Exploring affordances through design-after-design: the re-purposing of an exhibition artefact by museum visitors

Museums have increasingly focused on digital technologies and play as means to provide personalized, engaging experiences for their audience. Balancing educational and playful values is often conflicting. To address that conflict, museums often employ participatory design strategies. However, those strategies usually end after the deployment of those experiences, thus they do not accommodate for what occurs during actual use. In this article, we follow Light House, a research-through-design experiment of an installation that was developed using an iterative design approach which expands on actual use by deploying undetermined artefacts to support the discovery of novel interactions by visitors. Through our findings, we explore the “failure” of Light House to support the discovery of such interactions in relation to its educational character, but rather it inspired people to incorporate it in the activities supported by the surrounding space. Finally, we discuss the implications those discovered interactions in terms of potential re-design directions.

CCS Concepts: • Human-centered computing → Empirical studies in HCI; Empirical studies in interaction design.

Additional Key Words and Phrases: design-after-design, participatory design, museums, play

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1 INTRODUCTION

When developing playful experiences involving digital technologies in museums, there has been much interest in employing participatory methods [10, 21, 32, 34, 36]. However, those approaches often stop at the point of deployment [37]. Since, traditional lab-based usability tests fail to mimic the conditions of visitor behaviors in exhibition spaces [22], design approaches which account for the post-deployment functional phase of the artefact are necessary to address unpredictable technical issues [24] and discover new ways which visitors might engage with an artefact [1]. In other words, it is necessary to expand participatory processes to accommodate for that post-deployment state and engage with “design-after-design” [6] – a concept developed by Redström [29] which refers to the re-purposing of an artefact by the users after that artefact has been deployed. Such an approach, then, can capture the new uses that are discovered by the visitors and use them to inform potential re-designs of the artefact. For that to occur, the artefact itself needs to be open and undetermined, giving the opportunity to the user to define it through their use based on their own motives and interests [5, 14, 29, 30].

In this article, we are presenting our findings regarding a research-through-design [18, 30] experiment we set in-the-wild [8]. Our experiment consists of Light House, an installation set in the space of the NN architecture center for a period of five months. The installation’s focus was to help visitors explore the effects of natural and artificial light in architecture. Our work explores a design process which focuses on inspiring people to discover novel uses of the artefact at hand through facilitating the re-purposing – and design-after-design [29] – of the artefact. Through
discussing the various design implications revealed by our artefact, we contribute to the ongoing discussion regarding the incorporation of the post-deployment re-purposing of artefacts by users, in participatory design processes.

2 RELATED WORK

Museums have increasingly employed digital technologies as means to create personalised [2, 22, 26], educational [7, 31, 38, 40], and playful [3, 4] experiences that engage the senses [11, 16, 19, 24, 39], as means to position themselves in the experience economy [25] and move towards a participatory agenda [10, 36]. Designing for play may give users rich opportunities to appropriate technologies [17], but may also create conflicts with norms and stakeholder views of appropriate museum activities [24, 27]. Therefore, it is necessary to establish design processes that can support the need for play in museums, while addressing those issues that are associated with it.

To support the development of those aforementioned experiences museums turn towards participatory design (PD) processes [2, 9, 13, 20, 23, 32, 33], specifically when focusing on exhibition development and evaluation of deployed exhibits [37], or as means for discovering the motives, expectations, and interests of visitors [36]. However, those processes do not accommodate for the “design in use” – i.e. what happens once an artefact is available to the user – and thus failing to incorporate in the design process the re-design which happens through the re-purposing of the artefact by the users [6]; what Redström [29, 30] refers to as “design-after-design”. Regarding that, he [29, 30] suggests the deployment of “unfinished”, undetermined, and open to interpretation design artefacts when focusing on design approaches that facilitate design-after-design. Empirical uses of design-after-design are explored in studies that range from software targeted towards healthcare [35], to data collection frameworks [15], to supporting user’s product adaptations [28] or as a tool to generate new designs from users’ re-purposing [5], with all those studies attributing an active design role to the user, due to their ability to discover new uses and re-purpose artefacts. Design approaches which focus on design-after-design in museums have the potential to incorporate that active design role in the visitor experience, supporting the visitors in pursuing their interests when it comes to engaging with the interactive artefacts. Furthermore, such a process can address the tension between stakeholder’ expectations and playful visitor behavior [24], by using the post-deployment re-purposing of museum artefacts by the visitors as inspiration for re-designing the artefacts in ways that both visitors find engaging and stakeholders see value in their dissemination qualities [1].

3 METHODOLOGY

For the purposes of this experiment, we adopted the method of research-through-design [18, 30] as part of a research program which explores designing for the re-purposing of playful artefacts in the exhibitions spaces of cultural institutions. That method has the potential to submit artefacts that generate a discourse regarding the role of re-purposing in museum spaces, the design implications of releasing open-ended artefacts, and how to use the resulting re-purposing to re-design those artefacts.

Our approach follows an iterative design process that we proposed in a previous research effort [1] (figure 1). Employing Davis’ theory of affordances [12], we have suggested that the process of designing for design-after-design may be conceptualized as initially designing allow affordances – i.e. neutral affordances which do not directly support or deny specific behaviors – and in later iterations transform these into encourage or discourage ones – i.e non-neutral affordances that either suggest or oppose specific behaviors, while never prohibiting them.

Initially, the designer assesses the design situation at hand and, then, deploys an undetermined, open-ended artefact which primarily supports allow affordances – specifically regarding the elements that the designer wants the user to re-purpose. Following that, the designer observes the user interaction with the artefact looking for novel uses and
re-purposing. Finally, the designer re-designs the artefact based on what was observed, looking for ways to transform the *allow* affordances which were used in those novel uses into *encourage/discourage* ones, thus giving future visitors support to uncover those discovered uses easier. The idea behind that transition is that *allow* affordances are neutral and do not suggest specific ways of interacting, while *encourage/discourage* are suggesting possible uses of the artefact to its user. By transforming those affordances the object now provides "suggestions" through encouraging the visitor, or discourages the visitor away from specific behaviors. Through that transformation, we still maintain the open-ended quality of the artefact since we do not prohibit any specific behavior – all previous behaviors are still possible – while we also highlight its engaging qualities as discovered by past visitors. Maintaining that open-ended quality helps the further iteration of the process to reveal further novel uses.

To test that process we developed and deployed in-the-wild [8] *Light House*, an installation about Architecture and playing with natural and indoor light during the various seasons in Denmark. Through that, we went through one iteration of the suggested process. *Light House* was developed as part of the first author’s PhD project in collaboration with the NN institution – an institution dedicated to the dissemination of architecture. Our experiment began in December 2020, once its development began, and ended in October 2021, once the installation was removed from the exhibition space. During that period, as part of the evaluation of *Light House*, we gathered data – through note-taking – from meetings and discussions with the NN management stakeholders, and *hosts* – i.e. floor staff that are responsible for having conversations with visitors regarding architecture and facilitating their experience. We also conducted personal observations of visitors interacting with our artefact, with the primary author carrying out four scheduled observations of approximately two hours each, while also engaging in daily ad-hoc observations as part of the institution’s staff,
both for observing novel uses and perform maintenance of the installation. Interesting behaviors were documented using photographs and note-taking.

During the design process, the first author was responsible for the design decisions and was largely free to make those decisions. The stakeholders held an advisory role, providing suggestions regarding which design elements fit their exhibition space, raising concerns based on their observations. The analysis of the results was conducted by both authors.

Due to the ongoing pandemic of COVID-19 there were difficulties when studying visitor interaction, both due to reduced visitor numbers as well as social distancing policies.

4 LIGHT HOUSE

In our previous endeavor \[1\] we employed the suggested design process to design an installation that focused on visitor creativity and self-expression – i.e. interactions through which visitors can create something – through the supply of tangible artefacts. That support for creativity proved to be fertile ground for re-purposing. Following that experiment, we wanted to challenge our design process by designing an artefact that aimed to be a playful and interactive, while minimizing possibilities of self-expression on its core interaction. By doing so, we wanted to capture how the visitors would re-purpose the artefacts interactions when self-expression is not in the center of the experience, and what do those results tell us regarding potential re-designs – step six in the proposed design process (figure 1).

With Light House we aimed to set up a small installation inside an exhibition space dedicated to family interactions and learning. That decision was made primarily because Light House was going to be a playful installation, deemed as a good fit for families. The core elements of that installation were agreed to be the following four: (1) the installation should focus on the senses and, specifically, light, (2) its interaction elements should be oriented towards families with children, (3) the installation should be open-ended supporting the discovery of novel interactions by visitors, and (4) interaction elements which support interactions related to self-expression should be kept to a minimum, thus, challenging the activity of re-purposing.

Our development of the Light House installation began in December 2020 with a conceptual design that was subsequently turned into 3D renderings (figure 2). The institution’s stakeholders wanted to explore the theme of light and architecture. That focus was motivated by the potential for interactive lights to expose that architectural element, contrary to traditional means of architectural dissemination. As a result, the Light House was designed around helping visitors explore the following question:

How can the combination of natural and artificial light affect the mood of indoor spaces?

We wanted to support interactions between children and their guardians, since the installation would be placed in the educational space targeted towards them. That led us to use a small plywood house model (130mm tall, 100mm wide, 100mm deep) which was re-purposed from a previous exhibition. The house had a window on the right wall and another window on the left side of the roof. That choice was based on the different sizes between children and guardians. Children could enter the house and experience it in the inside, while guardians can reach the roof window and look inside.

Another aspect of Light House was its lighting. The installation had one smart bulb – emulating indoor artificial light – and one smart LED strip – emulating outdoor seasonal light. The visitor could control the settings of the lighting through the control panel that we installed on the roof of the wooden house. We selected that location for the panel to give the controls to the guardian, while children can experience the changes from the inside. The control panel
Fig. 2. 3D rendered sketches of Light House

(figure 3) consisted of (1) a 3D printed case, (2) eight buttons that controlled the light settings of the LED strip, (3) one showcase button, (4) two potentiometers which controlled the light settings of the indoor light bulb, (5) a Raspberry Pi and Arduino pair that process the inputs of the panel, (6) a screen that was connected to the Raspberry Pi and acted as a digital label which displayed the current setting of the lights. Through the panel, the visitor were able to select the season (Winter, Spring, Summer, and Autumn) and time of day (Morning, Noon, Evening, Night) using the white buttons on the right of the screen. The selection would determine the color and intensity of the LED strip. They were also able to change the color temperature and intensity of the indoor light using the potentiometers. The transparent button on the left initiated a sequence during which the LED strip light would go through all the settings, beginning on Winter Morning and changing to the next chronological setting every two seconds – Winter Noon, Winter Evening, and so forth. We designed the panel to fit the design of the surrounding education space. That space contains various buttons on its walls that all initiate different interactions. Due to that, we used buttons as a central interaction element, so that the interactions would follow those of its surrounding space.

A set of curtains was added to create an enclosed space for two reasons: (1) to make the effect of the artificial light stronger by blocking the ambient light of the educational space and (2) children regularly play hide and seek in the educational space – multiple hiding spots due to how the space is designed – and we wanted for Light House to facilitate the common interactions that occur in the surrounding space. Finally, we included a set of furniture inside the house – a chair, a table, and a stool (figure 5) – to create a home setting as seen through the window and when children enter inside – and a small black stool outside.

To support playfulness we focused on elements of exploration and social interactions. Regarding exploration, we left the installation largely open for people to pursue their own intrinsic motivations (i.e. set up their own goals). Regarding social interactions, the installation invited multiple visitors to cooperate (one using the panel while the other one experiencing the house from the inside).
5 FINDINGS

The Light House (as seen on figure 3) was deployed on the 23rd of April 2021. In our observations, the installation was mainly used as a space that visitors used to support of their regular activities in the educational space. Children enjoyed using its space for various activities – e.g. using it as a hide and seek spot, taking out its furniture in the surrounding space, bringing books or toys and using them inside the wooden house instead of the surrounding chairs and couches (figure 5). Visitors would occasionally also interact with the control panel for the lights, however most seemed to be confused and would quickly give up and turn their attention elsewhere. They seemed uncertain regarding the purpose of the installation and what was expected of them during their interaction with it.

In fact, the installation was confusing not only to the visitors but also to some of the stakeholders of the institution. For instance, when visitors asked the floor staff to assist them, staff members often struggled to help them. One staff member explained that visiting parents wanted to use the educational space to teach something to their children but when it came to the Light House they could not understand how to use it in order to educate their children – with the floor staff being uncertain of the same thing. Another staff member brought her own three years old daughter to the educational space and found that she very much enjoyed playing in the Light House’s space, however she did not understand the changes in the light as different seasons, but rather seemed to enjoy experiencing its enclosed space and the changes in the light color.
After some time (14th of July 2021) the installation was re-positioned and the curtain was removed (figure 6). That decision occurred after meeting discussions with stakeholders regarding how to make the installation more approachable and less confusing to the visitors. Initially, the visitors encountered the panel side of the installation when they entered the space. With the new position, the visitors encountered the entrance to the house instead. This seemed to enhance children’s use of the installation as a physical playground. Children were more engaged in running in an out of its space and bringing toys to play with in the wooden house. However, without the curtains visitors used it similarly to the rest of the educational space objects, and did not seem as engaged to explore its interaction elements of light or use its space, rather they used it as another physical object of the educational space. On the 11th of October 2021 the installation was removed from the exhibition space.

6 DISCUSSION

The Light House was designed as an object that would help visitors discover new uses of its interaction mechanics – control panel and lights. However, when it came to interaction with the features that the control panel supported, visitors rarely spent more than ten seconds interacting with the panel. Instead, the visitors re-purposed its space by engaging with other activities in the house – as a hide and seek spot, a reading spot, playing with puzzle pieces, or taking its furniture out into the surrounding space. To explain why its interaction mechanics were not engaging while
Fig. 5. Integration with educational space

at the same time the re-purposing of its space was, we first need to distinguish between two main classes of affordances. The first class relates to the interaction elements of the installation. Affordances in this class are the buttons of the panel that change the light and mood. The second class relates to the space enclosed by the installation. Affordances in this class are the possibility of moving furniture and objects in and out, and its possibility to act as a hiding space, a reading space, and generally a space that invites visitors to incorporate it in their activities.
We will now analyze those affordances in terms of allow and encourage/discourage [12] as described in our design process. Regarding the first class of interaction elements affordances, it only contains the interaction with the buttons and potentiometers which control the light. Those interaction elements only accept specific inputs – press for the buttons and slide for the potentiometers – while refusing others. Refusal can be problematic since it limits the amount of possible undiscovered uses. The tactile elements of the buttons, encourage the visitors to press them, and it is difficult to imagine how a visitor could re-purpose such an interaction. Buttons generally do not allow other uses than pressing. To that extend, we failed to employ allow affordances in the interaction elements which could be the reason why visitors did not re-purpose those core interactions. Comparing that to the second class of affordances related to space we can see that on that second class all the observed behaviors – using it as a hide and seek spot, a reading spot, playing with puzzle pieces, or taking its furniture in an out to the surrounding environment – are results of allow affordances. Specifically, they stem from the quality of the installation to encompass the surrounding playfulness of the space while also having an individual character – the colorful light attracts attention, while there is no other small wooden house the educational space. Visitors have limited expressive control over the Light House. The buttons control the state of the two smart lights, and no matter how many choices there are in the forms of buttons and potentiometers, in the end there are only two elements that the visitors can control and that is the status of those two lights. That stemmed from our purpose to challenge the design process and limit the expressive control that the core interaction supported.
On the other hand, the **space** of the *Light House* does not impose the same limits, which could be the reason why visitors were able to discover ways to use that **space**. It seems possible that these results are due to visitors being drawn towards re-purposing elements that indeed support self-expression – the **space** in our case. It might be important then to consider not just whether or not there are *allow* or *encourage/discourage* affordances in place, but also if those affordances can be combined to create diverse self-expressive interactions. In our case the visitors found engaging to integrate the house’s **space** in their other activities – e.g. hide and seek, reading books et cetera – while did not actively engage with the panel settings. Those two interactions seem disconnected, since one is focused on learning about light and architecture through altering light settings, while the other sees the *Light House* as a colorful enclosed sensory **space** with various uses. A possible solution here would be to re-adjust the light options to enhance those new uses of the house’s **space**. For example, instead of focusing on the seasons, we could focus on activities: reading setting, blackout setting, disco light et cetera. Through that, we could highlight the sensory aspect of its **space** that were its main attraction. Overall, we made a number of false assumptions in our design. First, we tried to make the design open by leaving its purpose open. At the same time, we purposefully tried to limit the expressive possibilities of the interaction elements. In our observations, that seemed to hinder visitors’ re-purposing of those elements. Second, even though we considered possible interactions with the surrounding space, our considerations were limited. Visitors seemed drawn into those possibilities. A better incorporation of the surrounding space could potentially support new uses by supporting visitors using external elements in combination with the installation.

Our original purpose was to initiate a design process that would support the re-purposing of our artefact’s interaction elements. We hypothesized that visitors would discover new ways to interact with the elements of our artefact due to the open nature of its interaction. To that regard, we failed to discover new uses for those elements – i.e. the interactive lighting through the control panel. However, we ended up discovering new uses of its **space**. Our findings show that visitors might be drawn to self-expressive mechanics of interaction when it comes to re-purposing artefacts, and by shifting our focus towards supporting those mechanics through the interaction elements of our installation, we can potentially assist visitors to discover new creative and playful ways to incorporate that installation into their visit in ways they seem fit, based on their personal motives and interests.

### 7 CONCLUSION

In summary, through our research we set out to explore the need for extending participatory design processes to include the re-purposing that occurs when a user interacts with an artefact in post-deployment real use settings. To do so, as described on our methodology, we employed one iteration of an iterative design process that focuses on design-after-design (presented in our previous work [1]). Wanting to challenge our design approach, contrary to our previous work [1], we set out to deploy an installation that self-expression is not a part of its core interactions.

Our results show that, when distinguishing between the affordances of the interaction elements of the installation and its space, visitors re-purpose the latter. A possible explanation for this might be that the space interactions engaged with *allow* affordances and provided larger expressive control – contrary to the rigid interaction elements which provided limited expressive control that *refuse* new uses. Furthermore, those two types were disconnected and, as a result, did not support each other. In other words, although we expected the visitors to re-purpose the interaction elements, instead they disregarded them and engaged with what they found the more interesting and expressive of the two, the space of the installation. A greater focus on understanding the connection of re-purposing, self-expression and *allow* affordances could produce interesting findings that account more for how can museums and designers employ those three elements to inform participatory design processes that extend through the post-deployment phase of artefacts.
Our failure suggests that not including self-expression in specific elements challenges possibilities of re-purposing. It uncovered an unexpected re-purposing that we did not design for. Our research is preliminary and further research should look into how supporting or blocking self-expression can act as a potential strategy for designers to support the re-purposing of specific elements in their designs. When designing for design-after-design, blocking expressive possibilities in specific elements may lead to visitors re-purposing other elements. That has the potential to help with redirecting visitors away from experimenting with fragile elements, or revealing new uses of other interaction elements.

Furthermore, our experiment uncovered that the institution could benefit from setting up a space that includes similar architectural small structures where visitors can play around and include them when engaging with other activities that they find interesting. Related to that discovery, we believe that in the future it would be fruitful to explore how our process can be applied to extract details regarding what type of activities visitors find engaging with the surrounding space, with the goal of using those details to inform possible future projects that institutions can initiate.

REFERENCES


