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How Workstyle Transitions Influence the Tools' Perceptions of Use

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1. Introduction

Software engineers need better interaction design tools: tools that will help them create higher quality user interfaces. Looking back at the evolution of interaction design and software development tools, what we see is a relentless march of ever heavier, more complex and less usable systems, systems that prevent the designers from focusing on their real important tasks: building usable and useful products.

There is increasing evidence from research claiming that real-world designers and modellers prefer to use general-purpose, unrestrained, tools instead of formal, rigid tools (Jarzabek and Huang, 1998; Wu et al., 2003), something that our previous research also showed (Campos and Nunes, 2007). However, the industries' tool vendors "who sell us the software tools that make disciplined design possible" do not use the tools themselves (Constantine, 2001). Companies often force designers to adopt certain tools or tool suites as a consequence of management intentions to instil standards and best practices. The designer has been framed into a vicious plot of imposed tools and methods: tools are not widely adopted and used.

In this paper, we propose a novel framework to assess the acceptance and usability of interaction design tools. Instead of leveraging on usability engineering work, we use a popular technology acceptance model from the Management Information systems (MIS) field and combine that model with usability evaluation techniques to study how interaction designers actually work.

Throughout this paper, we use the concept of work style (Campos and Nunes, 2005b) as a compact way to describe the user's way of working (working alone or collaboratively, thinking at problem level or at solution level, using a sound semantic or simply being creative).

Although some research has been dedicated to studying why modelling tools are not used (Ilvari, 1996), leading to some frameworks that can measure the tool usability in a cost-effective way (Seffah and Kline, 2002); our approach is distinctive because it combines work style quantitative data that can be easily obtained with logging tools (tools that measure the user's actions running unobtrusively in background) with qualitative data that predicts a given tool level of acceptance. By quantitative, we mean data that we can easily measure in numbers, like e.g. the number of times the user switches from a high-level view of the User

Inter-face (UI) into lower-level, detailed views of the UI. By qualitative, we mean data collected from subjects, which express their subjective feelings regarding any aspect of using a system, like e.g. the extent to which users found the system easy to use. The HCI field has surprisingly little research on evaluation methods that try to combine and make use of both quantitative and qualitative data. Combining them can contribute to obtaining a "bigger picture" of a system's level of usability and usefulness.
This paper is organized as follows: in Section 2, we describe some studies and frameworks about usability and evaluation methods with a particular focus on development or design activities. Section 3 describes the foundations of our proposed framework. Section 4 presents field study's results and discussion. Finally, section 5 concludes and discusses some implications of our findings to tool developers and designers.

2. Studying and Supporting the Designer's Behavior

Our research goal is to better understand the usability and acceptance factors of interaction design tools. We follow a two-phase approach: (i) study everyday interaction design tasks and (ii) exploit the information obtained in the design of new tools.
We devised an approach that aimed for an empirically sound framework that could be used to inform as well as to validate the design of new tools. This research objective is not new, but the question is very timely: the argument that the practitioner's behaviour must be studied in order to make better tools has been used recently by Seffah and Kline (2002); Ko and Myers (2005). There has also been a growing body of research aimed at building models for e.g. the design of interactive systems within their physical environments. Graham et al. (2000) describe a Dimension Space "intended to help designers understand both the physical and virtual entities from which their systems are built, and the tradeoffs involved in both the design of the entities themselves and of the combination of these entities in a physical space".
This need for better studying and supporting the interaction designer's work is even more evident in the case of model-based tools (Paternò, 2005; Navarre et al., 2001; Vanderdonckt and Berquin, 1999), which are our main research focus. In model-based tools it is common to provide the designer with a set of tools suited for each aspect of the development. For instance Sinnig et al. (2004) describe a set of tools for task modelling, dialog modelling and for designing the presentation and layout models. The problem with this approach is that it is difficult to go back and forth from one model to another: even if tools provide full traceability between models, there is a cognitive load in the designer's mind that gets higher as the number of transitions between different models increases.
Paternò (2005) has recently described how tools can support the development of task models, particularly for multimodal UI development, and has also analyzed a series of new challenges for model-based tools. Paternò also acknowledges that models can be represented with different levels of formality, which we also ad-dress in our proposed work style model.
Thevenin and Coutaz (1999) have also argued for "plastic" UI's, interfaces that must run on heterogeneous devices, where the contexts of use vary and may even change at runtime, according to the user's preferences and needs. This line of thought clearly supports our argument that more effort is needed for designing tools that are capable of transparently adapt to the interaction designer's work styles.

2.1 The Technology Acceptance Model

Complex work activities increase the difficulty of predicting the level of acceptance of novel technology and how it will be used in practice. An important and open research question is how to translate usability evaluation results into concrete design decisions (Morris and Dillon, 1997; Wright et al. 2000).

The Technology Acceptance Model (TAM) developed by Davis and colleagues (Davis, 1989) is a widely used theoretical model in the Management Information Systems (MIS) field. Basically, it attempts to predict and explain computer-usage behaviour, offering both researchers and practitioners a direct, pragmatic instrument to measure a technology degree of acceptance. Morris and Dillon (1997) pointed out that TAM offers HCI professionals a "theoretically grounded approach to the study of software acceptability that can be directly coupled to usability evaluations".

In TAM, depicted in Figure 1, there are five primary constructs: Perceived Usefulness (PU), the extent to which the user expects the system to improve his/her job performance within an organizational setting; Perceived Ease Of Use (PEOU), the degree to which the user believes the system's use will be free of effort; Attitude toward Using (A), the user's desire to use or favourableness feelings towards using the system; Behavioural Intentions to Use (BI), which measures the strength of a user's intention to use the system in the future; and the Actual Use, i.e. the amount of usage per time unit.

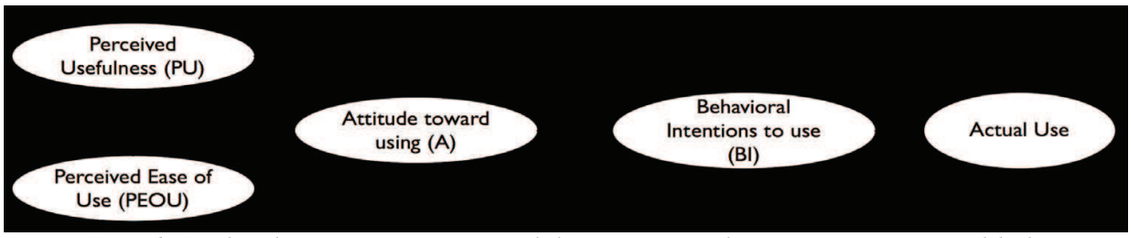


Fig. 1. Davis's Technology Acceptance Model. It suggests that a person is more likely to actually use a technology if he believes that it will be both useful and usable.

As depicted in Figure 1, the actual use of a system is a direct function of the behavioural intentions to use it. These are in turn influenced by perceived usefulness and attitude toward using. Perceived ease of use and perceived usefulness are both crucial to determine the attitude toward using the system.

TAM has been effectively used (Taylor and Todd, 1995; Mathieson, 1991) to predict system's acceptability, but it cannot be used to explain specific design flaws (Morris and Dillon, 1997). However, it presents the important advantage of being a reliable and cost effective way to evaluate systems at any life cycle time. The value of TAM stems from several aspects: it has a solid background on psychological theory, it is easy to apply and understand; it links to usability evaluations (Davis, 1993); and finally it has been replicated in different contexts and tools (Adams et al., 1992; Taylor and Todd, 1995; Morris and Dillon, 1997).

3. Styles for Work Styles: a Study Framework

Interactive Systems Design methodologies, such as Wisdom (Nunes and Cunha, 2001) and Usage-Centred Design (Constantine and Lockwood, 1999), often describe users in context by

using the concept of actors. UsageCD (Constantine and Lockwood, 1999), for example, separates the actors of a system from the roles they play during the system's usage. Indeed, users adopt several roles during the usage of a system, just like film actors do, but they also switch roles during the process. Although interaction design methods are well conceived to develop systems supporting the roles of usage, few systems provide support for flowing from different contexts/needs of usage. In our research, we found that interaction designers often engage into different work styles, a term coined by Wu and Graham (2004), who studied the activities and collaboration is-sues of software designers.

We define a work style as an informally defined set of values in n-dimensions. These dimensions describe the most important aspects of the way users work in order to achieve their tasks. A work style transition (or change) is a change in one or more values of a work style. A region (or plane) in a work style model is a set of work styles. Systems supporting work style regions are systems that can adapt to and support transitions in the users' styles of work. Figure 2 illustrates an example of a work style transition in the life of an interaction de-signer: on the left hand-side, a team of developers works together using post-it notes for task clustering in a spatially useful style. After this, the team splits and each designer is assigned a set of tasks and builds a concrete mock-up of the interface using an interface builder. Each designer transitioned from a low-detail, collaborative, low-tech work style to a high-detail, high-tech, individual work style.

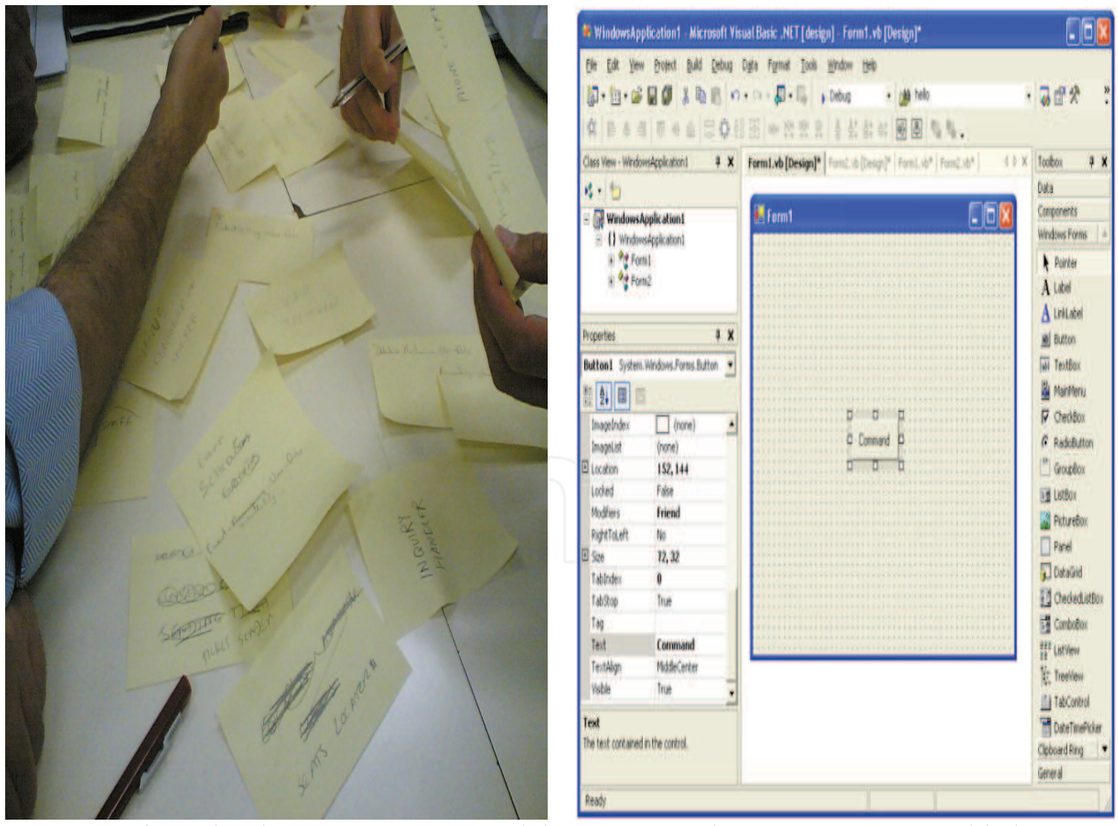


Fig. 2. Davis's Technology Acceptance Model. It suggests that a person is more likely to actually use a technology if he believes that it will be both useful and usable.

This is not the only example of a work style transition. "Moving from collaboratively modelling using a whiteboard into a digital version (using e.g. a UML tool)", "Moving from high-level descriptions of the user interface (e.g. sitemaps, navigation maps, etc.) to detailed screens of the user interface (concrete widgets, but-tons, etc.)", "Moving from sketching informal ideas/concepts (using e.g. blackboards or sheets of paper) into formal models (e.g. UML digital models), and back.", "Moving from non-functional prototypes toward fully-functional prototypes" and "Moving from business rules, use cases and problem space concepts into final solution design, and back" are concrete examples from a day in the life of an interaction designer.

3.1 Supporting the Work Style Model for User-Centered Design

In order to aid the characterization of different work styles as well as transitions in those work styles, we developed a novel model called the Work Style model for UCD (Campos and Nunes, 2005a). The model consists of eight continuous axes. These axes are grouped under three main categories:

- Notation style-related dimensions (Perspective, Formality and Detail),
- Tool usage style-related dimensions (Traceability, Functionality and Stability) and
- Collaboration style-related dimensions (Asynchrony and Distribution).

Each of these dimensions is described in more detail in (Campos and Nunes, 2005a), and for each dimension there is a set of questions that can act as guidelines, thus aiding the process of work style classification.

Perspective plots whether one is working at problem (business) level or at solution (design) level. Formality plots whether the designer is being informal (ambiguous, sketchy, creative) or formal (rigorous, semantically-sound). Detail refers to the level of abstraction being employed: at one extreme Traceability depicts whether one is interested in maintaining (or not) traceability between design models. Functionality describes the amount of working components in the prototype(s) being designed: a paper-based prototype has no functionality at all, whereas an interface designed in ubiquitous graphical interface builders shows a reasonable degree of functionality. Stability plots the rate of change and modification in the designs. And finally, collaboration-style dimensions plot Asynchrony (editing designs at same time or different times) and Distribution (working at the same place or remotely).

One of the main advantages brought by the work style model for UCD comes from the fact that, for the first time, there is a fundamental approach that can justify what kind of tool should be used, as well as when and how. For this purpose, we need to know which style is needed at what stage and what transition afterwards. Therefore, according to the development path (e.g., top down, bottom up, or middle out), different transitions might be explored. The model is also useful for driving the development of new design tools. We will de-scribe some aspects of the TaskSketch tool (Campos, 2005; Constantine and Campos, 2005) that were directly designed to support work style transitions.

The TaskSketch tool was developed both as a research proof-of-concept instrument used to test and validate our ideas, as well as an instructive tool, which has proven effective in supporting the teaching of UCD concepts at the undergraduate and graduate levels. Figure 3 shows a partial screenshot from the tool, illustrating briefly all the views and models that are currently supported.

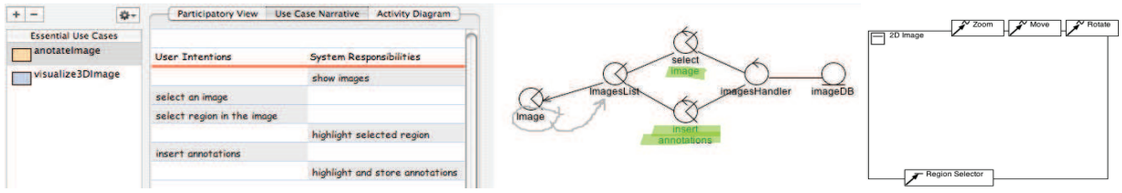


Fig. 3. TaskSketch briefly illustrated (From left to right): Use Case View, Task Flow View, Conceptual Architecture View and Canonical Abstract Prototype View.

As an example of how tools can be designed by direct inspiration of the work style model, consider the following example from the TaskSketch tool. How can we support the perspective dimension? Instead of merely supplying the users with a set of constructs and views for use case modelling, TaskSketch provides drag-and-drop mechanisms for extracting an initial conceptual architecture for an interactive system.
As another example of work style support, the tool allows editing of task flows at three different – but synchronized – views: the participatory view, which is a typical result of a participatory session with end users (obtained by manipulation of sticky notes); the use case narrative proposed by Constantine that can also be printed in index cards for stacking and ordering by the different stakeholders; and the activity diagram which could include additional details relevant to developers but that are not depicted in the other views.

3.2 A Framework for Studying the Designer's Tools and Work Styles

We argue that professional practitioners of interaction design engage into different work styles throughout their daily activities. We performed a survey distributed to professional interaction designers associations and mailing list, and collected 370 usable responses (Campos and Nunes, 2007). This study had two main goals:

- Assess the practical aspects of the work style model: in particular whether asking questions about work-styles would be understandable and would lead to interesting findings;
- Find interesting patterns of tools' use and/or work style transitions among industrial designers.

Among other issues, we were interested in finding out which work style transitions did the practitioners considered more frequent and more difficult, in their everyday work practices. By frequent, we mean, "how many times [the respondent] engages and transitions in those work styles", and by difficult we mean, "how difficult [the respondent] finds to perform that transition". We confronted respondents with several concrete scenarios of work style transitions and asked them to rate frequency and cost by selecting a value from a 7-point Likert scale, labelled from 1-low, to 4-moderate and 7-high.
Results showed that the most frequent and the most difficult transition was "Moving from business rules, use cases and problem space concepts into final solution design, and back". This is a perspective work style transition, and the average rating was 4.6 on the 7-point Likert scale for the frequency and 4.5 for the difficulty.
Combining the Technology Adoption Model, the Work style Model for UCD and our survey's results, we designed an experimental framework aimed at studying the interaction designer's tools and work styles. Figure 4 summarizes the constructs in our framework, as well as the hypotheses we tested.

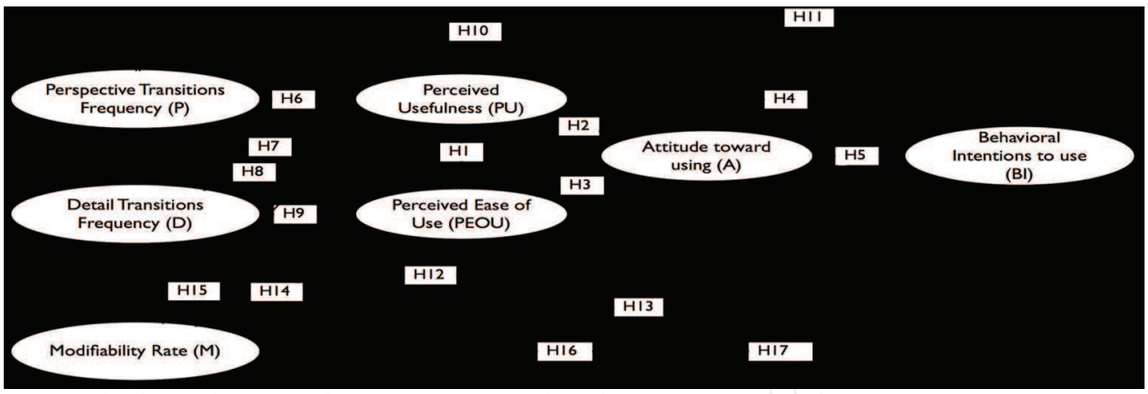


Fig. 4. The hypotheses and constructs considered in our framework.

As illustrated in Figure 4, we wanted to test the following variables:
Perception-related variables operationalize the constructs of this framework. Four perception-based variables are measured, just like in the TAM:
- Perceived Usefulness (PU) is defined as the degree to which the user believes that using the tool will enhance his or her performance in designing interactive systems;
- Perceived Ease Of Use (PEOU) is defined as the degree to which the user believes that using the design tool will be free from effort;
- Attitude toward using (A) measures the feelings of favourableness toward using the tool;
- Behavioural intention to use (BI) measures the strength of a designer towards using the tool in the near future.
Work style-related variables measure some aspects that come from our Work style model and from the transitions considered most difficult and frequent by professional interaction designers (according to our survey):
- Perspective Transitions Frequency (P) is defined as the rate (per minute) of transitions from different perspective views, i.e. the frequency of transitioning from problem space concepts (use cases, task flows) to solution space (architecture, abstract prototype) and back;
- Detail Transitions Frequency (D) is defined as the rate (per minute) of "drill-down" or "roll-up" between model elements, i.e. switching from high-detail views of an element to low-detail or the opposite;
- Modification Frequency (M) is the rate (per minute) of change made to any element of the artefact(s) being designed. This might include changing names, colour, size, values or any other property of elements.

As shown in Figure 4, our framework extends the technology adoption model (TAM). We augmented it by including work style quantitative data that can be automatically obtained from the usage of a given design tool. Both the perspective and detail transitions frequency can be obtained by logging mechanisms. The same happens to the modifiability frequency measurement. We extended TaskSketch in order to produce detailed statistics regarding the following quantitative variables:
- Perspective Transitions Frequency, the number of times (per minute) that a designer switches from a view to another (e.g. use cases view to abstract prototype view); in TaskSketch this is measured by counting the number of times the user switches his focus from one view to another;

- Detail Transitions Frequency, the number of times (per minute) that a designer switches from high (low) detail view of the user interface to low (high) detail view; in TaskSketch this is measured by counting the number of times the user switches from the Architectural view (which can be used to define navigation maps of the user interface) to the Abstract Prototype view and back;
- Modification Frequency, the number of times (per minute) that a designer performs changes to any given model element (e.g. changing the text/title of a use case, changing the layout of a prototype, etc.).

We chose to include only these transitions in our framework and experimental study because of two main reasons: first, according to our survey's results, these are the transitions rated with the highest combination of frequency/cost perceptions (between practitioners). This means they are among the most important ones. And secondly, because they are also the simplest transitions to measure. Functionality and Traceability are also easy to measure quantitatively but are more difficult to implement in a tool. For instance, a tool that supports Functionality transitions should allow designers to create fully-functional prototypes, partially-functional or non-functional at all. Collaboration-style transitions are easier to measure in intrusive ways, e.g. by videotaping users and/or running "think-aloud" protocols.

Since we were measuring the rate of modifications to modelling artefacts, we also gathered data regarding the percentage of time users were engaged in creation activities (e.g. adding a new use case, drawing a new element, etc.), modification activities (e.g. changing the text/title of a use case, changing the layout of a prototype, etc.) and searching activities (e.g. looking for a particular element using the search facilities).

4. Test Results and Analysis

Since there is currently no other tool for Usage-Centred Design, we didn't evaluate TaskSketch against a control method. We could compare it with, e.g. ArgoUML or MS Visio, but they would have to be adapted to ensure they supported the same notations equally. We examined the usage of TaskSketch in a field study that used subjects enrolled in an undergraduate 3rd year Human-Computer Interaction course at the University of Madeira in a similar procedure as (Ko and Myers, 2005; Abrahão et al., 2005). In this section, we describe in detail the experiment's procedure, variables, results and discussion.

4.1 Procedure and Variables

Our sample size was 15 students. Subject's average age was 22.71 (SD = 2.78). Five participants were female. In order not to bias the experiment, subjects' participation was entirely optional, and the experimenter was not an instructor in the course. The experiment took place in a single laboratory equipped with 15 eMacs, and to avoid ceiling effects, we gave no time limit for the execution of the task. The third year HCI students had already experience in using modelling tools, and their perceptions of use map very closely to what a professional designer might think or believe, because their objective is very much alike.

We asked participants to design a Use Case, Task Flow, Conceptual Architecture and an Abstract Prototype for an interface to a weather system for travellers, as Landay and Myers (2001) did. This problem is described in Usability Engineering (Nielsen, 1993) and provides a solid benchmark, since possible design errors are well-documented (Nielsen, 1993). It is

also small-enough for a study session and large-enough to ensure sufficient coverage of design situations.

After finishing the tasks, subjects were asked to answer a post-experiment survey. The survey included 14 questions, based on the variables of the theoretical model. The items used were formulated through a 7-point Likert scale, where the order of items' presentation was randomized and half the questions negated to avoid monotonous responses and prevent systemic bias in a process very similar to current research techniques such as the ones conducted by Abrahão et al. (2005), Morris and Dillon (1997).

We measured quantitative and qualitative variables. The questionnaire we developed uses scales for each qualitative variable in the theoretical model presented earlier. The whole set of constructs in this experiment and how they were built and measured are shown in Table 1.

PEOU-Perceived Ease of Use	1. Learning to use TaskSketch would be easy to me. 2. It's easy to create models using TaskSketch. 3. It would be easy for me to become skillful at using TaskSketch. 4. I would find TaskSketch easy to use.
PU-Perceived Usefulness	5. Using TaskSketch would improve my performance in designing UI's 6. Using TaskSketch would enhance my effectiveness in designing UI's. 7. Using TaskSketch would improve my productivity in designing UI's. 8. I would find TaskSketch useful in the University.
A-Attitude toward Using	9. Using TaskSketch is a (good/bad) idea. 10. Using TaskSketch is a (wise/foolish) idea. 11. I (like/dislike) the idea of using TaskSketch. 12. Using TaskSketch would be (pleasant/unpleasant).
BI-Behavioral Intentions to Use	13. I intend to use TaskSketch during the remainder of the semester. 14. I intend to use TaskSketch frequently this semester.
P-Perspective Transitions' Frequency	Number of times the user switches from a view to another (per minute), e.g. switching from use cases (problem perspective) view to abstract prototype (solution perspective).
D-Detail Transitions' Frequency	Number of times the user switches from a high (low) detail view to a low (high) detail view (per minute), e.g. switching from navigation map (low detail) to abstract prototype (high detail).
M-Modifiability Rate	Number of times per minute that the user edits or changes any property of any model element, e.g. changing the layout of a prototype, changing a use case description, changing the title of a task.

Table 1. Constructs and how they were built.

4.2 Validity and Reliability of the Model's Constructs

In order to evaluate the validity of the constructs in our model, we performed an inter-item correlation analysis. We assumed that all items associated with a particular construct had equal weights and measured the convergent and discriminant validity proposed by Campbell and Fiske (1959), which was used in several re-search reports in the SE field with similar sample sizes (Abrahão et al., 2005).

Convergent validity (CV) assesses if measures of constructs that theoretically should be related to each other are, in fact, observed to be related to each other. It is measured by the average correlation between the indicator and the other indicators that are used to measure the same construct.

Discriminant validity (DV) assesses if measures of constructs that theoretically should not be related to each other are in fact observed to not be related to each other.

The important thing to recognize is that these concepts work together: if one can demonstrate that there is evidence for both convergent and discriminant validity, then by definition, one can demonstrate that there is evidence for construct validity.

	CV	DV	VALID?
PEOU1	0.691	0,503	YES
PEOU2	0.821	0,443	YES
PEOU3	0.698	0,424	YES
PEOU4	0.772	0,457	YES
PU5	0.687	0,440	YES
PU6	0.725	0,529	YES
PU7	0.791	0,478	YES
PU8	0.745	0,491	YES
A9	0.794	0,430	YES
A10	0.795	0,439	YES
A11	0.792	0,644	YES
A12	0.689	0,498	YES
BI13	0.859	0,419	YES
BI14	0.859	0,496	YES

Table 2. Correlation between survey items (construct validity analysis).

Table 2 shows the correlation results (single inter-tem correlation values for every item in the survey was omitted for brevity). For every question in the survey, the convergent validity is always higher than the discriminant validity (by a factor of almost 2). This demonstrates the validity for the constructs. From the data, we conclude that the survey is a valid instrument for the intended study.

We also performed a reliability analysis on the items of our survey. The reliability of an instrument de-scribes the consistency (or repeatability) the instrument gives in measuring the same phenomenon over time or by different people. To ensure reliability of the scales, we calculated Cronbach's alpha for each variable. Cronbach's alpha is the most common form of reliability coefficient. By convention, behavioural studies are considered reliable if the alpha's value is greater than .60 (Nunally, 1978).

Construct	Cronbach's Alpha
Perceived Usefulness	0.902
Perceived Ease of Use	0.898
Attitude toward using	0.899
Behavioral intentions to use	0.937

Table 3. Reliability analysis.

The results that sustain the reliability of the constructs for qualitative evaluation in our survey are shown in Table 3. We have obtained high values for the four variables (all alpha values are around 0.9), meaning that the items on the survey are reliable and valid measures of the underlying constructs of the proposed theoretical model. In practice, this means there is a great chance of obtaining very similar measures for each construct over time or by different subjects.

4.2 Results and Discussion

The descriptive statistics results from the participants' perceptions of use, as well as their attitude and intention to use are shown in Table 4.

Descriptive Statistics	PU	PEOU	A	BI
Number of observations	15	15	15	15
Minimum	3.75	2.50	3.50	1.00
Maximum	7.00	7.00	7.00	7.00
Mean	5.8667	5.2667	5.6167	4.2000
Standard deviation	1.0892	1.4744	1.2206	1.8400

Table 4. Descriptive statistics for PU, PEOU, A and BI.

These results (all averages are well above the 3.5 neutral value in our scale) mean we empirically corroborate that participants find TaskSketch both useful and usable, show a positive attitude towards this tool, and they intend to use TaskSketch in a near future. The ideal method to measure this would be using a control condition, i.e. comparing the data from a group of subjects using another tool against the data from the group using TaskSketch. However, this would be unfair since there is currently no other tool (to our knowledge) specifically aimed at Usage-centred Design.

From our log analysis tool, we also extracted the mean frequency of usage time subjects spent on each view. The pie chart in Figure 5 shows the distribution of this time. We can see that work at the abstract proto-type has the largest usage time, followed by use cases, architecture and finally task flows. We also measured the time spent creating new model elements (mean=28%), modifying model elements (mean=79%) and searching (mean=1%). All these results corroborate our expectations and are according to what we expected. Also, these results contribute to increasing empirical data on how tools are actually used, and they also assured us of the correct functioning of our logging tool. They carry with them important implications to the de-sign of interaction design tools: use cases and abstract prototype views exhibited the largest time share of usage, which means more attention

should be devoted to the UI supporting these views. In the same manner, if users spend most of the time (79% according to the logging tool's measurements) modifying model elements, then it is clear that this activity is the most frequent, and therefore its performance should be carefully supported by the design tool at stake.

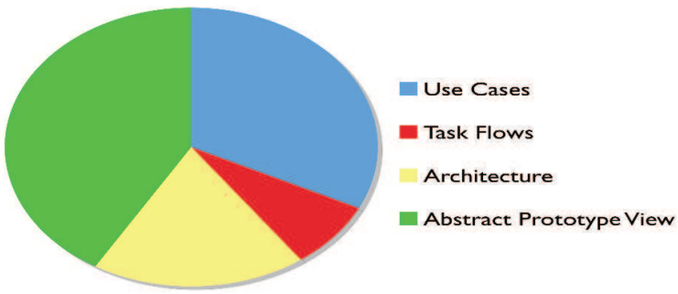


Fig. 5. Frequency distribution of the several views used by subjects (recorded through automatic logging tools).

After combining the work style transitions data, obtained by the logging tools and TAM, and the data obtained from the follow-up questionnaire, we performed regression analysis in order to test the hypothesis in our model. Table 5 shows the details of our simple linear regression analysis we performed. The grey-background rows are the hypothesis taken directly from the TAM model. All the other hypotheses are introduced by us, having in mind the proposed model (depicted previously in Figure 4).

Hyp.	Relationship	β	Std. error of β	t	p	R^2	Result
H1	PEOU→PU	0.44	0.164	2.71	0.018	0.362	Supported
H2	PU→A	0.96	0.158	6.13	0.000	0.743	Strongly supported
H3	PEOU→A	0.43	0.196	2.19	0.047	0.270	Supported
H4	PU→BI	0.89	0.397	2.26	0.042	0.282	Supported
H5	A→BI	0.81	0.352	2.32	0.037	0.293	Supported
H6	P→PU	-0.61	0.695	-0.89	0.397	0.202	Not supported
H7	P→PEOU	-2.45	0.530	-4.63	0.001	0.805	Strongly supported
H8	D→PU	-2.16	1.655	-1.31	0.219	0.147	Not supported
H9	D→PEOU	-7.34	1.499	-4.90	0.001	0.706	Strongly supported
H10	P→A	-0.24	0.788	-0.30	0.765	0.243	Not supported
H11	P→BI	-2.65	0.694	-3.82	0.004	0.735	Strongly supported
H12	D→A	-1.83	2.003	-0.91	0.381	0.077	Not supported
H13	D→BI	-8.07	1.768	-4.56	0.001	0.676	Strongly supported
H14	M→PEOU	-0.95	0.333	-2.86	0.019	0.477	Strongly supported
H15	M→PU	-0.46	0.317	-1.45	0.179	0.191	Not supported
H16	M→A	-0.92	0.234	-3.93	0.003	0.633	Strongly supported
H17	M→BI	-0.96	0.380	-2.53	0.032	0.415	Supported

Table 5. Regression results.

Table 5 shows, for in-detail analysis purposes, several commonly used regression results variables, which we will briefly describe as follows:
- β is the regression coefficient (the amount of change in y per unit change in x); in other words, it is the slope of the line, which describes the relationship between the independent and dependent variables;
- the standard error of β is the estimated standard deviation of error in estimating y from x;
- t is the statistic for determining whether the relationship is statistically significant;
- p is the statistical significance of the test;
- R2 tells us the percentage of the variation in y (the dependent variable) that is explained by the scores on x (the independent variable).

We considered a relationship was strongly supported when the level of significance p would be < 0.01 and R2 greater than 0.4, since in current research results are much more tolerant. Morris and Dillon (1997), for ex-ample consider relationships firmly supported even with R2 values lower than 0.2.

Figure 6 and Figure 7 depict the results visually and we can conclude that the tool's perceptions of use influence both the attitude toward using the tool as well as the behavioural intentions to use it. Also, we observed a strong influence of the work style-related constructs in the tool's perceived ease of use as well as in the behavioural intentions to use the tool. The actual use of the tool (following a time period, after the first contact with the tool) was not evaluated in this study.

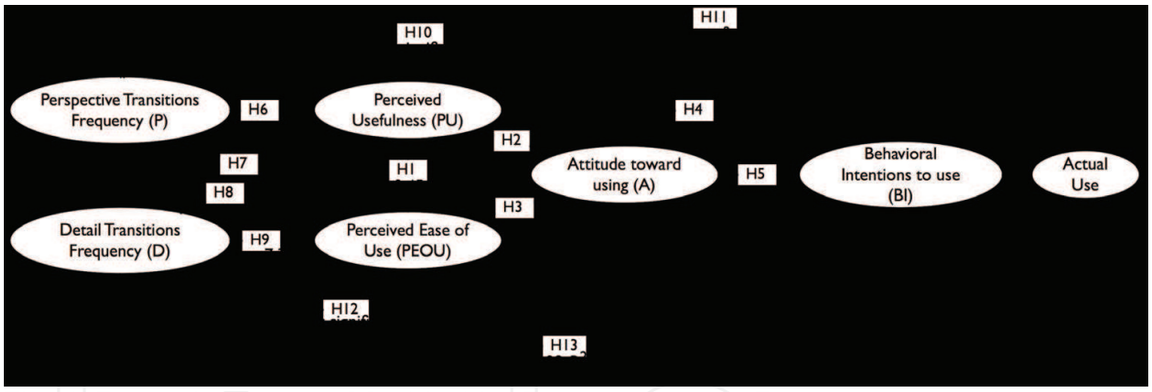


Fig. 6. Regression results (Modifiability Rate not shown). For each hypothesis tested we present the regression coefficient (b), R-square and the level of significance of the relationship.

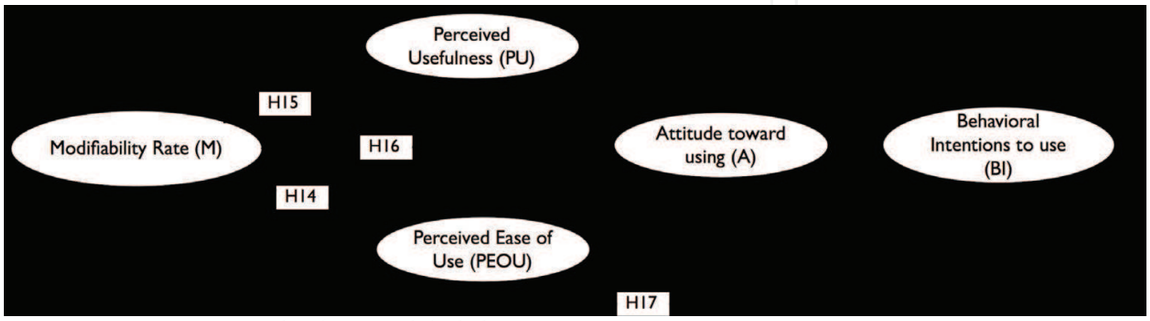


Fig. 7. Regression results for Modifiability Rate.

The final revised theoretical model is presented in Figure 8, where we use the stroke width of the hypotheses' arrows to depict the strength of the statistical significant relationships between constructs of our framework.

The results presented here firmly support all the hypotheses derived from TAM. As we expected, the TAM model's relationships were verified to be statistically significant. Some of the relationships were not found to be significant. Regarding the work style constructs, these were not found to significantly influence the perceived usefulness of the tool. However, they do play an important role when it comes to perceived ease of use and intentions to using a tool. Detail and Perspective transitions strongly influence Perceived Ease of Use and Behavioural Intentions to use. Modifiability rate influences not so strongly Perceived Ease of Use and (more significantly) the Attitude toward using, as well as Behavioural Intentions to use. In other words, work style transitions can influence the tool's perceptions of use.

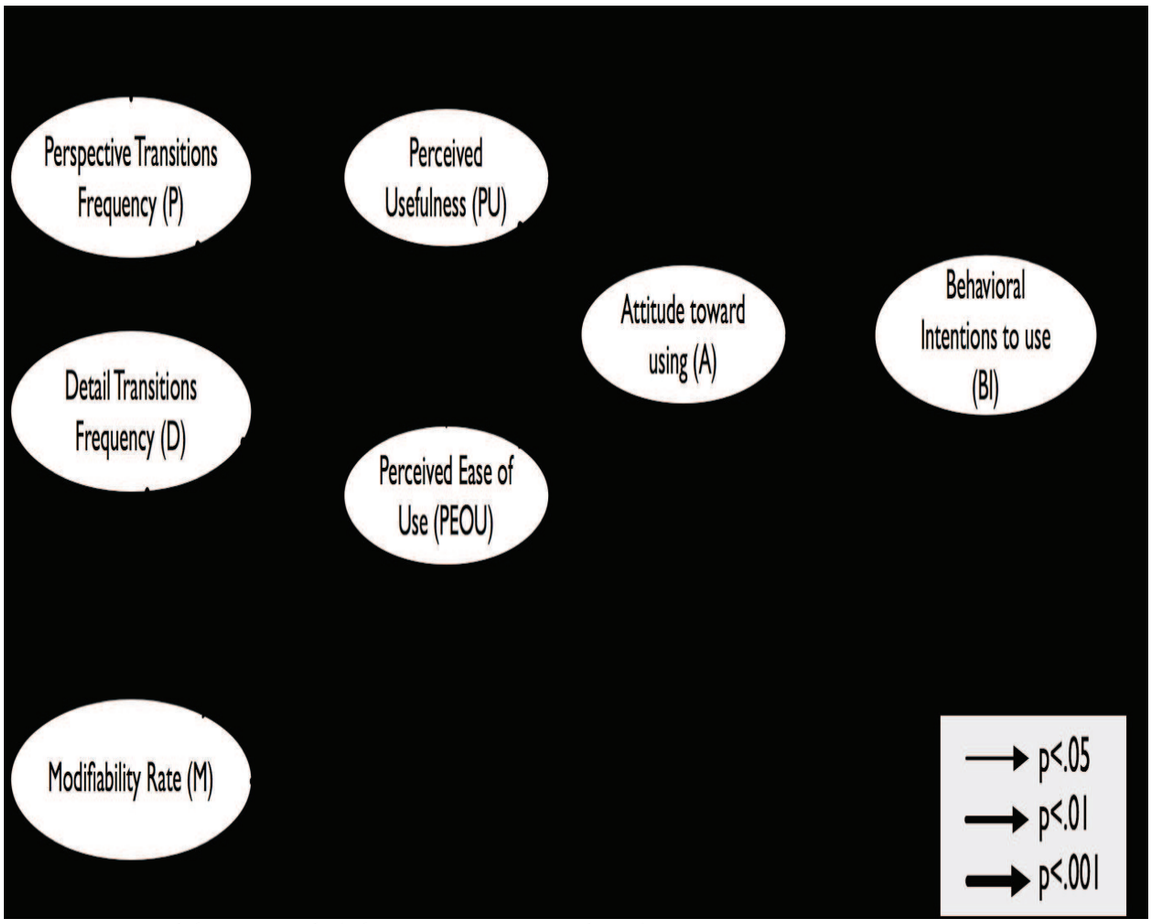


Fig. 8. Revised framework (after regression analysis).

5. Conclusions

In this paper, we have captured the interaction design styles into an empirically-based framework that can be cost-effectively used to study existing design tools as well as to inspire the development of new design tools like TaskSketch. We don't claim that our

framework completely addresses all the issues related to the current interaction design tools, but we do find our framework a useful discussion and evaluation instrument.

Here we also presented the TaskSketch tool, specifically designed in order to support work styles and work style transitions. In particular perspective-style transitions, which we previously showed to be regarded as one of the most frequent and difficult work style transitions, among professionals (Campos and Nunes, 2007). The results of TaskSketch's evaluation empirically corroborate that subjects found the tool useful and usable, and they also showed a positive attitude towards using it.

We have augmented the Technology Acceptance Model with quantitative work style data from users, which was easy to obtain in a transparent way thanks to automatic logging tools.

We know that user perceptions influence software use. We currently know that work style transitions can influence the user perceptions for the case of interaction design tools. Therefore, if we better support work style transitions we might be able to build better design tools, tools capable of achieving higher adoption levels than current ones. Our results suggest that work style transitions do have an influence on the tools' perception of usability and usefulness as well as behavioural intentions to use it.

One limitation of our study is related to how well do the results generalize. This is partly due to our small sample size and partly because the population is not sufficiently close to real world designers. However, HCI students are tomorrows' users of the design tools and their perceptions of use map very closely to what a professional designer might think or believe, because their objective is exactly the same. Also, since we are dealing with perceptions of use and attitudes toward future use, no previous significant experience is required.

This study carries with it important implications regarding the design of new interaction design tools. Some are based on our own development and evaluation experiences, some are based on the model itself, and some are based on the survey and experiment's concrete results.

Based on our experience and subjects written and oral comments on the tools (both in this study and in a previous one), we believe one of the major areas of weakness of tools is related to the expressive power of tools and the comparison and exploration of alternative designs that a tool can foster. Most of the times it is so much easier to grab a sheet of paper and explain (or explore) a design idea without using a digital tool.

Aesthetics are also important. Most of the positive remarks for our tool are related to how well the models created look either in screen or in print. Work style support clearly implicates stylish user interfaces for the sup-porting tools, an issue that's being more and more debated (Norman, 2004).

If perspective and detail transitions are viewed by professional interaction designers as the most difficult (perspective) and frequent (detail) kind of transitions, and if our results show that these transitions' frequency has negative impacts on the tools' perceptions and intentions of use, then tool designers should find innovative ways to ease those transitions. The same happens with modifiability: the results suggest that the more modifications, the lower the positive feelings regarding the tool. Since we have showed that almost 80% of the time is spent modifying artefacts, effort should be targeted at easing this activity.

If more research is targeted at studying the interaction designer's behaviour and work styles, and if we start designing tools that actually implement these ideas, then the future of

interaction design tools is bright be-cause they will be fit into the work practices and usage intentions of designers.

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The book consists of 20 chapters, each addressing a certain aspect of human-computer interaction. Each chapter gives the reader background information on a subject and proposes an original solution. This should serve as a valuable tool for professionals in this interdisciplinary field. Hopefully, readers will contribute their own discoveries and improvements, innovative ideas and concepts, as well as novel applications and business models related to the field of human-computer interaction. It is our wish that the reader consider not only what our authors have written and the experimentation they have described, but also the examples they have set.

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