Fidget Widgets: Designing for the Physical Margins of Digital Workspaces

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ABSTRACT
We present our ongoing work to develop the concept of physical "margin" spaces around software and a new type of human computer interaction. Our novel "Fidget Widgets" seek to engage users' interrelated bodily motions, affective states, and cognitive functions to selectively enhance creativity, focus, calm, etc. Building playful interactions embodying "mindless" activities like doodling, fidgeting, and fiddling, we are working to demonstrate the value of incidental tangible interactions in the physical spaces surrounding digital workspaces. We intend these secondary interactions to have no intrinsic goals; rather these interactions extrinsically enhance a user's state toward the completion of their primary tasks.

Author Keywords
Tangible; play; margin; productivity; creativity; affective; cognition; doodle; fiddle; fidget; Sifteo.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Human Factors; Design.

INTRODUCTION
Work today is as much cognitive exercise as it is physical exertion. We think, analyze, and create in front of computing interfaces in our offices, classrooms, labs, and studios. We observe from people at work that brainstorming engages forms of embodied cognition. We fidget with paper clips, tap pens, squeeze stress balls, doodle in notes, scoot mice about, and generally play with any item at hand while we contemplate problems, draw connections, and await inspiration. Though we work by interacting with software, our thinking extends into a physical "margin" space around our software through doodling, fidgeting, and fiddling [13].

Doodling has been shown to increase attention and to improve recall [1]. Fidgeting is theorized to modulate focus [6,8,18]. We see opportunity to harness these and other phenomenon in a manner removed from traditional HCI work. The effect is to be solely within the user, created through play in the physical margin space around a user's digital workspace, and enabling of a workflow through small but appreciable changes in focus, creativity, calm, etc.

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PHYSICAL MARGINS OF DIGITAL WORKSPACES
In the analog world, we have margins. Whether the ruled edges of notebook paper or the shoulders of a highway, physical spaces include margins that afford us support for our tasks. Software systems tend to be purpose-built without margin; word processing documents do not generally support doodling. However, we observe that digital workers' thinking involves the physical space and tangible objects immediately around a digital workspace.

TERMINOLOGY
Doodling is absentminded scribbling—often in a margin.

Fiddling is playing with an object usually through mindless manual manipulation with the hand.

Fidgeting is purely a bodily action, enacted absentmindedly and repeatedly. Fidgeting can include drumming of the fingers, bouncing of a leg, tapping, etc.

FIDGET WIDGETS
To explore and test our ideas we are creating small "Fidget Widgets." The following characterize the concept:

- Tangential. One "mindlessly" engages a Fidget Widget while mulling an idea or paused in work.
- Playful. The goal is the experience of the interaction not achieving a goal with the interaction itself.
- Digital. To allow for more supple experiences [9] than possible in physical objects (e.g. infinite resources, large virtual worlds in small spaces, etc.) Fidget Widgets are programmable. Interactions are reactive, though not necessarily predictably so.
- Tangible. Engaging the bodily movement of fidgeting and doodling inherent in our physical inspirations, Fidget Widgets embody physicality beyond only screen-based abstractions.

EXISTING WORK

Impact of Affective States on Cognition

Research demonstrates numerous links among affective states, performance, and cognition. Mildly positive affect promotes creativity and cognitive flexibility [2,12]. Anxiety and impeded progress have been shown to increase focus and attention [16,22]. Sadness and anxiousness have been shown to prime uncertainty reduction in decision-making [25]. We are designing with these effects to provide users choices in self-modulating their state.

Embodiment and Affective State

A phenomenological approach to human computer interaction has shifted thinking to consider not only the abstractions and mental models of interactions but the entire physical and emotional experience of interacting with computing interfaces [4,7]. Research shows a strong link between our bodies and our feelings; the former strongly influences the latter. Carney, et al have shown that holding one's limbs away from the body even for a short time ("power poses") increases confidence [5]. Contorting one's face to activate muscles used in facial expressions is known to induce feelings correlated with those facial expressions [21]. Other work has explored gesture design towards modulating affective state in human computer interaction [10,11,15,23]. We submit that interactions can be designed to induce changes in affective state complementary to one's work. Further, we believe any success to be found in such interventions requires tangible, embodied interactions rather than mouse-driven or even multi-touch interactions.

Impact of Bodily Movement (the Hand) on Cognition

New research is developing a compelling link between the act of writing (i.e. pen on paper) and cognition. The effects in the brain due to writing are far beyond that involved in typing or even touchscreens [3,17,27,28]. Neurologist Frank Wilson summarizes: "Any theory of human intelligence which ignores the interdependence of hand and brain function, the historical origins of that or the impact of that history on the developmental dynamics in modern humans, is grossly misleading and sterile" [28]. Dr. Virginia Berninger notes that handwriting requires sequential strokes whereas use of a keyboard involves only a single key press. Berninger has observed in brain scans that sequential finger movements activate large brain regions involved in language and working memory [3]. We submit that tangible interactions have potential to induce changes in cognition that are complementary to one's work.

Fidgeting, Noise, Focus and the Brain's Default Network

In "hyperactive" and ADHD children, researchers have hypothesized that fidgeting is a coping mechanism the body employs to promote natural stimulant release, enabling the mind to focus on tasks [6,8,18]. Anecdotally, encouraging fidgeting in the classroom through desk design and seating seems to improve focus in children [19,26]. From these, we extrapolate that we can design interactions to enable fidgeting tendencies that modulate focus.

Moderate levels of ambient noise have been shown to increase creativity [20]; the startup Coffitivity provides tunable coffee shop ambient sounds to boost creativity [29].

The brain's so-called default network seems to establish a baseline of activity, engaged in boredom, impatience, and indecision. Researchers have noted parallels between the motor activities of doodling, fidgeting, and fiddling with objects and the patterns of activity in the default network of the brain [24]. We find it plausible that tangible interactions can engage the brain's self-modulating mechanisms.

OUR WORK TO DATE

Design and Study Challenges

Our Fidget Widgets concept has proven challenging to design and test. The behaviors from which our concepts are inspired are "mindless" and tangential, complicating design processes meant for directly yielding productivity. Further, a Fidget Widget is intended to have effect through incidental use. Usability and psychologically-based testing are best accomplished with direct interaction, focused reflection, and measurement of quantifiable primary effects. Our concept is largely antithetical to these approaches.

Iterative Design and a Supple Approach

Given the inherent challenges, our approach, then, is iterative in understanding our users, the effects for which we are attempting to design, and the design of Fidget Widgets themselves. It is yet unclear to us the best methods to rigorously test our final result. Rather than take an overly structured approach to addressing so many difficult to quantify initial questions, we are instead working towards a more "supple" design and study strategy [9].

We have used lo-fi methods to understand basic user behaviors and find the edges of our design envelope. We used a survey to get at real doodling, fiddling, and fidgeting behaviors individuals employ in their work. We have built two exploratory instances of the Fidget Widget concept. With these Fidget Widgets, we have sought out expert opinion and user reactions to guide further development.

Survey of Behaviors During Computer-based Work

We created a web survey that collected 35 responses on doodling, fiddling, and fidgeting behaviors during work. While the results are surely biased by self-selection, it reveals interesting trends nonetheless. A web-based survey aligned well with our target user population.

Doodling, Fiddling, and Fidgeting Behaviors & Attitudes

91% of our respondents doodle, fiddle, and/or fidget while working—doing so multiple times a day. Only 4 respondents identified these behaviors as "wasteful"; the rest were evenly split between "neutral" and "beneficial."

Patterns in Self-Reported Behaviors

Descriptions of doodling, fiddling, and fidgeting behaviors varied greatly. However, a commonality emerged. Whether it was doodling, fiddling, or fidgeting, respondents used a language of repetition to describe their behaviors.

Conclusions

If these results are at all representative of the population at large, researchers may have missed important behaviors common and integral to modern work. Further, it appears that repetition may be a key component of "mindlessness."

Early Fidget Widgets

Form Factor: Sifteo Platform

Our exploratory Fidget Widgets are applications for first-gen Sifteo cubes [30]. We chose Sifteo because it affords interactions similar to fiddling and quick prototyping.

Infinite Bubble Wrap

Noting the visceral reward in popping physical bubble wrap and the common desire to pop bubbles repeatedly, we created a never-ending supply of virtual bubble wrap. Each Sifteo cube is a single bubble. The screen shows two states: an inflated or a popped bubble. When a user physically depresses the screen, the cube transitions from inflated to popped with an audible pop. Shaking the cube triggers an inflation sound and a reset. When cubes are placed together forming a "sheet" of bubble wrap, popping any one bubble begins a chain reaction popping each of the others. Note the key elements of repetition as revealed in our survey.

Rock the Cradle

Newton's Cradle is a classic toy made of suspended metal spheres that swing and collide, demonstrating inertia. Noting the almost hypnotic effect of Newton's Cradle, we created virtual Newtonian worlds with Sifteo cubes. Depressing a cube screen creates a new "pellet" in that cube's world. Tilting ("rocking") a cube imparts velocity to pellets within it. A 2D physics engine manages motion and bouncing. Pellet collisions generate musical tones (overlapping collisions create chords). When cubes are brought next to one another, the bounds of each cube's world disappear allowing pellets to interact within a universe as large as the touching cubes. Removing a single cube from a universe "traps" pellets within it. The whole of the interaction is similar to the experience of playing with ball bearings or marbles and also with wind chimes. Note the rhythmic qualities as revealed in our survey.

Expert Reviews

We elected to conduct expert reviews at the CHI 2013 conference to address our design and study challenges. We conducted 9 reviews using our prototypes [14]. Reviewers were of diverse backgrounds and even included usability expert Jakob Nielsen. Reviews lasted up to nearly an hour. Our 9 reviewers reacted positively and even enthusiastically to the Fidget Widget concept and experience.

Tactile / Tangible Experience

Reviewers consistently spoke of the tactile and tangible experience of items with which they fiddle, dominating the commentary. Pliability, softness, satisfying clicks, squeezes, and overall tactile stimulation arose repeatedly. Reviewers' reactions indicated that our design must take a variety of forms far removed from traditional electronics.

Sound

The audio experience of Fidget Widgets also garnered considerable feedback. Some reviewers were very interested in possible audio experiences, noting the creative personal music space due to headphones that facilitates their work. Others were quite concerned about annoyance.

Interaction Spectra

Feedback from our expert reviews filtered into three spectra of an interaction design envelope. In the Active Engagement–Passive Experience spectrum desires spanned from creative stimulus to support of ritual. At the audio end of the Audio–Visual spectrum reviewers desired experiences free of screens and embracing of music or rhythms. At the video end of the spectrum reviewers desired experiences like flipbooks and animated GIFs; culturally significant colors and shapes were also noted. At the personal end of the Personal–Social spectrum, reviewers spoke of emotional attachment to objects and of the creative space afforded by headphones. At the social end of this spectrum, reviewers talked of facilitating intra-office interactions and play patterns in group problem solving.

Expert Review Conclusions

From our expert reviews we draw significant conclusions:

- The concept of Fidget Widgets is compelling;
- Our design envelope is bounded by interrelated Active–Passive, Audio–Visual, and Personal–Social spectra;
- A highly tactile experience is key. A possible development direction might entail embedding sensors in fiddle-worthy items of highly tactile materials. Data from these sensors could be collected wirelessly to drive various interactions.

FUTURE WORK AND CHALLENGES

We plan to iterate on variations of Fidget Widgets in materials and form; in attributes from our identified design spectra; and in permutations of reward, distraction, anxiety, disgust, motion, and audio and visual stimulation. With these we hope to selectively create mild positive and negative affect; develop and alleviate stress; temporarily consume attention or operate in parallel to user attention.

Our next immediate step is to arrive at configurations of material and interactivity with the overall satisfying tactile stimulation our users have discussed. We are currently conducting design research into real users' fiddling behavior and material preferences. Further, we are investigating the Experiential Sampling Method for our eventual study design. We welcome input from the TEI community.

CONCLUSION

We introduced the concept of a physical margin space surrounding digital workspaces in which users often physically perform elements of their thinking in the form of doodling, fiddling, and fidgeting. We also introduced the concept of Fidget Widgets to be used in that margin as playful, tangible interactions. Fidget Widgets are intended to selectively modulate affect and shape cognitive state to support a user's productivity and creativity in their primary tasks. Work to create further Fidget Widgets in a variety of tactile forms and to study their effects on users is ongoing.

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