Paper Interface to Electronic Medical Records:
A Case of Usage-Driven Technology Appropriation

Elin Rønby Pedersen[1]
Google, Inc.
1600 Amphitheater Parkway
Mountain View, California 94043, USA
Ph. +1 650 253-1334

elinp@google.com

Greg Wolff
Ricoh Innovations, Inc.
2882 Sand Hill Road, Suite 115
Menlo Park, California 94025, USA
Ph. +1 408 346-4500

wolff@rii.ricoh.com

ABSTRACT

We conducted a 6-month project with a physical therapy clinic, involving equal parts ethnographic fieldwork and rapid prototyping. It differed from most reported user-informed design by having an explicit dual purpose. On the one hand, the prototype should provide significant, measurable improvements for the field site. On the other hand, the project sponsor did not intend to develop the prototype into a product but rather identify future opportunities and needs in the small-to-medium health care sector, requirements for next generation multifunction peripherals (MFPs), and business applications of existing technology. Thus, the project simultaneously investigated specific solutions for a specific work practice while looking for key technologies to address future needs. This paper provides a detailed account of the process and results, highlighting particular contingencies that come with a dual-purpose exploration, as well as the benefits of a small, focused team that "oscillates" between research and deployment.

Keywords

Usage-informed design; ethnography, work practice study; rapid prototyping, agile development; value proposition; paper interface, barcode; healthcare, electronic medical record.

1. INTRODUCTION

The project described in the following, we will call it the Healthcare project, was sponsored by an R&D group within a large IT equipment manufacturer. Having an unused, broad research portfolio, they first wanted to develop a method for efficient technology assessment and transfer into product planning.

They had specific concerns: the process should be user/usage informed and short-term; conclusions about usefulness of new technology should be strongly supported by empirical evidence of the actual impact. Working together with the firm, we created a
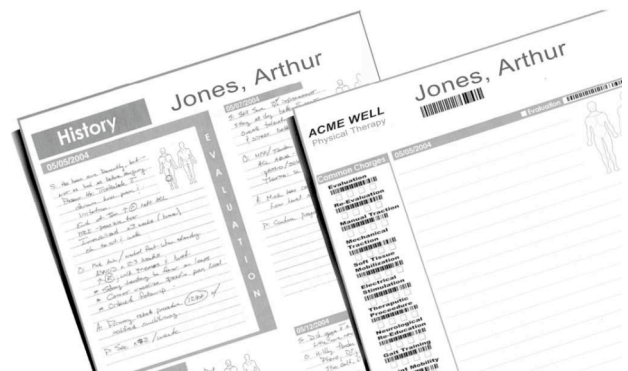
Figure 1: Paper interface to Electronic Medical Record system, i.e., a 2-sided documentation sheet with combined financial and medical documentation on the front and extract from the recent patient history on the back

"process blueprint", reflecting best practices and experience from work-practice studies and exploratory prototyping in the light of the above-mentioned concerns.

The process blueprint combined best practices from established approaches in user centered development, agile development / extreme programming, and business analysis. Ethnographic fieldwork is used throughout the process, first to identify opportunities for novel technology intervention, later to capture details of the work practices in the field site before and after the change. The technology to be explored is built out to be robust enough to be deployed in daily work processes at the field site. A major challenge is to build a very "thin" prototype with only the essential feature sets to test the concept.

The Healthcare project described in this paper was the second in a series of projects that tried out and refined the original blueprint. In this project the focus was on the small-to-medium size health care market such as independent medical centers, medical specialist clinics, etc. The project charter was to identify and explore new technology opportunities in this market segment.

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[1] The work reported here was performed while the first author worked at Kraka Inc., California

Table 1. Duration and relative place of each activity on the project timeline - each cell is one week

Main activity	Week number																									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Clarify technology & look for fieldsite(s)	█																									
Gather data about one or a few field sites		█	█																							
Identify and priority opportunities				█																						
Establish baseline for change, "Before picture"					█	█	█	█	█																	
Architect and build technology					█	█	█	█	█	█	█	█														
Installation, refinements and training													█	█	█											
Deploy and refine new technology																█	█	█	█	█	█					
Gather data for "After picture" of fieldsite																			█	█	█					
Assess the impact of technology intervention																						█	█			
Assess the maturity of technology																						█	█			
Sketch a business prospect for the technology																								█	█	
Catalog "unused" themes of opportunities																										█

2. THE HEALTHCARE PROJECT

The outcome of the project was – by design – twofold. It gave the field site new and better workflows to accomplish the necessary medical and financial documentation, including donation of IT equipment to run the new system on. The sponsor gained insight in new requirements to middleware component in multifunction peripherals (a core product line) to help them build new features into their devices and define corresponding Application Programming Interfaces (APIs).

Approximately 40 person months went into this project. Half the resources went into engineering; the other half was distributed among ethnographers, a UI designer, and occasional support from a market strategist and a process consultant. In addition the field site contributed significant amounts of time: they reviewed reports and designs; received training; and contributed to the evaluation. Table 1 shows the activities in the process on a timeline.

2.1 Understanding Challenges for Small-to-Medium Healthcare Providers

Initially we visited more than 10 health care clinics to get a feel for variations in the physical working environments, and we interviewed owners and managers about the state of affairs in their business and their sense of challenges. We found strong similarities in the overall eco-system regardless of specialty: work in most small clinics is tightly defined by two major forces, a **health professional** context (prescribing doctor, specialist, labs) and within a **financial** context (insurance carrier, external billing service).

Domain experts and market research data for the healthcare market had suggested four overall themes as important across the broad domain of small healthcare providers: charging/billing, inter-clinic communication, interruption management, and maintaining patient records [private comm. w/ consultants]. Our initial survey confirmed these were indeed important issues.

However, we found that the overall most important items of concern were the complex relationship between clinics and insurance companies, and a significant unease about regulatory requirements, such as HIPAA regulations. Somewhat related we found that clinics felt they were being pressed to adopt standardized EMR (Electronic Patient Record) systems which were very expensive, not well suited to their needs, and very difficult to manage for a small business.

Finding field sites in the health sector is a major challenge. There are obvious privacy concerns that pose a significant obstacle for any ethnographic observation study. That led us to look for a physical therapist clinic as field site, primarily because a lot of the patient treatment happens in quasi-public spaces like the clinic gym.

Even without such privacy concerns,, it usually requires some creativity to create a win-win situation for both parties: What would make any healthcare provider willing to risk the smooth workings of their clinic just to help us learn about our technologies in use? Sometimes it makes sense to pay one's way, but that solution was rejected in our case. We have had good success by engaging the field sites as co-innovators rather than "guinea pigs" with the explicit goal of also helping them find a better way of working.

To help mitigate the risks for both sides, we negotiated a 2-phase engagement, where either party committed to only one phase at a time.

The first phase was an ethnographic study of the work practices in the clinic followed by an assessment of major pain points and needs. For their efforts, the field site received a comprehensive report describing their site. In our experience, the utility of these work practice descriptions comes as a pleasant surprise to the field sites – management as well as the individual professionals.

At the time of initial contact, the second phase was described only in very general terms: as a 3-5 months collaboration where we would design, develop and deploy a technology solution in their clinic, and where they would provide us reasonable access to their facilities and data and take active part in the design and use of the technology to the extent it would not compromise the running of their clinic. We promised that, at the end of the project, we would either leave the solution in place (hardware and software) or we would bring everything back to the state it was in before we came, depending of what they wanted.

2.1.1 Gathering workflow data from two clinics

We were able to get access to two different physical therapy clinics: a small independent clinic and a larger clinic that was part of a hospital.

Field workers spent approximately 30 hours in each of 2 clinics over a 2-week period. Data were gathered through observations, opportunistic interviews, and collection of statistical information, both manually and through computer logs. The data provided comprehensive pictures of the work patterns for main roles in each clinic: Front desk/reception; Scheduling (done by receptionist in independent clinic); Treatments: physical therapists and in most clinics also "trainers"; Clinic management; and Accounting (independent clinic only).

It also clarified essential dependencies between the clinics and the surrounding systems as tight relation between "two demanding masters" that each determined what services a clinic could offer: on one side the doctors who prescribed treatments and protocols; on the other side the insurance companies determining which services to cover.

Not surprisingly, we found that having the medical documentation at hand (i.e., the patient records with treatment notes) was essential to the smooth functioning of the clinics, and we encountered several cases where unreliable delivery of (physical) patient records from a central filing office had led the health professionals to maintain their own "shadow" files – causing redundant work and potential regulatory noncompliance.

Both clinics were evaluating EMR systems before this project began. The hospital clinic expected a new system to be launched within a year with the staff expressing a neutral or positive stance, After investigating several options, the independent clinic was concerned that the systems they had reviewed would have negative impacts on how they preferred to run the clinic.

Observation results were converted into workflow graphs of photos, sample forms, and notes. These results were presented to the clinics for a "sanity check." The graphs depicted the major work done in the field sites and they had annotations of what is perceived by the people on site to be major issues and challenges.

At the same time we decided to use the smaller clinic as the field site for phase 2:. The data we had gathered about the larger hospital clinic was used as a reference point when we later evaluated the technology design and deployment at the other site.

2.1.2 From Data to Prioritized Designs

The transition from field data to prioritized design proposals happened in a three-step process. First, data was organized and analyzed and a set of so-called "themes" was developed – a theme being a need or opportunity statement. Second, we developed design solutions for each theme. And third, we phrased our hypotheses about the likely benefit of each solution, based on the insight from the field site.

(1) Organize and analyze: Data -> Themes

Observations from the fieldwork were used to create brief narratives of main clinic activities, see the example in Case 1. There are professional data analysis tools available (like Qualrus, ATLAS.ti). While these tools might serve experienced ethnographers well, we found the burden too high on our "occasional" field workers to have to learn a new system, and we

opted for maintaining maximum transparency between the raw data and the aggregated themes. Our solution was to use a basic spreadsheet, one sheet for each observation session log. The notes, which had a granularity of approximately one per minute,

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Case 1: Patient encounter and its documentation

The physical therapist must document the treatment in each patient encounter with a so-called SOAP (Subjective, Objective, Assessment, and Plan) note, a loosely structured entry of information to be added to the patient record. In addition, information to determine the financial charges needs be entered into the billing system.

Treatment and financial information should of course be consistent and reflect the actual patient encounter.

In the independent clinic, the treatment documentation was typically done partially during the patient encounter with the rest left for completion later in the day.

Submission of charging information for each patient visit had to be done at a shared computer in the reception area; the same computer the receptionist is using for patient booking. The inconvenience of this arrangement may be one of the reasons why charge captures were often delayed for days. Only one of the therapists was observed to make notes of charges at the end of each patient visit; the rest of the therapists would enter the charge information hours or days later and do it from memory

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were entered into the spreadsheet, one per row preceded by their time stamps.

The activity-coded observation notes were then juxtaposed with data from interviews and computer logs. This juxtaposition served to identify some interesting discrepancies, for instance between the interview statements from people at the field sites and observations of their actual activity.

One exemplary discrepancy came from the independent clinic where one therapist complained adamantly about having to report charges: "we are therapists, not accountants." Charge capture was seen as a nuisance and time sink. "It takes away from the time I have available for patients."

At this site, charges were entered through a shared PC, On Friday afternoons several therapists would stand in line to complete the data entry before leaving for the weekend. It seemed obvious that the burden of charge capture could be mitigated.

However, when comparing interview data with observations of the charge capture activities, we could not find anyone spending more than 5-10 minutes a week on entering the charges into the system. So there was a discrepancy between the interview data and the observations.

Further investigation showed that the perceived burden was due to high cognitive loads. To into the charge data, therapist had to remember details of the treatments. They worried about making errors and entering too many or too few charges.

This explanation led us to look for ways to make the charge capture happen when the medical documentation was available or – even better – make it when the charges arose, namely at the

Theme:	
Separation of medical and financial documentation	
Technical Challenge	*Field site business values*
Therapists tend to complete the medical documentation during or soon after patient visits whereas the financial documentation is often delayed till later in the week. Registration of financial charges – as done at the end of the day or week – typically happens without direct reference to treatment notes.	Risk of revenue loss due to omissions, errors.
	Obvious risk of insurance auditing and penalties due to the inevitable inaccuracies caused by the separation of charge capture from the treatment and reliance on memory.
Current technology and work practices seem to enforce or encourage a separation of medical and financial documentation.	Low satisfaction from the separated financial documentation (here: seen as pure clerical work)

Table 2: Excerpt from a table of themes, the result of the first weeks of fieldwork

patient encounter. It spawned the theme "separated medical and financial documentation."

The field workers compressed their main findings into a **list of themes** for the entire team to consider. Each theme evolved from problems and challenges reported by people on the field sites as well as our own observations and assessments. Each was described briefly as a challenge (problem or opportunity) with a rough suggestion of what the "size of" challenge might be. Table 2 shows an excerpt from the theme table.

The theme depicted in the table was called "Separation of medical and financial documentation" (i.e., closely related to the aforementioned area of discrepancy).

Observations had revealed that a significant time lag between the patient encounter and the finalizing of all the necessary documentation was a rule rather than the exception.

(2) Design: Themes -> Solutions

The entire team took part in a series of design sessions using the theme table as a starting point for a growing **list of proposed solutions**. Proposals ranged from paper interfaces for charging, to handheld devices to access and update electronic versions of the patient record, to video recording of the patients doing her exercises.

The paper interface proposal, for instance, was seen as a response to the challenge of separation between medical and financial documentation. It would replace the processes described in Figure 1 with the use of "face sheets" for all pertinent patient information. Figure 2 shows the proposed solution (which was the one we later implemented).

The receptionist would print out letter sized face sheets, one for each patient coming in that day. The face sheet would contain basic patient information, and spaces where the therapist could write notes. The left margin of the face sheet had an area for marking treatment charges. The main part of the face sheet would simply replace the semi-structured sheet of paper that therapists used for their treatment notes. And while jotting down the treatment notes, the therapist could easily mark the appropriate charges while working with the patient. At the end of a patient visit the therapist will simply submit the sheet for scanning. Software would interpret the charge markings to send to accounting, and the receptionist would file the face sheet in the patient record.

*(3) Hypothesize: Affordance -> Value proposition*

The themes and proposed solutions were rephrased as hypotheses about impact – on the clinic as a whole (including patients, partners, etc). Each impact statement relied on data from the first round of field studies, and they stipulated both "hard" and "soft" values (e.g., reducing the cost of accounting errors, or reducing the mental burden of interruption on the receptionist).

Looking again at the example of the Face sheet solution, we hypothesized the affordance of face sheets be integration of charge capture and medical documentation, which again would encourage submission of documentation soon after the patient visit. We should expect the solution to provide value to the field site along the following dimensions:

- More prompt and accurate charge capture
- Experience of less clerical work
- Less interruption of front desk staff
- Unchanged or improved treatment note taking
- Unchanged or improved face time with patients

Going through each of the design proposals this way, several was taken off the table simply because we could not establish a plausible significant usage value of the proposed solution. Left with a handful of proposed interventions (see also Table 3), we prioritized technical approaches along these dimension:

Figure 2: Existing medical documentation sheet in the back; the proposed solution in front showing the added financial input area on the left margin

Figure 2: The proposed solution in front showing the familiar note sheet with a new financial input area on the left margin. An example of the existing medical documentation sheet is shown in the back;
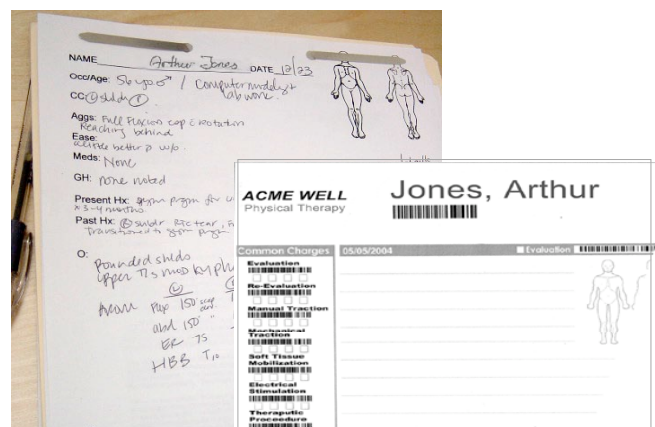
- Was the solution likely to be completed within the strict 6-month framework of our process?
- Was the solution fitting in any market segment of interest to the sponsor?
- Would the solution illuminate the novelty of the technology
- Would the solution be likely to have sufficient positive impact on the user site?
- Would the solution fit the skills and passions of the team members?

This prioritization led us to focus on the challenge mentioned above: that medical and financial documentation work happens separately. Design ideas suggested ways to "reconnect" the two kinds of documentation and to make both of them happen as close as possible to the origin of data, namely during the patient visit.

Two very different design proposals were evaluated: one solution was centered on using PDA's for documentation; the other provided a paper interface. The PDA solution was strongly favored by the developers and one of the therapists. The paper interface was supported by the field workers and a few of the therapists, who found that the brittleness and small interaction surface of PDAs would make them ill suited in the very physical work of treatment.

2.2 Development and Baseline Data
By this time we had a design to work on, and we consulted the field site to confirm interest in the potential solution. The go-ahead from the clinic initiated phase 2 of the project and system development began in parallel with data gathering for a **before-picture**.

2.2.1 Data Gathering for Before-Picture of Field Site
The field workers spent a total of 80 hours doing observations over the following 4 weeks. The goal was to gather data for a more detailed picture of the work situation before any technology intervention happened; where the initial field study at first had looked at the entire clinic workflow, the focus was now on just the areas of work that were likely to be affected by the technology intervention. For instance, we wanted to get good coverage of all the work related to pulling and filing the patient charts on a daily basis (receptionist), reading and writing in the chart (therapist), submission of charges per patient (therapist), and check for incomplete reporting to billing (accountant and receptionist). Areas like patient scheduling and administration of patient co-payment was of less interest going forward.

2.2.2 Design and build technology
Approximately 8 weeks were slotted for development and testing of the new system. The development task included programming towards the existing MFP APIs coupled with lots of system integration work. The engineers had ongoing communication with the field workers, helping to resolve uncertainties in the requirements with real user data. The designers focused on the user interaction.

The ongoing contact with the field site was maintained through the field workers who would also arrange for impromptu design reviews as needed. We ran weekly reviews of the user facing designs at the field site. That served two purposes: it helped the team calibrate the interaction design to the work practices; and it served to manage expectations among the clinic personnel.

Table 3: Main affordance of technology proposals and expected benefits

Technology	Theme and hypotheses
Face sheets Handheld devices	Reconnect medical and financial documentation Integrate charge capture and medical documentation and place the workflow at the time of patient encounter Metrics: •More prompt and accurate charge capture •Experience of less clerical work •Less interruption of front desk staff •Unchanged or improved treatment note taking •Unchanged or improved face time with patients
History squares (on the back of face sheets)	Make documentation review easier for therapists Make the necessary information ready at hand. Enable paper and electronic review of treatment notes Metrics: •Less work for front desk in handling patient files •More convenient document review for therapists •HIPAA compliance
Tracking of artifacts Workflow mapping	Identify and support main work flows Make tasks that will benefit from reminders be integrated into main schedule. E.g., calculate and post patient co-pay responsibility in today's schedule Keep track of pending tasks in distributed workflows. Metrics: •Less work in collecting copay •Better cash flow from collection of copay •Less work in collecting charge logs from the therapists •Less lag time before charges are submitted to billing •More efficient patient registration (intake)
Handheld devices, multiple access point	Distribute Scheduling Provide scheduling capabilities where scheduling is needed Metrics: •Less interruption of front desk
Personalized information; Just-in-time information	Improve patient engagements Metrics: •Reduce late cancellation •Reduce no-shows

2.2.3 Installation and training

The entire team was involved in installing the system and training the people at the field site. The installation included new equipment: a multi-function peripheral device (MFP, i.e., device integrating printer, scanner, copier, fax), a desktop system and a laptop, all networked; firmware parts to be running in the MFP; application software; and a database. It also involved adapters to the existing scheduling system which was a customized front-end for Outlook calendar.

The installation of the new system was challenging because the clinic had to be able to function normally 12 hours a day. The receptionist continued using the scheduling system on her "old" machine during the first week, and the engineers did manual synchronization and database update over-night. Two therapists volunteered as early adopters of the face sheets, helping the engineers and designers iron out a lot of the usability and functional problems before the new system was deployed more broadly. The new system was in place by the 2nd week, and by the end of that week, people in the clinic had become reasonably comfortable with it. The engineers stayed around for yet another week and were afterwards available at an hour's notice if something came up.

2.2.4 Deploy and refine technology

The clinic therapists were given access to both the paper facesheets and a handheld PDA with software customized explicitly for entering charges and treatment notes. Two therapists were excited to try the handheld. Despite their initial enthusiasm, they quickly ran into several practical problems. The handhelds were inconvenient to carry around; the screens were hard to read, and entering data was slow relative to the paper. By the end of the week, all of the therapists have stopped using the PDA's and switched to the paper interfaces. For these reasons, the results below include only the face sheet based system.

The face sheets were faithful copies of the SOAP form (see also Case 1) they were using in the existing system, providing space for both treatment notes and more administrative information like "how many visits left on current prescription", "contact info to patient", "contact info to prescribing doctor." The very first reaction from the therapists was a concern that they were wasting paper. It turned out that they used the SOAP form only occasionally. With recurring patients the notes from each visit might be only a couple of lines. The way we had designed the processing of the face sheets required they use one sheet per patient encounter.

However, after having used the face sheets for just a couple of days, they came up with the suggestion that we should use the back-side to reprint their treatments notes from previous visit. As the therapists, the engineers and the designer discussed this idea, it evolved into as the concept of a "history sheet" using the backside to show a scaled down version of last evaluation and up to three previous visits' notes.

As an unexpected side effect, this design made the daily pulling and filing of patient records, as described in Case 2, entirely redundant, saving the receptionist a lot of time and helping the clinic as a whole better comply with privacy laws and regulation. Figure 1 showed this expanded solution.

Case 2: Pulling and re-filing patient records

In the existing system at the clinic, the receptionists would print out the day's appointments for each therapist and they would use the printouts when pulling the patient files. This process would occasionally involve a search for folders that were missing from the drawers. Each therapist would receive a stack of patient records with the schedule on top.

During a patient visit the therapist would refer to notes from the previous visit and sometimes also to the last evaluation. In some cases the therapist would also write (parts of) the treatment notes from the current visit while the patient was there, but more often it would all be postponed till afterwards, possibly later in the day or later in the week. The patient records would be returned to the reception when the treatment notes were done; in some cases that would not be before the patient's next visit.

2.2.5 Data Gathering for After-Picture of Field Site

After the new system was well in place, the field workers conducted the 3rd field study of the project, spending a total of 40 hours over the subsequent 3 weeks, observing how the new system was being used and how it affected the general workings of the clinic. The observation data went into creating an **after-picture**, documenting the actual effect of the technology intervention. The after-picture was, like the before-picture, comprised of data from three different sources: observations of work practices, interviews with the main players, and data and artifacts that could be extracted from the environment, including the computers.

2.3 Assessments

The fielded designs were assessed according to the business values of the field site. This is what we call the usefulness or customer value below. From the sponsor's point of view, the project had an entirely different purpose, to evaluate the technology capabilities and identify opportunities to serve on unmet customer needs in the broader market of small-medium sized healthcare providers and similar businesses. Below we refer to this as the technology assessment and opportunities.

2.3.1 Usefulness – Customer Value

The impact on the field site and their work processes was assessed, based on the initial hypothesis and comparisons of the Before-picture and the After-picture. Figure 4 shows the work flow after the two kinds of documentation was combined. It is much simplified compared to the two flows in Figure 3.

The anecdotal evidence was clearly in favor of the new system, but unambiguous documentation of improvements provided by the data really brought the message home. In the list below, each bullet represents a value dimension as it was first stipulated along with the resulting value.

- More prompt and accurate capture of charges: the average time from patient visit to reporting to billing had decrease from 8 to 2 day (percentage of extreme outliers was also reduced: from 10% to 1% of the reports were more than 1 week late).
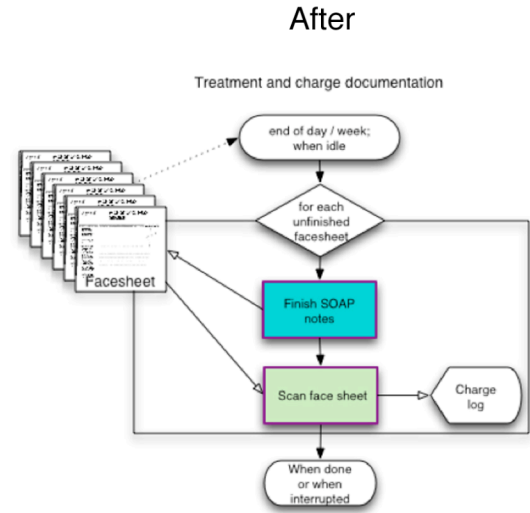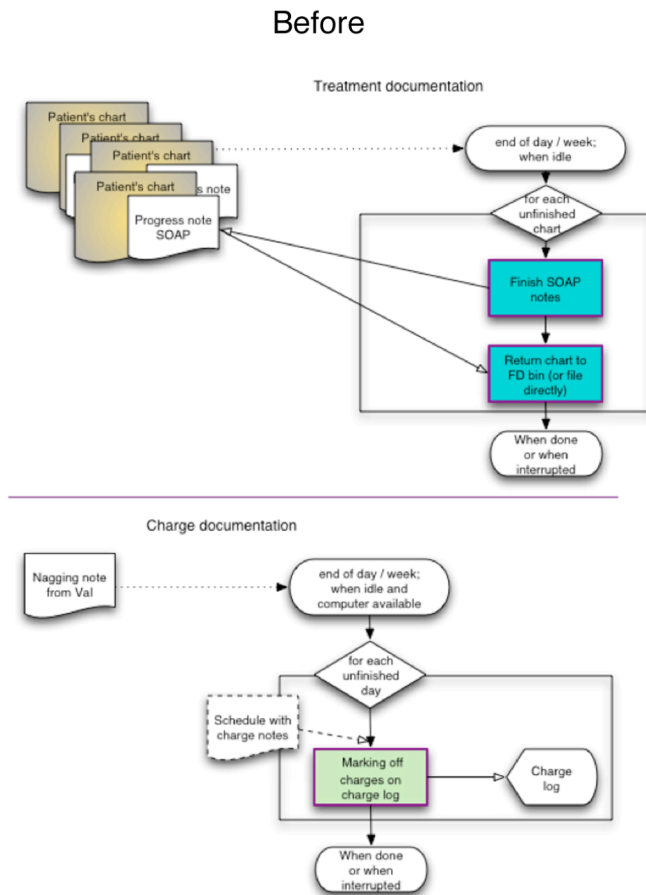
Before

Treatment documentation

Charge documentation

After

Treatment and charge documentation

Figure 4: After: Flow chart of actual workflows with combined financial and medical documentation

Figure 3: Before - Flow chart of the two separate work processes: one for medical documentation, the other for financial documentation.

- Experience of less clerical work: the therapists perceived the new charge capture method as no overhead at all; they liked the routine of scanning in the notes immediately after the sessions, something they could do while saying goodbye to the patient.
- Unchanged or improved treatment note taking: The therapists perceived an improvement in note quality, mostly due to the timeliness of reporting (during or immediately after the patient session).
- Better, less cumbersome compliance with privacy regulations: Less patient folders were found lying around away from the file cabinet.
- Less interruption of front desk staff: no data supported this hypothesis.
- Less work for front desk in handling patient files: observations confirmed that entire workflows around daily pulling and filing patient charts had vanished. Interviews with the receptionist confirmed that a very unattractive task was gone and time had been freed up to better attend to the patients.
- More convenient document review for therapists: observations confirmed that the therapists only in exceptional cases needed to consult the original paper charts (for instance when they wrote six-weeks evaluations), and interviews confirmed that the single sheet documentation was much desirable to the more bulky patient folders.

- Unchanged or improved face time with patients: no data supported this hypothesis

2.3.2 Technology Assessment and Opportunities

The deployed solution included several technologies from the sponsor's technology research portfolio. Among these components were architectures and methods for processing images at "scan time" and developing customized, data driven printouts. The solution also stretched the capabilities of existing MFP programming interfaces. Feedback from the ethnographic research and deployed prototypes drove specific, practical requirements for future products.

These assessments drove discussions of business prospects cases for the deployed technology components. The deployment experience also highlighted the critical role of co-designing the paper forms (sometimes called a "paper UI") and the scanning / printing system to create an integrated and smooth experience for the users.

The Healthcare project also identified new areas for innovation and many specific inventions in both technology and user interaction. Inventions were captured, and broader innovations ideas were cataloged for subsequent research projects

This illustrates also what we call "the oscillation model of R&D": time and time again we see how prototyping in the user environment gives rise to hard and deeply relevant research

problems. This goes counter to the prevalent waterfall view of research as the genuine spring of invention and innovation.

3. METHODS AND BEST PRACTICES

We prefer the term "process blueprint" when talking about the principles of the process reported here. In setting up our process blueprint we tried to specify a minimalist framework with just four components:

1. Equal attention to fieldwork and engineering;

2. Learning from "slim" but robust prototypes that are set out "in the wild";

3. Absolute time limits on projects; and

4. Explicit value propositions to drive the decision making and – as we found – facilitate the multidisciplinary interaction.

Beyond that we were pretty much method agnostic and extremely pragmatic: in each step of the way we applied the best practice techniques and tools that made sense and was needed.

The "process blueprint" has been shown to work in practice and has become a well-established and productive part of the sponsors research program as documented in [11].

3.1 Rationales for our approach

Many readers are likely to wonder: why did they do it this way? Why go through all the work of creating running systems? Why take the risk of potentially making a mess in the business conducted at the field site? And why didn't they do a "real" participatory design process? Why did they not use trained ethnographers only at the field sites? We will try to give an answer below.

3.1.1 Paper prototypes are not enough.
Conceptual prototypes are great as a quick and inexpensive way to imagine new technology; paper prototypes are excellent ways of seeing the technology in the hands of the user. In our experience, these tools can be deceptive at times. They trigger imagination but they are almost too malleable. Often the real success or failure of technology comes from the minute details of the interaction between user and technology, as well as the fit of technology enhanced work processes in a larger work environment. This type of learning by doing requires use "in the wild." Oftentimes it's only in the user's day-to-day environment that we can explore the true complexity of the problems and examine the utility of potential approaches.

As many colleagues have noted, this approach is relatively expensive and carries the risk of exposing proprietary technology. Our efforts to mitigate these costs are described below.

First we limit development expenses by doing "just enough" and deploying for a relatively short period of time. .This case study demonstrates that much can be learnt from a "slim" but functioning prototype. The absolute time boundary on the process itself (6 months total) forces realistic requirements and caps the expenses.

Concerns with intellectual property were handled on a case-by-case basis. Whenever possible, we try to use existing, publicly available technologies. Furthermore, we operate and maintain the system during the project, so aside from the user interfaces, very

little of the specific technologies need be revealed. Furthermore, all project participants sign mutual NDA's. In prototypes involving new technologies, patents may be filed before the systems are deployed.

3.1.2 Users are just too busy to participate in system development.
Much literature on user participation in system development addresses the challenge of giving the real users a seat at the table in decisions and design ([10], [16], [8]). In cultures with high degree of performance driven work culture, possibly coupled with less tradition for participation in organizational decision-making, the obstacle to extensive user participation is just as often reluctance by the users to spend the time necessary.

Initially workers at field sites tend to be reluctant to participate. They would prefer to spend their time on their field of expertise, and they would like to see experts on workflows and system design "do their job". However, many users are happy to share their thoughts on "what's wrong" with the system and offer their opinions on how to fix it. These individuals respond very positively when they recognize that somebody values their opinion and they can immediately see how their feedback changes the proposed designs. On exit interviews, most participants report that they enjoyed participating in the design work. They were still concerned with the amount of time they were asked to spend, but saw the value of their participation realized in the deployed solution and felt there time had been well spent.

Gaining support for full participatory processes may become easier with time as the society gradually develops awareness of the advantages of extensive multi-disciplinary collaboration.

3.1.3 Engineers need to experience fieldwork first hand.
It can be difficult for other professional groups to understand what ethnographic field data really is, so we encouraged the entire team to sign up for observation slots, in particular during the second phase of fieldwork (gathering "before" data). To support a meaningful use of everybody's time, we developed a basic set of tools for ethnographic data gathering and reporting. As a rule we insisted on always having at least one professionally trained ethnographer on-site.

In this way everybody came to understand – in a hands-on way – both the richness of data and the limitations of what can be pulled out of them.

3.1.4 Engineers and designers just see things differently.
A major challenge in any multi-disciplinary work is the collaboration and graceful handing over of work between the different disciplines. There are natural tensions between the roles, like the field workers' wish to gather better data before committing to a model, and the developers' desire to get the overall functionality nailed down once for all to allow them to make basic architectural choices; or the interaction designers' wish to change the fundamental software architecture in response to negative user experience.

We addressed some of the challenges by making the decision-making and prioritizing transparent to all participants. For

instance, design concepts were cast in terms of hypotheses about the value of the proposed change, and robust prototyping and deployment led to full "live specifications" of technologies that were tried in the hands and lives of real users. We found this use of hypotheses-turning-into-value-propositions throughout the project eased some of tension. The value propositions came to serve as shared objects to support communication across different communities of practice, a kind of virtual 'boundary objects'[14]. It gave the field workers a much better sense of how their models could still evolve as more data was gathered. It allowed the developers to be less defensive and negative towards change requests since any such would clearly be limited to those that would contribute to prioritized hypotheses.

We speculate that the explicit value propositions were actually the glue holding together the two main approaches user-informed development and agile development: Perhaps this could serve as a reflection in recent discussions in HCI and Design communities on inherent antagonism between agile development and user centered design, e.g. [4].

3.1.5 Sometimes it is hard to leave
The process of disengaging from the field site can be even more involved than the initial negotiation and requires careful attention throughout the project. In this project, we guaranteed that the field site would be able to resume work as it had happened before our intervention, or they could choose to keep the installed system and continue using the prototype as their own, without any ongoing support from us.

It is critically important to make sure that the field site is fully informed at the outset. Most field sites do not understand the difference between prototypes and commercial products, nor do they have the capabilities to support ongoing development.

In this case it all worked out well. The IT consultant who had supported the clinic before our intervention accepted the task of firming up the prototype. The consultant was able to continue developing a custom solution, which he now supports at several other clinics.

4. OTHER APPROACHES AND METHODS
Our approach builds upon many methods that combine a strong user focus and iterative development. The process in this project was somewhat unique with respect to the composition of stakeholders. For instance the sponsor who is only secondarily interested in the specifics of the clinic solution, versus the clinic staff who just wanted a better IT system and couldn't care less about opportunities for new technologies.

The following incomplete list includes some of the most relevant experiences to leverage.

We are close to the approaches of practice-based ethnography developed at Xerox PARC [15] focusing on the entire eco-system around the work practices; some of the later projects they undertook have similarity with ours, for instance the CalTrans projects, which also informed the sponsor about new requirements to a main product line.

eLab's/Sapient's experience modeling [9][12] was also related to our work insofar their efforts were directly geared towards understanding consumers and markets in order to help clients create new product concepts and services.

Our emphasis on getting working software in the hands of the users as a goal even in the earliest iterations was accomplished by using extreme programming [1] and agile development [3] in the engineering practices. Relative to most frequently used agile methods, our requirement gathering played a larger role, and our engineers took part in some of the early fieldwork.

The fact that we develop and deploy a running system in a specific user environment may call for a comparison with what is often referred to as the Scandinavian approach to system development, for instance [7]. Scandinavian system development typically aims at customized solutions to specific work settings, often through similar processes of prototyping and system integration as used in our approach [10].

Another approach to merge ethnographic exploration and in-situ prototyping is the technology probes [5], "a method for use in the process of co-designing technologies with users […]. Technology probes are simple, flexible, adaptable technologies with three interdisciplinary goals: a particular type of probe that combine the social science goal of collecting information about the use and the users of technology in a real-world setting, the engineering goal of field testing the technology, and the design goal of inspiring users and designers to think of new kinds of technologies to support their needs and desires."

There are major differences though: both the Scandinavian approach and Technology Probes are typically participatory processes with the future users of an IT solution, whereas the user participation in our process was much smaller. Also, in our process the development of a system to be used by the field site was in some way a side effect of the primary goal for the sponsor: gaining insight in more general issues, like the need for middleware component in the multifunction peripherals.

The explicit use of value propositions is another dimension that sets our process apart from the above-mentioned methods. It has significant resonance with Chris Rockwell's work of merging the value proposition work of marketing with contextual design [13]. However, where Rockwell uses the value proposition primarily to scope the project, we go further and phrase each design ideas as a value proposition – in the form of a hypothesis about the value to be expected from a certain technology intervention. Value hypotheses are guiding the prototype development as well as the final evaluation when we assess the extent to which our hypotheses held up. As it turns out, the values proposition came to be a critical instrument in gluing together the user-centric design with the agile or extreme programming style of the actual development work.

5. CONCLUSION
We have described a product exploration that was completed as a multi-disciplinary, user-informed project within a relatively short timeframe.

The project was a dual-purpose project that delivered significant value to both stakeholders: it resulted in a paper driven Electronic Patient Record system that supported actual work processes in the physical therapy clinic that was our field site, and it provided the project sponsor with three different results: experience from practical application of intellectual property that was previously developed in their research lab; requirements for new features in their MFP (multifunction peripheral) devices, and finally general insights into the small health care clinics.

What made this project so successful was, we believe, a couple of factors:

We set out to build a "slim" prototype, that is, the minimal, functioning system that would explore the technology and provide value to the field site. That put a useful constraint on "feature creep" which is typically a source for frustration and budget overrun in exploratory projects.

We maintained a balance between formal structure and space for individual initiative. At the top level, we set up some rather tough constraints, like the overall assignment of calendar time and people time to the process, in particular the 6-months constraint for the full process. At the process level we reduced our dependence on tools with significant learning curves, to allow everybody to participate in the fieldwork (we did not do a similar attempt to "democratize" the program development, though).

Dual-purpose projects like this do raise the ethical question, of how to avoid doing harm to the field site: they put a significant part of their business system in our hands and we had to be fairly confident that our prototype would stand up to the daily use. We don't have an easy answer, besides putting a significant effort into the disengagement from the clinic, even after we have obtained the assessment that was the sponsor's primary interest. As we already mentioned, the clinic in our project decided to continue using the prototype, and they found it gave them good value. When we recently revisited the clinic, after 3 years had passed, we found that the clinic was still using most parts of the original prototype system, now made stable by the IT consultant. The clinic staff found that it had definitely been a win for them. Were we just lucky?

6. ACKNOWLEDGMENTS

7. REFERENCES

[1] Beck, K. (1999). Extreme Programming Explained: Embrace Change. Boston, MA: Addison-Wesley.

[2] Blomberg, J., M. Burrell, and G. Guest (2003) An Ethnographic Approach to Design. In: J. A. Jacko and A. Sears (Eds) *The Human-Computer Interaction Handbook.* Lawrence Erlbaum Associates, pp. 964-985.

[3] Boehm, B.; R. Turner (2004). Balancing Agility and Discipline: A Guide for the Perplexed. Boston, MA: Addison-Wesley.

[4] Cecil, R.F. (2006). Clash of the Titans: Agile and UCD. In online publication, UX Matters, http://www.uxmatters.com/MT/archives/000153.php

[5] Hutchinson, H (2003): Technology probes: inspiring design for and with families. In Proceedings of the SIGCHI conference on Human factors in computing systems, ACM, 2003

[6] IDEO - Deep Dive (1999): Shopping Cart Concept http://www.ideo.com/portfolio/re.asp?x=50029

[7] Kelley, T (2005) *The Ten Faces of Innovation*. Doubleday Press, 2005.

[8] Kensing, F., J. Simonsen and K. Bødker (1998): MUST - a Method for Participatory Design. In *Human-Computer Interaction,* vol 13, no 2, 1998.

[9] Morris, M, and A. Lund (2001) Experience Modeling: How are they made and what do they offer? In *LOOP: AIGA Journal of Interaction Design Education,* Number 7.

[10] Muller, M (2002) Participatory Design: The Third Space in HCI Handbook of HCI. In *Handbook of HCI.* Elsevier Publishing, Mahway NJ USA: Erlbaum, 2003

[11] Phillips, D. (2007) Research to reality: a business perspective. In Cefkin, M. and Anderson, K. (eds.) *Being Heard*. Proc. EPIC 2007 (www.epic2007.com).

[12] Robinson, R. (1999) Things to Think With. In Doors Of Perception 6 conference, http://museum.doorsofperception.com/doors6/doors6/transcripts/robinson.html

[13] Rockwell, C. (1999) Customer connection creates a winning product: building success with contextual technique. In *Interactions*, Vol 6, Issue 1, ACM Press, 1999.

[14] Star, S. L. The structure of ill-structured solutions: boundary objects and heterogeneous distributed problem solving. In Gasser, L. & Huhns, M. (eds.) *Distributed artificial intelligence*, vol. 2, London: Pitman, 1989, pp. 37-54

[15] Suchman, L. (2001) Building Bridges: Practice-based ethnographies of contemporary technology. In Schiffer, M. (Ed.) *Anthropological Perspectives on Technology*. Albuquerque: University of New Mexico Press, pp. 163-177

[16] Wilson, S., M. Bekker, P. Johnson and H. Johnson (1997). Helping and Hindering User Involvement - A Tale of Everyday Design. In Proceedings of the SIGCHI conference on Human factors in computing systems, ACM, 1997