# User-Centered Design Methods in Practice: A Survey of the State of the Art

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## Abstract

This paper reports the results of a recent survey involving over one hundred leading professionals of user-centered design (UCD). The survey covered a broad range of issues ranging from the profile of a typical UCD project including the percentage of total budget on UCD, organizational impact of UCD, measures of UCD success, and the most widely used methods and techniques. Results show that cost-benefit tradeoffs are a key consideration in the adoption of UCD methods. Measures of UCD effectiveness are lacking and rarely applied. There is a major discrepancy between the commonly cited measures and what were actually applied.

## 1. Introduction

User-Centered Design (UCD) refers to a multi-disciplinary design approach based on the active involvement of users for a clear understanding of user and task requirements, and the iteration of design and evaluation. It is considered the key to product usefulness and usability. Much has been written in the research literature about UCD. However, despite a steady introduction of new methods and techniques, many of them including even the basic ones, such as observing users using prototypes and iterative design, are not commonly performed in practice for a variety of reasons (Nielsen, 1994; Vredenburg & Butler, 1996). There is a need for a better understanding of the UCD practice to provide guidelines based on the collective wisdom of the industry-wide community of UCD practitioners.

The objective of this research was to investigate the actual use of user-centered design (UCD) methods in practice across the industry. This project aims at providing for the UCD community empirical evidence on what works versus what does not, and what is tested-and-true versus what is hype. It also sheds light on the usefulness and usability of common UCD methods, which is expected to lead to practical guidelines and evaluative criteria. Whereas a recent survey has focused on the "strategic usability" in terms of embedding usability engineering in organizational processes and culture, and contributing to corporate-wide decision making and product decisions (Rosenbaum, Rohn, & Humburg, 2000), our study addresses product usability. More specific research questions include the following ones: Which UCD methods are most widely used? What are the costs and benefits of each method? What are the organizational impacts of UCD, and what measures are in place?

Results of this research were expected to provide an empirical basis for the introduction, deployment, and execution of UCD projects. For example, insights were expected to help identify key areas of focus on most widely used methods and techniques, and common difficulties and concerns with various methods. In addition, it was expected that results could confirm the importance of UCD as well-established and widely accepted in practice, as an informal survey by Hudson (2000) has indicated. The essential objective of this investigation was to make a major contribution to the UCD practice and community of practitioners by conducting a large scale, carefully designed and executed survey. The focus of the study was on the perspectives of individual UCD practitioners in terms of their personal perception and experiences working within their respective companies.

The remainder of this document is structured as follows: The next section reviews the relevant literature, and then Section 3 discusses the data collection method. Section 4 presents results of our preliminary data analysis, followed by conclusions and discussion in Section 5.

## 2. Literature Review

Vredenburg (1994, 1999) identified a core set of practical methods and techniques for UCD, and Vredenburg and Butler (1996) examined the practice within IBM and also across the industry, which has shown that many of these methods are not effective or practical in practice for a variety of reasons. Prior studies are generally in agreement that software development tools and practices had disappointingly small effects on improving software development (e.g., Curtis, Krasner, & Iscoe, 1988). Gould et al. admitted that the user-centered design process was still not often used due to both organizational and technical reasons after the idea had been in existence for over a decade (1991). It is important to find out if the situation has changed over the past decade.

Not coincidentally, several surveys have been conducted recently on UCD practice, reflecting the need of the UCD community for a reality check. Rosenhaum et al. (2000) surveyed 134 computer-human interaction (CHI) professionals with a focus on the contribution of organizational approaches and UCD methods to strategic usability. It was found that major obstacles to creating greater strategic impact include resource constraints, which were mentioned by 28.6% of the respondents, resistance to user-centered design or usability, lack of knowledge about usability. Partnering with marketing was identified as a very effective approach.

Hudson, along with Bevan, conducted an email-based informal survey of UCD (Hudson, 2000). Questionnaires were posted to several mailing lists of HCI groups, and resulted in 102 responses from mostly usability practitioners. The most commonly used methods, as reflected in the percentage of respondents using them, include informal usability testing, user analysis/profiling, evaluating existing systems, low-fidelity prototyping, heuristic evaluation, task identification, navigation design, scenario-based design. Other methods that received less usage include formal task analysis, contextual analysis, usability checklists, and usability surveys.

It appears that informal and less structured methods tend to be used much more widely than more formal and structured methods. For example, ranked on top are informal usability testing (94%), low-fidelity prototyping (85%), and heuristics (84%), whereas more formal methods are ranked at the bottom such as focus groups (9%), cognitive walkthrough (team-based, 2%), storyboards (2%), usability walkthrough (team-based, 2%). There appears to be a general awareness among the practitioners of the importance and the basic philosophy of UCD.

A 10-question web survey was conducted recently involving exactly 100 usability practitioners (Gunther, Janis, & Butler, 2001). Respondents indicated the most successful activities include usability testing, which was mentioned by 39% of the respondents, prototyping (19%), and heuristic evaluation (10%), confirming Hudson's finding (2000). In addition, they identified the top three best selling activities across the development lifecycle include customer interviews (Ph.1, 46%), paper or other prototyping (Ph.2, 65%), usability test (Ph.3, 41% and Ph.4, 36%). This survey also examined several key aspects of the organizational context of UCD such as developer resistance to UCD and the interaction between the UCD specialist and developers, design team composition and mission, and successes and failures with UCD processes.

These prior surveys have produced valuable insights to UCD practice, and each of them has its own focus and viewpoint. Our survey has several unique features such as the assessment of the overall organizational impact of UCD and measures of UCD success, profile of a typical UCD project, and detailed assessment of UCD methods.

## 3. Research Method

This section describes the methodology used for the survey. The definition of UCD given at the

beginning of the questionnaire was the following: "**UCD** is herein considered, in a broad sense, the practice of the following principles, *the active involvement of users for a clear understanding of user and task requirements, iterative design and evaluation, and a multi-disciplinary approach*. **UCD methods** are modular or identifiable processes involved in UCD practice. You should NOT think of UCD as merely usability testing or software engineering."

The questionnaire consisted of several general questions on the overall impact and usability of UCD methods in practice, and specific questions on a representative UCD project, and detailed assessment of five commonly used UCD methods identified by the respondents[1]. There were Likert-type scale, multiple choice, and qualitative questions. The questionnaire went through a pre-test by IBM corporate UCD Advisory Council members, and a pilot test by members of a human-computer interaction mailing list, with four and two responses respectively. The questionnaire was revised based on the feedback from these tests.

Three alternative media were considered for distributing the survey, namely conventional mail, electronic mail (email) and the world-wide web. A review of the literature showed that there is no significant difference in response rate between conventional and email surveys (e.g., Schaefer & Dillman, 1998), whereas some more recent studies have suggested that email surveys have a significantly lower response rate (Dommeyer & Moriarty, 2000). Compared to mail surveys, email versions produced more complete questionnaires and higher response quality, e.g., fewer item omissions (Kiesler & Sproull, 1986; Schaefer & Dillman 1998), fewer mistakes (Kiesler & Sproull 1986), and fuller response to open-ended questions (Bachmann et al., 1996; Mehta & Sivadas, 1995; Schaefer & Dillman 1998). Moreover, email provides more sample control than regular mail and web surveys (Mehta & Sivadas, 1995). Since individuals tend to keep email access to themselves, an email survey is likely to be completed by the intended individuals. In other words, the researcher can control and identify who actually complete the questionnaire more easily with email than with other methods. Moreover, completed surveys are returned more quickly by email than by "snail" mail, especially for large samples. For example, it was found that more than half of all completed email responses were received in two to three days (Mehta & Sivadas, 1995). There are other advantages for using email, e.g., it is inexpensive without postage, paper, envelopes, and printing costs. Therefore, we decided to use email as the medium to distribute our survey.

Email surveys can be distributed as embedded plain text or attached documents. A major advantage of embedded text is that it requires fewer steps to access and return the questionnaire. More importantly, because it is easier to access and potential respondents can take a look at the questions before making a commitment. Therefore, an embedded survey involves a lower level of motivational cost, which might increase the response rate, than an attached document or a web survey. An attached document affords greater control over the presentation and format, e.g., the use of check boxes and option buttons to give a professional appearance and the same level of ease of operation as web-based survey. However, a prior study has found that an embedded survey yielded a significantly higher response rate than an attached one, almost five times as high (Dommeyer & Moriarty, 2000).

Whereas web surveys have gained in popularity more recently, our survey had several unique features that rendered the use of web potentially difficult. First, it was important to have tight sample control, i.e., to involve only experienced UCD professionals as respondents. Second, because the questionnaire was lengthy consisting of many descriptive open-ended questions, it was expected to take about an hour to complete according to the pre-test and pilot test. Therefore, respondents might need to complete it in several sessions. If a web survey had been used, potential respondents would have had to have a high level of motivation to go to the survey web site to get passwords and remember them, before they knew what was really involved in the questionnaire. The biggest advantage with email-embedded questionnaire in this study was that the motivational cost was much lower, as people could take a look at it before deciding if the survey was worth their effort.

[1] The questionnaire is not attached due to space limit, but it can be requested from the authors.

The target respondents were experienced practitioners of UCD who had at least three years of experience with UCD, and considered UCD as their primary job. The invitation and questionnaire were distributed to the ACM Computer Human Interaction conference (CHI'2000) attendees and Usability Professional Association (UPA) members. In the invitation, the required qualification was highlighted and only those who qualified were asked to participate.

The survey was first distributed to CHI'2000 attendees towards the end of 2000, and a two-week period was given to complete the survey. A week after the distribution, a reminder was sent to the non-respondents to encourage response, along with the questionnaire. At the end, 49 usable responses were obtained. Twenty-four of them came before the reminder, and the remaining 25 arrived afterwards.

The 49 usable responses represent a response rate of just over 3% of the 1448 deliverable email addresses. This response rate is computed as the total number of responses divided by the sample size minus undelivered (Dillman, 1978). Since we have no information on how many of the CHI'2000 attendees actually belong to the target sample, the 3% response rate is different from the typical response rate reported in other surveys. Depending on the percentage of CHI'2000 attendees who qualify as experienced UCD practitioners, the real response rate can be many times higher than 3%.

In early 2001, the UPA management office emailed our invitation and questionnaire to their members directly, considering that the study was potentially of interest to their members. No reminder was sent out this time. After two weeks, 55 responses were received, from close to 2,000 members. The response rate was about 3%.

In total, the two waves of questionnaire distribution resulted in 104 responses. However, it was found that one person responded to both waves, and the duplicate was removed. The two samples were compared and no statistically significant differences were detected in the quantitative answers (t-tests of the quantitative data between the two samples were not statistically significant with one exception). Therefore, these two samples were combined for data analysis.

We did not ask our respondents to identify their company expecting some might not wish to release the information despite our promise of anonymity. However, judging from respondents' email addresses, we know 10 individuals representing three of the largest companies in the IT industry participated in this study. No other respondents appeared to be from the same company, but we cannot be certain about this as some respondents used generic email servers. The bottomline is that our respondents represent up to 96 companies of varying sizes, including some of the leaders in the IT industry.

## 4. Results

### 4.1 Respondents' Profile

Sixty percent of the 103 respondents worked and lived in the United States and the rest in Europe primarily. Most of them had a Master's or PhD degree, 46% and 24% respectively. Table 1 illustrates respondents' UCD-related background. Essentially all of the respondents were very familiar with UCD practice. Thirty-six percent of the respondents indicated 6 on a 7-point scale, and 48% of them indicated 7, which stands for extremely familiar with UCD practice

Note that the standard deviation scores in Table 1 are generally large except that of respondents' familiarity with UCD practice. They may be considered a reflection of the diverse background of our respondents, while they all believed they were very familiar with UCD. Based on these number, it can be argued that our respondents were representative of a broad range of UCD practitioners. However, the standard deviation of the annual number of UCD projects is even bigger than the mean. It is possible because the distribution is not normal, and the fact it is quite skewed. Whereas most respondents worked on few projects, a few individuals reported large numbers. Therefore, for most measures in this paper the medians and modes are also reported, which could be more meaningful than the means in some cases.

Respondents were asked to describe the main sources of their UCD knowledge and expertise. The top three were books and journals (91%), professional conferences or workshops (91%), and colleagues (82%). Internal training was not a major source of UCD knowledge, although the interaction with colleagues was.

Therefore, the respondents to this survey appeared to be truly experienced practitioners because of their multiple years of experience and familiarity with UCD. Furthermore, given that they attended the CHI conference or were members of the UPA, it could be reasonable to believe that they were opinion leaders in the UCD community, likely playing a leading role in their own organization's UCD practice. Furthermore, it is safe to assume that they were well informed about the state-of-the-art, and in the position to provide an assessment of the organizational impact of UCD, and the current state of practice in their organizations.

Table 1. UCD-Related Background

| Description | Mean | Median | Mode | Std. Dev. |
|---|---|---|---|---|
| Years of experience in UCD | 7.6 | 6 | 5 | 5.49 |
| Percentage of work time on UCD-related activities over the past 12 months | 77.31 | 85 | 100 | 27.25 |
| Number of projects involving UCD participated over the past 12 months | 7.98 | 5 | 5 | 9.18 |
| Level of familiarity with UCD practice* | 6.26 | 6 | 7 | 0.96 |

*Rated on a 7-point scale, ranging from 1- "not familiar at all" to 7- "extremely familiar."

### 4.2 UCD Project Profile

When asked to consider a representative UCD project in which they had participated over the past 12 months, nearly 63% of the respondents had chosen an Internet/Intranet project, whereas the rest reported mainframe, PC applications, or other systems. The average size of the project team was 17 people, and three of them were charged with UCD activities as their primary responsibility (see Table 2). The percentage of UCD personnel defined as those with the primary responsibility in UCD was 27%. Respondents' typical project involved a budget of US$1.6 millions on average, ranging from US$5,000 to US$20 millions. More interestingly, on average over 19% of the total project budget was spent on UCD, whereas the most common case was 10% and an equal number of projects spent over or under 10% on UCD. Both the mode and median are 10%, as shown in Table 2.

Table 2. Profile of a Representative UCD Project

| Description | Mean | Median | Mode | Std. Dev | Max | Min |
|---|---|---|---|---|---|---|
| Number of people on the team | 16.93 | 10 | 10 | 16.98 | 100 | 3 |
| Number of people with primary responsibilities in UCD activities | 2.55 | 2 | 1 | 1.93 | 12 | 1 |
| Percentage of people on UCD | 27% | 17% | 20% | 26% | 100% | 1% |
| Budget for the project (estimate in US$1,000) | 1,595 | 300 | 100 | 3,910 | 20,000 | 5 |
| Percentage of the total budget on UCD | 19.25% | 10% | 10% | 24.71% | 100% | 1% |

Thirty-one percent of the typical UCD projects had a team of 6 to 10 people, which was the most common size, followed by the second common composition of over 20 people in 21% of teams. Twenty percent of the teams were small with fewer than 5 people.

There is a U-shaped distribution in the typical project budget (see Figure 1). About 40% of the

projects had 20% or less of the total budget spent on UCD, 20% of the projects spent more than 20% (see Figure 2). Unfortunately, about 40% of the respondents could not specify a number for these two questions, for either lack of knowledge or other reasons.

Figure 1. Budget for a Representative Project (n=62)

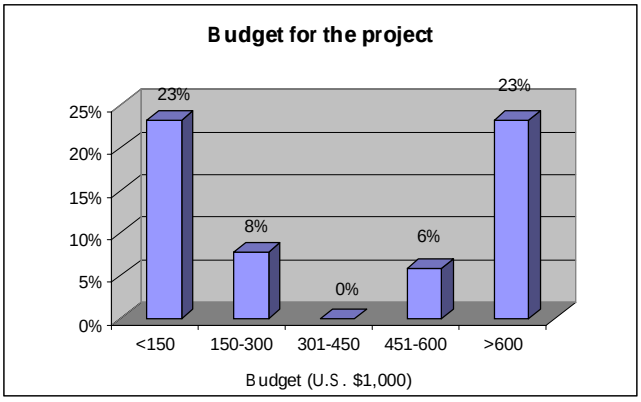
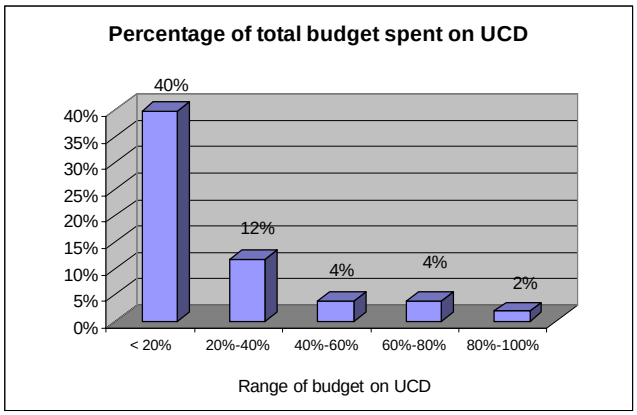



Figure 2. Percentage of the Total Budget on UCD (n=64)




### 4.3 Organizational Impact of UCD Practice

Table 3 and Figures 3 to 6 present the organizational aspects of the UCD practice, including the overall assessment of UCD practice. Each statement shown in Table 3 was a single-item scale, without any qualitative justification. For example, the majority of the respondents, 72% of them, indicated that UCD methods had made a significant impact on product development by indicating 5 or higher.

The degree of the application of UCD methods in product development varied in a wide range, as reflected in the largest standard deviation score in Table 3. Figure 3 graphically illustrates the distribution.

Figures 4 show that the overwhelming majority of the respondents, 82%, considered that UCD methods have improved the usability of products developed in their company. About 80% of them chose 5 or 6, and a quarter of them chose 7, on the 7-point scale. The same pattern holds for usefulness.

Table 3. Overall Assessment of Organizational UCD Practice

| Description | Mean | Mode | Std. Dev. |
|---|---|---|---|
| UCD methods are widely used in product development | 4.44 | 7 | 1.99 |
| UCD methods have made a significant impact on product development | 5.05 | 7 | 1.82 |
| UCD methods have improved the usefulness of the products developed | 5.37 | 7 | 1.66 |
| UCD methods have improved the usability of the product developed | 5.56 | 6 | 1.61 |
| UCD methods have helped save product development time | 4.37 | 4 | 1.51 |
| UCD methods have helped save product development costs | 4.41 | 4 | 1.5 |
| UCD methods are going to have more significant impact on product development over the next five years | 5.6 | 7 | 1.46 |
| UCD methods are going to achieve wider adoption in product development over the next five years | 5.47 | 7 | 1.45 |

* All answers were on a 7-point scale, ranging from 1-strongly disagree, 4-neutral, to 7-strongly agree

Figure 3. Use of UCD Methods in Product Development

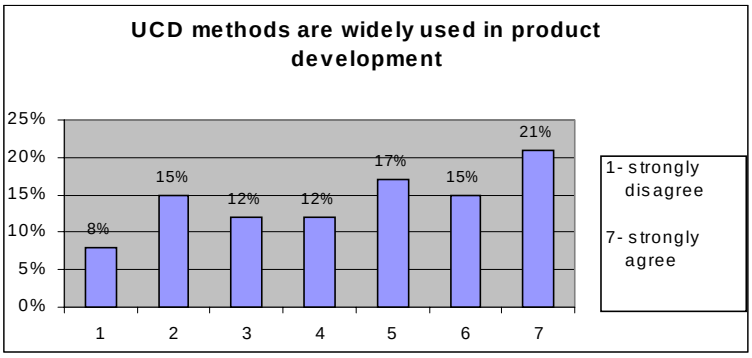
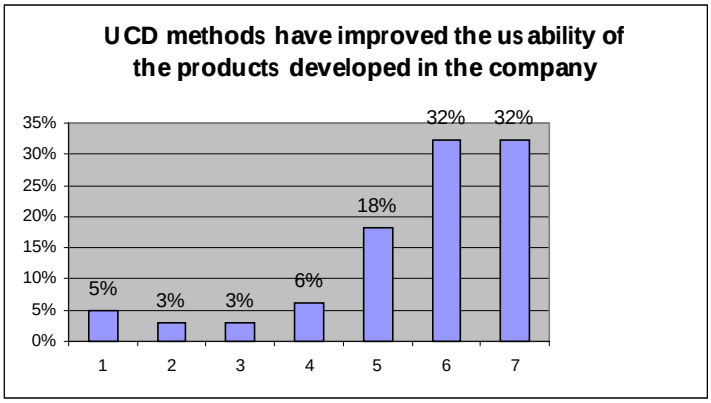


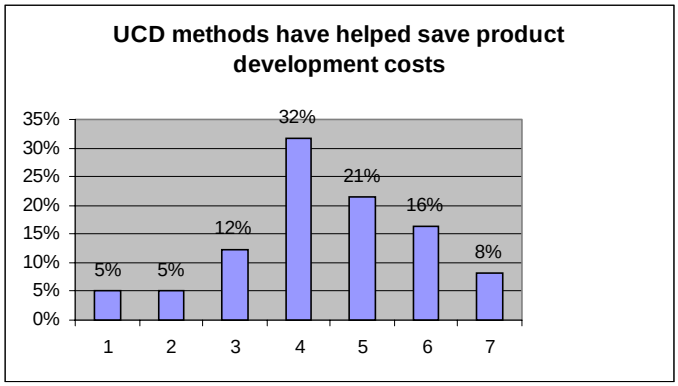

Figure 4. UCD Methods Improved Product Usability



However, Figure 5 suggests that about one third of the respondents were not sure if UCD methods had helped save product development costs by indicating 4 on the 7-point scale. Among those with a definitive opinion more people believed UCD methods actually saved product development time than those who thought the UCD increased it (45% versus 22%). However, the fact that more than one fifth of the respondents considered that UCD actually increased the costs of product development is quite alarming, and it calls for further studies. A nearly identical pattern holds for the product development time.

This result is a major surprise, as it is UCD gospel that in the long run applying UCD saves development time and money by reducing the rework needed. Perhaps respondents focused only on development time and cost for a given release and did not look at the big picture including service cost and redesign.

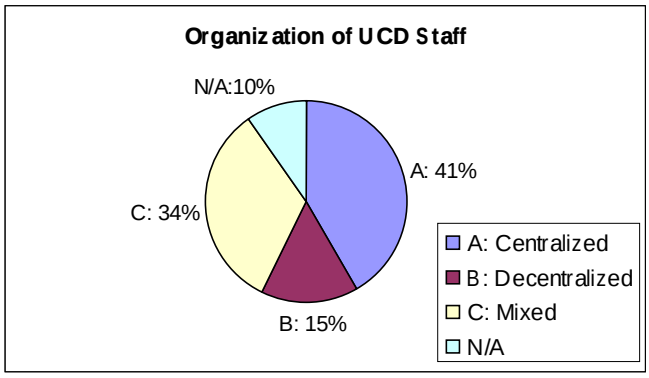
Figure 5. UCD Methods Saved Product Development Costs




About three-quarters of the respondents felt that over the next five years, UCD methods would have a more significant impact on product development and achieve wider adoption in product development, as shown in Table 3.

Figure 6 depicts the characteristic of the organization of UCD staff in respondents' organizations. It appears a centralized structure is most common, closely followed by a mixed structure. Many organizations do not insist on a close relationship of HCI professionals to their product teams. Future research should look at the effectiveness of this approach.

Figure 6: Organization of UCD Staff



### 4.4 Inferential Statistics

Some statistical inferences were made based on the quantitative data. First, we compared the responses from the CHI sample before and after the reminder (24 versus 25 responses) to test any non-response bias, as commonly done in survey-based studies. It turned out no statistically significant difference was found in all of the quantitative answers, as the significant levels of two-tailed t-tests vary in the range from .18 to .96. Based on this result, it is reasonable to assume that the opinions of our respondents were representative of that of their colleagues in the field.

The relationship between the percentage of total budget spent on UCD and percentage of UCD personnel is also examined. The correlation coefficient between these two numbers is 0.52 ($p < .001$). Apparently, these two measures are significantly correlated, meaning that the number of UCD personal depended on the UCD budget or conversely a significant portion the UCD budget was spent on personnel.

In addition, we took an exploratory approach to identifying any discernable differences among various sub-samples. For example, it would be interesting to see if the presence of internal UCD resources was an indication of organizational commitment to UCD practice, and whether this commitment made any difference in terms of the organizational impact of UCD. We divided the sample into two parts, based on whether or not the respondents' sources of UCD knowledge and expertise included the company's internal sources such as internal training courses or internal materials.

There is no discernable difference between the two groups except for the total budget for the representative UCD project. Companies with internal UCD resources tended to have a bigger project budget of U.S.$2.1 millions on average compared to U.S.$1 million for the companies without. Since the distribution is not normal, a non-parametric analysis, Mann-Whitney test, was conducted. The result is statistically significant ($z = 2.154$, two tailed $P = .031$). This could indicate that those organizations that had larger projects tended to provide internal resources and training for their UCD practitioners. However, the source of UCD knowledge had no impact on the overall assessment of UCD practice, contrary to our expectation.

### 4.5 Results from the Qualitative Questions

Respondents were asked to "describe a few quantitative and qualitative measures of the effectiveness of UCD methods applied in your company (e.g., growth in products' market share or sales volumes, product usability measures, increased user satisfaction)." A summary of the 10 most frequently cited measures are presented in Table 4.

Table 4. Top 10 Commonly Cited Measures of UCD Effectiveness

| **Measure** | **Frequency** |
|---|---|
| *External (customer) satisfaction* | *33* |
| *Enhanced ease of use* | *20* |
| *Impact on Sales* | *19* |
| *Reduced helpdesk calls* | *18* |
| *Pre-release user testing/feedback* | *16* |
| *External (consumer) critical feedback* | *15* |
| *Error/success rate in user testing* | *14* |
| Users' ability to complete required tasks | 10 |
| Internal (company) critical feedback | 6 |
| Savings in development time/costs | 5 |
| No UCD measures in place | 15 |
| No useful response | 20 |

The frequency score can also be seen as the percentage of responses as the number of respondents, 103, is close to 100.

As shown in Table 4, measures of UCD effectiveness were idiosyncratic and sparse. The 103 respondents mentioned a total of 191 indicators of UCD effectiveness, but there was little consensus. Fifteen individuals reported that there was no measure in place at all. Results were scattered in 16 different categories. Only seven of them (italicized) were reported by more than 10% of the 103 respondents. However, other than *external (customer) satisfaction* none of them was mentioned by more than 20% of the respondents. The other 12 indicators were either rarely used or questionable measure of UCD success.

Respondents were also asked to "describe the success of UCD practice in your company along the dimensions identified in your answer to the previous question." Their answer on each of the dimensions was coded at three levels, poor, good, and excellent. Results are summarized in Table 5. The lack of standard and effort in measuring UCD success is even more evident in Table 5 than in Table 4, as much fewer respondents were able to apply the criteria they just identified to assess their UCD practice. Only three of the measures were reported by more than 10% of the respondents and none of them was higher than 20%. Nevertheless, UCD practice was seen successful in general, either good or excellent, if there was a measure in place.

A comparison between Tables 4 and 5 shows several interesting patterns. Whereas in Table 4, more respondents mentioned external customer satisfaction or critical feedback sought from customers than internal satisfaction or critical feedback within the company, in Table 5 the design team's perception became the most commonly used gauge of UCD success. External consumer satisfaction was the only relatively commonly mentioned measure in Table 4 that was applied by more than 10% of the respondents. From Table 4 to 5 there is a shift from external objective measures to internal and design team's perceptions. In fact, respondents were so hard pressed to find applied measures of UCD success, they identified several new criteria such as acceptance of UCD by designers and design for user requirements (italicized in Table 5).

Table 5. Top 10 Applied Indicators of UCD Effectiveness

| **Measure** | **Poor** | **Good** | **Excellent** | **Frequency** |
|---|---|---|---|---|
| Internal (design team) satisfaction | 1 | 10 | 8 | 19 |
| *Acceptance of UCD by designers*[b] | *2* | *4* | *8* | *14* |
| External (customer) satisfaction | 1 | 7 | 6 | 14 |
| *Design for user requirements* | *1* | *5* | *4* | *10* |
| *Use of user feedback* | *0* | *5* | *4* | *9* |
| Avoidance of design assumptions (biases) | 4 | 4 | 1 | 9 |
| Impact on sales | 1 | 4 | 3 | 8 |
| *Identified the intended audience* | *1* | *5* | *0* | *6* |
| Users' ability to complete required tasks | 0 | 2 | 3 | 5 |
| Speaking users' language | 1 | 0 | 2 | 3 |
| No response/measure | | | | 21 |

Note: Poor is "no or very little perceived/witnessed benefits," Good means "moderate benefits witnessed, but those benefits cannot be directly attributed solely to the use of UCD methods", and Excellent refers to "great benefits witnessed, and can be directly attributed to the use of UCD methods."
Italicized letters indicate new indicators that did not appear in Table 4.

Respondents were also asked to "identify several of the most commonly used UCD methods in your practice." Then, they were also asked to "rank the five most important UCD methods on the basis of their actual impact on product development (e.g., user satisfaction, results in the market, and cost savings)." Response to this question was coded in a bottom-up manner without any pre-specified coding scheme or expectation. Results seem to fit into thirteen distinct categories. Summary results are provided in Table 6 below.

Several interesting observations can be made from Table 6. For example, five of the UCD methods were considered commonly used, as they were mentioned by about a third of the respondents or more (minimum of 28). They were iterative design, usability evaluation, task analysis, informal expert review, and field studies. All of these five methods were believed to have the most important impact in practice, except *informal expert review*, as reflected in the average ranking score. In other words, informal expert review was widely used likely because of its low cost, but it was not considered having a high impact. In contrast, *user requirements analysis*, which is typically more expensive and difficult to do, was mentioned by only few people as commonly used, but was considered very important in practice by the few believers. It appears that in both cases respondents were mindful of a strong cost-benefit tradeoff.

The product of the frequency measure and the average importance ranking is taken as an indicator of the overall importance of each UCD method. The five most commonly used methods turned out to be the five most important ones in practice.

Our finding is consistent with Hudson's informal survey (2000) in that informal low-cost methods were more widely used, but goes further by revealing UCD practitioner's belief about the practical importance and impact of various methods. Furthermore, it is interesting to note that two of the top three effective UCD methods identified by Gunther et al (2001) (labeled differently as usability testing, paper or other prototyping, and heuristic evaluation) appear high in our list. Moreover, our results show that two of the methods, field studies (including contextual inquiry) and user requirements were considered most important in practice, although not most widely used.

Table 6. Importance Ranking and Frequency of the Most Commonly Used UCD Methods

| | Ranking | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | Average Ranking | Frequency | Overall Importance |
| Field studies (including contextual inquiry) | 12 | 6 | 5 | 2 | 1 | 2.00 | 28 | 112.0 |
| User requirements analysis | 3 | 3 | 0 | 0 | 1 | 2.00 | 7 | 28.0 |
| Iterative design | 17[c] | 21 | 9 | 5 | 2 | 2.15 | 65 | 250.4 |
| Usability evaluation | 12 | 8 | 10 | 7 | 1 | 2.39 | 43 | 155.0 |
| Task analysis | 6 | 8 | 6 | 7 | 1 | 2.61 | 34 | 115.4 |
| Focus groups | 5 | 2 | 2 | 1 | 4 | 2.79 | 16 | 51.4 |
| Formal heuristic evaluation | 3 | 2 | 5 | 2 | 2 | 2.86 | 15 | 47.1 |
| User interviews | 2 | 0 | 3 | 4 | 0 | 3.00 | 11 | 33.0 |
| Prototype without user testing | 1 | 3 | 5 | 4 | 1 | 3.07 | 15 | 43.9 |
| Surveys | 0 | 2 | 2 | 1 | 1 | 3.17 | 9 | 25.5 |
| Informal expert review | 4 | 6 | 3 | 10 | 6 | 3.28 | 31 | 84.4 |
| Card sorting | 0 | 1 | 1 | 0 | 1 | 3.33 | 5 | 13.3 |
| Participatory design | 1 | 0 | 1 | 2 | 1 | 3.40 | 7 | 18.2 |
| No code/too sketchy to be categorized | | | | | | | 64 | |

Note: Ranking number 1 means the most important, and 5 the fifth most important. Therefore, The overall importance of UCD method is calculated as *Frequency* × (6 − *Average Ranking*).

The frequency score is typically bigger than the sum of the frequency of the 5 ranking scores (28 versus 26 in the first row), because some respondents reported a commonly used UCD method but did not rank it as very important based on its practical impact.

## 5. Conclusions and Discussion

Our data analysis has led to several interesting findings. First, UCD methods are generally considered to have improved product usefulness and usability, although the degree of UCD method adoption is quite uneven across different organizations. Our results were inconclusive regarding whether UCD has led to savings in development time and costs across all organizations. Perhaps respondents focused only on short-term development time and costs but not on longer-term savings. Nevertheless, UCD methods appear to be gaining momentum across the industry, and our findings suggest that they will likely achieve even wider use and greater impact in the next five years.

Interestingly, UCD staff in many organizations, 41% of our sample, is centralized, and only 15% of the organizations have completely decentralized UCD staff (as shown in Figure 6). This likely reinforces the need for UCD practitioners to have a home base for their professional development. It also suggests that there is a difference of opinions among HCI professionals about the need to work closely with their product teams in order to be effective.

To our knowledge, this is the first survey that has identified the profile of a typical UCD project. Of particular interest is that on average spending on UCD constitutes 19% of the total project budget, whereas the most common scenario is 10%. In fact, 20% of the UCD projects actually spent more than 20% of the overall project budget on UCD.

Another key finding is the lack of measurement of UCD effectiveness and any common evaluation criteria across the industry. The lack of respondent consensus or focus on measures is evident in Tables 4 and 5. Respondents emphasized external objective measures, but often reported the use of internal and subjective measures if any measure was used at all. This is likely a challenge for the UCD community, and for the continuing growth and acceptance of UCD practice, in light of the resistance and obstacles identified by Rosenbaum et al. (2000) and Gunther et al. (2001).

Finally, our results clearly suggest that cost-benefit tradeoffs play a major role in the adoption of UCD methods. This would explain for the most part similar results found in other recent surveys of UCD (Gunther et al., 2001; Rosenbaum et al., 2000). For example, field studies were generally ranked high on practical importance but relatively infrequently used likely because they were costly, whereas heuristic evaluations was the opposite because they were relatively easy and less costly.

Results of the study are informative and insightful in many ways. A preliminary conclusion is that user-centered design appears to be making an impact across the industry and a focus on the findings of this study will help many organizations further optimize their deployment of it.

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