Usability Planner: Development of a Tool to Support the Selection and Estimation of Cost Benefits of UCD Methods

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Abstract. Despite a growing interest in usability techniques in the overall systems development practice, and the existence of standards aiming to guide the selection of UCD (User-Centred Design) methods, the diversity of usability methods available for application, and the lack of easy to use rules for selecting and applying them makes selecting and planning UCD activities a hard task with little or no support available. This paper presents the Usability Planner tool, aimed to provide such support. Usability Planner suggests appropriate UCD methods for each software life cycle stage taking account of the particular constraints to consider, and includes support for prioritising types of methods based on potential business benefits and risks. Usability Planner is being developed as an open access and open source project. It has proceeded so far with iterations of wire frame prototypes, allowing feedback to be gathered from usability professionals and software developers, and with the building of the first software prototype.

Keywords: UCD method selection, development process, business benefits, business case for usability, risk.

1 Introduction

UCD approaches and methods for systems development are used to help build systems with a good usability level. While there is general consensus on the overall UCD activities to undertake in development for dealing with usability, there is a great diversity of methods. Each author in the HCI (Human-Computer Interaction) field proposes his/her own version of a method and links them in a particular methodology.

On the other hand, in systems development at large, there is an increasing interest about usability as a system quality attribute [1]. This might be related to the increasingly wide use of systems by the general public, and the importance of graphical user interfaces nowadays [9], but also because UCD methods are gaining a wider acceptance as the way to obtain a higher quality systems. According to a survey
performed between usability professionals [19], these methods will likely achieve wider user and greater impact in the near future.

Nevertheless, for the development organisation aiming at a good usability level in the systems products built, there is still a difficulty in choosing and applying usability methods. According to Seffah, "[UCD] methods are still underused and difficult to understand by software development teams and organizations" [17]. Developers with an interest in usability issues find the HCI field difficult to deal with in terms of usability methods and their integration in the overall systems development process, due to this lack of easy to apply knowledge on UCD method selection and planning in the development process.

When resource planning is discussed in a development project, usability professionals involved in a development team, or possibly developers self-taught in usability issues, may raise the need for applying UCD methods. But these usability advocates experience difficulties for justifying investment in usability activities in the development process in cost-benefit terms, or in avoidance of risks terms. This is particularly important in limited budget scenarios.

Usability planner is a tool for addressing these issues. The following two sections will establish the basis for the design of such a tool: Classification and selection of UCD methods in the next section; and method selection process. Next, the design approach and objectives will be tackled. Finally, some discussion on the difficulties a tool like this may deal with will be considered.

2 Classification and selection of UCD methods

Several approaches have been taken to the classification of UCD methods: by lifecycle stage, intrinsic properties, Human Centred Design (HCD) activities, and Human System processes.

2.1 Lifecycle stage

The most natural way to classify UCD methods is by lifecycle stage or activity group. While a kind of activity does not necessarily have to be carried out in a particular stage in an iterative process, activity groups and lifecycle stages are often used interchangeably in the software development practice. One example of classification by activity groups is the one used by Ferre (Table 1) [7].

Although this classification is a natural one for system developers, the disadvantage is that the same method can appear under different headings, as essentially the same method can be used at different lifecycle stages.

2.2 Intrinsic properties

Another way to classify methods is by their intrinsic properties, for example as in ISO TR 16982 (see Table 2).
Table 1. Methods classified by activity groups

<table>
<thead>
<tr>
<th>Kind of activity</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usability Testing</td>
<td></td>
</tr>
<tr>
<td>Follow-Up Studies of Installed Systems</td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Observation of users</td>
<td>Collection in a precise and systematic way of information about the behaviour and the performance of users, in the context of specific tasks during user activity.</td>
</tr>
<tr>
<td>Performance-related measurements</td>
<td>Collection of quantifiable performance measurements in order to understand the impacts of usability issues.</td>
</tr>
<tr>
<td>Critical incidents analysis</td>
<td>Systematic collection of specific events (positive or negative).</td>
</tr>
<tr>
<td>Questionnaires</td>
<td>Indirect evaluation methods which gather users' opinions about the user interface in predefined questionnaires.</td>
</tr>
<tr>
<td>Interviews</td>
<td>Similar to questionnaires with greater flexibility and involving face-to-face interaction with the interviewee.</td>
</tr>
<tr>
<td>Thinking aloud</td>
<td>Involves having users continuously verbalize their ideas, beliefs, expectations, doubts, discoveries, etc. during their use of the system under test.</td>
</tr>
<tr>
<td>Collaborative design and evaluation</td>
<td>Methods which allow different types of participants (users, product developers and human-factors specialists, etc) to collaborate in the evaluation or design of systems.</td>
</tr>
<tr>
<td>Creativity methods</td>
<td>Methods which involve the elicitation of new products and systems features, usually extracted from group interactions. In the context of human-centred approaches, members of such groups are often users.</td>
</tr>
<tr>
<td>Document-based methods</td>
<td>Examination of existing documents by the usability specialist to form a professional judgement of the system.</td>
</tr>
<tr>
<td>Model-based approaches</td>
<td>Use of models which are abstract representations of the evaluated product to allow the prediction of the users' performance.</td>
</tr>
<tr>
<td>Expert evaluation</td>
<td>Evaluation based upon the knowledge, expertise and practical experience in ergonomics of the usability specialist.</td>
</tr>
<tr>
<td>Automated evaluation</td>
<td>Algorithms focused on usability criteria or using ergonomic knowledge-based systems which diagnose the deficiencies of product compared to predefined rules.</td>
</tr>
</tbody>
</table>

One disadvantage of this classification is that many of the “methods” are not used in isolation, for example a typical user-based test might combine observation of users, performance-related measurements, critical incidents analysis, questionnaires, interviews, and thinking aloud.


### 2.3 Human centred design (HCD) activities

ISO 9241-210 describes four types of HCD\(^1\) activity:

1. Understand and specify the context of use.
2. Specify the user requirements.
3. Produce design solutions.
4. Evaluate.

This classification will make sense to the usability professional, as it is in terms of the types of activities that they need to carry out (see Fig. 1).

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**Figure 1.** Relationship between human centred design activities (from ISO 9241-210)

At a high level, these activities appear to correspond to the overall stages of design and development from requirements through design to verification and validation. But in reality these activities are intended to take place at each stage of design and development, iteratively evaluating each design solution, starting with the earliest mockups, through prototypes to the final system.

The ISO TR 18529 standard provides a detailed breakdown of the component activities (Fig. 2).

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\(^1\) Note that for the purpose of this paper UCD and HCD are used synonymously. UCD is the more widely used term, but HCD more accurately refers to all relevant humans (not only users).
**HCD.1** Ensure HCD content in system strategy
- HCD.1.1 Represent stakeholders
- HCD.1.2 Collect market intelligence
- HCD.1.3 Define and plan system strategy
- HCD.1.4 Collect market feedback
- HCD.1.5 Analyse trends in users

**HCD.2** Plan and manage the HCD process
- HCD.2.1 Consult stakeholders
- HCD.2.2 Identify and plan user involvement
- HCD.2.3 Select human-centred methods and techniques
- HCD.2.4 Ensure a human-centred approach within the project team
- HCD.2.5 Plan human-centred design activities
- HCD.2.6 Manage human-centred activities
- HCD.2.7 Champion human-centred approach
- HCD.2.8 Provide support for human-centred design

**HCD.3** Specify the stakeholder and organisational requirements
- HCD.3.1 Clarify and document system goals
- HCD.3.2 Analyse stakeholders
- HCD.3.3 Assess risk to stakeholders
- HCD.3.4 Define the use of the system
- HCD.3.5 Generate the stakeholder and organisational requirements
- HCD.3.6 Set quality in use objectives

**HCD.4** Understand & specify the context of use
- HCD.4.1 Identify and document user’s tasks
- HCD.4.2 Identify and document significant user attributes
- HCD.4.3 Identify and document organisational environment
- HCD.4.4 Identify and document technical environment
- HCD.4.5 Identify and document physical environment

**HCD.5** Produce design solutions
- HCD.5.1 Allocate functions
- HCD.5.2 Produce composite task model
- HCD.5.3 Explore system design
- HCD.5.4 Use existing knowledge to develop design solutions
- HCD.5.5 Specify system and use
- HCD.5.6 Develop prototypes
- HCD.5.7 Develop user training
- HCD.5.8 Develop user support

**HCD.6** Evaluate designs against requirements
- HCD.6.1 Specify and validate context of evaluation
- HCD.6.2 Evaluate early prototypes in order to define the requirements for the system
- HCD.6.3 Evaluate prototypes in order to improve the design
- HCD.6.4 Evaluate the system to check that the stakeholder and organisational requirements have been met
- HCD.6.5 Evaluate the system in order to check that the required practice has been followed
- HCD.6.6 Evaluate the system in use in order to ensure that it continues to meet organizational and user needs

**HCD.7** Introduce and operate the system
- HCD.7.1 Management of change
- HCD.7.2 Determine impact on organisation and stakeholders
- HCD.7.3 Customisation and local design
- HCD.7.4 Deliver user training
- HCD.7.5 Support users in planned activities
- HCD.7.6 Ensure conformance to workplace ergonomic legislation

**Figure 2. ISO TR 18529 Activities**

### 2.4 Human system processes

This basic approach has been extended in ISO PAS 18152 to incorporate all possible human centred activities in systems development (Fig. 3).
HS.1 Life cycle involvement activities
- HS.1.1 HS issues in conception
- HS.1.2 HS issues in development
- HS.1.3 HS issues in production and utilization
- HS.1.4 HS issues in utilization and support
- HS.1.5 HS issues in retirement

HS.2 Integrate human factors activities
- HS.2.1 HS issues in business strategy
- HS.2.2 HS issues in quality management
- HS.2.3 HS issues in authorisation and control
- HS.2.4 Management of HS issues
- HS.2.5 HF data in trade-off and risk mitigation
- HS.2.6 User involvement

HS.3 Human-centred design activities
- HS.3.1 Context of use
- HS.3.2 User requirements
- HS.3.3 Produce design solutions
- HS.3.4 Evaluation of use

HS.4 Human resources activities
- HS.4.1 Human resources strategy
- HS.4.2 Define standard competencies and identify gaps
- HS.4.3 Design staffing solution and delivery plan
- HS.4.4 Evaluate system solutions and obtain feedback

Figure 3. ISO PAS 18152 Categories of human centred design activities

The core ISO TR 18529 processes HCD.3 – HCD.6 are incorporated as HS.3. The other HCD processes are expanded into categories: HS.1 Life cycle involvement activities, and HS.2 Integrate human factors activities. To these are added a new set of processes related to personnel and staffing: HS.4 Human resources activities.

While the classifications based on processes and activities are very thorough, they are in terms of activities rather than methods. Each activity can be achieved through the use of several different potential methods or techniques.

2.5 Selection of UCD methods

Although there is a wide literature on the reliability and value of different usability methods, little has been published on how to select the most appropriate methods, although some collections of methods do state their advantages and disadvantages, e.g. [15], [13].

One of the first attempts was the INTUIT expert system developed by the HUFIT project 8 to recommend which user centred design methods should be used.

More recently UsabilityNet has provided a tool for filtering methods based on three criteria: limited time and resources, no access to users and/or limited skills/expertise [2].

The ISO TR 16982 standard mentioned above also provides criteria for selecting methods (Fig. 4) and indicates which methods that are recommended or not recommended for each constraint.

However, all these approaches require considerable existing expertise to know in what circumstances it is appropriate to use any UCD method, and what subset of methods might be appropriate in a particular situation.
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Primary life-cycle processes
- Acquisition – Supply stage
- Development - Requirements analysis
- Development - Architectural design
- Development - Qualification testing
- Maintenance – Operation

Project environment
- Very tight project time-scale
- Cost/price control
- High quality level of the product to be delivered as the dominant requirement
- Need for an early information/feedback/diagnosis
- Highly evolving specifications

User characteristics
- Users cannot be involved/accessed
- Users can be involved/accessed
- Users have a significant disability

Task to be performed
- The task is highly complex
- Errors can lead to severe consequences
- The task is completely new to the users
- There is a wide task spectrum
- There are major changes in organisation/jobs/technical
- There are high levels of time and accuracy constraints for interaction

Product used
- Adaptation of an already existing system/product
- Limited and simple well understood product
- High degree of adaptability of the product (customisable product)

Abilities required
- The designer/appraiser has access to extensive ergonomic/human factors skills/expertise
- The designer/appraiser has limited access to ergonomic/human factors skills/expertise

Figure 4. Constraints influencing choice of methods (from ISO TR 16982)

3 Method selection process

The reason for using usability methods is to make specific contributions to user-centred design. As Wixon [20] says, “the goal is to produce, in the quickest time, a successful product that meets specifications with the fewest resources, while minimizing risk”. “In the world of usability work on real products embedded in a corporate and business framework, we must focus on factors of success, such as how effectively the method introduces usability improvements into the product.”

This requires two decisions:
   a) Which stages of design and development would benefit most from use of user centred design methods?
   b) At each stage where methods are to be used, which method would be most appropriate?

Experienced usability professionals who are familiar with of a range of methods will select the method that they believe will produce the most useful results given the type of constraints listed in Fig. 4. If no method that they have used before appears appropriate, they may investigate using a different method, based on existing knowledge, or information obtained from other sources. They are also likely to customize the method to better match the constraints [14].
3.1 Which stages of design and development would benefit most from use of user centred design methods?

Bevan [3] gives examples of the cost-benefits that can be obtained from improved usability in the following categories:

- Reducing development costs
- Increasing traffic and sales on web sites
- Increased product sales
- Increased productivity
- Reduced support and maintenance costs

However, as suggested in [4], use of user centred design methods is also an effective means of risk mitigation. Each of the potential benefits listed above can be rephrased as avoidance of potential risks:

- Risk of increased development costs
- Risk of reduced traffic and sales on web sites
- Risk of reduced product sales
- Risk of reduced productivity
- Risk of increased support and maintenance costs

In many situations, project managers will be more concerned with managing risk than the promise of potential economic benefits.

The Usability Planner tool therefore supports users in considering both the relative cost benefits and potential mitigation of risks of user centred design methods when used at different stages of design and development.

3.2 Which methods would be most appropriate?

The problem with previous approaches to the selection of user centred design methods is that they start with the method, rather than the purpose for which the method is used. The human centred activities in ISO PAS 18152 provides a comprehensive list of all the potential purposes for using UCD methods during systems development (in the categories shown in Fig. 3).

The steps in selecting methods at each stage of design and development supported by the Usability Planner tool are thus:

- At which stages of design would use of UCD activities the greatest cost-effective or risk mitigation?
- Which activities from ISO PAS 18152 would be most cost-effective at each stage?
- Which of the potential methods that could be used to achieve each activity would be most appropriate? This can be decided by using the constraints in Fig. 4.

The output of the tool shows the relative cost benefits of using user centred design methods at each stage of design and development, and a prioritized list of suggested methods that could be used at each stage.
4 Design Objectives for Usability Planner

Our approach for the tool design considered a set of different contexts of use, representing the characteristics of the intended users and their needs, in relation to the difficult task of selecting which UCD methods to use in systems development, and establishing the business case for their inclusion as part of the development activities.

4.1 Intended Context of Use

Usability Planner aims to serve the needs of a variety of possible user profiles. The main user profiles identified are the following:

- **Self-trained developer**: Software developers with some but no extensive knowledge on HCI and UCD methods, will be mostly interested in knowing which methods to apply taking account of the specific constraints to be considered. The special case of a limited budget constraint will probably be of interest to this kind of user.
- **Trainee/HCI student**: Students will need to develop their skills in planning UCD methods according to particular constraints, but they will also have some interest in business benefits considerations.
- **Junior HCI consultant**: A usability professional will be mostly interested in planning usage of UCD methods in development, taking account of possible constraints. These users will be more focused on UCD-related constraints, assuming that their responsibilities in a software development project will be mainly circumscribed to pure UCD activities, and less dedicated to HCI-software engineering integration issues.
- **Expert HCI consultant**: These senior professionals will have interest in method planning issues, with any kind of constraints, but they will also have a great interest in cost justifying usability activities, and aligning any possible UCD method planning with business priorities. Limited budget scenarios, being quite common will be specifically of interest to these users, as well.

The scenario of use detailed in Table 3, focuses on a Junior HCI consultant user profile, and illustrates the possible difficulties in UCD method planning that could raise in any software development project.

4.2 Identified requirements

Different user groups have different requirements, which means that it is important to establish flexible mechanisms of work with the tool. The development of the tool is proceeding iteratively, with eight major wireframe prototypes used for eliciting feedback from usability professionals and software developers.

Here we present the results of this process in terms of the main user requirements for the tool to be built:

- Users will be able to select project stages or activities where they want to consider UCD method(s) application.
• Business case considerations should be optional, since the less the user is familiarised with HCI the less he/she will be able to deal with the subtleties needed to soundly establish the business case for usability.
• Users will be able to consider different constraints in different project stages or activities. This may accommodate the differences between user profiles.
• The rules that govern the suggestion of UCD methods depending on the setting of specific constraints can be revealed by the tool interactively, so that the users may understand the tool internal logic.
• The tool will offer a plan that gathers all the suggested UCD methods per project stage, with the addition of business considerations when applicable.

Table 3. Scenario of use for a junior HCI consultant.

| Jordan is a junior consultant working in the user experience group at Satware, a software development company, and he has been assigned to the project Visiguide, that will develop a system to guide visitors to an institution through the different exhibits and rooms. He has been requested to advise which UCD activities and methods should be included in the project development process with a very restricted budget. He has a time pressure to deliver quick results, and he regards the project specifications delivered by the customer as not precisely defined. He is interested in both estimating cost benefits in the selection of usability methods and in selecting the ones that best fit the particularities of the Visiguide project. As the project is just starting, Jordan focuses on the initial stages of development, that is, Envisaging opportunities and System scoping.

Regarding business benefits and risks, he does not have that much related criteria to consider in this project, but at least he can identify that an increase in the usability level can provide improved productivity as a benefit for purchasing organisation, since he considers that the customer will highlight the increased visitor satisfaction as a key aspect of the system.

Usability Planner can offer some guidance to Jordan in his selection of UCD methods to apply in the development process.

Regarding technical requirements, they were established at the start of the project, aiming at wide availability of the tool and a high degree of flexibility. These technical requirements are as follows:
• The tool will be able to run either through the web or locally. The first version of the tool will run on the web, but the technology employed should ease the creation of a version that runs locally.
• The following items will be set through configuration files to allow easy modification:
  • Project stages and categories of activities to consider for UCD method selection.
  • Assignment of recommended UCD methods to project stages.
  • Weights associated with particular constraints for UCD methods.
  • Categories of business benefits and risks.

The tool is conceived as a contribution from the authors to support wider use of UCD methods and practices in systems development. For that purpose, the tool needs to be
easily accessible and to allow for modification and extension to accommodate the needs of a diverse user population. In order to fulfil these objectives, the tool will be offered under an open source licence, so that the community can modify it or further extend it given that the original authors are credited and the same licence applies to the result.

5 Tool design

5.1 Process

For the tool design the initial paper prototype was turned into a wireframe prototype. This prototype was used in informal usability tests where feedback from usability professionals and software developers were gathered, and the prototype was redesigned accordingly.

After eight cycles of iteratively improving the prototype, the coding has started, with the building of a high-fidelity evolutionary prototype.

Usability testing of the prototype will provide further insight into the way users deal with the issue of UCD method selection and estimation of related business cost-benefit issues.

The evaluation effort will be directed as well to iteratively adjust criteria and weights in order to provide results comparable to expert advice.

5.2 Technology

Usability Planner is built over the Google Web Toolkit (GWT) [10], a web development toolkit for creating Rich Internet Applications (RIA). The technologies employed are similar to the ones present in popular websites like Gmail, Youtube, Flicker or Facebook, offering a modern look & feel to the system developed.

The project will be hosted in Google Code, benefitting from the exposure and facilities offered in this service for open source project evolution.

GWT uses CSS3 style sheets that offer a set of advanced visual effects, but given that only very recent browsers support this specification, it has backward compatibility with CSS2.

As for the aim of providing easy configurability for the different elements (weights, constraints, etc.) mentioned in the previous section, the chosen solution is to make use of XML. Relevant information may be modified in the configuration XML file, which is human-readable. The usage of XML also contributes to the aim of offering the tool as both a web-based system and a system that can be run locally.

5.3 Interaction Design

The tool starts with a presentation of the two main objectives in terms of usability planning that can be supported, as shown in Fig. 5:
• Decide which usability methods to use based on design and organisational constraints.
• Estimate the relative cost benefits of using usability methods at different stages of design and development.

**Figure 5.** Current version of the tool: Home page.

The user may select either or both before proceeding to the next step. Depending on the user selection, the relevant tabs are enabled.

The "Project stages" tab (see Fig. 6), allows the user to select the kind of activities for which they need to plan usability methods. The term "project stages" has been used to highlight that these are categories of activities that take place at different stages of the project. The categorisation of activities is the one used in [16], but alternative categorisations may be provided in later versions of the tool to meet different user needs.

**Figure 6.** Current version of the tool: Project Stages.
The project stages selected remain visible in subsequent screens, as the selection of methods and cost benefits relate to the project stages.

If the methods option is selected, the user can access the "Methods" tab and set the particular constraints of the project context, which will prioritise which UCD methods are recommended for each project stage (see Fig. 7). Additional information on particular methods could be provided by linking to the Usability Body of Knowledge [18].

**Figure 7.** Current version of the tool: Methods.

The "Business benefits" section (see Fig. 8) presents the user with a list of the types of benefits or risks that could result from use of UCD at different stages of the project. The tabular presentation facilitates setting the relative benefits and risks at each stage.

**Figure 8.** Current version of the tool: Business benefits page screen in a table format.
The "Plan" section gathers in one screen the results of the plan, providing a summary of the methods suggested and the relative cost benefits at each stage (see Fig. 9).

![Image](image.png)

**Figure 9.** Current version of the tool: Plan summary.

6 Discussion

The process of iteratively developing a prototype with user feedback helped refine what was initially a very complex process [5] into an increasingly simple set of steps, and the currently implemented system bears little relationship to the initial prototype.

The design of the tool is based on the hypothesis that the process that experienced usability professionals use to select appropriate methods is a combination of consideration of estimated cost benefits and consideration of applicable constraints. It is the intention to iteratively refine the constraints and their relative weighting to attempt to replicate the decisions made by experienced usability professionals.

A further step not currently supported by the tool is that usability professionals typically customise methods to the specific application environment [14]. This may be supported in future versions.

The approach taken by the tool is based on the principles of value centred systems engineering [6] as applied in the context of UCD [16]. Value based software engineering promotes rational behaviour aimed at satisfying the success-critical stakeholders in systems development. The challenge for a usability professional is that it is often difficult to gain acceptance for the use of UCD methods employing rational decision criteria, particularly when using agile processes and in less formal development environments. Nevertheless, it is hoped that the criteria used by the tool will both assist the user to make better-informed decisions and to make a more convincing business case for the use of particular methods.

Additional feedback is also needed on the potential value of the tool for use in education and training, and by self-trained developers and junior staff. This may lead to further evolution of the tool.
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