Public Social Private Design (PSPD)

Andrew Warr
HCI Group
Department of Computer Science
University of Bath
Bath
BA2 7AY
UK
cspaw@cs.bath.ac.uk

Eamonn O'Neill
HCI Group
Department of Computer Science
University of Bath
Bath
BA2 7AY
UK
eamonn@cs.bath.ac.uk

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Abstract
We present a computer-based tool for the support of collaborative sketching activities in design: Public Social Private Design (PSPD). We provide an overview of the empirical studies that have informed the development of PSPD. We present the current version of PSPD, briefly report an initial evaluation and highlight future developments and studies.

Keywords
Creativity, Design, Creativity Support Tools, Design Environments, Public Social Private Design (PSPD).

ACM Classification Keywords
H.5.2 Information interfaces and presentation: Interfaces – Theory and methods; H.1.2 Information Systems: User/Machine Systems – Human factors.

Introduction
The CHI community is concerned with the use of technologies for the support of human processes [2]. One such process which has received increasing interest within the CHI community is creativity [11]. Researchers and practitioners have studied and developed computer support tools (CSTs) for creative processes [e.g. 1, 4]. Although there is recognition of the need for theory [6, 11], such CSTs have often been developed on the basis of practical knowledge and experience. While acknowledging the importance of

such practical knowledge and experience, our research aims to inform the development of CSTs by increasing our theoretical understanding of creativity.

We have developed a theoretical understanding of creativity through a variety of empirical studies. Building upon our understanding of creativity, we have developed design requirements for CSTs to extend previous work such as [5]. In this paper, we present a CST designed to meet these requirements: PSPD. We provide an overview of the empirical studies that have informed the development of PSPD. We present the current version of PSPD, briefly report an initial evaluation and note future developments and studies.

Public Social Private Design (PSPD)

We have conducted a range of empirical studies focusing on creativity in the design phase of the software development process (SDP). Table 1 provides a brief overview of these studies and presents the key findings. PSPD builds upon this empirical foundation and our identification of 4 fundamental requirements for technology to support creativity in design:

1. Support multiple representation of ideas – verbal communication, sketching and annotation

2. Support the various group compositions of the design team [13] – individual, sub-group and whole group

3. Control social influences [15] that are known to inhibit creativity: production blocking, evaluation apprehension and free riding

4. Support all the phases of the creative process, including problem framing, idea generation and idea evaluation

Hardware

Extending the ideas embodied in tools such as the i-Land environment [12], PSPD utilises the different interaction spaces supported by different technologies [8] – in this case, an interactive tabletop, tablet PCs and PDAs (Figure 1).

Figure 1 –Hardware configuration for PSPD

Tabletop: This technology provides a public interaction space, allowing all group members to engage around the technology, collaborate with each other and interact simultaneously with the technology. Multi-user, synchronous interaction through the tabletop is enabled by an ultrasonic pen-based sketching application.

	Diary Study	Ethnographic Study	Experimentation	Evaluation
Overview	70 students formed 12 design teams as part of an interaction design course. Over 12 weeks each group member submitted a diary entry each week, containing information on ideas for their project and information on the context in which each idea was generated.	The 12 undergraduate design teams who participated in the diary study participated in an ethnographic study during the design phase of the SDP. Design teams were observed using recording equipment to capture an instance of their design process in the field.	96 participants formed 24 groups of 4 across four conditions: Nominal, Nominal-Real, Real-Nominal and Real group compositions. The experiment observed the effect of the group compositions on creativity when social influences [3] were controlled.	Using 7 groups of 4 participants performing an urban design task, we evaluated an existing CST - the Envisionment and Discovery Collaboratory (EDC) [4].
Key Findings	The design phase of the SDP gave rise to most new ideas, whereas the latter phases involved more refinement of ideas. Early phases of design were performed individually, moving towards group activity. Refinement was a group activity. Ideas were represented using sketches with annotations and textual representations. Refinements of ideas were textually described as more technical detail could be conveyed.	Teams verbally communicated with each other. Breakdowns [4] caused externalizations to be adopted through the use of sketching ideas on a whiteboard or piece of paper. Social influences inhibited creativity [3]. The design teams shifted between individual, sub-group and group compositions throughout the design process. This finding is also supported by previous research [13].	Real groups were found to be equally as creative as nominal groups when social influences were controlled [15]. This finding contradicts an abundance of previous literature showing nominal groups to be more creative than real groups [3] and refutes the claim based on this literature that creative activities are best performed by nominal groups [3].	The EDC allowed users to frame problems, generate ideas and evaluate ideas, by externalizing knowledge through the use of boundary objects [4], thereby facilitating the creative process [16]. Technologies introduced new social influences: e.g. technological production blocking – only one person can use the technology at a time. Interaction spaces [8] inhibited the dynamic change of the group composition.

Table 1 – An overview of empirical studies and key findings

Tablet PCs: This technology provides a social interaction space, allowing a sub-group to collaborate with each other and interact with the technology. Due to the constrained interaction space, it is not possible for all members of the group comfortably to collaborate around this technology, therefore providing a feeling of social inclusion for its users and exclusion for others.

PDAs: This technology provides a private interaction space, allowing members of a group to work individually. Due to the constrained interaction space, it is not possible for all members of the group, or even a sub-group, comfortably to collaborate around this technology, therefore providing a private environment for an individual user.

In addition to the hardware architecture supporting dynamic changes of group composition (*requirement 2*), the hardware also facilitates the control of social influences detrimental to creativity (*requirement 3*) as follows:

Controlling production blocking: The tabletop display and the ultrasonic sketch tool provide means for synchronous input by all members of the design team [9]. Members can also work simultaneously using PDAs and Tablet PCs and seamlessly integrate information between devices.

Controlling evaluation apprehension: The social and private interaction spaces allow members of the design team to work independently of other members, mitigating fear of criticism [9]. Information can then be distributed to other group members whenever the originator feels comfortable and willing.

Controlling free riding: Some users are not always willing to contribute in a group. The technologies provided by PSPD allow users to remove themselves from the group, while continuing to be productive by engaging in a sub-group or individual activity.

Software

PSPD is designed to support concept design – the creative process of getting ideas represented quickly through the use of sketching and annotation, an activity common in the design processes of many disciplines [e.g. 7]. Our research and that of others [e.g. 14] has shown that idea generation benefits from a mixture of media such as textual and graphical.

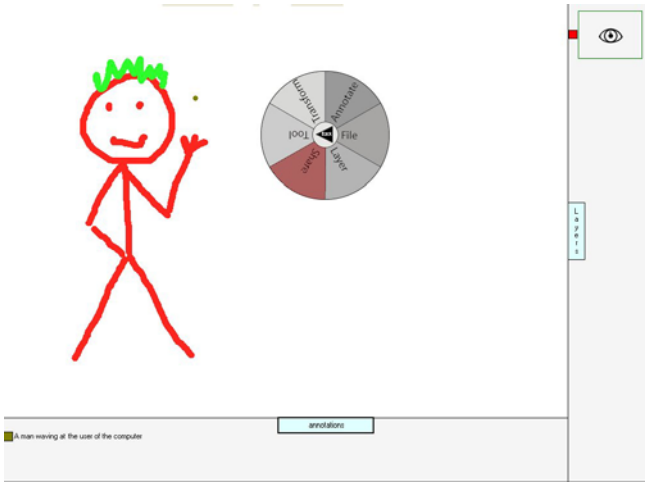

Figure 2 – A screen shot of the sketch application for PSPD

The software for PSPD supports concept design through the use of an innovative sketch program (Figure 2). The development of this application was informed by

previous research observing Disney animators [10] and our own studies observing how users sketch – 12 participants performed an individual sketching task and 6 pairs performed a collaborative sketching task. This led to the following design requirements for the PSPD sketch application:

- The interface is a blank canvas with no menus or floating tool bars. This allows users to be presented simply with their ideas, as if they were using a piece of paper, while providing functionality for layering. Ideas can be represented graphically with annotations (*requirement 1)*

- Menu selections are made using pie menus and marked menus, providing support for novice and expert users

- Ability to select different, sizes, pressures and hardness for the drawing tool

- Transformations are a common part of sketching: move, rotate, scale and zoom

- Vector graphics are used to maintain high quality images between devices and throughout transformations

- Sketches may be annotated without taking up available sketching space through the use of markers

- Sharing sketches between the available technologies allows flexibility while maintaining privacy of information.

Integrated with the hardware architecture, the software provides tools for the user to frame knowledge and establish common ground, generate and manipulate ideas, and evaluate and compare ideas, supporting the phases of the creative process (*requirement 4*).

Initial Evaluation of PSPD

In our initial evaluation of PSPD, 8 participants used either the sketch application on the PDA or the Tablet PC for an individual sketching task. In addition, 4 pairs of participants used the sketch application on the PDA or the Tablet PC for a collaborative sketching task. To avoid learning effects, participants were different from those used in our previous sketching studies. These were preliminary evaluations and evaluating the tabletop version is work in progress.

Participants found the PDA difficult to use to represent ideas – "I normally draw quite big", "the screen is too small on the PDA". This difficulty varied according to what the user was trying to sketch. The PDA allowed outline ideas to be sketched, but the screen size constrained details from being added. This was not a major failing since the intention for the PDA element of PSPD was to support initial sketches and expressions of ideas. These "doodles" could then be explored in greater detail using the other technologies and in collaboration with other participants.

Participants found the Tablet PC provided a useful medium for sub-group collaboration with 2 members. While the use of the stylus implied turn taking and hence perhaps a degree of production blocking, interactions and verbal communications between the participants around the Tablet PC were frequent throughout the activity, facilitating social creativity [4].

Overall, the functionalities of the sketching application were viewed as extending traditional tools. The use of this functionality reduced re-drawing – a frequent and time consuming task during sketching [10].

Conclusions and Future Work

PSPD is currently still in the implementation phase. The hardware architecture has been set up and the software for the individual technologies mostly developed. The next phase of development is to integrate the technologies allowing sketches to be transferred between devices. Once the application development is complete we intend to evaluate PSPD against theory and other CSTs. We shall assess the use of PSPD in design involving individual, sub-group and group activities. More information on the future developments of PSPD can be found at http://www.cs.bath.ac.uk/~cspaw/PSPD

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