Unfolding the future: Prototypes as epistemic objects in innovation and collaboration work

Abstract. Prototypes are objects that approximate the features of a product or service. In design practice, prototypes are known as objects that can facilitate collaboration across heterogeneous groups, thereby instantiating changes that can foster innovation. Powerful as this function may be, the focus on prototypes’ boundary properties has obscured their own endemic dynamism as objects, making it difficult to capture the ongoing dynamic of prototypes within the practices that they mediate. We use the notion of epistemic objects to capture how prototypes highlight what is absent, raise questions, and unfold indefinitely over time. Drawing on participant observation and interview data from a 6-week university invention accelerator, we show that prototypes mediate collaboration practices as well as unfold dynamically over time. Our conceptualization of prototypes as epistemic objects captures both the nature and function of artifacts as they facilitate dynamic practices.

Keywords: Epistemic Object, Prototype, Practice.

1 Introduction

In design practice, prototypes are objects that approximate the features of a product or service [3]. They are known for their boundary-mediating capacity to facilitate conversations among heterogeneous groups with shared interests [17, 18]. Through such conversations, prototypes can facilitate learning among groups by foregrounding new issues [12, 16, 24]. Indeed, Gill et al. [9] describe prototypes as “design thinking enablers” for their ability to help designers generate and refine their designs. As a means of exploring new design ideas, prototypes are objects that constitute innovation and collaboration practices among heterogeneous groups of people [24].

One challenge in studying objects such as prototypes is that they are highly dynamic [6]. Not only do they facilitate shifts across practices among people as noted above, they themselves are also subject to change. In this sense, we might say that they change both across and within practices. While changes across practices are often emphasized, changes within practices are seldom emphasized [7, 21]. As such, scholars have typically focused on the function of prototypes rather than their nature as objects, which has resulted in scholarship that inadvertently emphasizes prototypes’ stability rather than their endemic plasticity [2, 4, 7]. Although prototypes embed knowledge central to organizational activity and practices [2], we know much less about how that embedded knowledge affects a prototype’s ability to facilitate collaboration. It is therefore important to investigate prototypes’ dynamic natures within the practices they mediate.

This study attempted to do exactly this by drawing on data from a 6-week invention accelerator at a university. We use the notion of epistemic objects to describe the
nature and role of prototypes in this context, showing not only that prototypes mediate collaborations across heterogeneous groups, but they also unfold the innovation and collaboration practices they mediate over time. This perspective highlights the role and nature of the prototype as an object in and of itself. As such, we contribute to discussions around theorizing the role of objects across and within practices. In the remainder of this paper, we present relevant literature on prototypes and objects, followed by a description of the data and field site. Finally, we discuss our findings and conclude with our contributions.

2 Related Literature

Prototypes are central to innovation and new product development processes [3, 11, 16]. In such contexts, prototypes are intermediate objects that represent part or all of a product or service [1]. As they conjure a non-existent object into being, prototypes, in prompting this collaborative refinement, are themselves refined. As such, a prototype might best be understood as a dynamic object that iteratively unfolds in the course of being acted upon.

Information scholars often use the concept of boundary objects to describe objects that facilitate collaboration across heterogeneous groups [13]. According to Star, boundary objects maintain a stable but flexible structure that makes them recognizable but also individually useful within heterogeneous groups [19, 25]. In a similar vein, Lee proffers the notion of boundary negotiating artifacts, which are objects that alter the boundaries they traverse [17]. Both concepts emphasize the facility that objects have for enabling collaboration among heterogeneous actors by constructively occupying the liminal space that exists at a shared conceptual level.

Because they mediate collaboration across boundaries and shape those boundaries [8, 16, 23], we can assert that prototypes are both boundary objects and boundary negotiating objects. Yet, while such a characterization is useful, it elides a discussion of the nature of prototypes, particularly in relation to their constituent dynamism within collaborative practices. Ewenstein & Whyte [7, p.8] acknowledge this omission, noting that boundary objects seem “stable” and focus on their “use across rather than within practices”. This emphasis makes boundary-related objects, such as prototypes, seem primarily stable despite the acknowledgement that they are also highly acted upon within dynamic collaborations.

A turn to the notion of epistemic objects can remedy this misperception. Introduced by Rheinberger [22], epistemic objects are abstract notions of objects that are characterized by a lack of completeness of being [14, p.185]. Because they are incomplete, epistemic objects do not have fixed qualities as a boundary object might; rather, they point to what is absent. In other words, they are defined “by what they are not (but will, at some point have become) than by what they are” [14, p.200]. By pointing to what is absent, they help detail what is not yet known. This way, they can be a source of constant change and innovation [15, 20]. By raising questions, epistemic objects have the ability to unfold indefinitely [14, p.190]. Scholars have used epistemic objects to analyze phenomena ranging from change in organizations [20], the
multidimensional nature of objects [7], and creative practices [14]. In this study, we use the construct of epistemic objects to analyze how prototypes generate questions within the context of an innovation accelerator.

3 Study Context

The context for our study is a 6-week invention accelerator for undergraduate students at a university in New York state. The accelerator program selects and trains students to design, prototype, and pitch an original invention. Students were grouped into teams of 3, which were composed of individuals representing different academic disciplines. Throughout the 6 weeks, 7 student teams collaborated every weekday to develop their inventions. The teams also worked with a teaching team made up of design experts, with particular skills in prototyping and pitching. The teams met regularly with the teaching team to review their pitches and prototypes as they evolved from nascent ideas to patentable artifacts.

During the entirety of the program, the first author spent approximately 115 hours observing 4 teams that were participating in the accelerator. He documented these observations via field notes, photographs, and videos. He also conducted semi-structured interviews, which were audio recorded. The research team as a whole carried out iterative rounds of inductive, thematic coding at different periods throughout the data collection [10]. As part of our later sensemaking, we adopted the lens of epistemic objects as a theoretical frame [5, 14].

4 Findings

To develop our argument, we focus exclusively on the prototyping practices of one team: “Team Axis.” They collaborated to create an invention that enables asthmatic patients to monitor their condition and administer medication using one device. The three team members are Sam, Leslie, and Drew (all pseudonyms), who hailed from computer engineering, chemical engineering, and bioengineering and neuroscience respectively. At the end of the 6 weeks, Team Axis had developed a total of 9 physical prototypes, which are exhibited in Figure 1.
Fig. 1. A lineup of all the prototypes that Axis had created by the last day of the accelerator. From left to right, prototypes 1, 2, 3, 4, 5, 6, 7, 8, and 9.

By following Team Axis’ prototypes through time, it is evident that these evolving array of prototypes both facilitated collaboration among the heterogeneous members of Team Axis, but also changed in form and function as the invention matured over time. We detail both of these prototype qualities by drawing on details of how the team members described the progression of their 4 prototypes in conversations with the first author.

In week 4, Sam walked through the team’s 4 prototypes to date. Lifting the first prototype up from the team’s table, he said: “This was week 2, when we were talking about what the asthma thing would look like. And I was trying to describe what I was imagining.” As Sam described it, the prototype was the team’s way of saying, “look at how we could make it work”. This first prototype raised questions Sam said as he laughed: “Why is it so thick and why is it so big?” Later, Leslie made a similar funny comment when describing the first prototype: “Honestly, I don’t even know if this really counts as a prototype.”

Two days after creating prototype 1, Team Axis refined their idea and created prototype 2, a physically slimmer version. Their goal was a more intuitive design for people familiar with asthma pumps. “That’s kind of the prototype we stuck with for a really long time, because it got around a lot of issues and it looked cooler than this (first prototype)...This one is like a nuclear submarine. It’s got that cool aspect for kids.”

Prototype 3 evolved from prototype 2 by adding a hole to “allow for a placebo canister,” according to Leslie. “That’s why we hollowed it out, because we felt this (prototypes 1 & 2) wasn’t clear. So, we said ‘well, why don’t we just make it hollow anyway’?” Prototype 2 wasn’t clear in terms of where the canister would fit and how that would work. For prototype 3, Drew used professional CAD software and modeled it using actual dimensions. “It is the most accurate to date,” Sam said. Another addition was the mouthpiece: “That was one of the issues that people brought up when they saw this (2nd) prototype. Because they were like ‘where is the mouthpiece? That’s huge’. Absolutely massive. And so all versions after this have a mouthpiece of some kind.”
Prototype 4 is slender and a little longer to match the volume, Sam explained. Leslie and Sam clarified that prototypes 3 and 4 are both at least 100 ml, just above the minimum requirements for canisters. The team decided to cut down on the number of LEDs after realizing they don’t need the status LED. After the fifth prototype, which Sam referred to as theoretical, he commented, “I don’t know if we will be printing a sixth prototype. We will see how the reception to this one is and how it turns out.”

5 Discussion

5.1 The Nature of the prototype

Lack of completeness. As indicated before, prototypes are representational and incomplete objects that point to what is absent rather than what is present [14]. It is evident that Team Axis’ prototypes were incomplete at each build stage. For example, the lack of a mouthpiece in the first two prototypes facilitated the creation of one in subsequent prototypes. In week 3, Sam commented that the team’s latest prototype was, “taking shape.” This characterization indicates the prototype’s processual ontology—one that is not yet fully formed, yet is all there is.

Partially expressed in multiple instantiations. In addition to physical objects, prototypes were also represented as sketches and renderings. The first prototype is a case in point, where Sam used a simple CAD software to describe what he was imagining. Sam resorted to CAD because his sketches were crude. Beginning with prototype 3, Drew designed CAD versions that were 3D printed. Team Axis used these sketches, renderings, and 3D prints to communicate with the teaching team and/or judges in a pitch or debrief session. In this way, the multiple instantiations of the prototypes facilitated collaboration, communication, and unfolded the opportunity.

Generates questions. Questions were generated with every instantiation of the prototype. Some of these questions came from the judges and the teaching team. As Sam recounted, the first prototype raised questions such as: “Why is it so thick? Why is it so big?” This prompted a redesign of the prototype to make it less thick and more portable. The second prototype raised a question about the mouthpiece. Based on this question, the team decided to include a mouthpiece for all subsequent prototypes.

Capacity to unfold indefinitely. Team Axis’ prototypes demonstrated a capacity to unfold indefinitely. An example is when Sam calls their non-existent prototype a theoretical prototype. “So, prototype number 5 is a theoretical prototype. We know that we need to make changes to that (points to prototype 3). And so as soon as we know that something needs to be changed, a new prototype comes into existence. It doesn’t exist physically yet. But we are thinking about it. Because this (points to prototype 3) has some issues,” Sam said. By calling the prototype “theoretical”, Sam is describing it with an unfolding ontology. Thus, the prototype is not only the corporeal entity, it is also the capacity that the object embodies.
5.2 Role of prototypes over time

In flux. Team Axis’ prototypes are as dynamic as the processes and practices they facilitate. The team’s dynamic collaborations involved daily meetings with the teaching team, weekly pitches in front of a panel of judges, and product usability testing. As such, the representations of their evolving knowledge work had to keep up with the demands of these multiple perspectives, both for the members of the team as well as the various stakeholders who were part of the program.

Reference point. At the same time, Team Axis’ prototypes equally served as momentarily stable reference points amid the dynamism. The members of the team remarked that they were able to maintain a focus despite the changes in the prototypes. This point is made evident in a comment by Sam, “It’s doing the same thing, but how it does it is different. From week 2 on, what we’re trying to do hasn’t changed. The core of what we are trying to do hasn’t changed since week 2.”

5.3 Subject-object relation of prototypes

Dyadic and multiple. Team Axis’ prototypes also facilitated collaboration between multiple heterogeneous groups of people, namely the team itself, the teaching team, and the panel of judges. For example, the teaching team provided feedback based on the Team Axis’ prototype and the same prototype elicited suggestions from the panel of judges.

Object-object relation. Prototypes also have the ability to relate to other objects. As part of the requirements of the accelerator, teams had to design, prototype, and pitch their invention ideas. Pitches are standard narrative objects featuring slide decks that accompany a presentation. During pitches, Team Axis referred to their prototypes which enabled them to establishing legitimacy among the audience, which was primarily constituted as a panel of judges.

6 Conclusion

Using field data from a 6-week invention accelerator on a university campus, this study shows that prototypes act as epistemic objects for members of interdisciplinary teams and within heterogeneous stakeholder environments. Incomplete and partially expressed in multiple instantiations, prototypes become defined by what is absent, raise questions, and unfold indefinitely over time. In this way we show how epistemic objects can unveil the unfolding nature and role of prototypes within innovation and collaboration practices over time. By viewing prototypes as epistemic objects, scholars can complement the boundary-spanning and boundary-shaping roles of prototypes.
References


