From Personas to Design:
Creating a Collaborative Multi-disciplinary Design Environment

Ali Ndiwalana, Jason Chong Lee, Jamie L. Smith, Shahtab Wahid,
Laurian Hobby, C. M. Chewar[1], and D. Scott McCrickard

Center for Human-Computer Interaction and Department of Computer Science
Virginia Polytechnic Institute and State University, Blacksburg, VA 24061-0106 USA
{andiwala, chonglee, jls05, swahid, lhobby, cchewar, mccricks}@vt.edu

Abstract

This paper describes the use of personas in a multi-disciplinary academic setting to identify collaborators and tailor an integrated design and knowledge reuse environment to their needs. Our environment, LINK-UP, is an emerging web-based system that aids designers in the creation of notification systems—systems that deliver information of interest in a parallel multitasking approach. LINK-UP allows designers to access and/or create reusable design knowledge from a repository. Realizing that a knowledge repository can afford different outcomes to different people, depending on their goals, we sought to better understand the kinds of collaborators and how to meet their goals. This affects the structure of claims—the basic design knowledge unit and how each user group accesses and uses it. Engaged in this analysis, we reflected on the qualitative research technique of persona development that we relied on in the early brainstorming of LINK-UP. We also compare the use of personas in an academic setting with typical persona use in a commercial setting. Our results suggest some new directions for methodological enhancement of persona development, and we offer our new insights on supporting the needs of multi-disciplinary design stakeholders.

1   Introduction

In considering multidisciplinary design for human-computer interaction (HCI), it is necessary to define the underlying structures that will store design knowledge and make it available for reuse. This vision has been pursued for many years as a dominant research theme as the discipline of HCI has solidified. For example, knowledge storage in software engineering is accomplished with solutions such as problem frames and Domain Theory (Jackson, 2001; A. G. Sutcliffe, 2002). However, it was Carroll's task-artifact framework that first suggests the use of claims as a knowledge unit useful for abstracting a problem space and its design knowledge (Carroll, Kellogg, & Rosson, 1991). In recent years, other theoretical HCI work has sought to extend this fundamental approach, striving to make the use of claims practical for many different domains by storing the knowledge in a single repository that is of use to all.

Our work follows this theme, with an angle towards enabling design knowledge reuse through web-based information retrieval services. While we have made some initial progress in bringing claims reuse into practice, our work is still in the early stages of system envisionment and design. Following this overview, the majority of this paper describes qualitative research we have performed to clarify the understanding of the needs of multi-disciplinary design stakeholders. First, we review the conceptual underpinnings of our approach, beginning with the notion of claims reuse.

Formally defined, a *claim* is a falsifiable hypothesis that makes explicit the causal relationship between features of an artifact and its positive and negative psychological effects, or design tradeoffs, on the user within a scenario (Carroll et al., 1991). Claims are proven true or false during design and evaluation of a system under different conditions. In this way, claims provide "designer-digestible" packets of information that can both be used in design and further develop general design knowledge (A. Sutcliffe, 2000). The use of claims for design allows designers to explicitly manage the impacts of design choices on the user through the design tradeoffs. Claims reuse can allow designers to gain new insight into previously unconsidered design features and begin to theoretically and practically bring credibility to a design early in the design process.

---

[1] Author's current address: Department of Electrical Engineering and Computer Science, United States Military Academy, West Point, NY 10996

To facilitate reuse of claims, we have built a claims library. Our goal is to give access to many different user groups that want to leverage knowledge for a specific purpose. However, claims may be used in very different ways by different user groups. Each discipline may require a different access point to the same content and traverse it in different ways to meet their goals. Here, we begin to see the emergence of information retrieval challenges related digital libraries: *What are the key user-centered design considerations for a repository of design knowledge, intending to facilitate design reuse and knowledge accumulation, while supporting content contributors/consumers from diverse disciplines?* It is imperative to design with different uses and users in mind. Such potential differences, if not accounted for during early system envisionment, can cause significant changes to an information retrieval system over time, potentially leading to massive redesign.

Building on the challenge of Sutcliffe (2000) and our own previous work (McCrickard, Wahid, & Lee, 2005), we seek to explore how the fundamental structure of a claim can be accessed by various disciplines, including notification systems designers, HCI professionals, psychologists, and software project managers. While prior work has demonstrated that each discipline uses the claims-centric scenario-based design process, each also has different knowledge access needs.

A variety of methods enable designers to learn about potential users of their proposed system (Beyer & Holtzblatt, 1998; Carroll, 2000; Cooper & Reimann, 2003; Kuhn & Muller, 1993; Rönkkö, 2005; Rönkkö, Hellman, Kihlander, & Dittrich, 2004). These methods primarily enable designers to focus on the users' goals and better understand their motivations for doing what they do, even when the users are unable to enunciate those motivations. We adopted Cooper's personas as an avenue to help us identify and prioritize potential collaborating users with the highest chance of success, primarily because they revolve around real people. A persona is an exemplar of a user that is given a name and a face, and it is carefully described in terms of needs, goals and tasks. Through the use of personas, this work provides initial insights on how a knowledge repository must be structured and accessed to maximize the utility for many domains.

2   Related Work

We are creating LINK-UP (Leveraging Integrated Notification Knowledge with Usability Parameters), an emerging web-based system that aids design teams in the creation of notification systems. We focus our work on this particular class of systems as a metaphor for system design at large. *Notification systems* are computer interfaces normally used in a parallel multitasking nature to deliver information of interest (McCrickard, Czerwinski, & Bartram, 2003). Examples of notification systems include news tickers, automobile displays and system or network monitors. LINK-UP allows designers to access and create reusable design knowledge within a repository through the whole design cycle (Chewar, Bachetti, McCrickard, & Booker, 2004). Using a scenario-based design approach (Carroll, 2000), LINK-UP enables the design team to create successful systems by helping them to focus on the critical parameters for notification system design—essential psychological usage goals relating to interruption, reaction, and comprehension, or IRC parameters (McCrickard, Chewar, Somervell, & Ndiwalana, 2003).

Realizing that LINK-UP can support different tasks and afford varied outcomes to the many members of a design team, depending on their goals, it was conceived to be modular, providing interactive tools that support various design activities right from requirements analysis through to the evaluation of design prototypes. In order to better tailor the various modules to the needs of different members of the design team, we sought to better understand the kinds of design collaborators to target and support within LINK-UP.

Research in information retrieval has explored various ways that users access information in digital libraries. This is important because it has implications for how the library must be designed. One approach to understanding how a digital library is used is to analyze the type of work users do with the data they access in the library. Generally, users either search or browse digital libraries (Blanford, Stelmaszewska, & Bryan-Kinns, 2001), capability we provide in the current claims library. However, it is apparent that we will need to provide more capabilities in order to support other user groups.

Goncalves et al. (2004) put forth the 5S model as a framework unifying the theoretical and practical aspects that guide the creation of a digital library. The 5S are:

- Streams—types of data that is stored,
- Structures—how parts of the whole are organized,
- Spaces—objects an their operations,
- Scenarios--stories depicting system behaviour from the user's point of view and
- Societies—humans, hardware and software along with their inter-relationships.

While we take into account the multitude of scenarios that exist for different user groups, it is also important to think about the structure of the individual elements within the digital library in consideration of their goals and tasks. While some data can be highly structured, other data can be severely unstructured. Sanchez, Carlos, & Maldonado-Naude (2004) demonstrate the need to support structured, semi-structured, and unstructured data. All three types have impacts on the features exhibited by the digital libraries. The claims library currently has a semi-structured form, but whether this structure is sufficient or not is not fully known.

Personas are gaining ground both in academia and industry (Blomquist & Arvola, 2002; Calde, Goodwin, & Reimann, 2002; Grudin & Pruitt, 2002; Markensten & Artman, 2004; McQuaid, Goel, & McManus, 2003; Pruitt & Grudin, 2003; Rönkkö, 2005; Rönkkö et al., 2004; Sinha, 2003). They are primarily used to encapsulate the oodles of data that organizations collect about potential users of their products, allowing them to easily generalize when designing products meant for the mass-market. Personas enable the various participants in the design process to assimilate the data by not only providing a lingua franca (Erickson, 2000) allowing them to better communicate, but also an easier way to relate to a broad range of information available that could potentially contribute to a superior product (Pruitt & Grudin, 2003).

Blomquist & Arvola, (2002) observed a design team apply the use of personas to create an interactive system over a period of time. Through meetings, workshops and interviews, they documented the entire design process using various paper records as well as audio. In the end, they conclude that personas did not successful contribute to the design process primarily because the team members did not fully relate to them, something they attribute to a number of reasons. Personas were introduced much later in the design process as opposed to being available from the outset of the design process. By then, the design team was used to discussing the various design decisions and rationale using different terms and aspects. They highlight the lack of ownership feeling towards the personas, since these were created by someone other than the design team and handed down for use with the project. Interestingly, they posit that the design team was not fully comfortable with the application of personas as a conduit for design primarily because they did not accommodate some of the design techniques and methods that they had built up over time.

Pruitt and Grudin provide detailed information about their use of personas for commercial software product development targeting mass-audiences (Grudin & Pruitt, 2002; Pruitt & Grudin, 2003). They use personas to bring together data collected by different departments within the development organisation over long periods of time, using a variety of methods. Some of the methods employed in data collection include market research, usability studies, interviews and observations. They use personas in a variety of different ways to compliment other existing methods within the organization that help them overcome some of the shortcoming observed by Blomquist and Arvola (2002). These include using a cross-disciplinary team drawn from different teams within the organisation to create the personas, helping to create ownership and easy dissemination of the persona information within the various teams. They create a variety of materials and tools to educate and help the various teams to understand and use the personas within the development process. They advocate for continuously evolving personas with up-to-date data collected in an ongoing manner as opposed to basing them only on information collected during the initial requirements definition stage only (Cooper & Reimann, 2003).

Rönkkö et al. (2005) reflect on the use of personas within the context of three collaborative design projects between academia and industry. They were interested in determining how other usability factors affect the creation and usage of personas, their usefulness for justifying usability decisions as well as identifying a reasonable balance between the efforts invested in their creation vis-à-vis their usefulness. In the first project, the designers created personas in an effort to tailor an IM client to a given user group. The persona creation and use process was mainly influenced by the client's existing IM platform and their application style guide, forcing the discussion to revolve more around technical issues that usability ones. In the second project, designers credit personas for helping them think in a structured way while acting as a reservoir for usability information from the onset of the design process. They did not feel that personas directly contributed to the various design decisions that were made. Similarly in the third

project, while designers credit personas for helping them understand and reflect on their end-users, they do not think that they were worth the invested effort primarily because they regularly interacted with representative users and had detailed technical requirements for the project that had been provided by the client.

3 Personas

Having brainstormed about potential users, we chose to target notification systems designers, HCI researchers, psychologists, and project managers. We created a persona hypothesis for each category and designated teams to go out and identify potential candidates as well as get qualitative data on each of these categories. We did this by reviewing websites of various research labs and their publications, visiting with different lab individuals and observing what they did. The purpose was to better understand their motivations and goals, and the tasks they undertake to achieve their goals. It is at this point in the process that we started to think about potential behavior variables, as we observed the various range of behavior.

We formalized the list of behavior variables for each category and created an interview guide to help us map various individuals to the behavioral variables. After each interview, we plotted the interviewee onto the continuum of the various behavioral axes, creating a medley from which we would later try to identify patterns. Patterns usually occurred in the form of clusters across multiple variables and the challenge was to logically account for them. From these patterns emerged the basis for our personas.

From all this information, we began to actualize our persona for each category. Each persona iteratively refined through interviews, now had a user profile, a persona hypothesis—highlighting how LINK-UP could help them achieve their goals, a problem scenario—depicting their typical use of LINK-UP, and behavioral variables.

Personas aided us in developing a concrete understanding of how different users could benefit from LINK-UP. Consequently, we were able to reflect each user's activities and goals by creating a process structure that permits flexible and transparent traversal of the different modules in LINK-UP. Given this level of flexibility and the multi-disciplinary, team-based approach to design, we identified the need for tools that improve communication and awareness among team members. By developing and comparing a set of personas, we avoided the pitfall of creating over-generalized user definitions that merely adapt to the system design instead of guiding it.

Another benefit of the personas was that they allowed us to run simulated, ad-hoc user evaluations at any point in the process of developing LINK-UP without having to depend heavily on resource-intensive user evaluations. Since the personas were based on the goals and needs identified from interviews, they helped model how users would use and react to the system. We briefly elaborate on each of our personas below.

3.1 Notification System Designer

For this persona, we focused on people who develop new types of notification systems and interfaces. We were primarily interested in people whose usual focus while designing notification systems was more on the technical aspects compared to usability issues or human-machine interaction aspects. They did not pay attention to usability issues primarily because they did not have the know-how to incorporate them into their design process.

Our initial persona hypothesis was summarized as follows:

As part of his research and teaching, Martin develops new types of Notification Systems and interfaces. Being an engineer, he focuses more on the technical aspects without paying much attention to usability issues or human-machine interaction aspects.

He would like a tool that:
- *Helps him with the requirements analysis process*
- *Provides a structure to his design process, helping him think about and incorporate usability concerns*
- *Helps him capture design knowledge emanating from his current projects so that he might reuse some of it in future projects*

The notification system designer has a number of potential goals that we anticipated. They wanted to design novel hardware systems to solve emerging problems usually in multidisciplinary teams, contributing knowledge from their own specific area of expertise. Working at the edge of science, we assumed that they would be interested in capturing knowledge emanating from current projects in order to easily reuse it in future projects. Some of the variables included in the hypothesis included origination of design ideas (extend existing research ideas – new ideas from elsewhere); structure of the design process usually followed (very informal and unstructured – very formal and structured); degree of knowledge reuse that occurs between projects (no reuse at all – a lot of reuse), availability of tools used to aid the design process (no tools – plenty of tools); etc.

For this persona we visited with a number of professors and graduate students from the electrical and computer engineering department. We also interviewed researchers from the corporate research center who develop and evaluate in-vehicle notification systems. Based on the data we collected, we found out that the notification system designer engages mainly in applied research, where he is leveraging expertise in his area to address some practical problem. There are hardly any tools to assist him with problem definition when thinking about new design solutions and he would appreciate tools in this regard. He does not incorporate a lot of HCI principles in his work primarily because he is doing exploratory research and does not have a clear understanding of how to incorporate HCI in his work. Despite that, he shows a willingness to consider HCI if there is an easy way to incorporate it into his work. Given the novelty of the technology he is dealing with, there is not much knowledge reuse going on, although he is really interested in how he could capture and reuse knowledge from his past efforts or those of others within the same area. Another challenging aspect is how to evaluate his work since it is difficult to run lab experiments. The ideal option would be to deploy the prototype system in an authentic situation and observe how it used over a reasonable period of time.

3.2 HCI Researcher

With the intention of exploring beyond interface designers, we developed a persona for an HCI researcher. The initial hypothesis is summarized as follows:

> *Persona Hypothesis*
> *Mary is an HCI graduate student doing research in data visualization. She has a solid understanding of computer science concepts and approaches HCI research questions from a technical, computer science perspective. She hopes to receive a PhD and work as a researcher in a large corporate lab.*
>
> *She would like a tool that:*
> - *Allows her to access a broad range of HCI knowledge.*
> - *Allows her to quickly find in-depth information specific to her research area*
> - *Supports the development of small desktop interface prototypes to run experiments*

We interviewed seven HCI researchers including professors and PhD graduate students using a semi-structured format. From these interviews, we identified goals and characteristics of the persona and a list of behavioral, demographic and environmental variables to capture what research they conducted, how they conducted it and the context in which they do those things. These variables are defined on a single axis on which interview responses are mapped. The behavioral variables included: Type of work done (basic/pure – applied); Use of tools to assist in problem definition (not at all – heavily); and Design/research process usually followed (informal – formal). After the interview questions were mapped to the variables, the results were analyzed to identify clusters in the responses. These clusters were then used as a basis on which to build the persona.

Based on the collected data, our HCI researcher persona informally follows a scenario-based design process when developing tools to use in research but does not use and are not knowledgeable in claims or claims analysis. Much of her work is exploratory and does not have defined hypotheses or goals. Her research process roughly corresponds to the LINK-UP development cycle, but it is not formalized in any way. She often cannot communicate with potential end users or beneficiaries of her research because of limited time and researchers. She relies heavily on the ACM Portal to find recent and important papers in her area of study. However, if she needs information or papers from other areas she is not an expert in such as psychology or biology, she uses Google because it searches a broad range of websites and papers she would not otherwise know about. In addition, she often encounters problems finding

relevant information through search engines because the search space is so large, she does not know what keywords will return important results and because the number of returned results is very long.

3.3 Psychologist

LINK-UP can allow psychologists to test and develop claims about some hypothesis. These hypothesis could be things such as, "the user will be cognitively overloaded when factor A and factor B are used in conjunction." This simple example shows how a psychological question can have valid outcomes that could affect how to design an interface, or more specifically a notification system. Our initial psychologist persona hypothesis is summarized below:

> *Persona Hypothesis*
> *James is a research psychologist doing research on reaction times to various stimuli. He is familiar with computers and is using various computer notifications as a base of study. He is currently working towards attaining a research grant in this area and is doing preliminary studies.*
>
> *He would like a tool that:*
> - *Allowed him to quickly test various hypothesis he has*
> - *Has a library of related hypothesis to do background research in*
> - *Would help him with multidisciplinary collaboration*

The behavior, demographic, and environmental variables specifically used for the psychologist persona included: number of variables used in the hypothesis (small – large); level of background knowledge in the subfield of psychology (small – large); size of experiment teams (one – many); type of experiments (structured – flexible; empirical – analytical); nature of design project and the knowledge it requires for execution (own-discipline – multidisciplinary); tools used to aid the hypothesis generation process (none – many); tools that aid in the data collection process (none – many); subject number (few subjects – many subjects); desire to reuse knowledge gleaned from previous endeavors (hates to reuse – strives to reuse as much as possible). From these a well rounded view of what a psychologist is like and what their needs are was formed.

Four researchers were interviewed from areas such as neuro-psychology, Gestalt psychology, industrial organizational psychology, and learning psychology. Each of these professors was given the same verbal questionnaire that explored how psychologists currently do their research. An example question would be, "How do your research ideas evolve?" These questions were developed to explore the idea of how psychologists would actually want to incorporate LINK-UP into their current design methodologies. As each psychologist answered the questions follow up impromptu questions were asked to ascertain the different research methods used for each subfield. For example, one research said that he uses Psych Abstracts to see what others are doing to get his own ideas, whereas another research said that she keep a research journal of design ideas that she visits regularly. One thing quickly became clear at this phase in the research though, all researchers had a set method that they used each time. This was not an original question, but instead was an impromptu one that eventuated into a fundamental one that outlined a key quality of the persona.

From these questions, the psychologists were mapped according to the behavior variables above. The results were nebulous and it was hard to gather a firm idea of what the psychologist persona would represent for LINK-UP. For instance two researchers had very structured research methodologies that they used for design, whereas the others were more flexible depending on the research team they were working with. This might have been contributed to a cohort effect of age and experience in the field, but it created a dichotomy in developing this persona. In general, we observed that psychologists have the urge to reuse, be multidisciplinary, and use tools in data collection. The mismatches that emerged within this persona have forced us to rethink on how psychologists should be supported within the LINK-UP system.

A major issue with using this method was that although the mapping was able to provide an overview of the persona, it lacked the ability for it to outline major concerns for incorporating this persona into LINK-UP. One of the major concerns at the end of developing this persona was the conflict in the notion of a claim. Psychologists tend to think in terms of a hypothesis and then related sub-hypothesizes. For example, factor A will have effect B. Claims tend to be multifaceted, in that they explore one issue in terms of costs and benefits. For example, factor A should be

implemented because of reason B and not implemented in terms of reason C. This resulted in major design decisions for incorporating the psychologist persona into LINK-UP. The concern is that this information was brought to light by using Cooper's method, but it was not highlighted as it should have been; it was a secondary resultant that turned out to be one of the major design considerations.

3.4 Software Project Manager

The LINK-UP system can be used by individual designers; however, given the inherent complexity of the design process and the increasing size of software-intensive systems, teamwork is, in many situations, becoming the preferred method of software design and development. Thus, LINK-UP, as a collaborative design environment, must support teams in managing their projects. The initial persona hypothesis for a software project manager is summarized as follows:

> *Persona Hypothesis*
> *Isaac is the manager of a large-scale software development project, supervising teams of designers and developers in the San Francisco and London. He holds a B.S. in computer science, as well as an MBA, and has been working for three years on two projects as a manager.*
>
> *He would like a tool that:*
> - *Allows his team to maintain an external manifestation of their design process as it evolves*
> - *Aids in maintaining team coordination and monitoring progress*
> - *Supports risk management without adding substantial overhead to the project*

In developing a project management persona, we considered management in the context of a software design or development project and interviewed several experienced project managers. Management tasks are often considered only from the perspective of the project manager; however, they actually concern all members of a team. Individual team members, for example, are interested not only in their own task assignments and deadlines, but also in identifying the task assignments of other members of the team and in understanding how those tasks interact and depend on one another. To accomplish these and other management goals, managers, as well as other team members, require access to awareness information, both in relation to current project tasks and in the form of a high-level overview of the project as a whole. Currently, management tasks add considerable overhead to a project. The process of managing risk, for example, involves identifying and documenting potential problems, devising alternative plans of mitigation, and monitoring the status of each risk throughout the course of the project. Because these tasks are not integrated directly into the development process, managers are forced to spend a substantial amount of time coordinating project-related information.

Teams must complete projects successfully despite varying constraints on time and project resources. Consequently, managers must monitor progress based on overall constraints and assign individual tasks accordingly. By assessing and monitoring project-related risks in relation to specific tasks, managers can determine which project tasks are most critical at any given time and concentrate effort on accomplishing those goals. In relation to LINK-UP and the design of notification systems, collaborative design teams are developing the set of claims that best represents their design goals. From a manager's perspective, the upsides and downsides of project claims represent design opportunities and risks. These design risks can be prioritized according to how important it is that they be mitigated during the next design iteration. This risk analysis might depend on a number of factors, including the overall quality of a claim, the relevance of its supporting rationale, and the results of internal user evaluations. Some of these attributes can be stored with an individual claim at the repository level. Other attributes are project-specific and must be stored accordingly.

Key behavioral variables to consider for the software project management persona include the size and distribution of the project team, the specific focus of the project within the software domain, the scale and timeline for the project, the experience level of the project manager, the degree of formalism with which the manager oversees a project, and the manager's desire to reuse knowledge from previous projects to identify and mitigate common problems before they occur. From these variables, we developed a detailed picture of the project manager and his (or her) style of management. One problem identified in developing a project management persona, in the Cooper sense, is that individual project managers have distinct techniques for accomplishing their goals. Since project management is a relatively immature process within the software domain, managers have not yet determined the optimal

paradigm. Consequently, it is difficult to determine the best approach to incorporating project management into the LINK-UP system.

3.5   Reflections about Personas

Although use of personas proved beneficial, we encountered several obstacles in creating them—requiring us to modify Cooper's definition of a persona. For example, our personas embodied the behaviours and motivations of real people; thus, we encountered varying levels of interest among members of different user groups that we interacted with. We narrowed our list of potential users based on a number of factors including level of interest in collaboration.

Cooper's persona methodology dictates that interface developers focus there efforts towards satisfying a single primary persona (Cooper & Reimann, 2003). Other secondary personas should then be satisfied only as long as their goals are not in conflict with those of the primary persona. Given the design is a multi-disciplinary endeavour; it was impractical to determine one primary persona from the list of candidates. Developing the system around a single class of users will certainly limit the adoption and use of LINK-UP, thereby limiting both its content and usefulness. However, there is no denying that developing a system for a wide range of users will ultimately satisfy none of them. Our solution is to develop application profiles where each profile allows a single persona to traverse a given set of modules in ways that meet their goals and allow task completion while accessing the same common knowledge repository of LINK-UP. The appearance and behaviour of the system can thus be altered based on the profile applied to the system, allowing the user to access all the information in the repository, but retrieving and using only that information that pertains to their goals and tasks.

Creating a complete set of behavioural variables also proved challenging. Although Cooper recommends classifying users along ranges of behaviour, he does not clearly indicate criteria for determining when a variable set is complete or if the variables within the set represent the true characteristics, behaviours, and goals of the target user. Additionally, some user goals were difficult to quantify on a continuous scale of behaviour. For example, there are many different types of HCI cognitive modeling techniques that HCI researchers use. Since there is no way to order these methodologies on a single axis, multiple variables have to be defined for each technique, increasing the number of behavioral variables to deal with. In addition, there is not a defined process to assign values from each interview response to these variables, nor particular methods to help identify relationships among variables.

Persona-based research efforts must proceed in several directions in order to become more widely accepted and usable in both academic and industry settings. First, improved training materials and methods for using personas must be developed and made freely available. Currently, many of these methods and materials are proprietary. Second, better tools to support development and use of personas are vital if personas are to gain more widespread adoption. In particular, tool development should focus on supporting the analysis and extraction of insight from behavioral variables.

4   Concluding Remarks

We have depicted variations in goals, tasks, and information among the personas. These differences have implications for the design of the claims library. Although we have instantiated a basic claim structure, we need to extend it to accommodate the different needs and work processes of the different personas. Each persona identifies a specific set of information that is needed by the user group. This may imply that each claim must have an attached set of data for each persona we identify. Thus, the claims remain at the core of the library, but their use is expanded. This process still maintains the semi-structured nature of claims since the core claim is stored as strings of text in particular fields while additional data derived from other disciplines are stored as attributes.

With this structure method, each user group will have their own way of working with the claims library. For example, someone in the engineering discipline may want to search for claims based on certain attributes that someone in the psychology discipline would not use. This shows the need for each discipline to have a different access point to the same content and a way to traverse it in different ways to meet their goals. However, this does not mean this is the best way. To support additional personas, the claims library would have to keep expanding, creating additional complexity of the structure of claims and the library as a whole. To determine exactly how to

support each user group with the claims library, we are continuing to explore the different usage scenarios. Differences among scenarios can possibly lead to the incorporation of new features that support other disciplines.

5   Acknowledgements

References

Beyer, H., & Holtzblatt, K. (1998). *Contextual design: Defining customer-centered systems.* San Diego, CA: Academic Press.

Blanford, A., Stelmaszewska, H., & Bryan-Kinns, N. (2001). *Use of multiple digital libraries: a case study.* Paper presented at the 1st ACM/IEEE-CS joint conference on Digital libraries, Roanoke, Virginia.

Blomquist, Å., & Arvola, M. (2002). *Personas in action: ethnography in an interaction design team.* Paper presented at the Second Nordic conference on Human-computer interaction, Aarhus, Denmark.

Calde, S., Goodwin, K., & Reimann, R. (2002). *SHS Orcas: the first integrated information system for long-term healthcare facility management.* Paper presented at the CHI '02: Case studies of the CHI2002\&\#124;AIGA Experience Design FORUM, Minneapolis, Minnesota.

Carroll, J. M. (2000). *Making Use: Scenario-Based Design of Human-Computer Interactions*. Cambridge, MA: MIT Press.

Carroll, J. M., Kellogg, W. A., & Rosson, M. B. (1991). The task-artifact cycle. In J. M. Carroll (Ed.), *Designing Interaction: Psychology at the Human-Computer Interface* (pp. 74-102).

Chewar, C. M., Bachetti, E., McCrickard, D. S., & Booker, J. (2004). *Automating a Design Reuse Facility with Critical Parameters: Lessons Learned in Developing the LINK-UP System.* Paper presented at the 2004 International Conference on Computer-Aided Design of User Interfaces (CADUI '04), Island of Madeira, Portugal.

Cooper, A., & Reimann, R. (2003). *About Face 2.0: The Essentials of Interaction Design*. Indianapolis, IN: Wiley Publishing Inc.

Erickson, T. (2000). *Lingua Francas for design: sacred places and pattern languages.* Paper presented at the DIS '00: Proceedings of the conference on Designing interactive systems, New York City, New York.

Gonçalves, M., Fox, E., Watson, L., & Kipp, N. (2004). Streams, Structures, Spaces, Scenarios, Societies (5S): A Formal Model for Digital Libraries. *ACM Transactions on Information Systems, 22*(2), 270-312.

Grudin, J., & Pruitt, J. (2002). *Personas, Participartory Design and Product Development: An Infrastructure for Engagement.* Paper presented at the Participartory Design Conference, PDC'02.

Jackson, M. (2001). *Problem frames: Analyzing and structuring software development problems*: Harlow: Pearson Education.

Kuhn, S., & Muller, M. J. (1993). Special issue on participatory design. *Communications of the ACM, 36*(6).

Markensten, E., & Artman, H. (2004). *Procuring a usable system using unemployed personas.* Paper presented at the NordiCHI '04: Proceedings of the third Nordic conference on Human-computer interaction, Tampere, Finland.

McCrickard, D. S., Chewar, C. M., Somervell, J. P., & Ndiwalana, A. (2003). A model for notification systems evaluation—assessing user goals for multitasking activity. *ACM Trans. Comput.-Hum. Interact., 10*(4), 312-338.

McCrickard, D. S., Czerwinski, M., & Bartram, L. (2003). Introduction: Design and Evaluation of Notification User Interfaces. *International Journal of Human-Computer Studies, 8*(5), 509-514.

McCrickard, D. S., Wahid, S., & Lee, J. C. (2005). *Use and Reuse in Information and Interaction Design.* Paper presented at the HCII Workshop, Las Vegas, NV.

McQuaid, H. L., Goel, A., & McManus, M. (2003). *When you can't talk to customers: using storyboards and narratives to elicit empathy for users.* Paper presented at the DPPI '03: Proceedings of the 2003 international conference on Designing pleasurable products and interfaces, Pittsburgh, PA, USA.

Pruitt, J., & Grudin, J. (2003). *Personas: practice and theory.* Paper presented at the 2003 conference on Designing for user experiences, San Francisco, California.

Rönkkö, K. (2005). *An Empirical Study Demonstrating How Different Design Constraints, Project Organization and Contexts Limited the Utility of Personas.* Paper presented at the 38th Hawaii International Conference on System Sciences (HICSS '05), Waikoloa, HI.

Rönkkö, K., Hellman, M., Kihlander, B., & Dittrich, Y. (2004). *Personas is not Applicable: Local Remedies Interpreted in a Wider Context.* Paper presented at the Participatory Design Conference, PDC '04, Toronto, Canada.

Sanchez, J., Carlos, P., & Maldonado-Naude, F. (2004). *Supporting Structured, Semi-Structured and Unstructured Data in Digital Libraries.* Paper presented at the Fifth Mexican International Conference in Computer Science (ENC'04).

Sinha, R. (2003). *Persona development for information-rich domains.* Paper presented at the CHI '03: CHI '03 extended abstracts on Human factors in computing systems, Ft. Lauderdale, Florida.

Sutcliffe, A. (2000). On the effective use and reuse of HCI knowledge. *ACM Transactions on Computer-Human Interaction (TOCHI), 7*(2), 197-221.

Sutcliffe, A. G. (2002). *The Domain Theory: Patterns for knowledge and software reuse*: Erlbaum & Associates.