

Investigating Design Knowledge Reuse for Interface Development

Shahtab Wahid

Center for Human-Computer Interaction and Department of Computer Science
Virginia Polytechnic Institute & State University
Blacksburg, VA 24061-0106
swahid@vt.edu

ABSTRACT

Reusing HCI design knowledge shows potential in allowing practitioners to design based on previously identified concerns. A reuse approach is presented that is based on claims, design knowledge units encapsulating tradeoffs. Fundamental characteristics of reuse include abstraction, selection, specification, and integration. Claim relationships provide the key to instantiating each of these traits within the claims reuse approach. A claims library is used implement a working model of the reuse process. Studies analyzing various components of this work validate existing efforts and provide impetus for future work.

KEYWORDS

Claims reuse, claims library, reference claims, claims map

ACM CLASSIFICATION KEYWORDS

H.5.2. Information interfaces and presentation (e.g., HCI):
User Interfaces – *Theory and methods*

INTRODUCTION

The accumulation of knowledge within design disciplines is vital to the existence of such fields. If transferred and reused, it has the potential to aid designers with their own systems. Reuse is not only important because it can decrease time and cost, but because it can also allow designers to consider previous research and designs, permitting designers to create with sound reasoning. When stored in a repository, the knowledge can aid in establishing visions, possibilities, and alternatives for development projects. To make use of the knowledge, we must describe, retrieve, and adapt them seamlessly into a coherent conceptualization. A design representation taking advantage of reuse should permit designers to creatively amalgamate knowledge to yield new and innovative interfaces. Human-Computer Interaction (HCI) is a discipline continuously generating design knowledge, but the lack of a complete reuse and representation process hinders advancements. Working toward such a goal reveals the many challenges ahead of us. This research effort seeks

answers to the following questions:

- What methodology can assist knowledge reuse and contribute to future reuse?
- What form of design knowledge can focus designers on key domain concerns?
- Can a reuse approach lead to the creation of a design representation?
- How can the use of a representation further facilitate the reuse of design knowledge?

This work aims to present an approach to facilitating design knowledge reuse based on a software engineering perspective. It is then bolstered by efforts to define what components should describe and how high level system design representations are built. Portrayed as fundamental to these contributions is the notion of design knowledge relationships—succinct descriptions of interactions between knowledge units. The outcome of the reuse process is a design representation form based on the same relationships.

KRUEGER'S REUSE ASPECTS

To further reuse in HCI and create an approach, we turn to research from the field of software engineering. Krueger describes four innate reuse characteristics: abstraction, selection, specification, and integration [3]. His work demonstrates a reuse repository must *abstract* by showing designers limited information of reusable components to avoid having to peruse through all the contents. It must then allow them to *select* a component to view and expose the contents. If needed, components must be *specified* to adapt to individual needs, leading to the final *integration* of the component into the rest of a design. Following these four fundamental aspects shows promise in furthering the cause for reuse in HCI using design knowledge.

Imperative to Krueger's vision of reuse is that any approaches "provide natural, succinct, high-level abstractions that describe artifacts in terms of 'what' they do rather than 'how' they do it." It is more beneficial if designers know a component is a potential solution rather than knowing what the described solution is.

Copyright is held by the author/owner(s).

DIS 2006, June 26–28, 2006, University Park, Pennsylvania, USA.

ACM 1-59593-341-7/06/0006.

CLAIMS RELATIONSHIPS AND THE REUSE ASPECTS

To meet the prerequisite of Krueger's vision, there is a need for a method to describe what design knowledge does within the context of an interface conceptualization. Design knowledge relationships are seen as a strong candidate for this function.

The form of design knowledge concerning this work is called a *claim*. Introduced by Carroll, claims are units of knowledge encapsulating positive and negative psychological effects of design features [1]. Their grounding in theories and observational studies provide designers with valuable insight. Their role as reusable components was extensively researched [4], showing potential for benefits during conceptualization.

Claim relationships describe the connections and interactions existing among claims when collected together to represent an interface—the key to illustrating 'what' claims do. A framework of 10 claim relationships was created, giving the capability to connect claims based on problems and solutions, interaction, differences in scopes, alternatives, and combinations [5]. The relationships are described below:

- **Postulation/Predication:** The relationships between a claim depicting a problem and a claim describing a potential solution
- **Execution/Evaluation:** The relationships between claims describing information presentation and those depicting potential interactions
- **Generalization/Specification:** The relationships between claims covering broadly and narrowly scoped design features
- **Fusion/Diffusion:** The relationships between claims that are combined together to form "larger" claims or torn apart to yield "smaller" claims
- **Translation:** The relationship between two similar claims that are possible alternatives to each other
- **Mitigation:** The relationship to a claim that offers a solution to a specific negative tradeoff described in another claim

Through the use of these relationships, one can now express a connected claim in terms of what it contributes to an overall conceptualization. For example, one can now know a linked claim is a solution, alternative, or interaction without expressing what the claim actually describes. To develop a model using Krueger's vision, a claims reuse approach must utilize the notion these relationships.

Four distinct applications of the relationships were developed to correspond to each of Krueger's aspects. To implement and evaluate the potential of this effort, a *claims library* was modified such that claims were assigned relationships, creating a traversable network. When viewing a particular claim, related claims can be *abstracted* by providing succinct descriptions using any appropriate

relationship. Thus, without seeing the related claim completely, the essence of the claim is described. Designers can traverse through claim networks by following relationship links to *select* claims, creating a browsing mechanism within the library [6]. If a claim is not well suited, it can be *specified* to a designer's needs by using a relationship to create new claims. This chosen relationship can then be used to link the new claim to the original claim, expanding the network of claims and potentially aiding future reuse of the new claim. Finally, as claims are collected, relationships allow designers to *integrate* all the gathered claims and create a *claims map*, a graph of claims representing the eventual design, establishing a fundamental bridge between reusing and defining core interface characteristics. Together, the four applications of the relationships form a complete approach for claims reuse. This model must be completely instantiated within a claims library and claims map creation tool.

Experiments 1-3

A series of studies were run to evaluate the use of relationships for the four reuse aspects. A study with the goal of determining the impact of relationships on finding knowledge and validating a selection process as opposed to regular search queries analyzed the abstraction and selection applications [6]. Participants were asked to retrieve claims for the claims library by regular search queries or a visualization leveraging claim relationships to design a conceptual interface for a small system. An analysis of search strategies and gathered claims concluded relationships aid in the identification of correct claim types and placement within a design when using the visualization. The utility of the relationship-based selection process was also validated through the visualization.

A second study investigated the specification application to find a possible emerging standard claim creation process. Study participants were asked to identify relationships between a set of claims and create new claims based on chosen relationships. The results indicated claims could be easily created using a relationship, but a distinct creation process did not emerge for any of the relationships. Additionally, inconsistencies in the choice of relationships used to create claims were found.

A final study researched the claims map's ability to represent critical aspects of a proposed conceptual design once claims are integrated. Specifically, its abilities to identify different claim types, portray imperative connections between goals and features, present opportunities for evaluation and redesign, and depict the overall system were gauged. Participants extracted specific insights from a traditional list of claims and a claims map. A noticeable change in identifying claims was not found, however, claims maps proved to be highly successful at connecting goals to features. They did provide some insight into evaluations and redesign, but

designers continued to rely on their own intuition. Overall, claims map were found to be the preferred representation method as opposed to traditional lists of claims.

These studies demonstrate the importance of each reuse aspect within the overall approach. When examined individually, they yield challenges of their own. When combined together, they must yield a process that will allow practitioners to surreptitiously transition between reuse aspects. Future efforts must focus on all the aspects together to evaluate larger problems that may arise.

REFERENCE CLAIMS

Key to the utility of the approach is increasing reuse and emphasis on core domain issues. This challenge is addressed by a new variation of claims. Building upon Whittaker's vision of reference tasks [7], *reference claims* bring focus to core domain issues and increase reusability with the help of taxonomies. They are defined by four rules serving as guidelines for their creation and validation. Claim selection is facilitated by their increased reusability while their specifications let designers contribute to fundamental domain knowledge.

Experiment 4

A study was run to gauge three different concerns: the ability to increase reuse, capability to lead to consideration of important design concerns with the use of a taxonomy, and descriptive capabilities of reference claims. Participants were asked to retrieve and use either traditional or reference claims from the claims library to create a small system. Reference claims were found to cause a significant increase in reuse. The taxonomy lead to the significant likelihood of considering important domain problems. Issues regarding the generality of reference claims lead to some descriptive problems. Systems either needed to be outlined more specifically or were left unexplained due to the heavier usage of reference claims. It is anticipated the use of both reference claims and traditional claims together can alleviate this problem, however, future studies must concentrate of the use of both together.

CONCLUSIONS AND FUTURE WORK

Of greater importance is the need for HCI to accumulate knowledge such that others can constantly build upon it [7]. Lacking is the ability to reuse such knowledge effectively and contribute to future efforts. This research seeks to make several vital contributions to HCI reuse and design processes:

- A derivation of an extensive reuse model for knowledge units valued by the HCI community
- A design representation form facilitating the reuse of knowledge for interfaces
- Simple and effective tools to support obtaining knowledge and creating a design conceptualization

Although multiple studies have been conducted to assess parts of the reuse process, there is still a great need to evaluate the complete method. Through actual design efforts, the methodology must be followed to find its true utility. A lot of this work will concentrate of the use of claims maps. There is a need for a study to identify the process of integrating a single claim from the claims library into a claims map. How a claims map facilitates reuse must be demonstrated by showing a clear connection between the map and the use of the claims library.

The improvement and development of tools to support these tasks will also be needed. The claims library must be developed and populated to better support the intricacies of claims reuse. With the establishment of a critical mass within the library, a community of users must be able to create and retrieve claims. Allowing users to establish relationships they identify among claims can further semantic navigation—movement through information as a result of semantic relationships [2]. Reused claims must be integrated into a claims map in a tool granting constant and immediate access to the library and new claims created for the claims map should automatically be stored in the library. Additional guidance for SBD methodology steps should be provided to designers through this tool. To further help retrieval, social navigation—movement through information as a result of the activity of others [2]—will be facilitated by indicating the most reused claims by users. This will enable future design efforts to review more of what was used in the past.

REFERENCES

1. Carroll, J. M., & Kellogg, W. A. Artifact as theory-nexus: hermeneutics meets theory-based design. Proc. CHI 1989, 7-14
2. Dourish, P. & Chalmers, M. Running out of space: models of information navigation. Proc. of HCI 1994
3. Krueger, C. W. Software Reuse. ACM Computing Surveys, 24, 2, 131-183
4. Sutcliffe, A. G. On the Effective Use and Reuse of HCI Knowledge. ACM Transactions on Computer-Human Interaction, 7, 2, 197-221.
5. Wahid, S., Allgood, C. F., Chewar, C. M., & McCrickard, D. S. Entering the Heart of Design: Relationships for Tracing Claim Evolution. Proc. SEKE 2004, 167-172.
6. Wahid, S., Smith, J. L., Berry, B., Chewar, C. M., & McCrickard, D. S. Visualization of Design Knowledge Component Relationships to Facilitate Reuse. Proc Information Reuse and Integration 2004, 414-419.
7. Whittaker, S., Terveen, L., & Nardi, B. A. Let's stop pushing the envelope and start addressing it: A reference task agenda for HCI. Human Computer Interaction, 15, 2 & 3, 75-106