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Highlights

- Design anticipation requires the interaction between a temporal and a semantic dimension (a design anticipation space)

- Collective design anticipation is conditional to the formation of a boundary space that facilitates relational thinking

- Collective design anticipation is conditional to the formation of directionality in the design anticipation space

- Collective design anticipation requires the coordination of transitions from abstract to concrete semantic relations

Abstract
Design and anticipation are two closely related concepts. While previous research has focussed on exploring this relationship, less attention has been paid on uncovering the collective nature of design anticipation. The paper offers a theoretical framework to account for collective design anticipation and the conditions that make it possible. In specific, the paper discusses the notion of a design anticipation space, which embodies temporal and semantic dimensions, and discusses conditions for collective design anticipation through the concept of boundary objects. The results are derived through an abductive methodology that combines theoretical investigations with reflections on empirical work in the wild.

Keywords
co-design, collective anticipation, semantics, boundary objects

1 Introduction

Anticipation, seen in general terms as the capacity to act in in response to or in preparation for a potential future reality, has been studied from many disciplinary standpoints, as a property pertaining to biological (e.g. Rosen, 1985), physical (e.g. Dubois, 1998), cybernetic (e.g. von Glasersfeld, 1998), cognitive (e.g. Riegler, 2001), or social systems (e.g. Leydesdorff, 2005). Anticipation is also a key theme in futures studies in areas such as science and technology (e.g. Alvial-Palavicino, 2015; Nordmann, 2014), culture (e.g. Claisse & Delvenne, 2015) or environment (e.g. Granjou et al, 2017), and has been studied as capacity but also as a type of work and labour (e.g. Clarke, 2015) as well as an affective state (e.g. Anderson, 2010; Adams et al, 2009).

In his exploration of different views of anticipation in the human, social and physical sciences, Poli (2010, 2014) concludes that there are different types of anticipation to be taken into consideration, and proposes to make a distinction between studies that look at the phenomenon of anticipation, from studies that look at the properties of anticipatory systems (or what makes anticipation possible). This study looks at the phenomenon of anticipation within the context of design and aims to delineate some general principles and conditions that make design, as an anticipatory capacity, possible.

The notion of anticipation is closely linked to the notion of design as it relates to the construction of future realities. Design has been historically perceived and defined as a purposeful activity or process, which involves taking action in the present in order to construct a desired future reality (Simon, 1969; Buchanan, 2001; Krippendorff, 2006). It has also been conceptualised as a reflective practice which aims to construct futures in response to a 'problematic situation' that is uncertain, disordered and indeterminate (Schön, 1983; Dorst, 2015). In more recent years, design has been also approached as a speculative act that aims to create provocations and critical reflection about potential and preferable futures, explicitly linking design to futurology (e.g. Dunne & Raby, 2013). Finally, design has also being conceptualised as an 'Intentional' state and capacity, alluding to the semantic and affective properties of the mind to conceptually construct non-existing entities that could create preferred future realities (author, 2012)

What is common among the different approaches to design is that it is essentially defined as a future oriented phenomenon (process, work, state of mind or capacity) similar to anticipation. Celi and Morrison (2017) recently offered an elaboration of design as a critical foundation for anticipation, by virtue of its constructionist approach to the study of futures and particularly to 'making futures'. This paper concurs with the position that design is part of anticipatory studies. More specifically, the premise of this paper is that design is essentially a special type of anticipatory phenomenon. Whether seen as a special type of process, work (or practice), state of mind, or capacity, what we will call here 'design anticipation' is tightly linked to an interpretative dialogue between present and future, as well as problem making and problem solving. To that end we will use the term design anticipation to generally denote the capacity to conceive and specify intentional entities (material or non-material objects) in preparation of a preferable future. In a previous study (authors, 2007) we

developed a framework for defining design anticipation through a semantic lens: as involving the capacity to generate theories (i.e. expression of requirements and principles of a current and future desired reality) and models (i.e. specifications of entities in the world) in anticipation of a correspondence between the two. This framework allowed to view design anticipation as widespread phenomenon that arises in many different types and levels of complexity in neurological, cognitive, and social systems.

The present paper builds on this work and on empirical explorations of design research projects involving community groups, with the objective of identifying the characteristics and conditions of design anticipation when it is understood as a property of a collective: a network of people that may work together in some way or connect their resources in order to respond to their needs and aspirations for the future. In that respect, 'collective design anticipation' encompasses the element of connecting and/or negotiating multiple and possibly conflicting potentialities and preferences for the future. A key consideration will be the role and properties of the spaces and material objects (boundary objects) that enable the emergence of collective design anticipation (authors, 2019).

Methodologically, in order to identify the characteristics and conditions of collective design anticipation, the study followed an abductive (and iterative) approach: theoretical ideas were used to inform the co-development of hands-on practices that could instigate collective design anticipation in place-making community-led projects. The authors worked directly with such communities to develop these practices and tools. Reflection with participants about the conditions of collective design anticipation subsequently led to further development of theoretical ideas and practices. Data were collected through artefacts developed and used in the process, as well as through the recording of conversations and interactions between participants.

The paper is organised as follows: To set the scene for the main treatise of the paper, Section 2 presents the methodological approach and Section 3 delves into the key notions of anticipation, design anticipation and collective design. Section 4 develops the theoretical framework in detail. The paper closes with some conclusions and reflections on the conditions that make collective design anticipation possible.

2 The approach of the paper

Overall, the development of the proposed framework on collective design anticipation can be seen as part of an abductive research strategy (Blaikie, 2010; Timmermans & Tavory, 2012). The key principles that shape the development of the framework follow an iterative process between theoretical reflections that 'deductively' construct an argument on collective design anticipation, and empirical reflections that 'abductivelly' construct theoretical hypotheses that could plausibly explain the differences between theory and observations in practice. Technically speaking, empirical reflections may also include some

reflections that 'inductively' construct ideas that are drawn from the experience of multiple projects. This takes place in a qualitative manner and as part of a more general abductive strategy.

This paper draws particularly on experience from 3 projects funded by the Arts and Humanities Research Council in the UK. These projects generally aimed to develop materials and processes that would help communities to engage in design practices. In these projects, the authors aimed to translate theory about design anticipation into actionable practices. Of course this translation was not a trivial task and required re-interpretation or indeed the development of new notions and principles to fit the context and content of a community action project. For this paper, this re-interpretation and adjustment of notions and principles on instigating collective design anticipatory practices, in tandem with further theoretical elaboration, is the key process of knowledge production.

It may help the reader to explicitly articulate some of the key tasks that, although not linear, they did delineate key research activities for developing the proposed theoretical framework:
- *From theory to practice:* Theoretical research on design anticipation was used as a starting point in order to formulate processes and materials that could help communities to engage in collective design anticipation. At the most fundamental level this included using key theoretical concepts (e.g. the distinction between theory and models as we will see below) to formulate a design method, and translating key processes suggested by the theory into mechanisms to enable groups to engage in collective design anticipation
- *From practice to theory:* The research team aimed to develop practices that would instigate collective design anticipation. These practices (processes and materials) were not completely constrained by theory. Practices for instigating collective design anticipation were also largely based on previous experiences, practical knowledge and intuition of the authors and other members of the research team and came as a product of collaboration. So, many elements in the ontology and method used to instigate collective design anticipation were completely new, while others were adjustments of existing theoretical concepts.
- *Negotiation of areas of attention:* The research team/authors worked to identify the theoretical concepts that played an important role in different projects but also areas that needed attention because of adjustments made and/or new elements having been introduced in practices to instigate collective design anticipation. This means that the authors identified a number of projects, and even more strongly, a number of instances within these projects, that were considered as useful incidences to draw reflections about collective design anticipation. This instances or incidences 'prove' the existence of a theoretical element (but of course not its universal truthfulness).

It is important to clarify at this point that the purpose of this paper is not to make a methodological contribution, which would require explaining in detail how materials and process were designed to instigate collective design

4

anticipation and what their relation to theory was. The purpose of this paper is to present a theoretical framework that is constructed and articulated from the re-interpretations and adjustments that were made in theory and practice.

3 Key concepts: collective - design - anticipation

This section aims to briefly examine some key concepts that will form the building blocks of our proposed framework for exploring collective design anticipation.

3.1 The problem of anticipation
Anticipation is an appealing but also difficult idea, as it seems to violate fundamental principles of time and causality. This is because it implies circularity: how can future states of the world affect present time, how can the effect of an action determine the action in advance of its realisation, or how can an abstract concept be constructed without a known instance of this concept? Scholars have produced different responses to this circular causality problem.

Robert Rosen, whose study of anticipatory systems profoundly influenced the contemporary understanding of anticipation, associated anticipation with the ability of a system to contain a model of itself and/or its environment (Rosen, 1985). This allows a system to act not only according to its history, but also in response to possible or future states of the world. People customarily construct models which allow them to predict future situations, or consequences of future events, and on this basis to change their present course of action. The idea that an anticipatory system requires a model of itself and/or its environment is not widely accepted and for instance we have formulations of anticipatory systems where anticipation is an intrinsic property of a system without an explicit internal model. For instance, Dubois (1998, 2000) favoured a temporal/dynamic interpretation of anticipation. He asserted that Rosen's notion constitutes a special form of anticipation as it is founded on model-based prediction ("weak" anticipation) and proposed a formulation where anticipation as change of current state according to initial, as well as final conditions, is achieved at a system level ("strong" anticipation).

Temporal conceptualisations of anticipation are clearly very dominant in futures studies. In this context, anticipation is defined, for instance, as 'the capacity of an organised system to incorporate projected future states into its present functioning, as a way of orienting or modulating its activity' (Groves, 2017 p30) or for instance as 'a performative process of rendering the future actionable' (Anderson, 2010: p229). The key characteristic of anticipation is the attentiveness to future states of the world as orientation for reacting, planning actions and making futures. These futures are embodied in concrete representations such as objects or images but also narrative, stories or practices (e.g. Groves, 2017; Claisse & Delvenne, 2015). Around these concrete or more abstract representations, the futures are debated, planned and materialised.

However, anticipation is not only a temporal problem and its relation to causality also has also been approached through semantics. From this perspective, causality is also inextricably linked to the formation of a 'universe' or environment that imposes constraints and conditions of existence for the objects or systems that make up this universe/environment. For instance, Van de Vijner (2000) considers anticipation to be a problem of abstraction. Referring to the notion of anticipation in Greek philosophy she noted that 'anticipation is about the relation between universal and particular: anticipation is the capacity of designating things by a universal vocabulary, while having experience only with particular instances of those things. So, anticipation to them [Greek philosophers] refers to the capacity of the human mind to possess and use abstract ideas, before the immediate perception of the object'. A semantic perspective of anticipation can also be found in Clarke (2015) who approached anticipation work as a strategy for tackling uncertainty. According to her, anticipation is realised by three key processes: abduction, simplification and hope. Although she refers to the temporal orientation of anticipation, her conceptualisation predominantly brings to the fore the semantic and affective aspects of anticipation. Abduction would involve a process of creating meaning by theorising: a process of suggesting a hypothesis to be tested. Simplification would involve a process of imposing constraints, reducing the amount of data that considered irrelevant or transporting meaning into a new context. Hope is the affective state that is the driver and sometimes the end product of anticipatory work. The temporal aspects of anticipation are much more subtle and probably embedded in affective state of hope. A more logic-theoretic elaboration of such semantic interpretations of anticipation, and through the use of notions that appear in formal semantic theories, is found in author (2012). Within this context of formal semantics, 'theories' are the set of principles or conditions that create a universe of possibilities while 'models' describe specific instantiations of this universe. Anticipation is then the capacity and work of generating theories and models that are in alignment. In this paper we focus on this interplay of temporal and semantic dimensions of anticipation as a key characteristic of design.

3.2 Design anticipation
In (authors, 2007) we explored how the concepts of design and anticipation are linked, and proposed a theoretical framework which establishes the link between design and anticipation. In specific, we formulated an anticipatory view of design, which helps distinguish design from other conceptual categories or paradigms, such as problem solving (machine paradigm), exploration (evolutionary paradigm) or control (cybernetic paradigm).

The framework hinges on the idea that design arises in response to a problematic situation: when beliefs about the past, current, and future states of the world, are inconsistent with desires or needs about the future state of the world. As Smithers (2002) notes, in the core of what is design(-ing) lies an apparent paradox: designing has to do with arriving at a solution to a problem which is not a-priori specified. In other words, although design is driven by a need or goal, this goal is actually constructed by the very process of design. In

this sense, design is inherently anticipatory as it involves the capacity to generate design solutions, in anticipation of a correspondence between the design solution and the desires and needs that motivate it.

To express this more formally, we use the logic-theoretic distinction between theories and models. Theories can be defined as (desired or observed) descriptions of the organising principles of a world W of possibilities, and models can be defined as (desired or observed) instantiations of a world. In formal semantics, models are often considered to assign specific semantics to a theory because they provide a specific interpretation. On the other hand, theories are considered to describe families of models in W, where each model constitutes an instance or interpretation of the theory. A theory is in correspondence with a model when it is possible to deduce the properties of the model from the theory, and respectively, it is also possible from the family of models to induce the theory. In this sense, a theory can be seen as a 'universal model', an archetypal model able to encode the principles of a class of models. Theories in effect embody the conditions of satisfaction or truth conditions for a model.

More specifically in design, theories often represent principles or parameters that specify a solution space, requirements (e.g. criteria, properties or evaluation strategies), and plans for the resolution of a problem. Models constitute in turn interpretations of these theories into specific design descriptions, alternative configurations in a solution space, or instantiations of actions for carrying out design tasks.

Using this terminology, design is seen to involve the capacity to generate theories (requirements, principles of a current or desired reality)) and models (specific instantiations or specifications of objects in the world) in anticipation of a correspondence between the two.

By definition, the relationship between theories and models is essentially a semantic relation. By defining design anticipation as an interplay between theories and models, we essentially adopt a semantic view of anticipation, which emphasises the construction of meaning. The framework considers that design involves a phase transition from a state where theories and models are inconsistent to a state where they are consistent (author, 2012), so there is an overall directionality governing anticipation in design towards semantically congruent constructions.

Coming from a complexity-theoretic standpoint, the framework proposed did not make assumptions about the physical realisation of this anticipatory design capacity, making it applicable to neurological, cognitive and social systems alike. In (authors, 2012) we illustrate how the framework can explain how design evolves in the brain, as well as in the scale of cities. The purpose of the paper is to focus further attention on the collective character of anticipation in design, i.e. to explore anticipation as it emerges in collective design tasks.

3.3 Collective design

Within the design discipline, there has been a growing interest in studying and supporting the formation of collective design solutions. For some, it is a matter of harnessing the value of collaborative creativity (e.g. Sanders & Stappers, 2014), for others it is a matter of supporting democratic processes (e.g. Sanoff, 1999), transforming power relations (e.g. Ehn et al, 2014), or producing social change (e.g. Manzini, 2015). For a full exposure of the different concepts and practices that fall under the generic rubric of co-design, see authors (2018).

In practice, there is a spectrum of ways in which people may connect together or work together in a design project (Figure 1). People *collaborate* when they work together towards a common interest or goal. For instance, a local community may work together with academics and third sector organisations to develop shared knowledge and generate ideas and solutions to a common problem (e.g. tackling isolation of the elderly). In other cases, design activity is not steered towards a common goal. It may involve groups that have conflicts of interest and fundamentally different needs. In this case, people *cooperate* to find synergies across essentially different interests or projects but nevertheless work independently from each other to serve their own objectives. In other cases, people *coordinate* their knowledge, resources and capabilities to create innovative solutions. For instance, a health organisation that works with people with mental health issues may gather together its users/patients to learn from them and ultimately co-design a new service. Finally, people may simply *connect* their actions and resources – an example of this is the Open Design movement where distributed users (typically on a digital space) share and contribute information, that can be used to develop physical products, systems, or other solutions for different localities. All these are possible expressions of co-design practices, distinguished on the basis of how strongly they focus on shared goals and working practices. In some cases, the emphasis is placed on working together (collaboration and cooperation) while in others there is a tendency to work independently (coordination and connection). Also, while in some cases there is a strong commitment to finding and working towards common goals and values (coordination and collaboration), in others, there is a strong emphasis on individual (or multiple) goals and values (connection and cooperation).

Author (2011) has used the notion of coordination as an overarching term to describe design practices where multiple agents are involved. According to this view, design is a process through which all parties involved coordinate their goals and actions as well as their roles - i.e. they do not only create a set of solutions or outcomes to fulfil a set of goals, but they also define their mode of interaction and organisation.

In fact, there is a notion of collectivity in design even when we are considering individual design practice, as different goals, values and social structures or contexts directly influence the formation of design solutions.

In this paper we aim to delve deeper into the notion of collective design anticipation, encompassing the full spectrum of ways in which people come together in a design project.

4 A framework for constructing 'collective design anticipatory' capacity

Following the original theoretical framework for viewing design anticipation (briefly summarised in section 3.2), our engagement as researchers and enablers of co-design in community projects, was focussed on developing tools and processes to encourage groups to construct and anticipate semantic relations between their theories and their interpretations into models. These materials and structured processes were developed and evaluated in collaboration with the groups and other partners. Depending on the situation in which each group was, and the nature of their design problem, each activity was developed so as to help articulate a theory about their observed and desired world together with interpretations (i.e. models) that satisfy these theories. In this context, theories were understood as comprising people's knowledge, desires, beliefs and resources that set the conditions and principles for the creation of design objects (e.g. a building, a technology or service), but also their context (e.g. their users, or their cultural and socio-economic environment). *Models* were understood as interpretations of these conditions or principles, specifying design objects.

In the following, we present some key principles that underlie the notion of collective design anticipation based on reflections and observations on the development and the effects of the different approaches used.

4.1 The interaction between temporal and semantic dimensions of anticipation (the design anticipation space)
A key observation during the early phases of a design journey, was that most community groups struggled to make the distinction between theories and models in the first place. At the start of a design process, the actual object of design is undefined but also the wants and needs about a design object form a blurry constellation.

Working with groups engaged in placemaking projects (e.g. community gardens, community buildings, churches), we often started with conversations trying to formulate a view of what they have, what they want to achieve and their barriers or challenges, to help move towards general principles and/or specific ideas for the future. However, following these conversations there was difficulty to move from assets, objectives and challenges to general principles and specific ideas for the future.

For instance, working with a group looking after a historic building, one member claimed that 'our key challenge is that our place [building] does not have visibility, it feels like a closed, abandoned place, but we have some much activity going on', while another member said 'our key challenge lies with the actual usage and flexibility in our building for accommodating different activities but yes our key asset is the diversity of activities' and another one said 'our key challenge is funding – we need to fundraise in order to dream, but we do have a lot of skilful people for this purpose'. These different thoughts have of course connections with each other but these connections were not clear or indeed

shared among people in the group. The group found it difficult to identify some emerging principles (e.g. 'a place that feels open all the time') or indeed specific ideas (e.g. 'to reorganise the entrance') that could create a desired future. Moreover, the distinction between principles and their possible interpretations was not clear. Some people would see 'the creation of more open place' as a principle and others as an idea or interpretation. This was a situation we encountered with many groups at the beginning of a design process: they were able to express beliefs and desires about their situation, but without a clear sense of a theory that could guide their action or explain how different 'solutions' may satisfy their beliefs and desires. It was difficult to differentiate between what is their interpretation of *'what* needs to be designed' from what is their theory of the *why* this design is needed and the *how* it will achieve its purpose.

These situations where theories and models are difficult to distinguish and differentiate were seen to be very important for the creation of design anticipation. The research team put more emphasis on moments where such distinctions do not necessarily exist to explore the conditions that instigate the formation of such distinctions. On the ground, the research team focussed on helping people to make semantic distinctions by introducing a set of key questions that prompted people to 'time travel' between past, present and future situations. In this sense, engagement in design anticipation was facilitated by moving along the dimension of an *'imaginary time'* through questions such as:

● **What could the future be that would make the present better?** This is about encouraging groups to envisage potential and desirable futures
● **What exists in the present/past that compromises or creates opportunities for the future?** That is about encouraging groups to reimagine their past and make sense of their current situation, its meaning, challenges or opportunities
● **What could create the envisaged future?** This is about encouraging groups to specify things that can respond to a current problematic situation and create an envisaged future

For instance, in one of our collaborations with a community in Chester, UK, the research team printed those questions on large panels, and the group, individually first and then collectively, created a list of statements in each panel, about the way their community would address needs of the present and aspirations for the future. The formation of statements was facilitated through the use of a set of prompt cards that encouraged them to think about: desired/potential outcomes; issues that compromise their future; proposed changes; and relationships between these different parameters (Figure 2).

Here are two examples of the narratives that emerged:

> *Statement 1: Over the next years more people from UK and abroad would visit the centre of Chester [because of its heritage status] … For our sustainability, it is essential that long-term sustainable income streams are identified. There are unused spaces [in our building] and we [currently] cannot rearrange the chairs*

differently. So our space needs a complete rethink to be more welcoming and comfortable with room to grow. This should include formal and informal seating that allows people to see the front [a beautiful window with heritage value].

Statement 2: We want a future that brings in more people from all different walks of life but respect our values. To do this we need a diversity of formal and informal spaces and diversity of activities within our building. The current kitchen is too small and faces in the wrong direction. We need to change the size and orientation of the kitchen so as to be more visible to visitors.

Statement 1 expresses a probable future (a foresight) that connects to a current need for more sustainable income. The space of the community building is identified as an asset to help reach this potential future and a more flexible arrangement in the building was introduced as a means for realising this future. Statement 2 focused more on a desired future outcome (rather than a foresight) that expresses a key principle or value of the community but is also associated with a proposal that would realise this future.

Both statements were produced by enabling temporal anticipatory thinking that unfolds on an imaginary time dimension. However as the conversation developed in real time, the statements became objects of interrogation and various relations and interpretations of these relations were distinguished, creating a semantic dimension. In this particular case, most of the ideas and narratives generated delineated a context that focussed on the city of Chester and its heritage status. The space, arrangement and activities that are part of the building and community action emerged as the object of design. Some ideas became parts of a theory that articulates the principles or conditions of satisfaction for the object of design (e.g. we want a future that will bring people from all different walks of life or we want a flexible space) while other ideas served to provide specific interpretations of their theory (e.g. a space with a diversity of formal and informal spaces). The distinction between theory and models naturally emerged from the relations between these thoughts: some thoughts were simply describing the conditions of satisfaction and some giving interpretations of these conditions. This movement between theories and models is obviously very dynamic: when a specific interpretation or instantiation of a theory is proposed, it can in turn constitute a theory for new, more concrete interpretations (models).

Following on from these empirical observations, a new theoretical premise started forming: The semantic and temporal views of anticipation are not simply two different perspectives of anticipation, but anticipatory capacity requires an interaction between semantic and temporal aspects. This new premise helped revise our original framework to develop a more nuanced understanding of how the relationship between theories and models is activated and its relation to temporal thinking. More specifically, the new theoretical premise is that the temporal and semantic aspects of anticipatory thinking are interacting with each other, progressively creating an 'orthogonal' relation. This means that design anticipation may start as one type of thinking that unfolds in a temporal dimension (in *imaginary time*), but as past, present and future come together in the present moment (in *real time*), they also create relations between theories

and models and therefore give rise to meaning. In simple terms, this means that some expressions or events (e.g. statements or pictures) that embody relations about the past-present-future set the context and the conditions of satisfaction for other expressions and vice versa. Ultimately, it might be theoretically useful to think of the creation of a two-dimensional anticipatory space comprising a temporal and a semantic dimension (Figure 3).

Design anticipatory activity is ultimately unfolded in this space where time takes different realisations. There is a 'time travel' aspect that unfolds in an imaginary time as people reflect on relations between past, present and future. Of course these reflections are also positioned in a real time as discussed above. But there is also an aspect of time associated with moving within the design anticipation space ('space travel').

The above premise is connected or indeed requires some further theoretical assumptions regarding the nature of time and future. In general, the notion of time is assumed as a source of semantic potential. This is probably a departure from the more typical semantic theoretic perspective that focuses on how semantics create the notion of time (e.g. Ludlow, 1999). The notions of 'thick present' or 'extended now' seem relevant here in helping understand the relationship between the semantic and temporal dimension. Talking about the ontology of the present and the future, Poli (2010) and Hodgson (2013), discuss that every moment in real time essentially embodies both past (not only as memory, but also as retention - a lingering experience) and future (not only in the sense of imagination but also as potential or latency - a tension towards). Following this line of thought, every present moment is not the same as any previous or next present moment - it embodies a different potential. This differentiation or difference in the potential generates tentative semantic relations that form the basis of design anticipation.

4.2 The formation of a boundary space and objects that enable the sharing, creation and negotiation of temporal and semantic relations
As discussed, a key theoretical premise of our original framework was that design anticipation is a property of the complexity of a system whether this is neurological, cognitive or social system. Although no distinction was made between collective and non-collective design anticipation, the framework assumed the existence of a distributed system, whether it was neurons in the brain, different mental states of a person, or different agents in a city. Focussing on work with community groups leading design projects, we were able to focus on the notion of collective design anticipation or the nature of design anticipation in the context of collective design.

For instance, the research team worked with a community group that were trying to save their historical church and community space from closure due to the large cost associated with maintaining and running a big historical building. The group was an elderly community in Stourbridge UK that often reflected on the future of their community with pessimism. Their fears about the future were

expressed in their community meetings and there was a general agreement that new young people are needed, that would re-imagine the future of the place and bring to the fore their own aspirations and identity. But this was neither a trivial task nor one without contradictions as their own younger family members (i.e. their children and grandchildren) would prefer to use other places. Looking for people beyond their immediate environment was possible as the group was very well connected to the local town and many organisations had expressed an interest to build partnerships with the church, but the congregation also felt that their identity, needs and aspirations could be compromised by any new members or other users of the building.

Elements of design anticipation were observed at an individual level, when people for example expressed their ideas. For instance, someone talked about opening up the churchyard towards the train station, which was situated at the back of the church because, as he claimed, he expected that this change would increase the flow of people using the churchyard and therefore change perceptions about the church. Another talked about organising activities that would invite younger families to use the church and as a result construct an environment that would be more relevant to younger generations. Such sentences have both a temporal element of imagining a future state of the world and how this future can be constructed but also a semantic dimension as they offer an articulation of some values or conditions of satisfaction together with an instantiation of what would make these conditions true.

These sentences were the product of shared discussions and possibly did express the views of different people within their congregation. The space of the church itself was a key asset for collective design anticipation, as it allowed people to meet and discuss their issues and ideas. However, both the research team and the congregation observed that although the different thoughts were formed, shaped and debated in a shared space they did not form a shared network of thoughts. The thoughts were informed and shaped by collective discussion but were expressed by individuals.

To that end, different material objects and process were created in collaboration with the community in order to allow the sharing, co-creation and negotiation of different perspectives within a shared network of thoughts. One of the key materials was a very simple table that prompted the core group (but also wider members of their community) to share and debate three areas: first, the key priorities for their future, second, problems or concerns for the present and third, key principles of action. In the first phase, the key objective of the debate was to help express individual thoughts and discover whether these were common, conflicting or independent. The table was progressively completed and debated and every individual had the opportunity to post their thoughts and debate their position in relation to others in the table. In a second phase, the objective changed and the focus was to create vision statements for the future that were generated by combining existing responses from the expressed priorities, concerns and principles/values of action (Figure 4). Some of these visions were a synthesis of views (composed by common priorities, concerns and values). Other visions were expressions of antithesis within a group as they

were based on conflicting perspectives. Others were just mutually independent as they were based on statements that had no conflict or indeed relation with others. The formation of a space (containing those material objects and processes) was key for helping people engage in anticipatory design thinking as a group.

In a more theoretical sense, this shared space can be seen as the formation of a 'boundary space' consisting of materials and processes that are shared by a group of people, enabling them to position and collectively observe, create or negotiate the relations between the semantic and temporal elements of their anticipatory thinking. This aligns to the concept of boundary objects; an analytical concept which has been defined in order to describe objects that 'both inhabit several intersecting social worlds…. and satisfy the information requirement of each of them' (Star & Griesmer, 1989) thus helping people translate and share their thinking. The concept has been subject of research for many decades now and its meaning and role in situations that involve the connective, collaborative or cooperative action of different people has been explored in many publications. For instance, Carlile (2002, 2004) argued that boundary objects are involved in a process of knowledge transfer, translation but also knowledge transformation. Stevens (2013) focused more on the semantic and sense-making role of boundary objects: namely, the reflective dialogue of people that helps them to create meaning about a certain experience, understand connections or explain discrepancies. Lee (2007) and later Pennington (2010) differentiated between 'boundary specifying' objects and 'boundary negotiating' artefacts with the objective to include material objects that establish and destabilize protocols and ultimately 'push boundaries rather than merely sailing across them' (Lee, 2007).

In order to uncover the nature of boundary objects and their role in collective design anticipation it is useful to start with some general observations. The boundary objects that enable collective design anticipation are essentially *'objects for design'*: that is, they are socio-material structures and processes that are designed and used in order to enable people to engage and collaborate in a design task (e.g. to assist in representation of ideas, or communication and collaboration between individuals). This general observation has an important implication. The formation of boundary objects that enable design anticipation in a group requires on its own a collective anticipatory design capacity. That is boundary objects also constitute *objects of design* for the group.

In our empirical observations, the formation of such boundary spaces (and the associated objects), was crucial for helping people to share, create, negotiate and represent the relations and tensions within their design anticipatory thinking both in a semantic and temporal sense. In one sense, this is a trivial conclusion that arises simply because of the connective, collaborative or cooperative interaction between people rather than the intrinsic dimensions of anticipatory thinking. However, the premise that collective design anticipation requires the formation of a shared space that fosters certain types of boundary objects and

processes does have some important implications about the very meaning of collective design anticipation. It implies that collective design anticipation is not simply the added sum of individuals interacting with one another. Collective design anticipation requires the formation of a space, in which interactions between people and boundary objects and processes are formed. The notion also embodies the idea that people do not necessary hold a common perspective about the relation between future, present and past, or the relation between theories and models. The space of collective design anticipation, can be fragmented, conflicting and inconsistent. The boundary space affords the creation of a plethora of different models and theories about the future, but also affords the formation of a shared understanding and anticipation of their relations (e.g. complementary, independent, conflicting).

A boundary space for collective design anticipation should then be understood as a space that is formed by and in turn enables the formation of boundary objects, that facilitate the interaction between the temporal and semantic dimensions of anticipatory thinking. For that reason, it is important to look in a more detail at the required properties or principles of this special type of boundary objects.

4.3 The formation of boundary objects that facilitate relational thinking
What follows from the very nature of the anticipatory design space is that any boundary object essentially facilitates the interaction between theories and models, and between past and future. Indeed, a key observed challenge affecting the capacity of a group to engage in collective design anticipation, has been the difficulty to connect thoughts about the future with thoughts about actions in the present. Similarly as discussed in previous sections, there is often a difficulty to connect theories with models.

For instance in one of our research projects we collaborated with a group of young women who lived in a garrison town with their children, generally far away from their wider family and social networks. It was also a highly transient local population, as families were relocated to new posts quite regularly. At early phases the meetings and workshops focussed on talking about the future, thinking about questions such as 'what is your desired future' or 'what is your probable future' given all the current circumstances. Of course very rich conversations about the uncertainties they faced emerged from these meetings. But their challenge was not the uncertainty about the future but its relation to the present. The big breakthrough came when the question and materials developed become more relational: 'What exists in the present/past that compromises or creates opportunities for the future?' or 'What could the future be that would make the present better?'. To enable this relational thinking we used a method for mapping the group's assets (e.g. skills, spaces, resources, technologies) in relation to a desired future. At the centre of the map was the desired future while assets were organised in concentric circles around it. The closer the assets were to the centre, the greater their potential to be mobilised to create the desired future. In other words, assets closer to the centre expressed more certain expectations about the role of these assets for the creation of a certain future (Figure 5). This workshop was a catalyst for this local community to articulate the relation between what they considered as their future and their

present situation, but also connect their theories about their community on what they have, need and want with very specific models of action expressed by the mobilisation of different clusters of assets. Following this exercise, the group was able to better connect their assets and follow up ideas about actions - which resulted in the creation in a new soft-play service run by the group, helping achieve their goals around combating social isolation.

Relational thinking is at the heart of collective design anticipation and boundary objects should be such as to facilitate this relational thinking. Collective design anticipation requires the formation of boundary objects that encourage individuals and groups to identify and reflect on the relations between past, present and future, as well as the relations between theories and models. In this sense, a boundary object that facilitates for instance the creation of a vision for the future of a group, on its own, does not facilitate the formation of anticipatory capacity. What facilitates design anticipation is positioning a visioning exercise within a temporal and semantic dimension to reveal a relations between present and future and between theory and model.

4.4 The formation of directionality and the coordination of transitions within the boundary space

It is important to observe that boundary objects essentially help progress collective design thinking. This sense of 'progress' is essentially a transformation from more weak anticipatory relations and distinctions in the semantic dimension to stronger ones. More specifically, this qualitative change in the distinction between theories and models from non existent to weak and then to stronger semantic relations creates a sense of *directionality* in the design anticipation space. This sense of directionality needs to be understood as directionality in the 'space travel' of a community within the design anticipation space. It is not (only) about the sense of an arrow from past to the future but it is about the anticipation of a qualitative transition in semantic relations.

To explain this, we could recall the examples from previous sections and reflect on the transitions that took place from a stage where there was no distinction between a theory of what is needed/wanted and what are the different models of action that were expected to satisfy this theory. The boundary objects and processes developed led the groups to anticipate that certain models of action would satisfy their theories. In most cases, the boundary objects created a sense of directionality as members of the community would either explicitly express a sense of 'progress' in their understanding of their theory and possible models of actions and/or would go on to develop a new boundary object that would further refine their principles and ideas for action. For instance, the group in Stourbridge thought that the table with their priorities, concerns and principles together with their vision statements would become more concrete if they became part of a routine allowing the congregation to reflect, re-evaluate and discuss. A space was dedicated within the church where these materials were exhibited and people could further comment after attending a service. This little space became a new boundary object for these conversations.

Indeed not all boundary objects would play this role. In another event with the group in Stourbridge, historical artefacts from the Great War were used as a tool to open conversations about the church with the wider community. These conversations and artefacts became shared objects for the participants, the objects triggered conversations that helped them collect local stories and explore social relations within the community. In this sense, these artefacts became boundary objects that facilitated travel in time and meaning in the local community. The event was a success and received very good feedback from all participants and congregation. But, on reflection by the research team and congregation after the event, it was found that the discovered stories and relations, although very emotional and powerful for people, didn't contribute to progressing along their anticipatory path, as it didn't create a sense of directionality of 'what might be next'. From this perspective there was no collective design anticipation. Following these observations, we concluded that to enable design anticipation, boundary objects should help develop a sense of directionally that in turn would ultimately contribute to the formation of *transitions* from more abstract to more concrete semantic relations. Having said this, it may worth noting that boundary objects could in principle facilitate a move to more abstract semantic relations – as relationships between theories and models are evaluated and reformulated. But again this move to abstraction or weaker relations between theories and models happens in anticipation of semantic relations that distinguish the formation of theories from their models and establish their relation.

At this point there is a need to analyse this process at a higher level of observation (at a macro level). Boundary spaces often allow the formation of conflicting or inconsistent boundary objects. These boundary objects may in a sense carve different pathways within the boundary space (as they anticipate different directions). What is therefore required is a process of coordination of those separate pathways that is also anticipatory in nature. This requirement is associated with the need to progress design thinking overall, to anticipate more concrete futures. The different pathways that emerge by the directionality and (micro-) transitions constructed by boundary objects, need to be coordinated at a macro level in anticipation of a complementarity between theories and models. This is not a trivial task or capacity. Indeed in many community projects, participants commented about the lack of an overall sense of direction, the difficulties faced when people go in different directions, or when a notion of collectivity seems to disappear.

Practically, this means that collective design anticipation requires a meta-level of interaction between people. This is a level that allows people to reflect about the very structure of the boundary space. In several projects where the research team was involved in enabling collective design anticipation, this meta-level reflection was made possible by providing time and materials to allow groups to 'step out' of their situation (or present moment) and reflect on boundary objects previously produced and how they may be linked to one another to help progress their projects.

We assume however that collective design anticipation does not necessarily require a collaborative self-reflection. The transition from tentative relations between theories and models to concrete ones can be realised because of independent micro-level reflections about the relationship of a boundary object with the boundary space and other boundary objects. In other words, coordination between boundary object pathways can emerge from individual self-reflections. The case can be illustrated by the work done in one of our research projects in which academic and civil society organisations came together to explore ways to scale up co-design practices. The research team experimented with ways of creating this form of collective anticipatory space through a process that we referred to as cross-pollination (ref removed for blind review). By requiring participants to express and explore connections between their interests, concerns and resources at the start of the project, a space was created which allowed the formation of semi-independent sub-projects pursuing the same questions from different perspectives and through different boundary objects. The evolution of this network of sub-projects and boundary objects (both their specification and their relations) did not come as a result of explicit project-level reflections, although collective reflections were facilitated to look at individual sub-projects. So while the initial network included 15 collaborators (5 civil society organisations, 4 universities and 5 communities) that were connected around the same overall question of scaling up co-design practices, a year later, following the cross-pollination process, the network included 32 collaborators (including 12 organisations who were not originally connected to the research project and 11 communities) and the formation of 10 different community projects. These different projects may be understood themselves as boundary objects that were shaped to respond to a common question and develop models and theories of scaling up co-design by following a very different pathway within the anticipatory design space. It is important to note that these projects shared information and indeed some of them merged into the same pathway leading to four different models of scaling up co-design.

The key point in this example is that a social entity, such as a local community or a community of researchers, organisations and citizens, may develop a diversity of interconnected socio-material structures that not only shape different theories and models for the future (as discussed in previous sections), but they also shape different approaches for developing these theories and models into more concrete semantic relations. This is again a key anticipatory capacity. It requires a form of coordination that aligns micro-transitions from different boundary objects to an anticipated macro-transition: a transition from a situation where there are no relations and distinctions between theories and models to a situation where complementary relations are formed.

5 Conclusions and discussion

The paper discussed a theoretical framework that helps understand collective design anticipation and the conditions that make it possible. We started by introducing the notion of a design anticipatory space as produced from the interaction between semantic and temporal aspects of anticipatory thinking. We

then proceeded by observing that collective design anticipation requires the formation of a boundary space in which *objects of* and *objects for* design are developed and shared. We then focussed more specifically on the requirements for boundary objects to be directional and relational, and discussed the need for a meta-level coordination of transitions across different boundary objects.

This theoretical framework extends our previous work on design anticipation by taking into consideration the interaction between semantic and temporal aspects of anticipation, and helps formulate a view of design anticipation as a emergent property of a collective, of a social entity. Awareness of the dual temporal and semantic dimension of anticipation is a useful theoretical contribution in the understanding of anticipation, but it is also practically important. Facilitating thinking about the past, present and future, for the purpose of design, is clearly crucial, but this temporal thinking needs to go hand in hand with a consideration of the principles/conditions that will drive the construction of a desired new reality and the specification of that reality. This helps construct meaningful relations between past, present and future and also direct the development of design thinking. The formulation of design anticipation as a collective property is essentially a recognition of the complex and emergent nature of design anticipation, which not only resides in the capacity of individuals (intentional agents), but also on the formation of this shared boundary space that frames the work of a distributed set of individuals and the negotiation and coordination of transitions that take place in order to progress a design activity.

As a conclusion, there are some more general reflections regarding the socio-political context of collective design anticipation that seem to need further discussion.

The formation of boundary objects and the ability to coordinate them effectively depends crucially on the knowledge and resources available to groups. It is not for example a coincidence that many leaders in the groups we encounter are professionals with previous experience of running a design project. Also, our role as enablers of design capacity in the projects we discussed should also be taken into consideration. Similarly, the lack of resources, such as a space and time for a group to meet and engage in those anticipatory design conversations is a great barrier. Many group members have commented over the years about the crucial contribution of research projects in providing such a space and time for reflection.

We maintain that enabling collective design capacity should be supported by raising awareness about the value of collective design, through sharing examples and stories, and by offering design advice, training and mentoring. Following from the observations we shared here, such support at the early phases of design, when groups and their thinking is not yet formed is of paramount importance.

Finally, it is also important to recognise the fundamental influence of power relations. While many groups may in effect have the ability to collectively anticipate their future through design, they often lack the power to do so. This to

a certain extent goes back to the issue of resources, but it is also about how socio-political contexts can create unfavourable conditions for collectives to make their mark. Part of the problem is the lack of investment in facilitating the creation of those boundary spaces that we discussed in this paper, where people can come together in the first place, to express their views about their values, needs and desires for the future, and to share their skills, knowledge and practical experience for the purpose of generating multiple collective futures.

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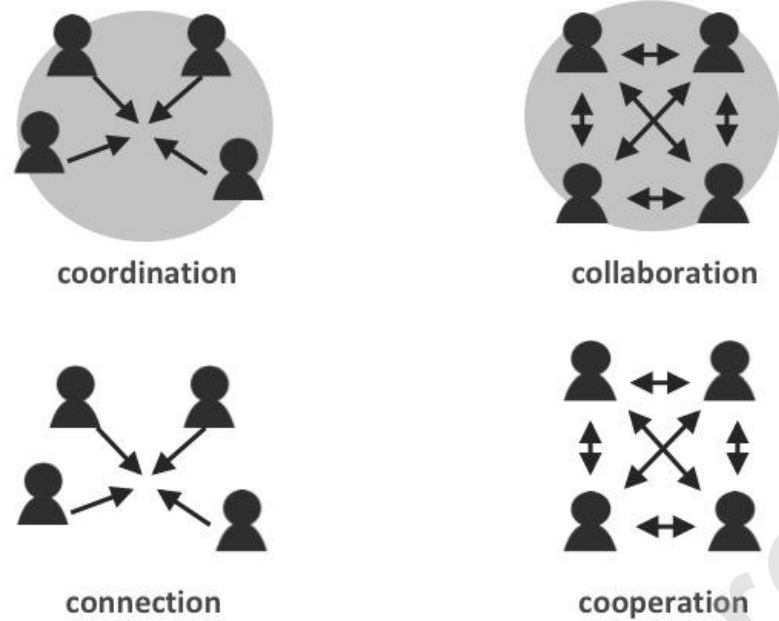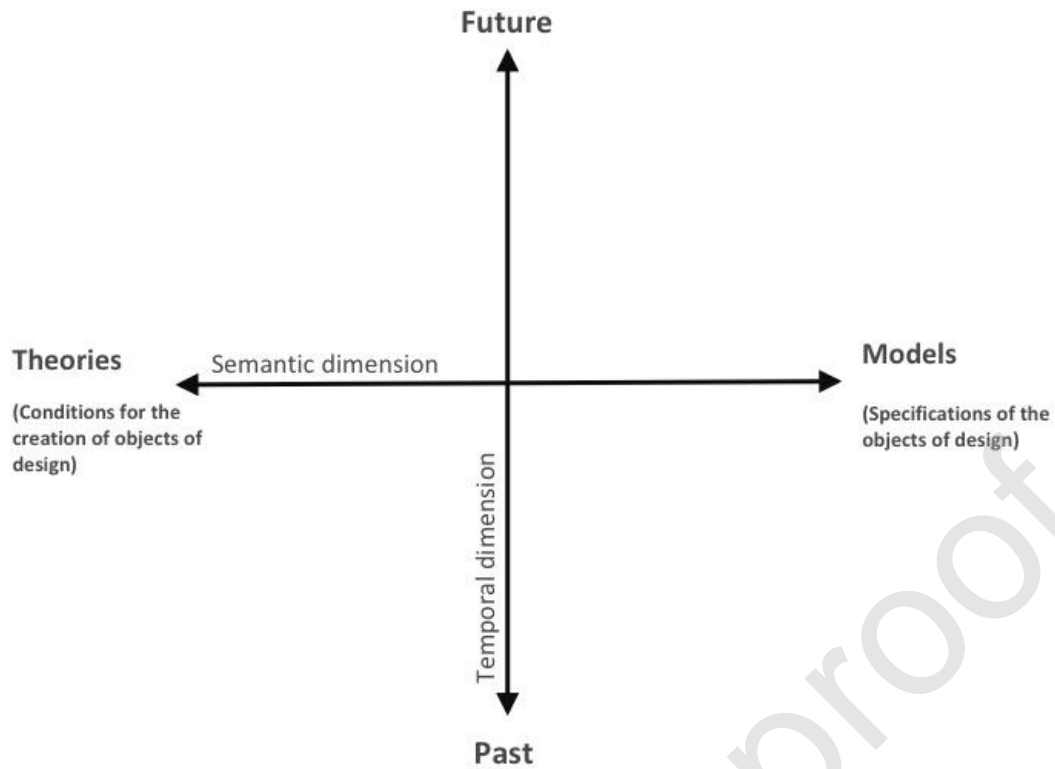
Figure 1 Different types of collective design

Figure 2 A panel created to help a group think about their past, present and future

Figure 3 The design anticipation space

Figure 4 A table helping a group create vision statements based on expressed priorities, concerns and principles of action

Figure 5 An asset map facilitating relational thinking