

Opportunities and Challenges of Interactive Public Displays as an Advertising Medium

Rui José

University of Minho, Information Systems Department, rui@dsi.uminho.pt

Jorge C. S. Cardoso

Portuguese Catholic University, School of Arts / CITAR, jorgecardoso@ieee.org

Abstract Advertising is often the key element in the business case for public display networks. However, this is still a limited medium in its support for key advertising concepts, such as targeting or impact assessment. This chapter analyses how the evolution of the medium is creating the opportunity for re-shaping advertising models for Digital Signage. In particular, we consider how the increasing availability of sensing and interaction opportunities may generate the necessary digital footprints that will help to characterise advertising opportunities in Digital Signage and measure impact. A generic footprint model would enable advertising models to be specified at a higher level of abstraction, enabling them to be applied across global display networks composed by very diverse display types, managed by many different entities, and serving many different purposes. We propose a design space that relates the multiple types of digital footprints that can be generated with multiple modes of campaign targeting and impact assessment, providing the ground for a fundamental shift from advertising based on measuring attention to advertising based on active engagement with people.

1 Introduction

Public digital displays are an increasingly ubiquitous element in our visual culture. We can find them in all sorts of public and semi-public spaces, where they can be serving multiple types of informative purposes. However, the main driver behind most deployments has been their use as an advertising medium. Digital Signage has attracted much interest as a marketing tool because displays can be close to shopping decision points, they can leverage on situations of strong attention availability, e.g. queues, and they can reinforce messages from other media. Advertis-

ing is thus almost always an integral part of their business case, which revolves around the revenue obtained from selling screen real estate and time to advertisers. In many cases, this revenue is indeed the sole purpose for setting up the network, but even if that is not the case, advertising is still very often an important way to off-set deployment costs and to guarantee the sustainability of the services.

While the revenue generated from advertising in these networks has been steadily increasing, and the medium continues to attract the interest of marketers, the evolution of this market has been somewhat restrained by key limitations of the medium with major implications for advertising. The first is that most public displays offer very little in ways of interacting with and responding to the people around them. This absence of systematic interactive or sensing features means that displays fail to produce meaningful traces of how they are used. The second is that the advertising process is essentially based on selling undifferentiated screen real estate within the scope of a single display network. As a result, there is no significant impact assessment and targeting is limited to the selection of the display networks in which the campaign is to be placed. Without effective solutions to these key issues, digital agencies will not embrace Digital Signage as a mature and worthy advertising medium with which they can have a clear and sustainable Return on Investment (ROI). Moreover, web marketing has been generating solid advertising models that are enabling that medium to become increasingly central in marketing strategies. The sophistication of web advertising provides an inspiring model for other digital media, but it also means that marketers will have increased expectations regarding the advertising models for Digital Signage and other digital media. Failing to live up to those expectations could potentially mean the fallout of the respective business case. These concerns have been widely acknowledged by the Digital Signage industry, which has been making an effort to address them, mainly through more advanced audience metering techniques. Also, a large number of patents have been filled in recent years on targeted advertising for public displays, including major companies such as Google, Microsoft, IBM, NEC or HP, reflecting a significant interest in this topic. With this quickly evolving landscape, there are many challenges to be addressed, but there is also a major potential for a significant evolution of Digital Signage towards more mature advertising models.

In this chapter, we discuss the opportunities and challenges for the evolution of Digital Signage towards a mainstream advertising medium for public spaces. We start by introducing key advertising concepts and how they are addressed across different advertising media. We then analyse the properties of Digital Signage and discuss how this medium can evolve to meet the increasingly high expectations of marketers. We then introduce the concept of digital footprint as a high-level abstraction for representing the traces left behind when people implicitly or explicitly interact with Digital Signage. This is the basis for a design space that associates various sensing and interaction features with the types of advertising functionality they can enable.

2 Pervasive Networks of Public Displays as a New Advertising Medium

Advertising is a key element of the promotion mix of companies and covers a wide range of communication tools in order to inform and persuade. As in any other form of communication, advertising effectiveness depends on understanding the communication process (encoding, decoding and feedback) and elements (sender, receiver and media). Developing an advertising process involves at least four major steps, namely: setting advertising objectives; budget; message; and media (Kotler and Armstrong 1998). Advertising will thus occur as part of advertising campaigns with specific communication goals that should determine the structure of the campaign, its intended audience, its duration, and the media used to support it, very often more than one. A specific budget will delimit the range of opportunities to be considered and will necessarily lead to optimisations that are able to produce more results with fewer costs. The economic valuation of advertising opportunities needs to be established based on the size, characteristics and situation of the potential audience. Impact assessment will measure the reaction of the target segments to the message of the campaign. Measuring the effectiveness of the campaigns is crucial for control and for validating the return on the investment. When performed in real time, impact assessment may also enable the campaign strategy to be adapted on the fly, according to the reactions it is generating. The execution of campaigns, especially in digital media, is normally supported by some type of campaign management service that supports the campaign specification (what to present in what circumstances), the actual delivery of the adverts (generating impressions and tracking actions) and some type of analytics (reporting on the results of the campaign).

A key part of the advertising process is thus the identification of the segments that are the primary targets for the message and the ability to direct the message to this target audience. This delivery of the right message to the right audience and in the right context is essential because it allows campaigns to be executed in a much more cost-effective way. If an advert is only shown to those people or in those situations for which it might be more relevant, it is much more likely to produce sales. A targeting process can be very diverse and refined, depending on the availability of information about the targets and the contexts in which they are consuming the message. With the emergence of digital media, marketers are increasingly empowered with a very rich set of information about people and their behaviour, enabling a broad range of new targeting techniques that may include not only the selection of the targets, but also the dynamic adaptation of the message to increase its relevance.

Demographic targeting is the classical segmentation approach that considers properties such as the age group, gender, the residential area or the education level. Demographic data can be a reasonable predictor for consuming behaviour and requires less information than other approaches.

Behavioural targeting tries to model people based on their past behaviour. It can be extremely sophisticated, depending on the number and nature of the behavioural data sources, and it has become increasingly important with web advertising, where it is often possible to collect substantial information about browsing patterns. For example, with information about previous visits to other web sites, normally obtained through cookies, advertisers can much more easily select the most relevant adverts to show to that person when entering another web site. Retargeting is another form of behavioural targeting whereby a person is shown adverts from a previously visited web site. The idea is that a person who has already demonstrated a certain level of interest on the products of that web site is more likely to generate sales.

Geographic targeting is also an important parameter for segmentation. With a small business running a local campaign this may involve selecting local media or global media with support for fine-grained geographical scoping. In global campaigns on digital media, geographical targeting may be used to adapt the message to different locations, considering for example the respective country, local language or time of the day.

Contextual targeting involves selecting places for the adverts that are related in content to the products. For example, a magazine about video-games would be a relevant context for an advert about a new video game. A web-site about babies would be a relevant context for adverts about baby food. Targeting occurs, not only because the message is being directed to people who seem to have an interest in those topics, but also because it is presented at a time when they are actively thinking about them. Contextual targeting may also explore not only the type of place where the advert is being shown, but also its potential credibility with the audience or even the affinity that people may have with that place.

2.1 Advertising Models Across Other Media

Advertising models have evolved very significantly in recent years, especially with the new possibilities emerging from the web, but audiences and impact can be expressed very differently depending on the supporting medium. Multiple advertising models have thus emerged to address the specificities of each medium. This section analyses several advertising media, uncovering their approaches regarding targeted advertising, impact assessment and advert valuation. This will frame our discussion on the advertising models for Digital Signage.

2.1.1 Television

Television is a medium with solid and well-established advertising models that have sustained and driven that industry for many years. Audience measurement is a high-profile activity strongly associated with the prestige of the TV shows. The

measurement unit is the number of exposures by time unit, with the audience data being gathered through phone surveys, diaries or even dedicated audience metering devices that detect and communicate which channels are being watched. Advertisers want their adverts to be seen by as many people as possible, but they also want to optimise the process by focusing more on their main target groups. Therefore, audience data is complemented with demographic data about viewers, enabling audiences to be determined, not only as a global number, but also according to multiple demographic parameters, such as gender, income, age and residential area. As a result, the valuation of adverts also considers the type of viewers. As certain segments may be more valued than others, a larger audience does not necessarily correspond to a higher price. Impact assessment, albeit limited, is typically achieved through surveys on brand recall.

2.1.2 Static Displays

Static displays differ from the other media being analysed in that they are an example of a static medium. With static media it does not really matter when people are watching because the message always remains the same. Therefore, audience measurement is mainly based on measuring foot traffic. This can be achieved manually or using people counters, small sensors that can count the number of people that walk through doors or virtual gates. Even though this is not effective in determining how many persons are actually paying any attention to the display, it is still effective enough to establish a reasonable valuation model for this medium. More elaborate techniques may also include visits to assess display visibility and obtain refined demographic data about visitors (Philport 2007).

2.1.3 Web

The emergence of the web raised many challenges, but also immense opportunities for advertising. What clearly distinguishes the web from other media in this analysis is its inherently interactive nature, and the consequent ability to obtain rich information about user context and behaviour. As a user visits particular web sites or places search queries for particular keywords, these actions can be used to infer interest in particular topics and select appropriate adverts or sponsored links. These characteristics were first explored by Google AdWords and Google AdSense to address two fundamental issues that had previously undermined web advertising: establishing a valuation for adverts and assessing their impact. The first issue involves determining which ads may be closer to the interests of the potential audience in order to target advertisements. The main alternatives include the geographic location, the context of the page being visited or some knowledge about user behaviour. The second issue involves assessing impact by determining which ads have actually managed to lead people into the desired action. In the web this is mostly achieved by measuring Click-Through Rates (CTR).

Despite being a relatively new medium, the web has now become a thriving environment for the emergence of new and sophisticated advertising models with implications for other digital media. The first is that exposure is no longer seen as the single or even the main element in determining the valuation of adverts. The focus has shifted from merely determining who receives the message towards measuring how many people were interested or even how many people actually bought something. This immediate feedback also means that it is now possible to try many different campaign strategies and evaluate on-line which ones are more effective. As a consequence, valuation models have also evolved from the traditional Pay-per-Impression, based on exposure, to models based on the achieved impact, such as the Pay-per-Click (PPC), in which payment is determined by the number of clicks generated by the advert. The economic value associated with each click as well as the allocation of advertisements to specific advertising opportunities are typically managed by automated bidding systems. The allocation algorithms try to maximise the value generated to all the parties involved by seeking to allocate adverts to the opportunities that maximise the generation of clicks, while subject to the limitation of capital available for the campaign.

Another major characteristic of web advertising is that it can benefit both large traffic web sites as well as the small blog page. The PPC model and the automated media planning system have created the ground for open and automated campaigns in which any web site can benefit from advertising revenue and any campaign can reach any web site. A web site does not need to attract a high volume of traffic to be considered a relevant advertising medium. Through affiliate programs, even a small website can offer relevant advertising opportunities and generate advertising revenue, as long as it performs well in attracting some niche segment.

2.1.4 Social Networking Sites

Social Networking Sites (SNS) have extended even further the already immense possibilities of web advertising by enabling campaigns targeted at very refined user profiles. Campaigns are mainly centred on the demographics of users, which may include detailed elements such as geography, age, job, company size or gender. Information about preferences or likes and the overall history of previous actions are also increasingly part of the targeting process. Additionally, social networks are particularly strong enablers for Relationship Marketing in which a brand aims to promote longer term and stronger ties with consumers in a way that extends far beyond traditional marketing messages.

2.2 Specificities of Digital Signage as an Advertising Medium

The evolution of the Digital Signage landscape in terms of technology, scale, openness and cooperation models provides a promising path towards the evolution of the medium and its support for more sophisticated advertising models. In particular, we consider two main evolutions that will provide fundamental contributions towards that objective: the emergence of open advertising markets for public displays and the systematic availability of sensing or interaction features.

Currently, the Digital Signage advertising market is very fragmented. There are many isolated display networks, each providing its own separate set of advertising opportunities and negotiation procedures. An advertiser who wants to create a large campaign may need to individually negotiate with multiple network operators to buy advertising space.

As a result, only large networks can have the necessary scale to be of any interest to advertisers. This limitation is being addressed with the emergence of advertising aggregators, such as SeeSaw, BookingDOOH, Vukunet, Argo Digital Solution or AdCentricity. These services collect information about the advertising opportunities across multiple display networks and provide a media planning service for matching adverts with advertising opportunities. This is opening the opportunity for automated allocation across multiple networks and for a global and open market for advertising in Digital Signage.

Systematically enriching Digital Signage with sensing and interaction capabilities represents the other major step towards new advertising models for Digital Signage. Public displays, whether digital or not, can be watched without generating any information on their usage, but without such information there can be no effective solution to the key issues of targeted advertising and impact measurement. Displays that react to the presence of people and offer them the possibility to interact will strongly enhance the user experience by enabling people, not just to be exposed to adverts, but to engage with content in a much more meaningful way. This increased engagement will implicitly or explicitly generate information for characterising social contexts and the advertising opportunity they represent. Even considering that the resulting information may never be as rich as click-through patterns on the web, it would still represent a major step forward when compared with the idea that displays are just to be seen by passive observers.

These evolutions may take the advertising models for Digital Signage one step closer to the rich advertising models supported by web advertising. However, one key observation from the analysis of advertising models across other media is also that the characteristics of the medium are central to the evolution of the respective advertising models. Therefore, despite the major role played by web advertising in setting the expectations for Digital Signage, we must also understand the specificities of Digital Signage and their implications in defining what the most appropriate model might be.

2.2.1 Proximity

Public displays are part of a physical and social environment that strongly determines their communication context. This means that not only geographic location, the type of venue, or the demographics of visitors should be considered for targeted advertising, but also other physical and social proximity elements. For example, two places sharing a significant percentage of visitors may be targeted in an integrated way enabling the mutual exchange of adverts or providing the ground for Life Pattern Marketing approaches (Zweben 2007) in which the same message is reinforced by being present, even if slightly adapted, in the multiple locations that a person may visit throughout the day. Also, nearby displays may act collectively to provide a consistent and strongly situated user experience, such as dynamic guidance services (Strohbach et al. 2009) that suggest directions to nearby businesses.

2.2.2 Place-sensitive

While web browsing is essentially an individual activity, Digital Signage is part of a social and physical setting in which adverts are seen in a shared environment. An effective advertising model must acknowledge the role of Digital Signage as an element with a potentially strong impact in shaping the places where the displays are located. It should, therefore, give the people responsible for the place increased control over the nature of the adverts displayed. If those adverts are not aligned with the place's values, practices or commercial strategies, their public presentation may become a source of embarrassment.

2.2.3 Generate Engagement

It has been argued in this chapter that a strong user engagement will be crucial for stronger advertising models in Digital Signage. However, achieving the type and level of user engagement that will enable audience characterisation and impact assessment is not very natural for this medium. It will require specific approaches for bringing people into interacting with public displays in ways that are both meaningful for people and relevant for advertising. Examples may include specific types of games, quizzes or polls, specifically designed for that purpose or models of shared control over the display in which increased engagement is rewarded with increased control. It may also mean that content adaptation should go beyond targeted advertising and be extended to other forms of content. Adaptive content will make the display more valuable to people, which will be more willing to express their preferences to influence displayed content rather than displayed adverts. For example, the ability to select content may enable targeted adverts to be injected into the selected content, while being valued by people.

2.2.4 Crowd Targeting

Public displays will typically have multiple simultaneous users and the adaptation process must consider the best strategy for dealing with the potentially varied interests expressed by those people. This generates a trade-off between the selection of adverts based on a profile combining the multiple interests of the multiple persons present and the selection based the use of each individual profile, one at the time (Alt et al. 2009). The first is a balanced approach, but faces the risk of not really matching anyone’s specific interests. The second approach can be targeted for each individual, but it raises additional privacy issues and may conflict with the idea of Digital Signage as a place-making tool.

3 A Design Space for Advertising in Digital Signage

This section will now consider how we can map multiple forms of sensing and interaction into the characterisation of advertising opportunities and their assessment. The challenge is that Digital Signage is likely to support multiple interaction modalities, from mobile technologies to touch-sensitive surfaces, and also multiple types of interaction semantics, in many cases associated with specific applications. Making sense of the myriad sensing and interaction events that can occur across a display network requires higher-level abstractions that are independent from the specific affordances or the semantics of the interaction offered by particular displays. Such abstractions should be able to play for Digital Signage a similar role to the one that click-through patterns and search phrases play for the web.

We propose a design space created around the concept of digital footprint as an abstraction for representing the traces left behind when people implicitly or explicitly interact with Digital Signage. A digital footprint focuses on the nature of the information generated about the interaction itself and abstracts away from the particular interaction modality being used or the particular application semantics in which the interaction occurred. They aim to represent preferences, characteristics and behaviour, regardless of how they are expressed. We have structured digital footprints around 4 main categories: presence sensing, self-exposure, user-generated content and actionables, as represented in Table 1.

Table 1: Digital footprints

Presence sensing (Detection, Characterisation, Identification)	Being physically there
Self-exposure	Explicitly managing exposed identity
User-generated content	Pushing content to the system
Actionables (Interactive, External)	Responding to the system

These categories represent not only different types of interaction, but also increasingly higher levels of engagement with the display system.

The design space that we propose associates the various types of sensing and interaction features with the type of digital footprint they can generate and maps these into the types of advertising functionality they can enable. This should inform Digital Signage creators about the relationship between sensing and interaction features and their possible role in the advertising process.

We will now describe these footprints in more detail, analysing how they can be generated and how they can contribute to the advertising process.

3.1 Presence Sensing

The ability to implicitly collect information about the presence of nearby people is an important element for characterising situations. Despite its stronger potential for generating rich information about usage, interaction events are necessarily sparser than presence events, as there will normally be many more people present than those actively engaged with the display at any given moment. Presence sensing is thus critical to enable targeted advertising to occur even when there is no one interacting. Presence sensing may involve increasingly complex levels of presence information, more specifically: the ability to simply detect presences (detection), the ability to characterise those presences (characterisation) and the ability to associate presences with unique entities across multiple sessions (identification).

3.1.1 Presence Detection

Presence detection is the most basic level of presence information in which the system is simply able to detect whether or not there is someone nearby, and possibly at what distance. Multiple off-the-shelf sensors can be used for this purpose. Distance to the display can be determined by combining presence sensors with different sensing ranges or using distance sensors that report distance. Computer vision techniques, such as frame differencing, can also be used to sense movement.

Information about the presence of someone near a display, even without knowing who or how many, can mainly be used as a trigger for presenting specific content, and particularly as part of an attraction loop designed to entice people to interact when passing-by. In *Community Wall* (Grasso et al. 2003) frame differencing was used as part of the presence detection system to prevent the display from changing content while someone was reading from it. Knowing the distance can be important for the display system because there is normally a strong correlation between distance and the awareness level that people may have about the display. If they are in a short distance, it is much more likely that the display is currently the focus of their attention. In the *Range whiteboard* (Ju et al. 2008), for

example, an infrared distance sensor was used to determine the distance of people using a whiteboard application.

The digital footprint generated by a presence detection mechanism is essentially a presence/absence pattern that may only provide a very basic characterisation of the place in terms of people flow.

3.1.2 Presence Characterisation

Presence characterisation is the ability to count and possibly determine particular characteristics about the presences detected near the display, which broadly corresponds to the concept of audience measurement. A vast range of audience measurement technologies has been emerging to estimate, not only the number of people in front of a display, but also to determine their attention span or inferring some type of characteristic about them, such as age or gender (Quividi 2010; Trumedia 2010). This normally involves placing a video camera on the display, typically on the top and facing the audience, and processing the images to generate reports about the number, attention span, and characteristics of viewers. In an attempt to set industry standards for these reports, the Digital Place-based Advertising Association (DPAA) (formerly OVAB) has produced a guidelines document that describes the Average Unit Audience as “the number and type of people exposed to the media vehicle with an opportunity to see a unit of time equal to the typical advertising unit” (Spaeth et al. 2008). These guidelines have a clear focus on what is normally called the Opportunity to See (OTS) and on three qualifying characteristics associated with that opportunity: Presence, Notice and Dwell time.

Audience metering techniques are very important for the Digital Signage industry because they may help to justify and value advertisement investment. However, they assume a model in which the objective is simply to estimate the number of people potentially exposed to an advert, without considering what their real engagement might be. Presence characterisation can also be used for targeting adverts according to the characteristics of the current audience, as for example in the case of the Eye Flavour that selects adverts based on age and gender (NEC 2009).

3.1.3 Presence Identification

Presence identification is the ability to identify unique identities within presences and thus recognise different visits by the same person. A common approach involves the use of a personal device as a proxy for the person. Bluetooth has been extensively used for this purpose, as it is widely available and enables many mobile phones to be discovered and uniquely identified through their Bluetooth address. Radio Frequency Identification (RFID) tags can also be used. They are small and can easily be incorporated into many existing artefacts, as exemplified by the IntelliBadge system (Cox et al. 2003) in which conference participants

were given RFID augmented badges and then tracked through the conference rooms. A display would then generate several visualisations of the resulting data.

Presence identification raises considerable privacy issues and therefore it should only occur as part of a process in which people are informed and value the extra functionality that the existence of this information may be providing. The ability to enable or disable presence identification according to the circumstances would be equally important. This is a point in which Bluetooth, which allows discovery to be easily disabled, takes considerable advantage over RFID tags.

The digital footprints resulting from presence identification correspond to individual presence information and open many new opportunities for the advertising process. They may serve to build individual profiles that characterise people according to their presence patterns, e.g. regular visitors vs. first-time visitors. They can be used to optimise advertising by selecting adverts that have not yet been shown to the people that are currently present, as exemplified by the BluScreen system (Sharifi et al. 2006) that uses Bluetooth detection to avoid showing advertisements to users more than once. If a network of displays is involved, presence identification may also serve to show some variant of the same advert to the same person at different locations, thus reinforcing the message, or to select adverts based on where the person has been before. The existence of multiple sensing points would also enable new forms of impact assessment. For example, it may be possible to measure how many people who have been shown an advert about a nearby store will then go to that store, or simply how the number of first-time visitors has increased as the result of a campaign.

3.2 Self-exposure

Self-exposure is the ability of the display system to collect information that people have explicitly created to represent their characteristics, preferences or personal tags. This personal information can take many forms, such as a reference to a user's personal webpage, the user id in a Social Networking Site or a purposely created profile. Self-exposure should also be seen as way for people to take control over how their identity is projected in the public space by the Digital Signage. It should be part of a process whereby people expose something about them because they understand and value the implicit response of the display to that self-exposure. Moreover, the intended level of self-exposure may be strongly influenced by a broad range of circumstances. Therefore, a key feature for self-exposure mechanisms is some type of control on how that exposure should occur at any given moment. This means not just the ability to enable or disable presence detection, but also the ability to dynamically manage self-exposure in a way that is easily controlled and understandable. Self-exposure differs from presence in the sense that it is an explicit act of identity management, while with presence we assume that all the information was implicitly generated. It differs from interaction in the sense that there is no pre-established connection between self-exposure and

a specific type of reactive behaviour by the display system. Potentially, different display systems may react very differently to the same form of self-exposure, or even the same system may also react differently under different circumstances.

Self-exposure may be achieved by combining presence identification with the *a priori* definition of a user profile that is associated with the identity. In Proactive Displays (McDonald et al. 2008), users attending a conference registered their affiliation, interests and personal webpage before the conference day and were given RFID augmented conference badges at the conference site. Throughout the conference, several displays reacted to the nearby participants showing and creating associations between their profiles and creating opportunities to socialise. A limitation of this approach is that people could not easily change their profile, and had no control over what information to expose at any given moment. Another alternative is the use of a personal information device running a custom application to manage and expose a profile. This application can connect automatically, or on demand, to the display system and communicate users' preferences. This can be exemplified by the Hello.Wall (Prante et al. 2003), a system in which people would carry a *ViewPort* device (a modified PDA) to communicate with an ambient display. Similarly, in the Camera-Phone (Toye et al. 2004) system, a custom mobile application can be configured with personal information that is made automatically available to the display system when a user interacts with it. One advantage of these approaches is that the information is always available to be updated by its owner and it may be possible to have greater control on how to manage self-exposure, but they have the disadvantage of requiring a dedicated application. The use of Bluetooth names to express self-exposure, as explored by Jose (Jose et al. 2008) and Davies (Davies et al. 2009), is an opportunistic alternative that is easily available on almost any device. It allows people to enter predefined commands in the Bluetooth name of their mobile phone. When that person approaches a display, these commands can be obtained and interpreted as part of the person's preferences. For example, Ribeiro (Ribeiro and Jose 2010) has shown how tags exposed this way by multiple people could be used to select from the Internet content feeds for presentation on a local display.

In all the previous examples, there was the assumption that information would be specifically created for the purpose of influencing a display system. However, a very promising alternative is to explore connections with the many Social Networking Sites where people already have extensive descriptions about themselves and their preferences. WhozThat (Beach et al. 2008) uses the SNSs profiles of people nearby to create context information that can then be used to support spontaneous interactions or drive the music selection. People are expected to use a mobile phone running an identity sharing protocol that will advertise their on-line identities to the other nearby devices. This system does not consider the use of Digital Signage or any explicit selection of which information to share, but it is an example of using SNSs profiles as a sort of personal data aura that can be used to mediate digital self-exposure. (Böhmer and Müller 2010) conducted a study on the exhibition of SNSs profiles in public settings. Using mockup images they asked people about their willingness to expose profile information in two types of what

they called social signs. The first was a personal social sign projected around the person and showing parts of the respective profile. The second was an interpersonal sign, projected in such a way to link two people and representing some type of connection between them, such as having a mutual friend or sharing an interest. The study provides an interesting example of the type of identity projections that can be generated by these connections with SNSs.

Information associated with self-exposure footprints can be very varied. In its simplest form, the result may be just a list of keywords generated from multiple forms of preferences expression. However, with access to profiles, much more structured information can be obtained. The potential of self-exposure in the advertising process is particularly relevant for targeted advertising, where depending on the type of information collected, it may support multiple forms of targeting, such as demographic, contextual or behavioural.

3.3 User-generated Content

User-generated content is the ability of the system to accept content originating from the users of the display. This is achieved by allowing people to post their own content for publishing at the display, either directly or indirectly through a reference to the content (e.g. a URL). Many displays have been created that support some variant of this feature. WebWall (Ferscha and Vogl 2002), for example, allows people to submit content using SMS, email or a web interface. The Plasma Poster (Churchill et al. 2004) system supports content (photos, text, web pages) submission through two interfaces: email and a web form. MMS has also been extensively used as an input interface for display systems. For example, the Joe Blogg project (Martin et al. 2006) includes a display designed in the form of an interactive artwork where people can send pictures and text messages through MMS or SMS. Bluetooth can also be used to push content to a display system using either standard OBEX exchanges or custom mobile applications. Both Hermes (Cheverst et al. 2005) and Snap and Grab (Maunder et al. 2007) use the OBEX feature to enable users to send pictures and other media to a display. In both cases, the user just selects the content on his mobile phone, selects the “send via Bluetooth” command and selects a particularly named device. An example of a custom Bluetooth application for sending content is Touch & Interact (Hardy and Rukzio 2008), which allows users to choose a picture in their mobile phone and touch the display in the position they want to place that picture. The main advantage of a custom application is that it can be built to interact specifically with a given display, thus allowing a richer and more convenient interaction. For example, the application may be able to automatically determine the Bluetooth address of the display system, alleviating the user from the task of manually searching for nearby devices and selecting the correct device name. The application may also be able to determine beforehand what type of content is acceptable by the display system, impeding the user from sending content that will be rejected. OBEX on the other

hand, has the obvious advantage of not requiring the installation of any additional software in the mobile device, and thus enable more opportunistic interactions. Also, from a developer's perspective, OBEX is more attractive because, given the multitude of different devices, it is often the case that multiple versions of the application have to be created to deal with the hardware and software variants in devices. Also, these applications must be somehow distributed to users which may be yet another barrier to usage.

When generating content to a display, users are implicitly associating that content with that particular place. The nature of the digital footprints generated by such process depends on the type of content. However, the analysis of the content and its meta-data should produce a relevant characterisation of that place and its local practices. This is already common on the web, where a vast and sophisticated range of techniques has been emerging to analyse user-generated content. For example, tags in Flickr images have been used to extract place semantics (Rattenbury and Naaman 2009), and tweets have been used to determine mood and emotions (Bollen et al. 2009). If displays were able to generate enough content from users, similar techniques could also be applied to generate footprints that would be very relevant for targeted advertising processes.

3.4 Actionables

Content on Digital Signage is often some type of actionable, a message or an interactive feature intended to cause people to act (Müller et al. 2007). Actionables provide a specific demand for action, such as downloading a content item, selecting one of several available options or reading a 2D code from the display. An actionable footprint represents a reaction to one of those actionables.

Generating this type of footprint requires some mechanism for tracking the actions taken and also some type of system-wide reference for the actionables, e.g. a URL or some unique Id. The existence of a unique reference that can be tracked system-wide separates actionables from the myriad interactive features that may exist in a display system and which in many cases will not be meaningful outside the specific application in which they are available.

Actionables may provide one of the most promising paths for advertising in Digital Signage. They enable several forms of automated impact assessment and advert valuation, ultimately leading to something similar to the pay-per-click concept. When considering how to generate actionable footprints, we need to take into account two major types of actionable: interactive actionables in which the reaction occurs within the system and can thus be automatically detected by the system; and external actionables in which the action that the actionable is promoting occurs outside the context of the display system and cannot be tracked directly by the system itself.

3.4.1 Interactive Actionables

Interactive actionables are invitations to interaction that can be interpreted by the system. They involve giving users some type of control and being able to track their options. Allowing people to pull content from the display system is a common example of an interactive actionable. Knowing who has downloaded which items enables the system to infer interest on the content items that are being offered. Giving people some type of control over the system behaviour may also be used to generate interactive actionables. For example, Jukola (O'Hara et al. 2004), which allows people in a bar to vote on the next music to be played by selecting music from a list, is an example of a system that could generate this type of footprint. Rating content items allows people to explicitly say they like or dislike an item. Ratings give the display system information about the popularity of content items. It is also possible to conceive a Games With A Purpose approach (Ahn and Dabbish 2008) in which all sorts of polls, quizzes, questionnaires, or games are designed to provide engaging experiences, while allowing the display to collect users' preferences and interests. These actionable footprints may be anonymous or identifiable depending on the interaction mechanism provided, but the key point is that the meaning of the reactions can be interpreted system-wide and not just within the scope of a particular application.

3.4.2 External Actionables

With external actionables, the intended action is to occur outside the scope of the display system, and therefore, the system is unable to automatically assess their efficiency. At best, their efficiency can be assessed through some type of off-line mechanisms, such as the collection of redeemed coupons.

MobiDiC (Müller and Krüger 2009) is an example of the use of digital coupons in public display advertisement. The public display shows adverts with coupons that people can photograph with their mobile phone and redeem at the associated shop to receive the announced item. The time and location where the ad was displayed is encoded in the coupon. When the coupon is redeemed and the shop owner enters the code back to the system, the specific advert and display are identified and the aggregated results can tell how successful the advert was.

3.5 Analysis

Our goal with this design space was to inform the process of mapping multiple types of sensing or interactive features in Digital Signage into specific advertising models. The digital footprints that have been presented support the first part of that mapping. By focusing on the essence of the information generated from sensing and interaction features, they provide a framework for reflecting on the mean-

ings of interaction without being caught by the specificities of any particular interaction mechanisms. In this final analysis, we discuss the second part of that mapping, which is to describe what types of digital footprints may be needed to support specific pervasive advertising goals. We hope that, by making the relationship between advertising goals and footprints more explicit, this framework may contribute to focus the design of public displays on the data generation objectives, while avoiding the pitfalls of focusing too much on a particular application or interaction technique.

Table 2 presents a summary of these mappings. Several types of advertising goals are listed and associated with the specific types of digital footprint that could support them.

Table 2: Mapping between advertising goals and digital footprints

Advertising goals	Digital footprints
Attraction loops	Presence detection can trigger specific content to get people's attention
Audience measurement	Presence characterisation may provide sophisticated reports about viewers and their attention
Demographic Targeting	Presence characterisation may infer basic demographic information from presences, but self-exposure and specific actionables may generate even richer information, given that they involve people explicitly saying something about themselves.
Contextual Targeting	Self-exposure and specific actionables may generate keyword sets and other types of aggregate descriptions that will help to dynamically characterise the context of a public displays in ways that are relevant for contextual targeting, such as hot keywords, social situations or on-going local activities.
Behavioural Targeting	Presence identification and identifiable actionables generate rich information about people's behaviour and enable multiple types of behavioural targeting. Presence identification will mainly revolve around presence patterns, possibly at multiple locations, whereas actionables will revolve around expressed preferences inferred from actions.
Optimise individual exposure	Presence identification supports several types of optimisations related with specific individuals, from avoiding repetitions to purposely generating periodic repetitions for reinforcement.
Impact Assessment	Actionable footprints provide the most appropriate measure for engagement and therefore for really understanding the reaction of people to the message

Based on this framework, Pervasive Advertising solutions may start by setting their specific goals, consider the digital footprints that the display systems may need to generate, and finally conceive sensing or interactive features that are capable of generating the appropriate information while providing an adequate user experience. This last step should also consider that these different digital footprints are not completely independent from each other. They are more like a stack of increasingly richer information about the audience of a public display. For example, availability of presence characterisation also generates presence detection. Presence identification is implicit in self-exposure and identifiable interactive actionables. The correct choice of the interactive features may optimise the generation of the most appropriate set of digital footprints.

4 Conclusions

Advertising models define key properties of the advertising process within a particular medium. More specifically, they should address key issues such as how to target the message to the most relevant opportunities and how to measure the impact of a campaign. Advertising models for Digital Signage are still very limited regarding these two key points, especially when compared with the rich and sophisticated web advertising models that are increasingly part of the mainstream advertising industry. Interactive displays and the emergence of open display networks are two trends that will necessarily re-shape the medium and will also open entirely new possibilities for advertising.

We have presented a design space that maps between interaction mechanisms and their contribution to the generation of digital footprints that are relevant for targeted advertising. While this design space has been conceived mainly for Digital Signage, many of these same concepts would also apply to other situated forms of situated marketing, such as Bluetooth Marketing. Overall, the emergence of a generic footprint model would represent a fundamental shift from advertising based on measuring attention to advertising based on active engagement with people. This would in turn provide a major contribution to overcome some of the most fundamental limitations in current models for advertising in Digital Signage.

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