The Sensing Beds

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ABSTRACT
The Sensing Beds domesticate communications devices by placing them in the bedroom. The beds mediate between two romantic partners who are not co-located by sensing body position in each bed and using a grid of small heating pads to warm the congruent points in the other bed. As an experiment in telepresence, they bridge the physical distance between two people who would normally share a bed, but find themselves sleeping apart. As an experiment in slow technology and emotional communication, they articulate users' existing concerns about intimacy, trust and knowledge.

Keywords
Intimacy, body, limited communication, telepresence, networks

INTRODUCTION
Intimacy and distance is an ever-fruitful source of inspiration for networked projects, from *Feather, Scent, Shaker* (1996) [1] to *LumiTouch* (2001) [2]. Often these projects use multiple physical objects as "digital, but physical, surrogates" [3]. That is, they embody a physically absent person's presence and/or action by altering their appearance or behavior.

These surrogates often communicate not just the presence of the user but also more specific information about the user's state of mind. The Sensing Beds, enter the intimate space of the bedroom as passive observers. We may not use our stoves every day, or sit down in our living rooms, but we all lie down in a bed at least once a day, usually at the around same time. An unavoidable part of our daily routine, the bed is an excellent site for low-bandwidth, low-effort communication.

The Sensing Beds applies this concept to the ever-more-common phenomenon of the long-distance relationship through the emotionally meaningful site of the bed. The bed, which usually unites a couple, here displays the presence of a distant loved one through heat. Sensors located in one mattress pad track the position of its occupant. The position data is transmitted every five minutes to the other bed where heating pads are activated at the same coordinates. Each sleeper thus synchronously feels the ghostly warmth of the absent partner.

SLOW-TECH

The beds are an example of what has been called *slow technology* [4]. They respond over hours, not milliseconds. Their effects mimic the pace of unenhanced life: the slow warming of a newly occupied bed; the cooling of an empty one. Designed to frustrate conventional expectations of immediate, obvious interactivity, the beds react sluggishly and unpredictably. Their artificial heat can be confused with their owners'; their communication is at best delayed by seconds, even minutes.

Slow technology regards the passing of time as an opportunity for engagement, not an obstacle to be overcome. As Hallnäs and Redström write, "we should use slowness in learning, understanding and presence to give people time to think and reflect. Using such an object should not be time consuming but time productive."

Thus the Sensing Beds are designed not for efficiency or clarity but for emotional resonance — what Dunne and Raby describe as the "translucent connections" between people. [5] They use the moments before sleep as an opportunity to reflect on what is absent — the person who has become a ghost in the bed.

The beds follow the pace not of desire, which is immediate, but of intimacy, which takes time to grow and flourish. Intimacy is not a task; it cannot be sped up or made more

efficient. We have to remember what popular music has known it for years: *you can't hurry love* [6]

THE BED

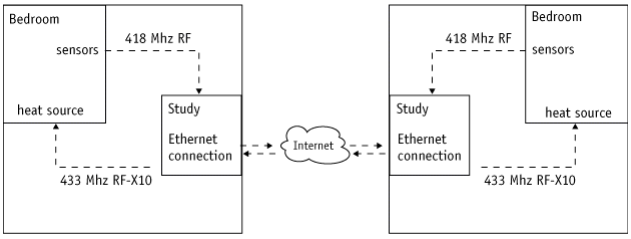
Using the bed allows us to capitalize on its cultural associations and practical functions. In English, the bed is a frequent metonymy for marriage; a loveless relationship is often imagined through a "cold bed." The physical attributes of the bed – cold or warm, empty or crowded – also describe the relationship. Our behavior in bed both results from and contributes to romantic intimacy. In bed, we are presumed to be at our most unguarded – whether asleep or awake.

The Sensing Beds track just this kind of intimacy-producing behavior: unconscious movements during sleep, early bedtimes, late rising. We may not use our stoves every day, or sit down in our living rooms, but we all lie down in a bed at least once a day, usually at the around same time. An unavoidable part of our daily routine, the bed is an excellent site for low-bandwidth, low-effort communication.

Like the hollows and lumps in the mattress left after years of cohabitation, the sensors and actuators of the Sensing Beds are buried underneath the mattress pad. Our approach differs from previous approaches, especially that of Chris Dodge [?]. Dodge focused on the pillow as a "physical avatar" for the absent partner's physical presence, equipping it with heating pads and vibrating motors. He also used curtains around his bed installation as screens for visual projections. Unlike Dodge, we locate intimacy not in the "physical artifacts" around the bed, but on the mattress, the common space shared by a couple. The flat plane of the mattress serves as a kind of ambient display, read not through the eyes but through the skin.

IMPLEMENTATION

Designed for American domestic use, the beds require only inexpensive, readily-available technology and could be deployed immediately. The Sensing Beds are two full-size beds in different locations, each with identical sensing and actuating functions. Each bed has a grid of foam pressure switches under the mattress pad. A microcontroller underneath the bed processes the data. If there is an ethernet jack nearby, an embedded server integrated with the bed microcontroller sends the data via TCP/IP to an identical module in the remote location. If there is no ethernet jack in the bedroom, the bed microcontroller transmits the data over RF to a microcontroller with an embedded server located closer to a jack. Our prototype assumes the second case, since few contemporary homes (as opposed to labs or offices) have ethernet jacks every few feet. In the second location, a module near a jack receives the position data and uses the X10 protocol over RF to turn on and off small AC powered heating pads located at congruent points below the mattress pad of the second bed.



In May, the beds were prototyped as a set of paired benches directly facing each other so that users had both visible and tactile proof that the system worked as described. The two benches, were each equipped with three position sensors and three heating pads hidden inside cushions. Each bench had three cushions, each with an embedded pressure sensor that activated a heating pad under the corresponding bench. This prototype uses heat to signal presence in much the same way as Dunne and Raby's bench concept [5]. In this case, heat does not serve as a precursor to further communication; it *is* the communication. Users were given information about how the benches worked, but not how they were to be used or what the results of use would be.

Over two days, more than 40 pairs of people tried the benches by sitting on the twinned cushions. The heating pads were unexpectedly powerful: after about ten minutes of use the cushions became uncomfortably warm and users had to stand up. But the essential conceit held: people who sat on the benches accepted not just that the heating pads represented remote physical presence but also often acted as if they were *feeling* the other person. In some cases, they reported disgust, or disquiet. A few compared the sensation to the unpleasant residual warmth left on recently-vacated public seats. Others approached the situation more analytically. Using comparative perceptions of heat they attempted to figure out how recently other cushions had been vacated, and how long the previous remote sitters had been there. In effect, some users tried to create hypotheses about previous use from fragmented and ambiguous evidence, even though they had been told that the evidence of their senses was unreliable.

MISCOMMUNICATIONS TECHNOLOGY

The Sensing Beds deliberately limit the data they sample. They do not recognize who is in the bed, or whether the bed's owner is in the room. Their heat may be a comforting reminder of a lover's presence — or perhaps create insecurity. Predictable data is comforting, while differences (Why is the entire bed warm? Why has the bed been cool all night?) in routine can bring distrust. Sometimes ambiguous data is more disturbing than no information at all. Knowing more about a loved one does not always make us happy.

The Sensing Beds derive meaning from people, not the other way around. They echo and amplify a relationship's

dynamic. The interpretations users of the prototype built around the larger project (is it a communications tool? a teddy bear? a surveillance device?) reflect different outlooks on communication – and miscommunication – in romantic relationships.

The beds are not placebo objects; they must work as planned in order to facilitate the real emotional relationships between two people. They can only be comforting when they are supported through emotional trust built with other, more active, communications methods: the phone, the email, the Instant Messenger (IM).

The uncertain warmth of the bed is a metaphor for the uncertainty of trust over distance. Would you rather trust the technology, or your partner? Whose body warmed the bed? When was it last occupied? Is the heat from another body or one's own? The Sensing Beds give only the vaguest outline of an answer.

A user touches the seat cushion next to him in order to figure out when another user vacated the corresponding cushion on the other bench.

ACKNOWLEDGMENTS

Tom Igoe, Bana Abou-Richeh, Amichi Wolf.

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