# Fast, Formal, & Beautiful: Effectively Capture, Document, and Communicate User Workflow Information for Designing Complex Healthcare Software Systems

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Successful user interface design for complex healthcare software systems requires a solid analysis and understanding of the users' workflow so that designers can create a solution that delivers the "right information to the right user at the right time" thus better supporting users' tasks and workflow. In spite of the current availability of several successful workflow modeling notations and tools (e.g., UML, Little JIL), none of these have been widely applied by user experience (UX) designers in their day-to-day practice. This observation motivated our study of tools and practices employed by UX designers in their day-to-day work. Our goal is to understand how designers currently capture, document, and communicate users' workflow information, and also to identify opportunities for refinement and adaptation of these approaches to their practice. In order to answer these questions, we conducted a contextual inquire, analyzing the work of designers with respect to three main concerns: process, communication and tools. The result is a set of implications for tool design, and a discussion of a possible method that seeks to make formal workflow modeling more suitable for designers.

## INTRODUCTION

Successful user interface (UI) design for complex healthcare software systems requires a solid analysis and understanding of the users' workflow so that designers can create a solution that delivers the "right information to the right user at the right time" . Compared to the functionality-driven approaches (Preece, et al, 1994), workflow-driven design can be an effective way to manage the complexity of software systems. In fact, the design of healthcare systems is highly regulated: it must comply with strict sets of rules prescribed by legislations and healthcare procedure (e.g., Kohn, Corrigan, & Donaldson, 1999). Take medical domain as an example, many clinical procedures in today's interventional environment are highly standardized, with stringent protocols and guidelines: the similar tasks, sub-tasks, steps, & sequences need to be fulfilled to achieve the desired goals.

Several successful workflow notations and tools, such as UML (OMG, 2007) & Little JIL(Wise et al, 2000), have been popularly used in software engineering and business process modeling domains. These methods are rigorous and formal. In spite of their availability, none of these have been widely adopted by user experience (UX) design community in their day-to-day practice. This fact comes at some surprise since UI design process is very similar to that of software engineering, where requirements, design and implementation are interactively approached by means of established models, processes and automated tools. In particular, UI design, it is a complex process composed of three main stages: Analysis, Conceptualization, and Implementation (Preece, et al, 1994).

Indeed, previous works argue that design practitioners don't use the complex analytic frameworks produced for them by researchers (Goodman, Stolterman, &Wakkary, 2011; Rogers, 2004). For instance, Rogers (2004) notes that "it appears that the analytic frameworks developed for use in HCI are not that accessible or easy to use." She continues: "It would seem that quite a different frame of reference is needed – one which focuses more on the process of design and how the different kinds of designers, themselves, want to be supported." Moreover, Bilda & Demirkan(2003) presented a study in which the designers were more productive using traditional (like pen and paper) than digital media during conceptual design. The authors argue that because designers have always used hand sketches as a cognitive tool to interact with throughout their educations; this may limit their cognitive interaction with digital media.

Given the increasing complexity involved in UI design, it is natural to imagine that UX designers would embrace the similar modeling tools in their practice, yet the reality is quite opposite. This observation motivated our contextual inquiry of formalisms and processes employed by designers in a UX group within a large enterprise IT development company. Instead of proposing yet another tool and process, we first conducted a study to understand the processes and formalisms currently applied by designers. Our goal was to understand the tools and formalisms used to capture user workflow information, document and communicate design decisions in their work, and manage the increasing complexity of concepts and artifacts that UI designers need to manage.

## RESEARCH METHOD

### Setting

We conducted one contextual inquiry in the UX department of a large enterprise IT engineering company. The group analyzed was composed of a dozen fulltime staffs (with professional experience varies from 2 to 20 years), and 6 to 8 interns. The projects they worked were centered in the area of healthcare software systems. The contextual inquiry was conducted during 4 months, from 05/11/2011 to 09/11/2011, when one of the authors was an intern in the team. We adopted participant and non-participant observation and semi-structured interviews for data collection.

The designers, projects and artifacts analyzed were set in the healthcare domain. The projects analyzed generally involve the design of UIs for systems that automate health care practitioners' tasks in areas such as diagnosis, administration, and patient records management. In this domain, the understanding of the user workflow becomes an essential requirement to the domain analysis.

**Data Collection**

We conducted a contextual inquiry for 4 months, by means of field observations, and semi-structured interviews. The interviews employed a common set of questions listed in Table I. The questions were grouped in three categories: process, communication and tools.

**Table 1.** Interview questions organized by three themes

| |
|---|
| PROCESS |
| What kind of workflow information UX designers collect? |
| How is the information collected and documented? |
| How is this information used during this design? |
| COMMUNICATION |
| How is the workflow validated with the domain users? |
| How is the information communicated to team members? |
| TOOLS |
| What tools are currently used to support this process? |
| How different tools might be used for different domains? |

The process questions seek to understand the common approach to system analysis and design employed by the study subjects; communication questions elucidate the participant's need for exchanging information with other members of the design team or with clients; and the tools set of questions focus on the technology employed by designers in support of their work.

## STUDY RESULTS

It is important to mention that the designers of the UX group we observed were encouraged to apply a common process for workflow analysis and modeling called UBAM (User Behavior Analysis and Modeling). This process was developed internally in the company over many years of practice. The UBAM process encourages designers to collect data and to understand the users' workflow along the following set of concerns:

- **Environment** – is concerned with the application domain where the system will be used. (Where)
- **User** – Who use the system? (Who)
- **Task** – What tasks the users perform? (What)
- **Data** – What data the users access while performing their tasks? (How)
- **Function** – What functions need to be provided to users in support for their tasks? (How)

The identification of these concerns is not very different from the practice of designers in other disciplines. However, the UBAM process seeks to make explicit these categories, helping them identify the elements of each category from the beginning, at the requirements elicitation stage. In order to identify the elements, designers perform end-user interviews, participate in meetings, and conduct surveys and field studies. After that, they link the information collected in order to represent the user workflows. One example of concerns elicitation and linking is presented in Figure 1, which shows concern elements and links related to a hearing aid system. Through the identification and linking of these elements, the designers are able to create workflow models for each scenario that the system must support, and are able to define the flow of functions in UI (using the sequence of functions), associated to each task in the workflow.

This approach, however, does not specify how designers link the information collected in the identification of workflows. Each designer adopts different criteria, and this information often becomes lost as the design progresses. In order to better understand how designers translate these concerns into actual design artifacts, we observed the strategies they adopted to identify and link these concerns, and the tools they used in support of this process.

In particular, we identified three different types of practices adopted by designers to capture and document the user workflow with its inter-related concerns, and represent them in a way that can be communicated to clients and other members of the design team. The three types of the practice were:

1. **Fast** - designers in this category adopt a minimalistic approach, using informal notations, e.g. post-its and drawings, which are only meaningful to the designers themselves.
2. **Formal** – represent designers that keep formal records of workflows and UBAM concerns in a way that facilitates their understanding by both the designer and the clients.
3. **Beautiful** – designers in this category document workflows in ways that are understandable and visually appealing to customers. As a consequence, certain design and traceability elements, not relevant to the client, are usually omitted.

**Fast - Be fast and fluid**

One of the observations of the study is that the designers use simple ways to create workflows, especially in the beginning, when they still don't have a clear idea of how the workflow will be. Designers often produce workflow diagrams making sketches with pen and paper. This can be exemplified by the declaration of one of the designers: *"I start everything in paper, do my brainstorming using paper and then I move to Visio ... My creation process is paper and pen."*

In addition, designers in this category were not satisfied with the existing tools for creating workflows. One of them argued that it is faster and more comfortable to create workflows using pen and paper, questioning whether it is really necessary to use a tool for this purpose: *"Maybe (it) will be a little bit easier to use, create the diagram, but for me I cannot do my creative process digitally. I do not know if I want to do ... It's much more comfortable to use pen and paper ... I do not know if it is necessary to do it digitally..."*

Another argument from the same designer is that the workload prevents him from spending time learning to use a new tool, an observation that was pointed out in previous works (Stolterman, 2008): *"Given the kind of work I have to do, my workload, I will not even think about investing time learning a new tool because I see no benefit."*

Another benefit of using paper and pen to create workflows is more fluid, i.e., it's quicker and places no restrictions on their use in terms of the kinds of diagrams. In fact, one of the designers argued that it is easier to move back and forward with paper and pen in the early stages of design: *"This is a process that is not linear, then you move forward, backward ... you think that you understood and it's already in another part of the workflow and then you think 'Hmm, it doesn't makes any sense' and you have to go back ... there isn't a digital tool that allows to do this, so I use paper."*

The designer declaration corroborate the argument found in (Goel, 1995) that designers shift their focus from a higher level of abstraction to a lower level with more details (vertical transition), as well from one idea to another (horizontal transition).

Another common practice used by designers is to use Post-Its with simple information about the interaction design, as shown in Fig1. In the figure, the Post-Its document where the system is used, who users are, what tasks they do, and what data and functions are needed. This approach is fast and fluid, but is low in formalism and semantics. Therefore, it is usually employed only at the beginning of the workflow modeling, since the Post-Its are not easily understood by other stakeholders, and cannot be stored for a long time. In the company studied, for example, there is a great concern about confidentiality and employees are instructed to remove the Post-Its from their workstations at the end of the day.


**Fig1.** Workflow modeling using Post Its.

**Formal - Represent workflows allowing them to be understood by both other designers and clients**

Designers in this category strive to document their work in a more formal way. The goal is to model the design concerns, the workflow, and to trace these concerns to the final product, so that it can be better understood by both clients and other designers, possibly over an extended period of time. It is usually the case that design decisions from early design stages are used to further formulate and formalize the design (Candy,1997; Sutton & Hargadon, 1996). As one of the group designers mentioned: *"It is often the case that after 1 or 2 months I ask myself: How did we do this? Then I had to open past documents that I saved to remember how the workflow has been defined."*

The documentation of the rationale of previous designs is also useful for the creating new designs within a domain, especially in the context of the studied company, since the majority of the designs produced are aimed at healthcare systems and a lot of similar projects have been done before.

Another motivation for producing well documented designs is to facilitate knowledge sharing to new team members. In the group we studied, there is a high turnover of interns, who are not very experienced in interaction design but still need to create professional workflows for the company systems. These interns frequently access documents of previous works to use as a reference to create new ones. If these documents are not easily available, the work of these designers can significantly increase. In fact, the thoughts and ideas that designers have are very fleeting, so it is important to keep the workflows documented in a way that facilitates the later understanding of their rationale.

However, formalization of design is only good if it can be located and understood by other designers. In the group studied there was a lack of tool support for searching and locating design files, either because they are not easily accessible or because they weren't properly stored. In fact, during our study, one of the interns had to do a reverse engineering in order to improve the user interface of a system. The task wasn't straightforward, as can be observed by the intern declaration: "*I'm testing the user interface to understand how the workflow was defined, but sometimes is difficult to understand… if at least one document with the workflow were available, that would be great…"*

Another important need observed in our studies was the lack of linking between artifacts. Designers not only create new documents but also augment existing documents with new information. They also strive to link conceptual documentation with their final artifacts and diagrams. Some examples of extra information added to design documents include: questions about the process performed by the user, details about the environment in which the system will be deployed, and pictures of the environment. Fig 2 shows an example of a Microsoft Visio diagram in which a designer augmented the steps within a workflow model with rationale notes, pictures and other relevant information. Those are organized in a tabular way defining implicit links among these elements. This type of meta-information is used for two purposes: 1) to support designers in better understanding the application domain; and 2) to promote communication between the project stakeholders, in particular, its clients.

For the first purpose the designers add information about the process and details about how the interaction and visualization need to be. One example of note found in one document is: *"Requires good visualization of needle to see interactions with septum wall (2D images, 3D would be better)"*.

For the sake of communication, the designers add information so that other stakeholders can read and try to answer the questions. Fig 2 shows an example of a document sent to the clients so they could validate the workflow and answer the questions posted in the right side part of the document (typed in red). One example of question was: *"What is the MR angiogram data used for?"*

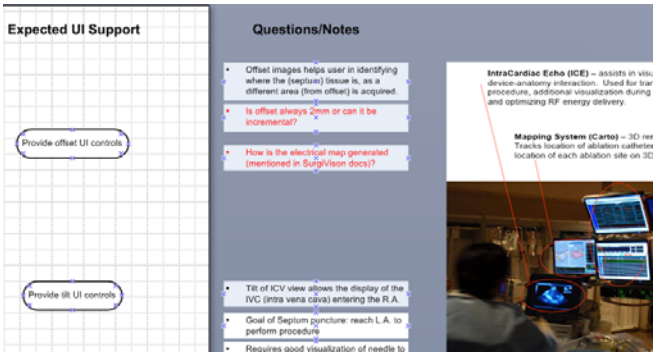

**Fig 2.** Workflow mapped with other information and pictures

**Beautiful - Present workflows understandable and visually effective**

The third type of designers we identified, focuses on the presentation of the design concerns to clients, in particular the user workflow, , emphasizing not only in the visual aspect but also how well the information is easy to understand and to manipulate. Designers often worry about these issues when they need to present and validate the workflow with different stakeholders. In particular, we observed that there are two major considerations in sharing the workflows produced with other people: visual appearance and ease of interpretation.

For the first issue, designers will use graphical tools such as Adobe Illustrator or PowerPoint slideshows. Thus, the idea is to present workflows and design concerns in a visually appealing and effective way. While this approach facilitates the understanding of rationale by clients, the resulting documentation is not adequate for designers. They do not convey relevant design information such as traces, function, data and rationale, nor provide adequate formalism for further implementation. In fact, there was a situation in which workflows were modeled entirely in one graphical tool and, after their validation, they were manually converted to a tool in order to easily search and edit their data. This was made evident in a statement of one project manager of the team: *"These colored papers list all the features that exist in an ultrasound machine. Designer A started making this list using Illustrator, everything very beautiful and colored, and took a longer time to do so. So we wanted to filter this list: We can't! We wanted to make a sorting of the list: We can't! So what we did: we put everything in an Excel sheet."*

The declaration above shows that in order to share the workflows, it is important to care not only about the visual appearance but also to the organization of information being presented, making it easy to be manipulated. As previously stated (see Fast - Be fast and fluid), the design creation process is not linear and the information being included must be frequently changed. Thus, it's important to use a representation that will facilitate the evolution of the design and its many concerns. In the group we studied, it is common practice to use spreadsheets to model the workflow, as one of the project managers said: *"For us, our internal work group, there is no need to be beautiful, just have to work." and "It's ugly but it works!"*.

In fact, it was observed that the designers sometimes prefer to send spreadsheets to the customers instead of workflow diagrams or "beautiful" graphs, since the spreadsheets can be easily modified by the customers using a tool that everyone knows.

## DISCUSSIONS & DESIGN IMPLICATIONS

The study results provide a number of implications for informing the design of tools for workflow-based UX design.

**Need for Simplicity**

The study showed that some designers prefer to use simple (and personal) strategies to elicitate the requirements of their design. They do not see much value in formalisms provided by existing tools. This is especially true in the early stages of design, when a clear understanding of the application domain and project requirements is not yet formed.

Thus, in these early stages of design, informality and flexibility are more important. If a tool is proposed for a team of designers, it must be practical enough to the user, who does not need to spend too much time learning how it works. In addition, the feedback provided by the tool must keep up with the pace of designers and their internal thought process (Campos,2004), otherwise it would obstruct the flow of ideas. One possible solution is use an approach similar to the one described in (Mangano, Baker, & Hoek, 2008). In that paper, the authors present Calico, a prototype sketching tool for modeling in early design. The focus of the authors was mostly on developing a "natural" sketch environment in which ideas can be flexibly explored. Thus, the tool is not restricted in terms of models and languages allowed, neither require that the designers provide many details in the models.

**Favor designers' domain language over standard models and notations**

One of the observations of the study was that some types of designers (the formal and the communicative personas) strive to make their design documents easy to understand by other stakeholders. In fact, in many situations they prefer to use non-standard tools like spreadsheet applications to describe workflows, because in this way other stakeholders can easily understand and modify the data if necessary. There was one situation, for example, when many workflows were produced using Illustrator, and had to be converted into spreadsheets. This process is usually costly and redundant, delaying the completion of tasks. So, in order to avoid such a rework, two solutions are possible:

1) Either designers should use standard models and notations,
2) Or they can continue using their own language and methods.

For the first solution, the designers should use models that are familiar to other stakeholders, in order to ensure that everyone else is using the same language. For instance, if software engineers are involved in the project, UML could be used. The problem with this solution is that designers already rely on their own models and languages, and are already used to them. Thus, a change to different models and notations may result in long learning curves. Moreover, as made evident in our study and also mentioned in previous works (Bilda & Demirkan, 2003) , designers usually prefer to use their own models and ways of work, even knowing that there are others that could be more useful.

The second solution, where designers use the same models and domain languages that they are familiar with,

supports a more fluid collaboration within a team. For example, the group studied uses UBAM to model their workflows, employing a common vocabulary. Whenever interaction with software engineers is necessary, they can generate documents in formal notations such as UML activity diagrams or flowcharts. This approach has the benefit of generating design documents in the language of each stakeholder, while speeds up the communication within the team.

**Need for linking interrelated concerns**

Another observation is that the relationships between design concerns and artifacts are not always explicit. Various diagrams are created to represent different user workflows, but it is not always clear how each diagram relates to one another or how each element of the diagram is associated with elements in other diagrams. Thus, one implication of this study is that the tools must support the linking between the diagrams and elements, in a way that users can easily see the relationships between them. Moreover, these links can also help users in understanding the impact of changes in other models, workflows and elements, thus better supporting the consistency management across the diagrams.

Another observation made during the study is that some designers augment their documents with meta-information, as shown in Fig. 2. In this figure, the workflow elements are presented together with other types of information such as: questions, notes, pictures and information about the environment. This meta-information help designers in better understanding the application domain and are also used as a way of communication between stakeholders. Thus, design tools need to support the use and linking of meta-information in their diagrams, making these links and meta-information explicit to the users. The combination of navigability, linking of diagrams and elements, and meta-information would imply in an integrated knowledge management tool, allowing the users to access related information and files in a quicker way, without the need to manually search in for artifacts in the file system or databases.

**The need for improve the navigability through concern switching**

One of the implications of the study is the need for separation of concerns, as a way to more adequately represent workflows, environment, functions and data. However, even though the concerns are separated, they are not isolated. They exist in one way or another, in the context of other concerns. In the case of a workflow diagram, for example, each workflow activity must be performed by a user, which may manipulate some data and use some functions of the system. These relations are not visible in traditional UML activity diagrams or flowcharts.

Hence, there is a need to support users in visualizing these concerns together, while editing them separately. In Mangano, Baker, & Hoek (2008), the authors argue that the expert designer fluidly moves back and forth over multiple levels of abstraction, sorting out details that may have impact on certain high level choices. Our study also shows that the design process is not linear, requiring designers to “move forward and backward” as needed. Through these observations and arguments one possible solution to improve the navigability is switch the concern according the user needs. Tools must support users in switching between diagrams according to the task. For instance, a tool could change the “mode of operation” according the model selected by the user.

One solution to this issue would be the use of decorators, notes or links between concerns, in diagrams, so that users can easily navigate between inter-related concerns in different diagrams.

Based on all these design implications, we are currently developing a tool that supports simplicity, using designers’ domain language, and that promotes separation & integration of different design concerns in a collaborative Web-based environment.

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