BLOW BITS: CREATIVE PLAYGROUNDS, GAMIFICATION AND VIRTUOSITY WITH HYBRID DESIGN TOOLS AND ENVIRONMENTS (HDTE)

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Abstract
Playgrounds (real or virtual) are universal areas where most people learn to play, interact, engage, immerse to unlearn and relearn repeatedly in order to get more fundamental understanding and insights on their creativity, communication and collaboration patterns with others. Consequently, finding out more about oneself in the process. This paper connects research and development of hybrid design tool environments with play, gaming, and gamification strategies and methods for application in multiple domains. We present a playful tool, game environment and preliminary case study from our ongoing research and experimentation in hybrid design tools and environments (HDTE).

Keywords: Design process, Computational design methods, Collaborative design

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Please cite this paper as:
Surnames, Initials: *Title of paper*. In: Proceedings of the 21st International Conference on Engineering Design (ICED17), Vol. 8: Human Behaviour in Design, Vancouver, Canada, 21.-25.08.2017.

1 INTRODUCTION

This paper is on agile development (Beck et al., 2001; Fowler and Highsmith, 2001) of hybrid design tools (HDT) and (micro-) environments (HDTE) for playful interaction, creative processing, and heuristic ideation in the early phases of design and design engineering. We use a holistic framework and a rawshaping attitude that founds itself on empirical research, experimentation, and exploration within the educational-, design, engineering- (i.e. design engineering practice) and industrial domains. Over the years we designed, authored, and build a wide variety of cyber-physical tools and systems (CPS) that we tested with large quantities of users in various interaction (IA) contexts and with diversity (range) in application areas. Initially we created, made and manifested hybrid tools (i.e. based on analogue and digital computational blends) purely from disappointment with so-called computer-aided-design (CAD) tools and applications (Wendrich, 2010; Wendrich, 2012; Wendrich, 2014a; Wendrich, 2014d, Kosmadoudi et al., 2013). Not only the tools where unsatisfactory and often tedious, even the user-interfacial (UI) connectivity, progressions, and interactions working with these tools were frequently disturbing, illogical, counter-intuitive and numbing the user experience (UX) and user engagement (UE). If you sit yourself down in a sandbox or go to a playground to do some activity, alone or with others, the principal idea and motivation to immerse yourself (i.e. willingly, motivated) into these realms is to interact, play, and communicate with other human-beings through "affordances", or better yet, through the use of playful artefacts and/or equipment. These interaction devices elude and inspire you to do particular actions, perform certain motions, enjoy the physics and gravitational power of milling around, dig deep holes in the sand with your spade or just relax on a bench while getting a suntan for free. The use of the equipment, play-tools and playground is free, uninhibited and mostly unaffected by rules and constraints, other than for example hitting your 'friend' over the head with a spade, as shown in Figure 1.

Figure 1. User play and engagement (UE) process flow (middle) and Hybrid Design Tool Environment (HDT-E) with 3-D sensorial playground (left and right).

Playgrounds and play-scapes are designed as integrated sets of playground equipment, made out of e.g., wood, metal, plastics, rope, safety glass, grass (i.e. real or artificial), sand and concrete. Most of the time the areas are 'naturally' covered with trees and shrubs that give the place lustre, shadow and light to enhance the experience, imagination and fantasy. You can even bring your own toys and play-stuff to share with others. According to Huizinga (2014) it is '…a closed space marked out for it, either materially or ideally, hedged off from the everyday surroundings.' To play is to engage in activity for enjoyment and recreation, rather than for a specific or practical purpose. Play or to engage in play is often directly related, analogue, and/or connected with children (i.e. being child-like), and not so much with adults. Adulthood is framed, agreed on, and placidly understood by most people (i.e. however without prior consent) as being serious, being conform, to be sensible, balanced, standardized, reliable, controlled and having a quality of stable consistency in attitude towards your peers, family, friends or other fellow human beings. The question is: if you put an adult unexpectedly in a playground, how would this person react? What would he/she do? Would "he/she" start playing? Would "he/she" pick up a game and play? Would "he/she" sit idle and feel depressed by the memory of play and fun the "id" used to have a long time ago? It is exactly this feeling that we have when we interact and work with our 'playful'- personal - computers (PPC) and CP-systems. Our quotidian is full, engrossed and overloaded with computational interactions to be without is considered to be 'mute', 'dumb' and 'blind' to the "synthetic force". According to Debord (1981), '…the study of everyday life would be a completely absurd undertaking, unable even to grasp anything of its object, if this study was not explicitly for the purpose of transforming everyday life.' One could deduce from this that real and even virtual playgrounds are a necessity to discover, explore, understand and position oneself in relation to the world-around-us. And play is grounded in the concept of possibility (Csikszentmihalyi and Bennett, 1971). Simon et al. (1989) stated, '…that the computer was made in the image of the human', this holds probably true in terms of 'software' related computational power or synthesis, however, when it comes to interactions, emotions, cognition, enaction and "affordances" the computer still has a lot to learn, understand and catch-up. Yet, our computers, computational systems and CPS's are not designed and engineered to act, trigger, stimulate, and behave 'naturally' like the state-of-being and social behaviour you encounter when one steps into a playground. Or thrive on our 'natural' ability and capacity to connect and affect (Liu et al., 2014) with our feelings, touch, senses, perceptions, eloquence or emotions like all of humanity manifests in one way or another. In such playful procedures and systematic stratagems provide keys to unlock doors to perception and unconscious consequently releasing the visual and verbal poetry of collective creativity (Brotchie and Gooding, 1995). However, '…who has time to engage in "alternate playgrounds?" (Flanagan, 2009). We should confront current thinking and flux in CPS's, HMI's and HCI's head-on and create freedom to explore new frontiers and spaces to "create new sandboxes and playgrounds in the hyper-clouds and metapolis" to promote and foster hybridization in the real-world.

2 BLENDING REALITIES AND SPACES

From the onset we developed our hybrid tools with an agile methodology based on play, gaming, action and enactive participation of users to fit 'the computer' to the human needs, wishes and expectations. At the same time we realized the potential of the machine as an active agent, support tool or assistive mode of interaction. We realized the power in use and attractiveness of traditional tools and processes in product creation processes (PCP) and/or creative design ideation phases in conjunction with computational assistive technologies (Wendrich, 2010; Wendrich, 2014a; Wendrich and Kruiper, 2016a; Wendrich, 2016d). Sener et al. (2008) states, '…current CAD developments make slow progress towards enactive mode of operation, but still far off from what humans can accomplish in terms of cognitive transformations, sensorimotor representations, through visual manipulations to fully matured formal operations'. Playful CAD environments (Kosmadoudi et al., 2013; Wendrich, 2014b) and constraints and limitations with CAD environments (Wendrich, 2010; Kosmadoudi et al., 2013; Robertson et al., 2009; Wang et al., 2002; Bilda and Gero, 2005) show the need for more research and understanding of 'how, what, when, and why?' the machine disrupts, transforms and reduces our natural abilities, interactions and personhood while immersing ourselves further and further into the digital realm.

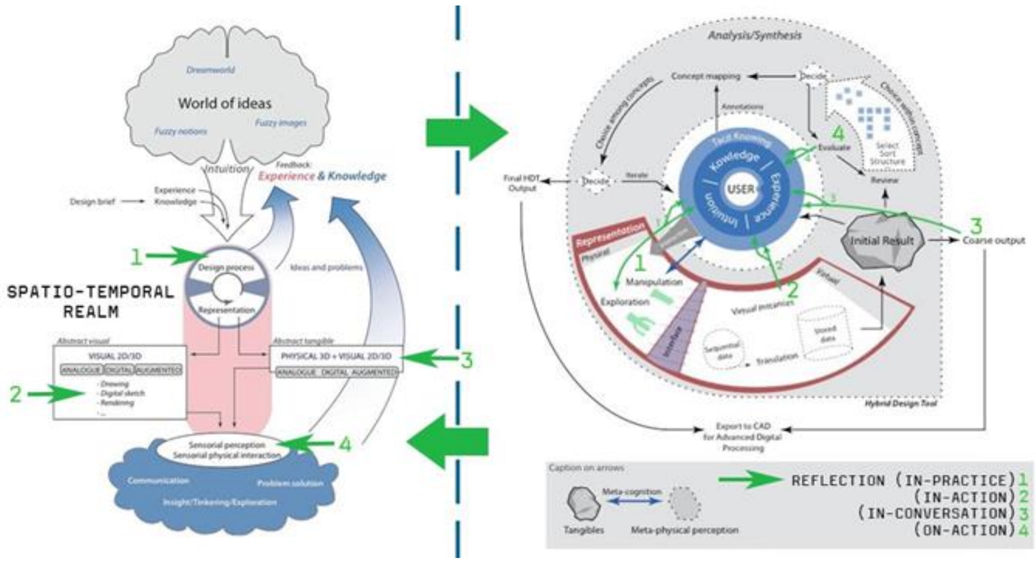

Figure 2. User engagement (UE) process flow (left) and Hybrid Design Tool Environment (HDT-E) (right).

It changes, evolves and modifies not only our visual perceptions, but also our manual dexterity, skills, tactility and haptic manipulations with our surroundings. Our sense of touch is actually being changed and converted profoundly and our imaginative abilities, idiosyncrasies and creativity are somewhat strangled by the interfaces, pre-programmed and prescribed interactions with our smart digital devices (Wendrich and Kruiper, 2016a; Wendrich, 2016c; Wendrich, 2016d).
The HDT (E) holistic approach is based on the dynamic and agile development of HCI, along with the inclusion of meta-cognitive affordances, intuition, and bodily experiences as indicated in Figure 2. Miller et al. (2005) state that intuition comes in two types; either holistic hunches, or automated expertise. A holistic hunch is a judgement or choice made through subconscious synthesis of information drawn from previous experience and knowledge. Automated expertise happens when judgements or choices are made through a partial subconscious (autonomous, self-aware) process involving recognition of the situation. However, often it is the software alone that defines and determines how and what actions are possible within a virtual reality. As a result 3-D modelling tools (CAD) on a computer, not much unlike e.g. 'hammers', impose limitations to the solution space. These limitations have direct implications to the freedom of a designer, as well as the understanding of form and shape of virtual models (Wendrich and Kruiper, 2016). According to Dyck et al. (2003) current CAD systems do not have a strategy to communicate between the systems and the designer and/or engineer to enhance the UX. Games on the other hand "…communicate information to users in ways that do not demand the user's attention and do not interrupt the flow of work" (Kosmadoudi et al., 2013). Humans excel at using resources, especially representational resources, in systematic but creative fashion to work their way to solutions. They are good at using and manipulating structures and constructs (Kirsch, 2005). Jetter et al. (2014) state, '...at the heart of blended interaction is an embodied view of cognition with its notion of conceptual integration to extend our understanding of a "natural" human computer interaction.'

3 TOOL USE AND INTERACTIONS IN MIXED REALITY

Tangibility, tactility in perception and manual dexterity during the early-phases of a PCP or design engineering process are highly undervalued in current human machine interface (HMI) and human computer interaction (HCI) design, systems and applications. Usability of computational tools and systems often (i.e. mostly) lack the inclusion of metacognitive, sensory and/or physio-psychological aspects, whereby the loss of tactile spatial acuity are deteriorating and lead to degradation over time in users. The need for embedding and inclusion of the aforementioned aspects in the design engineering process calls for new perspectives, holistic viewpoints, and novel approaches towards HMI/HCI as shown in Figure 3. Humans can excel in interactions and communication with others and possess amazing capabilities to use these complex skills to gather information or have an influence on others behaviour (Wendrich and Kruiper, 2013; Wendrich, 2016). The essential function of play is the modulation of experience and not characteristically undertaken to acquire profit or gain (Huizinga, 2014). To some extent (*extend*) we can witness an increase of computers and systems that get more fitting in nearly doing the same complex set of sensorial 'understanding' and recognition of recurring motives and patterns as humans.

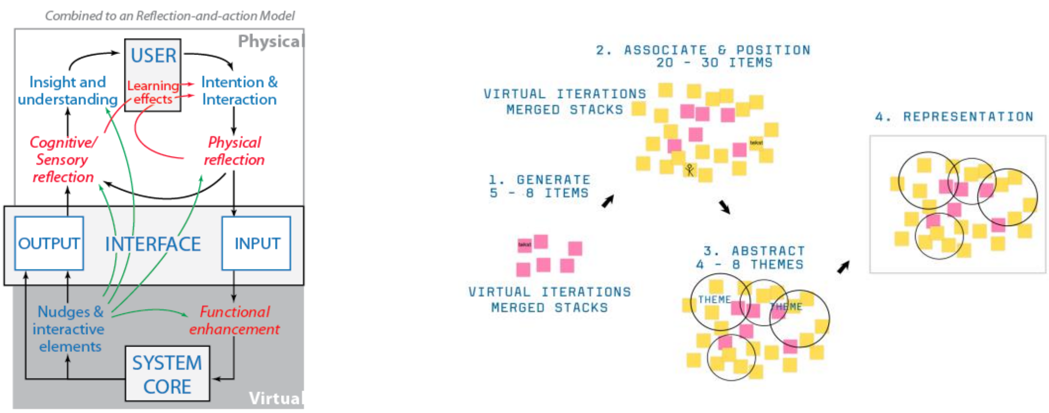

Figure 3. Embedded mixed reality (MR) continuum, based on HDTE holistic framework and typical rawshaping process flow (right).

Virtual assistants (robots) are quite common practice these days (i.e. services, communication, and information) and are often more cost-effective and efficient in their repetitive task fulfilment and core functionalities (Huang et al., 2008; Jain, 2016).
Humans continue to have, at least for the time being, an advantage in the physical domain in which they use their abilities and capabilities in often advanced and complex situations in either physical or cognitive challenges (i.e. communication, psychology, cognition). People are great problem-solvers in the physical and metacognitive processes, often ambiguous, non-linear, risky, predictable or unpredictable, but always in the state of motion, explicit intention, exertion and interaction (Wendrich and Kruiper, 2016; Gourgey, 19989; Gallagher and Hutto, 2008).

4 EXERTION OF AIR TO KEEP ON BREATHING IN THE REAL WORLD

We present a Tangible User Interface (TUI) with common off the shelf components that can accurately measure airflow and pressure of a human breathing, and make this data available on a computer for virtual representation and simulation (Wendrich, 2016).

4.1 CAD Enhanced with TUI

The Air-Flow-Inter-Face (AFIF) device and system allows glassblowing (blow bits) like interaction with a computer, humans have a lot of fidelity with the pressure and airflow (puff and sip) they can exert, so this makes it an interesting input modality for a 3-D design process and “affords” unconventional HCI (UHCI) as presented in Figure 4 and Figure 5. A graphic user interface (GUI), and visualizer (representation) for five data representations; pressure graph display (1), cumulative volume (2), plain text data XYZ (3), generated 3-D shape (4) and rotational orientation and position of TUI (5).are shown in Figure 6. The wireless handheld device (TUI) is capable of measuring both human blow pressure and flow rates, simultaneously sends the data values to a receiver that is connected to a PC as schematically presented in Figure 5. It has a 6DOF orientation sensor, so interaction with how the device is held can be created. The combined wireless sensor platform enables users to have new interaction with a PC. Complementary to the hardware we created a software data visualizer that enable data representations to create, for example 3-D meshes that can be opened and further iterated in 3-D software suites (e.g. Blender) (Blender Foundation, 2002).

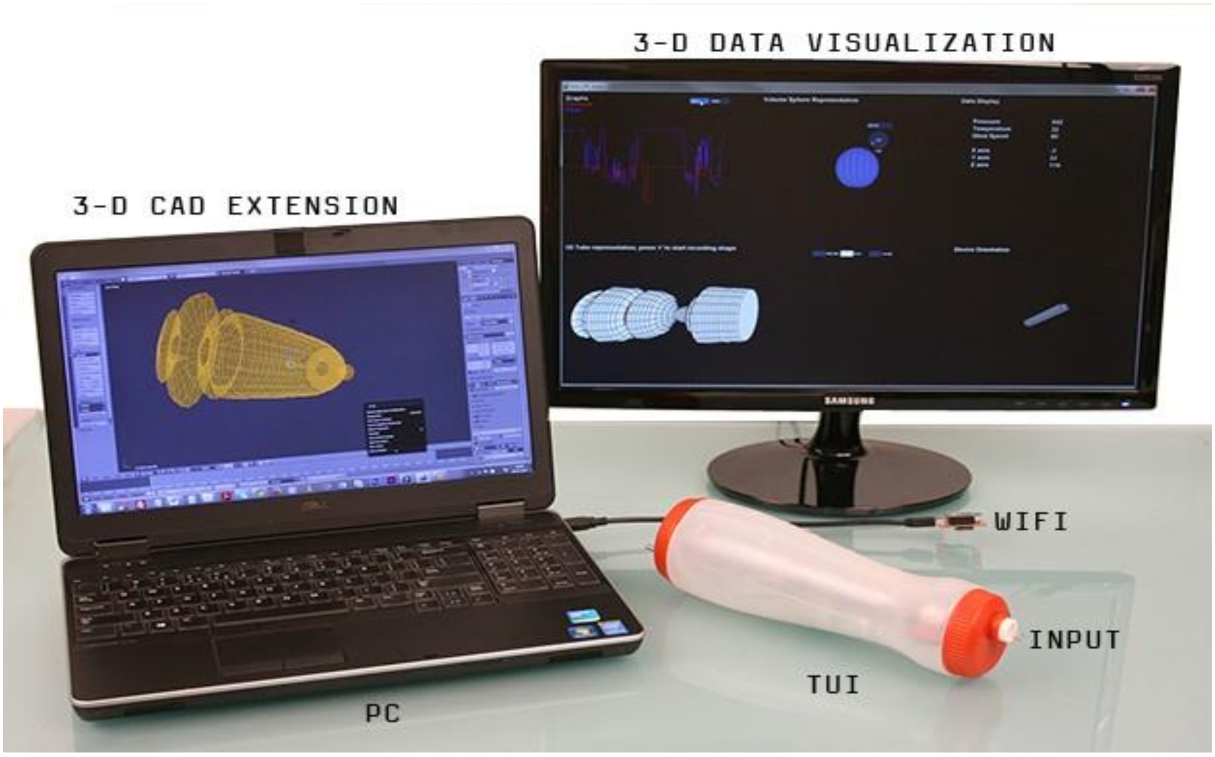

Figure 4. AFIF complete setup; shows pc with Blender visualization of generated content (3-D CAD), 3-D data visualizer of blow IA and tangible user interface (TUI) in foreground right.

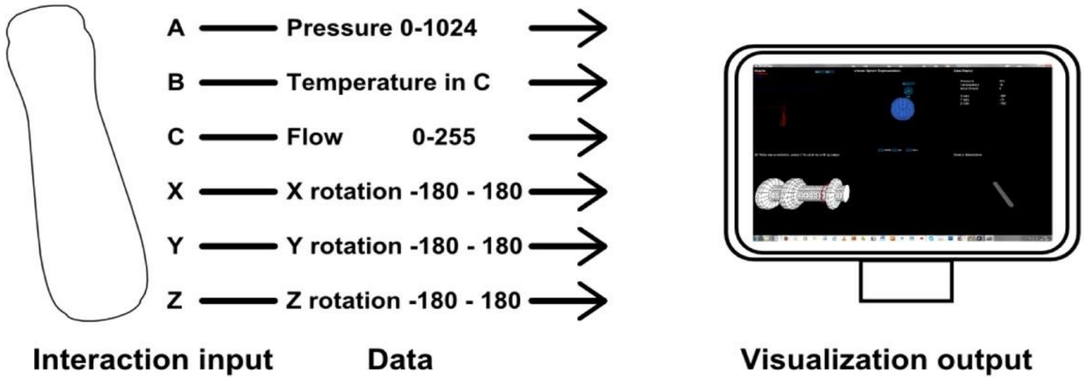

Figure 5. Diagram shows the connections between the TUI and GUI that consist of six different values and their individual ranges. An Arduino captures the data from the various sensors.

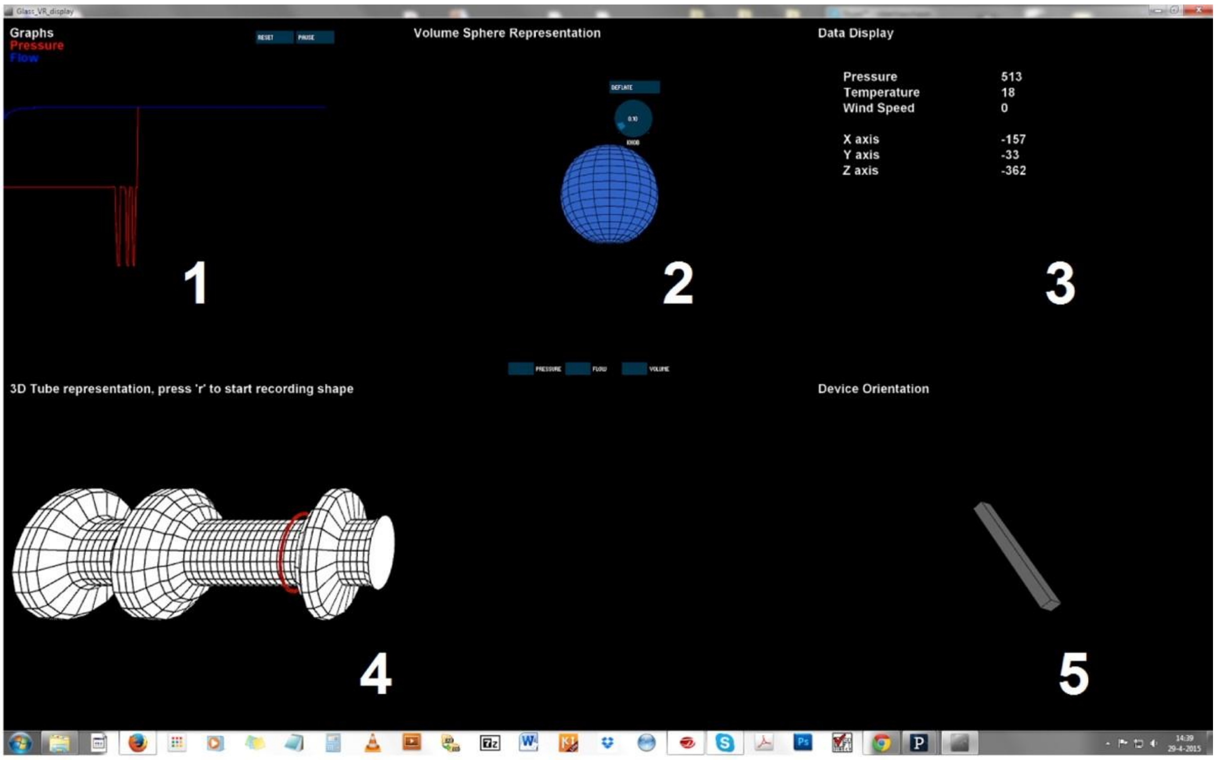

Figure 6. Five data representations; pressure graph display (1), cumulative volume (2), plain text data XYZ (3), generated 3-D shape (4) and rotational orientation and position of TUI (5).

The main interactions with 'glassblowing' are the pressure and airflow the glass blower generates with his or her blowing and the orientation of the blowpipe. This is without taking the tactile modelling of the soft glass with tools in mind. As this is a very complex real world phenomenon and not something that can be done in any virtual sense yet. The airflow system is made with regular plastic air-hose tubing, plastic valves and various plastic hose connectors, schematically represented in diagram of Figure 7.

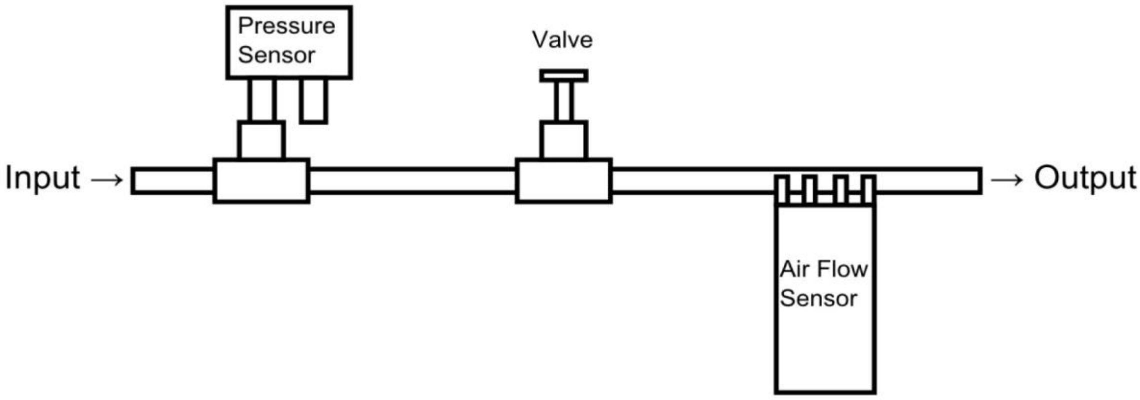

Figure 7. Input and output (IO) of airflow used in the AFIF TUI system.

From the user input where they can puff-and-sip on the mouthpiece the airflow is directed through the hoses and split-off with a T-split that connects to the pressure sensor. After the pressure sensor an inline air-valve is placed. This allows the user to choose to built-up pressure (*pressure mode* = valve closed) or to allow airflow to go through (*flow mode* = valve open). In the latter the airflow will pass over the airflow-sensor where wind-speed data will be generated. Once the airflow has passed this sensor the wind will blow out of the hose into the open.

4.2 Playing Flappy Bird with AFIF

The AFIF was tested (as a preliminary case-study) with second year Bachelor students Industrial Design Engineering at our university. A total of nine students (2 female and 7 male) were asked to participate (voluntary) in playing the very popular smartphone game 'Flappy Bird' (FB) (Nguyen, 2013) as shown in typical screenshot in Figure 8. All the game-interaction is recorded on video with consent of the participants. We use the footage for analysis and evaluation of IxD, UX, and UE.

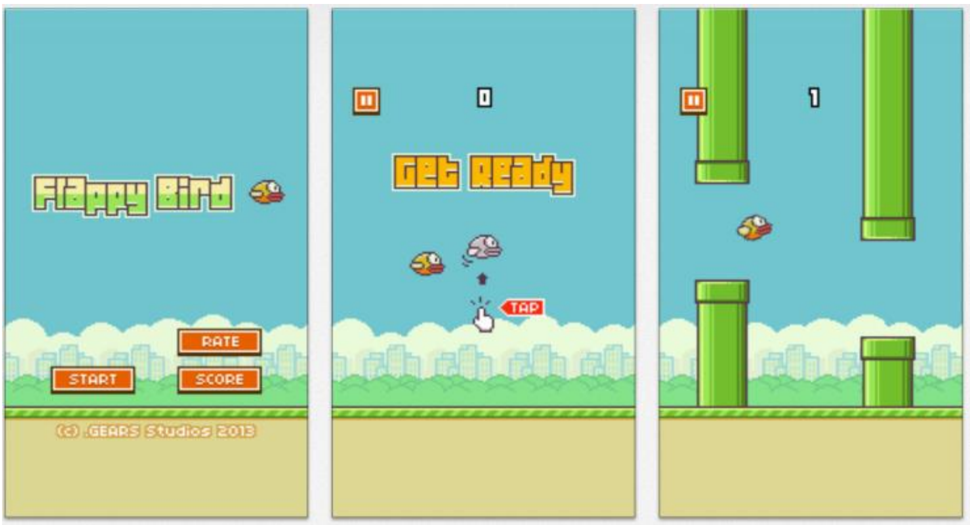

Figure 8. Screenshot of original Flappy Bird Game GUI (left)

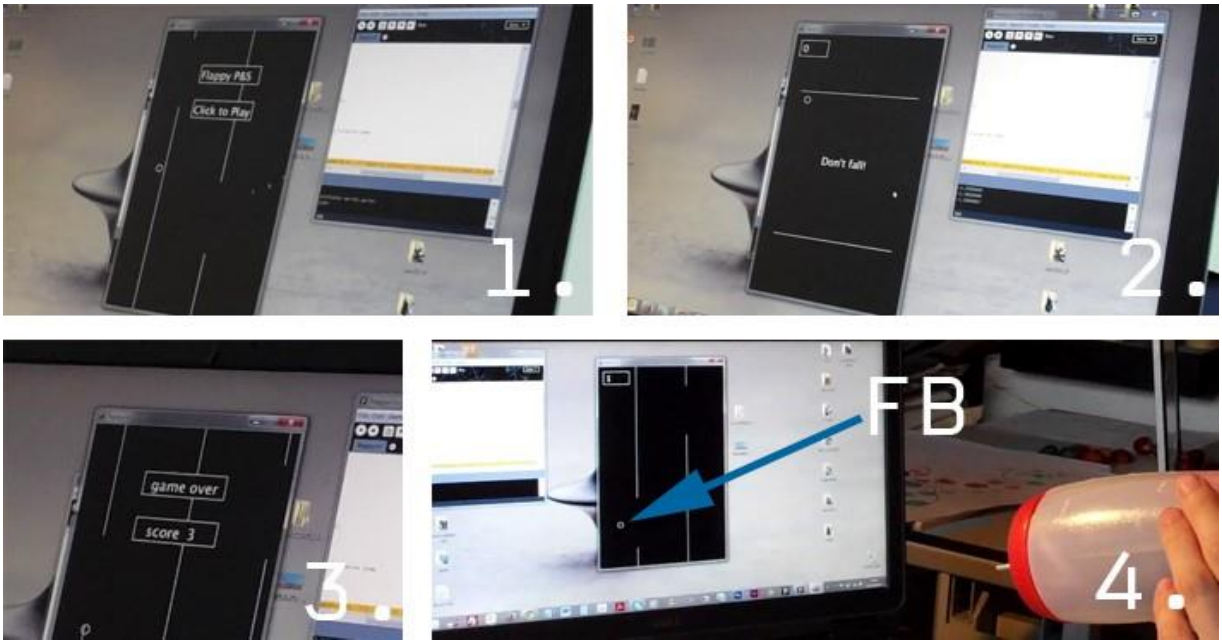

Figure 9. Screenshots adaptation of FB GUI (1-2-3) for use with AFIF system. User in expiration action to guide FB through the 'gaps' (4).

The FB-game was specially adapted to fit our objectives, requirements, and IxD models in conjunction with the AFIF device. The simplified black-and-white interface include the same gamification principles of the original game were made with Processing to operate fluidly with the AFIF system as presented in Figure 9 and Figure 10.

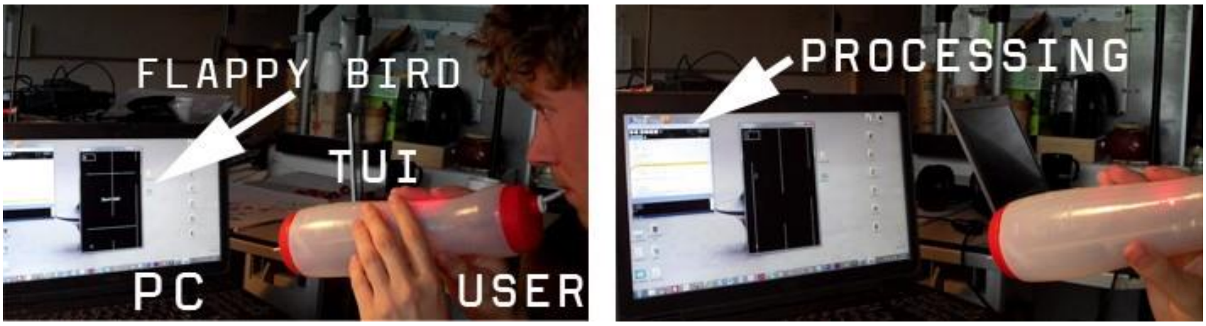

Figure 10. Setup of system including AFIF, FB GUI and user interaction.

The objective of the FB game is to jump as many 'holes' as possible without touching the barriers and oscillating constraints. The FB game is really simple, but with the AFIF in flow mode it became a real challenge and exercise in concentration, focus and perseverance as shown in Figure 11. However, all participants (players) were engaged and very much focused and eager to "win" the game.

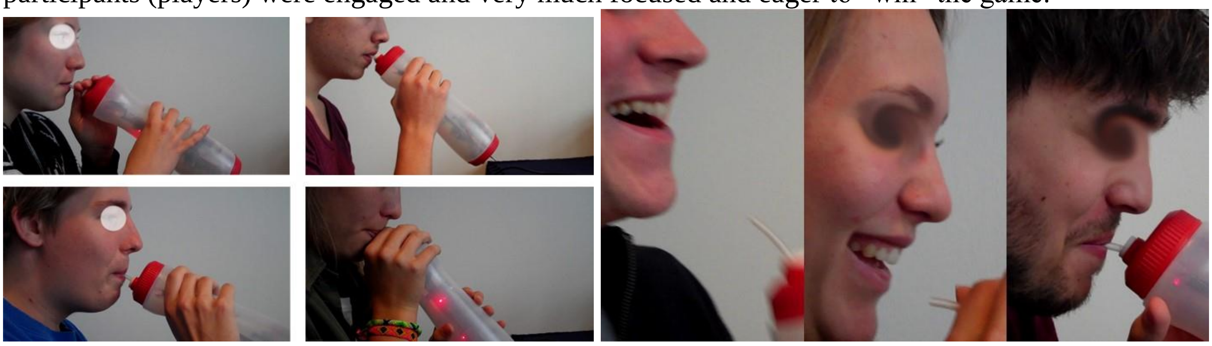

Figure 11. Game play interaction and users having fun, showing enjoyment during gaming.

Table 1. User result of AFIF-FB game task and performance.

User Nr.:	Sex:	Total Game Time:	Games Over:	Hi Score Points:	Mode:
1	F	0:02:40	12	3	Flow
2	F	0:05:13	24	3	Flow
3	M	0:03:15	12	5	Flow
4	M	0:02:51	14	5	Flow
5	M	0:02:03	10	4	Flow
6	M	0:03:06	18	2	Flow
7	M	0:05:15	29	4	Flow
8	M	0:06:29	34	4	Flow
9	M	0:04:20	25	4	Flow
n=9	-	Mean = 0:03:48	19.8	3.8	-

The first results from our analysis and evaluation of the game-task process made clear that most players were engaged and indicated that it was a pleasurable way of gaming. Every one of them showed endurance and great attitude in trying to up their scores by starting over after each ‘failure’. They were in 'flow' with their airflow and gaming. In Table 1 we show some preliminary results of the game-task. In this setup, we focused mainly on the highest score and game overs of each player including the total interaction game-time per player. The sample rate is too small to justify or draw conclusions at this moment, further research and experimentation is required to get more data on the use of UHCI, UX and UE.

5 CONCLUSION

Our agile development of hybrid tools over the years (Wendrich, 2010; Wendrich, 2012; Wendrich and Kruiper, 2014a; Wendrich, 2014b; Wendrich, 2016c; Wendrich, 2016d) confirmed our hypothesis that embodied imagination (physical experiences and its structures), intentionality, and cognition could simultaneously ‘link’ this imagination (individual or collaborative) with the digital realm based on natural and intuitive interaction and exploration. People in general enjoy playing, interacting and working with tools (real or computational) and CP-systems especially if the latter relies on the natural, intrinsic, explicit and intuitive qualities, capacities and abilities of humanness. Specifically designed and build computational and synthetic systems, based on a holistic framework and rawshaping paradigm, we take effort to construct embodied reality in balance, sensibly and fitting congruously with the huge potential of synthetic cyber- digital machines. Use of the human fidelity and capacity in all its splendour and greatness, enables these factors and aspects in direct and intrinsic relation to our interaction with our 'machines'. Consequently, it will bring us more pleasurable experiences, more successful performances and increased enjoyment in relation to the physical and virtual machines and CP-systems. Still, however, the question arises, once you emerge yourself in the digital virtual realm; “What about tangibility, manual dexterity, tactility and sensory perception?” "Perhaps it will be blown to bits?!"

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