

NOOT: A Tool for Sharing Moments of Reflection during Creative Meetings

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ABSTRACT

We present a fully working prototype of NOOT, an interactive tangible system which supports (sharing of) moments of reflection during brainstorms. We discuss the iterative design process, informed by *embodied situated cognition* theory and by user studies in context using various versions of the prototype. Apart from a potentially useful product, NOOT served as a research-tool showing how physical materials and social interactions *scaffold* people's sense-making efforts, and how technology might fit in to support this process.

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INTRODUCTION

In several iterations we developed NOOT [5][6][18], a system of tangible, interactive 'clips'. By activating a clip for the first time one creates a time-tag in a live recording of, and during, a *creative group meeting* (aka *brainstorm* [16]). Clips can be positioned anywhere in the room, clipped onto sticky-notes, put on the whiteboard, or on other objects, so as to provide a spatial, physical context to the audio tags. By re-activating a clip, the system plays back the conversation participants were having when that clip was first tagged.

Apart from being a potentially useful product, NOOT served as a research-tool by means of which we investigated in what ways *sense-making* activities during creative meetings are *embodied* and *situated* [12].

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Figure 1. A brainstorm in our 'ConceptSpace'.

We will first introduce the theory and then the design concept.

Sense-making in creative meetings

Creative meetings are group events in which people together take on a challenge, or problem, and by means of several activities collaboratively create opportunities or solutions. Sometimes meetings are highly regularized, as in a classical brainstorm with a professional facilitator [16]. But one may also think of an *ad hoc* get together of team-members aiming to tackle a particular problem in a project. Three phenomena interest us in particular:

1. Participants dynamically switch back and forth between individual and socially shared activities.
2. The *generation* of solutions often *co-develops* with the (further) *analysis* of the original challenge [8].
3. Talking and thinking are supported by the use of various materials: a growing physical record of the thought process in physical space. (Think of sticky-notes, personal notes, flip-charts, sketches and models on the whiteboard, quick prototypes in cardboard, screen projection, etc...).

Within this mesh of materials and activities, we ask how each participant tries to make sense of other people's contributions, and how the group as a whole develops a better sense of the design challenge. As said, this latter

process is not restricted to the so-called ‘problem definition phase’ which often takes place at the beginning of a session. Understanding the problem co-develops [8,19] with exploring solutions, e.g. during idea generation, integrating, prototyping and ‘pitching’ concepts. Presumably it goes on during coffee-breaks, or even after the session has ended (driving home, reflecting on the day). As one participant remarked: ‘Only when I had to present our solution to the others did I really start to understand the complexity of it all’.

Instead of stimulating ‘creativity’ and ‘out of the box’ thinking per se, we focus on how people gradually try to get a better grip on the challenge. To get a feel for it, think of those moments where you completely misunderstood another person (but only realized much later), or where you tried to recall something ‘very important’ someone said earlier (but failed to remember); or when you realized the problem was not as simple as it looked, and you felt that some ‘underlying issue’ needed to be resolved first (even though you couldn’t quite put your finger on it yet).

Cognitive scaffolding

In contrast to traditional theories that place the locus of cognition inside the head, the theory of *embodied, situated cognition* explains how internal processes and embodied actions in the material and social environment all work in concert to create cognition. (For introductions see [1],[3],[4]). Here we focus on *cognitive scaffolding* [3][13]. Cognitive scaffolding refers to the way elements in the environment can be ‘things to think with’ [13,11].



Figure 2. Deictic referencing during a design session at Van Berlo Design, our partner company in this project

For example, two people in a brainstorm may use a sketch in order to support their talking while using *deictic references* (i.e. pointing to the sketch and using phrases like ‘this one’ and ‘over there’ [4]). Using the sketch as a scaffold, much of the implicit knowledge needed for shared understanding need not be made explicit: one can simply show/see (figure 2).

The *activity* of creating a sketch, or the organization of items in space may also function as a scaffold: each action is quick ‘trial’, its result directly available, which may then guide further action [1,4]. Thus, physically organizing sticky-notes into groups on the wall is a way

of ‘organizing ones thoughts’ [19] and a sketch grows interactively as the idea is formed ([14], figure 3).

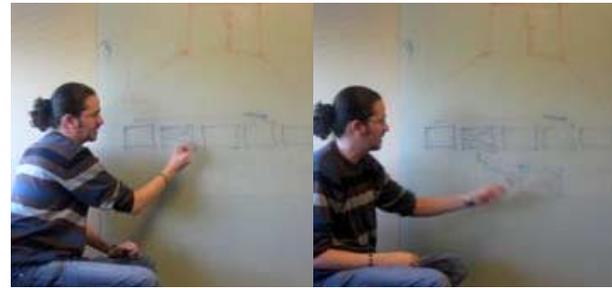


Figure 3. Sketching as a scaffold for sense-making.

Finally, making changes in the environment is often a form of ‘epistemic action’ [13]: People re-organize the world such that it better suits the task and their means for solving it. For example, it is easier to find a sticky-note if one first lays them out in groups, then if one searches in one junky pile.

The examples may sound familiar, but it is not always easy to predict how people use the environment as a scaffold. Scaffolding may involve local, idiosyncratic couplings that serve the thoughts of *that* person in *that* situation at *that* moment only [3]. As a result of ongoing interaction with the environment, pragmatic, locally effective strategies emerge that are objectively speaking not necessarily the most ‘rational’ or ‘optimal’ way of doing things, precisely because people will make do with what happens to be available in a given situation [4]. Some consequences of this for design are discussed in [9].

DESIGN & RESEARCH QUESTION

Our goal is to gain insight in 1) how cognitive scaffolding is part of people’s sense-making efforts in the creative space, and 2) how digital technology might support this process in a natural, coherent way. The examples above show how people use spatial arrangements of items to guide their thoughts. Our initial goal was to create interaction with digital media that could support such existing practice. As we will explain below, our project converged on the role of *digital audio recordings* and how audio-playback of earlier moments in a session could come to function as a scaffold for sense-making.

We will first describe our research-through-design approach. We then present NOOT’s various iterations, and how conceptual analysis and results of user studies shaped our understanding. We end by revisiting the role of digital technology from the perspective of embodied and situated cognition.

APPROACH

Our approach was guided by three basic principles:

1. *Grounding in theory*: At each major design decision, we discussed whether and how the concept fitted the theory of embodied situated cognition. The prototype

is our ‘physical hypothesis’: our operationalization of the theory in the context of practice.

2. *Grounding in practice:* We continuously contrasted our design proposals with observations of creative meetings, either with or without our prototype. We also organized two *co-design* workshops with 12 stakeholder parties (professional facilitators, designers and owners of creative facilities).
3. *Evaluate on the basis of people’s behavior, rather than their opinion.* Embodied couplings evolve ‘in action’, in (subconscious) ways that may not be open to post-hoc verbal accounts by the user himself [22]. Our empirical point of departure is therefore always what people *actually do* (including natural talk).

Following these three principles, we argue, the design process is also a research process into how cognitive scaffolding supports sense-making in the creative space. Through a discussion of the evolution of NOOT we will now present our findings.

THE EVOLUTION OF NOOT



Figure 4: First generation NOOT clip, placed on a whiteboard

First generation NOOT

The first NOOT consists of a system of tangible clips with wireless transmitters and central system that continuously recorded audio. The clips can be attached to sticky-notes or sketches and spatially arranged in the creative space, e.g. on the whiteboard (each contains a magnet; figure 4) Attaching the clip to a piece of paper sends a signal to the computer, which creates a time-tag in the audio recording. Pushing the button on the clip activates playback, via central speakers, of a 20 second sample, starting 10 seconds before the time-tag. With NOOT one can tag a fragment of conversation *about* a certain sticky-note and physically couple it *to* that sticky-note [5].

Initial motivation

Observing several brainstorming sessions, we noticed that participants talk a lot, offering rich experiences or reasoning, but write down only very little. People write down some words on a sticky-note, but the *talk* contained the real insight, not the words on the note. At the end of a session, all that was left was the sticky-notes and the meaning of the stories behind them would be quickly forgotten. In other words, the physical record created in the session did not function very well as a ‘storage medium’ for the content [2]. Linking back to the theory, our reasoning was that the physical record nonetheless serves a powerful function, not by ‘storing’ insights for later, but by ‘scaffolding’ communication and sense-making during the session. The sticky-note worked as a conversational ‘anchor’, constraining and guiding the ongoing conversation, inviting people to show, explain, ask questions, ‘keep in mind’, recall, relate, and so on.

The concept

We decided to *augment* the scaffolding of the physical record with digital audio. As we saw it, NOOT offers ‘audio-context’ for physical materials such as sticky-notes, helping these materials to function as cognitive scaffolds for a bit longer, since the audio-fragment would help people recall the original idea [5].

User study

We observed three creative meetings during the creation of the concept and did a qualitative evaluation using a Wizard of Oz prototype in 4 sessions, asking people to freely recount ideas a week later, either with or without an audio-sample. First results suggested that with audio-context, ideas were remembered in more detail. Results remained inconclusive mainly because NOOT proved a ‘strange’ new thing, the ‘clip’ didn’t work very handy, and people were somewhat hesitant in using the device. We needed a more user-friendly ‘clip’ and observations over a longer period. That is, we needed a new prototype.

Second generation NOOT

We developed a second prototype (figure 5) that was reliably working and could be tested in the creative space for a longer period of time. Inserting paper was more easy this time, but clips increased in size comparable to hockey-pucks (because of *Arduino* board & batteries). And we had only eight clips.

Studying the use of NOOT in practice

We videotaped six student teams using NOOT in a brainstorm session of one hour each. Sessions were part of educational design projects for an external client and not organized specifically for the test.



Figure 5. Second generation NOOT in context, wireless radio inside each clip. Audio playback from central speakers.

Each session figured the same overall design case, but with different student teams. Since we wanted to see how a person would ‘get used’ to NOOT over a longer period of time we decided to focus on the facilitator, a colleague in our centre, who guided all sessions. We also observed participants, but ‘through the eyes’ of the facilitator, who was gradually developing a sense of how to use NOOT, based on his experience with the prototype and on his professional expertise. The facilitator was in a way our ‘informant’ into the context of practice, serving the role both of a user and of a participant-observer [6].

We performed a grounded theory analysis [20] on three types of data: 1) video recordings of each session, 2) interviews with the facilitator between sessions and short interviews with participants 3) the physical record of the session (sticky-notes, whiteboard, etc...).

Results

Over the sessions, the facilitator (F) evolved a certain routine for using NOOT. This became our basis for revisiting the function of NOOT in the context of cognitive scaffolding. The routine consists of three steps:

Step 1. Marking the Moment (figure 6, top)

- *Opportunity for marking.* F steps back from the group and observes. An opportunity arises.
- *Prepare to mark.* F grabs a clip and an empty paper. F waits with both items in hand.
- *Marking the moment.* F puts the paper in the clip at a carefully chosen moment in the conversation

Step 2: Position (figure 6, bottom)

- F positions the clip on a suitable place in the space, e.g. on the table or on the whiteboard.

Step 3: Playback (figure 7)

- *Activating playback.* F presses the replay button.
- *Listening:* Participants stop talking and listen.



Figure 6. Top: Opportunity for Marking (l); Mark the moment (r). Bottom: Position on object (l); on wall (r).



Figure 7. Activating playback on one of the clips

A changing use of NOOT

Originally we saw NOOT as a natural extension of writing a sticky-note: one comes up with an idea, writes it down on a sticky, and then one attaches a clip to the sticky-note, linking ‘talk’ to ‘text’. Analyzing our data we saw a different way in which NOOT is related to physical materials. F did not use clips while actively engaged in a conversation. He used NOOT upon stepping *outside* of the action, in a moment of reflective listening. This routine evolved with experience. In the beginning, F would talk a lot about the audio and the fact that NOOT created a fixed sample of 20 seconds. He was busy “trying to get the *right* piece of talk [i.e. in which a particular idea was explained by a participant] *into* the 20 second sample”. This was a frustrating and conscious effort we had not intended. In later sessions he let go of this goal. F would listen to the group’s discussion, and in the middle of an engaging conversation he would simply mark a moment of ‘interesting conversation’. Taking a clip in hand caused a particular focus: F would become sensitive to upcoming opportunities for making a ‘good mark’.

NOOT was not used by F the way we had designed it. Instead of clipping to an existing sticky or sketch, F would use a clip and an empty sheet of paper to ‘mark a moment’. Only *after* that he would write a label which referred to the audio content, instead of the audio being a context for what was already on the paper. Putting the clip in a physical context would happen afterwards, when he *positioned* the clip with label in the space (figure 6).

We slowly began to see that the biggest value of NOOT is not to augment the existing physical record with audio, but to create new opportunities for scaffolding by putting digital audio in a physical, ‘actionable’ context. Grabbing a clip means one takes on a different role: one listens on a more reflective level. Marking a moment with NOOT invites short moments of reflection, of ‘taking a step back’, which is already valuable even without playback.

Playback

Still, the biggest problem was playback. It was not used often, and when it was used, it often disturbed the conversation rather than supporting it. Based on interviews and observations we offer three reasons why.

Firstly, participants did not see the immediate value of playback during a session, saying they ‘still remembered everything’. (This could be disputed, but it is how people experience it). Participants saw NOOT as a fancy memo-recorder to record and store ‘ones ideas’ for later. Since the sticky-notes were still functioning as scaffolds for the ideas, people didn’t see the added value of adding audio. We will return to this issue in the general discussion.

Secondly, the system did not invite ‘experimenting with’. The main reason for this is that audio was centrally played from the speakers. Activating playback quickly becomes an obtrusive act people will not easily perform. There was no way of privately listening to – and growing accustomed to – the recordings. People did not get a chance to experience its value first-hand.

Thirdly, in order to ‘tune into’ a piece of conversation one needs to be attentive. One cannot listen to more than one person speaking at the same time. This is different from certain kinds of visual patterns or sound that can be peripheral and still not disturbing. When one person suddenly decides to play a clip, other participants might not be ready for listening. A related problem was that playback simply started 10 seconds before the time-tag, regardless of the content. One could not scroll back or forth to find a meaningful bit of the speech that could be used to ‘step into’ the conversation.

THIRD GENERATION NOOT

In the third iteration we made substantial changes based on the following premises:

- Taking a clip means ‘marking a moment’, not ‘record a fixed sample’. The clip should function as a

physical link to one time-point in the entire audio-recording.

- Marking a moment is a short moment of reflection. One is –if only briefly – a passive listener to an ongoing conversation. The user is not herself actively engaged in the conversation.
- It should be possible for individuals to ‘experiment’ with playback in unobtrusively, just as one can gloss over the writings on the wall without disturbing other people. By experimenting participants get the chance to find how NOOT may provide scaffolds for them.
- The limited number of clips and their large size also inhibited its use. Ideally here are many small clips available at all times (like whiteboard magnets or pens) allowing for the creation of a large web of tangible entry-points to the audio-record in space.



Figure 8. The final NOOT prototype. From left to right: audio-playback, a clip on a sticky-note, the dispenser tray and the central computer. Physical design by Van Berlo

Final design

In the previous version clips were very large and expensive due to all the technology inside. We decided to take out all technology, leaving only a small RFID tag for identification, and a magnet. This way we can create many clips for a low price. This meant we had to create two new devices: a ‘dispenser tray’ which provided the ‘audio time tagging’ functionality and an audio-playback device, both connected wirelessly to the central computer (figure 8). Taking a clip from the tray causes the time-tag to be placed in the audio (figure 9). Holding the playback device close to a clip causes it to start playing the audio from the time-tag onwards, in ‘individual listening mode’ (figure 10). To encourage ‘playing around with’, the playback device has a large wheel on top that allows scrolling back and forth through the audio. When one has found ‘that one bit’ one was looking for (or another

interesting bit one happens to hear), one may ask the attention of other participants and push a button, which activates a ‘play out loud’ mode. When one scrolls to a starting point one feels comfortable with and stops playback, the clip will remain linked to that new point in time (the software also stores all old time-tags as well).

DISCUSSION

In this last iteration, we have further concretized cognitive scaffolding for sense-making. Following up on the previous study, NOOT provides a physical invitation to create personal, reflective moments. We now discuss how this works out in final prototype.

Marking the moment

Taking a NOOT means creating a mini-moment of reflection, in which one acknowledges: ‘I find *this* moment interesting, I might want to revisit it later and think some more about it.’ This can be of great value for creating deeper insight into the problem at hand [19].



Figure 9. Marking a moment by taking a clip from the tray

Without NOOT, one would have to make a ‘mental’ note or make one on paper. Mental notes are easily forgotten, and a written note means being explicit about what one is thinking about. Sometimes this is disturbing: one feels that there is ‘something’ – but one wants to postpone further analysis for later, exactly because things are happening fast and one does *not* want to miss out on the group action. Using NOOT one does not have to be explicit about *what* the moment is about, only *that* it is a ‘noteworthy’ moment.

Cognitive scaffolding and reflection

Each clip becomes as one ‘point of access’ to the complete, audio recording. This idea of ‘entry-points’ is strengthened by the possibility for the user to scroll, from the time-tag, all the way through the entire audio recording. In effect, NOOT maps the temporal domain of recorded audio (the history of what has been discussed so far) onto the spatial, physical world, by which it becomes open for embodied actions in the here and now [7]. By

coupling audio-moments to the physical space, NOOT puts these moments within a concrete field of action-possibilities. These actions (taking a NOOT, marking a moment, listening privately to a moment in the session-history, presenting a moment to others, discussing the moment) may then lead to new perceptions and insights. This is how we see the way that NOOT links digital audio to the process of cognitive scaffolding for sense-making. In particular, we hold, it invites reflection *in-* as well as *on* action, following the terminology of Donald Schön [19]. Reflection-in-action: when one marks a moment, ‘in the heath of the moment’, and there is no time to think further. Reflection-on-action: at a later moment, when current affairs in combination with the visible availability of existing NOOT-clips in the space invite one to take up the audio-playback device and return to that previous moment in order to reflect on it some more.

Creating couplings

Positioning ‘moments’ in space is different from graphical representations of time (as in a conventional user interface). To see why, consider that one could, if one

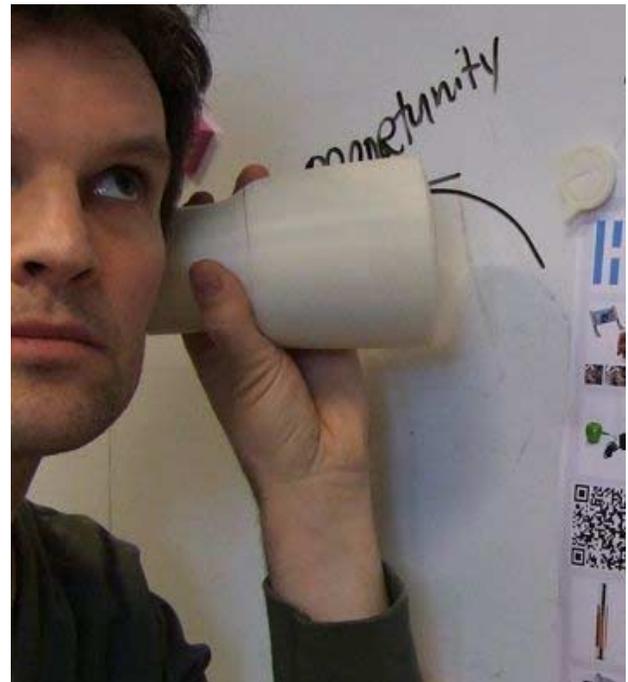


Figure 10. Privately listening and scrolling through audio

wanted, use NOOT to create a symbolic representation like a timeline, positioning all clips on the whiteboard from left to right. NOOT offers much more freedom; all kinds of ad hoc, local, idiosyncratic ways of spatially organizing clips are possible. User can therefore create their own particular ways of using the system. For example, one may position audio-moments (by way of the physical clip) on a prototype that was being discussed at that moment, or on the sketch that was referred to at that moment, or on some meaningful point in a mind-map, or

next to an object symbolizing that moment, or in front of oneself on the table (“here are *my* moments”), or in the very corner where people were having the discussion that was tagged, or even right on the person that was speaking.

Social scaffolding

One aspect of embodiment that emerged quite strongly in this study is that the ‘social’ aspect of situated cognition [21,9] is strongly connected to the role that material objects and spatial elements have in cognition [13,11,4]. In the literature, ‘material’ situatedness and ‘social’ situatedness are both acknowledged but sometimes discussed as separate processes [e.g. 4]. In our concept we see that all interaction with the audio: marking the moment, positioning the clip in space, listening privately to the audio, is always clearly visible to the other members of the group, since they involve intentional actions with hand-sized objects (the dispenser, the tray, the clips) in a shared space. This means that quiet, personal moments of reflection now become socially *accountable* [9 p.79]: I see you ‘marking this moment’, which may cause me to have a moment of reflection as well: ‘What might be interesting about this moment?’ One might say that NOOT creates ‘deictic references’ towards moments of personal reflection: Using NOOT, I explicitly show others that I am experiencing a moment of reflection, and later on we can all literally ‘point to’ that earlier moment of reflection (i.e. the clip), and use that to work on a shared understanding. Even if I have forgotten about one of ‘my clips’, someone else experimenting with the playback device may stumble upon it and ask who tagged that clip and why. In this way, NOOT not only services personal reflection but also sharing moments of thought in the social sense, which may aid in the group’s ongoing attempt at creating a better understanding of the design challenge.

Some questions regarding the classical information-processing function of digital technology

In closing, we would like to offer some speculations on how NOOT shows a re-conceptualization of the role of digital technology for an embodied, situated process like brainstorming. At the start, the fact that so little of what was being said got ‘stored’ in the physical record quickly lead us to abandon ideas like a “digital sticky-note” or “interactive whiteboards”. We focused on the conversation instead. This first concept still retained something of a ‘storage device’: saving ‘important bits’ of the conversation for later, which was also how users and facilitators will first talk about NOOT. When introduced to the concept, people see NOOT as a kind of memo-recorder, in which to ‘store good ideas’. Facilitators quickly express the need to ‘store all results’ and then ‘make them available very quickly and easily’ after a session.

We doubt whether the audio will often be used after the session, especially if it is framed as a kind of database in which all ‘results’ are stored. The word ‘result’ is an ambiguous term. People will say “I’ve got the results”, holding a pile of flip-charts under their arm. Participants photograph all materials, “so as not to forget anything”, but rarely look at the photos afterwards (figure 11). Participants and facilitators were aware of this problem, saying things like: ‘Of course, nobody is going to read the report’. *during* a session. The insight is not in what is written on the sticky-note so much as it is in the activity it supports.



Figure 11. A facilitator photographing ‘the results’.

This is to be expected given the thesis that physical materials do not in and of themselves ‘store’ the actual insight generated in a session, but function mostly as cognitive scaffolds facilitating ‘insightful activities’.

The ability for ‘live’ playback during a session was our first step away from seeing digital technology as a means for the ‘storage’ of the ‘results’ of the thought process in a session, towards thinking about how recording technology could actually support the ongoing cognitive process *as it was happening*. The next step was to acknowledge that audio playback functions as its own kind of scaffold (instead of ‘stretching’ the scaffolding power of a sticky-note). As we tried to argue, NOOT invites moments of reflection and sharing these moments with others.

Our view of the role of digital technology within embodied, situated practices, then, is that it offers new kinds of couplings between people’s action-possibilities and digital processes [7], which in turn invite and support, in real-time, certain kinds of sense-making *activities*. This is an altogether different role than the recording, representing and storing the *outcomes* of such activities (results, facts, data, conclusions), as is the case in traditional information technologies.

FURTHER DIRECTIONS

Our next goal is to conduct a qualitative, longitudinal study in which we will try out the new NOOT for a longer period of time (several weeks), at Van Berlo company. Our main question concerns the actual effect of playback on the group’s understanding of the design challenge.

CONCLUSION

In three iterations we developed a tangible interactive prototype called NOOT that served as a research tool into the role of cognitive scaffolding for sense-making processes in the context of creative meetings. By means of the iterative design and the user research results we provided a concrete operationalization of the way the theory works out in practice. In this way we hope to have added to a better understanding of how embodied situated cognition may play a role in sense-making processes during brainstorming. We ended with speculations on the changing role of digital technology, away from information processing and towards creating real-time couplings between ongoing human activities and digital information.

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