Interactive human-powered products: A literature review

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Abstract. The scope of the research is to investigate how associated research of interaction- as a mean of using human kinetic energy- and human-powered product (HPP) design development can raise the awareness of energy use in everyday life. This paper overview the literature reviews of research in the area of alternative energy system especially focusing on human power products. It will include research projects using interaction design as tool for increasing the awareness to energy use, and examples of real time designed products that practices human-powered system in various different ways. Furthermore, an illustrated map of interaction matrix categorizing different human-powered products (power applications) will be presented.

Introduction

Investigating reduction of energy consumption in consumer products is a fundamental proposition. However, there are still obsolete products being produced and the competitive markets are encouraging consumers to increase their consumption [1]. These markets have led consumers to live in a lifestyle where they subconsciously use excessive amount of energy through use and consumption of everyday products. Although many products' eco-efficiency has greatly improved and become lighter, the statistics show that aggregate consumption of environmental resources has continued to grow. The environmental burden of each product has diminished, but their quantity has increased disproportionately [2]. There have been attempts to solve this over consumption of energy. Technological developments such as photovoltaic, wind turbines, biological renewable energy are proposed as new resources where they alternatively supply energy through grids, through homes and through electronic products.

In the last years, there has been an increase in portable electronic devices, increasing mobility, and the need for communication and information [3]. The majority of these products are powered by batteries, therefore, self powered products are proposed as alternative option to reduce energy consumption. In other words, no longer rely on the use of power from the grid to perform its functionality. Interactive human-powered products (HPPs) such as hand crank radios compare favorably in energy generation terms to solar and natural energy generators due to factors such as cost, manufacturing methods, materials, complexity, and limited interactivity.

The scope of this research is to investigate how associated research of interaction- as a means of using human kinetic energy- and HPP design development can raise the awareness of energy use in everyday life. This paper will review the literature of research in the field of human powered products and illustrate examples of researches investigating applicable human-powered systems for consumer products. It will include research projects using interaction design as tools to increase the awareness of energy use, and examples of real time designed products that practice human-powered systems in various different ways.

Over Consumption of Energy

The invention of power unit has dramatically changed human life. It has influenced our industry to produce in mass, accelerated, time saving and sometimes enabled us to travel in longer distance. Today, people live in a life style where we consume ‘cultural energy services’, in other words, culturally meaningful services that happen to depend on a supply of gas, oil, or electricity [4]. As many daily products evolved with having electrical functions, the users were rewarded with the convenience that reduces the labour required when using the products. Proliferations of these products are making people to involuntarily consume energy through use of these daily products.

Fig. 1: Diagram illustrating how products became electronics.

Fig. 1, showing diagram of how products has transformed into electronics by comparing simple ‘before’ and ‘after’ transition. In this diagram, it is interesting to find that the invention of the motor system has widely influenced the product development and the battery system provided the function of mobility. The sequence of new product developments and practices are embedded in every society. As a story of how innovation works, this much-criticized account supposes that the link between new technologies and new forms of demand has to do with the psychological fabric of society and the relation between different types of risk taking [4]. However, while people pursuit for these novelties reflecting as convenience through use of daily products; humans may have self-consumed their own skills and those memories of using their own energy. Over the years, people have been indoctrinated into believing that products that have power plugs are better than among those don’t have plugs.

As mentioned in the introduction, the eco efficiency of electronic products have increased, consumes less energy. However, the consumption of environmental resource is still rising. This phenomenon is described and so-called as the ‘rebound effect’ by E. Manzini. According to Manzini, this is a phenomenon by which choices which had been considered positive for the environment have in fact generated new problems once put into practice [2]. Therefore, it is an insuperable problem that this over consumption energy may not be only solved with new products and technology. Question of how to make people to be conscious about their energy consuming behavior is perhaps more basic to the problem. There is an opportunity for design researchers to influence sustainable energy consumption behaviors and raise awareness to over consumption of energy through (re)design of future products. People will chase for taking risk of new novelties of products by instinct. It is important now to redirect and find what good valued novelty to embed in the design process of product development.

Why Human-powered Products?

As mentioned from previous chapter, humans began to gradually less use their own muscle since the invention of powerful motors and as electricity became more common in use. In reality, humans emit energy from everyday behaviour. As the eco efficiency of each electronics increase, as they consume less powering energy, the substitutability of using human power system into these products become more realistic.

Leading research group in this research field will be the PES (Personal Energy System) laboratory at the Delft University of Technology. The group aims to find alternatives for the increased use of batteries in portable energy products, focusing on the application of renewable energy sources in consumer products. Recent measurements from this group show an increase in energy density of new human-powered energy systems. Their research has concluded that the environmental pay-off of the use of human power will even be higher [5]. Arjen Jansen who has conducted numbers of human-powered system related research in this group describes three benefits of human-powered energy system [5]. They are as follow:

- Material benefit – do not consume energy from non-renewable sources during use-phase of the life cycle.
- Immaterial - convenience of using the human power product would be a fact that it is always available.
- Emotional; human-powered products enhance the quality of life by making the consumer feel environmentally pro-active

The other benefit of the human-powered products is the interactivity in use. It is a way of communicating to user for an environmental benefit of using your own energy as alternative power source which is a clean energy. The interactivity of power generation in HPPs is interpreted as educational intervention, communicating with people to appreciate what our body can do. It is also important to make people conscious about the energy generation during use phase otherwise they will loose the purpose of its influential learning process. This shows the opportunity for designers to facilitate the learning process through (re)design of products and through designing its interactivity in use. However, there is still a big challenge. How do we design in a way that it does what it meant to do?

There has also been research carried out in the field between interactivity and human-powered product conducted by global company such as Sony. They have been continuously investing the concept design practices for sustainability. It has been the biggest challenge to persuade users to apply certain kinetic energy when interacting with human-powered products. Sony is seeking ways to generate energy as user play with the devices, adding aspects of fun, playfulness, motivation from curiosity, ambiguity and unusual practices in use. They believe that by using such devices, they will enhance the life value more by having a sense of social consciousness and ecological values. One of Sony's products include the Spin N' Snap (fig.2) digital camera that is charged up by placing two fingers in two separate holes and spinning it around a few times to allow a charge [6].

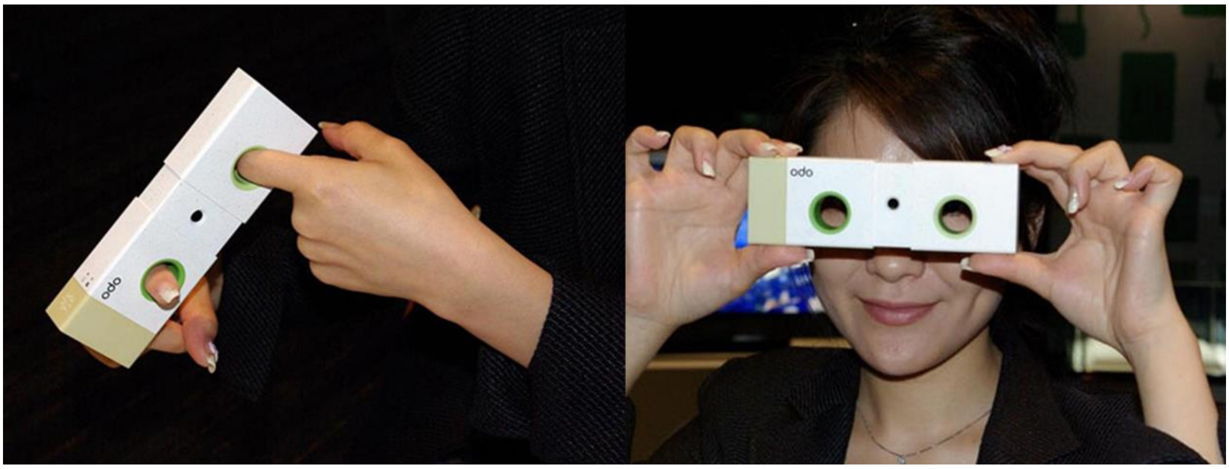

Fig. 2: Sony Odo project, Spin N' Snap digital camera [6].

Energy Generation Methods

The motivation of this research originated from projects undertaken at Nottingham Trent University in 2008 named '+' and 'X^2'. The project '+', meaning that it requires *direct* human kinetic energy interaction, suggested a lighting system with human-powered generator embedded. The final prototyped design performs to light 5 super bright LEDs for 5 minutes from 3 pulls of cord connected to the generator. Second project named 'X^2', fig. 3, expresses the meaning of one energy effecting into two functions. It is a design solution that manipulates *indirect* human kinetic energy into functional power, suggesting concept product that utilizes the human walking energy into chargeable electricity for mobile electronics. Both projects have emphasized the need of further research towards the field of interaction design in relation with free energy generation.

Fig. 3: Project 'X^2'.

The one challenge for interactive human-powered products will be how to reduce the power generating labor avoiding it from being fatigue. The Playpump, fig. 4, is an interesting design example, although this design is not powered by electricity, consisting two functionalities from one physical kinetic energy. The purpose of this design is to give clean drinking water facility for those who didn't have the access. When children have fun spinning on the PlayPump merry-go-round, clean water is being pumped from underground into a 2,500-liter tank, standing seven meters above the ground [7]. The ‘fun’ feature is encouraging user to create the kinetic energy from its physical interaction. The labor of energy generation in this device is compensated by an increase in other forms of quality.

Fig. 4: Playpump [7].

Along with the study results of project ‘+’ and X[2]’, the research developed an Interaction Matrix (fig. 5) for human-powered products mapped by their application types. The linear axis represents the user interaction of *direct* (active) and *indirect* (passive) power generating applications where *direct* is also described as ‘force exertion’ by Jansen in his research [8]. The *indirect* concept of energy generation was also termed as ‘parasitic’ in other related literatures. Besides these two applications, the ‘fun’ application has been inserted in between. The purpose of this map is to differentiate and analyze types of interaction in human power products. It will also be used as tool to forecast the potential design space, and to categorize the future scenarios/ideas of human-powered products.

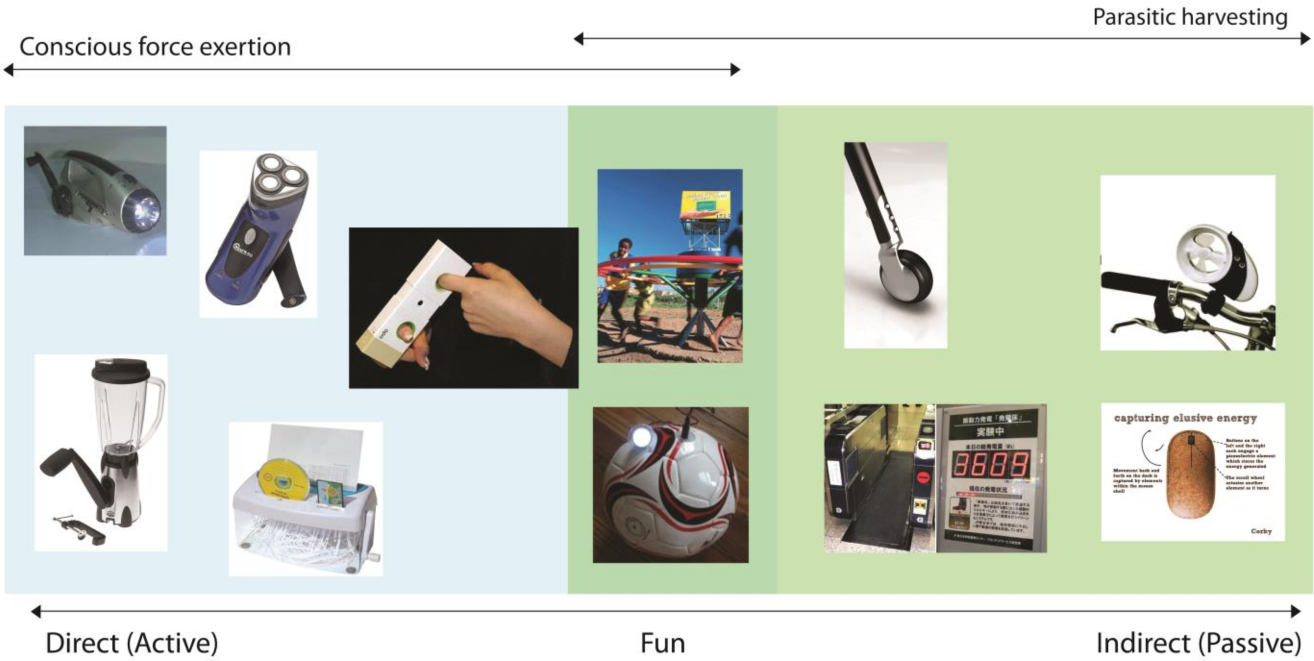

Fig. 5: Interaction Matrix in Human-powered Products.

Relevant Literature

The notion of associating interaction design into human-powered product research is urged by research work carried by Ramia Maze at the interactive institute Sweden. She carried out design research called STATIC, which investigates interaction design as a means of increasing awareness of energy use and for stimulating changes in energy behavior. The project considered energy as expressive material for design, where visibility and use are brought to the forefront in products, enabling people to have an increased awareness of, and control over, the energy in the things they use everyday. Moving beyond awareness promoted in information campaigns, her approach focuses on energy as a core aesthetic and functional issue in early stages of product design [9]. One of the critical design example is 'The flower Lamp', where it explored the design encouraging people to use less energy in their home. It is a display for electricity consumption, but not as in quantity number. If the house hold has a decrease in electricity use, the lamp rewards you by slowly opening up to "bloom". If, on the other hand, use is increased, the lamp closes back to original shape.

Fig. 6: Flower Lamp by Ramia Maze [9].

Arjen J. Jansen who conducted a number of research program at Delft University of Technology, his research focuses on the use of non-traditional forms of energy systems in consumer products, with an emphasis on human-powered [3]. His PhD work questions how human power can be a viable alternative to batteries in portable products. He has investigated the human body acts as an energy producer in different ways concentrating on muscle activities. He has presented four tasks of muscle activities such as push button, squeeze hand generator, turn handle, bike generator and estimated their maximum power generation. By combining the data of measuring four tasks of human power and the power consumption of portable consumer electronics, the project has showed number of opportunities for development of human-powered products.(refer to fig. 7) His other projects dealt with measuring 'critical power', testing threshold of fatigue of (dis)comfort level of human power application [8].

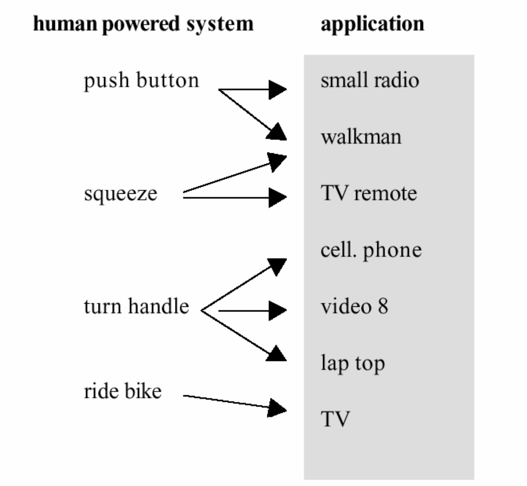

Fig. 7: Opportunities for human-powered products [3].

While Jansen's research focused on direct force exertion of human body parts, Joseph Paradiso from MIT Media Lab worked on human-powered electric devices in far sneakier way. The lab researched on harvesting from parasitic human powers. The idea is to generate power in an ancillary way while people are doing things like walking or typing, or to pick up energy from the body as it breathes, pumps blood and generates heat.(refer to fig. 8) The power might be scavenged indirectly from the user's everyday actions or might be intentionally generated by the user [10]. In the future, the research it will also investigate whether exerted force energy of human power or parasitic power harvesting is more adequate alternatives to consider towards raising the awareness of sustainable energy use.

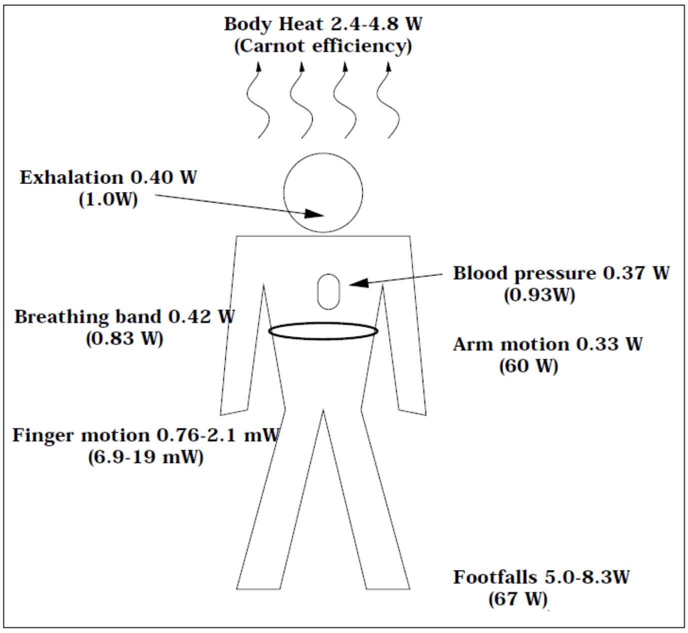

Fig. 8: Possible power recovery from body-centred sources.
Total power for each action is included in parentheses [10].

Examples in Reality

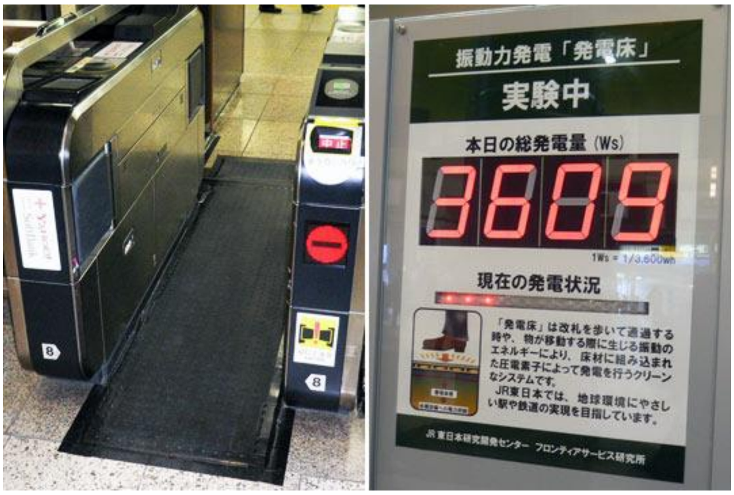

Fig. 9: Energy-Generating Floors to Power Tokyo Subways [11].

When East Japan Railway Company initiated the implementation of alternative power source, they have used their own user for energy Source. The company installed a new piezoelectric energy generating floor where the system will harvest kinetic energy generated by crowds to power ticket gates and display systems. Piezoelectric flooring is a technology with a wide range of applications that is slowing being adopted in alternative energy development. It is now widely being used in heavy crowded area such as a dance floor, or a tourist attraction. Although it is still parasitic harvest system, they have displayed a meter to show how much of energy is being generated. It is making people to feel environmentally pro-active.

Fig. 10: sOoccket [12].

Another example of using the ‘fun’ feature of generating human power is sOccket, fig.10. The sOccket is a soccer ball that captures the energy during game play to charge LEDs and batteries. After playing with the ball, the child can return home and use the ball to connect a LED lamp to read, study, or illuminate the home. The movement of the ball forces the magnet through a coil which induces a voltage to generate electricity where 15 minutes of play can light 3 hours of LED light.

Discussion and Conclusion

The interaction matrix map is most significant outcome after reviewing the related literatures. This map is expected to be use widely throughout the research especially in concept development stage. Jansen's research results will be utilized as head start data, being a knowledge base for selecting power options in the early design phase and scenarios/ideas development stage. Maze's critical designs showed an understanding of how interaction design can give educational intervention through design. Her work is highly appreciated in understanding how critical design practices can be a strategic method of making people to be involved and reflect upon discussing about the alternatives around the topic of energy use.

The questions on how interactivities in HPP can raise the awareness to sustainable energy have to be researched in detail. The next step of the research is to form a data mapping (behavioral mapping) of human activities and contextualizing daily interactions. The contents in this map, interactions and human activities for harnessing human power, will be referenced to generate new scenarios/ideas of conceptual human-powered products. The challenge for harnessing human power is finding ways to match various systems with the energy needs of any given machine. The HPP applicable technology and research data will be constantly monitored throughout the research.

References

[1] McDonough, W., Braungart, M: *Cradle to Cradle*, New York, North Point Press (2002)

[2] Manzini, E. & Jegou, F.: *Sustainable everyday: scenarios of urban life,* Milan, Edizioni Ambiente (2003)

[3] Jansen, A. J. & Stevels A.L.N.: *Human power, a sustainable option for electronics*, International Symposium on electronics and the Environment, 11-13 May, Boston, USA (1999)

[4] Shove, E.: *Comfort, cleanliness and convenience: The social organization of normality*. Oxford: Berg (2003)

[5] Jansen, A. J. & Stevels A.L.N.: *Human power; an environmental myth?* In; Horváth and Xirouchakis, Proceedings of the TMCE, April 13-17, Lausanne, Switzerland (2004)

[6] Sony *ODO*: http://www.sony.net/Fun/design/activity/sustainable/odo.html (Accessed 15 December 2008)

[7] *Playpump in Africa*: http://www.playplump.com (Accessed 1December 2008)

[8] Jansen, A.J. and Slob, P.: *Human power; comfortable one-hand cranking*, International Conference on Engineering Design, August 19-21, ISBN 1-904670-00-8, Stockholm (2003)

[9] Mazé, R.: *Occupying time: Design, technology, and the form of interaction***,** Stockholm: Axl Books (2007)

[10] Starner T. and Paradiso J. A.: *Human generated power for mobile electronics,* Low Power Electronics Designed C Piguet (2004)

[11] *East Japan Railway Company*: http://www.inhabitat.com/2008/12/11/tokyo-subway-stations-get-piezoelectric-floors/ (Accessed 30 July 2010)

[12] *Soccket*: http://www.soccket.com (Accessed 22 July 2010)