Tiles Cards: a card-based design game for smart objects ecosystems

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Abstract

We present Tiles Cards, a tool to foster end-user design thinking of smart object applications. Tiles Cards facilitate participatory design by abstracting the complexity of IoT technology into a set of interaction primitives and composition rules accessible to non-experts. Further, it promotes creative thinking by means of a mission-based game in which teams have to fulfill design tasks under constraints. Tiles Cards is a generic tool that can specialized to multiple application domains including learning and games. In this workshop we are presenting results from our pilot study discussing the opportunities of using card games for end-user design.

Author Keywords

Design tools; design cards; card game; tangible user interfaces.

ACM Classification Keywords

H.5.2 Information interfaces and presentation (e.g., HCI): User interfaces – Theory and methods

Introduction

Smart objects are everyday objects augmented with technology to provide digital interactivity on top of a traditional physical appearance. Examples are: a paintbrush that samples colors from surfaces and use

them as drawing palette in a computer program [20], a water faucet that lights up in colors to display daily water consumption data [14] and wood bricks that can be composed by children to create computer programs [8]. Technology can be used either to augment an existing purpose of an object, making it more useful, playful or engaging than the ordinary self or to add new functions that are controlled using the object's affordances; to the extreme that the object may look magic or enchanted [19]. Smart objects build on research on tangible [11] and embodied [5] interaction. They leverage both the emerging field of the Internet of Things (IoT) for implementing objects' interconnection and data exchange and established HCI theory for designing appropriate user interfaces.

Designing interaction styles for smart objects is more complex than for traditional graphical user interfaces. Besides the user interface can leverage mainstream approaches such as keyboards and touchscreens; it can also leverage physical manipulation performed by the user on the object self like touching, shaking, tilting or squeezing, the presence of nearby people and objects or its location. Those inputs are often coupled with simple feedbacks like light patterns, haptic or sound.

It does not just require to design software functions but also the hardware and object's physical semblance and affordances, requiring skills from the fields of software and hardware engineering and industrial design. This task is challenged by the lack of guidelines and tools to understand how the object's physical affordances and design are related [12]. Besides there are several technology toolkits that can be used to assist the prototyping phase e.g. Arduino [16] they usually don't specifically support smart object user interface design.

Our research aims at developing tools to involve end-users in the design of smart objects. IoT is a technology-driven field characterized by a jargon hard to grasp. In order to enable users to co-design applications that make use of ecosystems of smart objects we created a design card game, *Tiles cards*.

Tiles Cards facilitate end-user involvement in design practice by abstracting the complexity of IoT technology into a set of interaction primitives and composition rules accessible to non-experts. Further, it promotes creative thinking by means of a mission-based game in which teams have to fulfill design tasks under constraints. With Tiles cards we aim at increasing the number of people that can actively take part to the design of smart objects ecosystems.

Card games as a tool to foster design thinking

Card-based design tools have been extensively used in participatory design [21]. Cards are useful to present theoretical constructs and making the design practice more engaging and playful, thus extending the group of people that take part in designing new things. They can be an effective vehicle to transfer knowledge between theory and practice [4], for example to convert theoretical frameworks into guidelines that can be manipulated in design workshops [4]. Cards facilitate collaborative and divergent thinking by providing a conversation medium between stakeholders and designers [3,7,15], further they allow externalizing ideas and ensuring that a design space is investigated from different point of views. Card-based tools help keeping people at the center of the design process [10,15], they facilitate creative dialogue and shared understanding. Cards can be a source of inspiration to

Figure 1: Front and back side of a primitive card

steer a discussion when it becomes unproductive [9], for example by proposing provocative questions to unlock thinking [18]. Cards can be also used to evaluate, rate or bookmark ideas generated during design sessions [9,15].

Cards can be used to play design games [2,15]: games, often collaborative rather than competitive, which goal is to explore various aspects of a design space in a playful manner. Within participatory design games are a commonly used tool used in research for building competence, empowering users and engaging multiple stakeholders [13].

In fact, studies show that game rules add constraints that can improve design outcomes [2] and foster creativity. For example turn-taking helps ensuring that everyone is involved in the process [9], roles and rules help smoothing power relations and conflict among participants [2]. In this perspective cards act as physical props to externalize thoughts and help structuring common grounds that everybody can relate to [2]; helping taking risks within the frame of a game.

Tiles cards

Tiles cards is a set of seven decks of cards divided in two groups: *primitive cards* and *game cards*. The former explains concepts proper of tangible interaction and IoT in an informative way, hiding end-users from unnecessary complexities. The latter brings dynamics, rules and goals to be used to gamify the brainstorming process. Primitive cards can be used alone as an informative tool, to make end-users familiar with concepts from the HCI and IoT research fields like gestural input or haptic feedbacks; or together with game cards to spur design actions. Tiles cards can be

used by users alone or as part of design workshops facilitated by designers.

Each Tiles Card has two side: the front side explains the meaning of the card, and provide informative text and figure; the back of the card describes the category (deck) the card belongs to (Figure 1).

Cards are color-coded to facilitate sorting; they have imprinted a unique ID to simplify data collection by researchers during design workshops. In each deck single cards are replicated to allow playing multiple rounds without need re-shuffling. This is meant to leave combinations of cards used in a game session available for further reference. For each category we also provide blank cards that can be personalized by end-users with custom primitives and game rules. In this way we expect to free participants' creative impulses and allow for thinking-out-of-the-box; popular user-designed cards can be included in future version of the tool.

The design of Tiles cards comes from the awareness that how IoT manifests itself is very broad. The different technologies and use cases yield to a complex design space that can be difficult to navigate without a lot of research and knowledge about the IoT. This complexity makes it difficult for end-users to engage and contribute with their ideas in a meaningful way. The game was designed to bridge this discrepancy. It leverages the authors previous experience [13] with using similar of tools, especially when tackling multifaceted and complex problems, or cultural gaps.

Coded information

GOAL

Create a concept that displays information that is useful to the owner, but not understood by anyone else.

EXAMPLE

A wallet with a light that turns green when your account balance is low.

⊚⊸ **Missions**　　　　M - 3

User friendly

WHAT

Ideas that solve a real need for users, and which are easy to use for a large number of people.

HOW TO JUDGE

Would life be easier for the users with the ideas than without them? Could both your kids and grandparents use it?
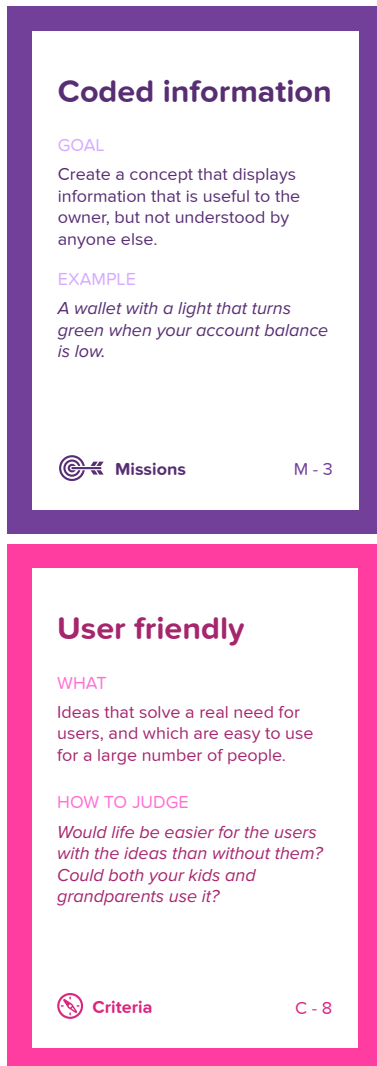
⊘ **Criteria**　　　　C - 8

Figure 2: Sample missions (top) and criteria (bottom) cards

In the remaining of this section we briefly describe the different cards desks we created. Tiles cards can be downloaded under the Creative Common license[1].

Primitive Cards
Primitive cards have both informative and inspiring roles. They are divided in four categories: objects, input, output and compound actions. *Objects cards* suggest a set of everyday, low-tech things that can be made "smarter" by technology; e.g. a bike, a pair of shoes or glasses, a wallet. *Input and output cards* include interaction primitives that can be used to describe the properties of an interface for smart objects in terms of gestural inputs e.g. touch, shake, rotate, location change; and output provided by the system such as vibration, color change, sounds or phone notifications. Those primitives have been chosen because they can be quickly implemented in prototypes using technology toolkits such as Arduino [16] and Little Bits [1]; facilitating the transition between design and prototyping. Finally, *compound actions cards* describe special interaction that can be achieved by an ecology of two or more smart objects. Example of compound actions are *synchro*: an input or output performed simultaneously on two or more objects and *grouping*: a set of objects grouped close to each other.

Primitive cards can be combined each other, adding input and output capabilities to a set everyday object, to define the characteristic of user interfaces for smart objects that can implement specific application logics.

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[1] Tiles Cards – http://tilestoolkit.io/cards

Game Cards
Game cards add game mechanics to the manipulation of primitive cards in order to foster end-user participation and facilitate collaborative creative thinking. It has been proved that adding restriction to idea generation activity can improve its outcome [6]. We designed games cards to be generic enough to be used for playing multiple games, for example to maximize the number or the quality of idea generated, using either collaborative or competitive dynamics. Game cards are divided in three categories: *missions*, *bonus* and *criteria*.

Missions (Figure 2-top) consist in a list of goals players in teams pursue collaboratively by combining primitive cards. Example of missions are "Off-screen: create a smart object that solves a task you would normally have had to use a screen to accomplish" and "Habit changing: create a smart object that helps a user to form or change a long-term habit".

Criteria (Figure 2-bottom) constrain users' design actions by providing guidelines to rate the outcomes of missions. Teams can be therefore incited to compete towards accomplishing a mission by maximizing certain criteria. Example of criteria are: "Enjoyment: How fun or enjoyable is the smart object for its users", "Creativity: How the smart object solves the problem in a clever and unusual way" and "Feasibility: How the smart object solves the problem in a plausible matter, and that seems realistic to develop". Criteria can be used to evaluate the outcome of a mission.

Finally, *bonuses* are cards that modify the gameplay by altering the game rules for a given round. This is expected to add elements of chance to disrupt and

make the gameplay easier or more difficult. Example of bonuses are "Pickpocket: swap one of your cards with one of the same category from another players' hand" and "Mission impossible: the next round will be played with two missions cards".

End-User Involvement in smart objects design: open challenges

Application in a pilot workshop

We piloted Tiles Cards in a small design workshop with nine students with IT background. The goal of the workshop was to understand whether information imprinted on cards were easily understandable. Only primitive cards were used. We briefly explained to participants the content of the cards and asked them to design a collaborative game using objects, input and output primitives. We let the users play with the cards and observed their design outcomes (Figure 3).

Open Challenges

The tool was well accepted by users. In particular, we noticed that cards well served the role of triggers for discussions. Unconventional associations of objects, input and outputs added an element of fun and creativity. On the contrary, we observed several challenges that need to be addressed in future work.

Most of the idea developed were quite trivial and lacked of creativity. Besides in this study game cards, which could have improved the depth of idea produced, were not used; we need to better understand what are the factors that enable idea generation to grow in complexity and to be grounded in users' needs.

Further, the cards didn't support the investigation of a domain-specific space. Mission card provided guidelines

that apply to multiple domains, even if blank cards can be personalized with domain-specific missions. We will consider adding cards bringing domain-specific dynamics (e.g. learning objectives) into the game.

Primitive cards were well understood by users whose, we underline, had an IT background. We need need to verify whether primitives have the same degree of acceptance among other user groups.

We observed that the users needed more guidance, for example it wasn't clear how several primitives can be combined together or whether there are exclusion criteria for some of those. We are considering adding a cardboard with placeholders and visual guidance for the association of the different card types.

Finally, we need to understand how the outcome of the design process could support moving into a prototyping phase, and how the ideas generated can be implemented with the help of technology toolkits. In this perspective we are in the process of developing technology tools to implement primitive cards with software and hardware tools [17].

Conclusions

We presented Tiles Card, a card-based game to include end-users in the design practice of ecosystem of smart objects. Tiles cards serves both the role of (i) making knowledge in field of IoT and tangible interfaces accessible to non-expert and (ii) fostering end-user inclusion in the design process by leveraging card game mechanics. Our first pilot study showed a good user acceptance for the tool, highlighting potentialities and limitations. We are in the process of revising the cards to address the limitations encountered during our pilot

Figure 3: Pilot study and example of application developed

study and we are planning new workshops to test both primitive and game cards. Future works will investigate how to support the transition between design and prototyping phases by providing technology tools to implement the interaction primitives described on cards.

Aknowledgements

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