Emergent Interaction: Creating Spaces for Play

Ben Matthews, Marcelle Stienstra, and Tom Djajadiningrat

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Introduction

Designers of technology always have designed for interaction. Everything in the built environment is made to be used in some way, by some people, for some purposes, irrespective of how peripheral any notion of "interaction" may have been during the design process. If the practice of interaction design deals with matters such as the determination of what interactive devices should be built, how functionality can be accessed, and how products can facilitate interaction, then among the questions that face interaction design "research" are methodological concerns such as how we should seek to understand what is built and how it is used—the implementation of technology and its appropriation. We will address these latter issues in this paper.

"Interaction design" is a relatively recent term. In one sense, it is a document of the recognition of the importance of understanding the development and consumption of technology as being irredeemably situated in human, social, and organizational contexts. Yet it also is an acknowledgement of the central role of the designer in shaping human interaction with technology. As a disciplinary label, interaction design is a purposeful delineation from the more analytic discipline of human-computer interaction (HCI), a field to which it owes a historical and practical debt.

This shift from HCI to the focus on the *design* of interactive systems carries with it familiar (to this audience) difficulties for the conduct of research. Only a few years ago, design research was characterized as an activity in search of a definition[1] in reference to the methodological pluralism and breadth of focus of research conducted within the field. Just how one should design, study design, conduct studies to inform design, and generate "design knowledge" continue to remain open questions for design research, with many competing perspectives being offered.[2] These issues in design research are a more attenuated predicament for *interaction* design research, particularly when one considers the breadth of settings in which interactive devices are now used, and the topics of interest to interaction design.

1 Susan Roth, "The State of Design Research," *Design Issues* 15:2 (1999).

2 Typically, design research has been informed by research practice drawn from other disciplines (e.g., psychology, physical and social sciences) with long, pedigreed and contrasting traditions of inquiry. There also have been moves away from established research models towards recasting design practice as a form of research itself, but this remains contested ground. See, for instance, *Design [x] Research: Essays on Interaction Design as Knowledge Construction*, Pelle Ehn and Jonas Löwgren, eds. (Malmö, Sweden: School of Arts and Communication, Malmö University, 2004); Bryan Lawson, "The Subject that Won't Go Away, but Perhaps We Are Ahead of the Game: Design as Research," *Architectural Research Quarterly* 6 (2002); and Darren Newbury, "Knowledge and Research in Art and Design," *Design Studies* 17 (1996).

Diverging Technologies, Settings, and Practices

First, one may consider the consequences for research of the increasing diversification of technology, and the (parallel) breadth of settings in which it now is used. The office, formerly the archetypal setting for the consideration of human-computer interaction, is losing ground in light of the realization that dichotomies such as work/play, domestic/commercial, amateur/professional continue to be blurred through the emerging patterns of use of distributed, mobile, and ubiquitous technologies. Where once sharp lines may have been drawn between, say, work and leisure; increasingly we see only shades of grey. And this is true whether we are speaking of work times, work places, or work tools. Thus, office environments are less likely to provide designers with a realistic gamut of where and how work technologies will be used and appropriated in use. This predicament constitutes a methodological issue when new technology is designed not simply to support existing practices (as traditionally has been the strength of research in computer-supported cooperative work (CSCW)), but to introduce wholly new practices,[3] suggesting that even basic methodological matters for research such as what to topicalize, what to look for, and where to find it are not necessarily straightforward for interaction design.

The Conceptualization of Interaction Design Topics

The diverging settings of use, general diversification of technology, and introduction of novel practices are factors that have encouraged interaction design researchers to focus on issues broader than those inherited from HCI, and to question existing conceptualizations of topics. Interaction design research already demonstrates distinctive disciplinary foci. Notions such as aesthetics of narrative,[4] expressiveness,[5] aesthetics of interaction,[6] aesthetics of actions,[7] experience design,[8] affective computing,[9] and embodiment[10] exhibit, in different ways, an orientation to the complexity of the networks of people, activities, and contexts brought into relationship by technologies. This too becomes a methodological difficulty due to the nature of these concerns.

For example, consider the increasing interest in the user's "experience" as the object of design[11] "Experience" (like other grails of design research such as "aesthetics") is a term that is not easily amenable to being operationalized in research. It is better understood as a "family resemblance"[12] concept in that it can be intelligibly used in a range of subtle, but important, different ways. Such terms take their definitive sense from their use in a local context. Thus, operationalizing such a concept for the purposes of research can get us no closer to "what it is," since stipulating an operational definition denies the flexibility that the term ordinarily enjoys in vernacular use. There is no core platonic essence of "experience": the term is a polymorph. Research that attempts to operationalize notions such as "experience" may, in some cases, tell us something of interest

3 See Andy Crabtree, "Design in the Absence of Practice: Breaching Experiments" (paper presented at *DIS2004*, Cambridge, MA, 2004); where valuable attention was paid to this issue.

4 Anthony Dunne and Fiona Raby, *Design Noir: The Secret Life of Electronic Objects* (London and Basel: August/Birkhauser, 2001).

5 Tom Djajadiningrat et al., "Tangible Products: Redressing the Balance between Appearance and Action," *Personal and Ubiquitous Computing* 8:5 (2004).

6 Lars Hallnas and Johan Redstrom, "From Use to Presence: On the Expressions and Aesthetics of Everyday Computational Things," *ACM Transactions on Computer-Human Interaction (TOCHI)* 9:2 (2002).

7 Mads Vedel Jensen, Jacob Buur, and Tom Djajadiningrat, "Designing the User Actions in Tangible Interaction" (paper presented at *Critical Computing: Between Sense and Sensibility*, Aarhus, Denmark, 2005).

8 Nathan Shedroff, *Experience Design 1* (New Riders Press, 2002).

9 Rosalind W. Picard, *Affective Computing* (Cambridge: MIT Press, 1997).

10 Paul Dourish, *Where the Action Is: The Foundations of Embodied Interaction* (Cambridge, MA: MIT Press, 2001); and Toni Robertson, "The Public Availability of Actions and Artefacts," *Computer Supported Cooperative Work* 11 (2002).

11 Johan Redström, "Towards User Design? On the Shift from Object to User as the Subject of Design," *Design Studies* 27:2 (2006).

12 Ludwig Wittgenstein, *Philosophical Investigations* (Second Edition), G. E. M. Anscombe, ed. (Oxford: Blackwell, 1958).

about the particular sense stipulated in its operationalization; and may be useful as benchmark-type means of comparison across cases (although exactly *what* is being compared is still an issue). However, the results of such research cannot be mapped back onto the range of phenomena or uses ordinarily associated with the term (be it "experience," "emotion," "aesthetics," etc.), since their ordinary use is not so constrained.[13] The point is that *a priori* definitions (theoretically informed or otherwise) do not help us investigate context-bound issues such as "user experience" or "interaction aesthetics." For similar reasons, laboratory experiments, questionnaires, and other analytically-specified frameworks for investigation often fall afoul of these same methodological troubles. These notions must be investigated in context, and in use, if we are to attempt to illuminate their ordinary and actual nature.

Furthermore, interests in such notions as "experience" have encouraged researchers to problematize extant conceptualizations of topics, and seek theoretical insight from fields beyond design research and HCI.[14] One such conceptualization that serves as an apt case in point is Norman's[15] influential discussion of good/usable design in terms of the fit between the designer's "conceptual model" of the behavior of a product, and the user's "mental model." Norman suggests that to the extent there is a "meeting of minds" between the designer and user *through* the product's behavior, the design can be seen as successful. This particular conceptualization continues to be of great importance to the field and practice of interaction design. But we should note that it is not merely an idle characterization. On the contrary, it encourages an understanding of successful design as contingent upon accurate predictions of users' interpretations and behavior. It defines *as problematic* deviations from "intended use," and it characterizes the artifact's purpose in a (largely) instrumental and semiotic manner. It could be argued that such a conception has informed even the label "interaction design" insofar that it is understood as the design of interaction.

It is here that we see the potential to cross-fertilize interaction design research with theoretical perspectives adopted from other disciplines. In this paper, we want to problematize the notion that interaction design is the design of interaction. We argue that it is not interaction per se that designers of products and systems design, but that the relationship between design and interaction-in-use is complex. We illustrate this through an empirical analysis (based on naturally-occurring, in situ, video data) of the use of two interactive devices for children, demonstrating how emergent forms of interaction arise in use. The product domain these cases are drawn from (i.e., game/toy design) is fitting for a consideration of aspects of interaction such as engagement, appropriation, interaction modalities, and interaction aesthetics.[16] The cases explore the benefit of moving away from conceiving of "good" design primarily in terms of fitness for purpose, efficiency, clarity, and effectiveness. We intend

13 See also Jeff Coulter, "Remarks on the Conceptualization of Social Structure," *Philosophy of the Social Sciences* 12 (1982).

14 An important example is Anthony Dunne, *Hertzian Tales: Electronic Products, Aesthetic Experience and Critical Design* (London: RCA: CRD Research Publications, 1999).

15 Donald A. Norman, *The Design of Everyday Things* (New York: Doubleday, 1st Doubleday/Currency ed.,1990); and Donald A. Norman, "Cognitive Engineering" in *User- Centered System Design: New Perspectives on Human-Computer Interaction*, Donald A. Norman and S. W. Draper, eds. (Hillsdale, NJ: Erlbaum Associates, 1986).

16 We expect that the lessons we draw from this analysis are generally applicable to interaction design to the extent that goals such as engagement, appropriation, and interaction aesthetics also are design objectives in other domains.

our discussion to contribute to the budding dialogue between the fields of design research and science and technology studies,[17] drawing on Akrich's[18] notions of "scripts" and "de-scription." These enable us to rethink inherited conceptualizations, such as the role of the designer, and to clearly articulate emergent forms of interaction in use. Our analysis of children's play around these toys shows just how meaning emerges locally from interaction, recommending that understandings of interaction need be inherently tied to an in situ examination of sites of use, and that these understandings may well defy abstraction from those sites.

Scripts, Social Constructivism, and Technological Determinism

The nature and scale of the designer's role in shaping the material world is a contested one. A number of discussions in science and technology studies[19] contrast technological determinism with social constructivism. In determinist views, technology itself is credited with a pervasive responsibility for shaping users' worlds—the nature of the technology released into the world determines much of that world: what is used, who can use it, and how it is to be used. In this view, users are channeled into acting in certain ways by the tools they are conscripted to interact with. In contrast, constructivism grants social actors the agency to willingly create their worlds—people are responsible for generating and sustaining the meanings that technology has, and the uses to which it can be put. Here, what technology "is" does not determine, but is itself determined by, social praxis.

However, for scholars such as Akrich, neither of these accounts is sufficient. Instead, she charts a middle ground, introducing the dual notions of "scripts" and "de-scription" to attempt to account for the active role that both designers and users have in negotiating the technology's consequent meaning and use. Her point is that designed objects are inscribed with (designers') assumptions about the world in which the product will be used, who will use it, etc.[20] This provides a "script" for a play between user and product which dictates certain roles to be enacted in use. At the same time, there is no guarantee that users will play these particular roles. Indeed, users are quite free, in many circumstances, to define their own parts.[21] Therefore, on the one hand, the object redefines the user's world by virtue of what it is; while, on the other hand, the object itself is redefined through being "dis-placed" into a setting that was not completely or accurately envisaged for it, and one in which it is never only used according to plan. For Akrich, this is the play of "de-scription"—that technology, use, actors, and settings are mutually constitutive of one another.

Obviously, this discussion is relevant for interaction design, both for grasping the nature of the role and responsibility that the designer has in shaping the material world,[22] and for attempting to understand the complex relationships that emerge in use between

17 For example, Edward Woodhouse and Jason W. Patton, "Design by Society: Science and Technology Studies and the Social Shaping of Design," *Design Issues* 20:3 (2004).

18 Madeleine Akrich, "The De-scription of Technological Objects" in *Shaping Technology /Building Society*, Weibe E. Bijker and John Law, eds. (Cambridge, MA: MIT Press, 1992).

19 For example, Donald A. MacKenzie and Judy Wajcman, *The Social Shaping of Technology: How the Refrigerator Got Its Hum* (Milton Keynes: Open University Press, 1985); and Nelly Oudshoorn and Trevor Pinch, *How Users Matter: The Co-construction of Users and Technology* (Cambridge, MA: MIT Press, 2003).

20 Compare Lucy A. Suchman, "Office Procedure as Practical Action: Models of Work and System Design," *ACM Transactions on Information Systems* 1:4 (1983).

21 Madeleine Akrich, "The De-scription of Technological Objects": 208.

22 Peter-Paul Verbeek, "Materializing Morality: Design Ethics and Technological Mediation," *Science, Technology, and Human Values* 31:3 (2006).

people and products. When determining how we can better understand the ways in which technologies are appropriated in use, we are committed to exploring not only products-in-themselves, but their active role in constituting and being constituted by users in interaction. Furthermore, in this domain, the contrast between the concepts of "games" and "play" is analogous to that between determinism and constructivism.

Games and Play

It is difficult to conceive of games without rules: games, in order to be games, must be played in a certain way. They have a structure. Games definitively contain a (usually explicit) script in Akrich's sense. While many games permit multiple ways of playing, there always must be a wrong way to play—a "game" is not a game if there cannot be a spoilsport. Game designers create a structure (through the rules of the game) in which players can participate, but designers are unable to design the players' experience,[23] which cannot be completely determined in advance. It must be enacted. The experience is made possible through, but not dictated by, the rules of the game. This point is complicated when we, following Akrich and Latour, begin to consider the "tools of play" as participants in this scene—devices for gaming (e.g., joysticks or gamepads) also carry scripts which operate in parallel with those of the game.

On the other hand, play may or may not be game-like. While it is certainly true that we play games, the notion of "play" is much broader than "game." Gadamer indexed the range of uses of the word in his discussion of the nature of "play":

> [W]e find talk of the play of light, the play of the waves, the play of a component in a bearing-case, the inter-play of limbs, the play of forces, the play of gnats, even a play on words. In each case, what is intended is the to-and-fro movement which is not tied to any goal which would bring it to an end.[24]

Clearly, there is play both within and outside of games. And as Gadamer notes, play also can be the *suspension* of goal-directed activity (whereas most games trade on ultimate goals, winners and losers, etc.). Play can be for play's sake. This distinction between play and games is instructive for our analysis of the following two design cases.

Interactive Tiles for Children's Play

In a project conducted in collaboration with two Danish companies and two other research institutes interested in designing interactive playgrounds, we participated in the design of simple interactive tiles for children's play. The original purpose of the collaboration was to find ways of creating technologically interactive play equipment with the (ultimate) aim of contributing towards reducing the prob-

23 Katie Salen and Eric Zimmerman, *Rules of Play: Game Design Fundamentals* (Cambridge, MA: MIT Press, 2004).

24 Hans Georg Gadamer, *Truth and Method* (London: Sheed & Ward, 2nd ed., 1979), 93.

lem of childhood obesity. It was thought that there might be design possibilities for increasing children's opportunities for physically active play without decreasing their opportunities for interacting with technology. Here, we will maintain our focus on the products in use—how children at play used the interactive tiles.

The tiles are very simple devices.[25] Measuring 30 x 30 cm in area, 6 cm in height, and weighing about 2 kg, they only have two states, and only do one thing. On their top surface, each tile has been fitted with nine two-state (blue and red) LEDs, and when the tile is stepped on, all nine LEDs change from their current state (e.g., red) to the other (blue). Each tile operates entirely independently of the others.

In the situation we describe here, fourteen of these tiles were delivered to a primary school's activity rooms and outdoor playgrounds, where school children (aged between 7 and 12) were free to play with them. The activities we detail here were spontaneous in the sense that the children engaged with the tiles without instructions or suggestions from the project team. In these cases, the tiles simply were placed at the school for the students to play with as they wished. Each of these "games" emerged from their play.

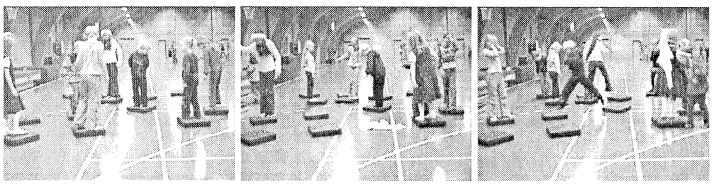


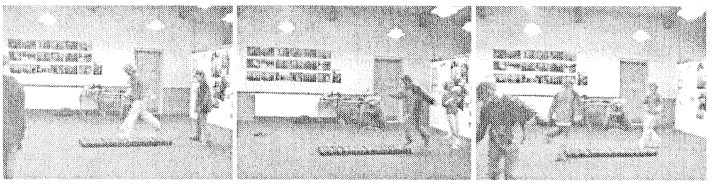
Figure 1
Sequence of children using the tiles as stepping stones.

Stepping Stones

One of the uses of the tiles was as something akin to "stepping stones." The tiles were spread apart on the floor, and children would step across from one to the other (see Figure 1). Children attempted to change the color of the tiles as they stepped onto them, before moving on to another tile. Virtually all of the children attempted to stay on the tiles without having to step on the gymnasium floor. A pair of girls made use of the colors of the tiles, only permitting themselves to stay on tiles that were blue. Red tiles were treated as "hot," and were jumped off of as soon as possible. These two girls ping-ponged around the tiles until they managed to land on a blue tile (which they attempted to step on lightly so as not to change its color to red). Other children played other games, such as trying to push each other off the tiles, hopping from one tile to the next trying to throw other children off balance in the process.

25 The design iteration of the tiles we discuss here was not the final product of the collaboration, but only an intermediate "provocateur" intended to enable the design teams to better understand children's play activities around technology.

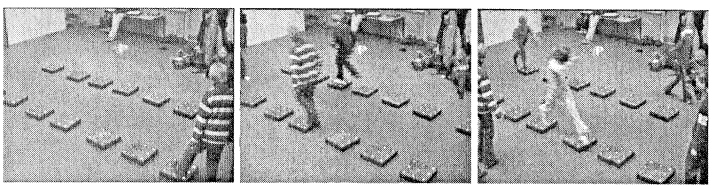
Figure 2
Sequence of children playing with rows of tiles.



Rows of Tiles as Playing Fields

One unexpected property of the tiles emerged through our observations of the children's play. A number of the tiles' sole function (the ability to change color from red to blue and back again to red) was inconsistent, due to variations in the material tolerances of their construction. Sometimes when children stepped on a tile, it wouldn't change color. Then maybe, as they stepped off of it, the pressure of switching to one foot and transferring their weight as they moved would work to change its color to blue. This "inconsistency" proved to be consequential to a number of the uses to which the tiles were put. For example, several groups of children arranged a series of tiles into rows, "setting up" the lane by switching all of the tiles to red, for instance. On one occasion, two girls created such an arrangement with four tiles (Figure 2). They then took turns to run across all of the tiles, attempting to change the color of each tile as they stepped on it. Several times, however, at least one or two of the tiles would stubbornly remain red, in spite of the fact they were stepped on. This presented the next girl with a row that had "gaps" (one or more unchanged tiles). She then used the remaining pattern as a challenge: only step on the altered tiles. Multiple patterns of red and blue tiles emerged from a combination of the tiles' being used in this way and their functional inconsistency. These worked in concert to increase the challenge of the game.

Figure 3
Sequence of images of the line race.



Line Race

One of the more organized uses of the tiles consisted of a "line race," (Figure 3) in which two rows of seven tiles were spread apart on the floor. The children "set up" the lines by switching all of the tiles to blue. They split into two groups, and each group lined up behind a row of tiles. The race was on, and one child after another would run across the row of tiles attempting to change the color of each tile as he or she ran. As before, however, the tiles' inconsistency again was consequential. Again, the children incorporated this feature into the rules of their game, whereby the next runner was not allowed to run across the tiles until the previous runner had successfully switched

the color of each tile. Thus, the game became not just about which team could run across the tiles fastest, but about which team could manage to switch the colors of the tiles with the least "faults."

Tiles Discussion

This range of uses of the tiles draws out several features of their design and use that have direct bearing on interaction design research. First, the simplicity of the tiles (single function/dual state) belies the wide range of uses to which the children easily put them. Furthermore, what we see taking place with the tiles is not a simple function of anything that might have been consciously entertained by their designers. Latour's famous "anthropomorphization" of technologies as "nonhuman actors"[26] is poignant here, since we cannot completely account for the uses of these simple devices in terms of what their designers conceived for them.[27] Nor would we benefit from evaluating them with respect to their congruence with design intent.[28] The difficulty is in predicting precisely how the system will be put to use. What we see happening here is not simply a product of "what the designers imagined," nor of "the actual properties of the tiles," nor of "what the users created in context." There is a complex relationship between these that becomes visible in an analysis of use. This raises an important methodological point for design research: if we seek to understand the relationship between design and use, we cannot hope to account for this simply by studying designers, analyzing products, or understanding contexts of use; though clearly each of these has an important role to play in contributing to such an understanding. This recommends a fundamentally different (in situ) method of investigation than often is seen in studies of design-versus-use topics such as aesthetics.[29]

Secondly, we acknowledge the difficulties we encounter in attempting to analytically circumscribe the "system" that is evident in play. Recalling our previous discussion of games and play, we see both the stability and the tenuousness of the structures of the games that emerged during children's play with the tiles. It is clear from our cases that the children frequently used the tiles as a "system" in the sense that the uses to which the tiles were put were dependent on their relationship to other tiles, other children, and some "rules" of play that were explicitly or implicitly negotiated in use. The "systems" that existed here were ones that were brought into existence in use; created and sustained through the play. This underscores what may be a valuable point for interaction designers by virtue of the fact that these systems that we saw in play were not themselves designed. The point is that "spaces" for play (for multiple and varied uses of the tiles, or for competing and sometimes contradictory meanings of the tiles) were created through the openness of the design of the tiles. Furthermore, the fact that the tiles were not a part of a formal system (e.g., the tiles had no capacity for responding

26 Bruno Latour, "Where Are the Missing Masses? The Sociology of a Few Mundane Artifacts" in *Shaping Technology/Building Society*, Weibe E. Bijker and John Law, eds. (Cambridge, MA: MIT Press, 1992).

27 See also Thomas Binder, "Intent, Form, and Materiality in the Design of Interaction Technology" in *Social Thinking Software Practice*, Yvonne Dittrich, Christiane Floyd, and Ralf Klischewski. eds. (Cambridge, MA: MIT Press, 2002).

28 The designers' decisions with respect to form, function, dimensions, etc. of the tiles are not only consequential to the interaction, but also have delimited the design space to privilege and marginalize various forms of and parties to participation (e.g., some children may not weigh enough to be able to get the tiles to change color when they step on them; and wheelchair-bound children may be excluded from playing simply due to the shape of the tiles). More than one "script" is in play here, and we do not mean to absolve designers from the consequentiality of their decisions. Our focus is on the scripted nature of the play, however.

29 This marks a contrast to, for instance, work such as Paul Hekkert, D. Snelders and P.C.W. van Wieringen, "'Most Advanced, Yet Acceptable': Typicality and Novelty as Joint Predictors of Aesthetic Preference in Industrial Design," *British Journal of Psychology* 94 (2003).

to the states of other tiles) contributed to the wide range of uses we saw emerge in play, where the creation of "systems" was a negotiated feature of use.

Finally, we note the variability of the meanings of the tiles depending on their circumstances of use. Here we find ourselves unable to talk about the meaning of the tiles independently of their particular employments in the system in which they currently play a part. We can see this in instances where the colors of the tiles had specific meanings (e.g., blue tiles being "safe" and red ones being "hot"); also where the colors themselves did not have a meaning, but their state (changed or unchanged) relative to the game being played did (e.g., in the line races); and other cases where neither the colors nor the change of states had any particular use for the game being played (e.g., where the arrangement of tiles was used as a playing field). What we see taking place here is akin to the interdependence of elements in a "gestalt-contexture," [30] where the meaning of each part of a figure is contingent upon its relation to the others. Yet in our case, we do not speak of a visual arrangement, but of a complex relationship between people, technology, and settings existing in use. The contextures we are considering (e.g., the different games) are in flux, as are the meanings of their parts (e.g., the tiles). Again, it makes little sense to ask which gives rise to the other. How it is that the properties of the tiles afford the specific games being played is in no sense a deterministic relationship; yet, clearly, had the technology taken a different form, these specific games would not have been possible.

30 Aaron Gurwitsch, *The Field of Consciousness* (Pittsburgh, PA: Duquesne University Press, 1964).

31 See Marcelle Stienstra, *Is Every Kid Having Fun? A Gender Approach to Interactive Toy Design* (Ph.D. thesis, Twente University, Enschede, The Netherlands, 2003).

Designer Toys for Interactive Games

In another project recently conducted in collaboration with Philips Research, three "toys" were designed as input devices for a video game.[31] A key aim for the designs was to provide physical and fun ways of interaction. While the original objective of the research was

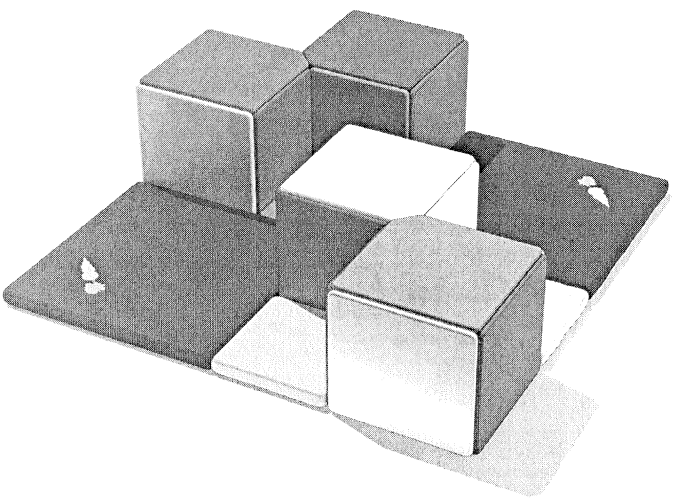


Figure 4
Twistyertouch interaction mat.

to investigate gender differences among the children's preferences for interaction input devices to the game, we will examine just one of these input devices here as a point of comparison with the tiles discussed earlier.

The input device, "Twistyertouch," is a "physicalized" play mat. On a 160 x 160 cm footprint stand, four cubes, each measuring 40 x 40 x 40 cm (see Figure 4). Each visible surface is covered with a soft cushion of a specific color. A button is positioned in the center of each surface, covered by a cushion. The button is activated by contact with the cushion, and there is audible feedback when a surface is activated.

In the context of the original study (where Twistyertouch was compared with two other toys), the play mat functioned as an input device to operate a fairly simple screen-based navigation / maze game. This game was displayed on a large screen positioned near the toy. The goal of the game was to direct a rabbit towards carrots that appeared and disappeared at different times and places in the maze. The children obtained points for each step that they managed to maneuver the rabbit through the maze, and "eating" a carrot earned bonus points. To move or change the direction of the rabbit, the children had to activate all the cushioned surfaces of a certain color. Next to the maze on the screen was a legend indicating the relationship between actions and cushion colors, and also how many (but not which) cushions had already been activated. This setup resulted in players constantly shifting their focus of attention: from the screen where the game was taking place, to the Twistyertouch where the interaction was taking place, and back again to the screen. Each game session lasted four minutes, and the the team was showed their final score.

Interacting with a device that was physically (proportionally) large, and collaboratively working towards the same goal—navigating the rabbit—created a structure in which the players interactively developed strategies to play. For example, children frequently divided the tasks they had to complete. One might look at the screen to see which color cushion had to be activated and how many there were left to be activated, while the other would look where these specific cushions could be found on the Twistyertouch in order to speed up the process. Children gave each other directions for which cushion to activate ("that one there, yeah great!"), and they would run around looking for specific colors, and shout them out to their friends ("Now pink!").

In a similar manner to the tiles discussed above, the construction of the Twistyertouch had consequences for play. For instance, the cushions on the play mat did not just hide the buttons underneath from view, but also made them more insensitive. Thus, the buttons did not always react when the cushions were hit. This encouraged children to play more aggressively: they sat on the

cushions, punched them, jumped on them, kicked them, etc. in order to activate the buttons (see Figure 5). Players also made use of the fact that a cushion could only be activated in and around its center: they found out that they could move around mat by hanging on the edges of the cubes without touching the surface on the floor which also was equipped with buttons.

Figure 5
Sequence of interaction with Twistyertouch.

Children also discovered and seized upon the absence of certain rules of the game (i.e., moves that did not have consequences for play). During play, some children realized that it didn't matter if, in the process of trying to reach one specific cushion, they accidentally activated a cushion of another color, as long as not too many cushions of any one other color were activated. Thus, activating the "wrong" cushions became used as a means to move across the mat in order to activate the "right" ones more quickly—children would step on a blue tile on their way to kicking a yellow one in, saving them the time it would take to hop off the Twistyertouch and run around it to the next yellow cushion.

Twistyertouch Discussion

In this case, we can see that even in fairly tightly scripted games such as this (e.g., where there are defined rules, scores, and right and wrong moves), strategies emerge that make use of much more than merely the rules of the game. Players are able to create, define, and negotiate "styles" of play both by virtue of, and in spite of, the relatively restrictive script the game embodies.

In comparison to the tiles, we also see different aspects of interaction emerge with respect to the Twistyertouch. With respect to the structure provided by the game and the observability of novel strategies of play, it is much easier for notions such as "challenge" and "skill" to take a foothold, and, consequently, to be able to speak meaningfully of "engagement": the interaction we witness is competitive, purposeful, and deliberate. However, we also can see disjointedness between the site of interaction (the mat) and the site where the scripted meaning of the interaction (e.g., orienting/moving the rabbit) plays out (i.e., on the screen). The Twistyertouch mediates the play in a manner that has no direct analogue in our case of the tiles. With the tiles, interaction *is the play* itself; activating a tile is identical and coterminous with making a move on the field of play. Thus, there is a qualitatively different relationship between the interaction and its meaning in the two cases; one that is quite clearly understandable as a consequence of the differences in the nature of

the scripts inscribed in the products. With the Twistyertouch, relationships between cushions and actions in the game are specified in advance by the system.

This brings into relief one final contrast by virtue of our earlier discussion of "gestalt contextures." Where the tiles are, what they are (e.g., their state), and what they "mean" is locally and inherently tied to their place in the contexture. However, we see a noticeably different picture with respect to the Twistyertouch, where "fixed" uses have been inscribed into the mat-game system. Of course, the point is not to suggest that there is some optimum trade off (for designers or users) between scripting possibility and constraint, but instead that each affords different degrees and varieties of emergence.

Discussion

Considering emergence in use, we now might ask how should interaction design research proceed? What should it seek to study, and how should it be investigated? In a highly relevant discussion, Redström has charted the shift in focus of design research from the design of products to the design of the user experience.[32] He finds this move problematic for a number of reasons: that design cannot be rigorously grounded in existing use practice, since none exists prior to its implementation;[33] that designers therefore are left to predict the use of the product; and that actual use often can be radically and ironically different to anticipated use.

In a recommendation analogous in several respects to our discussion of "spaces for play," Redström advises designers not to "overdetermine" use. But just *how* designers are to do this, and do this well, remains an open question. One possibility is that of Gaver et al.,[34] who advocate ambiguity as a design virtue. Yet they also warn against designers using such openness as a license for creating frustrating and confusing products. The "ambiguous" design directions they promote (e.g., blocking expected functionality and using imprecise representations) may be a notable beginning. However, as with other design recommendations (c.f. principles of "good design" such as affordances, feedback, mapping, etc.), they are as easily prone to being misapplied and badly implemented as they are to being profitable as design advice.[35] Furthermore, we would argue that there is no guarantee that particular characteristics of any design (e.g., "inconsistencies") will be universally responsible for particular experiences of use (e.g., "spaces for interpretation"). As in the cases we have presented, the attribution of responsibility for specific forms of emergence in use to particular features of systems is an achievement of retrospective analysis, and one that may be unlikely to function unproblematically as a normative or prescriptive resource for designers.[36]

32 Johan Redström, "Towards User Design? On the Shift from Object to User as the Subject of Design."

33 See also Andy Crabtree, "Design in the Absence of Practice: Breaching Experiments."

34 W. Gaver, Jacob Beaver, and Steve Benford, "Ambiguity as a Resource for Design" (paper presented at Proceedings of CHI 2003, Ft. Lauderdale, FL, 2003).

35 Grudin's discussion of the pitfalls of "consistency" as a design guideline is important in this respect. See Jonathan Grudin, "The Case against User Interface Consistency," *Communications of the ACM* 32:10 (1989).

36 This situation is analogous to the way "loopholes" in bureaucratic systems often are unforeseeable consequences of rules and procedures implemented on account of existing and anticipated cases.

Surely, a hazard endemic to operating with the subtle characterizations of the interrelationships between design and use articulated by theorists such as Akrich is their obstinacy to translate into prescriptive design guidelines.[37] This does not mean that designers cannot employ understandings of how existing forms of emergence arise in use to inform new designs. However, it does suggest that the ways in which novel forms of interaction emerge can only be partially understood with reference to aspects of the product under the control of designers; moreover, emergence is inherently tied to the *relationship* between product and context brought into being in use. In an important sense, designers create the rules within which users develop emerging modes of use;[38] but as we have argued, this is a constitutive rather than a deterministic relationship. Still, we maintain that such theoretically informed forms of analysis are valuable in spite of the fact they do not easily map to design recommendations.

For one thing, they enable designers to rethink inherited conceptualizations, such as what design work actually consists of, including the role of the designer. This is valuable not because existing conceptions (such as Norman's) are misguided or unhelpful, but because alternative perspectives can open new horizons to design; encouraging designers to reassess the nature of their own work and responsibilities. We have tried to illustrate the potential value of moving beyond conceptions of design work as solving problems and meeting users' needs or unarticulated desires. In our cases, design for emergence was not achieved by virtue of designers having a clear idea of such things in advance, but rather was tied to the creation of spaces for meaning to arise in use. We hope that such considerations might work to challenge the design of interactive technologies toward novel styles of interaction, whether they are inscribed into artifacts, or the result of users' creative appropriation of the spaces left unscripted by designers. Furthermore, the analysis reveals how products come to be as they are in use—whether enjoyed, tolerated, unpredictable, frustrating, or useful. Analysis of use, with the aid of theory, becomes a resource for designers to gain a view of how products and systems can and should be different. The diverse body of extant theory in cognate disciplines, coupled with an empirical examination of sites of use, can enable designers to better conceptualize the complex networks of relations that technology and its deployment bring into being.

Perhaps paradoxically, this understanding leads us to reconsider the welcome move towards "understanding context" prior to designing for a setting. In cases such as ours, the introduction of technology is itself an introduction of practice (i.e., no comparable practices exist in the absence of the technology's implementation).[39] Thus, no *prior* study could furnish us with this understanding of context. As we have seen here, many of the observations of the use of the toys and tiles are neither products of the "context" that

37 Compare Woodhouse and Patton, "Design by Society: Science and Technology Studies and the Social Shaping of Design."

38 See also Steve Woolgar, "Configuring the User: The Case of Usability Trials" in *A Sociology of Monsters: Essays on Power Technology and Domination*, John Law, ed. (London: Routledge, 1990).

39 Andy Crabtree, "Design in the Absence of Practice: Breaching Experiments."

existed before their introduction (however that might be analytically delineated); nor are dependent solely on the actual properties (e.g., form, interaction, functions) of the specific technology; but of the tenuous "context" created and sustained in use. It is this "context" that affords the possibilities and actualities of interaction; and this context that must be examined to inform design. This, at least, makes a clear case for where and how interaction design research must look to understand "interaction."

Finally, our discussion also may serve as a recommendation to design researchers to be wary of attempts to romanticize, semanticize, or abstract platonic interaction styles, aesthetics of form or interaction, the "emotional" content of technologies, or a host of other topics currently fashionable in interaction design research. Appreciating the inherent context-dependence of the meanings of technology and their relation to the forms of emergent interaction exhibited in use has clear methodological implications for the types of questions we can expect research to illuminate, and the types of settings we must inspect for their clarification. The manner in which we understand these matters demands that research appreciate how such notions take their definitive sense locally, not globally.