FunSquare: First Experiences with Autopoiesic Content

Nemanja Memarovic
University of Lugano (USI)
Faculty of Informatics
Via Giuseppe Buffi 13
6904 Lugano, Switzerland
+41 58 666 43 22
nemanja.memarovic@usi.ch

Ivan Elhart
University of Lugano (USI)
Faculty of Informatics
Via Giuseppe Buffi 13
6904 Lugano, Switzerland
+41 58 666 43 22
ivan.elhart@usi.ch

Marc Langheinrich
University of Lugano (USI)
Faculty of Informatics
Via Giuseppe Buffi 13
6904 Lugano, Switzerland
+41 58 666 43 04
marc.langheinrich@usi.ch

ABSTRACT
Public displays are becoming a ubiquitous resource in the urban environments due to significant price drops of large LCD panels. However, most public displays are still displaying simple advertisements in the form of slide shows or movie clips, instead of offering locally customized content that resonates with passers-by. So far, creating such customized content has been expensive. As a possible solution we present the concept and architecture for *autopoiesic content*, i.e., self-generative content that is automatically created by matching local context information with regular scheduled information into content that is highly localized. In this paper we report on the design, operation, and user experience of *FunSquare* – an application that uses autopoiesic content to present localized "fun facts" in order to strengthen the feeling of community.

Categories and Subject Descriptors
H.4.3 [Communications applications]: Bulletin boards; H.5.1 Multimedia Information Systems;

General Terms
Design

Keywords
Public Displays, Self-generative content, Context sensing, Urban computing, Urban informatics.

1. INTRODUCTION
Large public displays are proliferating in the urban environment: we can find them in train stations showing the schedule, in universities presenting upcoming talks, in shopping malls promoting discounts, or on building façades advertising new products [10]. While some of them are presenting contextualized information that reflects their surroundings, e.g., train schedules and university talks, a large majority is simply displaying traditional advertising, such as short commercials, slide shows, or simple images. One of the reasons these displays are not showing customized information that resonates with their particular location and surrounding space is the high cost associated with creating tailored content [1]. An alternative to designing custom-made content could be to sense the environment around the display and appropriate more generic forms of content. With sensors becoming cheaper every year [16] it is not hard to imagine that public displays could be equipped with them, providing them with awareness of their environment. This is the basic idea behind the concept of *autopoiesic content*, i.e., to provide self-generative content through environmental sensing.

The term *autopoiesis* comes originally from the field of biology and describes self-sufficient organic systems that continuously regenerate themselves [17]. The same term was later used by sociologist Niklas Luhman [15] to describe social systems that continuously create themselves through communication within. We believe that this notion of self-sufficiency can be carried over to public displays: by offering an economic way to reflect their surrounding space, these often-ignored displays [10] could become more appreciated. In this context, i.e., in the context of public display systems, we define *autopoiesic content* to be content that is not explicitly entered, but is instead dynamically assembled by individual displays, based on existing *content fragments*, a set of continuously updated *context streams*, and manually controlled *matching templates* [13]. Content fragments are static pieces of information like text (e.g., speed of a honey bee), image (e.g., Flickr images), or video (e.g., YouTube videos). Context streams are dynamic pieces of information that are coming from display's environment, e.g., number of people around the display, current wind speed, or even a live video stream. The two pieces, i.e., content fragments and context streams, are then paired through a carefully crafted matching template to create a new piece of content, e.g., a fun fact such as "The current wind speed in the city (12 m/s) is twice the speed of a honey bee (6 m/s)."

In previous work, we defined three classes of autopoiesic content [13], namely *context visualization*, *context connection*, and *context integration*. Context visualization (Figure 1.a) generates novel content by visualizing current context parameters, e.g., current temperature through color (no use of content fragments). Context connection (Figure 1.b) creates novel content through the exchange of content with related contexts, i.e., by exchanging information between two or more locations (content fragments are coming from the 'other' location while context streams are used to find the right location). Context integration creates novel content by portraying content fragments into current context through a matching template, i.e., by matching a content fragment with one or more context streams. In the case of our FunSquare application, context integration would create a new "fun fact" by taking the number of people around the display (context stream) and matching it with a population figure in its content fragment database: "The population of Pitcairn Island (50) is five times more than the average number of people around the display today (10)."

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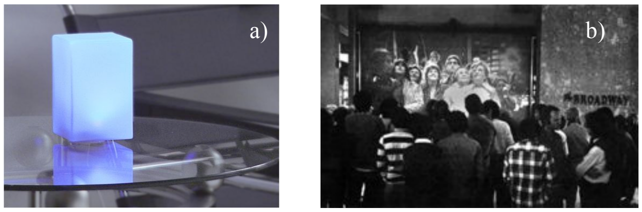

Figure 1: Examples of a) context visualization - 'Ambient orb'[1] and b) context connection - Hole in Space[2].

The first two classes of autopoiesic content, i.e., context visualization and context connection, have been explored to a certain extent. Colored orbs showing stock trends [2], water fountains indicating exchange rates [8], or lamps indicating web site access number [25] are all examples of content visualization, while research on media spaces [3] provides a number of examples for context connection. Little attention has so far been paid to the class of *context integration*, which influenced our decision to focus our research on it.

In this paper we explore the concept of autopoiesic content in general, and context integration in particular, through FunSquare – a novel application that creates localized "fun facts" by matching information from a display's surroundings (current temperature of -2C°) with information from a database of facts (the coldest temperature ever recorded in Sao Paulo was -2 C°) into a new piece of information (the current temperature is equal to the coldest temperature ever measured in Sao Paulo).

FunSquare runs in two modes: an *ambient mode*, where fun facts are continuously shown to provide a backdrop for conversation, and a *game mode,* where fun facts are displayed as a trivia quiz to encourage collaborative interaction. This paper will focus on these two modes in turn, describing:

1. The initial user experience with autopoiesic content in the ambient mode, based on two days of observations and interviews.
2. The potential for user engagement in the game mode, based on quantitative data over a two-month period and qualitative data from collected questionnaires.

The paper is organized as follows: first we will present related work (Section 2) and provide an overview of the FunSquare architecture (Section 3). Section 4 will present two sets of evaluations – one for the ambient mode and one for the game mode. We will then discuss the implications of our findings on autopoiesic content design in Section 5 and conclude in Section 6.

2. RELATED WORK

The idea of autopoiesic content draws from three active research areas, most notably a) public display content design, b) media spaces, and c) context aggregation.

To inform the design of networked public displays content, Alt et al. [1] looked at content on traditional public notice areas, i.e., notice boards. They note that content on notice boards comes in four forms: 1) scaffolded and 2) unscaffolded classifieds, i.e., organized and unorganized handwritten informal content, 3) information displays, i.e., professional content coming from institutions (e.g., churches, libraries, or universities) that informs people about the activities in it, and 4) event displays, i.e., third party content advertising music or sports oriented events. Most of the content on traditional notice boards comes in the form of text and image, which can also be found on digital public displays [6], [9], [14], [22]. However digital public displays also support more advanced content such as augmented reality [21]. More traditional content can be found in Cityspeak [14] which shows text messages sent from a mobile device or the Cityspeak's website. Each message is displayed in a different color allowing the installation to become a place where 'ephemeral graffiti' are created. CityWall [22] displays Flickr images of the place on a large multi-touch screen allowing people to more directly interact with the content. UBI-postcards [9] allow a social co-experience to be created by sharing virtual postcards. Sapporo World Window [6] is application currently under development that displays social media content, i.e., text and image combined, related to specific place from Foursquare and Twitter. All four applications rely on user-generated material for filling the display with content, which offers limited control of what is being shown on the display. Also, these installations reflect their surrounding space in a very broad manner since messages can be sent from anywhere and their content does not have to address the space. Moreover, the Flickr image tags used in the CityWall project are usually not specific enough. In contrast to the above examples that display more traditional content, O'Shea [21] broadcasted an augmented video feed of the display's surroundings on a large public screen. People who were in front of the display were 'picked up' and 'carried' from the screen by a 'hand from above', or they were 'squished' and miniaturized. Although this type of content can be seen as self-generative, its use is rather limited as it does not go beyond amusing passers-by. Also, none of the mentioned work considered multiple content sources.

While research on public display content mainly informs *context visualization*, research on media spaces [3] can additionally inform *context connection*. A typical example of a media space is Jancke et al.'s work [11] that connects three public spaces within a single organization based on full duplex audio/video connection. In terms of context connection this can be seen as connecting content within the same context. In contrast to Jancke et al., the Telemurals system of Karahalios [12] actually creates new content from two audio/video feeds. The two video feeds are blended together in a single video and projected into the two respective sides. The single video image includes a materialized audio connection between the two connected spaces by displaying words used in the conversation. In the Visiphone project [12] Karahalios visualized sound levels within a single space and between two connected places as spiral dots on a sphere, where the color of a dot conveys origin of the sound, radius represents volume, and the distance between the dots represents pauses in sound. The Visiphone and Telemurals are good examples of context connection and visualization.

Another source of inspiration for *context visualization and integration* comes from context aggregation [7]. For example, Phithakkitnukoon et al. [23] used points of interest and people's movement patterns as context sources on a map to create an activity-aware map, providing information of the most likely activity within a location. On the other hand, Calabrese et al. [4] have combined an aggregated cellular phone trace with a list of selected events to estimate the movement of crowds. Similarly Quercia et al. [24] explored the correlation between social events and attendees' home locations as a strategy for recommending social events. Both point out possible context sources that could be used to create autopoiesic content.

[1] www.ambientdevices.com

[2] www.ecafe.com/GETTY/GIS

3. FUNSQUARE ARCHITECTURE

The FunSquare application consists of four components: 1) a *context sensing component* which collects dynamic information about display's surrounding environment and turns them into context streams, 2) a *content fragments database* that contains a large number of manually collected (fixed) facts, 3) an *autopoeisic matching engine* that combines content fragments and context streams into new content, which from now on we will call *fun facts*, and 4) a *user interface* that visualizes fun facts (see Figure 2). In this section we will briefly explain the design and functionality of the four components.

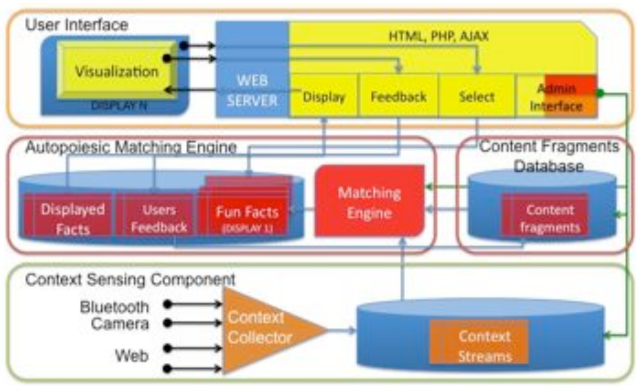

Figure 2: Autopoeisic content architecture

3.1 Context Sensing Component

The Context sensing component is responsible for collecting, processing, and storing dynamic contextual information about a display's surrounding environment. This component performs three main tasks: 1) it collects information from the surrounding environment and turns them into context streams, 2) it does additional data processing to create extrapolate/create additional context streams, and 3) it offers context stream simulation (which can be used for development and testing purposes). It currently has seven *core context streams*: 1) The *Bluetooth stream* provides the number of Bluetooth enabled devices present around the display, including their MAC addresses and Bluetooth friendly names), 2) the *presence stream* provides the number of people in front of a display, 3) the *touch stream* provides the number of times a display was touched, 4) the *temperature stream* provides the current local temperature, 5) the *wind stream* provides current local wind speeds, and finally 6) the *Facebook posts stream* and the 7) *Twitter posts stream*, which provide the number of posts and tweets at a given location, respectively.[3] These streams come from six different sources shown in Table 1 below.

To increase the number of context sources that fixed facts can be matched with, the context sensing component creates additional context streams through *stream extrapolation* and *stream averaging*. Stream extrapolation creates additional contextual information by extracting raw data from context sources and converting it into other units. For example, knowing the number of present Bluetooth devices in front of a display and knowing that each device consumes certain amount of power it is possible to extrapolate new contextual information in the form of Bluetooth power consumption. On the other hand, stream averaging simply creates an average of a context stream over certain predefined periods of time. The average values of *all* context streams are calculated at the end of every day, week, month, and year, as well as over fixed intervals, e.g., the number of touch interactions in the last twenty four hours. With these two methods the number of available context streams raises to 29.

Context Stream	Description	Source
Bluetooth	# of Bluetooth devices around the display.	Bluetooth sensor
Presence	# of people around the display.	Video camera
Touch	Number of touch interactions on the display	Display property
Temperature	Current temperature	Yahoo Weather
Wind speed	Current wind speed	Yahoo Weather
Facebook posts	Number of Facebook posts in a location.	Facebook API
Twitter feeds	Number of tweets citing certain location.	Twitter API

Table 1 - Context sources

All context sources produce an output in the same format, as described in Table 2. The *description* field contains text that is going to be used to form the beginning of a fun fact, e.g., 'The number of connected Bluetooth devices' or 'The temperature measured' (the second part of the fun fact will be provided from the *content fragment database*, e.g., 'the coldest temperature ever measured in Sao Paulo', as described in the next section). *Value* contains the current numerical value of the context stream measured, in *units*. The *source* field indicates the origin of the information (cf. Table 1), which may be core context stream. The *place* field contains the ID of the location where the context was measured. *Average* denotes if the value coming from the context stream is measured or is created through averaging.

Attribute	Purpose/description
Description	Text used to form fun facts.
Value	Numeric value of the context information.
Unit	The unit of context information measurement.
Source	Source of contextual information (e.g., Yahoo Weather or Bluetooth).
Place	ID of the place where the context is measured.
Average	Denotes if the entry is context information or its average over a specific period of time

Table 2 - Context source attributes

The context sensing component can also simulate data from context sources, which can be helpful in cases when a source is temporarily unavailable. Simulation is done by extrapolating previously collected data. The extrapolation process considers all previous entries and the average values to assure that simulated values are not outside of the normal range and cannot suddenly change too much. Also, the simulation capability of the context sensing component can be very beneficial in the development and testing phase. For example, if a context source for some reason is not yet available but there is a data set with typical values expected from it, the context sensing component can use it to show how this source would be used in the system.

3.2 Content Fragments Database

The content fragments database contains interesting information snippets that form the basis for the localized fun facts. In order to balance/control the display of fun facts, the fragments have been manually clustered into 15 categories: weather, curiosity, energy, music, technology, science, religion, law language, nature, history, health, food, sport, and ice hockey (given the popularity of this sport in Finland it got its own category). Each content fragment is associated with the following information (cf. Table

[3] Both Facebook posts and Twitter messages are currently not interpreted but just counted.

3): 1) *category*, i.e., the category it is belonging to, 2) *fact*, i.e., the text of the content fragment that is going to be used to form a fun fact, 3) *language* of the text (for international deployment), 4) *value*, i.e., the numeric value expressed in the content fragment as well as 5) the value's *unit*, 6) *last use*, i.e., the last time a specific content was used to from a new fun fact, 7) *uses*, i.e., the number of times content fragment was used to form a new fun fact, and 8) *source* of the information for the content fragment. For example, the *fact* 'the coldest temperature ever measured in Sao Paulo,' the category would be *weather*, *language* would be en (for English), *value* would be -2, *unit* would be C°, *source* would be a URI,[4] while the *last used* and *uses* would depend on the actual usage.

Attribute	Purpose/description
Category	Category a specific fact is belonging to.
Fact	The text of the content fragment.
Language	Language of the text.
Value	Numeric value expressed in the content fragment.
Unit	Unit of the value.
Last used	Date when the fragment was used to form a new fun fact.
Uses	The number of times it was used to form a new fun fact.
Source	Source of information for the content fragment.

Table 3 - Content fragment attributes

For the time being these facts are entered manually. However, it is not hard to imagine that a web crawler [5] could be made to collect and store this information automatically.

3.3 Autopoiesic Matching Engine

The Matching Engine takes information collected form the context sensing component (described in Section 3.1) about a display surrounding, data from the content fragments database (described in the section above) and finds a connection between the two. Once a connection is found, the engine generates a fun fact. A fun fact represents a readable and meaningful sentence formed from the 'description' filed of context information (current wind speed), the 'fact' filed of a content fragment (speed of a dragon fly), and a numerical relation/connection that combines the context information and the content fragment together (the speed of a dragonfly (97 km/h) is more than 4 times the current wind speed in the city (23 km/h)).

Every generated fun fact that represents an interesting phrase is also associated with (cf. Table 4): a reference to the context stream, a reference to the content fragment, the creation date, a field that indicates whether the fun fact has been displayed or not, a filed that indicates language of the text (e.g. English or Finnish), the place for which the fun fact has been created and which is directly related to the context information, and a rank field that describes how good the newly formed fun fact is and the probability of it being shown on the screen.

The engine generates a new fun fact every time there is a change in the context stream. This means that whenever the situation around the screen becomes different, the engine generates a new fun fact that describes/matches the new situation, e.g., an increase in the number of people in front of a screen. The new context stream value is then used to search the content fragments database in order to find a meaningful numerical relation with a content fragment, e.g., the population of Pitcairn Islands (60) *is the three times more* than the number of people watching the display in the last 5 minutes (20). While this connection can be made regardless of the units, e.g., "The number of people standing in front of a display (2) *is the same as* an average price of a muffin (2 Euros)," data with matching units is preferred. Once a fun fact is created, it is stored in a database from where it can be selected and displayed on the screen.

Attribute	Purpose/description
Phrase	The fun fact text that will be displayed.
Context Info	A reference to the context stream.
Content Fragment	A reference to the content fragment
Date	The creation date of the fun fact.
Language	Language of the text.
Rank	A numeric description of the fun fact.

Table 4 - Fun fact attributes

The selection of a fun fact that is to be displayed depends on its *rank*. Fun fact's rank is influenced by the following factors: *unit of measure*, *size of the relation number*, dynamics and *freshness of context information*, the overall *usage of content fragments category*, *the number of uses of particular content fragment*, and *the users' feedback* in the form of likes and dislikes of the particular content fragment category. First, by having the same unit in the relation between context stream and content fragment, the probability of showing a particular fun fact increases. Second, by having a smaller relation number the probability of showing a fun fact is increased, giving the advantage to relations that are easier for people to perceive (e.g., if a fun fact has a relation *twice as* it has more chance of being displayed than a fun fact with the relation *seventy-seven times as*). Third, the probability of showing a fun fact depends on dynamics and freshness of chosen context information. The advantage is given to fun facts which have in them information from context streams whose information changes very often, e.g., a fun fact with having the number of people in front of a display has more chance of being displayed than a fact with information about the weather (assuming that weather does not change that often). Fourth, the category of content fragment is used to create equal opportunity for fun facts from different categories and to limit repetition of fun facts on the same topic. Also, the probability of showing a fun fact is influenced by the number of previous uses of its content fragment in already shown fun facts. This is done to prevent showing a particular content fragment matched/related to different context streams repeatedly. Finally, the decision of showing a particular fun fact is influenced by the users' feedback through the number of positive (like) and negative (dislike) votes for the category of the fun fact content fragment. Making the selection of the most interesting and eye-catching fun fact from the number of generated ones is a subjective matter that mostly depends on the audience. However, using the automatic fun fact ranking system, the application can prevent showing inaccurate/old fun facts, limit repetitions of the facts from the same category, incorporate users' preferences, and therefore increase the chance of showing interesting fun facts.

3.4 FunSquare User Interface

As previously mentioned, FunSquare operates in two modes, i.e., *ambient mode* and *game mode*. In ambient mode, a fun fact is simply presented, as shown in Figure 3. They are introduced with an opening sentence 'Did you know that' displayed in a circle located in the upper left corner. Each fun fact is displayed for thirty seconds. If a user wants to get a new a fun fact before the time limit runs out, she can do so by simply pressing the '+' button. Users can also vote for a fact with 'thumbs up' and 'thumbs down' buttons, or they can leave a comment for the fun fact. In the upper right corner there is a QR code which enables users to 'take' a fun fact with them on their smart phone, i.e., providing them with a permanent URI to the particular fact. In the lower right corner there is a timer visualizing how much time is

[4] Extreme temperatures around the world: www.mherrera.org/temp.htm

left to view fun fact. By pressing the timer it will reset and a particular fun fact will be displayed longer. In the lower center there is a ‘switch language’ button that allows switching between languages (currently only two are used: English and Finnish).

Figure 3: FunSquare user interface in ambient mode

In game mode, fun facts are displayed in a form of a trivia question as seen in Figure 4below. The game starts with players choosing the neighborhood they want to play for. This was done with intent to raise the competitive spirit of the game and to boost players to play more. Once the players have selected the neighborhood the game starts. Players have to give as many correct answers as they can. As seen in Figure 4 each question has three alternatives where only one is correct. For each answer players get hundred points. They are rewarded for getting consecutive correct answers where the next correct answer is multiplied with the number of consecutive correct answers given (e.g., if two consecutive answers are given, the third consecutive answer would be worth three hundred points). The number of points is displayed in the central blue circle. The game also has a time constraint of ninety seconds, i.e., if no right answer is given by then, the game comes to an end. For each right answer, players are rewarded with additional five seconds. Time left to play the game is shown in the left circle.

Although user interface design for public displays is an interesting research topic, we focus more on the initial user experience with the autopoiesic content here. That is, we will reflect mainly on what users said about the *content,* than on what they thought about the FunSquare application design.

4. FIELD TRIALS AND EVALUATION

As part of the International UBI Challenge competition [19] we deployed FunSquare on the UBI-Hotspots [20] in the city of Oulu, Finland. The UBI-Hotspots are twelve networked public displays equipped with additional hardware, such as Bluetooth sensors, cameras, and audio, as well as Internet access, distributed throughout the city. The competition was held from May to August 2011. During this period we evaluated FunSquare in both modes: 1) in the ambient mode we conducted qualitative evaluation of FunSquare at two locations over two days through observations and interviews, while 2) in the game mode we conducted both quantitative evaluation, by logging user interaction within the game, and qualitative evaluation, through user trials and questionnaires. For the purpose of this competition, all information in content fragments and context streams was translated into Finnish.

Figure 4: FunSquare user interface in game mode

4.1 FunSquare evaluation *ambient mode*

FunSquare’s ambient mode was evaluated for two days at two locations in the city of Oulu (cf. Figure 5): in the Main Library and in the Market Square (city center). Due to bad weather, the evaluation at Market Square was cut short to one day only. At each site there was at least one researcher from the FunSquare team taking notes and photos and at least one Finnish native speaker who conducted open-ended walk-up interviews. Interviews aimed at assessing the experience with the FunSquare application and its autopoiesic content. Overall we conducted 28 interviews and roughly 18 hours of observations. Thanks to our Finnish colleagues we were also able to listen-in on some of the conversations around the display The quotes given below are identified by a two-letter code, indicating the interview location (**L** for the main library, **T** for the Market Square) and source (**I** for interview and **C** for an overheard user conversation).

In the 18 hours of observations, roughly 130 people paused to read at least one fact. Most of the people we interviewed characterized them as ‘nice’, ‘funny’, or ‘interesting’ (LI1, LI2, LC1, LI3, LI6, LI7, LI9, LI12-18, TI3-5, TI8). Some people referred to fun facts as ‘unnecessary information’ or ‘information snippets’ (LI3, LI7) while other thought of them as questions (LI9, TI2, TI9). Interestingly, this type of content was also characterized as ‘fitting with the city of Oulu’ (TI3-5). After reading a number of facts for the first time, some people came back to read more, e.g., LI12:

> LI12: ‘If my parking meter would not run out of money I would not leave these premises the whole day.’

Figure 5: FunSquare at Main Library and Market Square

Part of the interviewed people explicitly said that they *liked the connection between content fragments and context streams* (LI7, LI11, LI15). One person commented that by combining static information, like 'big numbers and distances' with the real world data makes it easier to understand big things (LI7), while one found the connection between local and non-local information especially appealing (LI11).

On the other hand there was a group of people who were 'puzzled' by the connection, or at least intrigued by the displayed content (LI10, TI7, TI9).

> LI10: *'How can you put together two facts that have nothing to do with each other?'*
>
> TI7: *'Is this really true? Are these facts real?'*
>
> LC2: [Mom commenting on a fact 'The number of people in front of a display (2) is the same as an average price of a muffin in Euros (2)' to her daughter] *'It's not true that all muffins cost 2 Euros!'*

To a number of people the actual selection of information seemed random (LI3, LI5, LI6, TI9). The idea of categorizing information explicitly, i.e., having visible categories from which people could choose the information they want to see, was seen as desirable (LI3, TI9).

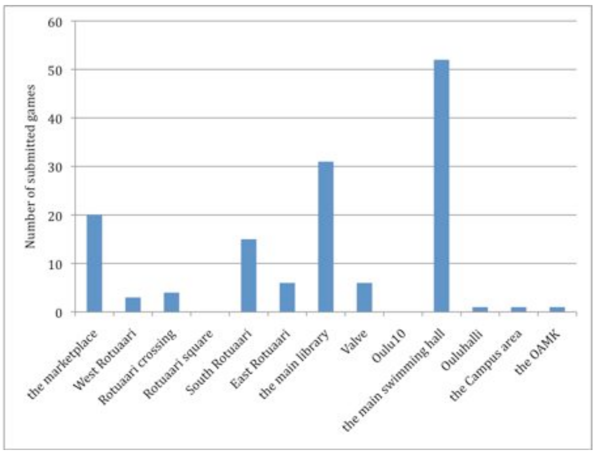

Figure 6: Number of submitted games per place

In general people expressed preferences towards certain categories of content (LI1, LI5, LI6, LI7, LI9, LI12-14, TI9). These preferences ranged from: 1) simply excluding some categories (e.g., LI1 said that everything but ice hockey is OK), 2) wishing to see more content from an existing category (e.g., LI5 wanted to see more environment and history, LI14 liked ice hockey particularly, while TI9 liked technology), or 3) displaying content from a new category that is currently not supported by the application (LI7 wanted to see 'space, time, and other complex things' while LI9 wanted to see more information on politics, parties, the prime minister, etc.).

Although there was a group of people who wanted to see more information from a certain category, there were also some who felt that information from some categories came up too often (LI5, LI6, TI9). Similarly, while some people explicitly said that they preferred information from a specific category, e.g., ice hockey (LI14) other explicitly said that this category is the one that does not interest them (LI1, LI13, TI2, TI9).

While some people preferred content on a specific subject, others preferred the locality of it and some even wanted to get more local content (LI5, LI9, LI14, LI15, TI2, TI3, TI8, TI9). There was also a group of people who wanted to get both, i.e., localized information on a specific topic, e.g., local environment, history and events (LI5), local politics (LI9), local ice hockey teams (LI14), or about Oulu in general (TI9).

We will discuss these results in more detail in Section 5 below. The following section will first describe our second evaluation, which looked at FunSquare's game mode.

4.2 FunSquare evaluation *game mode*

FunSquare in game mode is available since early July 2011 on all UBI-Hotspots throughout the city of Oulu. The game can be found in the UBI-Hotspots standard menu, which requires users to press a generic menu icon in the footer of the screen and choose from a set of application categories to select one of 22 available services. For the first 10 weeks after the launch, however, the quick-launch menu of the UBI-Hotspots offered a direct link to FunSquare, as well as to three other applications, in a more prominent fashion.

For the game mode, we conducted both a quantitative and a qualitative evaluation, i.e., 1) we logged all screen interactions within the game in the central server, and 2) we organized user trials in the wild where we distributed questionnaires to participants.

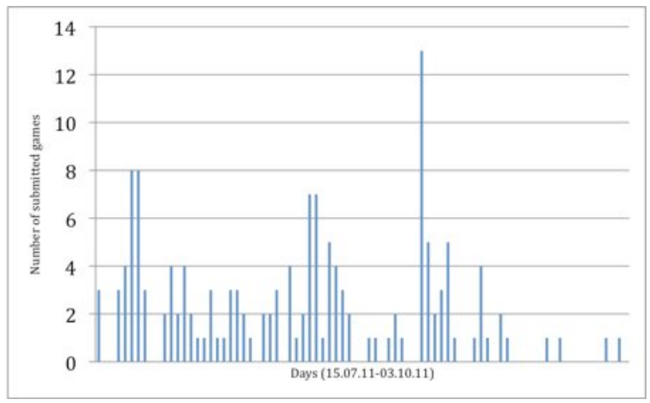

Figure 7: Number of submitted games per day

4.2.1 Usage statistics

The goal of logging all the interactions within the game was to get the insight of the amount and type of users' interest in the game. The interactions were analyzed from July 15, 2011 until October 3, 2011, excluding any possible testing interactions on the UBI-Hotspots within the first week of the game deployment.

During the observational period of 81 days, the game was selected 2309 times from the UBI-Hotspots standard menu or quick-launch menu. 605 games out of all 2309 game sessions were completed (26%), i.e., the 'game over' screen was shown as the timer ran out. 150 games out of 605 completed games were submitted to the high score list (25%) where the users explicitly pressed the submit button. For those 150 submitted games, only 42 gamers left their names and none of them left their picture. In incomplete games (74%), users switched to other applications before completing the game. This can be due to the exploration of the new applications shown in the quick-launch menu, and the presence of UBI-Guides who were promoting and explaining UBI-Hotspot applications to passers-by.

A more interesting result are the 25% of all completed games that were submitted to the high score list. In those game sessions the users were fully engaged, stayed until the end of the game, gave answers to all presented questions, and explicitly chose their score to be shown on the high score list. Leaving a nickname on the high score list can be important for some players, but the option for leaving a picture can be entirely omitted. Due to the users' engagement during submitted games, those game sessions were further analyzed in order to reveal the most used UBI-hotspots for playing the game (Figure 6), the distribution of submitted games per days (Figure 7), and the peak hours for playing the game (Figure 8).

The most popular UBI-hotspots for playing the game are the main swimming hall, the main library, the marketplace, and South Rotuaari respectively (see Figure 6).[5] On average there were 28.5 sessions per day, resulting in 7.46 completed games and 1.9 submitted scores per day. The distribution of submitted games per hour is shown in Figure 8. It shows three peaks around 10am, between 12-1pm, and between 3-4pm.

Figure 9 shows the absolute performance per category. Overall the highest number of right answers was given for the questions on ice hockey (167/588), followed by nature (117/367) and curiosity (98/376). This is not that surprising since these categories also had the highest number of questions. However the highest percentage of correct answers (cf. Figure 10 below) was for music (44.59%), weather (41.18%), and history (32.39%). The second graph may indicate that people are more interested in some categories more than other since they gave more accurate answers.

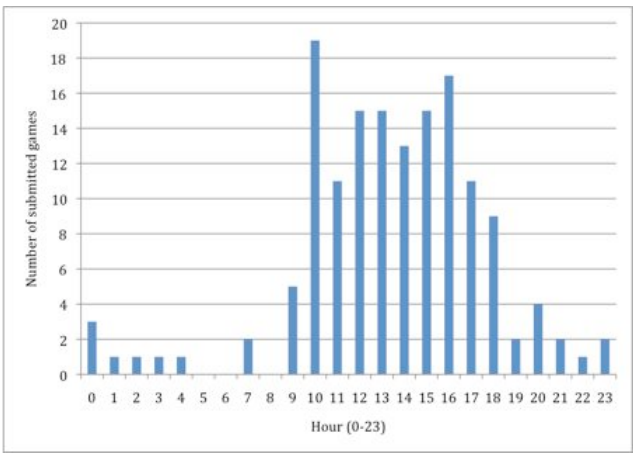

Figure 8: Number of submitted games per hour

4.2.2 Questionnaire data

The goal of the user trials in the wild was to get players' view of the autopoiesic content within the game. Ideally we would have conducted a set of open-ended interviews, just as in the case of the ambient mode, in order to get at a richer set of data. Unfortunately, scheduling constraints made it impossible for us to perform the evaluation ourselves. We thus had to rely on regular UBI-Guides – high-school students or undergraduate students without prior experience in interviewing – to conduct it for us. In order to ensure comparable results, we therefore decided to have UBI-Guides administer short questionnaires.

[5] See http://www.ubioulu.fi/en/node/102 for a map of these locations

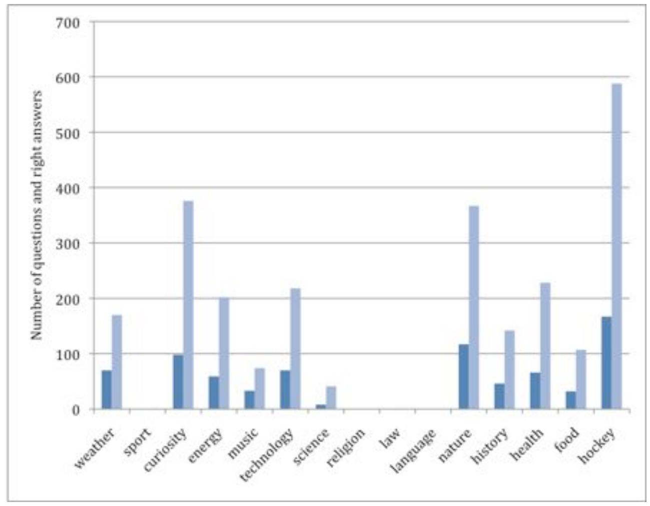

Figure 9: Number of questions and right answers per category

Questionnaires were distributed to 27 participants in two days at six locations. Apart from basic demographic data, questionnaires elicited a participant's prior experience with the UBI-hotspots and then asked about the experience (positive and negative) with the game. If the participant had not played the game before, we asked why they hadn't played it yet. UBI-Guides actively approached passers-by and invited them to play, and subsequently administered the questionnaire.

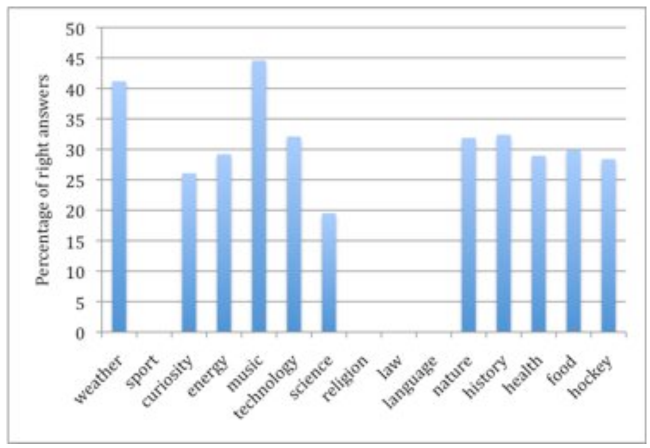

Figure 10: Percentage of right answers per category

We had 13 male and 14 female players with an average age of 24. Most of the participants had used hotspots before, though rarely (15), while some of them had never used them (9). Two participants reported using hotspots a couple of times a month, and only one reported using them a couple of times a week. Only one of the users had previously played the FunSquare game, while all others had never played it. As the reason for not playing the game, the majority responded that they did not know about it.

Most of the players reported a positive experience while playing the game (16). Some of them described the experience as exciting, some of them thought the game was entertaining and fun, some appreciated learning a couple of amusing facts, and some felt like they got more familiar with UBI-hotspots. Two players mentioned the locality of questions as a 'good thing' and felt that local questions were closer to them.

However players also reported on negative experiences (15). Some players thought that display was not responsive enough (4) while other complained about the questions posed in the game: some thought the questions were difficulty (8), some did not like that they did not know the answers (6), while some thought that there was not enough time to think and give a right answer (3). The overall negative experience raised by the game is nicely captured by one of the players:

> *'The questions are pretty fun otherwise, but there's not enough time to answer. Questions and answers are obscure and pretty hard to comprehend quickly.'*

5. DISCUSSION

Overall the majority of participants/users appreciated autopoiesic content, as noticed in the interviews (18/28 in the ambient mode and 16/27 in the game mode) and observations (roughly one hundred and thirty people read at least one fun fact in only eighteen hours).

> LI15: *'Full score for this application.'*

Even in cases where the content of a fun fact was not to the persons liking, people still saw the benefit of autopoiesic information and asked for content of their preference instead. For example, LI5 browsed through twenty or more facts although she did not see the content from a category she liked.

While we tried to diversify the information displayed by showing fun facts from different categories, some people wanted to see more *facts from the same category* or from a small number of different categories (roughly from those three: environment, history, and/or nature). If viewers of autopoiesic content would get more information that matched their preference, we believe that they would appreciate the information even more. This could simply be done by visualizing fun fact categories already present in the system and allowing people to select the preferred category (as suggested by some of the interviewees).

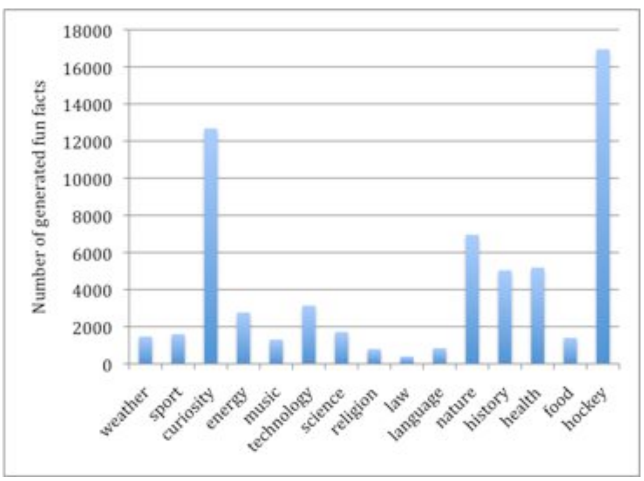

Figure 11: Number of generated fun facts per category

Although autopoiesic content connects local information from the display surrounding with information from without, some people wanted to get content that is even more connected within the locality. Some people even wanted to get *localized content on specific topic*, e.g., information about *local* politics, events, or history. With two parameters, topic and locality, categorizing content becomes difficult. We can even say that people wanted to see *personalized and situated content*, i.e., content according to their preferences. To summarize, we see three groups of viewers: 1) viewers that are interested in the *topic*, 2) viewers that are interested in the *local content*, 3) viewers that are interested in *localized content on specific topic*.

Due to the open-ended nature of the interviews we did not explicitly ask if people like the *connection* between context streams and content fragments which makes autopoiesic content. Since we were interested in getting the initial user experience with the content we were also interested to see how this information is perceived. When asked about the content people referred to it through 1) *topic*, 2) *locality*, and 3) both, i.e., *localized content on specific topic*, as mentioned in the paragraph above. This can be explained in two ways: 1) people saw only the information coming from content fragments or 2) due to the novelty of autopoiesic content it was easier for people to refer to it through information coming from content fragments. We believe that the latter explanation is more correct. In some cases people explicitly said that they were a bit 'puzzled' by the connection between fragments and streams (LI10, TI9) while in other people explicitly stated that they do like the connection between fragments and streams (LI7, LI11, LI15). Also one particular interview (TI9) revealed that it was easier to people to refer to autopoiesic content through content's *topic, locality,* or *both.* Throughout the interview the interviewees addressed the content through the topic, i.e., content fragments. However the man and woman who were interviewed did also discuss the *connection* between the 'two pieces of information'.

Some people felt that information from certain category came up too often, namely facts about ice hockey. After examining the number of generated facts per category we observed that a large number of fun facts came from it (from the 'ice hockey' category, Figure 11). Further examination revealed that this category had the highest number of content fragments, which was the reason for having the information displayed more often (as can be seen in Figure 12).

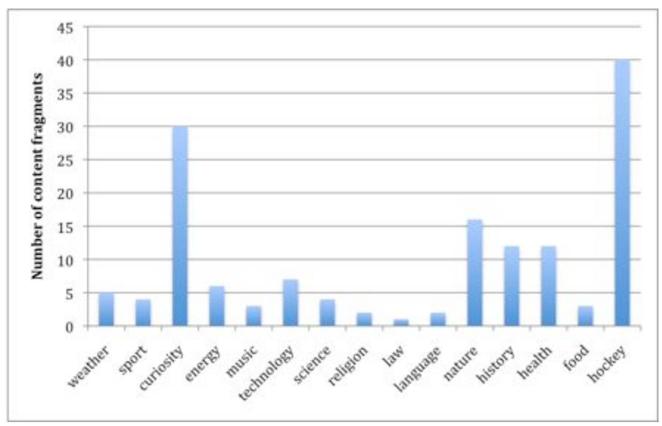

Figure 12: Number of content fragments per category

There are two reasons for a high number of facts from ice hockey: First, when testing the algorithm in the lab, some facts were never matched and we decided to exclude them – these were mostly from other categories, while facts from ice hockey tested well. Second, when researching about Finnish culture, ice hockey proved to be a very popular topic (our research team is not from Finland). Since this was our first attempt to create autopoiesic content, we concentrated more on creating interesting content than on making equal distribution of information from different topics. Future trials would need to make sure that each category has roughly the same number of content fragments. To even further satisfy content viewers, the system should have an equal number of local and global fragments for each category to please both groups, i.e., people who like the connection with information from without and people who like only the local connection.

Due to novelty of this type of content, understanding the information seems to have taken more time than we expected. Before deploying FunSquare in game mode, we tested it ourselves several times, which influenced our decision to limit the game to ninety seconds. We did not realize that during our in-lab trials we became expert users and understood the information faster than most of the people. We did test the game before deployment with people who were not involved in the project, however our tests were done with repeating users (i.e., same group of people). They too became acquainted with autopoiesic information and responded quickly to the questions in the game. However our user trials in the wild were aiming at inexperienced first time users who had problems understanding the information quickly. If they were given more time they could have performed better in the game and their experience could have been even more positive. This will be adjusted in the next field trials where users could simply select their skill level in the game (e.g., newbie, knowledgeable, or expert) or the game could adapt to their skills (e.g., time limit for the game could become shorter after ten consecutive answers).

6. CONCLUSION

Public displays are becoming a ubiquitous resource in the urban environments. Although some of them are reflecting their surrounding environment by displaying bus schedules or events within their locality, the vast majority is simply displaying advertisement. This is largely due to high costs associated with creating customized content, which for now is the only way to have content that is reflecting displays surrounding. We believe that autopoiesic content, i.e., self-generative content that connects information from *within* a display's surrounding (context streams) with information from *without* (content fragments), could be a potential solution.

In order to test the feasibility and user acceptance of autopoiesic content we have developed the FunSquare application. FunSquare presents autopoiesic information in two modes: 1) an ambient mode where the information is displayed as is, and 2) a game mode where this information is shown in form of a trivia quiz.

We ran two days field trial with FunSquare in ambient mode on two UBI-Hotspots in two locations in the city of Oulu, Finland. Our observations revealed that this type of content is received well. The majority of interviewed people reported that they found the content nice, funny, and interesting. People who saw the content that matched their topics of interest were simply taken by it (LI12). Even people who did not see the content of their preference perceived the idea as valuable (LI5). In order to show more diverse information we displayed facts from several categories in semi-random fashion. Although some people found this appealing, the majority wanted to see more content from a specific category. Some people preferred topics over content locality and vice versa, while some preferred having both, i.e., localized and topic specific content. This goes to show that people want to see *personalized and situated content*. This could be provided through a menu where people could choose their preferred category in addition to choosing if content type should be local or global. A more advanced approach would be to use user profiles to select the information automatically.

In contrast to ambient mode, our trivia-quiz inspired game mode used it in a more engaging context. Players had to match the two pieces of information, i.e., context streams (information coming from within display surrounding) and content fragments (information coming from without display surrounding). The game was deployed in early July 2011 and is still active. To get the complete picture of the game acceptance and usage we analyzed log files for the period of 81days and conducted user trials with 27 (mostly first time) users. Game usage analysis revealed that on average 28.5 game session were started per day resulting in 7.46 completed games and 1.9 submitted scores per day. We found that there are three 'hot spots' where most games are played, namely main swimming hall, main library, and Market Square (market place). Although sports, nature, and curiosity categories had the highest number of generated questions and highest absolute number of correct answers, music, weather, and history had a higher percentage of questions posed and right answers given. This could indicate that people are more interested in these categories.

User trials revealed that most of the people had a positive experience with the game, with some people mentioning that the locality of question is a 'good thing' and that it made the questions 'closer to oneself'. Most of the negative experience was associated with 'difficulty' of the game, which stems from people not knowing the answers or feeling frustrated that they did not have enough time to think about the correct answer. In future trials we will try to correct this problem by having users choose their skill level (which would give them more or less time depending on the level) before starting the game or by having the game adapt to their skills (e.g., having more time to answer if no positive answer was given).

Overall, the experience gained through observing and evaluating autopoiesic content in the wild provided valuable lessons that will be integrated in future trials. We will also investigate more possibilities in creating autopoiesic content, e.g., content generated from context streams from different locations.

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