# CPSC 681 - Topic

# Cost-Justifying Usability

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# Abstract

Investment on usability pays off better than any other business action but it is well known that the usability engineering is not that much applied in practice. One reason is the high cost of evaluation studies. To have a better justification of the costs of each usability evaluation we need to estimate costs of running a controlled evaluation in organization as well as the benefits of successful improvements. Although, different metrics are used for cost-benefit analysis, at the end, the manager is the one who has a rough estimation of the total saving achieved after improvements.

Usability specialists usually propose the best methodologies instead of being economically conservative. Insisting on using the best methods may come up to nothing. Discount usability suggests being more conservative and focuses on "the good" than "the best". This brings more chance for usability activities to be accepted.

This report reviews a good and economically viable approach that applies different metrics (applicable to every business) to create a cost-benefit framework for usability evaluation. In this report, we briefly discuss return on investment (ROI) in usability engineering; as a worked example, we present a case study on cost-benefit analysis of a particular method (Heuristic Evaluation) on a sample project.

**Keywords:** Cost-justifying usability, return on investment, measurement, user interfaces, performance, management

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# 1  Introduction

Money is the most significant driving force of any business. In order to have a successful business, it is necessary to have well structured and systematic methods for financial affairs. In most corporations, there are more business improvement proposals than available budget. The challenge of managers is to assign limited budget to projects which have the most successful influence on the success of their corporation.

Usability is an economic weapon since its return on investment (ROI) is better than any other business action. It focuses on users, to achieve more profit (what the companies looking for). A good usability evaluation is useful for managers, analysts, designers, developers, documenters and for the whole business. But how can we justify the costs of doing an evaluation?

It might happen sometimes that you know that conducting a usability study on a specific project in your organization certainly pays off; however, despite all your knowledge in usability evaluation you can't convince your boss to invest on it.  Money is the language of business and you should communicate with your manager in this language. You need to show a good return on investment using numbers, facts and figures and professional language.

All efforts aiming at improvement in an organization need to justify their contributions otherwise they will risk the budget axe. According to the observations of a budding organization, the usability professional association, "cost/benefit analysis" was the number one concern of its members [Bias, et. al. 94]. This report addresses this issue and arms usability engineers to answer questions of managers and demonstrate the value of usability to them.

Surveys show that for each dollar a company invests on usability it saves $10-100 [Karat, 93]. Usability cuts the costs and increases the sales by bringing more user satisfaction. It helps to catch the problems earlier in the product lifecycle to fix them with less cost. For each dollar spent to fix a problem in design phase, $10 are spent to fix the same problem in the development phase, and $100 or more are spent to fix the same problem after product release [Karat, 93].

First, we have a brief review on background of cost-justifying usability (section 2). Then we discuss a basic framework proposed by Mayhew and Mantei for cost-justifying usability in section 3. In section 4 we describe Jacob Nielson's case study called 'Guerrilla HCI' [Nielsen, 94b] which offers a good framework for discount usability. This case study shows how you can apply this method in practice for heuristic evaluation.

# 2 Background

Marilyn Mantei and Toby Teorey introduced the topic of cost-benefit analysis of usability to Human Computer Interaction (HCI) in 1988. Later Clare-Marie Karat expanded this idea and developed a business case approach that became a useful framework for ROI. In 1994, Bias and Mayhew published a book collecting various papers on the topic that became a strong document for HCI professionals [Bias, et. al. 2005].

Jacob Nielsen started the movement of discount usability for fast and inexpensive improvement of user interfaces and published his book, "Usability Inspection Methods", in 1994 [Nielsen, 94a]. With growth of the web and internet, this movement expanded, subsequently more researchers became increasingly attracted to the use of discount usability in justifying ROI of web-based applications.

## 2.1 Discount usability

Some managers mistakenly believe that impenetrable theory is required in usability activities as the result of visiting elaborate usability labs and encountering strange terminology of usability engineers. Discount usability engineering helps to dispel this misconception [Nielsen, 94a].

Discount usability focuses on "the good" methods than insisting on "the best" methods. Sometimes in usability projects "the best is the enemy of the good" and usability specialists should be careful to avoid the trap of perfectionism. Discount usability aims on reducing the costs by presenting a method that needs less experience, equipment and knowledge. For example, in order to early focus on users, it suggests to simply observe them at work without interruption.

This method is based on three techniques:
- Scenarios
- Simplified thinking aloud
- Heuristic evaluation

### 2.1.1. Scenarios

Scenarios are special kind of prototyping used to cut down complexity of full system by eliminating parts of it in two directions. As shown in Figure 1 the horizontal prototypes are used to reduce the level of system functionality to a user interface surface layer.
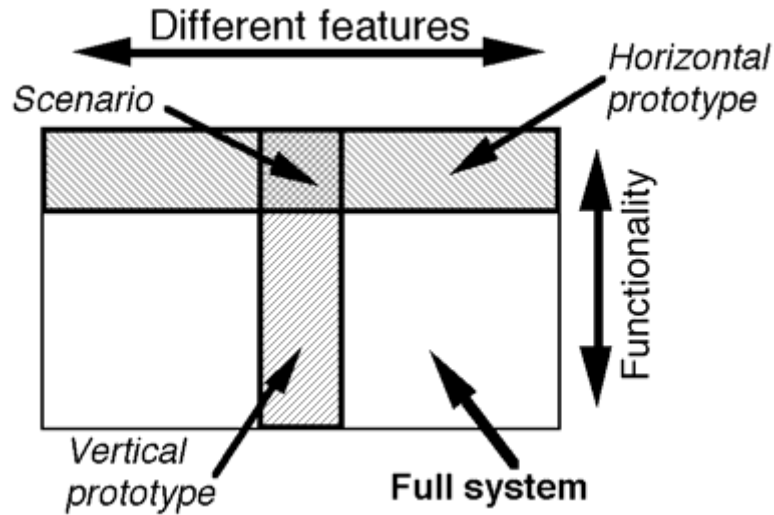
**Figure 1** : Scenarios place in prototyping

On the other hand, vertical prototypes are used to reduce the number of the features of the system. Finally we will have a small part of the system that is inexpensive to design and implement as a paper mock-up. Scenarios are good ways to get quick and reasonable feedback from users compared to advanced prototyping tools.

## 2.1.2. Simplified thinking aloud

Instead of using traditional thinking aloud method used in sophisticated labs (which is common in psychological studies), simplified thinking aloud can be used in computer science projects. In this method instead of videotaping subjects and performing detailed protocol analysis we just take notes while users are asked to think aloud when they are performing their typical tasks.
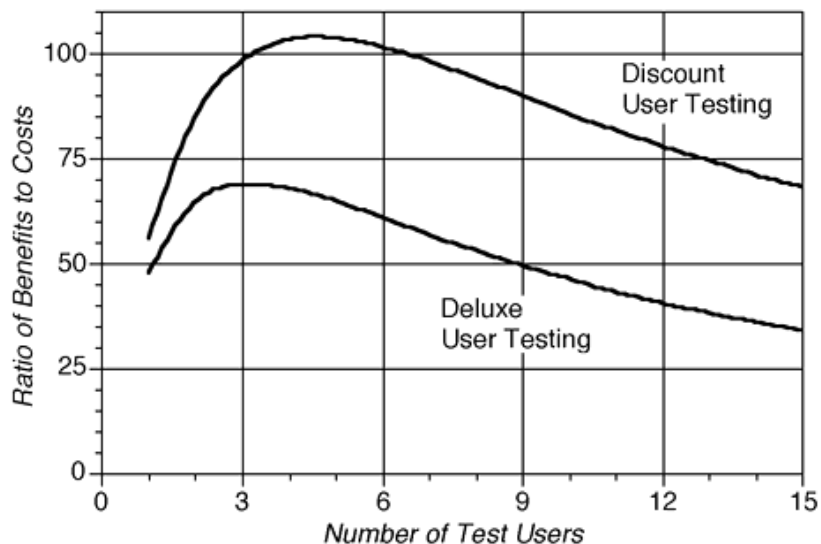
**Figure 2** : Cost-benefit trade-off curves of two methods

Figure 2 shows that there is no big difference between the results of the data analysis of the traditional approach and simplified approach. It is proven that one learns the most from the first few test users. Hence, by using between 3 to 5 test users in our simplified approach we can achieve approximately the same benefits as elaborate approach.

### 2.1.3.  Heuristic evaluation

Heuristic evaluation is another method to find usability problems just by inspections of evaluators. It uses 10 basic usability principles from huge list of usability guidelines (1000 rules). Heuristic evaluation needs some experience to achieve the best results, although it is easy to learn. However, even non-experts can find most of the problems using this method, and the remaining could be found using simplified thinking aloud. It might be necessary to consider a part of budget for outside usability consultants.

## 2.2  Nielsen's surveys on cost-justifying usability

This section provides some interesting results from [useit.com, 2007].

### 2.2.1.  Usability costs

Jacob Nielsen's surveys of 863 design projects (which included usability) suggested 10% of the budget of each project should be devoted to usability. It is notable that this cost does not increase linearly with the project budget. For example, if we have a project 10 times bigger, the cost of usability spending is only four times bigger.

### 2.2.2.  Usability benefits

Nielsen's team analyzed data from 42 cases using available metrics of website redesign (sales, traffic, productivity, etc). The redesign of these websites using these metrics produced a 135% increase in total usability. This measurement excluded five outliers with big usability improvements. Collecting the same metrics before and after redesign including these outliers produces 202% raise in usability.

### 2.2.3.  Return on investment

Spending about 10% of the budget of a project on usability to double the total usability is a feasible investment; however, these two estimates use different units. While cost is measured in money, usability is measured in increased use, more efficient use or higher satisfaction. Therefore, the challenge is to convert it to a classic ROI number. Yet again this number is not linear with the costs. Nielsen states that "the more people use a design, the bigger the usability ROI".

## 2.3 Samples of cost-justifying usability

Below are summaries of two samples of cost saving in usability projects [Nielsen, 94a].

### 2.3.1.  Australian insurance company

Customers of an Australian insurance company had average of 7.8 errors for filling of each application form. These errors took the company staff more than one hour to repair. A usability-enhancing project to redesign the old application forms with cost of less than A\$ 100,000 ended up to annual saving of more than A\$ 530,000.

### 2.3.2.  IBM employees login system

IBM financed \$ 20,700 for a usability project to make sign-on attempts faster for one of their security applications.

They achieved savings in work time of \$ 41,700 during the first day of the new system.

# 3  A basic framework for cost-justifying usability

Usability research is a conservative approach that helps to cut costs, by making simple and user friendly products. In competition between two products, usually the one that better supports user experience will win, not the one with less cost. Cost of doing a usability evaluation is high, but not as much as some people fear, because it has a good return on investment [webworld.com, 2007].

Usability can be helpful in time-constrained situations as well. It is not an activity that can be escaped. If you invest on it, you will be closer to your customers. Therefore, it is better to do cost-justifying analysis earlier in the project planning phase of the life-cycle. Following sections show the Mayhew and Mantei's cost-benefit analysis framework of usability engineering [Bias, et. al. 94].

## 3.1 Estimating costs

The first step in cost estimation is identifying which usability tasks should be applied. By defining all tasks and adding their costs, the total cost can't be calculated. Each individual task can be broken down into techniques, and a technique can be decomposed into steps and each step can be split into personnel hours and equipment costs. Total cost of personnel is calculated by multiplying the hours by fully loaded hourly wage of personnel. It should be noted that these estimates are based on one's own experience.

For example for the "user profile" task we can use "user questionnaire" technique with following steps:

- development of survey

- pilot testing

- distribution and collection

- responding

- coding and entering data

- analyzing results

- computer time

- supplies and duplicating costs

There might be additional one-time costs such as usability lab setup or purchase of prototyping tools.

## 3.2  Estimating benefits

Calculating the benefits is not as straight forward as calculating costs. The first step is to find the relevant audience. For example, is it related to internal development organization (development section) or Vendor Company (market section)? Then relevant categories of benefits should be determined.

For example the relevant benefits of an internal development organization are:

- increased user productivity

- decreased user errors

- decreased training costs

- savings gained from making changes earlier in design

- decreased user support

As a final step, the potential benefits should be estimated. To do this, we should first find the best unit of measurement for the benefit, (e.g. time per task for productivity measurement); then, we need to determine the sum of estimated magnitudes of all measured benefits. Following is an example for that.

Consider a typical data entry system developed for 250 intended users in an internal development organization. Assume there are two to four primary screens on the system and that users on average will process about 60 of them per day. Suppose these users work 230 days a year with total cost per hour of $25. We assume that by applying the usability engineering, the process on screens would be **one second faster**.

Therefore, we can calculate the total productivity benefit per year as follows:

250 users * 60 screens * 230 days * 1/3600 hours * $25 = $23,958 / year

Hence, benefits of one second speed estimated as $23,958 in the course of one year.

In addition to the increased productivity there are other categories of benefits in this example such as decreased training, decreased errors and decreased late design charges. Now it is the time to add these magnitudes of estimated benefits together to calculate the total amount of benefit to compare it with one-time cost of usability program. But how do we know what benefit assumptions are realistic? This is discussed in the next section.

## 3.3  Justifying the assumptions made for benefits

The first assumption of cost-benefit analysis of usability engineering is that, the improved system has tangible benefits acceptable by audience as reasonable and likely minimum benefits. We don't look for precise or specific benefits at all. However, the question is that how can we convince others to accept our claim? A simple proof for this question does not exist.

The goal of cost-benefit analysis is to calculate the likelihood that an investment pays off. It is better to be conservative in making benefit assumption. The trick here is that to base predictions on a foundation of known facts such as published research on specific user interface design. These studies can help us to do reasonable predictions by giving a general feel of benefit magnitudes.

Another way to defend the benefits of assumptions is using actual case histories of the benefits achieved. Finally, experienced usability engineers can estimate based on their previous experience or specific knowledge on a system.

## 4  Cost-benefit analysis of heuristic evaluation

This section borrows the worked example of Nielsen [Nielsen, 94b] about cost-benefit analysis of heuristic evaluation. According to the cost-justifying usability framework we introduced, there are two steps for this case study: estimating the costs (time of evaluation) and estimating the benefits (increased usability). This case study is based on a prototype used in an integrating system for an internal telephone company. The specification of the integrating system is outlined as:

"Briefly, the Integrating System provides a graphical user interface to access information from several systems running on various remote computers in a uniform manner despite the differences between the backend systems. The Integrating System can be used to resolve certain problems when data inconsistencies require manual intervention by a technician because the computer systems cannot determine which information is correct. The traditional method for resolving these problems involves having the technician compare information across several of these databases by accessing them through a number of traditional alphanumeric terminal sessions. The databases reside on different computers and have different data formats and user interface designs, so this traditional method is somewhat awkward and requires the technicians to learn a large number of inconsistent user interfaces."

As you see, doing these tasks require high technical and domain knowledge. Using a heuristic evaluation with 11 evaluators, Nielsen's team could find 44 usability problems.

## 4.1 Time expenditure

| | |
|---|---|
| Assessing appropriate ways to use heuristic evaluation, 4 people @ 2 hours | 8 |
| Having outside evaluation expert learn about the domain and scenario | 8 |
| Finding and scheduling evaluators, 1.8 hours + 0.2 hours per evaluator | 4 |
| Preparing the briefing | 3 |
| Preparing scenario for the evaluators | 2 |
| Briefing, 1 system expert, 1 evaluation expert, 11 evaluators @ 1.5 hours | 19.5 |
| Preparing the prototype (software and its hardware platform) for the evaluation | 5 |
| Actual evaluation, 11 evaluators @ 1 hour | 11 |
| Observing the evaluation sessions, 2 observers @ 11 hours | 22 |
| Debriefing, 3 evaluators, 3 developers, 1 evaluation expert @ 1 hour | 7 |
| Writing list of usability problems based on notes from evaluation sessions | 2 |
| Writing problem descriptions for use in severity-rating questionnaire | 6 |
| Severity rating, 11 evaluators @ 0.5 hours | 5.5 |
| Analyzing severity ratings | 2 |
| Total | 105 |

**Table 1.** Estimates of the total person-hours spent on the heuristic evaluation

Estimating the costs is usually easy. Table 1 demonstrates the total time estimates of the specialists involved in heuristic evaluation project in person/hours. The only exceptions are preparing prototype and attending debriefing sessions that include development specialists. The scenarios indicated in the Table 1 are written by evaluators, where we assume that system scenarios have been prepared before evaluation.

The evaluation sessions were videotaped, but it was not part of the heuristic evaluation. So the time spent on videotaping the evaluation sessions and reviewing them is not included in the Table 1. There were two observers during evaluations that were people familiar with the application. These observers could answer questions of the evaluators about system so that highly skilled experts of usability were not required.

Based on the data from Table 1, total time (person hours) spent on the evaluation can be calculated with the following formula:

$$(1) \quad Time\ (i) = 47.8 + 5.2\ i$$

where i is the number of evaluators. This formula is not accurate for large values of i. Reducing the team of two observers to a single skilled observer can change the above formula to:

$$(2) \quad Time\ (i) = 37.3 + 4.2\ i$$

There are also some additional costs such as laboratory space and computer equipment. By approximating the $100 for hourly load of professional staff (including overhead) the total cost of the heuristic evaluation for 105 hours of evaluation is $10,500.

## 4.2  Benefit estimation

Since there were just some prototypes for this case study, evaluators could not conduct a real study for exact benefit measurement. Therefore, they estimated benefits of fixing all 44 usability problems identified by the heuristic evaluation. Two criteria used in measuring the improvements: reduction of learning time and speedup in expert performance.
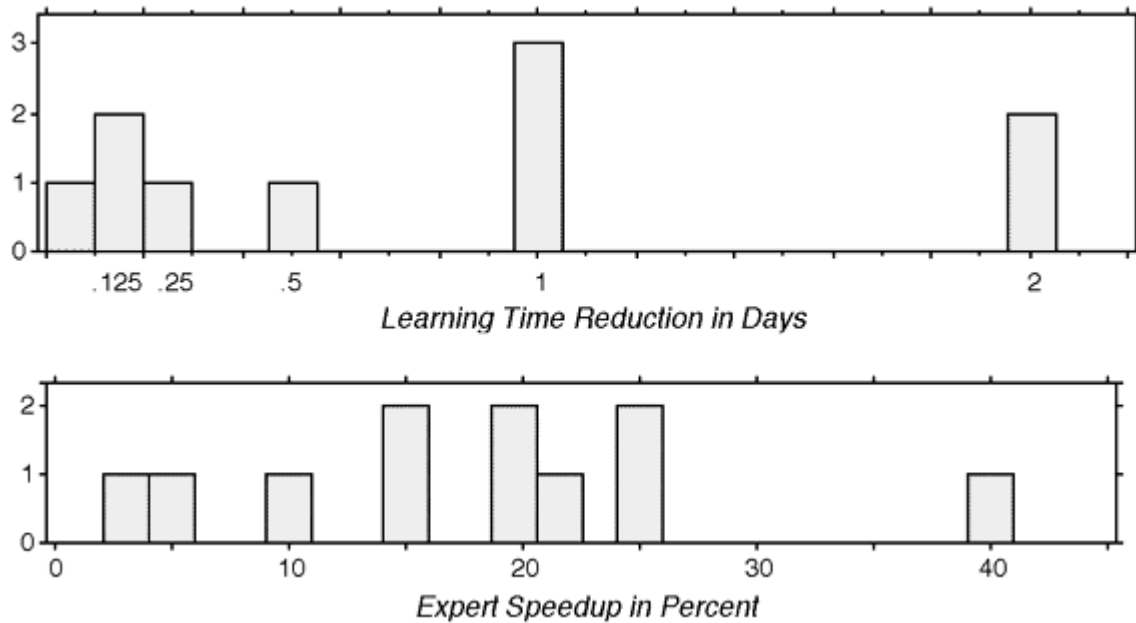
**Figure 3** : Histograms showing distributions of the estimates

Ten of the 11 evaluators estimated the saving in learning time. This was a one-time saving for each new user. All of the 11 evaluators estimated the speedup in expert performance. This was continued saving throughout the lifetime of the system. The distribution results are shown in Figure 3.

Based on these results, the mean values are 0.8 days for learning time reduction and 18% for expert speedup. To be conservative they reduced these estimates to 0.5 days for learning time reduction and 10% for expert speedup. Studies reveal that 1/3 of the users' time is spent on other tasks and 1/3 on performing task without using user interface. Therefore, just 1/3 of this 10% is allocated to operating the interface and actual speedup is 3.3% of the total time.

To estimate the total saving, assume that 2,000 people use the system. This is a conservative approach because the total number of users is 3,000. Since each user saves 0.5 days in learning the system, the total user-day saving is 1,000. Furthermore, the benefit magnitude of 3.3% expert speedup for 2,000 people would be 67 user-years. This is equal to 13,000 user-days. To be conservative they considered the saving just for one year. Hence, the total number of user-day saving is about 14,000.

To translate this number into money terms, they estimated the $100 cost for user-day and to be conservative assumed that only half of the problems could be fixed. Therefore, the actual saving is 50% of potential saving. Over again to be conservative they reduced learning time percent to 20% and expert speedup in the first year to 30%. Using these assumptions the total saving for one year would be $540,000.

Assuming that 400 hours of software engineering work is required for redesign of the old system, at a professional cost of $100 per hour. If the resulted cost of $40,000 deducted from total saving the net percent value for benefits achieved by improving user interface will be $500,000.

Comparing this $500,000 estimated improvement with the estimated cost of heuristic evaluation ($10,500), we can see a benefit/cost ratio of 48. Although, this is an approximation, it is enough to conclude that heuristic evaluation pays off.

# 5  Annotated Bibliography

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> This paper covers discount usability and a good case study of using discount usability in heuristic evaluation. We have used this case study as our worked example in this report

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