

# How Content Drives Interaction With Public Displays

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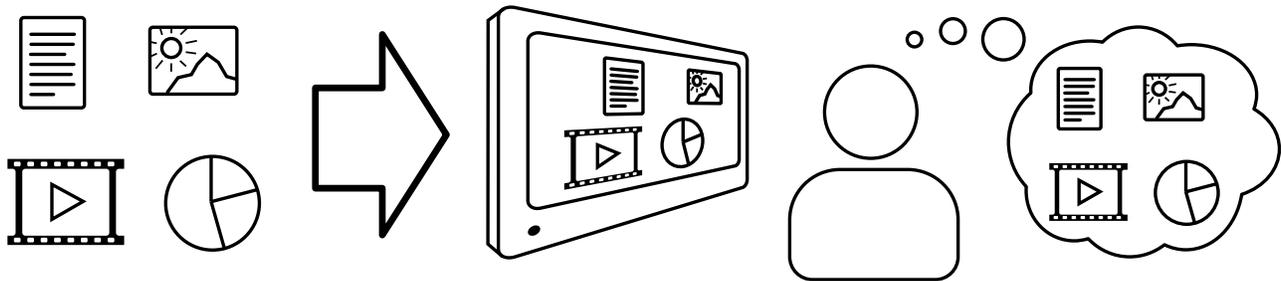


Figure 1: A visual summary of the role of content for public displays.

## ABSTRACT

Existing research into user engagement with public displays tends to focus on aspects of visual and interaction design, with less thought given towards how the choice of content may influence user behavior. In this article, we survey the existing literature, particularly deployment studies of public displays, for lessons learned on the ramifications of content with different properties. We find that local and timely relevance of content, as well as user-driven content creation, have been independently shown to foster user engagement, but that few other solid conclusions can be drawn from the literature. On the whole, the aspect of content tends to be underspecified and not fully reflected in studies of public displays.

## CCS CONCEPTS

• **Human-centered computing** → **Displays and imagers**; *Ubiquitous and mobile computing*; • **General and reference** → *Surveys and overviews*.

## KEYWORDS

public displays, public screens, attention, user engagement, literature survey

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## 1 INTRODUCTION

Public screens, especially interactive ones, have been used for many novel experiences far beyond static images or text. At the same time, an increasing presence of public displays that are perceived as useless or undesirable (most commonly advertisements) has contributed to phenomena such as *display blindness*, where public screens are ignored by people passing by [19]. Large commercial operators of public displays have understood this problem and reacted with new strategies that intertwine enticing content, such as weather forecasts, news bulletins, or quiz games, with traditional advertisements to hold users' attention more consistently [24].

In the academic sphere, much research on public displays is being done, including on how they should be designed to provoke users into engagement and interaction [18]. There are theoretical models for user interaction across time and space, multitudes of interaction techniques have been invented and tested, and users have been observed at scales from single users in front of individual screens to populations interacting with networked fleets of public displays [10].

Surveying this research, we find that not much systematic reflection has taken place regarding the *content* of public displays (in contrast to interaction techniques and design parameters). In most documented deployments the content is either tightly linked to the purpose of the study with no attempt to reflect on it separately (e.g. Grace et al. [11]), or the display content is externally imposed and the researchers only have limited influence on what is presented, as is often the case in studies involving existing long-term deployments of public displays (e.g. Michielsen et al. [16]).

This widespread lack of consideration of the display content leads to a blind spot in the research landscape. To highlight and address this gap, we present a preliminary literature survey of existing case studies and other empirical research on public displays with regards to aspects of content. We summarize what they have to say on the topic and draw conclusions from observations validated by more

than one study. We hope that our results can serve as an inspiration for designers and operators of public displays to consider aspects of content more deeply in their own work.

## 2 RESEARCH FOCUS

We need a working definition of *content* in the context of public displays that will allow us to examine prior studies through it and draw useful conclusions. We considered limiting our definition of content to media artifacts that are shown on the display, such as pieces of text, symbols, images, or videos. These kinds of content are usually created or curated in advance and then rotated on the display according to some scheduling method in such a way that the display would always look fresh to passers-by. As evidenced by specific research into scheduling algorithms for public displays [3, 5, 17], this notion of content is widespread in practice. However, during our investigation of experimental public display deployments we realized that such a narrow definition could exclude other types of content that are worth examining, such as dynamic content that is generated in real time based on user interaction. Thus, for the purpose of this paper, we arrived at a broader definition: *Content is all displayed information, independent of its visual design*. In other words, we investigate *what* is shown on screen, and how it influences user interaction and behavior. Any aspects only pertaining to *how* information is displayed (visual design etc.) is not part of our definition of content.

Fig. 1 gives a visual overview of the way this information reaches a user: content artifacts, regardless of their origin, first exist as abstract pieces of information, presumably stored somewhere as digital data. Following that, they are shown on a public screen at a concrete point in time and in a specific location. If someone is present in front of the display when the content is shown, there is a chance that the user will process and remember some of the content they see.

Our primary objective is to determine if existing research allows for conclusions to be drawn regarding whether specific kinds of content cause passers-by to react in different ways.

## 3 METHODOLOGY

Our ambition going into this research was to get an overview of the research landscape regarding public displays and their content through an analysis of the existing literature. To that end, we started with searches for relevant keywords and their combinations (such as “public displays”, “public screens”, “content”, “information”) in relevant literature databases including the ACM Digital Library and IEEE Xplore. We extended our list of potentially relevant articles through searches on aggregating search engines, namely Google Scholar, Elsevier Scopus and Internet Archive Scholar.

Each of these sources sorts its search results by some internal measure of relevance towards the search term(s), which in our case appeared to work very well: highly relevant articles tended to appear most often within the first 50 search results, whereas the relevance of the results dropped off steadily from there on. We examined at least the first 100 results for each library and query and then stopped on the first stretch of 10 articles that appeared entirely irrelevant based on the title and abstract. Unsurprisingly,

there was a lot of overlap between the search results in different libraries and search engines.

Through this process, we looked at approximately 200 articles of ostensible relevance to our topic. We were able to quickly filter results that were obviously irrelevant to our question based on the title, e.g. articles that had no connection to public displays at all. Wherever the title seemed promising enough, we decided based on the abstract whether the paper in question warranted closer inspection. We then searched the remaining articles for research claims, results, or other statements relevant to the content of public displays, and also followed promising citations to uncover threads of research that our keyword search had missed. Of the many papers we surveyed that discuss concepts or evaluation studies of public displays, most make no claims or observations about display content at all.

At the end of our literature survey, we had gathered 21 papers containing pertinent results ranging from perception psychology to content scheduling to numerous field studies examining the use of public displays in different settings [1–16, 19, 21–23, 25]. The most challenging part was to find concrete results matching our definition of content, because most of the research focuses on getting the audience’s attention through dynamic and vivid design [6]. Additionally, the term *content* is sometimes used to describe aspects to which we would refer as *design*, such as the size and positioning of visual elements [21]. Despite these difficulties, we are confident that the following findings are tangible since there is still some overlap regarding several interesting aspects.

Our literature research does not aim to fulfill the criteria of a systematic literature review as described e.g. by Okoli [20]. Most notably, the inclusion or exclusion of papers in our review is based largely on initial or overall impression instead of specific criteria defined in advance. Additionally, we did not keep track of which specific articles were deemed as irrelevant at what stage of the review process. We feel confident that our process captured the core of the pertinent body of research, but a full systematic review may yield more exhaustive results. The reasons for our approach are pragmatic rather than scientific: this work was conducted as part of a university course, where a full systematic literature review would have been out of scope, and we would not have had enough time for it. This paper should therefore be regarded as a research probe to prove that interesting answers to the research question *can* be found, and which gives preliminary results to motivate the potential for a deeper investigation than we are able to provide.

## 4 RESULTS

The content of a public display undoubtedly plays a core role, as it is always the goal of a display owner to convey certain information. In many cases, this goal is to promote products or events in order to attract more passers-by to what is being promoted. However, the range of applications goes much further, from signage, info boards to pure entertainment [8]. The content is decisive when it comes to determining the function of a public display. However, there is no explicit answer to how much the initial perception is influenced by the displayed information. When a public display catches the attention of passers-by, the content must be quite relevant to keep the user’s interest high, consequently prolonging the time spent in

front of the screen. Still, since this step must be preceded by people in the relevant area noticing the public display, capturing the gaze of passers-by is the more important task. Due to the ever-increasing number of public displays, passers-by tend to ignore or block them out. This effect is called *display blindness* [19] and is conditioned and intensified by the fact that many screens only show generic content, which is uninteresting for most users. Hence, *display blindness* presents a major hurdle to overcome, if a screen is to be recognized. One high-level goal to break through this barrier can be to ensure that the displayed content is relevant to the current user, thus establishing public displays as approved sources of information in the long run.

However, if we try to answer the question, which type of content is best suited for this task, we come across different and sometimes even contradictory statements. The intersection of several studies [9, 16, 22] finds that local content is often perceived as particularly relevant because it appears less general and more tailored to potential users. This approach is less effective in public places visited by a demographically and culturally diverse crowd, where there tends to be many more different interests, increasing the proportion of people for whom local content is less interesting [4]. Public display systems that use multiple screens run the risk of losing relevance if passers-by have the feeling that they see the same or too similar content on every display [7]. The content design of multiple-display systems must therefore be done very carefully in order to prevent losing passers-by to display blindness.

Another aspect is the correct timing of what is shown. Some content, such as weather forecasts or global news, tends to have broad relevance, provided that it is updated frequently enough. The timing for content that just offers value to the user for a short period of time is significantly more difficult. If such information is shown too early or too late, viewers conclude that the public display serves no purpose [3]. Regarding the variation of content over time, there appear to be some contradictory results. Alt et al. [1, 2] ascertain an increased attractiveness of public displays that show changing content. In contrast, Huang et al. [13] find that even public displays with varying content were not able to prevail over analog information sources, such as flyers. Of course, this does not completely refute the previous statement, but weakens it nevertheless and shows that this measure alone is not sufficient.

Another aspect that is mentioned several times in existing research is user-generated content, which some studies attributed with increased interaction. According to Do et al. [9] and Jose et al. [14], contributions from the local population provide for a strengthened appreciation of what is shown, since this appeals to a sense of belonging of fellow citizens, while also motivating other people to contribute, driven by the motivation to influence the content of the screen and the possibility to see the self-created content in public. The positive effects of content of this type are countered by the findings of Michielsen et al. [16]. Some of the interviewees in that study expressed disinterest, as content created by private individuals is only interesting for themselves, or because too many contributions show something that most locals are already familiar with.

Finally, Huang et al. [13] question the effect of content on the perception of public displays entirely. Based on their observations of displays featuring numerous different types of content, they were

not able to confirm any differences in user attention or engagement based on the content of the display.

## 5 DISCUSSION

Considering the literature examined for this work, we can say that there are different properties of content which ultimately decide its impact. We have discussed local or user-generated content. Both are presented as attention-grabbers independently by different authors and there is often a correlation between them, since in many cases user contributions are also locally inspired. We urge public display operators to consider whether local or user-generated content can fit into their content strategy. Changing the content frequently is mentioned in a positive way in more than one article and thus can be seen as a step to make a display stand out and avoid the perception of it being outdated or abandoned.

Still, most literature we found was focused on improving design, and articles that looked deeper into content often did not analyze their findings in enough detail to make statements about the impact of the content. Conducting an empirical study dedicated solely to the content would be helpful to make more definitive statements.

Coming back to our primary objective, we cannot give clear answers regarding which types of content cause passers-by to react more intensively. Nevertheless, we hope to present a useful overview of relevant findings and to sharpen the awareness towards content on public displays, as it plays a more significant role than many existing studies seem to give it credit for. Improving the content strategy may be a novel way to overcome display blindness in some cases.

As already stated early in Section 3, we cannot rule out the possibility that we may have missed research into content on public displays during our literature survey, for example if the text in question uses very different vocabulary for its core concepts and hence would elude our keyword search. A more systematic approach to the survey, although requiring a bigger time investment upfront, may uncover more relevant literature. Another promising avenue for future research would be to relate studies of public displays to insights about more distantly related areas of media design, such as print or television advertisement. By virtue of their longer history, research into the relation of content and consumer attention has had a bigger chance to develop for other forms of media, and valuable lessons may exist there.

## 6 CONCLUSION

As we have shown, multiple studies corroborate that the locality of public display content, as well as its timely relevance, are important factors in drawing users' attention and avoiding display blindness. Giving users the option to provide content for public displays may also be a promising way to foster interaction.

Beyond these points, the view becomes hazier. We have found that our initial question, whether there are types or categories of content that are particularly effective on public displays, has few clear answers in existing research. If there is a main conclusion to draw from the surveyed literature, it is that the content of public displays suffers from a dearth of reflection and examination compared to their design. We are hopeful that this work can inspire designers and operators of public displays to consider how content

relates to their effectiveness and evaluation, and to foster better documentation of content strategies in future deployment studies.

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