EnAct - A Cyber-Physical Environment Increasing Social Interaction and Place Attachment in Underused Outdoor Spaces

Figure 1: *EnAct*, configuration 1 – visualization of our initial concept in its intended testbed.

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Abstract
The emergence of social networks and apps has reduced the importance of physical space as a locus for social interaction. In response, we introduce EnAct, a cyber-physical environment installed in under-used, outdoor, public spaces. EnAct embodies our understanding of how a responsive, cyber-physical architecture can augment social relationship and increase place attachment. In this paper we critically examine the social interaction problem in the context of our increasingly digital society, present our ambition, and introduce our prototype which we will iteratively design and test. Cyber-physical interventions at large scale in public spaces are an inevitable future, and this paper serves to establish the fundamental terms of this frontier.

Author Keywords
Responsive environments; cyber-physical systems; interaction design; robotics; environmental psychology.

ACM Classification Keywords
H.5.2 User interfaces: User-centered design; J.5 Arts and Humanities–Architecture.

Figure 2: Ancient Greek Agora, by Edward Dodwell. Photo on Wikipedia.

Figure 3: The Village Tavern, by John Lewis Krimmel. Photo on Smithsonian National Postal Museum.

Figure 4: EnAct in confugration-1

Introduction

The subject of place attachment in public and semi-public urban spaces is an important contemporary issue that calls for careful examination and further comprehension in a technologically changing world. "Place attachment" is the cognitive and emotional bond that individuals develop towards a place [1]. Place attachment helps to explain and predict other outcomes, such as behaviors, perceptions and emotions [2]. As a setting for all sorts of social engagement, public outdoor places like plazas have been a remarkable example of beloved and attached places [4]. Traditionally, these positively-viewed outdoor spaces have been the capacious settings for people's interaction in many cultures and societies, such as the Agora (Figure 2) in ancient Greece and the tavern in colonial American (Figure 3). However, digital and networked technologies have drastically changed the way people interact with each other, and the way people interact with the built environment [3][4][5]. Such change has shown significant impact on the levels of place attachment to such spaces.

In response to public outdoor spaces being supplanted by social networks and apps, our team from design, computing, digital humanities, and library science, partnering with a library and local government, proposes *EnAct*, a cyber-physical environment at room scale, installed in underused outdoor, public squares. Our objective: to enhance information access, use, and archiving outside the walls of public libraries and to foster social interaction and place attachment in public, urban spaces. Our main goal is to rethink the relationship between people, space and technology, and ultimately, to redesign urban, outdoor spaces as a vehicle for human interaction embedded with today's digital technologies. The key is not to negate technology, but to reintegrate it into the built environment in order to, in William J. Mitchell words, "create fresh urban relationships, processes, and patterns that have the social and cultural qualities we seek for the twenty-first century." [6]

Research Questions

Based on these concerns, this research posits two major research questions:

1. How can a responsive cyber-physical environment create new, inviting, and meaningful forms of interaction among people in a public outdoor space?
2. How does a responsive cyber-physical environment affect social interaction and place attachment in a public outdoor space?

Our Vision for HCI in the context of the outdoor*: EnAct*

EnAct will serve as the physical manifestation of our understanding of how an intelligent, cyber-physical environment can augment social interaction and place attachment in urban, outdoor space. EnAct is an architectural-robotic origami that creates various meaningful scenarios, setting premises for people's appropriation in urban space.

Practically, EnAct is a collection of folding, hinged origami that aims to support several activities for urban dwellers. By physically changing its shape, color and sound, EnAct offers different activities, varying from one to another according to user's needs (Figures 4-6). Origami is mostly recognized as a three-dimensional sculpture formed by folding a sheet of paper. A variation of origami called kirigrami, also known as "pop-up" origami, introduces a single, internal cut into

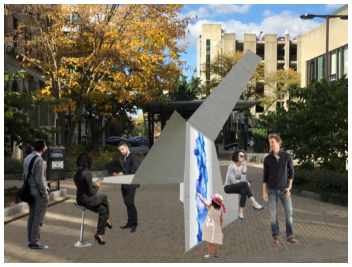

Figure 5: EnAct, configuration 2

Figure 6: EnAct, configuration 3

Alone	Friends/ Family	Strangers
exploring surrounding	talking / socializing	talking / socializing
reading	exploring surrounding	observing others
emailing / social media	observing others	playing games

Figure 8: Actor-Activity chart

the folded sheet of paper to expand the formal possibilities of the resulting form.

Using numerical computing program (MATLAB), we analyzed the gravitational forces actuating in the geometry of our first prototype in order to find the reaction force necessary to accomplish static equilibrium (Figure 7).

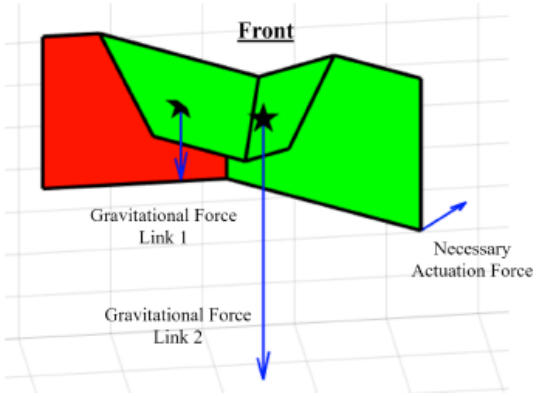

Figure 7: Geometrical Analysis of EnAct using MATLAB

Study Procedure and Analysis

Our main goal is to design for an under-used public space a responsive environment with imbedded information technologies matched to what people do with them. Therefore, we initially aimed to understand "*Who* does *what* with *whom* using *what* physical and digital resources?" To seek responses, we conducted a survey asking 41 participants (ages 16-68) to select three activities they would like to do in the under-used place under three different conditions: (a) being alone, (b) being with family/friends, and (c) being with strangers. Figure 8 shows the results of the survey and the actor-activity relationship we found.

Following from the results of the survey, we invited participants to engage in a co-design activity (Figure 9) where they designed a space that supported the top selected activities correspondent to each of the three conditions (i.e. treatments (a)-(c)). Participants were be given six fundamental components to design such a space – screen, light, bench, floor, canopy and table (Figure 9).

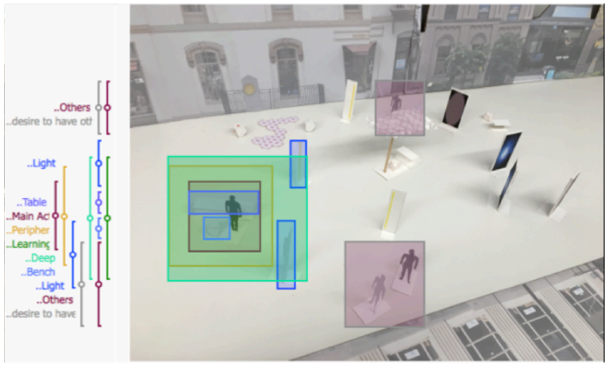

Figure 9: Coding of a Co-Design Activity

It'd be extensive to report the complete analysis in this paper given its level of complexity. As an example, however, in Figure 10 shows the most used components for each of the top 4 activities engaged by people when they are with family/friends. These matrixes enable us to create a collection of human behavior-environmental patterns and their associated fundamental components.

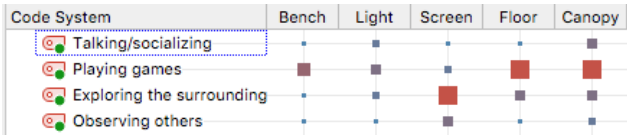

Figure 10: Actor-Activity-Component matrix

Figure 12: Quasi-Experiment, Remove Treatment with Pre- and Post Test. The letters 'O' means observations. Letter 'X' means add intervention, in this case EnAct. Letter 'X' means remove intervention.

Figure 13: Expected levels of place attachment for each observation.

Current and Future Work

In current work, we are constructing a full-scale prototype of EnAct in our lab. We will then invite participants to engage in an Enactment activity. Following this, we will iterate the design and run a Heuristic Evaluation, followed by the installation of the full-scale prototype in-situ where we'll measure the effect of EnAct in social interaction and place attachment. For this quasi-experiment, we'll do five observations: two before the installation of *EnAct*; two after its installation; and one after its removal (Figure 12). We expect to see no major change in the levels of place attachment in the first two observations (O1 and O2) (see figures 12 and 13). However, we do expect to see a significant increase in place attachment levels after the installation of EnAct (O3 and O4). Lastly, we expect lower levels of place attachment after the removal of EnAct.

Implications for the HCI Outdoors

EnAct will probe unexplored opportunities in public, outdoor places for Designing Interactive Systems at large physical scale, and will provide a deeper understanding of how people perceive and interact with each other in such new places. Others have created larger-scale interactive installations [7][8][9], but EnAct is distinct from these in its objective to foster place attachment and offer information services beyond the walls of the library. A key contribution is a "pattern language" for this interaction ecology of people, machine, place, and community. Servings as a design exemplar of large-scale outdoor HCI, EnAct offers a replicable installation and resources to underserved communities.

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