CREATING NEW USES FOR RECYCLED LAPTOPS

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1. ABSTRACT

Electronics are central to a global economy that has reduced poverty and improved the quality of life for many world-wide. The increased demand for electronic devices has created a growing surplus of electronic waste and disposal is a growing problem nationally and internationally. A particular problem is laptops used by government agencies and various data sensitive industries typically have their hard drives removed and destroyed/erased before being reclaimed for recycling out of concern for proprietary data of a secretive, sensitive and/or personal nature falling into the wrong hands. Many potentially useful laptop electronics are land filled or destroyed instead of being reused. By some estimates only 2% of "recycled" personal computers are ever used by someone else. Responding to this challenge and supported by a grant from Dell, the author and his research colleagues challenged teams of advanced students from engineering, design and marketing to create innovative new uses for discarded laptops and their components. The brief focused on the needs of subsistence farmers in developing regions of the world. Results included a number of innovative designs ranging from lighting to crop monitoring. The project results and design envisionings address a number of critical farming needs and demonstrate how innovative thinking by bright young minds can extend product life cycles through refurbishments and component reuse.

This session will explore the growing problem of discarded consumer electronics and how collaborative design education and research involving innovation teams of students and faculty can begin to address this growing problem. Presented will be the results of a cross-disciplinary research project supported by Dell, Inc. exploring new uses for discarded laptop computers. The semester long experiential study was conducted in the Product Innovation Research Laboratory (PIRL) at the University of Illinois at Urbana-Champaign. A sustainable design innovation strategy was embraced throughout with a goal of demonstrating how we can change our existing cradle to grave manufacturing and distribution system to a closed-loop cradle-to-cradle model.

2. ELECTRONIC WASTE

Discarded laptops are part of the growing national and international problem of discarded end-of-life electronics referred to as e-waste. Well publicized in recent years thanks to sluicing by Jim Puckett, executive director of the Basel Action Network, who first brought attention to the toxic global trade and dumping of e-waste in China and for over two decades has campaigned against the global trade of e-waste. In the US e-waste is the fastest growing component of municipal solid waste stream.[1] Included in e-waste along with lap tops are televisions (CRTs, flat-panel screens, projection equipment, and others), hard copy devices such as printers, fax machines, copiers, scanners, multi-functional devices) and mobile devices such as cell and smart phones, PDA's and pagers. Electronic waste is our collective problem. Individuals and small businesses, large corporations, institutions, governments and OEM's all contribute. As industrial designers, we in particular should be concerned if not ashamed for our contributions to the current paradigm of creating products that encourage a throw away mentality by playing to consumer desires based on artificial needs of status and styling. Mounting piles of landfilled electronic waste is not a legacy our profession can take pride in. We can and should do more as professional educators and practitioners to use our talents to address this growing problem.

2.1 A GLOBAL PROBLEM

The magnitude of this problem is underscored by the following statics. Global tonnage of e-waste currently exceeds 50 million tons per year and is rapidly increasing. 80% of this is exported to Asia according to the Consumer Electronics Association. In the US, 85% of e-waste is landfulled or incinerated.[2] A staggering 4,000 tons per hour worldwide is lost.[3] In India alone, e-waste is projected to increase by between 200 and 500 percent the next few years.[4] The volume of e-waste from the developing nations will soon exceed that of the West according to Eric Williams, Associate Professor at the Golisano Institute for Sustainability at Rochester Institute of

Technology. Consider cell phones. We purchase 150 million annually and throw away 130 million. On average we purchase a new one every 18 months, according to the U.S. EPA. It is astounding that by some estimates only 2% of used personal computers are ever again by someone else.[5]

The reasons we generate so much e-waste are fairly obvious but worth mentioning. A major contributing factor of course is the need to satisfy our techno-egos, and our desire to have the latest and greatest. The vast majority if discarded electronics are in working order when replaced. Cheap and disposable products that are not easily repaired are major factors as well. Fully 1/3 of laptops can fail within three years.[6] Of course new technological advances such as conversion to digital and HDTV are causal factors as well. Regardless of the reason, the lost value when electronics joins the waste stream is staggering. When considering a computers life cycle energy around 80% is attributed to manufacturing and 20% during use.[7] Producing 50 pounds of computers and monitors requires the use of 530 lbs of fossil fuels, 48 lbs. of chemicals and 1.5 tons of water.

2.2. REUSE ADVANTAGES

By reusing these products and/or their components and materials according to William McDopnough and Michael Braungart in "The Upcycle" we can prevent the up to 1000 chemicals used in their manufacture along with embedded toxins and carcinogens from entering the waste stream and environment. Through reuse we can extend useful life and save the embedded life-cycle energy required to manufacture new equipment plus the expensive but often hidden environmental costs needed to mine, transport and process virgin materials. Computer reuse has been shown to generate many more jobs than disposal. [9]

Laptops returned for recycling pose particularly challenging problems. Although improvements are being made, most are not well designed to facilitate disassembly and reuse and many entering the recycling stream from government organizations, hospitals, banks and other information sensitive industries are often are returned with their hard drives destroyed or missing. Through discussions with Dell, Inc. it was determined that the problem of what to do with these laptops missing there hard drives would pose a challenging problem for an interdisciplinary team of faculty researchers and students at the University of Illinois at Urbana-Champaign to tackle. The project was conceived as a socially responsible entrepreneurial design exercise to avoid appearances of competing with Dell's existing and well established and effective international recycling network business. A team of research faculty and advanced students from engineering, marketing (business and advertising) would address this problem by looking for socially responsible solutions focusing on design entrepreneurial opportunities for reuse in developing countries. A grant from Dell, Inc. provided the fuel, resources and incentive for the subsequent collaboration, Partners included industrial design colleague Assistant Professor Cliff Shin, Brian Lilly, engineering entrepreneurship program and Joy Scrogum and Nancy Holmes research scientists at the Illinois Sustainable Technology Center's (ISTC's) Sustainable Electronics Initiative and the Product Interaction Research Lab in the School of Art and Design Industrial Design program at the University of Illinois in Urbana-Champaign.

3. PRODUCT INNOVATION RESEARCH LABORATORY

A bit of history concerning the Product Interaction Research Laboratory (PIRL) may be in order. For over a decade, the Product Interaction Research Laboratory (PIRL) (formerly called the Product Interaction Research Laboratory) at the University of Illinois at Urbana-Champaign has facilitated interdisciplinary partnerships between industry, government and academia in response to the mission / vision and research objectives and activities of the University of Illinois strategic plan for research. Within these objectives is the mandate to increase the level of research and link the College with the diversity of inter university competencies. PIRL is an interdisciplinary research effort that fits the University of Illinois leadership vision of being a premier technological institute of the 21st century while integrating various units of the institute, building on technological strengths and providing a return on investment.

Housed in facilities in the Industrial Design Program, PIRL collaborates with other University of Illinois faculty research partners such as those in the College of Business and the College of Engineering. The collaborative research team members assembled depends on the nature of the research opportunities responding to industry needs.

PIRL is the means by which research and education are comingled in the laboratory. Linking design, business and technological resources, the lab has successful history of collaborative research studies for major corporations. The rationale for the lab is that while the University is technology driven with one of the top engineering schools among Tier One research universities, a user centered customer focus is increasingly necessary for market success. Successful companies must innovate products that delight customers. PIRL core user-centered disciplines include industrial design, marketing (business and advertising) with appropriate engineering technological resources supporting the project briefs. Students are invited to participate based on faculty researcher's recommendations and receive independent study credit. Research funds provide for all project materials and related costs.

3.1. COURSE STRUCTURE

Dedicated advanced graduate and undergraduate students invited to participate receive credit through an independent study course. This arrangement facilitates student flexible schedules and credit hour needs. Through course pedagogy, student design teams receive instruction in the dynamics of collaborative product development with a global perspective and current and new theoretical approaches and methods. Recent projects have involved students of 9 different nationalities.

3.2. RESEARCH OPPORTUNITIES

Interdisciplinary research opportunities for PIRL are wide spread. Examples of past deliverables for major corporations include smart product and technology transfer studies; user needs methodologies; design evaluation; start-up technology commercialization venture support; strategic product and systems concepts, new product innovation and marketing and human factors verification studies. Faculty researchers that will be involved have completed research for major corporations.

Co-PI Professor Cliff Shin working with students on New life for Laptops porject

Research funding for the laboratory and course is primarily through industry sponsorship. University research protocol as regulated by the University's Office of Contracts and Grants that prepare research budgets and monitors compliance with State and Federal regulations. Dispensation of overhead is in accordance with university regulations and at the discretion of the College of Fine and Applied Arts Office of the Dean. As Director, I manage the day to day operation of the laboratory as part of my university research obligations. One or more faculty researchers are invited as co-principal Investigator(s) on projects. Principal investigators identify research funding opportunities, develop research proposals, manage projects, issue invitations to top advanced students and oversee research and reporting deliverables. Research teams of advanced graduate and undergraduate recommended by principal investigators are invited to participate on sponsored projects.

The appropriate skills and tools at the University are assembled on a collaborative research team in response to sponsor research needs. Advanced research tools will be accessed through interactions with existing research laboratories and the sponsor. A collaborative product development graduate course and laboratory will provide

the creative interactive research and environment to conduct projects. Deliverables will include sponsor solutions, process research and instruction/learning.

New Life for Laptops: an entrepreneurial design exercise

The PIRL New Use for Laptops: An Entrepreneurial Design exercise during the 16 week spring semester 2012 focused on developing ideas to extend the useful life of laptops such as those returned through Dell's recycling program. Dell advisors on the project were John Pflueger PhD, Environmental Strategist and Mike Watson, Director of Compliance, Asset Recovery and Recycling and their Take Back program. Guidance and feedback was provided at key milestones by these sustainability and recycling experts and faculty researchers. The goal was to identify knowledge gained from core disciplines as well as from other University of Illinois interdisciplinary programs. A team of top 15 graduate and senior undergraduate students from industrial design, engineering and marketing (business and advertising were invited to participate on the project. (A list of participants can be viewed on the Power Point credits page http://www.istc.illinois.edu/about/SeminarPresentations/20120508.pdf) Two industrial design faculty and an engineering colleague directed the effort. Industrial Design graduate student Ehsan Noursalehi who had experience work on several previous PIRL projects was asked to help manage the day to day PIRL research activity. After an initial phase of explorations, the team decided to concentrate their research phase on identifying opportunities in agriculture, particularly in developing regions of the world, where laptops and and/or their components might be use to solve real problems. The focus on agricultural applications was also because of the University's rich heritage as a land grant institution emphasizing agriculture along with the mechanical arts and a continuing strong agricultural research focus and faculty research expertise. The Morrow Plots est. in 1876 (http://cropsci.illinois.edu/research/morrow) on the grounds of the university are a National Historic Landmark and the oldest continuously farmed experiment fields in US. With research narrowed to the search for agricultural application, four "microteams" conducted an initial research phase that included an extensive literatures searches and interviews with campus research experts, especially those with hands on experience in developing nation agriculture. Each team was composed of members from design, and marketing and engineering. A wide variety of concepts in nine separate categories were initially developed and grouped into categories at the systems level that dealt with issues of durability and replacement in association with heavy farm equipment, enhancing communications by using wireless routers and others. Using laptop components for GPS tracking of equipment and field chemical application was another. Another category included employee and data management as well at those involving issues security to improve communication and monitoring. Education and entertainment (for people and farm animals) concepts were other categories of ideas. Quick sketches of all nine concept category ideas can be viewed at http://www.istc.illinois.edu/about/SeminarPresentations/20120508.pdf.Through an iterative give an take process including presentation to Dell, focus was narrowed to farming needs/problems in several key opportunity areas championed by each micro team. These included:

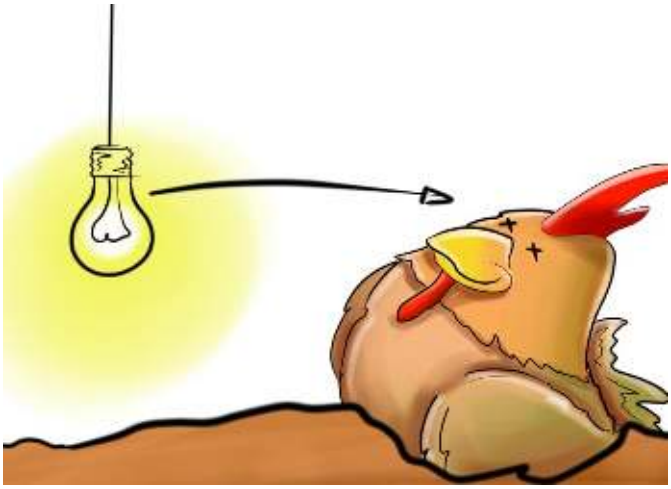
- Egg production
- Irrigation
- Education and training

Development Phase. During the development phase, the microteams scheduled meetings as needed and networked on their own during the week. At a regularly schedule weekly meeting with all teams, teams reported to faculty researchers and each other on progress showing idea development. All ideas were recorded in sketch form and with notes. This iterative process involved the important step of taking ideas back to research faculty in agriculture to discuss the appropriateness of ideas and solutions. This process worked like an inverted pyramid with many ideas slowly refined and wheedled down to those most promising concepts were generated. This process resulted in many ideas and recommended concepts that follow. While promising, the feasibility of these concepts is not certain and will need to be examined in further in subsequent research. Like much research, more questions were raised that answered. A parallel comparison is refurbishment of an old building where new problems frequently a rise when you tear into it. The sustainable issues are highly complex including complicated logistics of procurement, recycling, redesign, delivery and maintenance to name a few. That said, the concepts generated in the project illustrate the potential to extend the useful life of discarded laptops. The final concepts recommended by the four micro teams were:

- Egg production—LCD monitors and processors to facilitate and manage egg production
- Irrigation—automated drip irrigation system
- Education and training- educational kiosks on farms and one “used” laptop per child

These ideas can be viewed in an archived webinar and presentation slides of this project presented by student participants Ehsan Noursalehi, engineering and Industrial design and Kristina Schiller and Rick Matukro, marketing at http://www.istc.illinois.edu/about/SustainabilitySeminar20120508.cfm. for more project details. Two of the more interesting concepts are Egg production and Irrigation that will be discussed brifly here..

Egg Production- LCD monitors and processors to facilitate and manage egg production. Research highlighted the importance of proper light management critical for efficiency and safety in egg production. Farmers have to constantly manage lighting that is influenced by seasonal variations, circadian rhythms and other factors. Efficiency and foul welfare can be adversely affected. There is an opportunity to use laptop components to automate light management. This concept utilized laptop screens and processors for light and light management. LCD’s are arrayed and controlled by one main hub.



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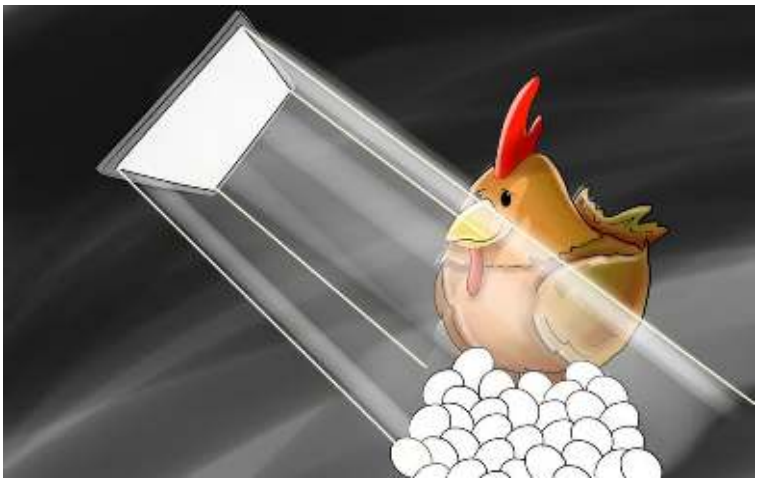


Automated Drip Irrigation System. The automated drip irrigation system is envisioned to use laptop components and solar power to better manage water resources in arid farming areas of developing nations. This concept is based on an existing low cost system now in place developed by Drip Tech, The need to provide facilitate more efficient use of water in arid regions is underscored by the fact that 70% of the world's poorest people, a staggering 900 million, are small-scale farmers. Obviously, access to water can increase food production and create income opportunities. Drip irrigation is the most efficient way to grow crops in scarce water areas in developing countries. The amount of water needed to flood one field can provide sufficient water for 10 fields is drip irrigation is used.

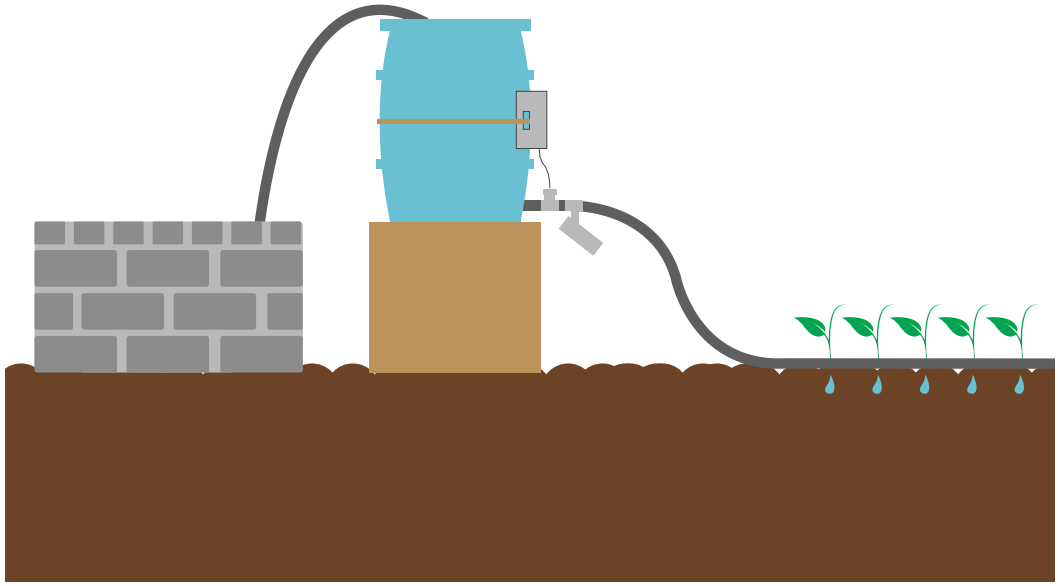
www.ideorg.org/ourtechnologies/dripirrigation.aspx , retrieved 2013-16-01.

drip TECH

http://www.driptech.com/product.html http://greenbusinessgo.com/drip-tech

Blog.greenmountaincoffee.com/amada/irrigation-for-food-gardens-in-tanzania

Drip Irrigation Final Design Concept.



Drip Irrigation Schematic.

The system as envisioned utilizes a computer control unit attached to a container. Symbol graphics are used, promoting ease of communication while avoiding language-literacy issues. The components of two laptops are used for this system.

Education and Training Education and training- educational kiosks on farms

This concept concentrates on education of children and involved a two pronged approach. One is creating a series of information kiosks from laptop components that would be situated at farms popular/accessible for students visits and field trips. This is envisioned as a ”one-stop” education portal providing how-to informational videos delivered through a subscription service. The second prong is envisioned to provide used laptops for children in need areas through a program such a the Dell Outlet (http://www.dell.com/learn/us/en/22/campaigns/outlet-green-usdfh) and by partnering with schools, and philanthropic and service organizations. Students would be supplied with laptops equippmed with video tuktorials, word processor and data collection hardware. Each laptop would be preloaded with as many as 30 “how-to” videos. If 2,000 school participate at 50 units per school this would utilize 1,000,000 refurbished laptops each year. Both the kiosk and laptop ideas could also be used for communication with workers including education and training and would provide timely seasonal weather information, instructing in safe and proper use of equipment (irrigation systems and others), an underscore good farming practices plus other information. This one “used laptop per child in addition to their use for education kiosks would promote continued viable use for old laptops.

SUMMARY

While many more questions were raised during this research project than answered and much work remains to be done, the project was a successful in many ways. Students gained valuable experience in team dynamics and leadership. They began to more fully understand the complex issues involved in sustainable design and to the feasibility of addressing the current wasteful paradigm by envisioning ways to extend the useful life of discarded laptops, The project while no providing definitive answers, illustrated the potential do so to the client and researchers and illustrated how we can begin to change the current wasteful cradle to cradle paradigm to a more sustainable one. As faculty researchers, we continued to learn about the intricacies of collaborative pedagogy and teaching delivery methods that always seem to change. For all involved, the project underscored the need to change the current wasteful cradle to cradle paradigm and importance of continuing to use our existing electronics as long as possible, thereby delaying their ultimate demise in a landfill. For those of you interested in repairing and/or upgrading or extending the use of your old electronics there is much useful information available on line. Check out how you might use an old computer to support biomedical research on Folding @ home (FAH or F@h) and if you are of average repair intelligence the wealth of information on the I Fix it website may be for you. Their web site offers free downloads on how to repair almost all laptop models as well as other electronics. "11 Uses for an Old PC" at pcworld.com [10] provides much viable information as well. There is also much chaff and silliness available such as tongue in cheek if humorous examples such as those on Dark Roasted Blend's website of using old laptops for Kung-fu practice. On a personal note, although my ten year old Dell laptop gets heavier the older I get it and it is bulkier, way heavier and slower and less attractive than more advanced equipment, it still functions well and keeps my hands warm in winter. I also want to encourage my colleagues to continue to emphasize the principles of sustainable design education in there lesson plans. The Ocala program that education friends and colleagues Steve Belletire and Phillip White developed are good source of materials for studios and lectures. Another excellent opportunity for a class projects dealing specifically with the issue of sustainable electronics the International Sustainable Electronics Competition (SEI) (www.ewaste.illinois.edu). An outgrowth of a research project on electronic waste in 2009 and originally referred to as the E-waste Design Competition the completion has been upgraded and streamlined so check it out if interested. The competition is coordinated by the Illinois Sustainable Research Center and registration is now open and there are sponsorship opportunities as well. The idea of e-waste focused design assignment is not glitzy at first blush, but therein lies the challenge. How can it be made so to make continued use a viable option? The SEI Resources link (http://www.sustainelectronics.illinois.edu/resources) provides a rich array of in-depth articles, research and information on sustainable electronics. Electronic waste is is a very real problem and one we must tackle head on as a profession. I encourage you to inform yourselves and to continue to educate your students in the need for creative solutions to this growing problem. To quote Michael Dell, CEO of Dell, Inc. "...we're living in the ReGeneration, which includes people of all ages throughout the world who want to make a difference in improving the Earth we all share." As colleagues, I urge you to continue to use you and your students to use your collective talents to help others make a difference.

REFERENCES

1. http://www.epa.gov/epawaste/conserve/materials/ecycling/docs/fullbaselinereport2011.pdf Retrieved 2013-01-14

2. Press Release, "Basel Conference Address Electronic Wastes Challenge. "November 27,2006., United Nations Environment Programme (UNEP). Available at:

http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=485&ArticleID=5431&l=en

3. .Network Design on Reverse Logistics of Electronic Wastes Recycling. Xiangru Meng, Proceedings of the IEEE International Conference on Automation and Logistics, Quingdao, China. September 2008, p. 2110, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=4636512&tag=1 accessed January 21, 2013.

4. UN News Center news release: February 22, 2010 accessed at http://www.un.org/apps/news/story.asp?NewsID=33845&Cr=waste&Cr1#.UP2uHGfsZ8E

5. http://www.dosomething.org/actnow/tipsandtools/11-facts-about-e-waste, Facts and Figures on E-Waste and Recycling" Electronics TakeBack Coalition, retrieved January 20, 2013

6. http://www.squaretrade.com/pages/laptop-rliability-1109, retrieved 2013-01-16.

7. Energy Intensity of Computer Manufacturing: Hybrid Assessment Combining Process and Economic Input-Output Methods, Eric Williams, United Nations University, Environmental Science and Technology, Vol. 38, No. 22, Environmental Science and Technology p. 6166-6174, retrieved 2013-01-16.

8. Treehugger.com/clean-technology/crazy-e-waste-statistics.

9. Institute for Local Self Rliance, “Recycling Mean Business,” 1987.

10. http://www.pcworld.com/article/209079/11_uses_for_an_old_PC.html