DESIGNERLY
HRI
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Predictive relations as part of designerly HRI

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Abstract — How would predictive knowledge influence the (nascent) practice of a designerly approach to HRI? Robots can be seen as specific types of artifacts that have intelligence and adaptability baked in. When robots become part of a network, they will be more than helpful tools. The assumption is that adding predictive knowledge from networked objects to the interplay with robotic artifacts will influence our perception and living in the future with robots. Design methods that understand this complex interplay are just on the verge of development. I hope I can be part of the workshop and contribute the discussions on design in HRI with the lens of predictive relations.

Keywords — design methods, predictive relations, predictive knowledge, urban robots.

1. INTRODUCTION

With the rise of the Internet of Things and the shift from single products to decentralized systems, the functional working of artifacts will be defined for a great part in the digital layer. With the addition of Artificial Intelligence and Machine Learning capabilities, predictive relations are added to the mechanics of designing connected products, with implications for the agency users have in an algorithmic society.

In the research to **predictive relations** we look into the way our relations with intelligent and autonomous artifacts change. Predictive relations are the way in which a user builds a relation with the future and produces a mental model of the working of the system. Predictive knowledge seems to unlock a new type of interplay between humans and the world and between humans and non-humans: the functional working of an artifact is now shaped through that interplay - not so much its physical characteristics or the service it provides. Predictive relations are a changing digital condition for our relationship with contemporary things like urban robots.

The influence of connectedness to the character of an object is explored in different concepts of smart objects, from *blogjects*, *spimes*, *objects with intent*, *enchanting objects* are some examples [1-4]. The object is static entity though its behavior is defined in the networked capabilities. With the notion of contemporary things objects are defined as constantly changing entities; or fluid assemblages [5]. In exploring predictive relations, the focus is on the relation of the human and the object. To understand this relation the point of departure is the concept of co-performance with the notion of contemporary things as fluid assemblages. In the concept of "co-performance" activities are delegated to a contemporary thing on the basis of the unique capabilities of human and artifact or human and expert system [6].

In decentralized systems, the consequence is that how a urban robot is experienced does not depend so much on its physical characteristics or the service it provides but on the relation the user has with the urban robot. A smart object defined as a construction of time and space that could understood by the perturbations it makes [7]. The specific functioning is depending on the interplay of the user and the urban robot: it is not a fixed state anymore. The lens offered by the notion of fluid assemblages helps to look at artifacts more explicitly as agents within decentralized networks, beyond a narrow focus on matters of user-product experience. The assemblage is here combining material and immaterial resources, and it is conceptualized as fluid because it is assembled in runtime and changes continuously by performing both on the front of the stage and backstage [5]. It adds an extra dimension to the relation as the decentralized network unlocks knowledge about possible futures in the relation with the urban robots. This knowledge has an influence on the appropriateness of the delegation that is taking place in the co-performance between the user and

the urban robots, and on the specific relations that are being shaped in the process. In the future it is expected that the robots know more than the user which might lead to asymmetry in the relation [8].

2. DESIGNING PREDICTIVE RELATIONS

The research is part of the activities in the Cities of Things Delft Design Lab where we research how to shape the future of our cities with intelligent things. The notions of Things as citizens relates a lot to the social interactions and societal context. How would predictive knowledge play a role in the social interactions? Not only in the direct interaction play, but also in relation to who is shaping the interaction in the end. Is there an alienating effect of these interactions? [10]

The design with predictive knowledge is a combination of modeling intelligent and predictive behavior. A way to understand the impact of predictive knowledge is to iterate on an already intelligent behaving device rather than starting with a so-called dumb device. In a short exercise with 30 design students this specific question was tested, as they were asked to take an existing intelligent behaving device and add predictive knowledge [11]. If a device could use insights from predictions to operate in the present, it would deliver a different kind of behavior than an adaptive system. In the table this is compared.

	Adaptive system	***Predictive system***
Basis for acting	*Profile for scripted behavior*	*Ruleset for prescriptive behavior*
Sources of knowledge	*- Behavior of user in the now* *- Patterns of stored behavior* *- Expert knowledge*	*Next to the sources of an adaptive system:* *- Data of forecasted phenomena (e.g., weather predictions)* *- Data of similar profiles that are in a different phase of the life cycle*
Results	*Updated profile for scripted behavior (in the past)*	*Execution of the rules for present behavior, steering co-performance (in the future).*

Table 1. comparing adaptive and predictive systems

In the notion of building predictive relations with the future the predictive knowledge is not seen as predictions in the sense of fortune telling. The key is that the data necessary to use a device is information that is already available in the network and is also been used in a similar use case as the one the interplay of human and device is having in that moment. An example is the way AlphaGo as intelligent gaming engine were constructed. By adding a component of self-play the AI was able to use knowledge from a self-generated decentralized network [9].

An envisioned design approach for predictive relations is divided in three phases combining a (1) deconstruction of the intelligence of the urban robot, (2) adding predictive knowledge to the behavior of the interplay and (3) building this into an engaging relation.

To explore how to integrate the predictive knowledge in the design process of creating urban robots I took a quick look into methods of HRI design and reflect on these three phases.

2.1. Deconstruction of the intelligence

Human Robot Interactions are designed with intelligence as design material. The way this intelligence is used is for adaptive systems as described in table 1. Dumb-smart narratives as referred to in the exploration of design perspectives in robot citizenship of robots. The three principles for creating co-performing communities as proposed – transparent, handleable, and shapeshifting - are illustrative for deconstructing intelligence in interactions with robots. [12]

The quick scan of existing robot design methods learns that these methods seems variations of iterative based engineering design with learning from iterations as key element [13, 14, 15].

2.2. Adding predictive knowledge

Next step is adding predictive knowledge to the defined human robot interactions. This predictive knowledge impacts the mechanics of the robots directly and thru that also the embodiment of the interactions.

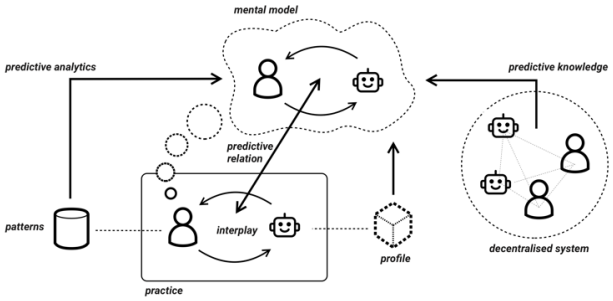

Figure 1. work in progress model predictive relations

In a work in process model for predictive relations (figure 1) the different intelligent types are positioned in relation to the mental model building.

- Predictive analytics indicates the learnings from behavior, knowledge that is a source for the before mentioned adaptive system.
- The stored profile is what also is referred to as digital twin. It feeds also the adaptive system.
- The predictive knowledge is built in the network outside the human-robot interaction.

Understanding the differences should makes it possible to focus in this process on predictive knowledge.

2.3. Building an engaging relation

Predictive knowledge generated in networked objects influences the shaping of the mental model on interactions of human and urban robot. This mental model build is the predictive relation. If the design is divided in different components from physicality, embodiment and mechanics than the predictive knowledge is mainly influencing the mechanics and through that the human robot interactions.

Designing predictive relations is not about predicting with certainty the future, it is about building a relation with the future to shape the present. This is surfacing an important question on the relation we will have with our future. On the one hand predictive relations may be designed to lock people in very prescriptive or rigid framework of not only behavior but also value creation. On the other hand, predictive relations can be designed to open up resourcefulness, actively pop filter bubbles. Yet, as designers we are unprepared to be effective, because we do not have a good grasp of how predictive relations work and can be unlocked towards a desirable impact.

3. SPECIFIC QUESTIONS FOR THE WORKSHOP

Robots can be seen as a specific types of artifacts that have intelligence and adaptability baked in. When robots become part of a network they will be more than helpful tools.

Starting statements on design for predictive relations and design for human robot interactions:

- Predictive knowledge is a defining component of the interplay with robots
- Design is not limited to the behavior of the interplay based on adaptive interaction, but is enhanced with the knowledge beyond that interplay
- The perception of the robot by the human is valued in a component of calibrated trust to understand what will be managed by who and under what conditions. This calibration is a continuous process.

Questions I like to add in this workshop.

- What will predictive knowledge mean for the design process in HRI practice?
- How does the real-time interplay relate to the stored and generated knowledge?

Are we designing for humans always or also for a position the robots take in the interplay?

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