Practical Considerations of Context for Context Based Systems: An Example from an Ethnographic Case Study of a Man Diagnosed with Early Onset Alzheimer's Disease

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Abstract. The meaning of context with respect to computational systems has been the focus of considerable discussion specifically as related to context aware and proactive computing. However, there are no reports of people's direct, experiential understanding of the "lived experience" of context. As a result, there is a significant gap between theoretical approaches for understanding context and the actual practice of context, which is critical for the specification of systems. This paper reports the results of an ethnographic case study that illuminates the practical nature of context and highlights specific challenges for ubiquitous computing systems in general. We conclude that context is simultaneously more subtle, fluid and idiosyncratic than previously reported under theoretical approaches to understanding context. We further suggest implications for the design of computing systems based on these findings.

1   Introduction

In computer science, several researchers have discussed theoretical approaches for understanding context [1–6]. In recent work Dey et al, [4] assert a definition of context that accounts for various abstract states of context. For example, they define context as "…typically the location, identity and state of people, groups and computational and physical objects". That is, while they might account for *variables* they do not) account for the actual *values*. Greenberg further argues that context is a dynamic construct "…a dynamic construct as viewed over a period of time, episodes of use, social internal goals and social influences". Knowing the appropriate variables, e.g., "location", Is but one part of what's required for context aware systems. The appropriate "values" must also be known. And they must be known sufficiently for the system. The question posed to us, then is this: what are the values and under what conditions can they be known to the system?

   Like context, much of human culture is often "in the background" infusing everything people do in their daily lives. Ethnography, literally "the writing of culture", was developed as a way to represent culture, informed heavily by the often unvoiced underpinnings of societies. Over the last decade, ethnographic techniques, such as participant observation, shadowing, contextual inquiry, etc., have been adapted and applied to a wider variety of settings, including more recently business settings and

questions arising from other academic disciplines, e.g., aging [6]. In this paper, we present our use of these techniques in a case study to understand the lived experience of context [7].

We suggest that *values* far out weigh the importance of the *variables* in the design of context aware systems, although it is the variables that have been previously discussed in the literature. Specifically, based on the case study described herein, we suggest that context is often qualitatively subtler than has been previously suggested, more fluid and more idiosyncratic – often simultaneously. Further we suggest that it is not merely a matter of more research or more time but that the many – often simultaneously occurring - *values* that define context at any particular moment are fundamentally unknowable in anything but the most constrained situations. We hasten to add that we have not abandoned ship. Rather, we should make some course adjustments, taking into account what we do know and differently supporting situations in which the proactive understanding of context may be an untenable ideal. We offer some possibilities of this at the end of this paper.

1.1   Background to the Case Study

As we've stated, context is often heavily "backgrounded", that is, it's tough to put context into high relief such that we can know it when we see it. In these situations, a useful technique is to identify contrasting environments from which one can more readily discover what's fairly well hidden.

In this case, as part of a much wider project related to context aware computing, we were fortunate to meet "Bob" a 57-year-old male diagnosed with early Alzheimer's Disease, with whom I (the first author) spent two full days "shadowing" his every move (see Methods below). As part of a previous project, we had interviewed Bob and his wife, Carol, in considerable depth and thus had quite a lot of relevant background knowledge about Bob and Carol before we began our two-day shadow. In addition, we have been able to set Bob and Carol's observations within the context of numerous other observations through out the general course of the wider project.

Bob was diagnosed with early onset Alzheimer's at 55 years of age. There is a strong family history of the disease from his father's side and both he and his wife (Carol) were sensitive to indications of the disease. As a result of some early, albeit isolated, incidents, both Carol and Bob harbored suspicions. A few years later, he underwent genetic testing, which revealed the presence of the late onset APOE-4 gene from his father, which was expected, but also from his mother, which was a surprise. Having genes from both parents appears to change its expression from late onset to possibly early onset. Subsequent testing resulted in a diagnosis of early Alzheimer's.

At issue for our purposes is that Bob is in many ways uniquely suited as a candidate to participate in this sort of ethnographic work. Bob and Carol rank among the most trusting and sensitive couples I've had the privilege of knowing (ethnographically). Of particular relevance is that they are quite perceptive to subtle changes in their behaviors and are especially self-reflective. For example, prior to his retirement last year, Bob practiced family therapy. His skills and training lend themselves to both self-reflection and to a positive resolution of difficulties. In their own words they are also "…children of the 60's". They are very open and I daresay have a bit of the activist about them in their pursuit of information and care for Bob, working with

the local Alzheimer's association, giving TV news interviews and even preparing for congressional testimony in April of 2003.

What's relevant to this work is that Bob's condition highlights important elements of context that appear to be increasingly relevant as his short term cognitive memory degrades (as a function of the disease process). Bob's condition places "context" in relief and permits us to "see" the attributes of context more clearly and more readily than we otherwise might. However, these attributes are not unique to Bob or to disease conditions generally; rather, they are simply more concentrated and observable. Thus, Bob, in this case, is a fair proxy for understanding attributes of context more generally. It's clear all of use rely heavily on "context" in our day-to-day lived experiences, but that it is simply more difficult to observe and delineate. Context is everywhere, if subtle [8]. In Bob's case, context is simply a bit more observable.

2   Methodology

In practice, the use of ethnographic techniques is less of a procedure and more of an exploration; inevitably the real world poses variability requiring one to make on the spot adjustments. One must have a fairly good idea of one's purpose, but how one achieves that purpose may evolve within some constraints.

As mentioned previously, we'd conducted an extensive contextual interview – in their home, on their time, with their artifacts – prior to these two days. Shadowing is a technique by which one acts as "a shadow, ever present, but out of the way. Participant Observation is a technique in which one is present and contributing to the activity and through the contribution, learning about it. Over the two days, depending on the circumstances, I would switch between shadowing and participant observations as appropriate.

I was particularly interested in observing Bob over the course of the two days going about his normal activities – from before breakfast until after dinner, roughly 7:30am through to 8:30 pm. We hesitate to say "perform routine activities" or "conduct his daily tasks" as both linguistically presuppose certain characteristics of linearity, efficiency and effectiveness often not presence in the daily lives of people. Throughout I attempted to maintain a certain distance as appropriate and when I was able. For example, while Bob was preparing to go grocery shopping, I mostly observed (shadowing): taking photos, making notes and occasionally taking video except when Bob offered commentary or asking me to do something that required my participation (e.g., putting something in the car, participant observation). Bob also provided frequent running commentary, which would be a form of a "talk aloud" verbal protocol that he did on his own, albeit for my benefit. I relied on my notebook and on the still image and video features of my Sony DSC 707 digital camera.

One of the symptoms of Alzheimer's is a reduction of short-term memory, i.e., forgetting things. Throughout the two days, I could easily have been Bob's reminder system. However, I wasn't. I did however, act as a "cognitive aid" at certain times characterized primarily by two elements: a) having already witnessed his own repeated failure to remember, e.g., passing the post office for the fourth and last time that day and having not yet mailed the letters in the car's dash, the letters he saw every time he got in the car saying "Oh, I've got the mail those", or b) waiting until the last possible moment before averting a "catastrophic" error, e.g., reminding him to

take his gym back as we were pulling out of the garage to go to the gym. In other words, while I tried to not be present, I nevertheless was and therefore had to make accommodations for the research by choosing when and how to interfere.

3   Results

According to David Shenk's, *The Forgetting, Alzheimer's: Portrait of an Epidemic,* it's the little things that begin to fade [9]. Small, inconsequential "lapses", indicate the beginnings of an inevitable decline. Indeed, it's the "little things" that seem to be fading for Bob. He referred to his condition as "progressive incompetence" and the many and varied lapses as *tiny incompetence's*. Little by little, foundational elements of "doing things" randomly begin to flicker on and off and finally don't turn back on. Bob retired almost a year ago, his last year at work fighting the small memory losses that occurred with increasing, but unpredictable frequency. It was a stressful year. Now he's without that stress, but he and Carol must deal with the slowly mounting stress of a partner who is slowly fading away. It brings to mind the Chinese proverb of the frog in a pot of heating water.

Bob and Carol had returned two days previous to my visit from a cruise vacation in the Baja Peninsula. Bob had to get the house going again. They had a list of chores to get through. Over the two days, Bob prepared a grocery list, went shopping, prepared his bag for the gym, went to the gym, bought tickets for a lecture at a local community college, posted some letters, picked up the mail from his mailbox, prepared three meals each of the two days, took two naps, prepared to go skiing but went for a short hike instead, took care of his correspondence and conversed with me about his days and interests. To assist Bob in his daily chores, he maintains a master list of the "things he has to do" for the day. This he keeps in a green stenographer's notebook that almost always sits by his chair or on the dining table.

We will focus the bulk of my comments on his correspondence, or what he called "going through the mail". It is a common enough activity to most of us as to be broadly relevant; but it is also deceptively simple. In fact, it's among the simpler of Bob's activities that we can talk about in this paper, cooking being be far the most complex and, as you will see, from the point of view of a system being contextually aware, "going through the mail" is sufficiently complex to occupy the remaining space of this paper.

3.1   Going through the Mail

One of these little things fading for Bob is his ability to go through his mail, make a decision about each item, and act on it both immediately and at a later time, as warranted by the content of the item itself. In Bob's case, he goes through the stack, makes a decision on what becomes the "last one" and then goes through the stack again, making the same decisions again, then acting on the new "last one". Or, perhaps, in the second time through, he reorganizes the list spatially (one small pile here for emails to write, one pile there for phone calls to make) only to almost immediately forget what the piles mean and to again go through the list. This itself is of interest,

but for the purposes of this paper, I'd like to examine what he did to respond to one particular letter, that from "Marsha".

We describe the event here and discuss it in the subsequent section. Bob has already decided (based on a master list of activities for the day) that he needs to call Marsha in response to her very nice card she sent after seeing him on the TV news. That is, he'd already written "Call and thank Marsha for her letter" on his master list. Bob prefers making phone calls to email or writing letters – and says he always has. Bob also believes – always has – in responding to correspondence, especially heartfelt correspondence. Bob worked with Marsha about 20 years ago on a project examining TV violence. On Tuesday (the first of my two days with Bob) Bob and I were in the grocery store and Marsha saw Bob and came up to us. Bob didn't recognize who she was, but after she introduced herself again, he remembered their relationship. In fact, Marsha explicitly thanked Bob for his return phone call. On Wednesday, Bob has "Call Marsha" on his list and proceeds to go through the mail.

1. Bob looks to see what's next on the master list.
2. Call Marsha. He decides to call Marsha, questions who she is and proceeds to go through the mail.
3. Flipping through the mail, he finds a card from Marsha. He re-reads the card: "That's nice."
4. He looks on the card for a phone number. No number.
5. Is there an address? Yes. He decides to get the phone book (from a cabinet in the kitchen not far away). He sits down.
6. He looks back to the card for the name. (See Fig. 1.)
7. Opens the book to "Smith". He realizes there are many Smiths. (It's not really Smith, but it's of similar ilk.)
8. He looks back for the address and it almost seems like he physically gets a hold of the address "19 Kitchen Hill". He decides to search the phone book for the number based on the address because the writer is a woman who's probably listed under her husband's name. He finds Smith: on 19 Tree Hill, 19 Pioneer, 19 Pottery Hill. No luck.
9. New decision, he'll have to write to her instead. He does have the address from the card.
10. He annotates the list and the envelope. He writes a note on the envelope and then highlights the note on the envelope because otherwise "he won't see the note."
11. The envelope is put back into the general mail pile.

As Bob begins in steps 1-5, he sees "Call Marsha" on the master list that he needs to check off. He moves from the list to mail pile. Then he's got at least two things to do: *find* Marsha's letter (in order to) *call* Marsha. As he passes each letter he rejects it as not being from Marsha. He finds the letter and re-reads the card, comments "That's nice". Steps 6-9 comprise a fairly complicated process, but he manages. In steps 10 and 11, Bob annotates the envelope and then replaces the letter in the pile. After realizing the phone number is not to be found, he opts for writing a letter and annotates the envelope as such and furthermore, highlights (with a bright yellow highlighter he keeps nearby) the note he just made because "…otherwise I won't see the note." He then puts the letter right where he won't lose it: in the stack. (Note: Erikson [10] has previously discussed the robust benefits of real space to structure interactions.)

Fig. 1. Step 6 – Bob looking back to the card for the name after getting the phone book.

4   Discussion

Bellotti & Edwards [1] list three relevant characteristics of context aware systems: a) they infer human intent, b) they mediate between people and c) they must be accountable to their users. To achieve these ends, context aware systems must be intelligent, i.e., they must be able to represent what they know and they must enforce accountability based on their inferences. According to Bellotti & Edwards, to be intelligent and accountable, context aware systems must understand context, the most relevant characteristics of which are listed here: identity of relevant people; arrival, presence and departure of relevant people; status and availability of relevant data and actions and their abstractions, such as, "waiting" or "busy"; the purpose and the social rules of the current situation, which in Bob's case might be: correspondence and at leisure.

   We rely primarily on Bellotti & Edwards as a theoretical approach for understanding context in this case study because they rely heavily on earlier work and are thus a summary of work to date and moreover, they provide design principles, which we understand as intended to guide design, and which include: a) informing the user of current system capabilities and understandings, b) providing feed-forward and confirmation feedback, c) enforcing identity and action disclosure, such as who is that, who did that, etc., and d) provide control to the user relative to the system.

   One possible caveat we mention at the start is that many of their design principles will be familiar to those who design interactive systems, which is, to some extend not the point of a context aware system and moreover not the point of a proactive system [11]. Yet, the principles are sound and they rely on elements of human context in order to act. Thus, these principles, if anything, should be more conservative than what one might offer if one were designing a more extreme proactive system; thus they will suit our purpose here: to examine the meaning of context in within this one relatively simple example.

Let's start with Bob's list. He made the list last evening before bed. By morning, the list had moved to the table where he eats breakfast from the chair in which he sits in the evening. At what point might a context aware system begin assisting/mediating for Bob? Does the system need to know where the list is? Does the system suggest finding the list? If Bob begins taking action on something not on the list, e.g., making breakfast (which was not on the list), should a context aware system note this, mention it to Bob in some way, or perhaps suggest something for Bob to do that is on the list? Does moving the list from the floor near the chair to the table mean he's about to start something on the list? Maybe it is. Maybe it's not. How is a system to know? The value of the notebook's location: on the floor, on the table, may or may not have meaning and it's meaning may be different depending on something known only to Bob. For example, he moved the list off the floor because he's going to vacuum the floor. In the case of an assisting system, suppose that Bob, who has Alzheimer's, moves the list from the chair to the table and then gets "stuck". What was he going to do? Go make breakfast, use the restroom, vacuum or commence with the list? In other words, it's not merely difficult to know where to start – where to start may not be knowable until Bob starts something.

This simple condition – where and when to "start" is a fine example of what we mean by context being **subtle**. It may not even be clear to Bob what his intention is. He may have moved the list intending to start something, then decided to make breakfast instead. If it's not clear to Bob, can it be clear to the system? Which of Bellotti & Edward's elements of context is relevant to the system? To Bob? Perhaps the system should maintain an ongoing dialog with Bob to make that determination. Bellotti & Edwards do not mention that the system may need to work with the user to figure out what it needs to know, though they do suggest the user should exercise control. Should the system inquire whenever it is unsure? What does uncertainty mean for a system in situations of this sort? Do we think Bob wants to be queried by his walls before his morning coffee?

After breakfast, Bob sits and begins to go through his list. Physically, Bob picks up the list and looks at it. He thinks: some items are for later – they are passed over. Some items are for now. Correspondence is now. He decides to give Marsha a call and thank her for her card. One imagines that the system could (and maybe should) provide Marsha's number. But how does the system know that Bob is going to call Marsha: so far, Bob has merely looked a the list. This is another example the subtlety of context. There were about 8 items on the list. Bob decides just by looking. In fact, he may have decided after looking at the last one, not at the item "Call Marsha". In lieu of the system actually knowing the context, what's a poor system to do? Bellotti & Edwards' design principles suggest a solution: The system might have inferred that Bob has decided to do something from the list from his picking up of the list. The system could, it would seem, at this point, reasonably make an inquiry.

A proactive system could provide Marsha's phone number. That much is obvious. However, Bob doesn't want to call her just yet. He doesn't remember the letter, and to make the call means responding to her letter, which he evidently wanted to read again (because he did). Even if the system had indeed inferred correctly that Bob wanted to call Marsha, how could it have known that Bob also wanted to read the card? This is a very good example of how context can be **fluid**. Subtle, seamless shifts from one "contextual milieu" to another suggest a fluidity of context, and yet, based on a logical categorization of activities and stimuli, could easily appear to be quite a different

task: going through the mail. That is, a system might infer from Bob's actions that the mail is now the focus of his attention. And it is, albeit in the service of calling Marsha. That is, his reading of the card is not a necessary step in calling Marsha in the abstract; though, for Bob, in this case, it certainly is. (In other examples from Bob's days, context could shift as seamlessly but far more severely, e.g., from cutting potatoes to watching TV because he heard something that interested him; but oh how casually he switched his attention and the context of what he was doing. Should he have been prompted to get back to the potatoes?)

Of course, it's quite unclear how the system could ever know about the letter. Also, who is Marsha? Bob hasn't talked with her in 20 years. Bob perhaps needs to tell the system about Marsha. When did he do this? Did Marsha change her phone number or address? Did she leave a new number in the letter? Bellotti & Edwards [1] discuss clearly the need for the system and the human to have access to information. But for the system to have access to the letter and to link that letter to the list item "Call Marsha" seems a bit improbable.

Even a simple solution can become quite difficult. For example, suppose rather than a green steno notebook, Bob keeps his list on a palm pilot or other hand-held device (e.g., the "activity compass"). Ticking a box near "Call Marsha" would tell the system what the steno book can't. It's easy to imagine. But Bob doesn't like palm pilots. (Bob doesn't carry a cell phone. He doesn't have a beeper. Bob used to carry a portable voice recorder he'd use to remind himself of things; he still uses it as an audible reminder system, but only in the house.) One might assert that using a palm pilot is better than using a steno notebook and is, therefore, the lesser of evils, and Bob should simply acquiesce to the palm pilot. Yet, Bob likes the notebook and at least one reason is that he can easily look back and see all the other items on his prior lists. In fact he stated explicitly that he used to cross off the items until they were illegible; then he switched to a line so he could see what he'd done. Bob is living Bellotti & Edwards' principle of providing status and abstractions of status. And yet, in so doing, a palm pilot would take a good bit of that ability away.

He actually thought about a palm pilot or similar device in his last year of work, but decided against it. Besides, he already had his voice recorder. We must accept that Bob has chosen the steno notebook. We must accept that people do not act in ways others might define as rational. This choice, in addition to his way of going through the mail, is Bob's idiosyncratic way to do things. In fact, there are layers of idiosyncraticity – the notebook, the letter re-reading, his desire to respond with phone calls rather than writing, the list movement, the list placement, the piles of the mail, etc. Thus, the context that surrounds his way of "calling Marsha" is therefore, **idiosyncratic**. Bob's choice of the Green Steno Notebook is but one of many choices he has made over his day, his week, his life. Finally, Bob is again exercising his control of the system by choosing the steno notebook, just as Bellotti & Edwards might suggest. (From the perspective of Alzheimer's. Bob's life strategy of "going through the stack" of mail and making decisions is now failing him; his ability to unlearn a fairly automatic process and relearn a new one is limited – years and years of "going through the mail" has had an effect.)

It sounds trivial, perhaps, to simply assert Bob's choices as an additional challenge for proactive computing in this example. But it is potentially a very real challenge, especially for a man with Alzheimer's. At this point in the disease progression, albeit early as it is, Bob would be hard-pressed to learn how to use a hand-held device. To

wit, as we were looking for a frozen stream to hike on Wednesday afternoon, Bob expressed his interest in learning the use the GPS device he has at home. He's highly motivated to learn the device because he simply loves to hike and is loathe to give-up his solo hikes and he knows that a GPS might help him not get lost. But it's "far too complicated" for him to learn, he said, and wishes that someone would spend about 4 days with him to teach him each function, one at a time, as he needs to use it. He's hoping that someone will help him this spring or summer "…before I lose the ability to learn how to use it at all," he said.

Bob was looking for Marsha's letter. He finds it, re-reads it, comments, and then looks for her number as described above. Now, of course, the system, were it to know who Marsha was, could provide the number. In lieu of that, the system could, one supposes initiate a dialog with Bob: "What's Marsha's last name, Bob?" "What's her address?" and proceed to find the number. Not finding the number, Bob decides to write instead, which will be at a later time (**fluid**).

Skipping to step 10, Bob annotates the envelope with a note and then he used a highlighter over that. Bob's compound annotation was written directly on the physical artifact and not, for example, on the master list. For Bob, the task seems linked to the letter rather than to the master list, which is not annotated at all. Moreover, Bob seems to know he needs to be visually stimulated and uses the highlighter to provide himself a contextual cue. (McCarthy [12] suggests that perhaps visual contextual cues might be more relevant to Alzheimer's patients than to others. There may be some validity in this, which requires further work.)

For Bob, the context of his decision is carried by a) his memory, b) the tangible artifact, c) his physical annotation, d) his additional visual stimulus, e) the letter's position with the other letters in the stack and f) the fact that "Call Marsha" is not scratched off the master list. All of these elements are covered by Bellotti & Edward's framework: *status and availability of data*, an *abstraction of status* (will write a letter, which he knows is a secondary decision), *feedback* (*in-process* and *confirmatory*, ironically, which he provides) to himself about his progress to date, *capture of information* relevant to the status of the letter and *subsequent access* of that information (by being in the stack). While Bob's contextual information is theoretically accounted for within Bellotti & Edward's framework, the practical elements – the values – of Bob's context remain *subtle*, *fluid* and *idiosyncratic* and for many intents and purposes remains practically unknowable *a priori*, mostly likely *ad hoc* and perhaps only possibly *post hoc.*

Bob made his list on Tuesday evening. Bob saw Marsha in the store Tuesday afternoon and they talked of the card and his return call. Wouldn't it have been nice if "Call Marsha" would have never made the list that evening.

5   Implications

In theory, there is no difference between practice and theory; in practice, there is. We find this to be an example of this famous quote. While Bellotti & Edwards' [1] theoretical approach – and others (cf., [4], [13], etc.) – seems adequate for encompassing the various categorical elements of context evident in Bob's way of going through the mail, they fail to predict or explain the subtle, fluid and idiosyncratic nature of Bob's

"context". Further analyses with other activities may be warranted to more fully examine the frameworks offered.

Theoretically, the abstractions enumerated in the referenced papers account for going through the mail. Yet practically, none of them accounts for the precise details of what context is or how it is maintained. Designing a "proactive" system for cognitive assistance requires accounting for the specifics of context, not just the abstractions. But since the specifics are mostly unknowable, our ethnographic evidence suggests that one simply cannot design such proactive systems in this way. All that this means, however, is that we must shift our research and design emphasis somewhat to accommodate these conditions.

For example, consider Bob's feelings about his green steno notebook. From the perspective of context aware design, one might consider that computational systems must blend with the extant "ways of doing things". That is, the components of the system must not dictate the process, but must, as Weiser [14] suggested "weave" with the long term "way of doing thing" and that it might, over time, work with the person to evolve the system cleverly, perhaps offering new elements of context at just the right moments such that they are useful but so that they don't require new learning. The system remains "invisible".

It's intriguing to postulate that proactive systems, to be effective, must do the learning and that the person with Alzheimer's disease – or indeed anyone - perhaps does no new learning. That is, the person needs to learn nothing. That would be optimal, of course, for Alzheimer's. But what sorts of technologies would be relevant?

A steno notebook comprised of electronic paper might be a good starting point. There needs to be a means of system input that's familiar to the patient and that requires no more management than what they know. A digital notebook that could also sense what's on its list might be terrific. For example, his list could inform Bob in a timely fashion of things to do, for example, remind him to take his gym bag with him when as he's driving out of the garage – not because the system knows when he's going to the gym, but because the bag was packed and the list knows that "go to the gym" is on the list. Actuators strategically placed can coordinate information among the notebook, the gym bag, recent action within the gym bag (it was packed) and a tag in the car that notices the bag is not in the car, but the car is leaving the house and it informs Bob in some pleasant way.

Similarly, in Bob's case again, linking what's on the list – in his writing, with his marks – with activities he's doing would be terrific. For example, his list says "Call Marsha". A digital notebook could "reveal" Marsha's phone number on the list without Bob having to do it. Of course, this takes an enormous amount of coordination. (For more on annotations, see [15]). Another sort of technology would be pens that write with ink, but whose motion transmits what's written to "the system". The system should be able to make certain inferences about what's been written and coordinate with the list and all the other tags and actuators.

In the example from this case study, embedding technology in everyday activities seems to be more about technology becoming, as Weiser said, "invisible", superimposed, or perhaps, under-imposed, on daily activities. Replacing the steno notebook with digital paper is one example. Co-opting the motions of what's otherwise your average pen is another. Adding a few tags to common devices and coordinating their meaning. Embedding technology in such as way as to exercise control, to predict

activities, to explicitly enhance and replace cognition in situations that require detailed understanding of context seems rather impossible. To work at the periphery, to coordinate among perhaps simpler, less contextually demanding activities and embed technology appropriately in the situation Gershman, McCarthy & Fano [16] would be of valuable assistance , not only to people with Alzheimer's, but everyone. This is one possible approach for creating supporting technologies. A second approach follows.

In Foucault's [17] master's thesis at Cornell University, she applied to adults an internet search strategy she designed for children. In the children's version, a child enters a word, e.g., tiger. The system returns images of tiger in various contexts. Kids, unable in their elementary years to manipulate language appropriately for Boolean searches can nonetheless identify (though cannot necessarily verbalize) attributes of images relevant to their searches. They then select an image, which is a proxy for verbal attributes we might otherwise enter in a "traditional" search. Perhaps, a similar search technique works for adults, albeit differently. Adults see the images, which initiates a string of associations otherwise not considered. The user can continuously modify the search based on the context of the images without being verbally specific about the context – indeed, without being specific at all. The crucial factor is that not once does the computer know anything about "context" or "intention" as the interaction is entirely under the user's control, and yet can deliver a satisfying experience

For people with early Alzheimer's the difficulty is exactly that the person cannot completely control their interactions with a system. An obvious, but we've argued flawed approach is for a system, as a cognitive prosthesis, to assume increasingly amounts of control over time. Using Foucault as a guidepost, suppose that the system does not assume control of the interaction, but rather acts much more subtly, making unconscious and ambient suggestions to the person. The system could act, less like a drill sergeant and more like a friend making gentle suggestions less precise, but sufficiently accurate perhaps to stimulate memory.

We offer one simplistic example as illustrative of our point, but by no means sufficient. A display occupies the top of the refrigerator. The "system" knows things it knows: time of day, presence of person(s) in the kitchen. That's it. The display is perhaps a washed out image of the kitchen itself. The system can flash images superimposed on the system – a grocery list, a sandwich, a cup of coffee, etc. The point is not to tell the person what to do, but perhaps to jog a memory trace based on a fleeting image, as a possible reminder in the periphery and encouraging the user to perhaps interact with it in some, hopefully subtle way. Smaller displays around the home, e.g., positioned as picture frames, might serve not only to show photos of family and friends, but also as casual, suggestive mechanisms - that can be ignored - and that don't necessarily seek to control the interaction. That is, if we can't know the precise context, can we support in the periphery by providing an enabling environment rather than one that must anticipate and act on the users' behalf?

6   Conclusions

In this paper, we described the deceptively simple example of Bob responding to a mailed greeting card wishing him well. It is, as Tolmie et al. [8] asserts, a rather "unremarkable" routine that "places powerful requirements on any technology that might

become embedded in such activities," (p 406). We suggest the further step, however, that proactive computing is less what computing can do for people, that is, on their behalf [11], but rather what computing can *enable people to do*. We focused on what Bob wanted to do - his goals, desires, and needs. Focusing on people, rather than on what technology does, enables us to design appropriate ubiquitous systems that will actually work "unremarkably" in the world [8].

The example was extracted from a larger ethnographic study of Bob, a man diagnosed with early onset Alzheimer's disease. We examined this example in terms of Bob's context as relevant to ubiquitous computing systems. In our examination, we find that the actual values of context, e.g., Bob's notebook location, may or may not vary, but that the meaning of these values themselves can and do vary independently. Further, the values and their meanings can be very subtle to start, and based on something Bob does, their meanings can change almost as if in a flow, i.e., fluidly. We also find that Bob's "way of doing" is just that: Bob's way. The meanings he applies to objects and their attributes and the meanings he extracts, in addition to being subtle and fluid are also idiosyncratic. Finally, we find that these characteristics of context are often expressed simultaneously as Bob goes about living his experiences each day.

Context aware systems that attempt to know what's happening and to guide a person through certain activities in lieu of their own faculties may be overreaching rational boundaries into that of human lived-experience which is more often than not, not as rational as we might like. It may be not only difficult, but also impossible to provide this level of rational support for any activity except for those in the most constrained and proscribed situations. We find advantages to approaching assistance from the periphery by designing systems with that enable human touch-points, rather than trying to reduce them. The examples we've mentioned offer only the briefest of possibilities. There are innumerable ways ubiquitous computing can not only assist people with Alzheimer's disease, but also in which ubiquitous, appropriately context aware computing systems can facilitate the ever increasing complexity of our daily lives.

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