

# Fostering User-Developer Collaboration with Infrastructure Probes

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## ABSTRACT

In this paper we present a new variation of cultural probes, called *Infrastructure Probes* (IP). IPs can be seen as an additional ethnographic method to get a deeper understanding of the user's working context and thus help to improve the collaboration between users and developers regarding requirements elicitation. They consist of a screenshot tool, a digital camera, Post-it's, forms, an IT diary and a writing pad, allowing end users to observe and document their use of the IT infrastructure in question with special emphasis on problematic situations. The results of a first evaluation of the concept show that IPs could supplement traditional ethnographic methods to give researchers as well as software engineers a deeper insight into the working habits of users, but could also be a means for users to document and exchange technology usages. For a reflection of the IP concept we conducted feedback workshops together with the participants of the evaluation. The feedback resulted in an improved version which is currently already under evaluation.

## Categories and Subject Descriptors

D.2.1 Requirements/Specifications, H.5.2 User Interfaces

## General Terms

Human Factors, Design, Field Research

## Keywords

Cultural Probes, Infrastructure Probes, Empirically Informed Software Design, Requirements Engineering, Field Research

## 1. INTRODUCTION

Understanding user's needs is the basic challenge in Requirements Engineering (RE). As an important initial phase in the SW engineering process the goals and demands of the users can be identified with different ethnographic methods. Traditional elicitation techniques include interviews, questionnaires and surveys. Cognitive techniques like protocol analysis and card sorting can also be used to identify the requirements. Contextual techniques emerged as an alternative in

the 1990's; here, observation (cf. Anderson [1]) or video analyses are employed to explore a user's context. Considering the social context of users in system design is an important factor for the development of interactive systems (cf. Hughes et al. [7]). As noted by Nuseibeh [11] there is a fundamental methodological discrepancy between the traditional and the contextual techniques. While traditional techniques can be used anywhere, the contextual techniques have to be applied in local 'real life' situations. Potts [13] distinguishes between two philosophies – he calls the first *abstractionism* and the second *contextualism*. Both of them have advantages (see Table 1) so that he argues for a synthesis that recognizes the complementary values.

	Abstractionism	Contextualism
<b>Role of description</b>	Abstraction are powerful and general	Particularities are as informative as generalities
<b>Design criteria</b>	Design integrity	Contextual fit
<b>Origin of requirements</b>	Prescriptive recommendations	Current practice
<b>Role of users</b>	Management	End-user
<b>Community of practice</b>	RE and software engineering	CSCW and HCI

**Table 1: Comparison of abstractionism and conceptualism [13]**

One technique of collecting data in the context of the users is *Cultural Probes*. This approach – originally introduced by Gaver [5] – is one of the most interesting concepts for self-observation and self-documentation used in cultural studies. Cultural Probes should encourage people to produce and collect materials in everyday situations which they hand over to the scientists or designers later on. The advantage of this approach is its possibility for easy and fast feedback without disturbing the participant's working routine. Originally the cultural probes are playful artifacts that support an engagement of participants early in the design process. Over the last years many different probes variations were introduced (for an overview see Boehner et al. [2]), one of these variations is called Technology Probe [8]. Such probes are simple and flexible technologies designed to understand the user's need, to evaluate the use and to inspire new design-spaces. The data from the probes can function as a starting point for modeling schemes in RE. As Boettcher [3] has shown, additional feedback gathered with the probes can be used to identify roles and goals. Inspired by Cultural and Technology

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probes we developed the concept of Infrastructure Probes (IPs) which will be described in more detail hereafter.

In our current research project we are developing new End User Development (EUD, [10]) tools for small and medium-sized enterprises (SME). By using these tools end users can improve their software infrastructure. The first step of our project was to find out what the typically used software infrastructures of SME look like and which problems arise with them. We also wanted to unravel possible reasons for problems like unrealizable tasks and breakdowns of existing systems. Additionally, it was important to identify how users try to solve their problems with their software infrastructure (e.g. by 'misusing' existing tools). In the first phase we conducted semi-structured interviews as a traditional ethnographic method. The study is described in detail in [4]. The analysis of the interviews did not produce results in a satisfactory quality to fully understand usage problems. Users had difficulties with the reconstruction of problems and problem solving strategies used in the past. Their solving strategies could only be roughly sketched, because detailed examples could not be stated in the interviews. Possible improvements of the software infrastructure remained rather vague. Therefore, we tried to come up with alternative ways for adapting a contextual technique. The new method should allow users to remain in their working context and should enable them to document problems and improvements easily on the job. Inspired by cultural and technology probes we developed the IPs. IPs are tools that enable users to document and reflect on their IT infrastructures. By using the probes users are enabled to exchange descriptions of their problems and needs among each other. Using this technique in an RE process for software engineering should help designers to get a detailed picture and a better understanding of the users' context. Compared to other contextual techniques like observation or video analysis, the results of the probes are focused on the most important problems and needs in the eyes of the user.

## 2. INFRASTRUCTURE PROBES

The infrastructure probes are an arrangement of different probes to a probes package. This package should attract users in different ways (depending on their skills and knowledge), to make them start their self-documentation. All probes are quite simple to understand, making sure to get as many users as possible involved. The arrangement of probes follows Gaver's arrangement of cultural probes [5,6]. The original cultural probes package consists of postcards, maps, a camera, a photo album and a media diary, but also of collected material, like tickets and receipts. Our arrangement of the infrastructure probes targets the documentation of usages of IT infrastructures. The term 'infrastructure' does not only refer to the notion of infrastructure described in the introduction, the probe development is theoretically informed by research on E-Infrastructures as described in [12]: We aim at documenting 'infrastructure breakdowns' and 'use innovations'.

A *snapshot tool* – which can be understood as a Technology Probe – is the most important probe of the package, because it gives users the chance to create, annotate and manage screen shots. The program was implemented in Java and was pre-installed on a USB (Universal Serial Bus) stick from which it can be started without prior installation. The taken screen shots can be annotated with different tools before they are stored automatically on the USB stick. A *digital camera* has been added to reveal problems that are not even restricted to software alone (e.g. if the transfer of data

between two applications is done by paper documents). The *Post-it's* are intended to be used for taking down short notes. Their small size makes it possible to put them on the desk, without hindering the normal work. Besides, they can be used to mark important areas in paper documents or on the desk, before pictures are being taken.



Figure 1: Infrastructure Probes Package

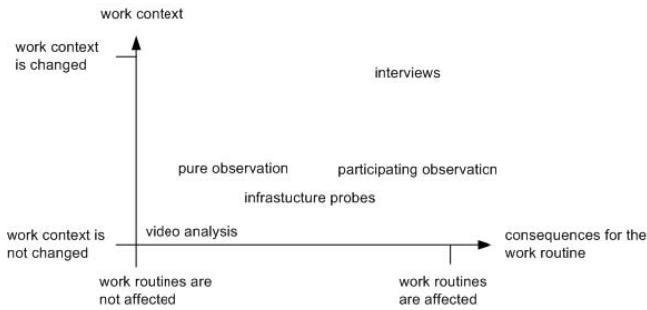
The *forms* are designed for a structured documentation of problems and improvements. They contain six short optional questions to characterize the incident. An *IT diary* has two functions. On the one hand it offers an alternative to register problems and problem solving strategies in an unstructured way (in contrast to the forms) and on the other hand users have the option to put problems in chronological order by using the diary. The *writing pad* can be used for the creation of paper mock-ups. These mock-ups can for instance present concrete suggestions for improvements of the software infrastructure. The probes package and all probes are shown in Figure 1.

For us it was important to design the probe kit in a way that it allows easy articulation of usages and usage problems. As addressees of these articulations we focus here on researchers and software designers (as an ethnographic method), although the ultimate goal is to assist users in mutually describing usages to each other, too.

## 3. CLASSIFICATION OF THE IPS

In figure 2 infrastructure probes are compared to other ethnographic methods by using the two dimensions work context and consequences for the work routine. The figure shows that IPs are similar to video analysis and observations, because they change the experimenter's work context only slightly and have therefore minor effects on his work routine. However, there are still certain differences between the IPs and those methods, which make the IPs different. The *self-ethnographic character* of IPs enables users to report their problems to researchers via a rich medium over a long period of time (several months) in an easy way. The IPs do not only serve the purpose of informing scientists or engineers in an efficient way, they also *encourage users to reflect on their use of technology*. This reflection should further lead to discussions about the use of technology within a community of users, like the departments of a company. IPs may sometimes change the work context and may also affect users work routine, but this is not an important disadvantage, because *users control how (much) the IPs change their work context* and if and when their work routine is affected. Likewise, Jääskö and Mattelmäki [9] point out the differences between interviews, observations and probes by using the

example of two case studies. They claim that the special properties of probes enable scientists to reveal problems, which cannot be discovered by interviews or observations alone.



**Figure 2: Ethnographic methods**

#### 4. RESULTS OF THE FIRST PHASE

We evaluated the IPs in an eight-week field trial to find out if they are suitable for our research interest. The probes packages were given to twelve participants from five different companies. The packages were distributed to the users who had already been interviewed by us during the interview study. Before they started to use the packages we gave them an introduction to the aim of IPs as well as a short explanation of each probe. This information was also enclosed in written form in the packages. Approximately after the first third of the exploration period we interviewed the participants by telephone (due to long distances between the different locations and our university) to ask them about their experiences with the IPs. At the end of the eight-week trial, the participants sent the probes packages back. Before we started to analyze the results, we collected the data in a table and summarized it in a document. After the analysis of the data, we organized feedback workshops together with the participants, where we discussed the results and asked them about their experiences with the probes packages. The following paragraphs describe the result of the telephone interviews, the analysis of the data and the feedback workshops.

##### Telephone Interviews

The telephone interviews showed that the probe packages were accepted by the users to a certain degree. Five of the twelve users uttered doubts about the usage of the packages. One user said he was afraid to use the snapshot tool, because he thought it would record all his actions secretly. Another person used only the camera, because this was the most convenient tool for this participant. Three employees of one enterprise used a different method for the documentation, because they were already familiar with it and didn't want to learn a new one. They did their documentation in Microsoft Word and added some screen shots to the documents, which were taken with the print function of Windows. In contrast to this, three users of another enterprise accepted the probes packages very well. They had already done some documentation with different probes and were enthusiastic about the new method. Altogether the users of all companies stated that they had only minor problems with the different kinds of probes, except for the uttered doubts.

##### Data Analysis

Table 1 provides an overview of the data we received back from the IPs. The data analysis leads to the following conclusions: Participants who used the IPs most were those who talked about

their problems in the interviews, too. One participant for instance complained about hardware problems in the interview without remembering a concrete incident. The images we received from this person showed some error messages, related to concrete driver problems.

Feedback	Count
Pictures taken by the camera	26
Screenshots taken by the Snapshot tool	11
Screenshots embedded in Word documents	17
Handwriting notes*	5

**Table 2: Quantitative overview of the feedback**  
(\*Notes = Post-it's, forms and diary)

The IPs were used most in a company in which a culture of problem documentation already existed - as we knew from the telephone interviews, the employees were already familiar with other snapshot tools. Two participants used the IPs to document problems, although they stated to have no problems in the interview series! All data we collected with the help of the IPs were problem documentations. No participant used the probes to specify improvements of the software infrastructure or described problem solving strategies. The IT diary and the writing pad were not used by anyone and the forms were merely used by two persons. Participants of one enterprise used a different documentation technique (embedding screenshots in Word documents), providing partially very complex problem descriptions which were not written right after the problem occurred, but some time after the incident.

##### Feedback Workshop

The feedback workshop was conducted to get a detailed feedback from users about the IPs, with special regard to things they did not like. They criticized the introduction of the IPs, because it was only done orally. The short introduction was apparently not sufficient to understand the functionality of the different probes and the written explanations were not helpful at all. Two participants did not know whether their computer had a USB interface to plug in the USB stick, as they had never used this interface before. Therefore they did not use the snapshot tool. The duration of eight weeks for the field trial was considered to be too short by the users, because they had no or only a few problems during this period of time. For two participants this was the reason to not use the IPs at all. Concerning the diary, the Post-it's and the forms, participants noted that these probes looked too bureaucratic and required too much time to be used properly. In general, the time aspect was considered to be very important. Using the snapshot tool for documentation was preferred as opposed to using paper and pen. Most users considered the IPs to be a 'job' that had to be done in addition to their normal work, instead of considering the documentation as useful for themselves as well.

##### Improvements for the second phase

As we knew from the feedback workshop there was definitely room for improvement. We therefore revised the concept before the probes were introduced again in November 2007. In the first phase we added explanatory documents in the probes boxes, e.g. a description of the project, an instruction manual, tables of content and so forth. This amount of information seems to have been too much - the users in the feedback workshop complained about an information overload. To make the instructions easier to comprehend we decided to draw the documents in comic style. Another functional improvement we made concerns on the Snapshot

tool. In this tool we integrated an Email function which enables the transmission of screenshots to other persons. By offering this function we hope that the tool will be integrated better into the documentation of the working process. A couple of participants complained about the short evaluation period. For this reason we estimated a longer test period for phase 2 (which is already in progress at present). As we learned from the feedback, the introduction of the probes was now done personally.

## 5. CONCLUSION

Software developers often find it difficult to collaborate with users in the process of making sense of possible future uses of technology. The problem is partly related to the distance between the design and the use space that can be overcome by using ethnographic methods. Traditional methods may still miss crucial information about dependencies between technological work infrastructures that are caused by use patterns from the ‘contextual’ perspective. These could be unravelled by intensive observation, but this is usually considered too costly and relevant use problems may not occur during the observation. We employed an approach that aims at capturing breakdown situations in software infrastructure use. It is a new variation of ‘cultural probes’, which is indented for use in working environments. Users are supported in documenting software problems, problem solving strategies and improvements of their software infrastructure. This enables a richer communication between developers and users, and may also support users in making sense of processes of software infrastructures among themselves. During the field trial we could prove that our ‘infrastructure probes’ can be used as a supplemental ethnographic method, because it helps to discover new aspects of the working field, which could not be discovered by interviews only. The fact that two participants used the IPs to describe problems although they did not report problems during the interview sessions serves as an example. Insofar, we can confirm the findings of Jääskö and Mattelmäki [9]. Furthermore, the results of the IPs can act as a starting point for in-depth interviews. Although the amount of data we gathered was rather small the general idea was appreciated by users and the results indicated that a different quality of empirical material can be gathered this way. The correct interpretation of the results strongly require personal information (position of the participant in the enterprise, experience in using a computer, etc.) gathered with other ethnographic methods, which makes the use of IPs as a stand-alone empirical method problematic. Therefore we agree with Potts [13] in saying that a combination of traditional ethnographic methods (in our case interviews) and contextual methods (in our case probes) will lead to a rich understanding of the user’s problem space and his needs. The feedback workshop should be considered as an integral part of the methodology since it provides a second round of use reflection.

On the basis of the experiences and criticism from the feedback workshops, we improved the concept of the IPs (improved motivation, less bureaucracy) and started a second field trial in November 2007. While we focused on the use of the concept for researchers/software designers here, we are also integrating the IP concept into a use reflection strategy for the further development of software infrastructures as described in [12]. To support users to reflect on their infrastructure we integrated an email function in the screenshot-tool. This new version of our technology probe is still under evaluation at the moment. While the new tool was introduced

we already got positive feedback from the participants. We are looking forward to get the probes back at the end of February 2007.

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