Elements of Consumption: an abstract visualization of household consumption

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Abstract. To promote sustainability consumers must be informed about their consumption behaviours. Ambient displays can be used as an eco-feedback technology to convey household consumption information. Elements of Consumption (EoC) demonstrates this by visualizing electricity, water, and natural gas consumption. EoC delivers three key components: (1) an abstract art piece, (2) a visual way to display data, and (3) to use an abstract art piece as a visual way to display data in order to persuade homeowners to conserve.

Keywords: eco-feedback, a-life, household consumption, sustainability

1 Introduction

The earth's resources are limited and conservation is the key to a sustainable future. In an effort to promote energy conservation and sustainability consumers must be informed about their consumption behaviours. One way to help people conserve is to enable them to monitor their consumption. There are three main types of consumption that can be or will be monitored in the near future: electricity, water, and natural gas. We look at artistic ways of displaying this consumption information so that homeowner can be informed. Our work is an eco-feedback technology [3] is called *Elements of Consumption* (EoC). EoC delivers three key components: (1) an abstract art piece, (2) a visual way to display data, and (3) to use an abstract art piece as a visual way to display data in order to persuade homeowners to conserve.

Eco-feedback most commonly comes in the form of a *in-home display* (IHD) which are usually very small and have an unaestheticly appealing look. Having a larger art piece that can convey, in an indirect way, household consumption strikes a balance between wanting to know (or be informed) but not wanting to have an intrusive hi-tech gadget as the focal point of a room. This approach is related to work by Bartram and Rodgers, who use an ambient art piece showing the three consumption types as a kitchen counter backsplash [1]. Wave-like strings of LEDs illuminated or dimmed according to aggregated levels of consumption, and discovered that while the embedded art piece as display is extremely popular with people, they like it best fully lit (meaning large consumption). This suggests

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that the relationship between the visibility and attractiveness of the art piece and the data to be mapped is complex and needs to be explored more thoroughly than the traditional information visualization approach of quantity=visual presence. In this paper we present two such explorations of one artistic representation that incorporates sophisticated behaviour and richer visual elements.

2 Background

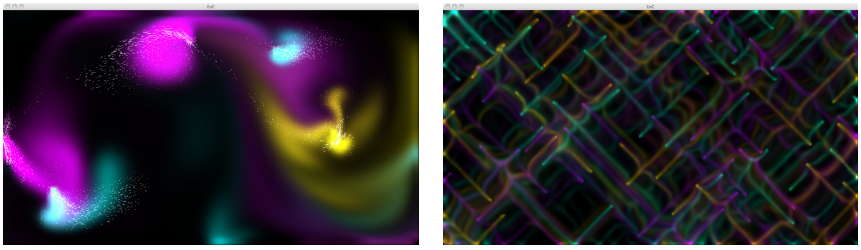
Much research has been conducted on persuasive computing, eco-feedback technology, and sustainable HCI which has influenced the design considerations and research goals of EoC [1–5]. Artistic ambient displays are a good candidate for looking at incentive and decentive based, high-level feedback which has been proven to motivate people to be more sustainable [3].

If we look at EoC and how it pertains to sustainable HCI we map it to the following genres: persuasive technology, ambient awareness, formative user studies (eventually), and pervasive, participatory sensing [2]. Being that EoC is an art piece, we indent to show that homeowners can have a *greater attachment* to these devices *intervening in the cycle of rapid obsolescence*.

He *et al* purpose the *Transtheoretical Model* [4] which they describes how *motivation* has a series of stages which many eco-feedack devices do not address. We feel that this point is rather mute because these devices (of which some can be purchased) would only ever be used by motivated people (in the *action* and *maintenance stages*). However, if these devices were mandated in someway as to be part of every house (such as a fire prevention sprinkler system) then there would be a need to provide a way to move a homeowner through each stage of motivation.

3 System Description

We have created two canvases: EoC Normal (EoC^N), see Figure 1(a); and EoC Inverse (EoC^{-1}), see Figure 1(b). Both canvases have *artificial life* (a-life) populations that are linked directly to consumption and are visualized using real-time fluid dynamics on an ambient display. Our system has four main technological pieces: (1) real-time fluid dynamics, (2) measuring consumption, (3) artificial life, and (4) ambient displays.



(a) The Normal Canvas (EoC^N) (b) The Inverse Canvas (EoC^{-1})

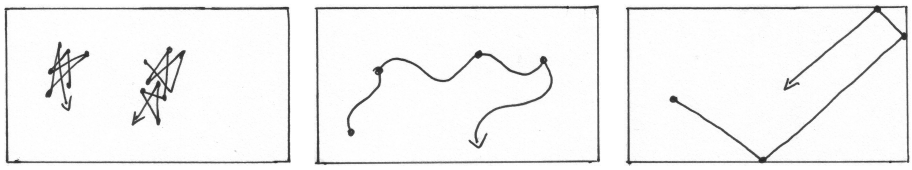
Fig. 1. Example screen-shots of how both canvases look when running.

Real-Time Fluid Dynamics Both canvases render visuals based on *real-time fluid dynamics*. We explore the idea of using different fluid colours and motion to represent household consumption of different types.

Measuring Consumption In order to measure consumption there needs to be a physical infrastructure in place to do this. Meters must be installed at each point of consumption (three meters, one for each consumption type that enters the house. There also needs to be local equipment installed that periodically collects this data from the meters and sends the data to a central data-store where the history of consumption can be aggregated. These aggregates form the stimulus needed for the a-life.

Consumption of different types are measured differently. For electricity, we measure power (or rate of consumption) in kilowatts (kW) and energy (or amount consumed over time) in kilowatt-hours (kWh). For water, we measure consumption rate in litres-per-minute (L/min) and amount consumed in litres (L). For natural gas, we measure in cubic-meters-per-hour (m^3/h) and gigajoules (GJ) respectfully.

Artificial Life We use a-life to visualize consumption within a home. Artificial life organisms receive stimulus from their environment in the form of consumption levels from a given household. Each species receives stimulus from its consumption type and secretes a distinct fluid colour. The a-life organisms themselves are not visible only the fluid that they secrete is.



(a) Electricity (b) Water (c) Natural Gas

Fig. 2. How the three types of a-life move around the ambient display canvas.

EoC^N compares the historical daily average versus the last 24 hours of consumption. The stimulus level will increase as the rate of consumption increases (creating new a-life); and *vice versa* (causing a-life to die). A-life organisms are distinguished in two ways on the EoC^N canvas: colour, and movement. Figure 2 depicts how a-life moves and Figure 1(a) depicts the colours used.

EoC^{-1} uses the current instantaneous consumption rate as it relates to the historical maximum demand. More consumption means less stimulus (or food) for a-life to live on and less consumption means more stimulus (i.e. the more a household consumes the less artificial life lives and is rendered to the ambient display). Unlike EoC^N, a-life organisms on the EoC^{-1} canvas are only distinguished by colour due to a considerable more amount of a-life used to emphasis the linkage with consumption behaviour. Figure 2(c) depicts how a-life moves and Figure 1(b) depicts the colours used.

Ambient Displays EoC can render visuals to an ambient display of different shapes and sizes. When thinking about energy conservation, we need to consider

whether the ambient display should be on when no one is home (wasting electricity). If the homeowner(s) is not home or if they are asleep then the ambient display should automatically be turn *off*. To do this, EoC will communicate with our *Home Occupancy Agent* [6].

4 System Implementation

Both canvases have been implemented as Windows and Mac screen-savers and as an iPad app using Cinder[3] and the MSAFluid library[4]. EoC receives real consumption data from meters installed in our smart home. Information is collected in near real-time (intervals of 1 minute). A stand-alone display version is currently being developed for our user studies.

5 Conclusions and Future Work

We have presented EoC an ambient displays that has a *low information capacity* and is *visually appealing* having *iconic image representations* [5]. We now must develop a short-term user study to look at the effectiveness of how information is conveyed. As well, we are planning to track EoC over a multi-year period to understand its impact on consumption habits. We need to understand if the persuasiveness of EoC has a longterm lasting effect. It could be quite conceivable that in the beginning EoC garners considerable attention but then the attention fades over time to the point where EoC is just another art piece hanging on the wall. As the creators of EoC we hope that this is not the case.

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[3] Cinder is a creative coding C++ library. See http://libcinder.org/.

[4] This is part of the Cinder library.