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ORIGINAL ARTICLE

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Lessons from the scrapyard: creative uses of found materials within a workshop setting

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Abstract This paper focuses on a spectrum of workshops developed by the authors, collectively referred to as Scrapyard Challenges. These workshops ask participants to create a computationally designed object within a fixed time frame using cast-off materials and junk. Depending on the focus on the workshop, participants develop musical controllers, fashion-oriented wearables, or street interventions. Though operating in diverse application domains, each workshop introduces a "third place" where creative appropriation of materials and playful experimentation is the primary reward. The end results have been remarkable, with both the novice and advanced participant producing highly creative prototypes. Each variation of the workshop and selected results are shared and detailed. Future work, as well as the implications of this approach within a singular workshop setting and a classroom is discussed. The Scrapyard Challenge workshops have been deployed in six different countries and have contributed to curriculum development for a graduate-level class which utilizes the workshop principles at the MSc. Multimedia Systems course at Trinity College Dublin.

Keywords DIY computing · Sustainable design · Musical controllers · Wearables · Fashion · Artistic applications · Education

1 Introduction

The Scrapyard Challenge is a spectrum of workshops which have been developed over the past 2 years. Beginning with the first MIDI Scrapyard Challenge held in Dubin, Ireland in 2003, the Scrapyard Challenge has been used as a fun and accessible way for novice and experienced participants to come together and experiment with physical computing and interaction design. In this paper the authors present their motivation for developing the Scrapyard Challenge

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workshops, detail the workshop structure, and share selected workshop results. Through describing the manifestations of the workshops and discussing their background and motivationc the workshops are presented as a teaching strategy where safe exploration of technology can take place. Additionally, some of the larger critiques implied in such an approach can provide valuable insights into future educational opportunities. While not advocated as a total educational curriculum, it nonetheless can be a meaningful contribution to an educational initiative, either alone or incorporated into the classroom.

2 Motivation and background

While various systems and approaches for learning and experimenting with electronics and physical computing exist, often there are two difficulties these methods encounter: (1) A high ceiling of technical knowledge which must be reached before engaging in the design process. (2) Cost and accessibility.

Electronics classes designed for artists often take hobbyist microcontrollers such as the Basic Stamp or PIC and attempt to teach the participant from the ground up how to build their own electronic circuits to drive interactive projects. Since there is a great deal of basic knowledge needed in order to do this, even at the hobbyist level, the lengths of these classes tend to align towards a semester or several weeks. While there is value to this approach in that it allows for time to thoroughly cover basic concepts, it is also prohibitive. The payoff of creating an interactive object is often delayed and only enjoyed after several smaller skill-building tasks. The direct experience of the design process is extracted and spread out over this period of weeks. Some systems attempt to circumvent this process, such as the popular Lego Mindstorms, through providing a complete development environment where components can be combined and programmed to interact with each other. However such systems do not allow departure from a predefined aesthetic and are generally expensive. With other educational electronics systems the associated start-up costs (The Handyboard costs $299 USD, an EZIO board is priced at $129 USD and a TELEO starter kit is priced at $189 USD) are still quite high for beginners, and additional electronics instruction is still required to take full advantage of them. On the other hand, a self-contained workshop can provide a condensed design experience which, however incapable of imparting technical proficiency, can still impart key elements of interaction design. The participant would still require a more extensive class to learn basic electronics, yet the groundwork for future development would be set.

The motivation for the Scrapyard Challenge workshops came from a desire to create a workshop experience which would first and foremost allow people to immediately begin creating interactive objects, but to do so in a way that was not prohibitive due to cost or time commitment. While not envisioned as a replacement to a more focused electronics class, the Scrapyard spectrum of workshops began as a way to open the interactive design experience to a variety of individuals with differing skill levels. In order to accomplish this, the workshop had to be open enough to welcome everyone, regardless of experience, be inexpensive, and not require specialty equipment. As inspiration, the authors looked to DIY practices, hacking, and pop culture for insights on how to develop such an environment.

2.1 DIY practices

With roots in the punk movement, a DIY ethic favors direct action and independence. If one doesn't approve of or like what others have done before then the responsibility is on the individual to take up the creative mantle. Inherent in the culture of DIY is the critique of consumer culture and a rejection of institutional hierarchies. By skirting around the mainstream, followers of DIY methods find inexpensive, alternative ways of doing things. While popularized by "Zine" culture, which encompasses a wide range of small circulation and non-commercially produced self-produced publications (Spencer 2004), DIY practices are alive everywhere. From the joys of self-made home-improvements to the Tokyo street fashion captured by Aoki (2001), the DIY aesthetic will exert itself where people desire non-commoditized differentiation and choice. The extensive "circuit bending" (Ghazala 2005) community is another example of this, which advocates turning cheap electronic toys into personally constructed musical instruments. The relationship between DIY enthusiasts and hackers is a close one, as often the same impulses drive their actions. Many members of the Homebrew Computer Club were also hackers, and it was the synergy between DIY motives and hacking which produced the first Apple computer (Wozniak 1984). "Thinking outside of the box" comes naturally to the DIY practitioner as they've already eschewed the box for whatever else lies outside of it.

2.2 Hacking

Originally meant to denote elegant programming shortcut and elaborate pranks, hacking has evolved to encompass any modification to an object or experience in a manner not originally intended. While the pursuit of hacking is mostly recreational, many "old school" hackers also operated with a code of ethics which supported open access, free information, sensitivity to beauty and art, and the power of computers to change one's life for the better (Levy 2002). From the edgy world of phone "phreaking" (Mungo and Clough 1992) to contemporary tomes detailing how to alter a PS2 Playstation (Mitnick 2004) hacking celebrates the joy of acquiring knowledge and finding solutions for their own sake. Interestingly the pursuit of something "for its own sake" has been identified as a key element of the autoelic experience, or flow state which is characterized by intense concentration and loss of self-consciousness. Within this state an individual experiences an optimal experience which is challenging yet extremely satisfying (Csikszentmihalyi 1990). In this environment where challenge meets skill and reward is intrinsic to the activity at hand, judgment-based values on the merit of an activity or design come not from a higher authority, but from the action itself and acknowledgement from one's peers.

2.3 Popular culture

The DIY enthusiast and hacker share commonalities. Both apply their skills and efforts to personally satisfying activities which bring enjoyment for their own sake. Additionally there is a sense of sly mastery and empowerment that comes from their irreverent actions. In the 1980s and 1990s a slew of movies (*Wargames, Sneakers, Real Genius*) and television shows (*MacGyver, A-Team*) celebrated resourceful misfits able to combine street-smarts with expertise. In the current decade reality television has found a winning formula in shows like "Junkyard Wars" and the British counterpart "Scrapheap Challenge" which pit ordinary people on multidisciplinary teams against each to build the best machine out of cast-off parts. With the rise of the Internet and technology companies, the "geek ethic" of hackers and eccentric self-starters has renewed cachet, which resonates well with youth culture and "extreme" sports. Being "hardcore" or singularly dedicated to one's passion can be cool whether through creative engineering or gravity-defying feats of skill.

3 Scrapyard principles

Keeping the inspiration mentioned above in mind, the Scrapyard Challenge developed along the following constraints: (1) limited time frame (2) found materials (3) simple input/output (4) cheap hobbyist electronics.

Limited time frame To create a sense of urgency and also to sustain a high level of energy, a limited time frame is imposed upon the workshop. Usually the time limit is slightly less that what is necessary to fully complete a project or prototype. With a limited time frame, participants do not have enough time to excessively fixate on details which are extraneous to their design. This serves as motivation for unconventional solutions which may not be considered unless under duress.

Found materials The Scrapyard Challenges look to the materials collected and found in a particular place as the starting point for the projects. Each workshop attempts to incorporate locally-specific elements of the location where the workshop is held into the experience. (For example, the first MIDI Scrapyard challenge was held in an abandoned warehouse where the junk collected on-site served as the raw materials for the workshop.) Found materials can be seen as a question for the participant, which must be answered through response to the specific affordances and design constraints suggested by the object.

Simple input/output To keep the focus on interaction design and the application domain, computational behavior is limited to simple digital or analog input and MIDI serial output. The use of basic electronic circuits allows participants to focus on developing their prototype and keeps the technical learning curve required to a minimum. Within a clearly defined technical constraint, application-based innovation can flourish.

Cheap hobbyist electronics All the electronic circuits used in the workshop can be built or purchased from electronics hobbyist suppliers. This is a key aspect of the workshop which provides avenues for participants to continue learning after the workshop has ended. Information on the electronics used in the workshop is provided in a follow-up email to participants. Hobbyist supplies tend to help keep costs down and the large level of support and documentation for the more popular hobbyist microcontrollers (such as the Basic Stamp) ensures that interested participants will find additional guidance should they desire such.

4 System setup

The Scrapyard Challenges utilize both custom-made input/output boxes and cheap purchased pre-assembled electronics hobbyist kits. The custom made input/output boxes are built with a BasicX microcontroller and are configured to accept digital and analog input, with output set to MIDI via serial transmission. A MIDI-Man USB serial interface passes the MIDI data sent out by the circuits to a laptop running the built-in operating system software synthesizer to generate sound. The hobbyist kits can be found at any electronics retailer and generally sell for less than 20 US dollars. The types of kits used might include simple recording and playback modules, solar battery kits, and LED modules.

At the beginning of each workshop, the group of participants introduce themselves and each person provides a brief description of their reason for attending and what they hope to learn. Basic electronic concepts, such as digital input (switches), analog input (dials and sliders), conductors, insulators and both fixed, and variable resistors are explained to the participants along with basic safety issues and precautions that should be observed regarding electricity and soldering. Participants are given a fixed amount of time in which to create their object. Usually this is limited to 5 h. They are given the option to work alone or in groups. While the workshop takes place the authors are on hand to answer questions and provide assistance. The atmosphere is atelier-like (Fig. 1). After the allotted time has elapsed we gather all individuals and projects regardless of their state and begin to organize for public presentation. The type of public presentation varies depending on the workshop. Regardless of the form the public presentation takes individuals are always given the opportunity to personally show their project and take credit for what was accomplished in such a short time frame.

Fig. 1 A typical Scrapyard Challenge environment

5 Workshop details

As described above each variant of the Scrapyard Challenge shares the same general format, yet differences in the focus and materials in each workshop changes according to the needs of the topic.

5.1 MIDI Scrapyard Challenge

The MIDI Scrapyard Challenge is the first of the Scrapyard Challenges and has been held in five different countries on three separate continents. In the MIDI Scrapyard Challenge workshop participants create musical controllers. All materials used are either found within the city in which the workshop is being held, or brought by the workshop participants. Typically there is collaboration with a local sound artist who coordinates the performance at the end of the workshop and each participant is given the opportunity to present and demonstrate their controller.

The following objects are a selection of controllers, which were developed in a MIDI Scrapyard Challenge, held in Berlin, Germany. In general most of the MIDI Scrapyard Challenge results tended to divide between analog and digital controllers. Some participants however, completely ignored the MIDI aspect of the workshop (which would be in keeping with the DIY spirit of the experience) and made their own percussive musical machines.

5.1.1 Yes/no shaking helmet

A helmet that has metal joints which swing back and forth. Depending on which direction the head is moving (forward/backward or left/right) one of two switches are completed, causing alternating tones to play (Fig. 2).

Fig. 2 The yes/no shaking helmet

5.1.2 *Beat scratching hard drive*

The beat scratching hard drive is a discarded computer hard drive with two wires taped down onto the exposed metal. Decal sticker material was cut out to expose only two lines of metal, which completes a switch when the hard drive is spun. The result is a scratching beat machine (Fig. 3).

5.1.3 *Auto beats*

The auto beats machine used an old printer mechanism mounted onto a metal plate to produce a set of rhythmic beats. The metal plate was covered in cast-off sticker decal to block off connections at certain intervals. When the machine was activated the printer mechanism slid back and forth, and played the drumbeat rhythmically (Fig. 4).

5.1.4 *Sound scarf*

The sound scarf is a long strand of fixed resistors still in their packaging and a wand. Wires are attached to the ends of the resistors and to the wand. Moving the wand over the 'scarf' produces a digital input and series of notes (Fig. 5).

5.1.5 *Bottle violin*

The bottle violin is constructed out of two wires. One wire contains five fixed resistors of varying resistance placed in series. The other wire is unmodified. A long piece of plastic encloses the unmodified wire, and keeps the two wires separated. When the wires are immersed into a bottle containing a liquid (water) the wires short at different points, creating a change in resistance which alters

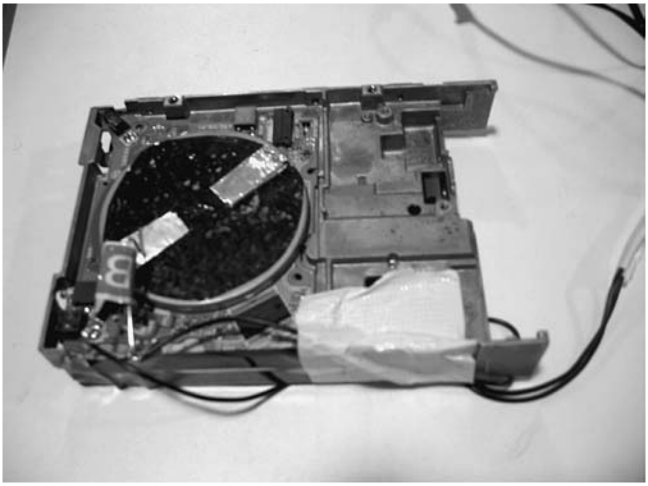

Fig. 3 The beat scratching hard drive

Fig. 4. The auto beats machine

Fig. 5 The sound scarf

the pitch bend of a note. A participant with no prior electronics experience developed this project (Fig. 6).

5.1.6 Speaker string

The speaker string uses the piezoelectric element of a speaker as an analog input. A cast-off armature for a desk lamp was mounted over the speaker and wire was strung between the armature and the speaker and secured with hot glue. When the string is plucked, it agitates the piezoelectric element in the speaker, creating an analog input and alters the pitch bend of a note (Fig. 7).

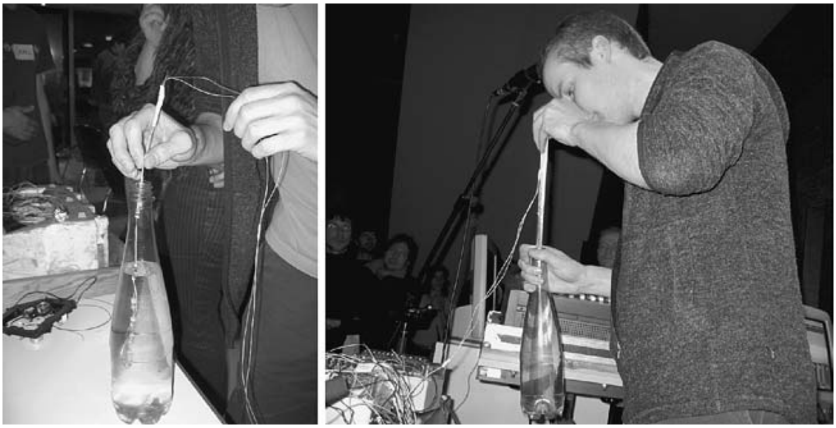

Fig. 6 The bottle violin

5.1.7 Washboard printer

The washboard printer is a printer mechanism with a washboard backing. A thick metal wire protrudes from the printer mechanism and scratches the washboard. The printer mechanism can be controlled to scratch back and forth along the full range of the printer mechanism (Fig. 8).

5.1.8 Rotating scratch machine

The rotating scratch machine is a simple motor attached to a battery, which slowly spins a small wooden plank over a wood box. The ends of the plank are covered in discarded metal, which scrapes over other metal elements affixed to the box. The result is a rhythmic repeating beat (Fig. 9).

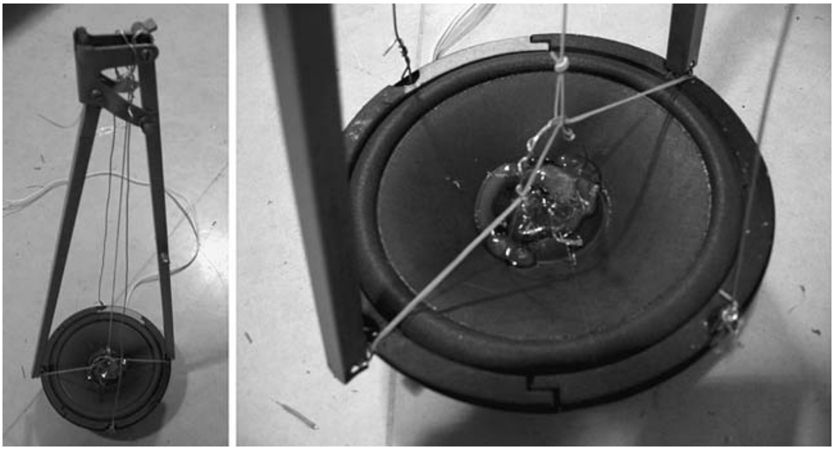

Fig. 7 The speaker string

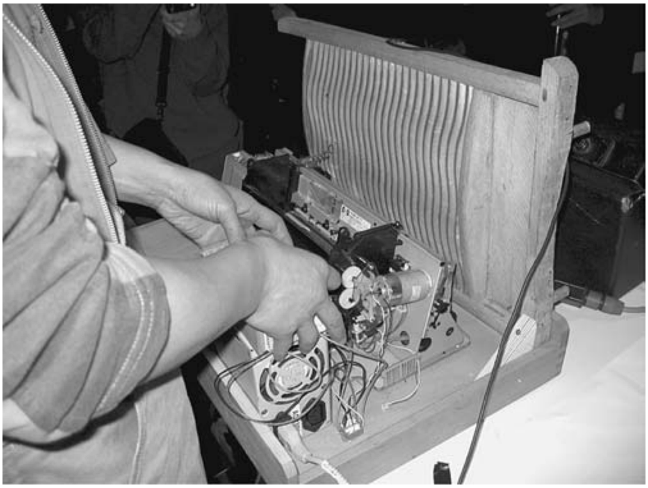

Fig. 8 The washboard printer

5.2 DIY wearable challenge

The DIY wearable challenge follows the same format as the MIDI Scrapyard Challenge, but explores wearable technology and fashion instead of musical controllers. Moving away from a high-tech aesthetic and towards a literal and metaphoric interpretation of "street wear" the DIY wearable challenge uses scrap fabric, hobbyist kits, and conductive thread and fabric to create wearable technology in about 5 h. Old clothes, often recycled or discarded are provided for participants to take apart and recombine into new garments and accessories. The presentation at the end of the workshop is a fashion show where each participant models and demonstrates their creation.

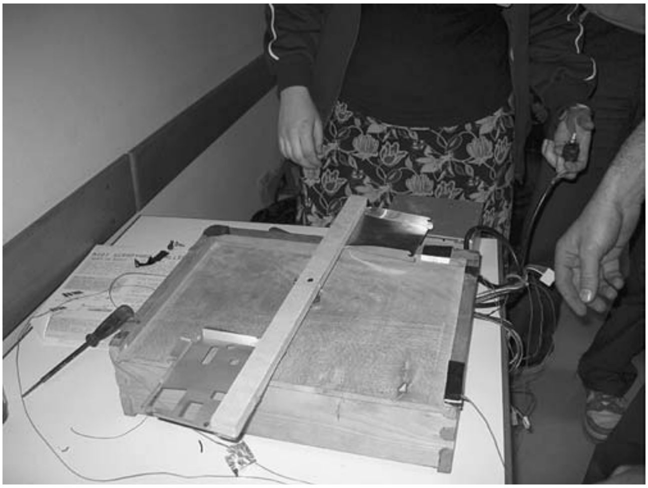

Fig. 9 The rotating scratch machine

The DIY wearable challenge results showed both whimsical integration of technology into garments and clothing with the potential to supplement social interaction. Selections of projects from two DIY wearable challenges held in Tallinn, Estonia are described below.

5.2.1 *FM jacket*

The FM jacket is constructed out of an FM radio receiver that has been hacked apart and integrated into the jacket. In the place of wires conductive threads and materials are used to complete the electrical connections. Through touching two conductive elements on the jacket together the wearer can select different radio channels (Fig. 10).

5.2.2 *Reconfigurable trenchcoat*

A trench coat is modified with conductive fabric and light-emitting diodes (LEDs) so that an LED brooch displays a different state based on the wearer's physical movements and how the garment is configured (open or closed, tied together) (Fig. 11).

Fig. 10 The FM jacket

Fig. 11 The reconfigurable trenchcoat

5.2.3 Gossip hat

The Gossip hat takes an audio amplifier kit and places the microphone at the back of the head, while an ordinary set of headphone speakers are integrated into the hat. The bonnet allows the wearer to hear what is happening behind them (Fig. 12).

5.2.4 Mother/child outfit

The mother/child outfits are comprised of a pair of women's pants and a baby jumper. Conductive fabric was sewn onto the lap of the pants and over the hands, feet, and seat of the baby's garment. During play with a baby a mother would be able to trigger various sounds depending on how the child was positioned on her lap (Fig. 13).

Fig. 12 The gossip hat

Fig. 13 The mother/child outfit

5.2.5 *Intimate whisper dress*

The intimate whisper dress allows the private message recorded by a loved one while dressing to be played back throughout the day. The dress was created by modifying an existing skirt which was wired to close a switch when the zipper was pulled up. At the time the zipper is closed the person dressing their loved one can whisper an intimate message to the person and a speaker placed at the shoulder of the dress will replay the message throughout the day (Fig. 14).

5.3 Hacking the street

Hacking the street veers slightly from the basic format of the previous Scrapyard Challenges. Rather than acquiring cast-off materials before the beginning the workshop, the authors explicitly asked participants to go out and find materials to bring back to the workshop space with the understanding that they would modify these objects before redeploying them in the field. Participants were asked to 'locate and transpose' their environment through observation and mapping the site of their public intervention in addition to creating their object. This increased the total time of the workshop, which was held over 2 days. In lieu of traveling to the sites of the installed works the public presentation used photographic documentation.

Results from hacking the street ranged from the personal to the explicitly social. Some participants chose to create objects for their own enjoyment. Other participants chose to design for imagined groups whose traces had been left at transition points or in-between spaces. Participants tended to work in groups.

5.3.1 *Roving bicycle music*

A roving musical bicycle instrument made out of cast-off bicycle parts took the remains of stolen and forgotten bicycles and turned them into a lively sculptural piece that could be easily moved to different locations (Fig. 15).

Fig. 14 The intimate whisper dress

5.3.2 Junkyard water fountain

Using scrap aluminum siding and copious amounts of plastic tape the junkyard water fountain played musical tones (Fig. 16).

5.3.3 Safety notices for public spaces

A repurposed smoke alarm delivered notices of public safety in a clandestine meeting spot (Fig. 17).

5.3.4 Space tuner

A lamp rescued from the trash was combined with a potentiometer to create a device which would transpose the aural properties of crowded and secluded spaces, shifting the sonic ambience (Fig. 18).

Fig. 15 Roving bicycle music

Fig. 16 Junkyard water fountain

Fig. 17 Safety notices for public spaces

6 Discussion

Many of the projects in each of these workshops remained unfinished or in the early prototype stage. But the intent was not to create finished pieces, rather than to let the spontaneity of the moment and materials at hand provide the creative working constraints. While each workshop generated innovative ideas within their own activity domain, there were similarities in terms of the skills activated within the workshop experience

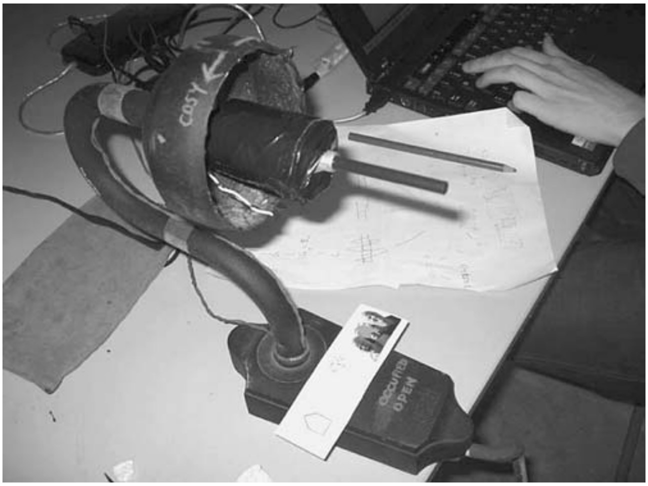

Fig. 18 The space tuner

6.1 Use of materials

In all of the workshops, participants showed an innovative response to the materials at hand. Within the Scrapyard Challenge environment, the affordances and material properties of found objects served as a baseline constraint, grounding participant ambition, but remaining open to design objectives. Each individual was free to respond to and recombine the materials in their own way.

An excellent example of this might be the "Bottle Violin," which was created during a MIDI Scrapyard Challenge. Using only the electrical principles taught in the workshop this individual re-imagined an ordinary bottle into an expressive analog controller. The entire process activated the ability to repurpose found objects (an empty plastic bottle, discarded fixed resistors, and a thin plastic strip cut from a piece of packaging) and construct them into a new artifact. This is a powerful experience for individuals who have had little exposure to electronics and physical computing.

For individuals with prior experience with interactive design, experiencing an alternative instinct-driven way of working stimulates creativity. An example of this might be the "Beat Scratching Hard Drive" which used a discarded computer hard-drive, sticker decal, and wires to create a beat machine. A very simple and easy to make controller, nevertheless a trained individual might not usually begin with discarded junk as a starting point for a project, instead relying on standardized design methodology or a bottom-up electronics development approach. The value of the Scrapyard experience for such an individual comes from "breaking the rules" in order to encourage mental and creative flexibility.

6.2 Imagining alternatives

Another advantage of the Scrapyard environment is the ability to engage a variety of individuals in a design process from which they would normally be excluded. As discussed in previous sections of this paper, most individuals interested in physical computing and interactive design must scale steep learning curves in order to begin developing creative projects in a hands-on manner. The Scrapyard Challenge workshops allow the novice and beginner to readily begin designing and prototyping, opening the possibility for previously unimagined alternative applications to emerge.

Within the DIY Wearable Challenge, many participants came from backgrounds with no electronics experience, yet showed sensitivity to the delicate relationship between the physical and social body. A good example of this is, the "Intimate Whisper" dress described in the previous section, which used a cast-off skirt and a hacked hobbyist electronic circuit as the basis for its design. The skirt was repurposed as a dress, and the zipper was constructed as an on/off switch to the electronic circuit. During the act of dressing an individual a person could whisper a personal message into the dress which the wearer could then replay. The end result is a garment which manages to articulate the historical and contemporary social potential implicit in the performative act of "getting dressed." Though the prototype of the garment was crude, the concept was highly sophisticated and could easily be refined and improved at a later date.

In a traditional educational setting, an individual would first have to spend a lengthy time learning electronics basics, or be content to work with non-electronic based materials to develop their ideas. Within the Scrapyard environment, participants are able to jump directly into creating working prototypes, which can set the foundation for more structured learning and design activity later. During the workshop no judgment is passed on the value or merit of a design or object, yet critical evaluation can come later. As an educational "third place" (Oldenburg 1999) the Scrapyard Challenge provides neutral ground, where each participant regardless of disciplinary background and training is free to experiment.

6.3 Invested practitioners

In addition to the observations previously noted, the Scrapyard Challenge provides the opportunity to explore several implicit issues contained within the workshop experience. Among these are critiques of "throw-away" culture, and the uneven distribution of knowledge and practice in technology and arts education.

The large amount of waste collected for a Scrapyard workshop presents an excellent opportunity to discuss the need for proper recycling and sustainable development for the technology industry. Also interesting is the opportunity to emphasize the tension between local and global flows of goods and services, which contribute to the particular type of, refuse found in different cities or regions. While classes such as the MIT Media Lab's "How to Make (Almost) Anything" focus on creating technologies from scratch (and require large infrastructure and sophisticated equipment) a Scrapyard Challenge approach operates with low costs and minimal resources. While surely not as technically impressive, the Scrapyard Challenge still provides the necessary environment in which design, analysis, and knowledge sharing can take place. The resulting prototypes, while not polished, still show great creativity and promise.

The language of the Scrapyard experience borrows from popular culture and "low art". While the jargon and specialized knowledge required for fluency within an arts and technology setting might intimidate newcomers, the Scrapyard Challenge familiarizes the experience of physical computing and interaction design into a cultural context that many can easily relate to and understand. Through capitalizing on the ethics and actions of subversive groups the workshop transmits these values into an open yet structured environment where experimentation is made safe. The non-judgmental nature of the workshop and the emphasis on process rather than product allows individuals to play the role of a confident expert whose resourcefulness and ability to creatively re-imagine materials provides its own reward. For novices who have never worked with electronics, the satisfaction of creating a musical instrument out of a discarded speaker, a broken desk lamp arm, twine, and hot glue, carries a sense of accomplishment and thrill. For the advanced participant, flinging away the "best practices" advocated by a discipline, and tinkering for enjoyment provides a welcome creative break from the status quo.

7 Conclusion and future work

Recent experiments in incorporating the Scrapyard Challenge into educational settings have yielded interesting results. In a class titled "Electronics Playground," elements of the Scrapyard experience were integrated into the class syllabus. Activities such as re-mapping the interaction of a non-electronic object and the actual MIDI Scrapyard Challenge itself were paired along more traditional educational approaches such as lectures and technical labs. While this paper will not discuss the class profile at length, initial impressions point to the need to address the balance between the unchecked enthusiasm generated by the workshop and the sustained energy needed to engage in a controlled design process. Supplementary activities must encourage focused attention and directed development. Within a classroom setting the Scrapyard functions best as an early "warm-up." Once participants have a condensed experience of the design process, further explication can proceed at a more standard (school semester or quarter) curricular pace.

Future versions of the workshop might include differentiation into other areas previously suggested such as sustainable design and renewable energy. Expansions of the workshops, to include lengthier terms of engagement as well as incorporation into other classes are possible directions. In the fall 2005 semester, a variation of the DIY Wearable Challenge will be incorporated into a class titled "Social Fashioning" at Parsons School of Design, which will focus on fashion, technology, and social relationships.

It is also encouraging to see other classes such as "Systems" (currently taught at the Interactive Telecommunications Program at New York University) begin to emerge with a similar orientation towards cast-off electronics. In academic circles, "hackability" in design is drawing increased attention (Galloway et al. 2004). In combination with globally oriented and socially responsible design endeavors such as "How Stuff is Made" a Scrapyard-based curriculum could prove to be a compelling component of a design and technology arts curriculum.

While not advocated as a complete design methodology, the Scrapyard approach allows for fluidity and intuitive response to one's materials and environment. As evidenced by the workshops which have run internationally there is value to the approach when applied within an art and technology setting. As a component of a structured class syllabus the Scrapyard principles and methodology may prove be a powerful and flexible asset within a learning environment.

8 Links

Basic Stamp: http://www.parallax.com

BasicX: http://www.netmedia.com

Electronics Playround: http://www.personaldebris.com/playground/

EZIO board: http://www.ezio.com/

Handyboard: http://www.handyboard.com/

How to Make (Almost) Anything: http://www.fab.media.mit.edu/ How Stuff is Made: http://www.xdesign.ucsd.edu/howstuffismade/

Lego Mindstorms: http://www.legomindstorms.com

Scrapyard Challenge Workshops: http://www.scrapyardchallenge.com/

Systems: http://www.stage.itp.tsoa.nyu.edu/~tvh204/systems/index.html

Teleo: http://www.makingthings.com/teleo.htm

9 About the authors

Katherine Moriwaki is an artist and researcher investigating clothing and accessories as the active conduit through which people create network relationships in public space. She received a Masters from the Interactive Telecommunications Program at NYU and was formerly a Design Fellow at Parsons School of Design where she co-developed and taught the groundbreaking collaboration studio "Fashionable Technology." Currently a Ph.D. Candidate in the of the Networks and Telecommunications Research Group at Trinity College Dublin, her work has appeared in IEEE Spectrum Magazine, and numerous festivals and conferences including numer.02 at Centre Georges Pompidou (02), Ubicomp (03,04), Transmediale (04), CHI (04), ISEA (04) and Ars Electronica (04). She is a 2004 recipient of the Araneum prize from the Spanish Ministry for Science and Technology and Fundacion ARCO.

Jonah Brucker-Cohen is a researcher, artist, Ph.D. candidate, and HEA MMRP fellow in the Disruptive Design Team of the Networks and Telecommunications Research Group (NTRG), Trinity College Dublin. He worked from 2001 to 2004 as a researcher in the Human Connectedness Group at Media Lab Europe. He received a Masters from the Interactive Telecommunications Program at NYU and spent 2 years there as an Interval Research Fellow creating interactive networked projects. His work and thesis focuses on the theme of "Deconstructing Networks" which includes projects that attempt to critically challenge and subvert accepted perceptions of network interaction and experience. He is co-founder of the Dublin Art and Technology Association and a recipient of the ARANEUM Prize sponsored by the Spanish Ministry of Art, Science and Technology, and Fundacion ARCO. His writing has appeared in numerous international publications including Wired Magazine, GIZMODO, Rhizome.org, Print, and I.D. magazines. His work has been shown at events and venues such as DEAF (03,04), UBICOMP (02,03,04), CHI (04) Transmediale (02,04), ISEA (02,04), Institute of Contemporary Art (ICA) in London (04), Whitney Museum of American Art's ArtPort (03), ZKM Center for Contemporary Art (04), Ars Electronica (02,04) and others.

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