

SocialStools: A Playful, Socio-Spatial Interface for Fostering Togetherness Across Strangers

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ABSTRACT

Leveraging the human propensity for embodied interaction, *SocialStools* is a socio-spatial interface that facilitates playful social interactions across strangers in a physical space, fostering togetherness. Three stools on caster wheels generate sound and image around them in response to sitting on them, and moving and rotating relative to each other. In this paper, we identify the challenges of stranger interactions, introduce our cyber-physical system, and describe and demonstrate three interaction situations: sitting, moving closer and away from each other, and rotating to face or turn away from each other. By translating these interactions into visual and auditory effects, we explore the possibilities of merging the socio-physical world with a digital system to create unique social affordances for interpersonal interactions that foster togetherness. Our demonstration transforms three strangers into a trio of sound-and-image makers interacting through creative, embodied play.

CCS CONCEPTS

• **Human-centered computing**; • **Human computer interaction (HCI)**; • **Interactive systems and tools**; • **User interface toolkits**;

KEYWORDS

Computer-Mediated Communication, Human-human Interaction, Interaction Proxemics, Projection Mapping, Ludic Design

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1 INTRODUCTION

Being surrounded by *familiar strangers*, people who one regularly recognizes in public spaces but doesn't interact with [21], helps people form a sense of familiarity and belonging in physical places [2] [23]. However, the ongoing COVID-19 pandemic has affected people's social interactions with others in many ways, and especially with strangers [26], with social distancing and mask wearing rules that have distanced us further from others. In response, we designed *SocialStools* to foster interactions between strangers in a physical space.

One of the hallmarks of designing interactive systems is supporting social interactions in a physical space using various modalities [17]. Following recent efforts to explore interactive furniture [4], we propose a socio-physical interface to leverage the human propensity for embodied social interactions in our everyday surroundings [7] [20]. We developed *SocialStools*, an integrated physical-digital experience of "social affordances", defined as "*the relationship between the properties of an object and the social characteristics of a group that enable particular kinds of interaction among members of that group*" [3]. Practically, *SocialStools* are three identical units of interactive furniture – three stools set on caster wheels. The input of our socio-spatial interface is the physical movement and rotation of each of three individuals seated on the stools, detected by a camera above. Mapped to the inputs are visual and audio effects that create an immersive experience that has the potential to facilitate togetherness of strangers in the physical space.

In the demonstration, captured in the accompanying video to this paper, three interaction states are presented: the sitting state, the state of changing the distance between stools, and the state of rotating the angular orientation of the stools. The video demonstrates how these three interactive states of the cyber-physical *SocialStools* map to digital outputs, changing the atmosphere of the shared space through dynamic, user-controlled sounds and projected, moving images (Figure 1). We leveraged these affordances and designed various kinds of visual and audio effects to encourage social interactions.

2 RELATED WORK

In the book *e-Topia*, William Mitchell encouraged designers of interactive environmental systems to account for the nature of social life, and to move beyond a "one human, one computer" interaction modality. Mitchell envisioned "smart space" as a socio-spatial extension that engages our bodies; its physical manifestation being what



Figure 1: Three interactions of *SocialStools*. (A) Visualization of personal space; (B) Changing volume, pitch, and timbre of sound output by distance between stools; (C) Changing of shapes and colors of bubbles on the floor by angular orientation of stools.

Mitchell called a “robot for living in” [8] [22]. For example, *iFloor* is an interactive floor surface for making gestures that change the graphics on the floor, facilitating communication and collaboration [8]. Similarly, *Interactive table* mediates the consultation process between doctors and patients [25]. We focused our *ludic design* efforts [9] on playful, embodied interactions between strangers – especially at a time when people are encouraged to “socially distance”.

Our project also builds on previous research on proxemics. In *The Hidden Dimension*, Edward T. Hall emphasized the impact of proxemics on interpersonal communication, especially nonverbal communication [8] [10]. Previous studies have explored how interactive technologies apply proxemics to mediate interpersonal interactions. Some studies explore tangible applications as a bodily extension, a prosthetic, as do the interactive hairstyle [16] or changing clothes patterns [14]; others utilize virtual methods such as public displays or personal projections [1] [19] [24] [27]. *SocialStools* integrate tangible, embodied interactions with digital projections to facilitate novel and natural interpersonal interactions.

3 SOCIALSTOOLS AS AN SOCIO-SPATIAL INTERFACE

3.1 Technical Realization

Our system is comprised of three stools, and, hung above the stools, a 4k webcam to locate the stools and a projector (1080p, 3000 Lumens) to project images on the floor (Figure 2). The stools were fabricated of laser-cut MDF. Four casters screwed to the underside of a stool permit mobility by the person seated, much as someone moves an office chair.

We used projection mapping to project imagery on the floor around the stools so that the visuals themselves could change the atmosphere of the shared local environment. We calibrated three different coordinates (the coordinates of the camera, the projector, and the physical world) using the homography mapping method [5]. The position of the stools in the physical world are transformed and mapped onto the PC screen, and the chosen visuals are precisely projected back to the corresponding location in the physical world.

To get the location and the orientation of the stools, we put fiducial markers on the stools and utilized *reactIVision*, an open-source computer vision framework to track the markers [12]. To detect if people are seated on the stools, we put a light sensor below

the top surface of the stool. The visual and audio effects were coded using Processing. To sync the real-time data between different platforms, we used the *TUIO* protocol to link the input (sitting, position, and orientation of the stools) and the output (visuals and audio) [13].

3.2 Design Concepts and Prototypes

In the interactivity demonstration, as captured in the video accompanying this paper, we explore different physical affordances of the *SocialStools* for social interactions (Figure 3). Inspired by studies of proxemics, in the first interaction, we detect the moment when people sit on the stools, triggering rings projected on the floor and rippling from the center of each stool. These moving circles symbolize a person’s personal space as a social cue for interpersonal interaction. In the second interaction, we calculate the distances between stools to control volume, pitch, and timbre of the electronic musical output in the space. In the third interaction, we utilize the angular orientation between the stools to control the shape and color of visual bubbles projected on the floor to encourage further interpersonal communications.

3.2.1 Demo, Interaction-1: Visualization of Personal Space: Ripples. According to the theory of proxemics, human beings are surrounded by a set of invisible zones of interpersonal distance, from smaller to larger: Intimate, Personal, Social, and Public [10]. Studies of proxemics show that proximity has psychological and neurological effects on social behaviors [10]. *SocialStools* interactively visualizes and embodies these interpersonal zones, offering social cues that encourage interactions between strangers.

As a metaphor for the interpersonal zones, we designed a projected ripple that follows the sequence of rings, like a doppler effect, caused by, for instance, a droplet’s impact on the surface of still water. This ripple envelopes people to symbolize the proxemics of social interaction (Figure 4 A-1, A-2). When a person enters a room and sits on a stool, a ripple starts to spread out from the position of the occupied stool and slowly begins to embrace a second stool as a social cue for welcoming the next arrival. When another person sits on a stool, the ripples emanating from that stool add to the other ripples, providing a psychological cue for merging of the boundaries of interpersonal spaces and a social cue to start an exchange (verbal or non-verbal) with the other seated strangers. A dynamic between strangers unfolds, each time unfolding differently

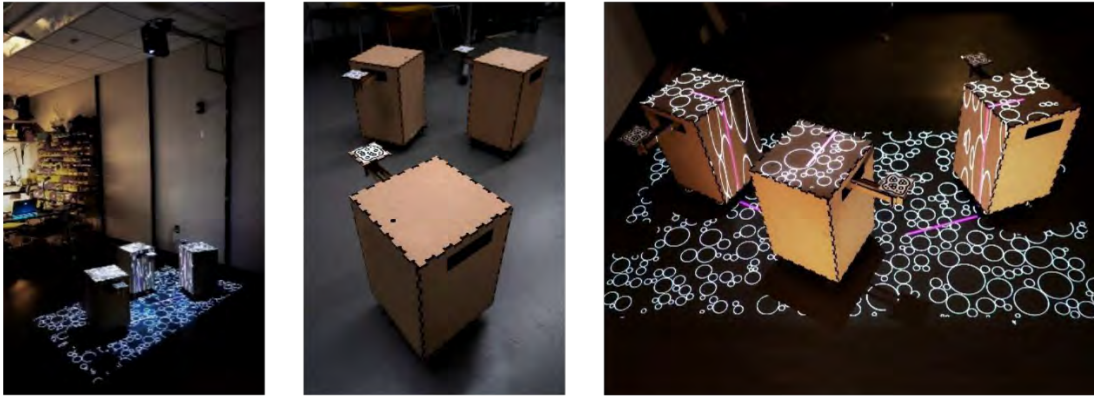


Figure 2: Physical setting of *SocialStools*. (A) Overall physical settings including projector, webcam, pc, and stools. (B) Details of individual stools including markers, light sensor, and touch bar (the latter, under development). (C) Imagery projected on the floor.

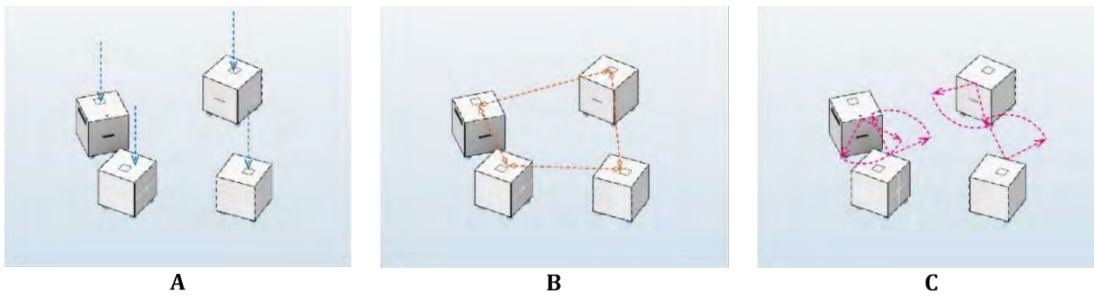


Figure 3: The three socio-physical affordances of *SocialStools*. (A) Sitting on the stools; (B) Distance between stools; (C) Angular orientation between stools.

depending on the personalities and how they respond to the visual cues offered by *SocialStools*.

3.2.2 Demo, Interaction-2: The Distance between *SocialStools*: Sound. The physical distance between people suggests psychological distance. People naturally form different spatial patterns in physical space, and the dynamics of these spatial arrangement, encourage or discourage certain social interactions [18]. Music offers people a wide range of emotional expressions and social significance, creating rich associations to the atmosphere of a space [6]. Therefore, in the second interaction, we explore the possibility of combining human senses of kinesthesia with the auditory sense in interpersonal interaction. *SocialStools* provides different electronic musical output based on the different measure of distances between people, to cultivate communication.

Inspired by the *Kaossilator* [15], a touchpad musical synthesizer, we transform the floor underneath *SocialStools* into a large “touchpad,” leveraging the movement of the three stools to change different parameters of music (Figure 4 B-1, B-2). We translate the distances of three pairs of stools respectively into volume, pitch, and timbre of the generated electronic musical output. The closer or farther pairs of stools are from one other, the higher or lower the volume, the pitch, or the timbre of the background music. The

manipulation of the adjacency not only allows people to make music together but also permits individuals to have equal power as a member of the trio to control the audio effect of the environment.

3.2.3 Demo, Interaction-3: The Orientation of *SocialStools*: Bubbles. Eye contact and body orientation are hidden components of interpersonal communication. People’s body orientation suggests attention, and eye contact may suggest a gestural greeting or a start of a conversation. These nuanced social behaviors are part of our everyday lives but physical spaces are typically unresponsive to them. *SocialStools* registers these instances by projecting interactive imagery on the floor when users rotate themselves to orient towards each other. As flower petals growing and their colorfulness often symbolize vitality, for *SocialStools*, we offer imagery of petal-like “bubbles” as a metaphor for growing togetherness. We hope to create emotional bonding between people by providing positive visual feedback to encourage people to orient more often towards one another.

In the third interaction, we calculate the orientation of the stools so that when the two individuals begin rotating to face each other, projected bubbles slowly “grow” on the floor (Figure 4 C-1). When they rotate away from each other, the bubbles slowly shrink and fade (Figure 4 C-2). When a third individual rotates towards the first two, the bubbles change from white to colorful, and when

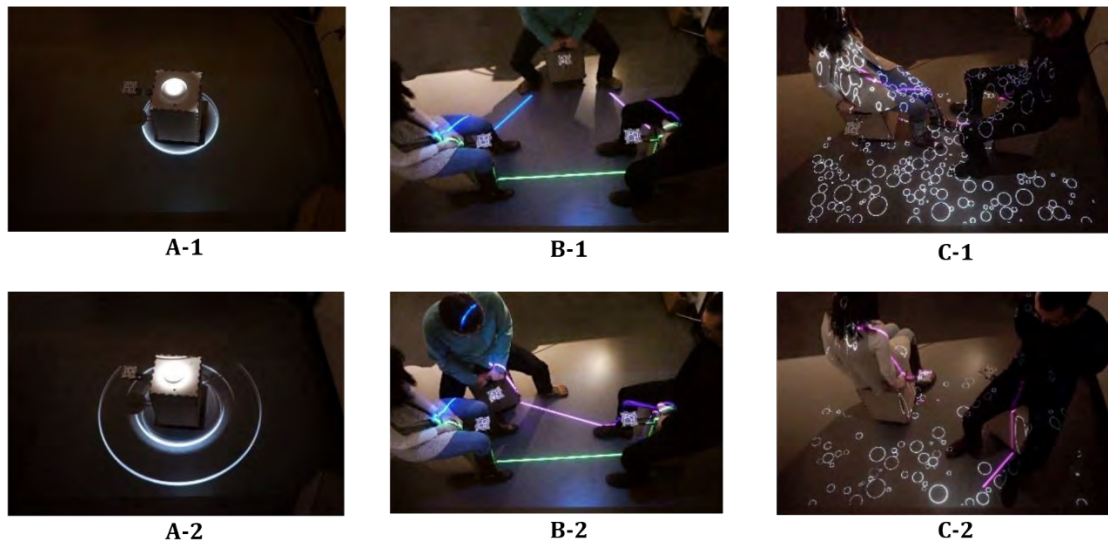


Figure 4: The three core interactions of *SocialStools*. (A-1, A-2) The expanding of ripples, (B-1, B-2) Distance between stools controlling volume, pitch, and timbre music, (C-1, C-2) Angular orientation between stools controlling bubble effect.

rotating away, the bubbles change back to mono-color. Like in the previous scenarios, each individual has equal power to control the effects. To smoothen the visual transformations, we set up a certain threshold of the angle differences of the stools so that the bubble would gradually grow up and slowly fade away following the individuals' body movements.

4 INTERACTIVITY EXPERIENCE

The interactive in-person experiences engendered by *SocialStools* engages three strangers. The first enters a defined precinct containing the three stools; the projections cue one stool to be seated on; once occupied, the stool expands its rippling effect. The person might fidget or intentionally move the stool, which then alters the sound output. Then, another person comes in and the ripples begin to emanate toward an empty stool as a cue to occupy it. The two strangers might explore what moving and rotating their stools do to the sounds and visuals being generated. They might get closer or turn to each other, or maybe not, depending on their dispositions. A third person enters, adding to the socio-physical interaction. *What occurs now between the seated couple? Is the third welcomed? We look forward to observing the dynamics between strangers facilitated by *SocialStools*: Is togetherness cultivated, to what extent, under what conditions?*

In the future, we hope to understand the social and technological implications of *SocialStools* as a socio-spatial interface and to advance the potential for more sophisticated electronic music authorship by strangers as a community-building activity.

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