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Design Fictions for Learning: A Method for Supporting Students in Reflecting on Technology in Human-Computer Interaction courses

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Design Fictions for Learning: A Method for Supporting Students in Reflecting on Technology in Human-Computer Interaction courses

ABSTRACT

Design fictions describe non-existing prototype devices and services, encouraging reflection on technology matters. However, until now most of the fictional design work has been carried out either by "experts" to foster critical thinking within the Human-Computer Interaction (HCI) community, or by user groups to mostly define requirements for creating novel devices. In this article, we aim to use design fictions as a method for supporting students in thinking of the assumptions and consequences of emerging technologies. We report a multi-year experience in using fictional design in the context of academic education to show that such method can be employed to both teach fundamental elements of technology design and HCI and, at the same time, elicit a critical thinking, helping students reflect on the ramifications of their creations and their role as designers. We discuss the methodological implications, pointing out the opportunities this method opens as well as its weaknesses. Finally, we propose a series of methodological suggestions addressed to facilitate the use of design fictions as a "tool for reflection."

KEYWORDS

Postsecondary education, teaching/learning strategies, human-computer interface.

1 INTRODUCTION

Design fictions have recently received much attention in Human-Computer Interaction (HCI) and design research. They describe "non-existing" devices and services, created in order to facilitate reflection on the political and/or social impacts of new technologies (Lindley & Coulton, 2015a; Lindley & Coulton, 2015b; Blythe et al., 2018). For example, this method has been used to increase awareness of the presuppositions lying behind the design of technologies for behavior change (Purpura et al., 2011) and self-tracking (Lawson et al., 2015). Nonetheless, design fictions have been commonly developed by "experts," who both created fictional prototypes and commented on them, to offer a critical point of view to the HCI community (e.g., Blythe, 2014b; Lindley & Coulton, 2016). Their capability of generating reflection on relevant technology issues, therefore, has been circumscribed to the circle of HCI practitioners and researchers.

It has been noted, nonetheless, that fictional design might help a broader population think of the implications of technology (Linehan et al., 2014): participants to the Steampunk subculture, for instance, use a retrofuturist perspective on Victorian society to inform a set of material values and aesthetics (Tanenbaum, Tanenbaum, & Wakkary, 2012). Recent attempts showed that different user groups can be involved in the creation of fictional prototypes (e.g., Nägele, Ryöppy, and Wilde, 2018). However, design fictions' potentialities of enabling individuals to critically think of technology are not yet fully exploited. We believe that further research is actually in need.

In particular, we think that design fictions could be helpful in the context of academic education to teach fundamentals of technology design/HCI, being capable, at the same time, of conveying a critical perspective on the discipline, helping students reflect on the assumptions and ramifications of designing technology. This is especially relevant to all those contexts in which HCI is taught as an introductory or a stand-alone course: in such contexts, due to time constraints, teaching a complex and multifaceted field as HCI could result in a simplistic view of the discipline, whereby the focus may be on the fundamentals, while leaving apart the ambiguous implications and responsibilities of developing technologies.

In this paper, we aim to use design fictions as a "tool for reflection" in order to support students in thinking of emerging technologies: design fictions may help students look beyond the short-term implications of designing technology, encouraging them to explore its systemic consequences, critical issues, and hidden presuppositions. In doing so, students could also acquire some basic concepts and practices of the design process through a hands-on activity.

In other words, on the one hand, design fictions may favor a form of "reflection in action," whereby conceptualizations can be embedded in plausible stories and new knowledge may be developed through insightful debates; on the other hand, by creating fictional prototypes students may familiarize with fundamental elements of technology design, experimenting the same methodological tools employed during the design of "real" technologies.

We present a multi-year experience of using design fictions in the context of academic education. Our contribution will be threefold. First, we will show that design fictions can be used in an educational context by students with no design/HCI background to introduce the design process and make them critically reflect on technology. Second, we will offer the design fictions created by the students as "knowledge objects," which may generate new understandings once interpreted by researchers and practitioners (Bardzell et al., 2015). Third, we will discuss the methodological implications of design fictions used in an educational context, highlighting their weaknesses and opportunities, also proposing a series of methodological suggestions.

2 BACKGROUND

Over the last ten years, design has been progressively tied to HCI research, in a way that has been called research through design (Gaver, 2012), a design practice that produces artifacts offering a critical perspective on the present, while suggesting alternate futures (Bardzell et al., 2015): in other words, rather than creating objects to be commercialized, this design perspective applies design techniques to novel issues that may produce new knowledge (Bardzell et al., 2015). Such a

perspective somehow represents a reaction against the tendency of design to imagine near and utility-driven futures, without exploring the ambiguous long-term implications of technology (Kuznetsov et al., 2011; Marttila, 2011). On the one hand, as Linehan et al. (2014) highlighted, the envisioning of HCI scholars has been recognized as often simplistic and short term; on the other hand, in design practice there seems to be little questioning of the assumption that technology will transform our lives into something better.

Despite this trend, a variety of methods have been proposed to elicit critical reflections on the assumptions and ramifications of technology design. Value sensitive design, for instance, attempts to bring to light and criticize those values intertwined with technology design (Friedman et al., 2006). Instead, critical design aims to reject how things are in contemporary society, and create designs that embed alternative social, cultural, technical, and economic values (Dunne & Raby, 2001). Reflective design (Sengers et al., 2005) defines a series of principles that drive researchers in reimagining the present, by making emerge hidden aspects of everyday experience.

Lately, the HCI community has started exploring fictions as tools for supporting reflection. This attempt has a long history in HCI. Narratives have been employed to describe user study findings or to surface novel prototypes in the form of e.g., scenarios (Carroll, 1997) or Personas (Pruitt & Adlin, 2006). In this landscape, design fictions have been considered as a method for raising matters of concerns about technology and its development (DiSalvo, 2012), on the basis of the hypothesis that designs could be fruitfully debated even if they are not concretized in real prototypes (Blythe, 2014b). Design fictions may be enacted in written stories, comics, movies, and objects (Blythe, 2004): they recount “fantasy prototypes” embedded in plausible worlds that may show utopian or dystopian aspects (Knutz et al., 2013). Researchers strived for identifying guidelines for developing design fictions, defining classifications (Hales, 2013), models (Lindley & Coulton, 2014), and toolboxes (Grand & Wiedmer, 2010). However, design fiction is still an “open” practice (Lindley & Coulton, 2016), in which diverse perspectives and enactments can exist side by side.

In HCI, fictional design has been employed e.g., to create fictive articles (Lindley & Coulton, 2016), presenting studies about imaginary devices; to speculate on the adoption of technology (Lindley et al., 2017); to explore the relationships between human and nonhuman citizens in future "cities of things" (Lupetti et al., 2018); to create a Future IKEA Catalogue for facilitating cooperation between academic institutions and industrial partners (Brown et al., 2016); to imagine future urban environments where 3D virtual models and physical reality are intertwined seamlessly (Ylipulli et al., 2016); to surface and assess the sustainability of future information societies (Pargman et al., 2016); and to envision tracking devices to engage issues of surveillance and privacy (Wong et al., 2017).

Unlike other techniques for imagining the future, fictional design mostly aims to unveil the presuppositions and ramifications of *current* technologies. This method encourages reflection on the present, instead of predicting future developments, which is rather the goal of futurologists (Kahng, 2012). Further, design fictions present peculiarities with reference to traditional design scenarios. First, they allow social matters to enter the design practice (Blythe, 2014a), enabling the investigation of the ambiguous impacts of technology on society. Second, they give opportunity to imagine also the non-ordinary facets of "future life", supporting creative thinking to a larger extent than traditional usage scenarios (Grammenos, 2012). Third, they present "diegetic" prototypes, namely inserted into a coherent fictive ecosystem where technology can be accounted for its systemic consequences (Tanenbamum et al. 2016). In doing so, they often play with dystopian worlds, which offer a critical gaze that emphasizes issues hardly identifiable through common scenarios (Knutz et al., 2013). On this point, Coulton et al. (2017) argued that design fiction is a "world building" activity: "worlds" may be created "through the crafting and sculpting of a miscellany of different media and forms" (Coulton et al., 2017: 167), expanding design fictions beyond single texts to multiple components. To this aim, Sturdee et al. (2016) built a world in which it makes sense to use a "Voight Kampff Machine" (inspired by the Voight Kampff Test recounted in "Blade Runner"), by using a software development kit, physical prototypes, a comic,

and a crowdfunding video, in order to encourage reflection on the lack of empathy characterizing our online communication.

Design fictions have been usually developed by practitioners and researchers in order to elicit reflection among the members of the research community (e.g., Blythe, 2014b; Blythe et al., 2018; Lindley & Coulton, 2014; Lindley & Coulton, 2016; Elsden et al., 2017; Wong et al., 2017; Lawson et al., 2015). Nonetheless, in recent years the practice of creating design fictions has also spread outside the narrow circle of "experts". Prost, Mathheis, and Tscheligi (2015), for instance, invited users of eco-feedback technology to collaboratively create future domestic energy visions, allowing them to extrapolate current implicit concerns regarding energy consumption and the environment. Lyckvi et al. (2018) created fictional designs that imagine future technological solutions for supply chains, and then invited company representatives to continue to develop the fictional prototypes and share reflections on them; likewise, Nägele, Ryöppy, and Wilde (2018) involved individuals suffering from a chronic disease in the creation of design fictions, encouraging them to imagine far-out technologies and medical concepts for self-care. Further, Tsekleves et al. (2017) used co-created design fictions to help older citizens envision the future implications of policy initiatives through the lens of technology in an ageing society. In all these works, design fictions provided researchers with insights about the preferable futures articulated by different user groups, as well as enabled individuals to express concerns and aspirations related to the researched technology. Although these studies show that design fictions may support reflection on technology impacts among a broader population, as a matter of fact they mostly focus on defining some "user requirements", in order to inform the development of novel technology. Such a focus is also present in works presenting design fictions created by "experts": Sturdee et al. (2017), for instance, explored the potential applications for shape-changing interfaces in the game context by creating a fictional instruction manual for a shape-changing game, which points at features and ideas that could be implemented in novel designs.

Actually, the design fictions' capability of eliciting critical thinking on technology in a "non-expert" population may be a valuable outcome per se, whereby the goal is not to design novel devices, but to transfer knowledge about design theory and practice, and raise awareness about technology development. In fact, the use of fictional design in an educational context is still overlooked. Markussen and Knutz (2014) involved design students in the definition of fictional designs speculating about how a civil war would effect a radical change in our society. Nonetheless, they did not have educational goals, rather being interested in exploring different poetical forms for writing design fictions. Skirpan, Cameron, and Yeh (2018), instead, engaged 22 students from computer science and art departments to produce an immersive theater show centered on ethical uses of personal data. They found that the collaborative activity of creating a theatre piece allowed computer science students to see the social impacts of their work, while the arts students gained an understanding around the technical issues presented. Although they did not have learning aims and the activity was not carried out within any particular course, their work shows that "designing fictions" may have an educational relevance.

Building on these previous works, we aim to use design fictions as a method for supporting critical thinking on technology and the design process and, at the same time, teaching basic elements of HCI/design. In other words, we present design fictions as a tool for supporting students in learning "how to design technology" and, more importantly, in reflecting on the assumptions and impacts of current technologies and their advancements. This could allow for the consideration of the ethical implications of designing technology as well.

Traditional HCI education is addressed to teach the HCI foundations, as well as the elements of interaction models, methods and technologies. However, scholars and educators have been reflecting on the way interaction design and HCI are taught to students for years. For instance, they explored how design education can be tied to experiential learning through hands-on approaches, making students deal with real-world problems (Reimer & Douglas, 2003). Schön's "reflective practice" model has been used to ground the way we teach HCI, enabling a holistic exploration of

technology through its understanding in action (Obrenović, 2012). Dukes and Kock (2012) further aimed to support creative habits in education, by making students understand storytelling and engage with empathic behaviors. Whereas Hauser, Desjardins, and Wakkary (2013) argued in favor of including design activism in HCI education, to encourage students to become change agents and critically reflect on their designs.

Though all these works attempted to improve students' thinking while "doing" HCI, they mostly focused on the present: this somehow reflects common practices in HCI design, which, as we have seen, tend to leave apart reflections on long-term consequences of technology. In line with the idea that students can be fruitfully engaged in a "reflective practice", we used design fictions to make them "learn by doing", encouraging them to go beyond the short-term horizon of design implications and think of the broader impacts of technology design.

3 METHOD

3.1 Research purpose

We organized a 40-hour course at our University in a master's degree of Psychology. It was meant as an introductory course in HCI for students with no previous experience in technology design. The learning goals were to a) introduce fundamental elements of HCI/design through practical work; b) offer a critical perspective on them, making students reflect on technology, their role as designers and the impacts of their creations.

We asked ourselves whether design fictions could be usefully employed to convey some basic notions of designing technology through practice, as courses focused on the realization of "real" prototypes actually do (e.g., Reimer & Douglas, 2003).

Moreover, we defined the following research questions:

1) Are design fictions able to move students' thinking beyond the consideration of the short-term consequences of technology design, supporting them in reflecting on its systemic and long-term implications?

2) Are design fictions able to support students in reflecting on the presuppositions that lie behind *current* technologies and how they may change due to technological advancements?

3) What kind of reflections, if any, design fictions are able to elicit on the role of designer and her ethical responsibilities?

We based our approach on a constructivist framework: having roots in the works of Piaget, Bruner, and Goodman, it assumes that people learn by actively constructing their own knowledge (Perkins, 1991). Whereas cognitivism sets the goal of learning in mapping the structure of the world onto the individual, through an information-transfer model (Jonassen, 1991), constructivism looks at knowledge as a function of how the individual creates meaning from her own experience and interaction with others (Lave, 1993). Computer science has used constructivist theory in different ways: examples span from Papert's Logo programming system (Albenson & DiSessa, 1986) and Scratch (Resnick et al., 2009), to interactive machine learning (Sakar, 2016). Within HCI education, Zaharias, Belk, and Samaras (2012) employed a constructivist approach to develop HCI students' critical thinking skills, also relying on technological tools, such as 3D worlds, to increase opportunities for collaborative and problem-based learning.

By using design fictions within a constructivist frame we aimed to develop students' own understanding of the assumptions and impacts of technology; by encouraging them to discuss their own creations, we elicited confrontation between different points of view, fostering the development of new knowledge. In this perspective, the teacher acted mainly as a guide, a facilitator for the expression of the students' perspectives, rather than an expert in charge of conveying specific information.

3.2 Setting

The course has been running for four years (5 editions): each edition involved a different number of students (max=24; min=6) for a total of 77 students, who were asked to create fictional prototypes. The course was optional and lasted 8-10 weeks (depending on the edition). We tuned and perfected the method we used within the first two editions (e.g., by balancing the timing of the activities), in which fictional design was employed to gain insights on technologies for behavior change (Anonymized for peer review). The method in its final form, which is reported in this paper, has been used in the subsequent three years, one edition per year, which had 12, 11, and 6 students each, for a total of 29 students (Female=15; Age Average=24,6). Every year we introduced a new application domain circumscribing the topics that could be tackled during the design work: technologies for the mind, technologies for the body, affective computing.

Students could freely join the course, which was visible in the list of the courses available. Participation to the 75% of lessons was mandatory to be granted of four formative credits. The students did not have previous expertise in design methods (e.g., brainstorming, prototyping). By contrast, they had knowledge of psychology (e.g., clinical and cognitive psychology). Psychology students are interesting because they do not have a technological/design background and may not be aware of the multiple implications of designing technology: they thus may give insights on the outcomes we may expect when using design fictions to teach fundamentals of technology design to students that do not have prior knowledge of the discipline. Further, by exploiting their humanistic background, such students may produce design fictions focused on the “human side” of the interaction, which could be interesting to discuss within the wider HCI research community: in fact, HCI envisioning has been often noted unconvincing from a sociological, psychological, and cultural perspective (Linehan et al, 2014).

Although the participants may be seen as typical cohorts of undergraduate Italian students, we cannot claim that they represent any population. Instead, we point out that they may be good cases for experimenting design fictions as a tool for supporting students’ reflection.

We can distinguish five stages of the course.

1. We provided a brief technical and methodological overview of the discipline to contextualize the subsequent design stages. This stage was also addressed to introduce the main theme of the course (i.e., body modification, mind enhancement, affective technologies) by presenting relevant HCI works.

2. Students were solicited to explore opportunities for design in the application domain in focus: they had to sketch a series of design concepts that could be plausibly realized within the next fifteen/twenty years. We advised students that they could imagine concepts not necessarily grounded in the actual technological possibilities. However, they needed to be plausible[1]. At this stage, we introduced the design studio method, which prescribes a progression of i) imagination, ii) sketching, iii) presentation, iv) critique, and v) iteration: we chosen a technique commonly used in design practice (Ewans, 2014) to elicit the design thinking, as well as the exploration of novel design concepts. Students were split into small groups (three-four students): each group, then, had the goal to set three different design challenges, i.e., questions that point out opportunities for designing a new technology (e.g., "How can we augment our memories?"). First, each student had to work independently for eight minutes, by defining eight concepts for the first of the design challenges previously set. Afterwards, each student had five minutes to pitch the concepts she envisioned to her group, whereas the other students had five minutes to discuss them, trying to point out their criticalities. These activities were iterated until all the design challenges were addressed. Each group had then thirty minutes to collectively select the most insightful concept, by choosing or assembling the previous ideas. Finally, each group presented the selected concept to the class, which commented on it and provided further feedback.

3. Each group, on the basis of the previous discussion, turned the selected idea into a conceptual prototype, in the form of a textual description of its functionalities (also using conceptual maps and affinity diagrams, which are widely used in the process of designing technology to specify the

[1] For instance, a device that is able to invert the "direction" of time does not adhere to the requirement of "plausibility", given our natural laws, unless it is inserted in a coherent universe in which this is possible.

system's functional requirements). This activity was conducted also through the creation of a written usage scenario, where one or more Personas used the technology in their daily life. The scenario had to take place in the near future (fifteen/twenty years). Personas and scenarios were chosen to make students familiar with narrative-based techniques for design and experience how their prototypes might be enacted in practice.

4. Each group had to project their concept in the far away future (50-100 years) developing a fictional prototype (in the form of a textual description of its functionalities) and a design fiction (as a written narrative), imagining a world where that technology is an element that contributed to shape it.

First, the students were instructed to define a "what if"-statement, namely an imaginary, even impossible "basic rule of fiction", which a design fiction can be described according to: it reveals a fictitious society, in which the fictional prototype has become pervasive, that we could end up in or be strongly challenged by (Markussen & Knutz, 2013). For example: "What if emotions could be completely controlled through technology?".

Second, the students had to express the goal of their design by answering questions that make visible its purpose in terms of critique or design objectives: e.g., "do we want to criticize a trend in the current way of recording personal data?"; "what are the probable implications of our design?". Then, they had to develop one core feature characterizing the technological concept (which could consist of one technological artifact, or a set of interconnected devices), and some ancillary functionalities that could complement and expand its potentialities. In doing so, the students were invited to describe the device's interaction modalities (e.g., by envisioning the channels through which the technology could communicate with the user and outlining the user interface), imagining how the continuous interaction with the device could produce change in how people behave, feel, understand and stay together. This activity resulted in a *provisional* description of the fictional prototype, in the form of a list of its characteristics, ways of working and input/output modalities.

Third, the students were encouraged to discuss the world they were designing for through the following questions: What kind of world is your prototype part of? What kind of technology exists in this world? Who inhabits this world? What do they do in their everyday life? What kind of society is present in this world?

Fourth, having defined a provisional fictional prototype and having discussed the kind of world they were designing for, the students had to start generating the narrative, creating the plot and the main characters, as well as specifying further both the prototype and the imaginary world. The students were first invited to think of a "conflict", which could be "internal" (the main character has an interior conflict), or "external" (the main character needs to obtain something, and faces some difficulties). In so doing, they were encouraged to think of sci-fi stories in literature, cinema, and TV series, as a source of inspiration for developing the story.

Finally, they were told to insert the characters in the world surfaced in the previous phase, making them interact each other. In so doing, the fictional prototype had to remain in the "background", as if it were taken for granted by the people inhabiting the fictional world. Actually, they had to imagine how a technology completely integrated in the characters' everyday life and in the society in which they live would have affected their actions, thoughts, feelings, interactions, and weltanschauungs. As long as they were creating the fiction, they also had to refine and develop the fictional prototype, in order to maintain "coherence" between the device's functionalities and the events happening in the fictional world. Conversely, as long as they changed the prototype's features they had to immediately assess their impacts on the fictional characters and the fictive world.

5. The groups presented their designs to the class gaining preliminary feedback. The class had then to select the fictional designs to debate: in this way, we wanted that students autonomously decide on what they considered important to be examined in depth. The teacher did not orient the discussion by recommending aspects to be debated: he only intervened to regulate turn-taking when needed. The design fictions were discussed for an average time of 120 minutes each. Even though

each discussion was focused on one design fiction, participants were free to move the debate to other fictional prototypes. Presentations and debates were audio recorded. Then, they were transcribed verbatim.

3.3 Analysis of data

The analysis of data used open and axial coding to connect the gathered data to the defined research questions (Strauss & Corbin, 1990). Results were analyzed separately by two researchers through open coding. They broke the results down and took apart sentences. Then, they labeled them (e.g., "virtuality" or "technological surrogates"). Afterwards, they reviewed the outcomes of the coding activity for ensuring consistency in the segmentation of data and in the selection of the codes (MacQueen et al., 2008). Inconsistencies, which mostly referred to differences in the code labels, were then resolved. Resulting codes, then, were grouped separately in abstract categories by the researchers and labeled. A further confrontation led to keep eight categories. A final amalgamation resulted into the definition of three key axial categories representing the main themes emerged from the findings: *reflecting on long-term and systemic technology impacts*, *reflecting on theoretical assumptions of technology*, and *reflecting on agency and morality of technology*.

4 RESULTS

During the five course editions, 21 fictional prototypes along with 21 design fictions have been created. All the groups completed their assignments. The students collaborated intensively and they all contributed to the accomplishment of the tasks assigned. The students showed to have learned to master the design tools they used for designing technologies, by generating a variety of preliminary concepts through brainstorming techniques, developing complex and detailed personas, writing well-structured usage scenarios, and specifying precise prototypes' features. The resulting fictional prototypes were carefully defined in their working principles and interaction modalities, being

situated in “contexts” illustrating how they could work and affect their potential users. Finally, the creation of design fictions allowed them to embed their concepts in a wider world, experimenting possible future implications of their design work. During a final informal discussion with the students, they reported positive feedback about the course, highlighting that they particularly appreciated to work in group on stimulating problems with a method that elicited their imagination.

In the last three editions, students were required to evaluate the course. They had to fill a brief questionnaire (which is identical for every course taught in our university). The evaluations highlighted a high degree of satisfaction in all the editions of the course, scoring 3.33, 3.16 and 3.75 on a four-point Likert scale. Further, the format of the course showed to be effective in conveying the basic concepts of the discipline (“Are the supplementary didactic activities (such as tutorials, labs, and workshops), if any, useful to learn the content of the course?”: this question was meant to assess the practical activities different from frontal lessons): it scored 3.63, 3.17 and 3.00 on a four-point Likert scale.

This might show that design fictions may be successfully used as a method for conveying the basic concepts of designing technology through practice, as courses based on the design of “real” prototypes are able to do (Reimer & Douglas, 2003).

In the following, we present the three fictional prototypes that have been selected for the final discussion in the last editions of the course, which enacted our method in its final form. By being chosen by the students themselves, such fictional prototypes embed the issues they considered most important and worthy to be debated. Along with a short description of the fictional prototypes, we summarize the plot of the design fictions presented (the design fictions were available for the students before the discussion). Their recount may represent a valuable contribution per se, being a source of further reflections for scholar and practitioners (Bardzell et al., 2015). Then, we will outline the main themes emerged across the class discussions.

4.1 Fictional prototypes and design fictions

The Memorizer. Fictional Prototype: The Memorizer consists of a series of sensors directly implanted in the brain, which allow for the registration of important episodes of the individual's life. The system is activated when a high level of arousal is detected, automatically recording the experience and storing it in an individual server. Memories can be retrieved by the user and re-experienced from a first person perspective. An enhanced contact lens displays the user interface, advising when the experience is ready to begin.

Design Fiction: In 2076 the human memory dramatically weakened for mysterious causes. The government has supported memory training programs, by encouraging the daily reliving of a random memory elicited by The Memorizer. At the same time, a black market of memories hacked from the individual servers has spread all over the world. People engage in living brief episodes of others' life and do not seem to mind that their memories are at risk of being stolen. It was a rainy day, when John found one of his most precious memories among the "products" of his memory dealer. His wedding day was there, ready to be relived by everyone. He then remembered that his colleague told him something about his wedding, yesterday. He didn't give it credit in that moment. Suddenly, he bought the copy in the (impossible) hope of keeping it private. Finally at home, John decided to re-experience that day of happiness: he could not remember all the details, but he was sure that it was a perfect day. *I was completely overwhelmed by a sensorial experience coming from my past... My wife was there, gorgeous... Strangely, her face didn't look happy... 'I cannot believe that you ordered this cake. I have an allergy to strawberries, do you remember?... This is the care you have for me...'*. John saw that his wedding was anything but a beautiful day. Actually, it was the origin of his relationship problems, connected with his incapacity of meeting her expectations. When the memory ended, John was completely astonished. *How could I forget that day?... My memories are so sugarcoated... so reassuring that are almost ridiculous.* The day before came to

his mind. He remembered his colleague and what he mentioned. It was a joke referring to his mistake. He had experienced his memory.

The Emotional Regulator. Fictional Prototype: The Emotional Regulator consists of a wearable EEG, almost invisible, that is able to detect the emotional states of the individual. A wearable bracelet further allows for the regulation of her emotional life, by offering a set of seven basic emotions that can be selected and tuned with reference to their intensity. The device can automatically detect a "critical" emotion and acting accordingly (e.g. by changing the emotional state), as well as be programmed to activate a particular emotion at certain times of the day. The Neutral Mode elicits a "neutral" state, in which the individual is prevented from feeling any emotion.

Design Fiction: It is 2076, and the TV news are broadcasting the nth disaster which provoked 10 thousands victims. Arthur is sitting on the sofa apparently unflappable. His Emotional Regulator is set on Neutral Mode. That morning he has to go to the funeral of his colleague, and he literally hates this kind of circumstance. At the ceremony, he is still impassible, but soon he turns his device to the "sad mode", increasing the intensity of the emotion, so as to appear shocked for the sudden loss, and keen on sharing his sorrow with the deceased's parents and friends. Shortly after, he is ready to go back to work, as if nothing had happened. However, when the evening comes Arthur becomes excited. This night he will go out with his friends after a long time. Finally a moment when he can turn off his Emotional Regulator and share moments of authenticity living true emotions. And the evening does not fall short of his expectations. He enjoys himself so much. When he returns home he still has a smile on his face. He is so happy of having lived those "real" moments. He is going to put off his wearable, when he sees that it displays the message that "happiness" will end soon. *He suddenly becomes aware that it is Thursday, and his device is programmed to elicit happiness from 9.00 pm to 11.30 pm when he usually meets her "girlfriend"... She bothers him, but he doesn't want to break up, it is a commodity...* Arthur thinks that it's fine for

him to use the device with her girlfriend. But that evening, it was different. He believed to be truly happy, but he wasn't. *Even this evening Arthur, as every other Thursdays, has felt an emotion called happiness, but it was induced, artificial, a fake. Arthur now is sitting on the bed, staring into space, as he had realized that he believed in a false story.*

The Body Duplicator. Fictional Prototype: The Body Duplicator allows the user to project her mind into an artificial body, a sort of remote-controlled droid made of extremely resistant organic materials, in order to execute dangerous or burdensome tasks. It has been thought as a capsule that maps all the individual's brain activities, transmitting the brain signals to the droid, and receiving in turn its body signals. The human mind is totally embodied in another body, remotely perceiving and feeling what the artificial body feels and perceives. There are different droid types. The basic version is provided with enhanced sensorial channels (e.g. thermal vision, night vision), a sonar, and an improved body strength.

Design Fiction: Song is a scientist that works for the New Korea government, in charge of advancing knowledge in the field of "bio-dronic." After a devastating war, the two Koreas finally reunited, given life to New Korea, now the most technological advanced nation of the world. Song experienced the war as a child, and this made him decide to commit himself to science, as a way for creating technology helping to keep the peace. The Body Duplicator is a technology that allowed to save many lives, by being employed in health-care, rescues from fires, and so on. In 2066 Song was recruited by the government droid factory: he was so amazed in discovering that droids could feel exactly what a human being is capable of perceiving, that he immersed himself in his work, becoming one of the most distinguished scientists of the factory. One day, his supervisor took him apart, asking him whether he wanted to join the military division of Seoul-Droid. So, he discovered that military droids have been developing for years, with important new features: deactivation of "mirror patterns" and nociceptors, to provide substitutes for soldiers, incapable to feel empathy for the enemy as well as pain. '*We could fight without feeling any pain, nor recognizing pain in our*

enemy, in case of a war occurs...' I was astonished... However, Song then thought that they could be a means for preserving the peace. *If we could fight through these droids... no one of our people would die.* Song accepted to join the program and two years later when the war against Russia began, he was one of those controlling the droids. He found the battles quite boring. There was no possibility for the Russia to win. It was strange that someone could die for Korea in the past. New Korea was granting safety to all its citizens. And although he could think of the Russians as human beings, when he was on the battlefield they were merely "things" to be wiped off the face of the earth.

4.2 Class discussions

Reflecting on long-term and systemic technology impacts. Using design fictions as a stimulus, students engaged in reflecting on the nature of their technological devices and the transformations on the "human condition" (both individual and social) they could entail over the long term once widely adopted. All the participants primarily focused on the consequences that prototypes could have on the internal world of individuals. S1, for instance, noted that The Memorizer allows to re-live "true episodes" of the individual's life somehow substituting the memory function, which instead always modifies the past in function of the present: "*What does it mean to have an infallible memory for the individual's experience? It could destabilize identity, do we really need to better remember things? Do we need to always know the truth about ourselves?*". S7 brought the discussion back to current technology: "*Well, we do photos for better remembering some moments, but this is somehow a conscious act. We decide to select a specific moment to be remembered. What would happen if such photos will be continuously recorded directly in our mind, with the possibility of retrieving them when we want? It would be similar to this prototype, but it would change the memory function, rather than simply enhancing it*", S7 said, emphasizing the deep impacts of the prototype on the "nature" of biological memory itself. Those discussing the Emotional Regulator

faced more or less the same dilemmas. S22 noted that "*I don't know what kind of experience would generate a system like this... I mean, Arthur can always be what he wants to be, whereas a characteristic of our emotions is that they are unpredictable. Probably his emotional experiences using this instrument is different from ours*". And S20 noted that "*he is living in a lie, it is true that he is not acting, because he is really feeling those emotions, but they are a fake, it is the device that generates them*".

Thinking of the design fictions also yielded reflections on how the changes technology provokes cannot be easily isolated, as they are intertwined with social practices, other technologies, side-effects, and opportunities for appropriation. S16, for example, stressed that the Emotional Regulator would not only erase the authenticity of the individual's experience, but also of every social interaction: "*I think of the parents of Arthur's dead colleagues... They would know that everyone could have this device, so they know that no emotional expression could be sincere. It would not only change the authenticity of Arthur's experience, but it would also foster a widespread mistrust towards others*". Other students noted that the Memorizer would change how we behave, and how the others behave. "*Maybe everyone would behave differently if we know that someone could perfectly remember what we're doing*" S3 said; whereas S5 added "*Maybe it's the use of the device that has weakened people's memory*" and S6 explained "*In that society, everyone can know the others' memories, everyone can buy a piece of the others' past... Potentially, there would be no more secrets... Maybe we're going in that direction, with all our data scattered on the Internet, and all these devices that track what we do*". A device that was thought as a means to train memory, therefore, could lead to unexpected consequences modifying ourselves as humans, as well as our society.

Students also imagined different plot developments, envisioning variations in the usage of the discussed prototypes and the potential side-effects that would emerge. "*What if Arthur uses the device to be always happy, like a drug? What would it happen when Arthur removes it?*", S21 said, and S23 noted "*I don't see any reason for not using it always in the happiness mode, I mean,*

everyone could be happy, always, and living in a unreal world, yes, like a collective drug, that would change our way of staying together... Everyone at that funeral could be happy, maybe there wouldn't be funerals at all". A similar variation was proposed by S2 with reference to the Memorizer: "*What if John and everyone else use the Memorizer for reliving a happy moment over and over again, it would be similar to a drug... There will be a society made of people that spend their time in reliving the past, like a continuous research of pleasure... What would it happen when they return to the present?*", and S5 added "*There won't be any interest in building the future, because everyone will look into the past*".

Reflecting on theoretical assumptions of technology. Through the discussion of the fictional prototypes, students explored important conceptual "dichotomies" and theorizations lying behind our perspective on technology, and how such conceptualizations could change by means of technological advancements. The design fiction of The Body Duplicator, for instance, engendered a debate on the opposition between the natural and the artificial and how current technologies are changing, as well as future devices will change, the boundaries separating them. S28 noted that "*This system provides a complete new body that substitutes the human body, I mean, a human could decide to live her whole life with that body. Would it be an artificial life?*". S29 added "*It seems taken for granted that technology is artificial, whereas the body is natural, so every modification or substitution by means of technology transforms it in something different... think of prostheses, they are not natural*". Whereas S27 stressed "*But what happens when we have a complete new technological body that is identical to our body, maybe made of organic materials... I'm asking myself why it should be considered artificial. If those droids are made of flesh and bones, maybe it is correct to call them alive, even if they are remotely controlled*". Students reflected on the fact that our conceptions of nature (and its related concepts, like life) are shaped by the current technological landscape: Artificial Intelligence, for instance, is changing how we conceptualize things, as "*intelligence is no more a sufficient characteristic for considering an entity alive*", as noted by S25.

They all agreed that we are currently assuming that the natural is the domain of the organic, which may reproduce itself and give birth to new life, whereas the artificial is the domain of steel and silicon. However, this could rapidly change, as it happens in the future depicted in the Body Duplicator design fiction, when "organic technology" could create artificial organic bodies.

A similar debate emerged around the discussion of the Memorizer, when participants questioned the opposition between the real and the virtual. S9, for instance, noted that "*It seems that technology creates worlds that encourage the individual to escape from reality, but this is only because these worlds are external, out of our mind, in this fiction instead John can escape in a world that is real, I mean his past, it is within his mind, it really happened*." All the students of this class came to the conclusion that the idea of reality itself may change according to the varying technology landscape. In sum, participants became aware that their prototypes not only impacted on individuals and society, but also redefined how we look at categories that we use for framing technology and its effects. They stressed that we need new concepts to keep the pace of technology progresses.

The discussion about the Emotional Regulator, instead, led to deepen the "ideology" currently pervading the way we design technology. Substituting emotions with surrogates, which are not spontaneous but "mechanically elicited", "*It's similar to replacing all the natural trees with artificial ones with the same functions. Would they be really the same?*". All the class emphasized that this would modify the role of emotions in our life by making them completely instrumental. Students arrived at the conclusion that a technological surrogate could have the same value of "*the original*" only if we embrace a pure functionalistic and utilitarian perspective on technology and design, whereby entities have functions, and the goal of design is to replace them with (possibly) enhanced copies. In thinking so, the majority of the students also expressed concerns about the current trends of design that seem precisely to embed these assumptions: "*I mean... we are searching for ways to purify the air in our homes as a remedy against pollution, it's like to say, no matter if all the trees die, we can substitute their function*", S21 said. Students highlighted that this take on technology is short-sighted, because "things" cannot be reduced to their function: "*Robots,*

for example, could be useful for taking care of our parents or children, but care is not only the function of caring, it's also emotions, duty". Then, they discussed variations of the Emotional Regulator going beyond its utilitarian perspective: "*It could display Arthur's current emotions, and make him experiment how people would react if he changes his emotional state... I think of a sort of virtual reality... this could make him more aware of how and why emotions are important, instead of pushing him to use them to be more socially acceptable*", S17 said.

Reflecting on agency and morality of technology. While discussing their design fictions, students explored the ethical implications of designing technology, as well as themes related to individual and collective agency and responsibility. The Emotional Regulator, for example, triggered reflections on the difficulty in identifying a precise agent responsible for Arthur's choice. S18, for instance, explained that "*It's not clear whether it's Arthur that decided to be happy when he meets her girlfriend, or it's the technology that is guiding him. He's using the device to turn something that he doesn't like into something that he likes, but somehow he imposes this to himself...or better the device does*"; whereas S19 added "*Yes, Arthur believes to control his device, but it's the opposite. The automatic regulation of the emotional states is a feature that subtly influences Arthur's decisions and reduces his freedom*". This discussion made the group of students that created the prototype aware of the assumptions embedded in their design: it led them to think that a technology designed as a tool for increasing users' freedom (the freedom of feeling what they want to feel) actually turned out as a means of constrain. S16 admitted that "*We did not think of the problem of control when we designed it... and that the device could be seen as an external agent that constrains the individual to feel certain emotions... But this is precisely what it does through the automatic presets. Arthur pre-programs his emotional life, and this transfers the action to the device... Why? I think that he is acting this way because the Regulator is allowing him to do so, and everyone is doing so... I mean gradually it changed how they interact each other, so it becomes normal for them to be controlled by the device.*" As a result, students reflected on the fact that their

creations could be not neutral. Thinking that their morality only depends on their use "*is too simple*" as stressed by S15. New technologies may open new possibilities that cannot be ignored, changing things for the better or worse for the mere fact of their existence.

Similar argumentations were generated during the discussion of the Body Duplicator, which highlighted that the possibility of fighting through the mediation of an artificial body reduces the moral responsibility of the human, as it puts an interface between the individual and her enemy. S26 said that "*Fighting without the possibility of dying, or even without feeling pain, and seeing the pain of the others make killing easier*". All the students of this class agreed that technologies like the Body Duplicator are by no means neutral and their outcomes are not exclusively dependent on the use people make of it. S25, for instance, noted that "*It doesn't matter that they can be used for helping others or that they can save lives... For the mere fact that this technology exists there are potential war applications, it's offensive use is almost natural, I think that it intrinsically encourages war*".

This entails the intrinsic morality of certain technologies, and the fact that they, as designers, may be partially responsible of the people's actions when using them: "*I mean, if Song kills hundreds of soldiers, perhaps civilians, through a technology that erases his capability of empathizing with other... is it still his responsibility or that of the droid that made him like this?*", S24 noted; whereas S28 added that "*Song could make other choices, could sabotage the program or refuse to take part in it*", and S29 replied "*But all the people living in that world think that it is right, and actually these droids allow to minimize the loss for the New Korea, why should they think that it is wrong? It's almost impossible to go against a technology that has been accepted by the whole society as a good thing. The responsible is who originally designed it*". By reflecting on the different decisions that the main character of the design fiction could take, therefore, participants explored different ethical consequences, yielding considerations on the moral implications of the technology and the responsibilities of designers.

5 DISCUSSION

In this work, we tried to incorporate design fictions within a university course to both teach fundamental concepts and practices of design/HCI and support students reflect on the presuppositions and ramifications of technology. During the course, students familiarized with the design process, by using tools commonly employed for designing technologies, like the design studio methodology, Personas, scenarios, and features specification, to ground and develop their fictional prototypes. At the same time, by projecting their design work in a distant future and by enacting it in a narrative form, they critically thought of i) the systemic and long-term implications of designing technologies, ii) the assumptions lying behind the current technology landscape and the ways through which we conceptualize certain technologies, and iii) their role as designers and the potential ethical impacts of their work.

More in details, with reference to the *first research question*, by creating design fictions the students were helped to move their thinking beyond the "here and now". Further, by envisioning a distant future and an imaginary world, they were pushed to reflect on the potential "side-effects" of technology that may occur over the long term, as well as how their introduction may connect with wider changes happening in the individual and society. As for the *second research question*, the students were able to reflect on the fact that both current technologies and design practices are based on a series of theoretical presuppositions: dystopian, paradoxically, and somehow "extreme" concepts and stories (like the possibility of artificially eliciting our emotions, and of escaping in an artificial world of memories) supported students in thinking that such presuppositions may change as novel technologies are introduced, and this may also affect how we conceptualize fundamental aspects of our world. Finally, as for the *third research question*, the students reflected on the intrinsic morality of technological artifacts: by "playing" with the design fictions' characters and imagining their different decisions, the students were helped in thinking that the use we make of technology plays a minor role with reference to relevant ethical dilemmas. This yielded the students consider the responsibility of the designer in creating "intrinsically moral" objects.

Recent HCI research involving "non-experts" in the creation of fictional designs mostly tried to define "user requirements" for developing novel technologies, scarcely exploring the design fictions' potentialities of eliciting reflection in their creators. Instead, we used design fictions as a method for teaching HCI, as well as for supporting reflection on HCI practice and technology matters. On the one hand, differently from previous attempts of using fictional design with students (e.g., Markussen & Knutz, 2014; Skirpan, Cameron, & Yeh, 2018), we showed that this method can serve educational goals, by allowing "non-expert" students to learn fundamentals of design/HCI and critically reflect on them. On the other hand, differently from traditional experiential methods of teaching HCI (e.g., Reimer & Douglas, 2003; Obrenović, 2012; Dukes and Kock, 2012; Hauser, Desjardins & Wakkary 2013), which focus on present, we showed that design fictions may encourage students to go beyond the short-term implications of design and think of the broader impacts of technology development.

This makes our experience relevant to those that want to teach HCI/design as an introductory course. It shows that we can convey basic concepts/practices of the discipline connecting them with wider psychological/social implications of which students may not be aware of. Students learned some fundamental steps of "designing technology" by creating fictional prototypes and gained capability of discussing them with reference to their systemic/long-term implications. They developed awareness of the importance of thinking about the consequences of design, discussing how it could affect individuals, society and culture. This experience may be particularly insightful also for teaching students that do not continue in HCI (in our university we have different degrees with a stand-alone HCI course): by having limited time for conveying concepts and practices, such courses may risk of providing an uncritical view on a discipline that is widely recognized as complex and multifaceted (Tractinsky, 2018). Design fictions, instead, seem to support critical thinking while allowing students to develop basic skills of designing technology.

In the following we will discuss themes related to the method we employed and our three research questions, also emphasizing opportunities and weaknesses.

Narrative worlds. Design fictions enabled reflections on the systemic and long-term consequences of technology. This would be likely supported by their narrative forms, which allowed to intertwine the designed technology with a diegetic world where all the elements were interrelated forming a coherent agglomerate. This further enabled students to imagine plot changes, eliciting a variety of "what if" scenarios in the form of variations of the presented narratives, favoring a sort of controlled imagination. In other words, stories worked as tools for creating multiple thought experiments, which, nevertheless, on the one hand remained anchored to a shared ground (i.e., the original version of the design fiction in focus), and, on the other hand, were always inserted in a coherent world. This engaged students in imagining the possible impacts that their changes would have produced on such worlds, supporting a form of situated thinking about technology. Moreover, design fictions were not interpreted as closed narrative worlds, which could have confined the debate to imaginary technologies. Actually, students were able to connect them with present technologies, using them as a lens to interpret current issues: for instance, the increasing adoption of robotic and automated technology in healthcare, the spread of our personal data on the Internet, and our tendency to photograph everything enabled by digital cameras.

Constructing new meanings. Current research about HCI education encourages hands-on activities that tackle real problems, arguing that real projects provoke real engagement and a real purpose (Sas, 2006; Schneiderman et al., 2006), enabling experiential learning (Hauser et al., 2013). In our work, we substituted the "reality" requirement with a "plausibility" requirement, whereby fictional prototypes had to be credible and coherent with the world in which they were inserted, but freed from any technological constraint. This freedom allowed students to depict paradoxical or somehow extreme worlds, which made emerge their understanding of technology and design, as well as enabled further conceptualizations. By creating fictions, and critically discussing them, students elaborated on relevant conceptual categories of our culture that are involved in current

technology and design discourses. For example, they unfolded the cultural oppositions between the natural and the artificial, as well as the real and the virtual, tying them to the technology advancements and relativizing concepts that initially appeared as fixed and given once for all.

Moreover, the situations depicted in the design fictions made them reflect on some presuppositions lying behind design, for example that technology is neutral and that its outcome depends on the use we make of it, or that design is utilitarian, e.g., it is interested in how the things function. This, on the one hand, allowed for the critical discussion of such presuppositions, yielding novel theorizations (e.g. that technology is not neutral); on the other hand, it led students to elaborate alternatives of their designs, embedding different values (e.g. self-awareness instead of utility, with reference to the Emotional Manager). Obviously, we do not claim that these insights are completely new, as non-neutrality of technology is a central topic in philosophy of technology (Verbeek, 2005) and the utilitarian take on design has been already questioned from different perspectives, such as slow technology designs (Odom et al., 2012), designing for ludic engagement (Gaver et al., 2004), and counterfunctional things (Pierce & Paulos, 2014). Rather, we suggest that design fictions allowed for the spontaneous development of such awareness and understanding, making students conceptually work on technology assumptions and their alternatives.

Fictional characters. Interestingly, students engaged in envisioning how the prototypes' features impacted on their fictional characters, affecting their perspectives, possibilities of action, and ways of seeing things. Moreover, they accounted for the characters' choices, which turned into the discussion of ethical matters. In fact, design fictions encouraged an "internal" take on technology, allowing students to imagine how individuals subjectively experienced the technology they created. By manipulating fictional characters that perceive, feel, understand, and "live" technology, students were allowed to explore emotions, decisions, deviant uses, and moral dilemmas, from a first person perspective. This supported identification and created engagement with the issues raised during the debates, which were framed as embodied problems having concrete consequences. For instance,

students tried to imagine Song's and Arthur's internal experience as a consequence of the use of the devices, which yielded discussion about the moral legitimacy of those technologies. They ascribed intentions and goals to Arthur's choice of pre-programming the system in the happiness mode, and this further enabled reflections on the reasons lying behind his actions, whether and how the device was influencing him, and how technology could work against human freedom. Similarly, during the discussion of the Body Duplicator, students tried to imagine Song's feeling on the battlefield, and to figure out whether other choices were possible. All these "mental experiments" based on fictional characters yielded the students recognize the responsibility of the designer, who creates technologies that may constrain an individual or "shape" a society toward directions that are embedded in the technology artifacts themselves.

Texts and other media. The students could sketch their prototypes in the initial phases of the design process: actually, they were invited to do so, even though some of them preferred to write down their ideas and concepts due to their unfamiliarity with drawing. However, as the final outcome of the course, they were required to produce a description of a fictional prototype and a design fiction in the form of written texts. This led to a design practice mostly based on written narratives, which may be seen as a limitation of the employed method, narrowing the students' creativity to a single form of expression, but also as a strength.

On the one hand, as we have pointed out in the Background Section, it has been recently emphasized that fictional design may move from the narration of "single stories" to the building of "worlds", through the crafting of a miscellany of different media and forms (Coulton et al., 2017). "Game of drones", for instance, depicts a world in which individuals are allowed to use their drones for acting as enforcement officers, being made up of different artifacts recounted through a fictional research paper and a 5-minute demonstration video (Lindley & Coulton, 2015a). Comics (Sturdee et al., 2016), theatrical enactments (Elsden et al., 2017), radio shows (Helms & Fernaeus, 2018), video advertisings (Tsekleves et al., 2017) have been further experimented by the HCI community over

the years as means to create and communicate design fictions. There are thus a variety of opportunities coming from the usage of different media that we actually did not explore, given also some "material constraints" we had in our course (e.g., no equipment or laboratories for video/photo editing, or 3D printing, the need of realizing most of the design activity in the classroom where no computers were available, etc.), but that are certainly worth to be investigated in the educational context. These forms of expression, if used together as "traces" or "entry points" to a unique reality, may likely give life to more "ambiguous" and/or "open" design fictions.

On the other hand, by relying on written narratives, the students were able to develop new meanings, engage with thought experiments, "think" through their characters' point of view, and develop philosophical reflections directly stemming from the fictions they produced. Written texts likely encouraged such philosophical activity, as language supports reasoning and allows people to express complex and nuanced concepts. Moreover, it is worth noticing that the created design fictions did not focus only on the single storyline recounted in the fiction, rather depicting entire "background worlds", as if the main plot were only a possibility among other potential stories taking place in there. Further, during the discussions, the students lingered over "side-stories" happening in the same world (e.g., how the parents of Arthur's dead colleagues experienced the funeral), potentially leading to alternate narrative developments; as well as developed the rhetoric of those worlds, by imagining how the people's everyday life would be in there (e.g., living in a world where everyone can remember everything, or has embraced a war technology that minimize the losses in the battlefield). This may show the potentialities of written narratives in supporting the creation of "worlds".

Sci-fi influences. During the design process, we suggested that the students think of sci-fi stories as a source of inspiration, and they reported later that they were inspired by Black Mirror TV series, and other sci-fi movies. Indeed, the memorizer reminds the world depicted in "Strange Days", a sci-fi movie directed by Kathryn Bigelow, in which a technology called SQUID allows people to

record their memories and physical sensations onto a MiniDisc-like device for subsequent playback. The Black Mirror episode “The entire history of you”, in which people have devices recording everything they experience, bears many similarities as well. Likewise, many aspects of Song’s story seem to be taken from “Surrogates”, a movie directed by Jonathan Mostow that narrates a future society in which humans interact with others through remote-controlled humanoid robots.

After all, science fiction and technology design have been tied together for a long period of time (Kaye & Dourish, 2014): a variety of technologies, like mobile phones, have taken their functions and forms from the imaginative worlds of science fiction, which actively shaped technology futures through their effects on collective imagination (Dourish & Bell, 2014). Design fictions themselves produced by “experts” explicitly draw inspiration from sci-fi popular stories. Edwards et al. (2016), for instance, were influenced by Jeff Noon’s Vurt trilogy (among others) to envision a future where bees have been replaced by swarms of bee robots. Whereas the Voight Kampff Machine recounted in Sturdee et al. (2016), as we have seen in the Background Section, is directly taken from Blade Runner, where it is used to discover the replicants.

Be either unconscious influences, or intentional copies, it is apparent that sci-fi imaginary shaped also the design fictions produced by the students. This shows how the current media landscape may mediate our conceptualization of technology inspiring and at the same time limiting our imagination. For instance, the underlying mistrust towards many of the technologies depicted in the students’ fictional designs might be a byproduct of the sci-fi stories that inspired their work. Dystopias, in fact, are much more common than Utopias in sci-fi literature, as in “perfect” worlds conflicts, which are fundamental to animate the narrative structure, are almost absent, thus appearing less attractive for sci-fi writers (Blythe, 2014a). In this perspective, design fictions may be considered as a tool for allowing our “cultural presuppositions” to emerge, making them explicit through the narrative components used for creating the fictional designs. This may be particularly interesting for students, because it could make them aware of the lenses that (maybe unconsciously)

framed their expectations about specific technology evolutions, and how such lenses may have oriented their creations.

Enabling technologies. It is worth briefly describing what are the current technologies that might support or be forerunners for the design fictions created by the students, as these fictional works may also help us, as researchers, reflect on the evolution of some current key research areas in HCI. The Memorizer is clearly connected with lifelogging research, which aims to capture the whole life of a person (Mann, 2004; Gurrin, Smeaton & Doherty, 2014), and, by and large, with all those technologies aimed at enhancing the human memory (van den Hoven, Sas, & Whittaker, 2012). The miniaturization of commercial cameras (e.g., Narrative clip) and the evolution of smart glasses (e.g., Vuzix Blade), as well as progresses in algorithms for activity recognition (e.g., Lee et al., 2016), are enabling the continuous recording of our experiences and the subsequent retrieval for recollecting purposes.

Likewise, the Emotional Regulator refers to the advancements in wearable technologies (Schmidt et al., 2018; Mencarini et al., 2019) and emotion recognition techniques for detecting cognitive and emotional states on the basis of physiological data (Shu et al., 2018). Commercial wearables (e.g., Empatica E4, Emotiv Insight, MUSE Headband), as well as research prototypes, now allow for the continuous monitoring of e.g., stress (Parlak et al., 2018), anger (Jha et al., 2018), and sadness/happiness (Lu et al., 2019), also opening opportunities for users for taking action to regulate the onset of “inappropriate” emotions (Miri et al., 2018) and change behavior (Rapp et al., 2019).

Finally, the Body Duplicator points to progresses in humanoid robotics (Goswami & Vadakkepat, 2019), which are being progressively employed in domains as diverse as healthcare (Costa et al., 2018), education (Mubin et al., 2013), and manufacturing (Bolotnikova et al., 2017), as well as to advances in brain-computer interfaces, which convert the brain activity into computer commands (Nicolas-Alonso & Gomez-Gil, 2012). These technologies are able to remotely control

devices and robotic arms supporting medical rehabilitation and providing communication and mobility capabilities to disabled people (Moustakas et al., 2015): combined with Augmented Reality technologies, for instance, they may allow locked-in syndrome patients to experience the outside world through the eyes of their caretakers (Faltaous et al., 2019).

All these technology developments make the futures depicted in the students' design fictions closer: such fictions may then be a source of further reflections for HCI researchers, encouraging them to take seriously the potential long-term and moral implications of these promising research fields.

Design fictions and "conventional" design techniques. Using design fictions in combination with more "traditional" design techniques, like Personas and scenario-based design, allowed us to compare the two approaches, discovering differences about the kind of contribution they can bring about in the learning process.

First, while Personas consider the user from a "third-person perspective," being developed on the basis of demographics, daily habits, and goals, design fictions focus the design activity on a "first-person perspective," whereby the design fictions' characters have thoughts, emotions and struggles. As we have seen, the students did not make their fictional characters simply interact with the imagined technology prototypes; rather, they endowed them with an "internal life", which enabled the exploration of issues relevant to the HCI discourse.

In other words, Personas can be used to create prototypical users that can orient the design of novel applications and services. In so doing, they rarely elicit critical reflections on the use of technology, as they do not have a proper "subjectivity" and "agency": Personas are a "tool" to tailor the design process to the users' idiosyncratic needs. Nielsen (2002) argued that these characters are often stereotypes, mere functionaries that illustrate the workings of the product being described. It has also been noted that they lack the depth, personality and history that characters in novels

possess, and are often little more than a static list of attributes that do not suggest a sense of personal growth or internal experience (Blythe & Write, 2006).

Design fictions' characters, instead, are more complex and rounded and may create ambiguity that can lead to novel design insights and challenges (Gaver, 2003). They encourage the students to reflect on how individuals may subjectively act in, react to, and be influenced by a "world" in which a given technology has become pervasive: by "living" in a fictional context, they foster the exploration of the moral dilemmas and the "internal impacts" that a technological artifact may produce, focusing the attention on the interior aspects of the user experience. In sum, on the one hand, Personas methodology may make the students aware that technology needs to be designed on the basis of the users' characteristics; on the other hand, design fictions may support them in investigating the ways people are affected by a world that is changed due to technological advancements, enabling the exploration of "felt-life" issues (Blythe & Write, 2006).

Second, design fictions offer different creative tools with reference to scenario-based design, giving opportunity to envision the non-ordinary aspects of "future life" and be free from technological constraints, thus supporting creative thinking to a larger extent than common scenarios (Grammenos, 2012).

Common scenarios are a means to envision how users will interact with a given technology "in practice", usually representing the technological artifact as a "problem solver" that satisfies the user's situated needs and positively affects her everyday life. Their "plot" is a plain description of the interaction between the user and the technology, as well as of the immediate and "local" impacts that it has on her life, as in famous Weiser's scenario of ubicomp technologies (Weiser, 1999). Here, technology does not generate any side-effect, the political and social contexts are commonly taken for granted, the future "world" is assumed or depicted as benign, and conflict and struggle are almost completely omitted (Blythe, 2014).

Design fictions, instead, use more complex narrative techniques, developing stories where "conflict", the basic driving force of narrative, assumes a central position. This helps the students

consider the side-effects of design, whereby the technological artifact might produce unwanted consequences on the individual and the world she inhabits, generating conflicting situations and struggle (as in the Emotional Regulator, in which Arthur swings from the desire of turning off the device in order to experience authentic emotions to the need to regulate his emotional life). Moreover, differently from common scenarios, which often linger over the description of "situations" in which the technology is enacted, design fictions insert the envisioned prototype within a coherent future world, discussing it as diegetic, i.e., belonging to an imagined fictional "universe". Actually, "world building" is a core activity of design fiction method, as we have seen in the previous Sections. This encourages the students to go beyond the immediate implications of the prototype, rather framing it within the broader cultural, political and social ecosystem that characterizes the imagined world, thus supporting the investigation of the wider impacts of technology.

In sum, while scenario-based design focuses the students' attention on the positive, "local" and immediate consequences of technology design and can be useful to imagine how the interaction will take place in specific situations, design fictions bring to light the issues stemming from the systemic adoption of technological artifacts, offering more complex narratives and "worlds" that may make the students aware of their ambiguous, systemic and double-edged effects.

Third, design fictions encourage to "play" with dystopias: this provides a critical distance that may point out theoretical concerns far more difficult to identify in common scenario-based design, which uses more realistic settings. For instance, Kirman et al. (2013) envisioned a distant future when robots enslaved humanity due to the responsibility of the HCI community. The issues raised in that work, namely that the HCI focus on the improvement of technology simultaneously made it more ubiquitous, subtle and capable of controlling human behavior, would have been hard to consider while remaining an engaged researcher: positioning the critique of current HCI research within a dystopian world allowed Kirman et al. to tackle a difficult topic from a critical distance (Tanenbaum et al., 2016).

Moreover, dystopian “extreme” worlds support “theoretical creativity”, allowing for the exploration of paradoxical situations that may subvert the conceptual presuppositions embedded in current HCI trends. By proposing “alternative” realities that are built on (even radically) different assumptions from those of the real world (e.g., that emotions can be rationally controlled, as in the Emotional Regulator), the students are able to bring into question relevant conceptual categories of our culture and design practice. Traditional HCI scenarios, instead, often take for granted the assumptions of HCI research and practice, confirming the conceptual categories on which such research is grounded (Blythe & Wright, 2006).

Limitations. A limitation of this work relies in the “uniformity” of the sample we involved. In particular, we did not test our method with Computer Science and Engineering students, who are often enrolled in HCI courses. This was due to the fact that the method proposed in this article stemmed from the need to convey basic concepts of HCI to students that did not have a strong technical background.

Recruiting psychology students, however, could have biased some outcomes, such as the focus on the psychological impacts of technology, which could also be a consequence of the students’ background. The naivety of some prototypes, which often tended to convey a deterministic perspective on technology, as if the mere fact of a specific technology exists implies that people behave differently than now, could also be retraced to their humanistic background. Students often ignored how people also appropriate and “go against” the purpose of a design - both intentionally (because they are in opposition to its purpose) and implicitly (because people often happen to use technologies differently from what they were intended for). This is interesting as it also reveals something about the students’ fears and conceptions of technology. They could have emphasized the risk that technology modifies the “mind” and controls people, not only because of the influence of sci-fi literature inspiring their creations, but also as a means for reaffirming the importance of

mind and human agency, of which they will have to take care as psychologists. This shows how design fictions may reveal visceral concerns about technology, as they were a "projective" method.

Despite these limitations, design fictions used in this course were able to elicit philosophical, social, and moral reflections, showing that they were able to move students beyond their current terrain (no students had a social science or philosophical background).

Future research could explore whether involving students with different backgrounds could entail more multifaceted debates and generate more complex design fictions. Another point that is worthy to be noticed is related to the gap existing between the envisioning of fictional designs and the development of "real" HCI prototypes. We did not test whether the awareness and knowledge the students developed during the course turned into more aware design practices, even because the course was unique of its kind within their curricula. It would be interesting to use design fictions within a design, computer science or HCI degree, even as an advanced course (thus involving "expert" students).

6 METHODOLOGICAL CONSIDERATIONS

Thinking of our experience we see five main stages in design fictions creation in order to introduce basic elements of HCI/design and elicit students' reflections on technology: identifying a design problem, generating ideas, creating the fictional design, and critically discussing the result.

The first stage is the identification of a design problem, deciding what the most interesting challenge to tackle is, as the subsequent design work will try to give an answer to that. Students should be left free to formulate their own challenges on the basis of their own understanding of the design space that is under exploration.

The second stage is the generation of multiple ideas. Here, students should be invited to envision as many concepts as they can. We noticed that the first ideas generated were the most anchored to the current technology landscape. Insofar as the students were "forced" to define multiple concepts,

they started imagining provocative ideas, disrupting or going against the trends of the specific design space they had to explore.

The next stage is designing the fictional prototype, inserting it into a design fiction. Students have to narrow the focus of design activity, tracing back all the generated concepts to a single design: they may find it difficult to combine different ideas into a coherent and plausible design, and assistance, when asked, should be provided.

Design fictions should be created starting from a "what if"-statement, a "basic rule of fiction" like "What if Artificial Intelligence raises against humans?. This represents the "setting" of the design fiction. Students may be invited to think of sci-fi stories coming from literature, comics, cinema or TV series, in order to find inspiration for defining the fiction's set-up: this may connect the design activity to a "familiar" domain, allowing students to exploit and rework their imaginary.

Then, students need to focus on one or more main characters and a "conflict" that they may experience: conflict represents the driving force of the narrative and can be actualized in an internal struggle that the character lives (as in the Emotional Regulator, where Arthur wants to both have and lose control of his emotions), in a difficult journey that it has to travel (as in the Memorizer, in which John has to trace back to what he really lived in the past), or in a "battle" that it has to fight against someone or something (as in the Body Duplicator, where Song fights against Russia exploiting the potentialities of technology). Furthermore, design fictions need to have a "beginning", where the character "encounters" the difficult situation, and an "end", where the conflict is (partially) solved or still persists, which may make the narrative more ambiguous.

A relevant point is that the protagonist of the fiction has to be the character rather than the fictional prototype, which, instead, needs to be moved to the background, as something that has been taken for granted by all the individuals living in the fictional world. In other words, the imagined technology has to act behind the scenes, as the events narrated in the fiction were a byproduct of its ways of functioning. This allows the students to focus on the impacts that technology has on the people's way of living and not only on the technology per se.

While designing the fictional prototype, the students should careful consider the interior aspects of user experience, which are almost absent from Personas based approaches (Blythe & Wright, 2006). On the one hand, characters should be created by taking into account their "internal life", and students should pay attention to their emotions, perceptions and thoughts. On the other hand, when proposing the fictional technology, core functionalities and input/output modalities should be developed by keeping in mind how they will affect the "felt-life" of individuals, namely their ways of thinking, feeling, and conceiving the world. Moving away from exclusively functional criteria when developing the prototype allows the students to reflect on how the adoption of a given technology may change the ways people relate to themselves and the world.

Another point that the students should consider when creating the fiction is the social and cultural contexts in which the "action" takes place. To this aim, they should be encouraged to build a coherent fictional world, in which a society has been shaped by the proposed technology: this would enable the students to reflect on the long-term and systemic consequences of technology design. In so doing, it is important that the fiction is settled in a very distant future, so that the students may imagine even radical changes in society without being anchored to current "ways of living". Attention should be drawn to social relations, values and weltanschauungs and how they could be affected by the spreading of the fictional prototype.

In other words, in developing their fictions students should give an answer to questions like: how do people will organize their everyday activities, interactions, transfers, and so on? What kinds of "ideologies" would orient their actions? What form of society is coherent with the systemic adoption and ways of functioning of that particular technology?. This means that after having provisionally defined the main characteristics of the fictional prototype in a preliminary phase, students need to develop the prototype and the design fiction in parallel, as the world surfaced in the latter should be a byproduct of the former. We noticed that this activity was the most demanding for the students, because they constantly had to assess how changes in fictional prototypes' features

would have impacted on the fictional worlds and characters. However, participants found this phase highly stimulating as the animated debates emerged within the groups testified.

In sum, an "external" and functional description of the prototype is not sufficient to create a "good" design fiction. Students should focus on envisioning how its features may affect the individual and her interior states and functions (e.g., memory), the society in which she lives (e.g., the ways people stay together and interact with each other, the social values and the dominant "ideologies"), and, by and large, the "world" in which the fiction is settled.

If for Psychology students a stronger focus on the "internal" impacts of technology could be particularly useful, as it allows them to leverage and put their knowledge about mind into practice during the design activity, Sociology/Anthropology/Philosophy students could consider more in depth the social and cultural contexts in which the narrative takes place, as well as the moral concerns arising from the characters' interaction with technology.

The focus on the interior and societal aspects of the user experience could be extremely useful also for Computer Science and Engineering (Mechanical and Electrical) students engaged in learning HCI fundamentals. In our experience, design fictions were able to move Psychology students beyond their current terrain, by making them reflect on the moral and social implications of technology design, even though they did not have any sociological or philosophical background. Likewise, design fictions could shift the focus from the technical aspects of technology design to its human "wider" implications when used with Computer Science and Engineering students, offering them a nuanced and multifaceted picture of HCI discipline and its impacts.

The final stage is the critical discussion and reflection on the created prototypes. Here, design fictions should first "speak for themselves", and the full texts should be made available to all the participants before the debate. The "designers" should then be allowed to explain their own story, but the other students should be encouraged to express their own interpretation of the fictions, also questioning the creators' ones, being advised that no "correct" readings exists.

We want now to point out some futher methodological considerations that could further help HCI teachers, researchers, and designers to enact the proposed method. The following suggestions are addressed to the use of design fictions within the classroom, but they might also be applied outside the educational context, being used by people without expertise in technology or design in order to raise their "awareness". Despite grounded in a multi-year course experience, enacted across several cohorts of students, such suggestions still stem from a relatively low numbers of "cases", taken from a specific master's degree of Italian psychology undergraduates: this advises us to consider them as hypotheses that will need further testing to prove their validity.

Mix "real" and fictional methods. In the first phases of the design work we invited students to use the design studio methodology, as well as scenarios, Personas, affinity diagrams and so on. This allowed them to familiarize with the design process, experimenting and learning tools that are commonly employed when designing "real" technologies. Creating design fictions on the basis of "traditional" design methods, which pose precise steps to be followed in order to achieve the desired results (e.g. the definition of (fictional) users' needs through Personas and scenarios), may further avoid that the design fiction creation phase turns out in a mere exercise of imagination disconnected from the design activity. Actually, it allows for the reflection on the design activity itself, enabling students to think of their role as designers. However, other design techniques could be experimented in combination with design fictions, as well as other design phases included in the process (e.g. the evaluation phase). Can we create fictional prototypes on the basis of empirical user requirements (e.g. by inviting students to conduct interviews)? Should design fictions be anchored to real users' needs? What would it mean to evaluate a fictional prototype? Can we involve real (or fictional) users for co-creating a fictional prototype or testing it?

Support "narrative thinking". The stories produced by the students varied widely in terms of length and complexity (e.g., the minimum length of the fictions has been 830 words, whereas the

maximum length has been 5282 words). We neither provided requirements or instructions on how to build stories (apart from giving general suggestions about the plot development, i.e., that it needs to have a beginning and an end and should focused on a "conflict"), nor gave lessons about storytelling. We may notice that the design fictions that "achieved the most success", being voted by the class for further discussions, were the most ambiguous and complex (in terms of the prototypes' consequences on characters), even if quite simple from the narrative point of view. Blythe (2017) argued that a deeper understanding of storytelling may help us develop more nuanced and reflective research fictions. And we have highlighted that characters and plot variations allowed students to identify with the issues raised and experiment different possibilities. So it is reasonable to suppose that more complex narratives could provide richer food for though and source for discussion. We recommend that future research will explore whether a stronger focus on narration techniques could improve the kind of reflections that design fictions could engender.

Provide a "light" guidance. In line with our constructivist approach we tried to make the students take the guidance of the learning process, by leaving them free to formulate their own research questions and find the means to solve them. We only suggested an application domain to be tackled during the design work, and provided a methodological scaffolding to structure the design process. Leaving students completely free of selecting the topic of their fictional prototypes would have excessively scattered the subsequent discussion, whereas excessively narrowing down the application type would have limited their imagination and autonomy. Another point is related to the discussion phase. We did not introduce precise topics on which reflecting. This allowed for the development of the concerns and understandings that students considered important. We suggest that future research will continue on this line, exploring other means to open up students' imagination and allow for self-expression, supporting students' autonomy and self-guidance. Blythe et al. (2018) for instance, suggested that there are advantages to images over text in terms of leaving room for interpretation and creativity.

This said, there are further possible evolutions of the method we proposed: even though we did not enact these possibilities "on the field" yet, they could be experimented in future work.

On the one hand, teachers could invite their students to use different media when creating fictional prototypes. We have seen that the HCI community employed comics, videos, and "products", as well as ads, theatrical enactments, and radio shows, to create fictional designs. We, instead, mostly relied on written language and "traditional" story development, which may have limited the students' creativity in favor of a sort of "philosophical" activity. Future research could explore how diverse media might differently affect the students' outcomes, as well as the subsequent class discussions. Teachers could also tackle directly the idea of "world building", by inviting students to produce multiple and heterogeneous artifacts pointing to a unique fictional universe. In doing so, they could still rely on narratives to complement the "objects" developed. If Coulton et al. (2017) stressed that design fictions entail the creation of multiple artifacts that simply put together create a "world", Blythe (2017) argued that we should focus on plot and storytelling. Luu et al. (2018), instead, showed that storytelling and world building are not contrasting practices but may work together: while written stories have potential to facilitate speculations on future scenarios, other "artifacts" are more open for interpretation. We have noticed, for that matter, that narratives can create worlds as well. Opening the students' design activity to different "materials" and "forms" could also widen the applicability of the method, e.g., to product or media design degrees, leaving the students free to exploit their specific skills to create their own fictional prototypes. Finally, teachers could also propose different "technology domains" as themes of the students' fictional designs. As we have seen, design fictions in HCI have developed fictional technologies in domains as diverse as shape-changing interface (Sturdee et al., 2017), virtual cities (Ylipulli et al., 2016) and cities of things (Lupetti et al., 2018), artificial animals (Edwards et al., 2016), and drones (Lindley & Coulton, 2015a). Technologies for "smart" building, organizations

and cities may widen the "unit" of the students' design work, potentially enabling reflections on the environmental, organizational and urban consequences of technology design.

On the other hand, future research could investigate techniques for deepening the students' reflections on the design fictions they produced. We have emphasized that most of the fictional designs created during the course were directly (or unconsciously) inspired by science fiction. However, we did not encourage the students to compare their work with their sources of inspiration. Presenting sci-fi stories that bear similarities with the created designs, after a phase of "free discussion", might make the students more aware of the cultural assumptions that influenced their conceptions of technology. This would foster them to analyze their concerns and expectations, tracing them back to both their personal and cultural imaginary. Alternatively, the teacher could prompt those technological innovations that most resemble the students' fictional prototypes, making more explicit the connection between the future and the present. "Experts" in specific technology domains (e.g., Artificial Intelligence, Robotics, etc.) could also be invited to discuss with the students the produced fictions, bringing their perspective as supplementary food for thought. In doing so, the students could be allowed to set the "agenda" and the themes to be debated, in order to preserve their autonomy and opportunities for self-expression.

7 CONCLUSIONS

In this article, we asked ourselves whether design fictions could be usefully employed in academic education to support students in critically reflect on the assumptions and ramifications of technology, as well as on their role as designers. To this aim, we organized an introductory HCI course for psychology students, asking them to produce and discuss design fictions. We noticed that the students acquired the basic concepts of designing technology through the creation of fictional prototypes. Further, we explored three different research themes.

Firstly, we investigated whether fictional designs are able to move the students' thinking about technology beyond the here and now. It turned out that design fictions may push them to reflect on the potential long-term and systemic implications of technology. Their narrative form allowed the students to elaborate a variety of "what if" scenarios and thought experiments: these made them acknowledge the ambiguous individual and societal changes entangled with technology development. Moreover, design fictions stimulated critical thinking on some of the common practices that revolve around our technology usage, connecting the future world depicted in the fiction with the present condition. This suggests that fictional design can be a tool for involving people in a sort of "controlled" philosophical activity, which encourages the investigation of "situated" problems, i.e., anchored to a specific "context" represented by the fictional world.

Secondly, we tried to understand whether design fictions are capable of helping students unveil the presuppositions that lie behind current technologies. It resulted that fictional designs may enable the students to identify the theoretical categories that frame our understanding of technology and its design. By being free of creating somehow "extreme" worlds, the students became aware that conceptualizations about technology may evolve as novel devices are introduced, and that alternate theorizations may lead to different designs grounded in different values. However, it also became apparent that sci-fi popular literature affected the representations of technology given by the students, encouraging them to stress their dystopian aspects. This further shows the "weight" of the cultural lenses that inspire and limit our imagination about technology, driving our understanding of and expectations about its future development, as well as the potentialities of design fictions in making them emerge.

Lastly, we asked ourselves whether design fictions can support students in thinking about their responsibility as designers. We discovered that design fictions may stimulate ethical reflections, unpacking the potential moral implications of design work. By manipulating their fictional characters and seeing problems through their eyes, the students not only imagined how individuals could subjectively "live" the technology they envisioned, but also explored moral dilemmas from a

first person perspective. This fostered identification and engagement with the issues raised during the discussions, allowing the students to reflect on the intrinsic morality of technological artifacts and the ethical relevance of design choices.

To conclude, it is worth pointing out the applicability of the findings presented in this article and emphasizing the many future possibilities for this work.

On the one hand, even though the method has been experimented only with Psychology students, it may be applicable to all those students that do not have a strong technological background and need to be introduced to HCI. Design fictions, in fact, are able to elicit psychological, cultural, philosophical, sociological and political reflections that could connect with and leverage the "humanistic" background of a variety of students, building on their previous knowledge to produce insights about technology design. Our experience may be useful for teaching students attending only one HCI course in their academic career: fictional design gives a critical lens to understand a discipline that is complex and multifaceted, the assumptions and implications thereof could be hard to convey in the limited time of a stand-alone course.

On the other hand, the proposed method could be employed in other courses beyond Psychology degrees and involve students at different levels of expertise in technology design, as well as having diverse backgrounds who may collaborate together; different technology domains from those reported here could be investigated as well. For instance, given the increasing interest of HCI educators in teaching Engineering students, design fictions could be employed in Mechanical or Electrical Engineering degrees. In fact, design fictions could allow to easily shift the focus from the technical issues to the moral, individual and societal concerns of designing technologies, providing a wider perspective on the implications of HCI as a discipline. Even if they were not yet employed within a specific course with precise educational aims, early attempts of using design fictions in workshop activities with Computer Science students pointed out that fictional design may allow them to see the social impacts of their work (Skirpan et al., 2008). Our experience further highlighted that design fictions are able to move the students outside their terrain within HCI

courses, encouraging them to make reflections going beyond their current background. Future work could then assess the effectiveness of the method proposed in this article even in HCI courses in Engineering degrees, exploring the learning outcomes achievable with students that have a strong technical background.

Finally, there is room to explore different "forms" of fictional design, encouraging students to exploit different media, and move away from the development of single storylines; different ways to debate the produced fictions within the classroom could be also experimented, by making more explicit the connection between design fictions and sci-fi imaginary, as well as between fictional and real technologies.

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102. Anonymized for peer review.

- We present a multi-year experience of using design fictions in academic education

- We show that design fictions can be used to teach HCI and help students reflect on technology

- We present three design fictions created by students as “knowledge objects”

- We discuss the methodological implications of design fictions used in education

- We propose a series of methodological suggestions