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Emergence as a Feature of Practice-based Design Research

This essay explores emergence as a positive feature of practice-based design research

William W. Gaver

Interaction Research Studio, Northumbria University, London, United Kingdom, w.gaver@northumbria.ac.uk

Peter Gall Krogh

Digital Design, Aarhus University, Aarhus, Denmark, pkrogh@cc.au.dk

Andy Boucher

Interaction Research Studio, Northumbria University, London, United Kingdom,
andy.boucher@northumbria.ac.uk

David Chatting

Department of Design, Goldsmiths, University of London, London, United Kingdom, david.chatting@gold.ac.uk

Practice-based design research is often emergent. Methods, tactics, goals and even topics can unfold and change as researchers adapt and learn in the course of their projects. This adaptability is one of the strengths of design as an approach to research, but it seems to contradict assumptions about research as a systematic, inquiry-led investigation. This leads to a tension in practicing and reporting research that we unpack here, before making a series of suggestions for practice-based researchers and reviewers for how to better navigate emergence when pursuing, reporting and evaluating practice-based design research.

CCS CONCEPTS • human-centered computing • interaction design

Additional Keywords and Phrases: emergence, design practice, design research, research through design

Der mentsh trakht und got lakht. (Man plans and God laughs.)
- Yiddish proverb

1 INTRODUCTION

Research is often portrayed as a systematic, inquiry-driven investigation of predetermined topics and questions. Our experience as practice-based design researchers, however, is that the reality is far messier. We routinely invent, adjust and reconfigure methods, issues, goals and even topics in the course of our projects. This often leads to outputs that are entirely different (and arguably better) than we imagined when we began. From conversations with other practitioners, this is unremarkable. If the ability to adapt and learn as one engages with materials and settings is integral to good design, why wouldn't it be for research that uses design practice as a methodology? From this perspective, practice-based design research is often characterised by its *emergence*.

Emergence seems something of an 'open secret' in practice-based design research. It has been extensively discussed in other disciplines, and we doubt that many design researchers would fail to recognise it, yet the HCI design community rarely reflects emergence in representations of practice-based work. The mismatch between normative assumptions about research and actual experiences in design projects seems to lead to tension when pursuing and reporting practice-based design research. We think this is a problem. If emergence is underrepresented in reports and even in practice, then at best this leads to misrepresentations of practice-based design research, and at worst to a constraint on designers' ability to use their skills. A better appreciation for emergence would benefit both research practitioners with a clearer view of how their work can count as research, and the wider community in engaging with practice-based design research.

In this essay, we discuss emergence in practice-based design research and explore how we might more fully frame and respond to it in our research, reports and evaluations. We set the scene in the rest of this introduction by describing what we mean by emergence and reflecting on the balance between emergence and intentionality in research, before briefly contrasting how emergence is addressed in the physical and (some) social sciences. In the following section, we first explore emergence in practice-based design research, and then reasons for its inhibition. The third and final section draws on the previous two to suggest strategies for working with and appreciating emergence. Throughout, our fundamental message is that we should more openly embrace the potential for design research to be radically emergent and reflect this in the way we report and evaluate our work.

1.1 Emergence and intentionality

What do we mean by emergence in research? A counterexample may help to orient our discussion. A growing 'preregistration revolution' [60] is extending across many research disciplines, from psychology and economics to quantitative sociology and international development impact evaluations. This is designed to address a tendency for researchers to re-evaluate their original hypotheses and methods in response to data they have collected. The problem is that statistical tests of "predictive" hypotheses formed before data collection have much higher validity than tests of "postdictive" hypotheses. The answer, preregistration, is to predefine the hypotheses, methods, and analyses for a given study and register them on a secure website, where they are held until after the study is performed. At this point, the two can be compared – including by journal referees or editors – to check that the study went to plan.

Preregistration is the antithesis to the kind of emergent research we discuss here. It privileges investigations that cleave a preplanned route from hypotheses to methods to outcomes. We refer to this form of research as *intention-bound*, because sticking to researchers' original plans and predictions is seen as paramount, and unexpected discoveries, insights, tactics or formulations are viewed with suspicion, or at least reserved for later consideration.

Emergence-friendly research, in contrast, is "something arising out of ongoing activity, enacted rather than predetermined" ([74] p.177). It is responsive to external influences, material potentials, new learning, ideas and inspirations. Methods, understandings, outputs, even overall topics are all left continually in play, and at the extreme can stray more or less completely from the originally intended course. This is an exploratory form of research, not a predictable one, and one which values surprise.

Intention-bound and emergence-friendly research approaches are not two distinct categories. In practice, research projects always involve a combination of work to achieve intentions with intervals in which new ideas and activities emerge. Nonetheless, some research methods, projects, and approaches are more open to working with and talking about emergence than others.

1.2 Day and night Science

Emergence is not exclusively characteristic of design and design research. In the physical sciences, unexpected data may lead to the reformulation of hypotheses or the discovery of new phenomena, seemingly outside the scope of the original investigation, as when the Curies discovered to their cost the lethal effects of radiation in the course of investigating the physical properties of uranium and radium [24]. Moreover, scientists do not always adhere to the 'scientific method' in their research. For instance, Andre Geim and Kostya Novoselov discovered graphene during one of the 'Saturday Night Experiments' sessions they routinely held to explore scientific phenomena [76]. Nonetheless, most accounts portray the sciences as thoroughly intention-bound.

The Noble-prize winning biologist Françoise Jacob to the contrary that emergence is integral to the experimental sciences, writing in a dramatic essay [39], about "day and night science":

Day science employs reasoning that snaps together like gears, and achieves results with the force of certainty... Conscious of its progress, proud of its past, sure of its future, day science advances in light and glory.

Night science, in contrast:

...is a sort of workshop of the possible where the future building materials of science are made... Where thought proceeds along sinuous paths, winding streets, most often blind alleys.... What guides the mind, then, is not logic. It is instinct, intuition.

In this characterization, before hypotheses can be formulated and experimental tests devised, there is a more or less lengthy phase of emergent understanding as "innumerable suppositions, connections, combinations, associations that constantly flash through the mind". This is what produces the hypotheses and tests that make up the rigorous and logical investigations – day science – that follow.

In Jacob's view, night science is as integral to scientific research as day science. But night science doesn't appear in scientific reports. This is because to "convince his colleagues of the importance of his work", the scientist must "purify the research of all affective or irrational dross." The result is that "to write an account of research is... to

transform the very nature of the research; to formalise it. To substitute an orderly train of concepts and experiments for a jumble of disordered efforts.”

Night science can be written out of scientific research reports because it is the backdrop to day science. Experiments get run, quantitative data is collected and analysed, hypotheses are tested, just as the ‘preregistration revolution’ assumes, and these are the core outcomes of scientific research. Science can afford to repress emergence. For some fields, however, the distinction between day and night science may not be so clear. For some, the most valuable outcomes might come from the emergent chains of thought and action that Jacob characterises as night science.

1.3 Embracing emergence in the Social Sciences

The notion that emergence may be integral to research is more explicitly embraced in at least some areas of Sociology, STS and Feminist Technoscience. For instance, Lucy Suchman – whose definition of emergence we borrow above – provides an account that resonates strongly with the idea of emergent design research that we discuss here. She describes situated action as emerging in the interactions of actors’ embodied skills with one another and their environments [74]. In contrast to the dominant cognitivist accounts of the time (e.g. [59]), which theorised actions as relatively straightforward – if sometimes error-prone – executions of mentally-represented plans, Suchman views plans as presupposing rather than specifying the possibilities for actions. They serve to orient actors rather than guide them, and the impossibility of predicting in detail how events will play out means that plans are contingent, underspecified, or likely to be proven wrong. Moreover, plans themselves are a form of situated action, shaped in response to the needs of a particular social and environmental setting. For instance, they may be more or less specific and detailed depending on the contexts in which they are devised.

Suchman’s thinking was deeply influenced by ethnomethodology, which views social order as produced and maintained by members’ ongoing activities rather than a manifestation of underlying ‘social laws’ (e.g. about group dynamics, deviance or economic actions) (e.g. [25]). Not only does this perspective lead to a view in which social order emerges in action, but to an approach to research which is fundamentally emergent. Studies are approached with ‘ethnomethodological indifference’ (see [54]) both with regards to the adequacy of the social orders they study, and with regards to the theories and methods that might traditionally be brought to bear on them. In its pure form, this means that ethnomethodological researchers approach their projects without preconceived questions or concepts, instead allowing these to emerge through their encounters with the settings and people they study (though see [57]).

More recently, there have been increasing trends to see social research not as the objective study of a subject, but as a deeply participative “becoming with” [36] the entities and settings one engages. For instance, social studies may go beyond gaining knowledge about social realities to become “performative” [50] by playing a direct role in how those realities evolve, whether through relatively subtle and direct influences on study participants themselves, or at a large scale through effects on policy or marketing. Recognising performativity has led some researchers to rethink social research as a matter of “inventing the social”. As Marres et al. [55] put it: “If to inquire is to participate, and it is impossible to avoid intervention, then we may as well try to become good at it”. For these researchers, performativity should be treated “not as a topic to be exposed or described, but as a research task or challenge: can we do it? Can we contribute to the creative articulation of social phenomena?” This line of thinking has led to collaborations with artists and designers to work with social setting in ways that prize emergence (e.g. [2], [53]).

2 IS DESIGN RESEARCH EMERGENT?

The contrast between social science's embrace and physical sciences' suppression of emergence is useful in considering how practice-based design researchers negotiate emergence in their practice and reporting. In this section we consider factors that support the view that emergence is an integral feature of practice-based design research, before considering some of the reasons for its inhibition.

2.1 Emergence in accounts of design practice

Despite significant differences among them, different approaches to practice-based design research (e.g. [23][80] [29][44]) all propose approaches to research that draw on the skills, strategies and tactics of designers, and researchers [64] [48] [35] have studied and argued about how understandings and designs emerge in this kind of work. For instance, design has been characterised as *intentional change in an unpredictable world* [58] – a definition that echoes the tension between intentionality and emergence – when addressing what Rittel and Weber [66] call wicked problems. These are problems which have characteristics that make attempts to solve them emergent and divergent. For instance, since every wicked problem can be considered to be a symptom of another problem, proposed solutions will depend on which underlying problems appear important.

Rittel and Weber's account is congruent with Schön's [69] description of design practice. Beyond his description of design as a 'conversation with materials' is his account of architecture students responding to a brief, in which initial characterisations of important issues lead to rapidly diverging design responses. In Schön's account, the words designers use to describe situations impel and constrain their design decisions: their ontologies and designs co-evolve. For Schön, "design moves" reveal new opportunities and challenges, leading to new moves, new issues, and so on. Each step of the way is indeterminate and consequential, so that designers may quickly diverge in their approaches to seemingly identical problems, and the course of any given design may be impossible to predict from its starting point. This line of thinking is further developed in [17] who points to continuous framing and reframing of design challenges – frame innovation – as a core competence in design.

Krogh and his colleagues [48] looked at how emergence is managed across discrete design experiments by reviewing ten PhD theses to examine the trajectory of their work over time. They describing five tactics ("ways of drifting") for bringing about knowledge. These range from relatively linear ('accumulative') explorations that build knowledge step by step, to sequences of experiments that evolve as results point in new directions ('serial'), to more opportunistic and idiosyncratic experiments ('probing') that allow new ideas and approaches to emerge rapidly. This taxonomy is consistent with the spectrum between *intention-bound* and *emergence-friendly* approaches, reflecting possibilities for researchers to encourage or inhibit emergence in their practice. Moreover, each of these approaches resonates more or less strongly with 'epistemic traditions' that Krogh and Koskinen [47] suggest characterise practice-based design research. For instance, 'accumulative' experiments might be associated with research ideals of *general rules* and *high degrees of certainty*, while 'probing' might emphasise standards such as *relevance* and *imagination*.

Of course, there are many other accounts of design and design research we could draw on here. What seems clear, however, is that while some may call for more intention-bound and goal-oriented approaches to practice-based design research in principle, virtually all admit to at least a degree of emergence in actual practice.

2.2 Practice-based methods

Many design methods developed by and used in design research also encourage the co-emergence of design possibilities and conceptual understanding. For instance, ethnographic studies are widely used to understand peoples' settings and practices to inspire designs that might fit them. Cultural probes [27] use designed materials as a way of encouraging participants to reveal an "impressionistic account of their beliefs and desires, their aesthetic preferences and cultural concerns" that can serve as "inspirational data" helping designers identify directions for design. Brainstorming and design workbooks [28] support designers to generate a 'space' of design ideas and simultaneously a space of social possibilities. Techniques drawn from improvisational drama (e.g.[12]) encourage designers to embody characters to understand possibilities for design and think about their implications. Design fictions [7][15] use literary techniques to work out social implications of design possibilities more dramatically. Technology probes [38] explore people's reactions to new functions, for instance in the form of conversational interfaces that introduce new voices to explore future worlds [51]. All these methods have in common that they are not just focused on culling information from participants about their current worlds, or on helping designers think about technical possibilities for design, but are also aimed at helping both to imagine simultaneously new social worlds, the designs that might enable them, and the implications these might have.

Many design methods have grown from within practice-based design research, and increasingly design researchers in HCI are drawing on approaches from the sociological, STS and feminist traditions as well. In 1998, for instance, Button and Dourish [13] drew on examples of contemporary ethnomethodological research in HCI to argue for 'technomethodology' as a 'primary aspect of system design'. Participatory design has long involved using 'low-fi prototypes' or 'mock ups' developed with participants to explore possible interactive products [20] and people's imaginations about technological futures more generally [1]. More recently, Shaowen and Jeffrey Bardzell's seminal paper outlining prospects for feminist HCI [4] advocated interaction qualities [52] of pluralism, participation, advocacy, ecology, embodiment, self-disclosure, all of which are at least compatible with the sort of unfolding investigations of interest to us here. Rosner and her colleagues [67] developed collaborative quilting workshops designed to engage participants with the history of the women who produced hand-woven 'core memory' for the Apollo project. Not only do these embody many of the qualities suggested by [4], but the idea for the workshops itself emerged when the team "noticed the samples held a surprising resemblance to quilt blocks" ([67], p. 4). Frauenberger's [22] proposal of 'entanglement HCI' draws on theories from STS, sociology and philosophy to argue, among other things, that knowledge production is situated and contingent, emerging in the intra-action of material (research) practices. Increasingly, it seems that HCI design researchers are recognising and adopting emergent-friendly conceptual approaches when it comes to understanding the social-facing aspects of their work, supported by their neighbours in related fields such as sociology, STS, feminist technoscience and the like.

2.3 Accountability affords emergence

Another significant factor in the acceptability of emergence in practice-based design research has to do with the economic context in which it is pursued. In general, practice-based design research is increasingly being pursued outside of traditional commercial contexts, supported by governmental research councils, foundations or industrial R&D organisations. This means that practice-based design researchers seldom have readily identifiable clients in the commercial sense. Nonetheless, they do operate within a diverse and interconnected network of stakeholders – such as funders, participants, reviewers and curators – who are crucial to their continued reputational success and financial solvency [45]. While design research is accountable to these 'clients', however, what it is accountable

for may be strikingly different from commercial design. Commercial designs typically cannot be wholly successful unless they demonstrably respond to their clients' brief, which outlines the goals, acceptable solutions, timelines and budgets that constrain emergence in commercial settings. Such briefs may be negotiated, but they are always sanctioned by the paying client. Design researchers, too, often work to a brief, but usually this is one they have devised themselves, in the form of a research proposal, and, crucially, once the proposal is funded, they tend *not* to be held accountable for responding closely to that brief. Instead, what funders, participants, curators and publishers typically care about is that innovative and engaging designs are produced, alongside new understandings, insights and questions. This is because, pragmatically, participants, exhibitors and publishers don't have access to an original brief, and funders – particularly non-commercial ones – own accountability is to the production of new knowledge and artefacts, not necessarily to the precise methods or exact objectives presented in a given proposal. This both encourages, and removes major obstacles to, emergence-friendly design research.

2.4 Plans and situated design research

It may be tempting to conclude, from the discussion so far, that Suchman's account of plans and situated action [74] provides an apt description of practice-based design research. From this perspective, plans (research proposals) are crafted for particular situations and stakeholders. They do not completely specify activities but instead help guide the deployment of resources according to expectations. Once projects start, actors (researchers) use their skills and resources more or less adeptly to engage with events as they unfold. Because emergence is integral to many accounts of design, encouraged by many design methods, and allowed by the economic context of most design research, the resulting practice – design research – would seem to be inevitably emergent.

It is certainly possible to find examples from recent design research publications that illustrate how projects may shift their focus and concerns over time. For example, Gaver et al. [30] describe how a project that was originally conceived and funded as a project to support older people in maintaining contact with younger ones was transformed into a study of how technology could support spirituality by a fortuitous encounter with a group of cloistered nuns. Odom et al. describe the emergence of a programme on *everyday design* across a series of publications [77][78] in which their exemplary designs change radically with their emerging understanding, and are eventually used to address issues about the nature of design outputs [62] that had not been articulated at the time of their original design. Over the course of that programme, the original broad question of how to support everyday design may have remained stable, but the nature of artefacts to design, the issues to address in developing them, and most importantly the conception of 'everyday design' itself emerged in the process.

While it is possible to find reports of design research that illustrate emergence in the research process, however, they seem relatively unusual. Instead, many practice-based design research reports adopt a relatively linear structure: setting or issue, related literature and theory, questions or objectives, process and outcomes, evaluation (usually with user feedback), and a discussion framed by original questions and theoretical framing. It is impossible to tell from the outside whether this sort of linear and predictable narrative structure reflects design research that is genuinely intention-bound, or whether it reflects researchers' efforts to "substitute an orderly train of concepts and experiments for a jumble of disordered efforts" [39]. Either way, it appears curious that practice-based design research seems to rarely reflect the emergence that appears so integral to design. In the next sections, we consider why emergence might be inhibited in design research and the ways it is reported.

2.5 Adding research to design

One factor in inhibiting emergence in practice-based research, or our reports of it, may involve the community's assumptions about what is required to turn design into design research. The logic goes something like: "If we are design practitioners who want to do research, then we must have to change something to our ongoing practices, otherwise we would already be researchers." Given the names, the most obvious answer is "add research". What that entails is unclear, however.

An example of two distinct answers to what it means to 'add research to design' comes from the separate lines of thinking developed historically at the Royal College of Art (RCA) and Carnegie Mellon University (CMU)¹. The term 'research through design' itself was used by the RCA's Christopher Frayling [23] to articulate practice-based art and design as valid form of research distinct from scientific models, at about the same time that Gillian Crampton Smith, founder of the Computer-Related Design (CRD) department at the RCA, wrote about the role of the 'artist designer' [72], arguing that "interaction design is more of an art than a science" (p56). Bill Gaver and Tony Dunne, both researchers in CRD, presented Dunne's Pillow as research through design to the HCI community: "an example of our ongoing attempt to understand how we can do research while respecting the methods and perspectives of designers."([18], p. 362) – building on the concept of artist-designer by articulating the lessons of a designed artefact without altering the designers' practices. With the same intent, this collaboration would later invent cultural probes [27], arguing that the open-ended and sometimes puzzling tasks these included provided "inspiration, not information". This school of thought suggests that design practice – untamed, as it were – can open new research approaches and ways of understanding if its aims and lessons are appropriately articulated.

An alternative understanding of research through design has also gained influence in the HCI community, one that draws on a tradition of Herbert Simon's Design Science at Carnegie-Mellon University (CMU) [70][71]. Design science attempts to make design rigorous and systematic, indeed scientific, in marked contrast to Crampton Smith's artist-designer. Whereas Gaver and his colleagues tended to embed their remarks about design research in papers about particular projects, Zimmerman, Forlizzi and Everson published a paper presenting a more abstract account outlining their views on research through design as a methodology [80]. Here they presented research through design as an endeavour more in keeping with scientific research, invoking theory-informed research questions, systematic methods, empirical data, and generalisable results that can feed back to theory. In a subsequent series of publications, Zimmerman and colleagues made a number of calls for increased standardization of research through design, for instance to develop "a proper research methodology that can produce relevant and rigorous theory" ([81], p316), in what can be seen as an portrayal of research through design as a form of Design Science. This school of thought can be seen to propose that for design to become design research, it must be embedded within an intention-bound research process.

As research through design has been taken up by more practitioners and in a wider of variety of institutional settings, the influence of these two schools of thought have diffused and elaborated in a variety of ways. Still, they remain useful as a way of thinking about alternative approaches when design is used to build new understandings, and the different requirements for representing design activity that they imply. Can emergent design practice be articulated as research, or does it need to be subsumed within an intention-bound process to qualify?

¹ Of course, there have been many other historically influential practice-based design research groups, e.g. at Politecnico di Milano, Interaction Design Institute Ivrea, Parsons School of Design, etc. We focus on these two because of the clear contrast in their views about what it means to practice design as a form of research.

Pragmatically, these requirements are negotiated on an ongoing basis in exchanges between would-be practice-based researchers with reviewers and editors who grant or withhold access to the field. Increasingly it appears that many in the practice-based design research community have concluded that it is safest to include at least some of the elements of more intention-bound versions of design research, such as appeals to theory and a statement of *a priori* research questions, to have work accepted in HCI – in Jacob’s [39] terms, that it is necessary to turn night science into day science. This may reflect a genuine commitment to intention-bound forms of research. However, it is also likely to reflect the pressures we feel from other neighbours in the HCI community.

2.6 Emergent research in a technical field

Another reason that emergence may be inhibited in HCI practice-based design research has to do with its disciplinary neighbours. As we have discussed, design’s neighbours in sociology, STS and feminist technoscience tend to embrace emergence, and this has been conducive to the use of emergent-friendly, social-facing methods in practice-based design research as well, even when design methods have been developed independently or in defiance of more traditional social science approaches [27] [33]. However, the HCI design community also works alongside a different set of neighbours: the scientists and engineers involved in investigating new interactive systems and technologies, and this may actively discourage emergence from practice-based design researchers’ activities or discussions.

The goal of many practice-based design research projects is to produce fully functioning design products [62] to serve as ultimate particulars [73] that can be variously deployed, studied, exhibited and explained. When it comes to the technical making involved in crafting these products, design practice becomes less about exploring alternatives and instead focuses on how to achieve a desired technical effect, assembling hardware, software and the design of product casings and detailing. This aspect of practice-based design research becomes accountable to the technical community, which tends to epitomise ‘day science’ [39] in its descriptions of work that is goal-directed and concerned with optimization². Insofar as practice-based design researchers develop technical artefacts that must compete on the same stage, they too may tend to present their work as intention-bound. Linearity may ‘overspill’ in reporting, affecting the way early and later socially-facing phases are reported, as researchers ‘clean up’ their accounts to create clear narrative arcs through the things they make. In short, emergence in practice-based design research reports, and perhaps practice, seems likely to be inhibited by its technical neighbours.

3 EMBRACING EMERGENCE

So it seems that the practice-based design research community is in a quandary, at least when it entangles itself with HCI research. Its methods and practices are often emergent, this is often facilitated by its accountability when pursued in academic contexts, and some of its disciplinary neighbours have also embraced and articulated emergence in research. On the other hand, practice-based design research often seems inhibited by its conceptions about how research must be conducted and reported, and by associations with other, technical disciplinary neighbours. The result is that practice-based designers may be reluctant to allow new issues, methods, goals and topics to emerge in the course their research, or at least to report this openly in reports and publications.

² Although reports of technical research tend to present it as largely intention-bound, hard- and software engineering may well have its ‘night science’ too – and we suggest later that the potential for technological affordances to lead to new ideas and possibilities should be embraced.

We believe that one of the core skills of design practitioners is to negotiate emerging understandings and possibilities in their interactions with ‘an unpredictable world’ [58], and that this should not be constrained by the fact that design is pursued as a form of research. Instead, we believe practice-based design researchers should embrace emergence as integral to their approach.

In this section, then, we offer a number of strategies for negotiating emergence based on our experiences pursuing practice-based design research. In some ways similar to Eno and Schmidt’s Oblique Strategies [75], they offer pointers for orienting to emergence as a positive feature of practice-based design research. We present them in four groups, suggesting ways to encourage, manage, report and evaluate emergence in turn. The strategies – and the many others that are possible – are not intended to be prescriptive, but instead to collectively sketch the kind of mindset required to embrace emergence as a feature of practice-based design research. Neither definitive nor comprehensive – nor even entirely consistent – we offer them to support and inspire practice-based design researchers and to promote reflection and discussion about emergence more generally.

3.1 Encouraging emergence

Whether practice-based design research is conducted in an intention-bound or emergent-friendly fashion depends on researchers’ openness to surprise and change, and this may vary in the course of a project. Many design methods encourage emergence, as discussed above. Beyond this, there are several strategies for encouraging new perspectives and activities to emerge in the course of projects that we outline here.

Emergence Strategy No.1 - Consider anomalies to be inspirations. In the quantitative sciences, observations that differ significantly from most others are often considered ‘outliers’ to be rejected because they can warp more general conclusions. More emergent-friendly approaches, in contrast, may actively welcome anomalies, whether in studies of users, or ideas for designs, or engagements with research projects, as inspiration for new perspectives and possibilities for action. For instance, in cultural probes studies it is often the unusual returns that are most inspiring [33] Similarly, new directions can be mined from the ways people appropriate designs in unexpected ways [68]. In general, attending to the unusual can be a fruitful tactic for allowing new design ideas and directions to emerge. The following two suggestions are more specific examples of this general rule of thumb.

Emergence Strategy No.2 - Seek idiosyncratic examples of design settings. Studying ‘typical’ examples of topical settings for design (e.g. design for homes, environmental design) often seems optimal to achieve results that are representative and generalizable. To gain new perspectives and innovations, however, it can be more useful to seek out seemingly unusual examples of instead. For instance, in [30] the choice to work with cloistered nuns as an example of older people led both to a novel understanding of how technology might support spirituality, and to a more general conclusion that older people should not be treated as a homogenous population for design. Similarly, Oogjes et al. [63] sought out people living ‘alternative’ lifestyles to expand ideas about homes and domestic technologies, as did Jenkins in his study of co-housing and IoT [40][41]. Often studies of ‘unusual’ settings such as these will lead to insights and approaches that are valuable for more ‘typical’ instances as well.

Emergence Strategy No.3 - Allow technical affordances to suggest new directions. The work to develop conceptual designs into highly-finished research products [62] can often involve frustrations when it becomes technically difficult to achieve expected effects. Rather than seeing the recalcitrance of technologies as a hurdle to be overcome, however, it can be taken as an inspiration for new directions. For instance, [31] describes the development of handheld Datacatchers that stream location-specific information drawn from a number of online datastreams. Originally conceived to highlight environmental issues, the nature and availability of the data they

used encouraged the researchers to rethink the devices first as highlighting more general sociopolitical issues such as inequality, and later as also raising questions about the ways that data (mis)represents ourselves and our communities. To be sure, technical difficulties are usually problems to be solved, but sometimes they are pointers to new research opportunities.

3.2 Managing emergence

Strategies for encouraging emergence need to be balanced with ways to ensure that new directions are productive. On the one hand, this is a matter of reassuring researchers that they have licence to follow new ideas; on the other, it is a matter of identifying when things have wandered too far.

Emergence Strategy No.4 - Understand emergence in terms of research programmes as well as projects. While research projects may seem like natural units for narrating design research, the tendency for them to be defined in terms of a set of objectives or questions to be addressed with respect to defined settings and methods tends to emphasise intention-bound approaches to practice-based design research. Design research programmes, in contrast, are characteristic ‘ways of working’, like styles or schools of art and architecture, that associate research interests with a palette of methodologies and typical outputs and evaluation criteria while leaving open the specifics of individual projects ([64][65][45][46][29] c.f.[49]). Examples of HCI design research programmes include Somaesthetic Design [37], Slow Technology [61], or Self Build Research Products [10][32], each of which have framed numerous and diverse projects. As Redström [64] points out, there is a continual, mutually informing relationship between articulated programmes such as these and the design activities that they inspire which allows for emergence within and between projects. Emphasising the relationship between projects and programmes may help in accepting radical changes in the course of projects: rather than seeing changes as a deviation from project objectives, they can be viewed as expanding and enriching the encompassing research programme.

Emergence Strategy No.5 - Emphasise design in settings. Another perspective for appreciating the legitimacy of emerging directions is to understand design research projects primarily as encounters with settings and situations, rather than as tests of theories or methodologies. Not only does focusing on design for settings allow the skills and approaches of design practitioners to be brought to bear more directly than if mediated by external conceptual concerns, it creates an anchor that allows conceptual and methodological concerns to evolve. Moreover, defining projects in terms of settings and situations is not incompatible with the pursuit of design research programmes, as long as those settings and situations are carefully chosen to involve the sorts of issues and design possibilities that programmes are intended to address.

Emergence Strategy No.6 - Be mindful of what emerging directions may contribute. While emerging ideas and approaches may be exciting enough to seem self-warranted, there are also several approaches to assessing them more systematically. Within participatory design, approaches such as Program Theory [35][5] have been suggested as ways to track and reflect on how well unfolding design activities support programmes’ objectives and outcomes. At a broader scale, Krogh and Koskinen [46] argue that controversies about how best to conduct practice-based design research reflect the inherent multidisciplinary of HCI and interaction design, and in particular the several ways of understanding and knowing – epistemologies – that this brings together. For instance, a *methodic* tradition sees knowledge as an outcome of methodological rigour (e.g. [42][6]). Other authors argue for an *experiential* approach, often involving craft-based studies that draw inspiration from art and design rather than the sciences or the humanities (e.g. [79]). Still others follow a *dialectic* tradition, in which new understanding and knowledge emerge in interactions between users and designers; this way of working is inherent to Participatory

Design (e.g. [19][43]). Finally, the *programmatic* tradition involves a discourse between theory and practice in which design artefacts are intended to challenge existing theories and frameworks, helping to slowly expand knowledge in the field (e.g. [80][65]). From this perspective, orienting to these various epistemic traditions is useful in understanding the contributions that emerging understandings and activities might make, and how they might be made legible and trustworthy to others.

3.3 Narrating emergent practice-based design research

To some degree ‘cleaning up’ research reports is natural: creating a clear narrative trajectory by omitting ‘irrelevant’ details increases readability both for reviewers and an intended audience. Cleaning up narratives of design research to fit a linear model may be harmful, however. As Bardzell et al. [3] have pointed out, documentation of design research is performative. Not only may misrepresenting practice-led design research lead design practitioners to internalise an excessively rationalised, linear version of research, and reviewers to prevent exploratory work from being funded and published, but the results may lose the excitement of the practice itself. Here we point to alternative possibilities for writing about practice-based design research.

Emergence Strategy No.7 - Present design research as a journey, not a quest. Blythe [8] describes the narrative structures used in reporting research in terms of Booker’s [9] ‘basic plots’: a list of seven basic story structures which, Booker claimed, underlie virtually all of the world’s stories. According to Blythe, the basic plot of many HCI papers is either *overcoming the monster* or *the quest*, depending on whether the emphasis is on solving a problem or seeking something of value. Both these plots share the feature that a goal is known in advance. Emergent design research, in contrast, might better be described in terms of *voyage and return*, in which design researchers journey to an unfamiliar land, undergo encounters that teach them unexpected lessons, and finally return, often changed, to their homes. An essential feature of these stories is that there is no predetermined goal to the journeys they describe; in other words, they are emergent. From this point of view, it appears promising to consider writing about emergent design research not as a quest or problem-solving exercise, but as the story of a journey.

Emergence Strategy No.8 - Tell the full backstory. Many accounts of design research describe projects as if they are self-contained bubbles, floating free of their history and settings. Objectives, questions, theories and methods are the only representation of how research journeys start – yet as Jacob [39] so vividly describes, these are the results of a process, not its beginning. Describing how projects came to be, how they are supported, their accountability, constraints and freedoms is useful for an appreciation of how they are undertaken and the sorts of trajectory that might emerge. This is also likely to help explain why a research journey that starts with one set of assumptions may change as it travels from its original context.

Emergence Strategy No.9 - Seek inspiration from different literary genres. There are plenty of sources of inspiration for thinking about new ways to write about emergent research. Ethnographic writing [14] has long drawn on a variety of narrative techniques, reflexivity and multiple voices to disrupt linear narratives and the “view from nowhere” [36] in telling their stories of research journeys. Michael [56] advocates anecdotes as sources of insight, pointing out that they are both literary and factual, performative, revealing of their author, and open to reinterpretation and retelling. Travel writing provides a more literal analogy, suggesting that we “show, don’t tell” about journeys by using techniques from fiction such as “such as character, action plot, foreshadowing, dialogue and payoff” [34]. Guides to scriptwriting [21] offer techniques such as the use of plot points (“any incident, episode, or event that hooks into the action and spins it around in another direction”) and narrative structures that can allow readers to experience challenges prior to achieving resolution. Within HCI, design researchers have worked with

professional writers to produce stories about data (e.g. [16]), allowing new insights to emerge through narrative extrapolations set in particular worlds. These approaches, and more, are promising in allowing us to break from traditional linear narratives to highlight emergence as a feature of design.

3.4 Assessing emergent research

Accepting emergence as a fundamental feature of practice-based design research presents challenges to evaluating results for practitioners and especially for reviewers and audiences after the project is done. Currently, clearly articulated intentions at the outset of a project are a major resource used in making judgements about the 'rigour' of the research project and the outcomes it produces. This by definition favours intention-bound approaches, at least in reportage. The following strategies suggest how to rethink accountability in ways that allow for emergence in practice-based design research.

Emergence Strategy No.10 - Recognise starting points as provisional. While research questions, objectives, projected outputs and theoretical framings might be useful in initiating design research enquiries, they should not be seen as contractual commitments. Instead, they might be assessed in terms of how promising they are as launch points for explorations. Do they situate design investigations in topical areas? Do they offer paths for development that are predictable and obvious, or does the starting point offer opportunities for discovery and adventure? Good practice-based design research can emerge from unpromising beginnings. Nonetheless, the way projects are framed should be approached less as methodically precise research plans and more like thought-provoking design briefs.

Emergence Strategy No.11 - Assess outputs on their own terms. Emergent design processes are not always rational or easy to explain. Rather than evaluate 'rigour' solely in terms of the rationale behind each design move, look to the success of the output as a sign that a process has been successful. Relinquishing accountability to original intentions implies appraising the outcomes of design as they are, with less emphasis on how they came to be, for instance by considering them as portfolios to be annotated [11][26][29]. Such an appraisal needs to be made with regards to outputs' fit to a destination and their resonance with conceptual research issues – both of which may have emerged over the course a project. How effectively do outputs engage with their contexts of use, whether by supporting existing practices and understandings or challenging them? Who are their audiences, and how do they engage with them? How do outputs illuminate research issues, opening new understandings and possibilities? Questions such as these can help expose the value of outputs without recourse to the intentions behind them.

Emergence Strategy No.12 - Value agility and responsiveness. While it is reassuring to read about projects that build steadily from a set of initial concerns to a relevant output, we should also recognise the skill it takes to rapidly change course in response to events, insights, design ideas and material influences. At the same time, emergence alone is not a sign of a successful project, as it can lead to endless drift and an unsatisfactory conclusion. Thus, in evaluating processes, we need to appreciate the negotiation of emergence and intentionality. Are new ideas allowed to profligate endlessly, or are they accepted because they allow promising routes forward? Does the unfolding 'plot' of design research appear contrived or convenient, or does it reveal skilful manoeuvring to explore an unknown territory? A research community that prizes emergence must learn to value surprising choices and unexpected conceptual shifts in design research as an alternative to an account that "snaps together like gears".

4 CONCLUSION

At heart, what we are suggesting here is simple. Plans and understandings can change during in the course of practice-based research, in response to experience with people, settings, ideas and things. This is true for any

human endeavour [74], of course, but design practitioners are traditionally trained to develop the judgement needed to navigate unpredictable projects agilely to successful outcomes. The tendency for practice-based design research to be emergent should be embraced, not inhibited or hidden by the adoption of intention-bound traditions of research and reporting.

To be clear, we are not advocating that design research should abandon intentionality or even become predominantly emergent. As we discussed at the outset, unchecked emergence can produce aimless drift, just as rigid adherence to intentions can miss opportunities. In practice, practice-based research – and design practice more generally – requires a mix of intentionality and openness to change. Thus, we see our remarks as equally applicable to relatively intention-bound forms of practice-based design work as to those that draw on more empirical or artistic values. In both cases, emphasising the intentional aspects of our work while avoiding or failing to report emergent developments misrepresents our work and undervalues the skills of design practitioners.

Embracing emergence has proven difficult within the HCI design research community, not least because of the mixture of disciplinary traditions with whom we associate. Borrowing approaches to emergence wholesale from design’s socially-oriented neighbours is useful, but will not entirely solve the problem, both because design has different concerns and outputs, and because our research often overlaps with that of our more engineering-minded neighbours. If we are to embrace emergence, we need to find our own ways to frame, evaluate and articulate it in the context of practice-based design research.

In the last section of this essay, then, we have discussed twelve strategies based on our experiences of negotiating emergence as a feature of practice-based research, nested in the themes of encouraging, managing, reporting on, and assessing emergence. We don’t pretend that these strategies are comprehensive, definitive or even entirely consistent. Rather, we see them as inspirational, both for practitioners who want to contribute to research and for a dialogue about the role of emergence in practice-based design research, a dialogue we think is topical and important for our community.

After all, appreciating emergence broadens the scope of design research. Without denying the rigour of patient, focused enquiries into recognised problems, we can also appreciate the insights and learning to be found in more unpredictable research journeys. There is also a kind of rigour in attending to clues, seeking radically new perspectives and following untraveled paths, a rigour that is one of the hallmarks of good design. From this perspective, perhaps we should consider turning the norms embedded in the ‘preregistration movement’ on their head. Instead of valuing projects that adhere to the theories, methods, procedures and predicted outputs they started with, we might ask instead how much can be learned if everything goes to plan.

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