Wearable Studio Practice: Design Considerations for Digital Crafting in Harsh Environments

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Abstract

Wearable and Ubiquitous computing necessarily expose digital electronics to new environments. Traditional methods of creating new technology, within climate controlled laboratories, can cultivate hidden assumptions within the design of the devices, and prolong design iteration time. Designers can instead find new ways to free the development of ubiquitous and wearable technology from the laboratory and into the site of use.

This paper will describe the design and use of portable workshop equipment that has been created to enable engineers to create tools in harsh and restrictive environments. With these devices an entire workspace for digital prototyping can be quickly setup in the wild. Examples are taken from “Hiking Hack” workshops held in Panama, Madagascar, and the U.S. The mobility of our setup will enable us to bring our studio directly to the “Wear and Tear” to illustrate the key components and elicit feedback about new designs for portable studio practice.

Author Keywords

Portable Studio, Design, Fieldwork, Wilderness

Figure 2 – Building electronics and sensors on a hand-made workbench in Madagascar underneath a Silnylon tarp

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous;

Introduction

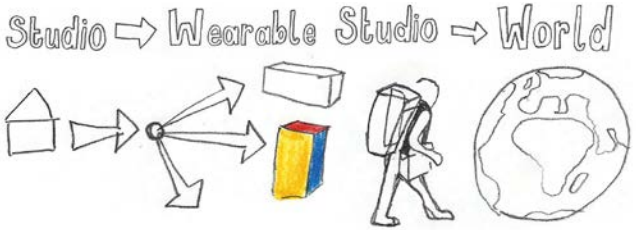


Figure 1 - Illustration of the Concept of a Wearable Studio

As designers exploring the evolving role of computation in the world, we must not only change how we think about technology, but also how we create it. Digital technology's use is growing towards different environments in the world, but the way it is designed and built typically relies on traditional conventions.

Climate controlled laboratories can cultivate hidden assumptions within the design of devices. Artifacts can be erroneously designed to fulfill the needs of the laboratory environment instead of the target milieu. Divorcing the sites of construction and implementation also prolongs design iteration time. By restricting the creation of digital media to the laboratory, one also drastically lengthens the iteration time for tools meant to be used in wild environments.

Designers can instead find new ways to free the development of ubiquitous and wearable technology from the laboratory and into the site of use. The goal is to build a set of wearable and portable accessories that allow engineers and designers to build directly at their sites of inspiration. With such a nomadic studio one can travel to unique places, experience their cultures, explore their environments, collaborate, and incorporate local crafting techniques and materials

Building devices within the same context of their use lets creators make new devices appropriate to their environment. Devices built in the field will necessarily force the designer to account for rugged robustness in their creations. Perhaps most importantly, devices built in the field can also be repaired in the field, accelerating the design process of wearable and ubiquitous computing

Creating new spaces for working will affect the kinds of work designers are able to create. A Wearable Studio practice can keep designers more engaged with the environments, animals, and people around oneself.

Examples of portable studio practice described in this paper include cheaply making large, lightweight, compactable tarps (from Silnylon seconds), using butane soldering irons, and rapidly deployable work surfaces and stations.

Figure 2: Workshop participants building digital tools in the portable studio at night and day during the third, “Wearables in the Wild” hiking-hack workshop

Designs and Concepts

The ideas presented here were developed in a series of Hiking Hackathons. These are participatory design workshops created during Quitmeyer's research with field biologists[1]. The concept is to design robust instruments for working with animals in the wild, by transporting the tools needed for digital design deep into the forests themselves.

The first hiking hacks learned the important role that proper working conditions play for building tools. In the first hiking hack, the participants simply had to sit on the muddy ground, under a dark tarp, hunched over the devices they tried to build, with tools scattered about the area.

By the second hiking hack in Madagascar, we worked to create tables and shelves from nearby natural materials. We also built lighter, and more transparent, tarps to keep out the rain, but allow for an adequate workspace. These initial experiences inspired even more development into specific items designed explicitly for doing digital-electronic prototyping in the wilderness.

By the third hiking hack, the tools need to transport and setup a large workspace for 10 designers had been refined. A mobile kit of Shelters, lights, tool-kits, tool organizers, and work surfaces were tested with great success. These techniques let all 10 individuals work simultaneously on many electronics projects far removed from the traditional luxuries of the laboratory.

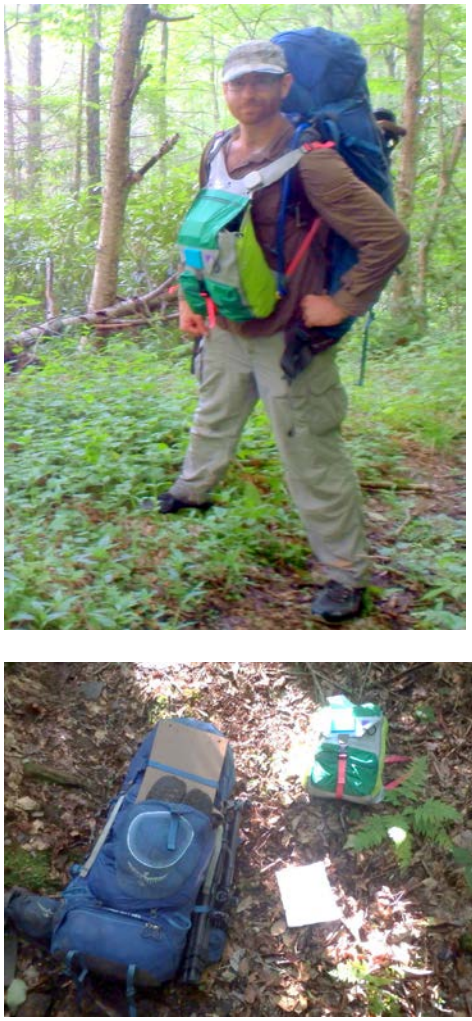
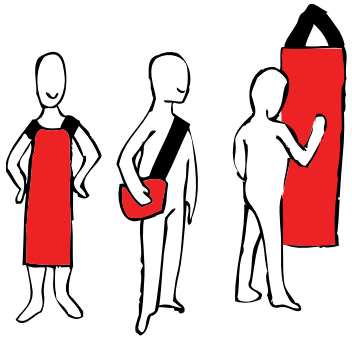


Figure 3 – Transporting an entire studio on one's self



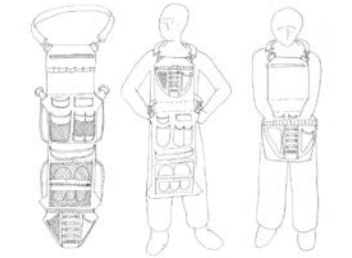


Figure 3 – Concept, Design, realization, and testing of a portable, wearable studio.

Tools and Materials

Important tools for implementing a portable studio are detailed below:

- Butane Powered Soldering Irons
- Lightweight Laptops
- Silnylon Tarps
    - Raw material from Diygearsupply.com
- Hanging Supplies
    - Polyester Webbing, Paracord
- High-density power packs
    - 20 amp-hour 5 volt packs
- Voltage booster devices
    - DROK® LM2577 DC Boost Converter 3-34V to 4-35V Adjustable Voltage Power Supply
- Solar Panel
- Fabric Portable Reference Sheet
    - Printed Spoonflower performance knit
- Breadboards
- Water-tight tackle boxes for electronics organization
- Stiff, Lightweight boards
    - MDF for work surfaces
- Heat-resistant material
    - Kapton Film for soldering surfaces
- Solder-able Conductive Thread
    - #3981 kupfer blank 7x1 fach verseilt
- Lighting
    - Headlamps
    - Led Strips
- Natural Materials
    - Sticks, vines, whatever one can forage

Wearable Daypack

Perner-Wilson created several successful iterations of a special wearable daypack which could unfold into an organized studio. She was inspired by the small “daypacks” carried by the field biologists containing everything they needed for a day doing research in the field.

The pack transitioned from a normal messenger or backpack, into a hang able or wearable tool organizer. Perner-Wilson tested this design in several locations ranging from urban, semi-natural, and fully natural areas. She built another day pack which was tested on the third “Wearables in the Wild” hiking hack in the Appalachian Wilderness in the US.

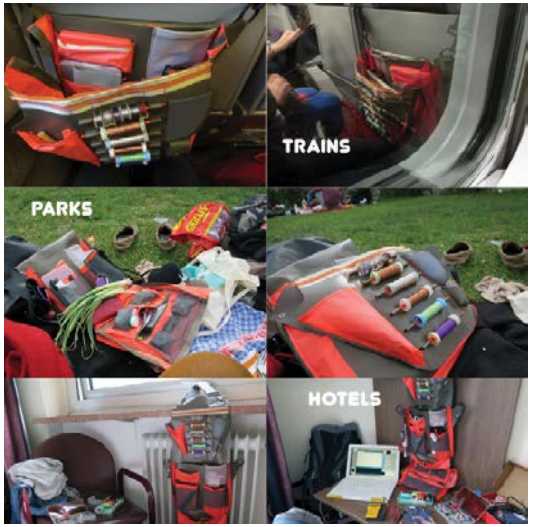


Figure 4 - Many locations opening up to digital crafting via portable studio

Portable Work Surface

Thin sheets of lightweight MDF were also carried into the field to experiment with quick, modular work surfaces. Notches were cut into the panels into which webbing could slide. The webbing would be tensioned around two trees, and the panels would exert a perpendicular force to provide a rigid structure. The modular panels allowed persons to shift, extend, or separate working areas according to the needs of the group. The key improvements for this design are zig-zag notches which keep the webbing from slipping out, along with lighter-weight (and waterproof) replacements of the MDF. A similar design could possibly be constructed using light-weight tent poles, grommets, and the webbing.

Figure 5 - Daypack/Tool organizer hanging under Silnylon tent in between ultra-light modular table-space

Power

The primary question people have for a portable studio is how to power all the tools. During the hiking hacks, several portable methods were examined for ways of getting the electrical power our devices needed.

Needs

Rough estimates of previous hiking hacks help form a basic idea of electrical needs in a digital design workshop.

Power breakdown:

- 60% Documentation Gear (camera batteries)
- 20% Computer for programming
- 15% Lights (Headlamps, etc.)
- 5% Powering microcontrollers

We estimate needing about 300 amp-hours of power total for 7 days building in the field. This amount of power would help keep documentation cameras rolling, lights shining, computers programming, and microcontrollers functioning for a full 7 days in the field.

Laptops can be charged off inexpensive 5V power sources by simply connecting them to cheap DC voltage boosters like the LM2577 (available for $4).

Different strategies are available for supplying this power.

Transporting Pre-charged batteries

This is the most fool-proof plan, and most important for shorter trips. Just charge up a bunch of power packs, and carry them with you. Obviously the major downside of this plan is all the additional weight.

Figure 6 - Charging Numerous Batteries

Solar

Solar is terrific, but it tends to need much more direct bright sun than most people anticipate. The difference between a cloudy day and a clear day is greatly magnified when trying to charge off solar. You also might find yourself chasing patches of sun throughout the day if you are in a thick forest (like we were).

Figure 7 - Solar Charger

Pyro-Electric

Pyro-electric devices are starting to come out on the market. They use Peltier devices which are little ceramic tiles that create an electric current when there is a large heat-gradient from one side to the other. Thus the key to making electricity is getting one side hot and the other side cold. This type of electricity is generally quite inefficient, but the advantage is that you can forage for fuel. This form of power only really makes sense if you are going to be making fires every night anyway. The amount of power we got out of one fire, though seemed quite small. We could maybe charge 2-3 amp-hours of a battery over the course of a couple hours. You also need to be constantly paying attention to the position of your device in the fire.

Figure 8 - Pyroelectric generator

Hydro-electric

This was one of the craziest forms we tried out in this recent trip. If you know beforehand that you will have easy access to a source of running water, you can try to tap into this resource. You will need a way to control or direct the water, and a way to generate power from it (turbine). Our technique was to carry a large (50 foot) firehose that could be attached to an electrical generator.

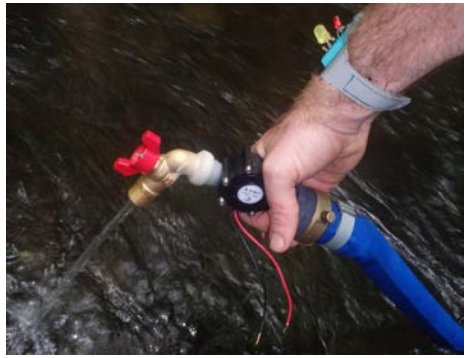


Figure 9 - Testing portable hydro-power

Our early tests with DIY hydropower still need much development. We were able to place the hose at two different spots in the flowing creek and get a decent flow of water. We were also able to find a generator that could get 3-5 volts and power and LED by spinning it. Unfortunately this generator needed a much higher pressure than was available from our hose. The hose also tended to collapse unless the flow was much better. Our homemade turbine (that we created from a vibration motor and a plastic cap), showed that we could generate power, but only in the 40-50 mV range.

Future designs will be made to more efficiently harvest energy from low-pressure systems.

Conclusion

The way we build and design our technology will become increasingly important to wearable and ubiquitous computing. A portable studio can help engineers and designers work and evaluate their projects directly at the sites of inspiration.

We can transport our mobile studio to the wear and tear workshop to let others experience and evaluate our system for making in the wild.

References

[1] Digital Naturalism. “Transcontinental Hiking/Hack”: *http://andy.dorkfort.com/andy/digitalnatural/2014/06/05/transcontinental-hikinghack/*. Accessed: 2015-06-24.