, to tents, to curtains and upholstery – to everything under the sun.

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Tennebaum, D. (2014) Save Power, Make Power: Professor Trisha Andrew Confronts Ambitious Research Agenda with a Laugh. [Internet] https://www.chem.wisc.edu/content/save-power-make-power-professor-trisha-andrew-confronts-ambitious-research-agenda-laugh [Accessed 03/09/15].

FIGURE CAPTIONS

Figure 1: *transform/transport II*, JAM (2002). 15' x 15' x 15': Stationary bicycles, generators, small lights, wire, and scrim.

Figure 2: Sun/light, JAM (2003), 50" x 22" x 20": plastic newspaper dispenser, booklets, solar panels, LEDs, sunlight.

Figure 3: Sun/light, JAM (2003), 50" x 22" x 20": plastic newspaper dispenser, booklets, solar panels, LEDs, sunlight.

Figure 4: Personal Power, JAM (2003). Flexible thin film solar panels, jacket, batteries, gameboy, hardware, electronics, sunlight.

Figure 5: Personal Power, Prototype 2, JAM (2004). Flexible thin film solar panels, signage vinyl, jacket, batteries, cell phone, hardware, electronics, sunlight.

Figure 6: Noon Solar (2007) Messenger Bag. 28" L x 8" W x 20" H, flexible thin film, vegetable tanned and dyed leather, naturally dyed cotton lining, metal zippers and hardware, cotton webbing, iPod, lithium-ion battery.

Figure 7: Noon Solar (2007) Messenger Bag. 28" L x 8" W x 20" H, flexible thin film, vegetable tanned and dyed leather, naturally dyed cotton lining, metal zippers and hardware, cotton webbing, iPod, lithium-ion battery.

Figure 8: Organic Dye-based Solar Cell on paper, Fairbanks and Andrew (2015)

Figure 9: Solar cell test on conductive copper fabric, Fairbanks and Andrew (2015). Photograph by Jeff Miller.