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# GENERATIVE PROTOTYPE ITERATION IN THE FRONT END OF THE DESIGN PROCESS

**David MCKENZIE**
Design Fellow, The Ohio State University, USA; mckenzie.368@buckeyemail.osu.edu

**ABSTRACT**
Iterative prototyping has traditionally enabled engineers and designers to test concepts in the latter stages of development once problem and solution have been defined. Exploring the use of this technique in the problem definition area of research to stimulate interaction and discovery during co-design [1] has the potential to generate insightful, user driven ideation.
Combining and taking inspiration from Presumptive Design [2], Speculative Design [3] and Co-Design through making [4], this research introduces a fruitful connection between provocative artifact engagement and user generated ideation, while implementing digitally fabricated objects, in the generative front end of the design process.
A six-person multi-disciplinary design group generated an initial, 'Presumptive' artifact followed by subsequent user inspired objects. Four workshop sessions involving a total of thirteen different participants were facilitated during three iterations. Workshop participants were introduced to ill-conceived artifacts and asked to critique and reflect. The artifacts were not introduced as valid prototypes, only objects to spark conversation about the cycling experience at The Ohio State University. Through discussions, observations and the use of maketools [5], participants documented their responses and needs for future use. These responses were then used to inspire and provoke the design group to further evolve the discussion and iterations while exploring the problem space. The digitally fabricated, provocative artifacts created by the researcher stimulated users to discuss and ideate in a co-creative setting, eventually leading to a clearer understanding of their future needs. Interaction with artifacts and designerly concerns introduced participants to product evaluation and critique that was then applied to their own considerations. The process transformed the sacrificial artifact, through a series of iterations, into a physical representation of a solution to those needs.

*Keywords: Co-design, prototyping, generative, provocative, iterative.*

## 1 BACKGROUND: RESEARCH THROUGH MAKING

Throughout this paper, reference to 'artifacts' can be interpreted as "objects whose function is not to test or prove, but which provoke reflection, experimentation and discussion." [6] This interpretation considers tangible objects as a means to explore ideas and concerns, not to assess physical attributes or perceived use.
When applied to problem space exploration, participatory design research can be used to facilitate co-design workshops with future users in order to discover insights and new opportunities. Incorporating methods that engage participants and spark meaningful conversations to create insight can be challenging, however. Even more challenging is getting people to express their tacit and latent knowledge and use it in designerly ways of thinking and making [7].
Over the past 20 years design research has expanded to include designers and engineers searching for inspiration and insight. The introduction of those skill sets means more 'designed' materials and objects entering the field of qualitative research. "This new generation has been trained in design, making them not only keen to undertake research with holistic qualities and to seek out knowledge which is highly relevant for application by design(ers), but also to apply the methods and techniques from design to use in a research project." [8]
This investigation has been inspired and informed by design research practices from industry and academia. These practices are Presumptive Design, Co-design and Speculative Design.
Presumptive Design provided the inspirational foundation to explore ill-conceived artifacts through iteration. "The designer, with minimum input about the requirements for the project, creates a set of

solutions, puts them in front of the target user, collects data about the fitness of the designs, and then performs analysis that feeds into an iterative cycle." [9] Participatory design research through making in the "fuzzy front-end" [10] allows multidisciplinary groups to engage with various stakeholders in order to co-design for problem areas of concern. [11] Presenting artifacts in participatory workshop sessions facilitates and empowers co-designers to collaboratively engage and respond to these artifacts. Scaffolding this activity with generative maketools can allow designers and co-designers to lead artifact evolution and speculate on future use. "Maketools are essential for encouraging people to engage in associative, bisociative and creative thinking… and can support the jump to imagining the future." [12] Making stuff to make sense of the future, [13] supported by interpreting objects as "matters of concern, not matters of fact." [14]

## 2 PROJECT: IDEATE, CREATE, ITERATE

"Cyclist on Campus" was selected as the main focus of the project as it meant a large pool of participants could be tapped into. The six-person graduate design group was multi-disciplinary with industrial design, mechanical engineering, visual communication and business represented. The design group all agreed that cycling on campus was an area that needed to be addressed and had potential for innovative insights.

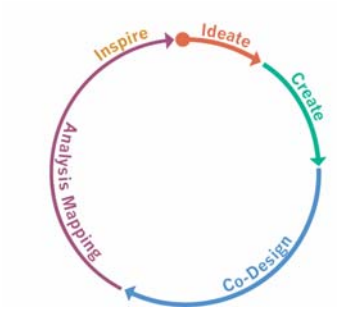


*Figure 1. Proposed Generative Cycle: process repeated for each iteration*

Understanding the needs of cyclists on campus and identifying areas of opportunity was the focus during the project. However, understanding the potential role of provocative artifacts in the front end of co-design was the overriding interest and research objective.

Tangible, low fidelity artefacts were introduced during co-design sessions to explore how their inclusion would influence participants to generate insightful responses related to their own cycling needs. (Figure 1) The four participant sessions investigated the means of artifact production and fidelity, participant response to ill-conceived objects, ideation through artifact interaction and discussion, and the application of iteration to co-design in the front end of design.

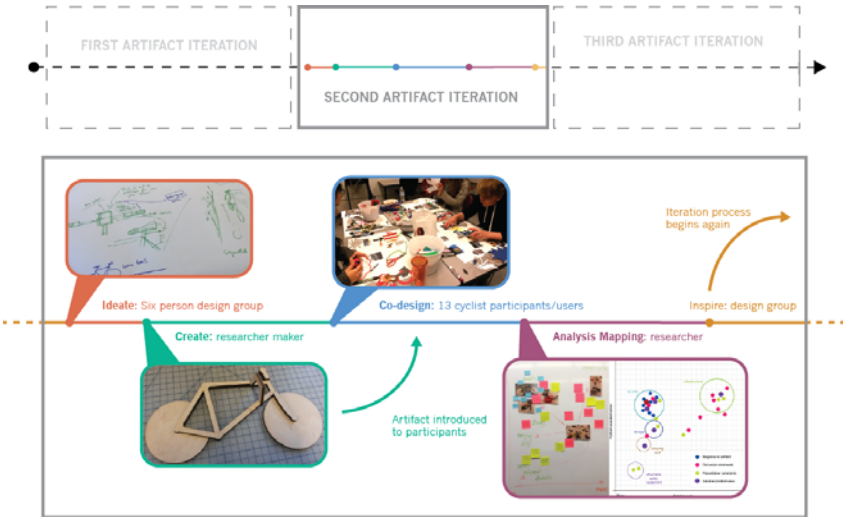


*Figure 2. Iteration Timeline (Second iteration highlighted): As shown at the top of the figure, three iterations were done. The timeline at the bottom shows the second iteration only in more detail. Activities of the design group and the user groups are shown above the timeline and activities of the researcher are shown below the timeline.*

## 2.1 Ideate and Create

The first design group session was a playful inquiry with multidisciplinary creatives ideating and speculating around the prompt “Cyclists on Campus”. The chosen bicycle rear-view mirror attachment, a combination of two concepts during ideation, allowed users to install their smartphone as a bike mirror, utilizing the front facing camera. (Figure 3)

Initially, the 3D-printed “Rear-view mirror smartphone attachment” was a crude, if usable prototype. The second and third iteration artifacts were only representative of the concept in a physical form that participants could interact with. The first artifact was quickly rejected as ‘trash’, so investing a lot of time to manufacture the object seemed unnecessary. For initial iterations the lowest resolution settings work best to provide an artifact that can elicit valuable response. Thinking of the artifact as ‘low resolution’ is a helpful way to understand the purpose of the object. “A prop can be a fully working prototype or not. This is not the issue; its purpose is to facilitate imagining”. [15]

*Figure 3. Artifact iteration evolution: The first iteration rear-view smartphone mirror attachment (left) was rejected during user co-design, the insight generated from the first iteration led the design group to incorporate a locking mechanism into the bicycle frame (centre). The final iteration was security themed but considered the use of ‘stigma’ instead of brute force to dissuade thieves (right)*

## 2.2 First Artifact Iteration

Seven cyclists of varying abilities participated in two separate co-design workshops. In the hope of validating the process, both groups were provided with the same materials and were exposed to the same artifact. (Figure 5)

For the initial artifact, a CAD model was created, based on the sketches of the “rear-view” mirror concept. This model was then printed using a Makerbot Replicator 2.0. The cyclists shared their experiences of cycling in and around the city. Themes emerged during the discussions that were later mapped on the problem area abstraction grid. The cyclists were then introduced to the artifact and given a brief explanation of the concept behind it (Figure 3). Presentation of the artifact was carefully approached so as not to misrepresent the object as prototype. Participants had time to record their reaction to the artifact using a Deconstructive Map that exposed them to designerly considerations of concept, use, form and detail. They then placed the artifact on a scale from ‘Trash to Praise’ and explained their decision.

All participants responded negatively to the artifact citing a host of reasons that would later be analyzed to understand where the idea had failed, and what could be learnt for future iterations. Once every participant had contributed, they were asked to individually create a response to the discussion and artifact using the maketool materials provided. Participants were told this response could be related to the discussion and/or the artifact and could describe a problem or even provide a solution to that problem. The participants were finally asked to present their finished responses to the group.

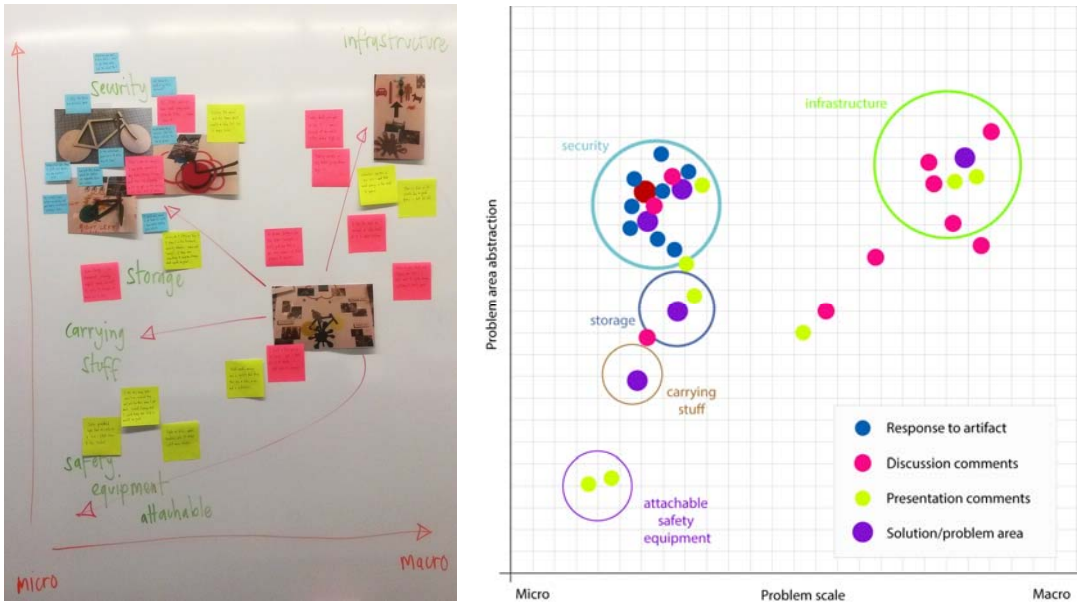


*Figure 4. Problem Area Abstraction Map (Second Iteration): Documenting and charting what the participants created and discussed in relation to the artifacts helped to inform the design group's next iteration*

The first and second cyclist workshop sessions discussed and produced responses that focused on security, wearable safety technology, infrastructure, bike trails, bike transportation, and attachable tech. When the data from both workshops was combined the two problem areas of "infrastructure" and "security" were of greatest concern. This newfound understanding of cyclists was presented to the design group through the Problem Area Abstraction Map (Figure 4) which acted as inspiration for the second round of artifact generation. Design group members took time to look at the images and read the comments before generating new concepts. The second artifact created was based on the perceived need for a bicycle lock that could be incorporated into the bike itself versus current independent locks.

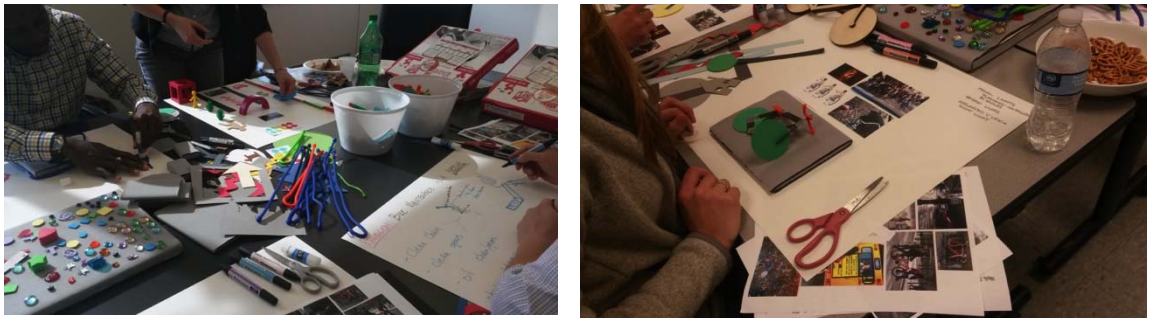

*Figure 5. Co-Design Workshops: All the sessions incorporated the same rules and materials to better gauge the success of each artifact, each workshop had different participants, 13 in total*

## 2.3 Second Artifact Iteration

The third workshop involved three participant cyclists and utilized duplicate maketool materials to gauge the reaction to the new artifact. The second artifact merely represented the notion of a locking device that could be incorporated in the frame of the bicycle. (Figure 3) This artifact was much more 'successful' in the critique by the cyclists. It also generated a more focused and relevant discussion on a problem area.

Once again, the information gathered from the participant workshop was displayed on a fresh problem area abstraction map that allowed the design group to better understand the needs of the cyclists. The map also acted as a catalyst within the design group to raise questions about how to approach security. This meant consideration of storage versus security and how the two areas overlapped in the

participant discussions and solution application. ‘Brute force vs. Stigma’ as a deterrent against bike theft was discussed in a quick sketch session. At this point, the design group better understood the nature of the iteration process and didn’t spend long imagining potential solutions and handing them off. The next concept speculated that by locking a wheel at a 90 degree angle, bike thieves would be less inclined to steal as the theft would be more suspicious. (Figure 3)

### 2.4 Third Artifact Iteration

The final artifact in this short series was taken directly from a response created in the second iteration workshop by a participant. This iteration tested the theory of ‘brute force versus stigma’ by presenting it to participant cyclists through the third artifact.

The three participants rejected the idea of stigma being used to protect their bicycle and focused on a system that would physically secure both the front wheel and frame by incorporating an inbuilt ‘cover’ that could be locked. If further iterations were continued; this would be the direction of the next artifact. The poor cycling infrastructure in the city continued to be an area of discussion, along with cyclist safety on the road. A new area that was highlighted was the need for seasonal bike access in the city. The cyclists complained about having to own something that was only used six months out of the year. A system whereby they could rent a bicycle during the spring and summer months appealed to both cyclists. Another suggestion was a bike that could be easily stored indoors for a six-month period.

## 3 ANALYSIS: ARTIFACT PROJECT

Understanding how the participants responded to each successive artifact was another way to gauge the success of the objects, beyond the problem areas highlighted. The visual below (Figure 6) represents the ‘direction’ participants expressed when creating a response to the first artifact iteration.

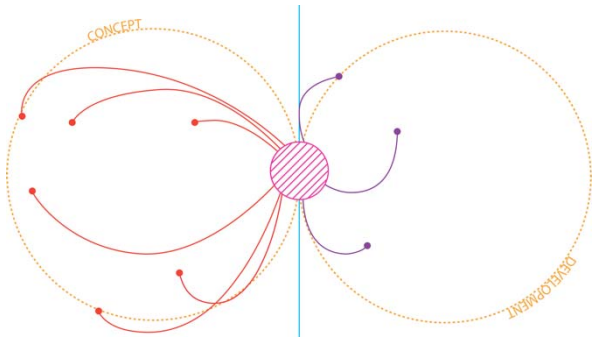


*Figure 6. Artifact Projection: The responses could be divided into two areas: ‘Concept’ (left circle) and ‘Development’ (right circle). The center of the visual represents the artifact that the participants were provoked by. Each smaller point and line is a participant response created. The further the line was away from the center, the more abstracted or developed their response was.*

The artifact allowed the participants to move either back into the conceptual (problem) area or forward into development (refinement). Overall, this visual helps to highlight the perceived success of the artifact on two differing levels. In the first iteration, more participants entered the Concept portion. This would suggest that they rejected the artifact in favor of their own perceived problems. If further iterations continued, the amount of participants entering this area would reduce as the design group moves closer to a need established by the previous responses. The third artifact could be deemed as a ‘failure’ in this analysis. However, the insight gained about the artifact would still be valid.

## 4 CONCLUSION

This method is still in development. Generative prototype iteration has potential to be used across the development stages of the design process, but will have the most impact during the problem space exploration and definition. The following establish considerations for using this proposed method:

Time, people, place and presentation are all important considerations. People: Research participants must be invested in the research topic in order to project their own inherent needs in response to an artifact. These participants can range from early adopters to laggards as insight can be gained from all when exploring areas of concern. The design team needs to also be fully informed that the process will

strip away and reject ideas that are unrelated to the true user need. This means that members of the team should 'detach' from concepts that fail. Time: Early 'intervention' in the design process is critical to encourage new direction and development in the shortest amount of time. Place: The nature of the interactions and response process means that this method is best practiced co-presently. Presentation: The co-design process and presentation of the artifact is crucial. An artifact should not be introduced as prototype and participants should feel free to express ideas completely unrelated to the conversation sparked by the object.

In conclusion, low-fidelity artifacts can provoke participants to imagine and ideate on future use. How the artifact is interpreted is more important than its fidelity with 'low resolution' objects allowing for greater interpretation. The first object was the most 'product-like' and generated the greatest negative response, and wide-ranging concerns were expressed. The second artifact could be considered the most 'successful' as it was well received and generated a lively, focused discussion and ideation session. The third artifact was, again, rejected but confirmed insight from the previous sessions. The success of the artifacts is not determined by the initial response to the object, but by the information and insight gathered. From this perspective, all the artifacts contributed to inform the design process.

To further this investigation, a comparative study of artifact inclusion vs. exclusion in co-design workshops would establish how the introduction of artifacts affects the outcome. Analysis of different materials and processes of making could also be further explored to determine a relationship between insight and object fidelity. This research focused on the design team and end-users for insight and inspiration, however, involving stakeholders such as engineers, non-users (pedestrians) and producers could generate a more holistic understanding and potential solutions. Finally, ideating through artifacts led to insightful discussions with co-designers and the design group on current, local concerns. However, the introduction of speculative artifacts could produce futurist discussions and ideation amongst co-designers regarding matters of concern in the near-distant future.

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