Bitácora 30

Teoría y Epistemología

**Bitácora 30** (2) 2020: 87-100
ISSN electrónico 2027-145X. ISSN impreso 0124-7913.
Universidad Nacional de Colombia, Bogotá

# Using prototypes to produce high-resolution systemic future maps.

## A proposed model for design research and knowledge [1]

### Uso de prototipos para producir mapas futuros sistémicos de alta resolución.

Una propuesta de modelo para la investigación y el conocimiento en diseño

### Uso de protótipos para produzir mapas futuros sistêmicos de alta resolução.

Um modelo proposto para pesquisa e conhecimento em design

### Utilisation de prototypes pour produire de futures cartes systémiques haute résolution.

Une proposition de modèle pour la recherche et les connaissances en conception

▲ **Fotografía:** autoría propia

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**Recibido:** 19/09/2019
**Aprobado:** 26/02/2020

**Cómo citar este artículo:**

DE LA ROSA, J. A. y RUECKER, S. (2020). "Using prototypes to produce high-resolution systemic future maps. A proposed model for design research and knowledge" Bitácora Urbano Territorial, 30 (II): 87-100. 10.15446/bitacora.v30n2.81801

[1] This article was presented as a paper in the 3rd. International Design Research Congress (3CIDI) held in March 2019 in Bogotá, Colombia.

## Abstract

Design's arguments of innovative transformation and its constant search for a preferred future have become a contemporary principle of the discipline, and yet most design models limit their process to the production of the next stage of incremental innovation. This approach to the future carries significant systemic problems that can go from unexpected behavioral changes to unintended discrimination against certain groups, especially when addressing complex social problems and transformations. Avoiding these systemic problems might require the use of Design Research to study the conditions that produced them. However, design researchers seem to still disagree on the nature of Design Research, and the specific knowledge that can be produced through it. This paper seeks to introduce a possible model for design research that integrates various design theories to help obtain a more sophisticated view of the systemic situation of possible preferred futures. The goal of these process is to seek to produce a better understanding of how stakeholders envision their future, their intentions, values and needs as a systemic view within any given socio-technical system.


Keywords: design research, systems design, value systems, future studies, methodology.

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## Resumen

Los argumentos del diseño de transformación innovadora y búsqueda constante del futuro preferido se han convertido en un principio contemporáneo de la disciplina, sin embargo, la mayoría de los modelos de diseño limitan su proceso a la producción de la siguiente etapa de innovación incremental. Este enfoque hacia el futuro conlleva importantes problemas sistémicos que pueden ir desde cambios de comportamiento inesperados hasta la discriminación involuntaria contra ciertos grupos, especialmente al abordar problemas y transformaciones sociales complejos. Evitar estos problemas sistémicos puede requerir el uso de la investigación en diseño para estudiar las condiciones que los produjeron. Sin embargo, los investigadores de diseño parecen estar aún en desacuerdo sobre la naturaleza de la investigación de diseño y el conocimiento específico que produce. Este artículo intenta presentar un modelo posible para la investigación de diseño que integre sus distintas teorías y ayude a obtener una visión más sofisticada del estado sistémico de futuros posibles preferidos. El objetivo de dicho proceso es producir una mejor comprensión de cómo las partes interesadas visualizan su futuro, intenciones, valores y necesidades como una mirada sistémica dentro de cualquier sistema sociotécnico dado.


Palabras clave: investigación de diseño, diseño de sistemas, sistemas de valores, estudios futuros, metodología.


## Résumé

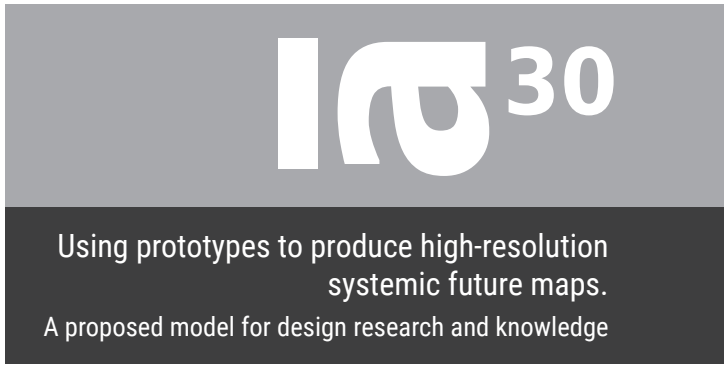
Les arguments du design pour la transformation innovante et sa recherche constante d'un avenir préféré sont devenus un principe contemporain de la discipline, et pourtant la plupart des modèles de design limitent leur processus à la production de la prochaine étape de l'innovation incrémentale. Cette approche de l'avenir pose d'importants problèmes systémiques qui peuvent aller de changements de comportement inattendus à une discrimination involontaire contre certains groupes, en particulier lorsqu'ils traitent de problèmes sociaux complexes et de transformations. Pour éviter ces problèmes systémiques, il peut être nécessaire d'utiliser Design Research pour étudier les conditions qui les ont produits. Cependant, les chercheurs en design semblent toujours en désaccord sur la nature de la recherche en conception et les connaissances spécifiques qui peuvent être produites à travers elle. Cet article cherche à introduire un modèle possible pour la recherche en conception qui intègre diverses théories de conception pour aider à obtenir une vue plus sophistiquée de la situation systémique des futurs possibles préférés. Le but de ce processus est de chercher à produire une meilleure compréhension de la façon dont les parties prenantes envisagent leur avenir, leurs intentions, leurs valeurs et leurs besoins en tant que vision systémique au sein d'un système sociotechnique donné.



## Resumo

Os argumentos do design de transformação inovadora e sua constante busca por um futuro preferido tornaram-se um princípio contemporâneo da disciplina, e, no entanto, a maioria dos modelos de design limita seu processo à produção do próximo estágio da inovação incremental. Essa abordagem para o futuro carrega problemas sistêmicos significativos que podem passar de mudanças comportamentais inesperadas a discriminação não intencional contra certos grupos, especialmente quando se trata de problemas e transformações sociais complexas. Evitar esses problemas sistêmicos pode exigir o uso da Pesquisa de Projeto para estudar as condições que os produziram. No entanto, os pesquisadores de design ainda parecem discordar da natureza da Pesquisa de Design e do conhecimento específico que pode ser produzido através dela. Este artigo procura introduzir um possível modelo de pesquisa em design que integre várias teorias de design para ajudar a obter uma visão mais sofisticada da situação sistêmica de possíveis futuros preferidos. O objetivo desse processo é buscar uma melhor compreensão de como as partes interessadas visualizam seu futuro, suas intenções, valores e necessidades como uma visão sistêmica em qualquer sistema sócio-técnico.


Palavras-chave: pesquisa em design, design de sistemas, sistemas de valor, estudos futuros, metodologia.




Mots-clés: recherche en design, design de systèmes, systèmes de valeur, études futures, méthodologie.

## Introduction

Design activity, as a form of thought and as a tool to produce and collect a specific kind of knowledge, is a relatively new concept, and yet, it has acquired in the last decades a significant relevance for several areas, like innovation for products and services (Verganti, 2009), addressing social problems (Brown & Wyatt, 2010) and the development of public policy (Edelenbos, 1999; Kimbell, 2015). Even a cursory search on the subject will show that the perceived role of design in society has been experiencing a positive transformation, and this has also impacted the perceived role of design research.

We have a wealth of models of the design process, as well as many structured approaches to design research. However, more discussion is still needed about the nature of design knowledge and how that knowledge can be captured and used (Archer, 1981; Bayazit, 2004; Muratovski, 2015). Buchanan (2001) suggests this is part of a search for validation of academic and economic interests of faculty members or researchers. However, it may also be understood as a permanent inquiry for a disciplinary identity and the understanding of the intrinsic potential of a profession whose role is in a constant space of innovation.

*This uncertainty, this underlying gap that exists at the essence of our profession, has also been a persistent engine of transformation; the constant search for a self-produced definition of our role has led researchers and practitioners to produce frameworks and methodologies that seek for the epistemological definition that has seemed elusive to the discipline.*

This paper begins the discussion with the epistemological concern, to later move into the question regarding the type of knowledge that seems specific to design research, and finally proposes a model to exemplify how the design research process can be used and modified to actively search for this knowledge. It is therefore important to recognize some of the theoretical foundations that have led to the current clustering of design research processes, and the possible gaps that they present, so we can propose new ways in which this activity can evolve.

Bruce Archer (1981), based on the experience of running one of the first design research programs, proposed a series of ten different areas of research for designers. He later clustered them into three basic areas: a phenomenological one which observes the history of design and the basic principles that have been presented over time, a praxiological one which focuses on the practical application and action of design, and a philosophical one that seeks to recognize the deep motives and arguments of design to produce new theories and principles.

This characterization has been subsequently reinterpreted in different ways. For Cross (2001), this research triad is analogous to the modes of research of science and can be described as: *clinic research* that observes and investigates specific cases with the intention to produce models and solutions that apply directly to the initial problem; *applied research* that

uses the praxis as a mechanism to produce generalized principles, and *basic research* that seeks to produce a fundamental theory of design through argumentative and discursive processes.

Another proposal to define design research spaces, and a broadly accepted one in academic environments, is the use of spatial prepositions (Frayling, 1993; Findeli, 2004; Faste & Faste, 2012). This model seems to be the one that has received more recognition and use and it also defines three spaces for design research: *Research for design*, which interest the observation of the pre-existing characteristics of the system, such as the socio-cultural background, the physical human factors, or the trends of the competitors. *Research into design*, which seeks the understanding of the role of design and the design process to produce reusable models for innovation. This area has led to the idea of *design thinking* and carries a long tradition of design engineering, cognitive sciences and economics. Finally, *research through design*. In most cases, it is defined by the practices of critical and speculative design, where there is always a big question about the future and the knowledge that is embedded in the objects we design.

If we observe these three definitions, there are common agreements as well as conceptual contradictions that are important to recognize. The notion of *phenomenological research* as presented by Archer (1981) seems to be disappearing from the scholarly spectrum of design, becoming an issue of contextualization of the preexisting knowledge that leads into the broad idea of *philosophical research* in design. This philosophical approach and the idea of *research into design* can arguably fit inside what Cross (2001) defines as *basic research*, assuming that both definitions imply positioning *design* as the subject of research.

Then there is the production of knowledge through praxis, and even though there are significant differences among the three formulations, they share the overall notion that there is certain knowledge that emerges through the action of design. This knowledge is situated and tacit, and as Polanyi (1966) points out, hard or even impossible to formalize. Despite the common assumption of a praxis-based research, there are certain differences between the praxiological approach, the applied one, and research through design. The first two are trying to use praxis to produce knowledge of the design process and practice, but the intention of research through design is to create knowledge of the design-produced realities as they are envisioned and produced. That perhaps is a singularity of the idea of *research through design*: it presents a search for an elusive emergence of knowledge about human intentions and individual and collective realities.

## Conceptual Framework

### A specific type of design knowledge

Among all the conceptual advances that have defined the contemporary views of design, there are two that we consider to be milestones in the epistemological definition of design disciplines. The first is being able to identify design as a systemic discipline (Simon, 1969; Banathy, 1996; Edmonds, 1999; Jones, 2014; Sevaldson, 2017). This definition relies on the work of General Systems Theory (GST) presented by von Bertalanffy (1968), where natural and social problems are situated inside complex systems, cannot be reduced to linear analysis and require a holistic approach.

Situating design in the conceptual space of systemic thinking has led to many other theoretical advances, like the notions of design for complex social systemic transformations (Banathy, 1996), the ideas of participatory design and prototyping (Bødker, 1987), transitional design for social development (Irwin, Kossoff & Tonkinwise, 2015) and design for social innovation and policy making (Edelenbos, 1999; Kimbell, 2015). These new spaces for design have not only extended the action of the designer but have helped in the redefinition of the core meaning of the basic design disciplines, prompting designers to move to a more analytical practice.

A systemic view has also led to the acknowledgment of a series of consequences that are connected to the role of the designer. From behavioral changes in human groups to sustainability and productivity issues that arise as unintended consequences of an unconscious action of design, new designers are more aware of the existence of actors and stakeholders, both human and non-human, and the impact of their work inside all ecosystems.

The second milestone of contemporary design is the acknowledgment of time rather than place as the main conceptual space of design (Simon, 1969). It is true that every process of design happens in a place and a context, it is situated, and that the local con-

ditions of the system are decisive for that process. However, as Simon points out, this is true for many disciplines that observe physical conditions in a specific setting, but one element that is specific to the design action is the fact that we observe the future rather than the past. Design is a futurist discipline that bases its action on the definition of a not-yet-existing reality (Bødker, 1998; Nelson & Stolterman, 2003).

Simon (1969) states that the role of design is the diagnosis of an existing tension with reality that produces an idea of a preferred future, and then a series of planned interventions through a constructed reality (the artificial) with the expectation of achieving this future. This argument is foundational to the contemporary view of design, because it construes the work of the designer as a purposeful materialization of human intentions with the goal of transforming reality.

Based on these two arguments, we could state that the knowledge that is specific to the design action is of the built environment, the constructed objects that do not-yet-exist in the world, and with this idea we refer to every artefact of mediation that can be produced or formalized, from an image to a policy. Design investigates the possible futures, the intentions to transform and innovate of the stakeholders to reach their preferred future and how this future becomes actual in the world. But this statement leads to a pressing question, how do we investigate the future?

## Design research as a future-oriented action

The definition of design research presented by Frayling (1993) is based on the use of spatial prepositions. It looks at the design process as a non-temporal practice, where there is an input to the process (research for design) that is purposefully transformed by a series of specific actions (research into design) with an intended goal (research through design). For this paper, we propose the idea of assuming the temporal nature of the design process and define the design research activity based on its timeline.

For this purpose, we can use the analogy presented by Simon (1969) about time. He introduces the idea that the perceived construction of reality in time is like the light beam of a lantern in the night: past and future move far into the left and right and we stand on an everlasting present. The farther we move our view from this present moment, the more the light of the lantern disperses and the image that we receive becomes more diffuse. Our view of the past is a series of recollections and memories, fragments of data that need to be placed and contextualized to build an idea of what the past was. In the same way, the future is based on predictions and forecasts, intentions that are normalized into a view of the path to follow. This principle has been defined as uncertainty, and it is perhaps one of the most important elements of design since it differentiates our process from the scientific model: there is no one solution to the questions – only possible answers.

Most of the research that we produce as designers is based on the observation of the *past*. This seems paradoxical when the objective of design is the future; maybe the best way to create a clear prediction of the future is to recognize the patterns of the system in the past. This type of research, that we call *research for design*, is intended as an observation of patterns, trends, cultural practices and emerging needs, tensions that are produced as elements in the system emerge and move.

The second type of research is the one that investigates the *now*; the current actions of design or *research into design*, and how these actions can be characterized into reusable models or methods. This type of research makes a lot of sense based on the original argument of this paper that recognizes the gaps in the way we understand the design process. We know what we can do, but many times we fail to explain how we do it, therefore being able to understand how the process works is essential for the progress of design. And yet again, we seem to be failing to address the main province of design, *the future*.

To shine more light on this issue, we should delineate the ways in which design investigates the future. First, there is the project-aimed view, that assumes that there is a solution to a problem and that designers are there to figure it out. This model is the one that is most common in professional practices, where designers need to produce, in a very little amount of time, solutions for a very concise problem; the greater the need to operate, the more reductionist the map of the system becomes, under the assumption that the consequences of the solution are just limited to the original problem. Therefore, actions that are intended for limited, defined problems usually use low resolution maps of the system (Figure 1).

The second way in which we observe the future is to treat it as predictable (Zamenopoulos & Alexiou, 2007); in this approach, we assume the existence of a future that, even though it is constantly changing, is

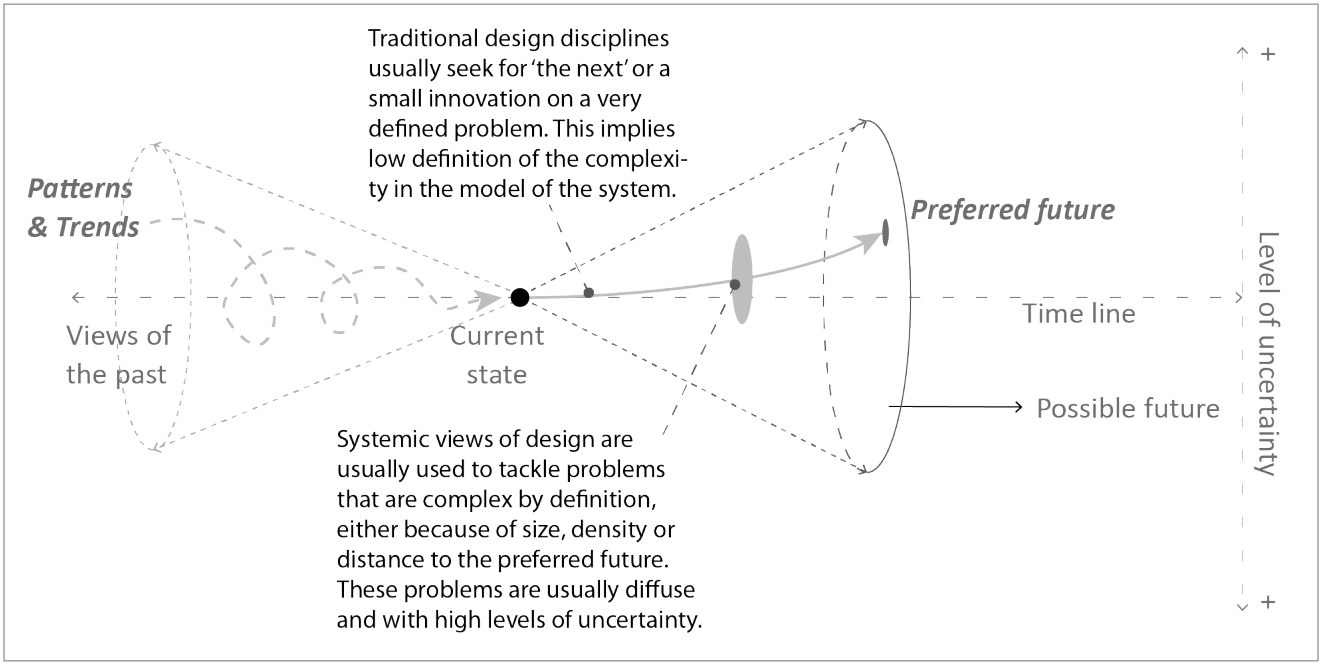



**Figure 1.** Design actions can aim to transform different moments in the future
**Source:** the authors.

also prescribed in a probabilistic way (Voros, 2003). Our role as designers is not predicated on the definition of that future, but on the production of artefacts that have anticipated that future and will be aligned to it. This model seems to be ideal for the design of experiences and services, where it is necessary to recognize possible actions of the users in the future and anticipate their needs to fulfill them. And yet, it is highly positivistic and it only patches and maintains the existence of the current system. Iskander (2018) refers to this issue when she argues that design thinking only serves to maintain the *status quo*.

A third way to observe the future from a design perspective is through speculation, a critical view that seeks for awareness of a broader range of possible repercussions. In this version, the future is not prescribed, but it is on a forecasted horizon: therefore, the role of the designer is to use tangible objects to test the limits of those plausible futures and the responses that they are likely to produce in their interactions once deployed in the real world. This view has been supported by schools like the School of Design in the Royal College of Arts, UK, where the work of professionals and researchers has been centered on the production of critical prototypes, boundary objects, and other speculative tools. This vision covers a significant part of what has been defined as *research through design*.

Finally, there is the transformative way, one that assumes that not only is the future not prescribed, but the role of the designer is to work toward an intentional and responsible transition away from the probable future and into a preferred future (Irwin, Kossoff & Tonkinwise, 2015). This might be the most contemporary view of them all, and the one that locates more power in the role of design as a mediator of change. For transition design, the future is an active process that is led by intentions and that requires constant check and correction, so every design action is part of a larger plan of persistent interactions with the system, leading into one desirable future.

This is a compelling approach, but the main issue with this process is: how do we recognize not only the current values and desires, but also how their effect becomes visible in the structure of the future system. The problem is that every actor might hold different values; moreover, those values may transform as the system becomes different. Therefore, as we seek to produce solutions for the current needs, we fail to recognize that the needs and the system are being transformed as we deploy the design actions in it.

It is important then, to go back to the idea of tensions inside the system and how they produce transformations.

### Actors and tensions inside the system

Based on GST principles, we can establish that all socio-technical systems are composed by actors, both human and non-human, relationships between them and the structures they form. These elements coexist inside a dynamic complex system that constantly changes, fueled by the forces inside the system. The tensions that exist inside the system push and pull actors in different directions, and they also produce spaces for other elements to emerge.

This idea leads us to two main elements to incorporate in the proposed model for design research: first, that there is a natural displacement between the actors that the design process tries to correct for: as we move through the system we can perceive the natural tensions that result from it. Through the design process, designers interview, survey, prototype and test, with the goal of recognizing the tensions that the object produces with its user, and then correct the course. Not acknowledging those tensions may in part account for the apparent linearity of certain models (e.g. Alexander, 1964; Banathy, 1996).

The second element for the model is recognizing that these forces in the system are based on values, needs, and intentions that are altered by our experience of the world, as well as the forecast that we build through them. So, as designers, working for the current system, we sometimes ignore that as soon as we implement the artefacts that we are designing, the perception of the needs of the actors in the system changes, and so does their idea of the future.

A model for design research should then include a possible mechanism to capture some of the knowledge that the introduction of the artefacts we design produces in the system, and even more, should seek to produce knowledge about the future of the system based on stakeholders' intentions of change.

## Constructing the model

the initial research proposed to produce the model presented in this paper started with a phenomenological approach of observation of the design process, with an intention to understand possible gaps or missing elements, either in the process or in its formal description. The intuition that something might be missing was based on experience in the field as well as the observation of cases where the result of the design process ended up not aligning with the future intentions of the stakeholders. Therefore, we aimed our effort at recognizing what elements of the general design inquiry were more relevant when trying to produce an image of a possible future that was collectively defined as preferred. We kept in mind two perspectives. First is the idea of non-linearity presented by Bijl-Rouwer (2019), who points out that there is a difference between initial framing and its evolution during the design process. Second is the notion presented by Banathy (1996) that in complex social systems, the production of an image of the preferred future is the first part of the design process. Building on these ideas, we selected a series of elements common to the design process that we argue could improve the initial process of framing through the construction of a more detailed image of that future.

First, from a systemic perspective, we considered that the production of this image should be based in a process of mapping, since maps and giga-maps (Sevaldson, 2011) are some of the main tools in the analysis process of systemic design. But the need to map a preferred future implies that the process of mapping should recognize a diffuse image of reality, one that is based on intentions and desires, and that we argue, is ultimately defined by the social values of the stakeholders.

We argue that the mapping process of the values of a group or individual should not be built based only on a unilateral qualitative process, since those initial needs and values can be imposed by other forms of power (Escobar, 1992). We have observed that the use of prototypes as conversational objects (Galey & Ruecker, 2010) and the tacit knowledge they unveil about the stakeholders is a more adequate mechanism to understand values and intentions. Observations of the tacit knowledge of the system allow us to compensate for some of the displacement between the initial framing and its evolution, and eventually produce a more comprehensive image of a particular preferred future.

In the production of the model we have done several iterations, some of them conceptual, some of them through experimental approach in design workshops, but based on the nature of this paper, we have decided to only present the final model and the conceptual elements that we have used to produce it. The model uses common methods of design as a tool to seek for a better understanding of the possible futures as we

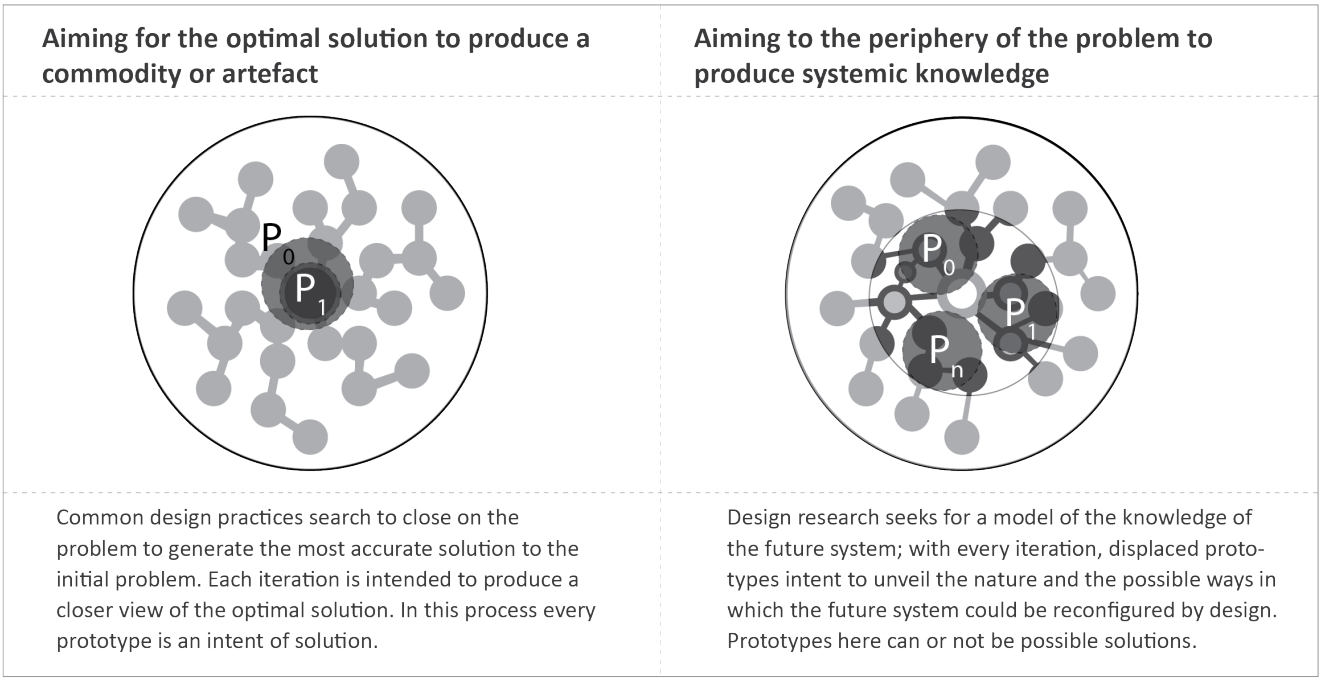



**Figure 2.** Comparison between validation prototypes and displaced prototypes.
**Source:** taken and modified by the authors from de la Rosa (2017).

build them. To better understand the model, we find it beneficial to further articulate some of the key elements we are using: tacit knowledge, displacement, and future mapping.

## Tacit knowledge

Design practice recognizes the need for a contextualized artefact. Objects and messages are not independent and they need to be tailored to a specific audience and user; without this, design stays as a form of self-expression. From semiotics, and the definition of a message and a receiver, to the studies of ergonomics popularized in the post-war industrial boom, we know that we need to acknowledge *the other*: a final user or stakeholder that directly interacts with the designed artefact. This idea is deeply connected to systemic thinking and Actor-Network-Theory (ANT), since it assumes that the artefacts we create mediate and interact inside the system, and it is only through this relationship that they acquire a meaning. A proof of this relation is the work of Susanne Bødker (1987) in the analysis of the process and the definition of tools for participation and collaboration inside design projects.

We recognize the importance of having an end user in the design process because that is the only way that we can produce real knowledge about the physical experience of the artefact in place. Designers access this physical knowledge by prototyping: actualizing ideas and then testing them, with ourselves and with others.

Prototypes as tools of validation have a long tradition outside and inside design practices, but their role was originally largely limited to a final stage validation of an almost finished process. Bødker (1987) introduced one of the early descriptions of prototypes in the design process as a tool to recognize possible futures, and from there we have had a cascade of different uses and descriptions of prototypes.

All the different definitions of prototypes seem to reinforce a premise: our physical experience of the world circumscribes our perception and definition of what is real. Further, the knowledge that this experience produces (Polanyi, 1966; Merleau-Ponty, 1996; Gallagher, 2010) leads our decisions and interactions inside the socio-technical system. Hallam, et al. (1994) discuss how the actions and predictions of agents are based on their perception and experience of the world, the model that they produce of themselves and their reality. And, since the forecast of the future depends on the tangible experience of the past and present, a way to modify that forecast is by modifying the tangible experience of the world.

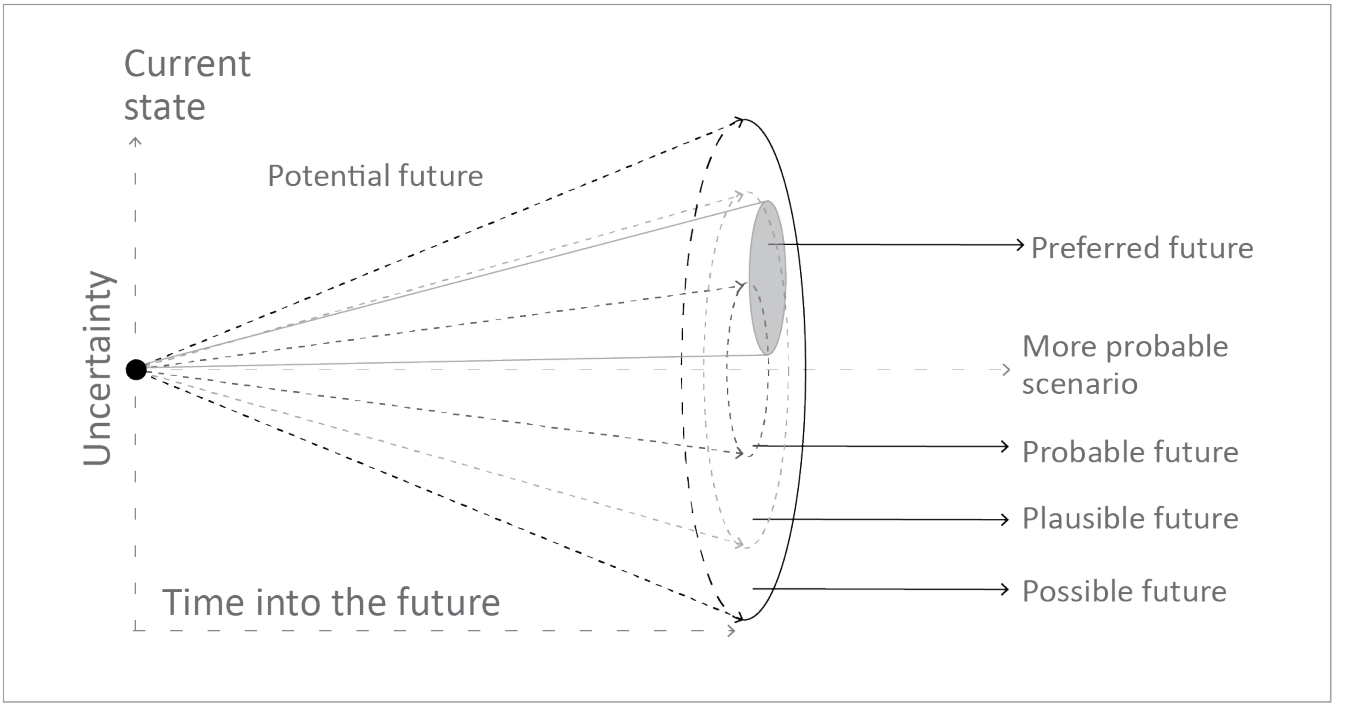



**Figure 3.** A probabilistic model of the future of a Dynamic Complex System
**Source:** taken and modified by the authors from Hancock & Bezold (1994) and Voros (2003).

Therefore, we argue that prototypes can be deployed as a central tool for design research – one that involves the physical actualization of ideas and notions of the future, including both the knowledge of the designer in the making and the user in the experiencing. In this context, prototypes are probing mechanisms into possible futures (Forlano & Mathew, 2014), but rather than assuming the solution as the focal point, we offer the idea of displaced prototypes, or prototypes that are intentionally deployed in the periphery of the problem/solution. If common prototypes are deployed as a validation tool that aims for a solution of the problem without attempting to create systemic knowledge, we argue for the use of prototypes that seek to produce partial knowledge of the system (Figure 2). These prototypes are on the periphery in two senses: some might be alternative focal points, while others are simply adjacent without ever being themselves candidate solutions for the initial problem.

Having established that there will be a variation in the trajectory of a project into the future, we believe that one role of design research is to investigate possible variations in the definition of the future, rather than focusing on one single choice; based on the application of this premise in real settings, we have observed that in the periphery we can find information about the problem that is usually discarded in current methods.

## Displacement

There are several uses of the word *displacement*: in this paper, we have decided to use a definition that relates to Latour's (1990) ANT. We see displacement as a natural dislocation between the initial framing that every actor or stakeholder makes of the problem/solution, and the eventual problem/solution as it evolves through the process, both in the framing and the redefinition based on the action of design. We find this to be a natural tension of every complex dynamic system, and even though it presents a problem when trying to forecast how the system is going to change, it might also be a tool to catalyze knowledge. If we observe one of the most significant models for the design process, the one introduced by Banathy (1996), we see that the objective of the designer is the production of a model for the future system; but the way that it has been interpreted by designers and organizations is by promoting that the end of the process is the preferred future itself, and that *that future* is the moment when the envisioned artefact is produced.

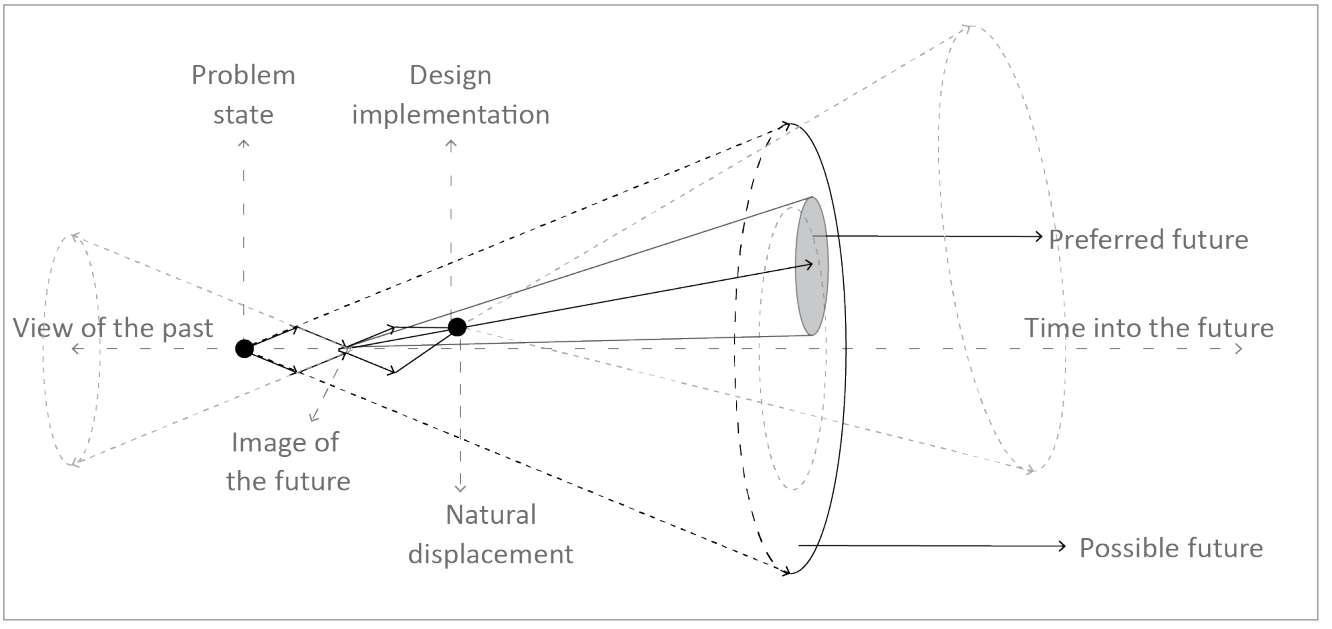



**Figure 4.** Aggregative model from Banathy (1996) and Voros (2003). The natural displacement is acknowledged as part of the system

**Source:** the authors.

Instead, we argue that the final stage of Banathy's model ends in the *now*, with a *plan for the future.* Therefore, the model might benefit from the addition presented by Hancock & Bezold (1994) and later modified by Voros (2003), of the possible futures (Figure 3).

This model recognizes that there might be a deviation on the path to achieve the preferred future, a deviation that could be expected from the beginning of the process. In practice, it is more common that there is not a single deviation, but in fact a series of deviations that are corrected through the design process – as we test and fail, we correct the path. However, not adding these natural deviations produced by the tensions and displacement inside the system creates the false sense that the path is a straight line. A new model then should include the idea of the future and the deviation in the current process (Figure 4).

The problem is that displacement is a consequence of dynamic forces. We can establish ideas of a preferred future from our current view, but as we move forward that notion changes. To accommodate this perspective, we have proposed adopting a metaphor based on Digital Imaging Theory (DIT) and the principle of *superresolution* based on center displacement (Irani & Peleg, 1990). This principle establishes that it is possible to increase the resolution of a core image by producing low-resolution images whose centers have been purposefully displaced. Overlapping these images as a multilayer image can produce high-resolution images – in our case, speaking metaphorically now, of the future system.

## Future mapping

Mapping and modeling have become one of the main tools of design research (Sevaldson, 2011) and a necessary skill of a designer. Therefore, we have also decided to incorporate this process as a mechanism in our model.

Building an image of the future is a difficult task, first because, as mentioned before, every idea of the future is going to be defined by our experience of the world, and second because the future is built of expectations and intentions that are formalized as we build it. But in a non-deterministic system, these intentions and expectations are the forces that drive the construction of a future.

Images of the future can be built on basic speculation, personal intentions, forecast, or trend analysis, but we argue that the process of mapping can add better insights about the future if it uses tacit information collected from the stakeholders to produce a representation of the system. Nevertheless, producing maps that can depict the structure of one possible future becomes more challenging because of the lev-

MODEL FOR DESIGN RESEARCH USING DISPLACED PROTOTYPES DEPLOYED AS A LAYERED PROBING TOOL

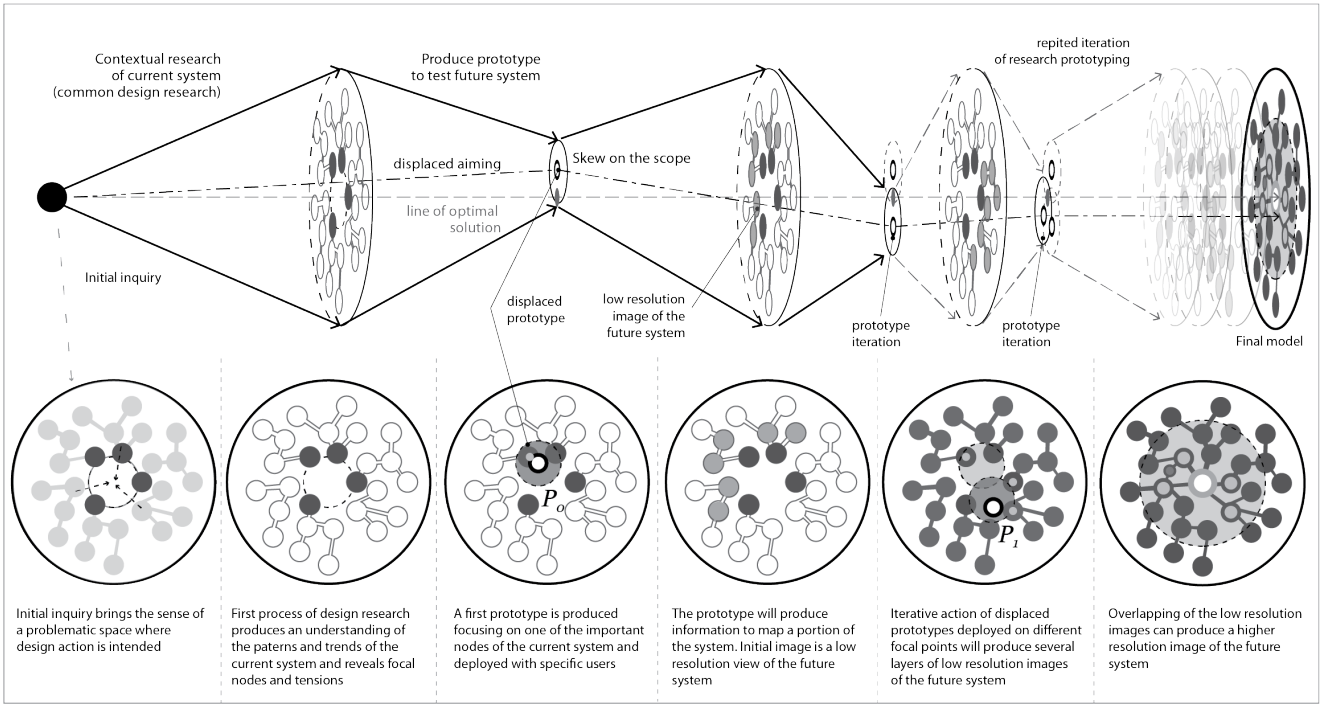



**Figure 5.** Final model for design research using displaced prototypes deployed as a layered probing tool
**Source:** taken and modified by the authors from de la Rosa, Kohler and Ruecker (2016).

el of uncertainty and how diffuse these intentions of the future can be. Based on the observations we have done, building prototypes that are not aimed to find a solution of the problem helps with the conversation about the future and produces more information to map. We propose that the process of displaced prototypes applied as a multilayered tool can be used to produce hi-res maps of the preferred future system.

## The model: design research using displaced prototypes deployed as a layered probing tool

Based on the arguments presented, we have produced a possible model for design research that uses prototypes as probing mechanisms around the periphery of a preferred future. The model proposes that by establishing peripheral arguments around the design problem, we can recognize alternative displaced centers as well as adjacent concerns that can be interrogated by the prototyping process. The information collected through these prototypes can produce one specific map of each one of the arguments surrounding the core design problem.

Once the maps have been produced, a process of layering the resulting maps can help us increase the resolution of the systemic model of the initial problem. If applied with a futuristic view, they can help us produce higher resolution maps of a possible state of a preferred future system. Through this map, we can start to identify possible future unintended consequences of our ideas, ethical objections or intentions that might be hidden or the systemic impact of the transformation of the system, and make any necessary course corrections before we even establish the path to follow (Figure 5).

In this model, the process of layering each one of these maps is possible because the prototypes investigate a periphery of the system where the initial framing of the problem is included. Therefore, all maps have a common element: they share a portion of the system where the initial design problem exists and it works as a link for all of them.

## Discussion

The model is grounded in several of our research projects in community-based methods for infrastructure design and grassroots policy making. One of the main reasons for this model is that through the process we realized that we did not have the specific tools for a design research process into a complex system that included a participatory view and that could capture more complex images of the future and the system of values that are embedded in the artefacts we design.

This is a condition that is common in long-term projects and design for policy making, since the definition of a preferred future is usually set in a long-term transformation, which once set in motion becomes harder to modify. These plans require a long process of commitment, social involvement, and public resources to make possible a plan that might not be aligned with the basic values or principles of the community, that might produce severe unintended consequences in the socio-technical and natural system.

We see in this model a tool for policy making based on its ability to capture the possible ways in which the social values adapt and react to possible changes in the future. It can also be used to address possible consequences of these policies in the local socio-economic structures and environments since it can accommodate situated knowledge and local capabilities.

We have tested a portion of this model, particularly the use of diffuse prototypes as a probing tool, using case studies of future-oriented design innovation in complex problems, and the initial results have shown that the model might be viable for design research. We have also organized several workshops with communities, testing the functionality of the model and helping communities map their preferred future with very promising results. We present this model to encourage others to use it, test it, and extend our understanding of its possible implications.

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