Abstract
Public issues are complex: they concern many different stakeholders who have conflicting stakes and are involved from their unique perspective. Working on public issues requires an open process that allows stakeholders to not only contribute to decision-making but also to take up a role in the process. We propose [X]Changing Perspectives, a product service system that stimulates participatory sensemaking: the joint construction of meaning between individuals that could not have been reached on their own.

We visually demonstrate the designed materials and service elements and discuss the promise of our approach to [X]CP for complex design challenges in public issues.

Authors Keywords
Multi-stakeholder collaboration; Product Service System; Participatory Sensemaking; Embodied Sensemaking.

ACM Classification Keywords
H.5.m. Information interfaces and presentation; H.5.3. Group and Organization Interfaces.

Introduction
Societies are faced with complex issues, from the refugee crisis, to the availability and the cost of urban housing, to youth unemployment or affordable health care. These are public issues that are characterised by different stakeholders with conflicting perspectives. Recently, Norman et al. [6] observed that designers are increasingly working on complex socio-technical issues that they call 'DesignX problems'. Public issues present examples of DesignX problems because as they are characterised
Focusing on innovation, Buur and Larssen [1] argue that innovation emerges from interactions between people with different stakes as their ‘crossing intentions’ can create new insight and new ways of thinking and doing. They call for designers to develop “new formats of collaboration for large, complex contingents of stakeholders” [1, p.12] beyond common workshops and for design-facilitators to address the role of conflict and crossing intentions. Norman et al., [6] emphasise that implementation is often the biggest challenge in socio-technical issues (DesignX problems).

In local governance, multi-stakeholders like municipalities, entrepreneurs, citizens, companies and organisations work together on local solutions for complex public issues. Such collaborations require open processes that shed light on different perspectives and open forms of participation that allow all different stakeholders to take a role in the process. Within this context, we take on the challenge of designing for constructive interactions in multi-stakeholders dynamics around public issues. More specifically, we aim to design for participatory sensemaking: the collaborative generation of meaning in and by interactions between multiple agents in a social encounter [4]. Participatory sensemaking finds its roots in enaction, the principle that sees cognition as a continuous, active process of perception and action to make meaning in the world [7]. It emphasises that cognition is embodied and not a separate computation in the head, and participatory sensemaking adds to that that people can make meaning together.

In this pictorial we introduce [X]Changing Perspectives ([X]CP): a product service system (PSS) that invites participatory sensemaking between multi-disciplinary stakeholders in a participation setting around public issues.

We start with a graphical outline of the design space in terms of theoretical lenses and practical contexts. We continue with a visual overview of the [X]CP system and its technological and material specifications. Then we elaborate on the service elements of the PSS. This is followed by a photographic scenario of the PSS in use and observations of interactions in screenshots from video recordings of real-life sessions. Finally we discuss the value of our proposal of [X]CP for complex design challenges in public issues.

[X]Changing Perspectives in use (left) in a multi-stakeholder discussion and demonstrated at a congress (right).
CONTEXT: SYSTEM & LIFEWORLD
In the context of multi-stakeholder collaborations around public issues, this work focuses on interactions between local governance and citizens. Recognising their differences, Habermas [3] described a dichotomy of System and Lifeworld, respectively: guided by rules and regulations (instrumental rationality) and the messiness of interrelations in everyday life (communicative rationality). These two paradigms meet when public issues need to be discussed, in the Public Sphere. This is a zone where a critical-rational debate can take place. It must be noted that in our work we value Habermas’ theory as a contextual framework. We move away from his emphasis on rationality and instead take an embodied approach to sensemaking.

EXPERIMENTAL SPACE
Our design intervention is implemented in the Public Sphere. We designed [X]Changing Perspectives, an interactive system that invites participatory sensemaking [4] between different stakeholders. Participants move and relate tokens on the table, in order to discuss the central question, at the centre of the table, that introduces the public issue at hand.

DESIGN SPACE
In the foregoing we have introduced the design challenge. In this section we sketch out the theoretical and practical design space and position our design intervention in it.

MULTI-STAKEHOLDER INTERACTIONS
Stakeholders interact with the tokens and with each other around the table, creating an intimate setting for personal exchange. Their discussions gain physical shape through the tokens. The tokens act as physical scaffolds [2] that enrich the discussion, as they invite people to interact with them- and thus play into the cognitive loop of action and perception through which meaning is generated [7]. The design of [X]CP speaks to the bodily senses of people and enables them to talk through materials. We explain the designed materials in detail in the next session.

Moreover, the [X]CP system allows for scaling up from an intimate setting of interpersonal thought exchange to the mass expected to reach a democratic decision.
In the foregoing we sketched the design space. In this section we explain the designed system: [X]Changing Perspectives.

**SETTING: [X]CP SYSTEM IN USE**
The [X]CP system consists of 15 tables each with 6 tokens and one real-time online visualisation of the token movements. Participants are distributed over the tables so that all different perspectives are represented at each table. Six to eight participants group around a table. In total, the system enables 90 - 120 participants to discuss a public issue simultaneously.

**SCALING UP: REAL-TIME DATA VISUALISATION**
The movements of all tokens are visualised in real-time and projected on a screen. The moderator of the session can use filters (select specific tables or tokens) to find patterns in the movements. For example, the visualisation could show a clutter of yellow lines, indicating that the Puzzle icon (yellow token) has been moved around a lot on most tables. During an intermezzo, the moderator uses these patterns to collect stories from different tables and opens up a dialogue across the tables.
The tokens are 3D printed of white plastic and aluminium. They have wooden tops with icon cut-outs and marker patterns printed on the bottom. The shape was designed to indicate that tokens can be picked up and pushed to slide. The materials are comfortable to hold and touch. Each of the 6 tokens has a different coloured light (neopixel LEDs) that corresponds with the colour of the token in the visualisation. The light is not only functional, but also contributes to a friendly ambience, as participants have indicated in the iterations. Tokens are equipped with a capacitive sensor and an ESP WiFi module and send data of touch to the visualisation in real-time.

As we observed in the iterations, participants often point or circle their fingers above a token that they are discussing. To capture these interactions, we calibrated the capacitive sensor to not only sense touch, but also ‘pointing’: fingers hovering over the token. This data is included in the real-time visualisation.

Finally, the tokens can be fitted with ‘action points’ (yellow notes on pins) to create a physical agenda on the table. The notes fit into the participants name tags as well, and in this way participants can take home action points at the end of the session.

The table surface is made of a transparent round plexiglas plate of 90cm in diameter, with a coloured outer border on which the tokens can stand when they are ‘not active’. Integrated in the tables are a Raspberry PI2 with Wi-Fi module, a powerbank, a fisheye IR camera and IR-LED’s. The Raspberry runs Visual Computing software and the fisheye camera enables to capture movements on the whole table surface. The IR-LED’s can be turned on to overcome difficult lighting conditions. The Raspberry uses Wi-Fi to send the token positions ‘that it sees’ to the database in real-time.
We collaborate with the partner to create suitable media to invite participants (different media for different stakeholder groups) and to develop a central question and follow-up strategy to work with the input from participants in a meaningful way and to keep participants in the loop. The invitation for the [X]CP session is important to generate willingness to participate and to manage expectations. It is sent out up to 4 weeks prior to the session and includes the central question.

An [X]CP session lasts between 1.5 and 2 hours. Within this time, there are two discussion rounds of 15-20 minutes and two intermezzos of 15-20 minutes. The session consists of up to 120 participants around up to 15 tables.

In order to approach the richness of the sensemaking that occurred around the tables, we use mixed qualitative methods to capture and analyse data. The movements of tokens are tracked, the conversations are recorded with a 360° camera in the center of each table. We use video-analysis to explore interaction patterns and content of conversations. We categorise the ‘action points’ in terms of stakeholder group and topic. Participants receive an online survey about their experiences directly after the session. We create a video impression of the session and a cross-media report that describes our observations, the broad interpretations and stories of participants and a brief translation into follow-up advice. All participants receive this info per email.

Two to four weeks after the session there is a collective evaluation session where all participants and partners are invited. We present the report and our observations and trigger reflections of participants. What was the value of the session, and what does it mean for our (shared) next steps?

The [X]CP system is not only a research vehicle but also part of a service provided to partners (project owners) & stakeholders of public issues.

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In the foregoing we have introduced the product service system. In this section we illustrate the PSS through a step-by-step scenario with pictures.

1 | Invitation: The partner invites (sometimes selects) the participants, via e-mail and flyers that are, when possible, co-created with the researchers. We stimulate a broad invitation of stakeholders. Sometimes an online survey is set out before the session to gather input.

2 | Central Question: The topic of the discussion is formulated as a question that allows prioritisation, e.g. "what is needed for / most important when..." The question is developed in co-creation with the researchers and formulated such that it invites different views and an open discussion.

3 | First Token: The participants are distributed over the tables so that the different perspectives (stakeholder groups) are represented at each table. The youngest person at each table starts by placing the token that they relate most with the question on the table, and motivating their choice.

4 | (Re)Positioning: The participants (re)position the other tokens on the table, while sharing ideas, opinions, knowledge and experiences.

5 | Collective reflection: During this intermezzo, the visualisation is used to discover patterns and relations among the tables.

6 | (Re)Positioning: The participants (re)position the tokens on the table, reflecting on their landscape whilst taking into account the stories of the other tables.

7 | Action Points: In order to realise the landscape they created, the participants attach action points to each token. Finally they take action points with them or give them to others, which unlocks a discussion about roletaking and responsibilities.

8 | Evaluation: We analyse the token data, observations and recordings, and visually report it to all participants. We present and reflect on the insights with all participants in an evaluation session. The partner presents the next (participatory) steps.
The [X]CP system was developed in three iterations. In each iteration, the prototype system was implemented in real-life settings, in a total of 10 sessions that present pilot user studies for our research. The final [X]CP PSS was implemented in three sessions, of which two were commercial settings.

**IMPLEMENTATION**

[X]CP sessions in real-life contexts
Over the course of one year, the different iterations of [Name] have been implemented in 9 real-life contexts wherein stakeholders discussed about their roles concerning public issues. The topics for these pilot sessions ranged from “What do you need in order to collaborate on pleasurable living in the village?” to “What is important when refugees are housed in your neighbourhood?” to “What is needed to become a data-driven municipality in a good way?”. The partners of the sessions were municipalities, housing corporations or congress organisers. The stakeholders and thus participants of the sessions varied from citizens, aldermen, entrepreneurs, social welfare professionals to caretakers, consultants and policymakers.

PSS implementation
Additional to the 9 pilot studies, the [X]CP system was implemented in two commercial settings and one full scale research study. The commercial implementation was based on the product-service-system as outlined on page 6. Additionally, we developed a moderation manual and trained prospective moderators for [X]CP sessions. Main points of attention were the use of the visualisation and handling the scale (10-15 tables). Finally, we created checklists and an IKEA-inspired manual to physically set up the [X]CP system. Using these materials, and with our on-site assistance, partners were able to moderate their own [X]CP sessions for their clients.

Feedback loop
The insights from the analysis of each session were presented and reflected upon in a participatory evaluation with all participants and partners. In these reflections and in the questionnaires, participants indicated that during [X]CP sessions the tokens provided conversation starters and helped to express conflicting stakes and viewpoints that in turn led to opening up their horizons regarding the public issue at hand. Partners remarked the conflict-free atmosphere as a unique contribution of the [X]CP system. Critical participants said that the tokens felt childish and stood in the way of expressing their rational arguments as they could normally do.
**OBSERVATIONS: TOKENS**

In order to illustrate the potential of [X]CP to contribute to participatory sensemaking we highlight some observations of interactions with the [X]CP system. To avoid comparing different settings and iterations, we use the video-analysis for one of the sessions. The session was organised by a (social) housing corporation and their consultants, tenants and members of the city council and representatives of the tenant association participated. In this section we share our observations of participants’s interactions with tokens.

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The previous observations were focused on the interactions with tokens. In this section we highlight some observations of interactions with the action points of the [X]CP system.

1 | Taking on action points: Taking action point for oneself and pinning it onto nametag: “This is so much fun!”. After the session she volunteered to roll out the idea in collaboration with the partner.

2 | Handing out action points: Participant gives an action point to another participant, and, playfully, even pins it onto her name tag for her.

3 | Capturing physical agenda (of action points): One of the iterations included reflection booklets wherein participants could stick their action points. They were experienced as a hassle and instead we observed that participants prefer to take pictures with their smartphones in order to capture and share their memories of the session.

4 | Handing out action points: Giving action point to other participants: the man on the right reaches over to the man opposite him, to give him the action point. However, that man is not inclined to accept that action point. He left the man hanging for two seconds, and then the woman on the left stepped in and volunteered to take the action point. It seems that a sense of common ownership and responsibility emerged at the table.
Discussion
In this pictorial we proposed [X]Changing Perspectives: an interactive system that aims to promote participatory sensemaking between stakeholders of public issues. We outlined the design of the materials, the procedure of use and the service elements that allow for implementation in real life contexts.

We highlighted some observations of interactions with the tokens and the action points of the [X]CP system during pilot studies. These observations indicated that the icons on tokens trigger primary associations from participants: these associations often elucidate their viewpoint and are telling for their past experiences. The observations show that participants use the tangibility of the tokens to express, for example, that they want to speak next (holding it without moving it) or that they relate to the other statements (pointing), or to emphasise the importance of a certain statement (tapping).

The action points seem to provide scaffolds for the memory of participants (taking pictures) and a playful way to discuss role-taking in multi-stakeholder dynamics (pinning to another person’s chest) or an opportunity to build co-responsibility for the collective landscape of tokens (volunteering for an action point).

These observations uncover a few first hints of the promise of the [X]CP system to contribute to participatory sensemaking in multi-stakeholder collaborations in public issues.

Further research is needed to unravel the theoretic principle of participatory sensemaking in order to link it to observations of concrete interactions.

With this design we aim to inspire design-researchers and practitioners to develop systems that approach users as sensemakers. We hope that sharing insights into our embodied approach to the design space and design materials inspires other design-researchers and practitioners to embrace the complexity of socio-technical issues and to try out an enactive approach [7] to address that complexity in their designs.

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References