

Iterative and Participative Action Research

a designers approach to Research through Design

Daniel Saakes

Department of Industrial Design, KAIST, daniel@saak.es

During a two-year period we studied practitioners in creative group meetings and introduced new tools into their design process. In this paper we describe how we employed iterative and participative action research cycles in a Research through Design process. We report on two cases in which we varied the research design of the action research cycles: iterations within a single company and between companies. The multiple iterations allowed us to understand domain specific design constraints and provided insights into governing variables that drove the direction of our research. We therefore explain our approach as a double loop learning process.

Keywords: Research through Design, Participatory Action Research, Professional Users

1. Introduction

A large part of our research effort consists of studying teams of professionals in practice, in their workplaces. We intervene in their processes with digital and physical design tools as they work with our prototypes. Although we plan our interventions using appropriate participatory means such as contextual inquiries [10] and context mapping [20], our initial assumptions on the impact of interventions are regularly challenged when interventions uncover implicit rules of the game. Often it was during reflection with practitioners that valuable pieces of information were revealed. Introducing new tools inevitably changes the way these practitioners work and is an ill-defined or wicked problem which requires an explorative approach. We therefore adopt participatory action research (PAR) cycles and we stress the iterative nature as a means in doing research.

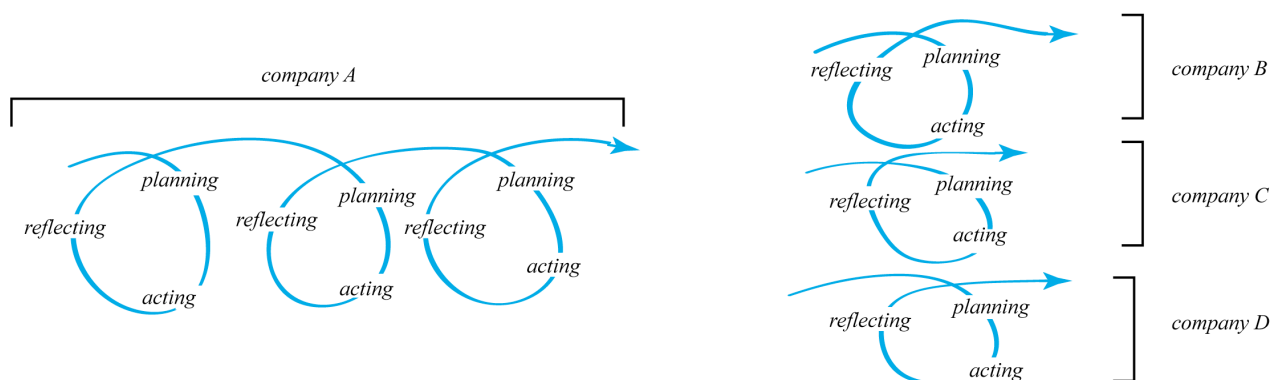


Figure 1. In this paper we draw two cases from a larger project. The first case (on the left), consists of three consecutive action research cycles within a single company, The second case consists of three cases in parallel between companies

We illustrate our approach with two multiple-case studies drawn from a larger project. In total, during a period of two years, 17 interventions were performed, in 3 European countries at 7 different companies. These interventions were implemented during “meetings” between professional users, using projects they were already working on, mostly with a

commercial goal. The two cases we describe here consist of consecutive series of interventions, of which we previously published the results and implications [24,25]. The first case involved a large multinational in package design [anonymous]. Here we implemented a number of interventions with the same team, we refer to this as “within-subject iteration”: multiple-case iterations in the same company. The second multiple-case example was implemented at three different companies, and is previously published [anonymous]. We call this “between-subject iteration”.

Our approach is one implementation of Research through Design (RtD) [5]. Throughout this paper we treat “design” in RtD as a verb and we define design according to Simon [19, pp. 111]: “*Everyone designs who devises courses of action aimed at changing existing situations into preferred ones.*”. We first discuss a few related RtD projects before we differentiate our approach from known approaches in Section 3. We show how participatory action research helped us plan and reflect on interventions and how we separate domain specific knowledge (useful to designers) from more widely applicable knowledge (useful to researchers) in a double loop learning process.

We conclude with a discussion on the advantages and limitations of the applicability of our approach. In this paper we deal with professionals who are generally well trained, highly educated, creative and capable of reflection on their actions. Therefore, we do not advocate this approach as universally applicable. Nevertheless, we think that our approach might provide a new angle to the special session of “*blending design research and practice*”.

2. Related Work

In their paper “*Lab, Field, Gallery and Beyond*” Koskinen et al. [14] discuss methodological foundations commonly used in design research. Horvath [9] takes another approach when discussing design research. He positions RtD between fundamental research and applied industrial design. Together, the two papers provide the basis to frame our approach within RtD and to compare our approach to those taken by other design researchers [28,29].

2.1 Framing RtD between scientific research and applied design

Industrial design is applied, contextualized, and multi-disciplinary, in contrast to fundamental research, which is mono-disciplinary, generalizable and can thus potentially be applied in multiple contexts. Horvath [9] distinguishes three approaches falling between fundamental research and design practice, combining design and research.

Research in a Design Context is a method where an artifact, the design, is used as the stimulus material for an experiment, having the research methodology and objectives of fundamental research. This approach is exemplified by the alarm clock of Wensveen [26] or Ludden [15], who studied surprise in products. In their studies, aspects of consumer products were manipulated in order to gain insight into the contribution of those aspects to how people experience the products. Their research, in the field of psychology, made use of consumer products as stimulus materials in formal experiments.

The methodology of Practice-Based Design Research, on the other end of the spectrum, describes a thoroughly documented design process. Examples of this method are Niedderer [17] and Mäkelä [16], both designing physical works of art. The practice-based design research approach takes design as a verb, an activity used to plan and create work with a given objective, and describes the design and insights thus generated as a research process, unrestricted by the established methods of fundamental research.

In Design-Inclusive Research Horvath combines the methodologies found in design practice and in fundamental research. He encapsulates a design process within a research process and sees design as the step between theory and proof. The design project has little interaction with the research project. This is a popular approach and a often cited example of this method is the Ph.D. work of Frens [6] on tangible interaction. Frens documents a thorough design

process that ultimately leads to the design of a camera, used to demonstrate his ideas regarding interaction. Horvath, when taking design as a noun, it is used to test a previously conceived idea for research.

Even though Horvath gives a compelling overview of how design and research complement each other, the presented approaches do not include the act of designing as an inductive step in a scientific research process. The value of design is reduced to producing stimulus materials with some notion of external validity towards experiments or quasi-experiments.

2.2 Framing RtD within established research approaches

In contrast to Horvath, Kiskonen and colleagues acknowledge the inductive use of design. They argue that design researchers who integrate design activity in their research often borrow their methodology from established approaches in experimental psychology, sociology and the arts.

The lab approach consists of classic controlled experiments conducted in laboratory conditions. The foundation of this approach is in experimental psychology and it is widely applied in computer-human interaction and interaction design. The projects by Wensveen, Ludden and Frens all take place in the lab, and the products, the alarm clock, vase, and camera, are all used as stimulus material to which participants can easily relate and of which the design is documented. The lab provides a clean environment for formal experiments. However, Koskinen et al. question the external validity of this approach, e.g. whether the lab provides a good representation for the world and whether results can be generalized. In a controlled environment the researcher inherently has to make many assumptions about real-world situations and in addition the typical participants are design students.

The field approach is based on sociology and takes place in the world. Here they argue that the artifact should not be understood as stimuli in a laboratory, but as objects as part of peoples' lives, evolving over time. Although there are several methods to study the context of use, such as design probes [20] or contextual inquiry, intervening in practice with technology is difficult and not commonly found in design research. A good example of this approach can be found in the work of Keller. [12] His prototype "Cabinet" was evaluated in three design firms for four weeks each. During weekly visits and interviews he collected qualitative data, and his prototype recorded usage data.

The gallery approach is rooted in the arts, and as Kiskonen et al. explain is by definition not scientific, but that doesn't mean documentation and reflection on the artifact and its creation aren't systematic or valuable. However, similar to Horvath's Practice Based Research, it is less relevant to this paper.

In both the lab and field approaches the design process is central, however they are not clear on how design iterations drive research intentions. We think that Kiskonen et al. hide the real contribution of iteration in what they call "programs" [3], larger structures that span multiple years of design/research experiments and set new research agendas.

3. Approach

Gaver [7], in a recent paper on RtD, cited Feynman on making physical laws. Feynman explains that before computation and comparison of theory to nature, one first "guesses". In our practice, we try to make educated guesses with our design activity and by studying users in the field. We argue that introducing new tools in highly dynamic contexts of group meetings is a wicked problem [18]: The impact and implications cannot be designed nor understood completely prior to the intervention. In addition, solutions are so-called one-shot-operations, cannot be repeated, and are too complex to be tested with multiple condition experiments. Solving these wicked problems requires explorative, quasi-experiments performed in the messy field.

3.1 The group-meeting as efficient intervention

In multi-disciplinary design processes important decisions are made in the meetings between stakeholders [23]. These meetings regularly contain brainstorm sessions to generate new ideas or to select concepts from multiple variants. We decided to stage our interventions at these group meetings because they provide certain advantages of the lab in the field. For instance, meetings take place in a finite amount of time, making it feasible for the researcher to participate and observe. Discussions and dynamics between participants are easily captured on video. Because the researchers are present they can offer technical support on the prototypes. Reflection on an intervention can be organized directly following the meeting. Finally, for participating companies the time investment is clearly defined and the risk is low.

3.2 Working prototypes to understand the context of use

Prototypes are instrumental in interventions. A prototype is a version of the intended product that has two main uses in the explorative stages of a design process: developing technology [13] and studying users [4]. In our field studies prototypes are mainly used for the latter and therefore have to function within the workspace of our participants. By involving the practitioners when adapting the prototypes to their needs and sharing ownership of the solutions we aim to avoid the often described “not invented here” syndrome. We see prototypes as a means, not a goal, and make agile prototypes which are just developed enough to test ideas and are open, allowing for reinterpretation by participants. Because the researchers are present, they can solve unsupported tasks or unforeseen requirements on the spot, acting as Wizard of Oz.

3.3 Participatory action research as contextualized design processes

We think that research in the field, with the participants, helps them to relate our tools to their materials, their design problems and their studios. For our interventions in practice we therefore employ action research cycles of planning (designing), acting and observing (user studies), and reflection, shown in Figure 1. Action research originates from organizational psychology, and is an iterative process involving researchers and practitioners acting together in a particular cycle of activities [1, 8].

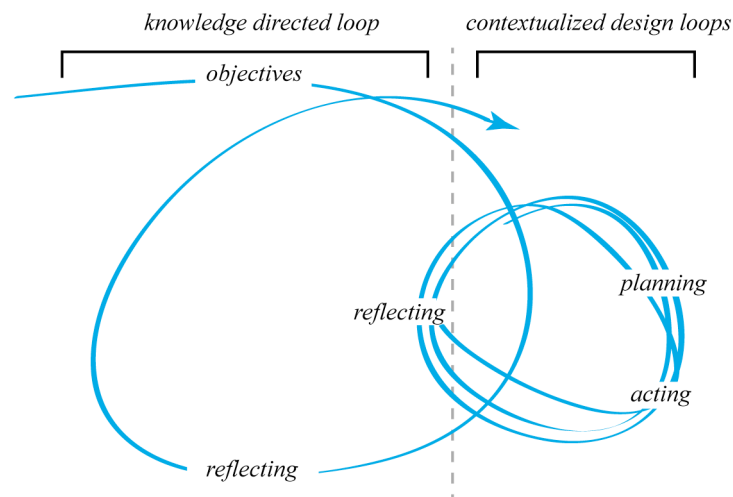


Figure 2. Action research consists of cycles of planning, acting (intervening) and reflecting. The proposed research approach consists of a double loop. The small loop consists of multiple action research cycles and is contextual design directed. The large loop includes the small loop as a case study and is knowledge directed.

In the participatory action research method [27] the participation of practitioners is emphasized, using the definition by Argyris [2]: “Participatory action research is a form of action research that involves the proposition that causal inferences about the behavior of human beings are more likely to be valid and enactable when the human beings in

question participate in building and testing them". Participatory action research acknowledges participants as experts on their own work process and domain. In the planning step, the participants' needs for support are collaboratively identified and contextualized prototypes are developed. In the "acting and observing" step the practitioners use the prototypes in their practice and we observe how it affects their process. In the reflection step we jointly evaluate the impact, leading to additional cycles or to a reframing of the initial ideas.

We experimented with several types of action research cycles. Cycles within a company with a single team we refer to as within-subject cycles. We do not see such studies as longitudinal, since we adjust the prototypes and interventions between workshops. Cycles between various companies or application fields we call "between-subject". We experimented also with cycles in parallel, making only minimal changes to adapt the tool to an application field, but generally we include insights gained in one case in the next.

3.4 Double Loop Learning to frame the research objective

We understand PAR cycles as contextualized, applied design processes that identify design constraints and test implicit assumptions. Iterating through multiple cycles helps to reflect on actions and to identify emerging and larger themes that are less dependent on specific contexts, allowing us to refine our research efforts.

Schön and Argyris distinguish a single loop learning cycle from a double loop learning cycle. In a single loop cycle learning is carried out without altering the fundamental nature of the activities, whereas in a double loop learning includes questioning and modifying of existing norms.

We use a double loop process to separate the context-specific knowledge generated in the action research cycles that helps us in designing tools, from the reframing of the research objectives and governing variables that helps us as researchers. Shown in Figure 2, We include small loops of participatory action research cycles as quasi-experiments in a larger loop that reframes the research objectives and identifies generalizable knowledge. For example, in the small loops we might learn how to apply our tools to ceramics design, or to specific team composition or size, whereas in the larger loop we integrate this knowledge towards generic principles on how to maximize the impact of a tool and when to apply it.

4. Cases

The subject of our research is how to prototype and discuss material/texture/graphics considerations in group meetings. We augment the designers' collection of materials on early prototypes of the product, using augmented reality techniques with projectors. We applied these techniques in various design situations ranging from large ceramic statues to USB memory sticks and from exclusive undergarment to packaging of commodity products such as yoghurt. The team composition varied considerably, sometimes consisting of designers that have collaborated for years with excellent expressive skills, whereas in other companies the teams were multidisciplinary with many participants unused to partaking in creative processes. In the course of a number of interventions we developed a workshop format adaptable to specific situations.

The creative group meetings we host take two to four hours as a trained facilitator coaches a team through the condensed design process. In the divergent stage, participants test and play with about a hundred different materials. In a second, convergent stage they cluster their ideas spatially on a large wall display and typically select a few concepts for further exploration. The result of a meeting is a good understanding of what the team does and doesn't want and insights in the constraints and opportunities of the design at hand.

Prior to each intervention or series of interventions, we demonstrate prototypes in our laboratory, and perform a contextual inquiry into the participants at their workplace and observe their current work process. The mutual visits

establish a shared understanding, forming the base of the domain-specific goal of the intervention. Prior to each workshop we ask the participants to collect relevant materials, which we then configure in the prototypes according to the workshop goal. Directly following a workshop we jointly reflect (with the workshop participants) on the benefits of the tool, how it relates to their current practice and possible future use. A follow-up discussion with the team leader a few weeks later, evaluates what happened with the results. The pre-intervention inquiries and the post-intervention reflection reveal the status quo, and functioned as a base line to judge the impact of the intervention.

To illustrate our approach we take two cases from a larger project. Shown in Fig. 1, a case consists of the large loop containing a few interventions as small loops. The first case is performed within a single company, the second is performed in multiple companies.



Figure 3. An impression of the workshops.

4.2 Case: Cycles within a company

The interventions are performed at a big multinational that produces commodities, and we collaborate with the packaging design & prototyping group, the details have previously been described here [24]. The team, consisting of designers, visualizers and a facilitator, facilitate intense multi-disciplinary “workshops” for various product divisions developing new product ideas. Typically, these ideation workshops have about ten to twenty participants, whose expertise ranges from packaging design, product engineering to marketing research and usability testing.

After establishing shared understanding between the researchers and practitioners, the case consists of three action research iterations. The workshops, except the first, had commercial goals, with results proving relevant and useful to the company in latter design stages. Prior to this case we had hosted meetings for artists and small teams of designers, this case provided the opportunity to experience large multidisciplinary teams. Our research intent was to see if the participants without a design background could actively participate and contribute to the design solution.

In the **first iteration** we planned two design sessions. In the first session, participants generated initial ideas using sketching. In the session participants developed promising ideas into physical models using our prototypes to project graphics. We were surprised to notice that the physical modeling in the second session did not lead to new insights. In the first session, ideas were already detailed in drawings, and the physical models only made a nicer presentation. The participants, through their in-company experience, have been trained to complete their conceptualizing in a dialog with visualizers, who sketch out their ideas. Hands-on exploration was new to them.

Therefore, in the **second iteration**, we started with the physical modeling dispensing with prior paper conceptualization. We simplified the modeling task to combining foam and paper shapes. We extended the graphics collection and asked the participants to collect relevant graphics to the workshop. As a result, participants were engaged in lively creation and review of various ideas, using simple models, using projected graphics for their presentations. During the reflection following the workshop participants argued for layering and composing capabilities of projected graphics similar to collaging or mood-board making. This insight led to new prototypes that included capturing physical collages and materials for the projection on models.

In the **third iteration** we selected a workshop topic without much shape variation in order to focus on the collaging of physical materials. Now, we found the participants actively searching their surrounding for materials and browsing in magazines for inspiration. Physical composition of artwork made the tool accessible to all participants, expressing themselves as readily as they with the simple physical prototypes.

Our initial assumption was that non-design participants in these workshops would engage in prototyping with foam and paper and develop graphics into concepts. However, that was not the case. These participants were not used to hands-on-experience, and it took three iterations before we understood how to provide a solution space that would fit their mindset: limiting the solution space for shapes exploration to a minimum, with no detailing and adapting a collaging style to make rich graphics creation possible without drawing skills.

Another insight that became apparent over the span of these workshops was the need for a convergent stage. In the earlier iterations we worked with smaller teams of designers and artists and converging was not found to be an essential part of the workshop. Here, in the first iteration was that participants experienced difficulties presenting their augmented models in plenary reviews. Therefore, from the second iteration we asked participants to use their cameras to document their designs. In a short break prior to the concept review we collected these pictures and prepared them for review on a wall display as shown in Figure 3.

4.3 Case: Cycles between companies

In this second case we illustrate how we performed action research cycles between three workshops with different companies. We configured our prototypes to the companies' team composition, the available materials and the project at hand. Two workshops were described earlier [25] and preceded by a pilot at a third company. The setup and tools between the interventions were kept similar. This allowed us to focus on the differences and similarities between teams. Research goal was to see if our session setup was generalizable within various team compositions, products and materials.

The first intervention was located at another large multinational in a creative group session for the design of a packaging for a dairy product. The second intervention involved the design of a chair at a leading design company. Even though we started out with the same workshop plan in all interventions, the dynamics of the workshops were very different. The chair team consisted of designers who had worked together for a long time, whereas in the dairy workshop not everyone had a background in design. As the participants of the multinational came from various departments, a large part of the workshop consisted of getting a shared understanding between the participants. This resulted in a slower process. The chair assignment was more straightforward, seat material for an existing chair design, whereas the dairy assignment was positioned earlier in the process with many more design decisions to make.

The design team for the chair had a rich collection of visual material and they developed a fluid way of experiencing and reviewing enormous numbers of digital patterns and graphics for their chair model. Interestingly, their discussion also included non-visual aspects of projected textures, such as how to fabricate the chair and the tactile experience. The dairy teams assignment was more open, and started with exploring various package shapes decorated with graphics of the existing brand. In the course of the workshop they changed the plan to creating new graphics for the existing package shape. Being graphics- rather than texture-orientated as in the chair workshop, most material exploration for the dairy package happened in composing physical items.

During the reflection, both teams independently reported experiencing a "break in presence" when capturing a concept with their digital camera and both suggested automatic capturing of results. Both teams felt the clustering step

was essential and talked about multiple iterations or merging the diverging and converging steps. Also, both teams indicated that they wanted to use the interactive prototypes in discussions with other stakeholders. For certain products the design firm would like to have their clients participate, in order to jointly explore the product brief. The packaging team speculated that they would use the workshop to interactively brief designers from external graphics design firms.

Both workshops showed a unique setup and character. The slideshow technique with digital materials fit the context of the design team better, whereas the open question and multidisciplinary team was better served by a collaging technique. However, despite the differences, the results were similar: both teams produced a few clusters of ideas for further elaboration.

Reflecting on the results of both workshops, we confirmed that our approach is an appropriate means to discuss materials/graphics/texture consideration for products within various team compositions and disciplines.

5. Discussion

We have introduced our approach of Research through Design that intertwines practice and research. Using creative group meetings for interventions, we have found a useful middle ground between existing *lab* and *field* approaches when working with professionals in companies. We let the interventions guide our research and have participants join in on all aspects using participatory action research cycles from planning to reflection, as we think that this is the most instructive for us. We are mindful of our multiple roles as both tool-designers and researchers [21]. Using a double loop learning process, we separate the tool-designer domain-specific decisions from the research objectives decisions.

5.1 External Validity

We illustrated this paper with a few interventions out of a total of seventeen. The amount and variety of studies we claim external validity to our results. We took care to include companies and people well-known and successful in their respective areas, willing to innovate and expressing to benefit from including our tools in their design process, as we expected to learn the most from them [23].

However, the huge differences between design problems and approaches participants take, made it difficult to impossible to compare cases and gather inter-case statistics, even employing a strict protocol, as described in Section 4.3. The explorative workshops in practice allowed identification of user needs, but in order to gain insights into the effectiveness of the results of a workshop measured over time, further studies are necessary. A large company with numerous design projects, employing a standardized process, would allow quantitative comparison of the proposed technique to the status quo, studying the technique's effect on the latter design stages, and its use as an integral part of the designer's toolbox.

5.2 Participatory Action Research

Many, rapid iterations of simple prototypes and user evaluation make an effective process to identify user needs. In our studies participants worked using their own materials on their own problems with a commercial goal, in a familiar and relevant context. By thus relating the use of the prototypes to their practice, they were supported in reflection on how they work and identification of their needs and desires. Often we were proved wrong in our preconceived assumptions, such as the necessity of a converging stage after the diverging stage. Typical domain knowledge was collected from these small loops, such as how to adapt to specific team compositions (e.g. client and salesman vs. experienced design team) and it took several iterations before we understood how to restrict the solution space of shape manipulation in order to optimize material manipulation.

However, testing prototypes in practice from an early stage of their development in this way does not allow for complex technology, nor assumptions regarding future technology or future practice. Prototypes had to work with the

materials designers had, at their workspace. Consequently, the solution space for innovation was reduced in favor of external validity, as is often considered a limitation of participatory approaches. [11]

5.3 Double loop learning

The roughness of reality made the proposed double loop learning model less clear and well organized than planned. Due to company availability, design situations' diversity and time constraints, insights gained in a contextualized small loop could not always be followed up on or continued in subsequent cycles.

Despite these difficulties, from the small loops larger themes emerged that guided the research from an initial focus on single designers using computer aided design towards "sketching" tools suitable for group sessions, including support for participants commonly less involved in generative activities but important to decision making. It became clear that the focus should not be on improved graphic quality in prototypes, but on developing interaction styles that supported the designers in their exploration of the solution space, both laterally and vertically.

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7. References

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