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Model-Driven Inquiry

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Abstract. Model-driven inquiry is an agile approach to investigating user requirements that reduces the need for field study by reversing the popular process of contextual inquiry and other ethnographic approaches. Instead of gathering data from which to build models, models are built in order to simplify and shortcut data gathering. The technique and its rationale are described and compared with contextual inquiry and combinations are explored.

Introduction

What do users need? Every usability professional knows that to design truly usable and useful products requires detailed knowledge and deep insight about users and user needs. But how do we gain such knowledge and insight? Although many diverse techniques can be used, the gold standard for user studies is ethnographic field research. Arguably the best known and possibly the most widely practiced ethnographic approach to field study for gathering user requirements is contextual inquiry, the technique popularized by Karen Holtzblatt and Hugh Beyer (Beyer and Holtzblatt, 1997). Contextual inquiry is a well established and effective part of the usability professional's toolkit, but it is not the only way to learn who your users are and what they need from you.

Model-Driven Inquiry is an alternative approach with a solid real-world track record and some distinctive strong points. It is a systematic, model-based approach for quickly and efficiently building a clear and comprehensive picture of users and their needs. In some senses, model-driven inquiry turns contextual inquiry and conventional ethnography on their heads, so it is perhaps best understood with these latter as a frame of reference.

People Writing

Ethnographic research, the core qualitative approach of cultural anthropology, is a means for understanding a human culture. Its primary method is participant observation, in which the ethnographer becomes an observer, but one who is immersed and fully engaged within the cultural context being investigated. The purpose of this apparently paradoxical positioning is to

overcome what anthropologists call the etic perspective—the outsider's existing cultural frame of reference—to obtain emic understanding—the insider's experience, viewpoint, and insight.

Central tenets and principles of the ethnographic method include complete immersion in a context, holistic study and interpretation, and in-depth exposure and analysis. A core strategy is known as triangulation of data, that is, conclusions and findings must always be based on multiple sources and be reached from multiple directions. Neither a single observation nor many observations in a single form are considered sufficient. Ethnography, at its heart, is based in narrative exposition and analysis; it is about stories and storytelling. Indeed, the very term itself has Greek roots meaning "writing about people." Ethnography is generally recognized by its proponents and practitioners as intrinsically interpretive and not replicable. Thus no two ethnographies—even of the same cultural phenomenon—can be expected to be fully congruent.

Contextual inquiry is a proven technique of requirements elicitation grounded in the ethnographic tradition. Contextual inquiry is itself based on the core principles of (a) understanding in context, (b) partnership with the subjects of inquiry, and (c) focused investigation. Understanding in context means simply that knowledge and insights about users and user needs must be based on direct observation and discussions of work or other practice in the actual ordinary setting in which that practice does or can be expected to take place.

The principle of partnership means that the investigators regard themselves not as researchers dispassionately studying subjects but as collaborators engaged with practitioners in a joint effort to understand and make sense of their work practice. Insight emerges interactively.

The concept of focus represents an explicit statement of assumptions and beliefs about what to accomplish in an investigation, comparable to what in ethnography is referred to as the guiding question. Focus not only shapes the inquiry process but also helps in exposing and clarifying the etic framework. In practice, focus setting can be established in varied ways. Although brainstorming and discussion are probably most common, other possible approaches include preliminary investigation using focus groups, surveys, or other techniques to narrow and frame the inquiry.

Once the broad objectives of investigation are established, contextual inquiry moves to what may often be quite extensive and extended data gathering from the field, through discussion, interviews, and other techniques, but primarily by participant observation. Such field research, if carried out diligently, may involve extended periods of participant observation generating great quantities of data. It is not uncommon to end up with hundreds or even thousands of sticky notes or index cards representing the sundry bits and pieces of observational data. This mass of collected data is then categorized and organized using techniques such as affinity clustering that seek to identify categories and groupings of information from the data itself. Initial models are then developed from the analyzed and categorized data, and overviews emerge from or are abstracted from the welter of detail. This is an altogether rational and scientific research paradigm that clearly reflects its methodological roots in the social sciences, notably anthropology. Using what is classically known as a grounded theory perspective, field study generates data and observations which are, in turn, analyzed to finally yield ideographic theory (a theory of a specific context) or, more modestly, models.

In practice, of course, what practitioners call contextual inquiry can differ radically from the official and formally defined approach. I have seen cases where a scant hour of observation and interview quickly written up as a single page of notes was described as a contextual inquiry, but these are hardly in the spirit of either ethnography or its adaptation to gathering user requirements.

Contextual inquiry builds its picture of users and user needs through construction of a series of five fairly elaborate models, all derived from and based in the data obtained through field study. These include a Flow Model which represents the coordination, interaction, and responsibilities of participants within a work practice, a Sequence Model that outlines the steps to accomplish an activity, a Cultural Model that is intended to capture the norms, influences,

and pressures within the work environment, an Artifact Model that includes the documents or other work products that structure or contribute to work, and a Physical Model that describes the physical environment where work is accomplished. Again, the models and their form bear the clear stamps of their social science origins in anthropology.

Driving Models

In contrast, model-driven inquiry is a purely pragmatic child of necessity, the result of work on projects with compressed schedules, inadequate budgets, and little or no institutional support for rigorous research in the field. In the interest of streamlining the inquiry process, model-driven inquiry turns the scientific rationale of contextual inquiry on its head. Instead of gathering quantities of data as the basis for building models, it builds models as the basis for gathering limited data. The rationale for this inversion from inductive to deductive process is simply to reduce the need for potentially expensive and time consuming field research to the barest minimum necessary for confidence in the models.

Model-driven inquiry is based in the exploratory modeling methods developed at Siemens in Germany (Windl, 2002) and borrows techniques from Joint Essential Modeling (Constantine & Lockwood, 1999). From its ad hoc beginnings, the approach has evolved through practice on multiple projects into a streamlined and simplified agile alternative (Constantine, 2002) to ethnographic approaches.

The rationale hinges on one of the often unacknowledged shortcomings of ethnographic inquiry, that large quantities of data are compiled only to be radically reduced to generate relatively limited amounts of insight. It can be argued that extensive observation is needed in order to expose those insights and to ensure sufficient confidence in conclusions. On the other hand, it often seems in retrospect that a great deal of time could be saved if only the investigators had started out with some idea of what to look for. Then again, how could they have known? That is the question that lies at the heart of model-driven inquiry.

In outline, model-driven inquiry is a straightforward process:

1. Build exploratory models.
2. Compile emerging questions or issues.
3. Select expeditious means for answering questions or resolving issues.
4. Conduct limited, highly focused inquiry.
5. Refine and complete the initial models.
6. Review and validate the models.

Exploratory Modeling

Model-driven inquiry begins by building simplified, provisional models of user requirements based on whatever information and insight might be available at the time. Typically these models are in the form of simple inventories or lists, such as a list of all activities in which users are or might be engaged. The purpose of exploratory modeling is twofold: first, to create preliminary models, and second, through the process of modeling, to uncover areas for investigation.

A frequent objection to exploratory model at the outset of a design effort is that there is no basis for modeling, that one cannot model what is not understood. How can we possibly know anything about users and their needs without first doing research?

In the real world, however, there is no such thing as a blank slate. We always know something, even if it is incomplete and, at least in part, incorrect. And there are lots of things to draw on, including past experience, both personal and professional, related systems and applications, previous versions or editions, and the emergence of perspectives from the group process itself. In many cases we will already have a variety of resources before we even begin the work of requirements modeling and interaction design, including artifacts such as mission statements, preliminary requirements documents, strategic project plans, market studies, or competitive

analysis. All of these can contain valid and informative material that is, unfortunately, intermixed with noise, nonsense, contradictions, as well as wrongheaded conclusions and assumptions. One of the byproducts of exploratory modeling is to expose these limitations and problems in what we think we know.

We build systematic models drawing on the background material, prior knowledge, and assumptions instead of merely discussing the matter because the discipline of more rigorous modeling facilitates uncovering unknowns and ambiguities. In principle, we could use almost any models for this purpose, but because we are not creating throwaways but rather developing provisional or initial forms of models that will eventually guide and inform our design process, it makes sense to use moderately formal models that are useful as input to interaction design. For example, use cases and personas are two popular models that could be used in exploratory modeling.

My own work takes an activity-centered approach to understanding user requirements. Recent critiques of user-centered and human-centered design (Constantine, 2004; Norman, 2005) have argued the case that the primary focus of design should be not so much on users themselves but on the activities in which users are engaged. For exploratory modeling this focus translates into three simple inventories (lists, catalogs) that are intended to capture the essence of user needs. These are an **Activity Inventory** that catalogs the immediate and proximal (nearby or adjacent) human activities within which use of the system will take place (Constantine, 2008), a **User Role Inventory** that identifies the roles that users will play within those activities in relation to the system being designed (Constantine, 2007), and a **Task Inventory** that compiles all the tasks (use cases) that users will need to perform in the course of those activities. Where a simple name is not enough to make clear what is meant by a given activity, role, or task, a short description might be generated. In general, however, only a minimum of detail and refinement are generated at this stage.

Exploratory modeling is probably best carried out in a workshop setting with anywhere from three to as many as a dozen participants. There are two principal variants on who might be recruited to participate. In the expert-driven variation, participants might include not only interaction designers,

Activities, Roles, and Tasks

Activities, roles, and tasks are three closely related concepts that help design and usability professionals organize what they know and understand about users and user needs. The notion of human activity derives from activity theory, a framework that has been particularly productive for informing design.

In human activity modeling, a systematic modeling discipline based on activity theory, an activity is a loosely ordered collection of goal-oriented tasks or actions contributing to a shared or common purpose. All activity is mediated by artifacts and performed by actors (participants) within specific roles. Activities take place in a context of place and time and are shaped by a both implicit and explicit rules. An activity is not a specific, focused, narrow process with a simple, direct objective, but a broad, amorphous composition of tasks and actions having more specific goals that contribute, whether directly or indirectly, to the broad purpose of the activity. For example, exploring the city of Pisa might be the activity. Locating the famous Leaning Tower on a GPS device might be a specific task within that activity. Following the turn-by-turn directions from the GPS device might be another.

A role is a differentiated collection of responsibilities and represents a particular relationship to both other players in an activity and to artifacts of interest. The GPS-using self-appointed guide might be a role within the activity of exploring Pisa.

Tasks can be further decomposed into operations, the small steps, adapted to changing conditions, by which a task is carried out. While this finer-grained modeling is often crucial for effective interaction design, it is rarely the focus of exploratory modeling.

information architects, and other design and usability professionals, but also business analysts, domain experts, and even marketing staff, as well as system architects, software engineers, and developers. As a rule more diverse participation tends to improve the results and save time on the subsequent inquiry process. The other, more collaborative variant directly involves not only end users but also managers, decision-makers, customers, and other stakeholders. When non-technical participants are included, it is especially important to use simple, relatively non-technical models—such as activity, role, and task inventories—that require little or no explanation or special expertise. In any case, the exploratory modeling workshop should be led by an experienced facilitator who is not only familiar with the process and the objectives but also is effective in involving and drawing on diverse participants to build the models and to identify areas for further investigation.

As exploratory models are being first brainstormed and then subsequently reviewed and refined by the group, questions will arise and issues will become apparent. These are collected in the form of inquiries, basically things we need to find out or resolve in order to complete and correct our provisional models.

Card-Based Modeling

For brainstorming activity, role, and task inventories, the preferred technique is one known as card-storming or note-storming. In this variant of conventional brainstorming, there is a supply of blank index cards or sticky notes. Each participant who thinks of a proposed item (activity, task, or role, whatever is being addressed) calls it out, just as in ordinary brainstorming, and then writes it down themselves on a card or note. A descriptive name or phrase is all that is necessary.

As each proposed item is created, the creator arranges it on a surface—typically the floor or on a table—according to its relationship to all the other ideas. In other words, as the elements of the model are being generated, these are being clustered on the basis of their similarity or differentness from other proposed elements. This "affinity clustering" helps organize the elements of the model and facilitates later review and analysis, particularly finding missing elements and eliminating overlap.

Questions, Questions

The kinds of inquiries generated during exploratory modeling include unknowns, ambiguities, matters of policy or priority, and points of disagreement, debate, or dissent within the group doing the modeling. Rather than arguing over and attempting to resolve every disagreement, an inquiry is formulated and recorded. Basically, an inquiry is generated for anything additional that arises that may be needed to complete and validate the models. A recommended process is to do this modeling on whiteboards with digital capture technology and to record inquiries on flipcharts.

Here are a few examples of the kind of inquiries generated in the course of various projects.

"How long does lesson planning for the teaching day take?"

"Are objectives in lesson plans the same as or related to state-mandated rubrics?"

"How do the lesson planning needs of K-5, 6-8, and 9-12 teachers differ, if at all?"

"Does lesson planning take place only before or also during class hours?"

"Is the controller commissioning activity carried out by the same person who does the PLC programming for a given application or installation?"

"Are there any special tasks in commissioning that are not part of programming/debugging activities?"

"How are particular seats for concert events selected/assigned?"

"How important is automated seat assignment for concert attendees?"

"How are ticket refunds handled?"

"Should the public Web site be identical to the telephone sales support application or only compatible."

"What if anything can we say about where visitors to our Web site are actually located."

The next step is to consider how best to answer each inquiry. This involves picking a source of information and a method of inquiry. Sometimes all that is needed is a phone call to the right person. To pick the right person, you want to consider:

Who is likely to know?

Who can make an educated guess or informed estimate?

How important is an exact answer?

How confident must you be that you have the right answer?

What difference will the answer make?

What is the easiest way to find out?

Inquiry resources include not just the obvious ones, such as the actual end-user community and selected customers, but also sales and marketing people, tech support staff and logs, user assistance specialists and technical writers, as well as business decision makers. Informants, that is, the subjects of inquiry to observe or interview, may be selected on the basis of various criteria, such as, their specific knowledge related to the inquiry, their location within the region or area where product or service is to be marketed or deployed, or conformity to either assumed or documented demographics. Particularly useful is to involve informants who represent the user roles that have already been identified. On a practical level, it can often be helpful to involve marketing and sales people in gaining access to informants.

The Benefits of Bins

A broadly useful tool for workshops of all kinds is the meeting management technique of using bins or holding areas for collecting and organizing related thoughts and issues as they arise. Also sometimes referred to as "shoe boxes" or "parking lots," bins typically take the form of labeled sheets of flipchart paper posted on the wall. This approach works far better thanh havine=g a scribe or recorder keep notes on regular paper, because the accumulating content is available and visible to all participants at all times. Each bin holds a particular kind of question, issue, or information. Any useful category can be employed, but for exploratory modeling, three categories are likely to be broadly useful: (1) questions; (2) ambiguities and uncertainties; and (3) debates, dissents, and disagreements.

Besides the mainstay method of participant observation, possible means of inquiry include simple questions, both direct and indirect, small scale experiments, interviews, and surveys. An inquiry can be conducted in person and in context or in any media, from telephone and email to instant messaging or Web forms. The idea in all cases is to do as little actual extended field work as possible—only enough to answer outstanding questions or resolve issues.

Complete, Consistent, and Correct

Once inquiries have been handled, the new findings are incorporated into revised versions of the models. In theory revising the models could generate new inquiries, but in practice this almost never occurs. Once fully revised, the models should be carefully reviewed for the classic "three Cs" of quality: completeness, consistency, and correctness.

It is also considered best practice to conclude the modeling process by validating the revised models with end users and subject matter experts as appropriate. This is relatively easy where simplified, non-technical models, such as user role and task inventories, are being developed. Basically, informants are asked: does this cover everything you would need to do or all the roles you play? Is there anything you think we might have missed? Within your responsibilities, are all of these things needed? Business decision makers may also be recruited for review of the revised models. Here the question is whether all the business objectives appear to be covered by the identified activities, roles, and tasks to be supported by the system.

In practice, best practices are not always realized, and, for the sake of expediency, validation may consist of little more than a desk review by one or more members of the design team.

Payoffs, Problems, and Potential

Of course, there can never be a guarantee that model-driven inquiry will, in any given project, actually yield a sufficiently complete and valid picture of user requirements. As with contextual inquiry or any other approach to eliciting requirements, much depends on the skills of the practitioners and their ability and willingness to do a thorough and credible job.

It is also true that biggest problems are not with what you don't know but rather with those things where you don't even know that you don't know. It is impossible to generate inquiries for what you are not even aware of or for the contradictions that never become clear. But similarly, one can never be certain that a few more hours of participant observation with another informant might not have uncovered a critical missing need or otherwise substantially changed the findings.

Few would doubt that contextual inquiry has already proved its worth, but there may still be a number of good reasons why usability and design professionals should consider trying model-driven inquiry. This somewhat more streamlined strategy provides very early, day-one, draft versions of core models. In areas where confidence is high, the draft models may themselves be sufficient to begin selected design activities. Because these provisional models generally provide a good overview of the needed functional content and its organization, they can be particularly helpful in making sound preliminary decisions about overall structure or architecture of the user interface.

By reducing the time and money invested in field research, model-driven inquiry can potentially cut both initial lead time and reduce total project costs. A side effect of the exploratory modeling process itself is that it helps to build and disperse knowledge of models and methods within a broader base within a design and development organization.

Compared to traditional field research approaches, model-driven inquiry provides an earlier overview of the problem and possible solutions .Exploratory modeling in itself typically identifies the substantial majority of needed functionality and most potentially useful features; model-driven investigation fills in the blanks.

Model-driven or contextual?

For those already firmly committed to contextual inquiry and contextual design techniques, model-driven inquiry could be a valuable adjunct. Exploratory modeling can be used as a more structured approach to focus setting, whether or not this is followed by traditional participant observation. When combined with ethnographic participant observation, model-driven inquiry has the potential for substantially shortening the investigation and analysis processes. In addition, the usual models of contextual design can be developed through exploratory modeling, providing a potentially useful framework to guide and speed up the later modeling activities.

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