Experimental Design and Observational Studies in the Impact of Irrelevant and Misleading Information on Software Effort Estimation

N. Rajasekhar Reddy, P.V.Madhusudhan

Abstract: ***Nowadays software manufacturers are faced with a bewildering task with regard to development software meeting customer requirements and expectations, achieving the desired level of quality, and making development within the budget and schedule. Although there are many estimating tools available that can be used for software development, many projects still suffer from late completion time and exceed budgets. A great number of software applications fail to meet user requirements and quality requirements and result in unacceptable maintenance costs. So we reduce the length of specifications without changing the main content. Existing projects drawbacks are listed out. Avoid short development period. And create the awareness about the irrelevant contents in the project requirements. To do that, we developed the project in laboratory environment. Laboratory settings can be useful to demonstrate the existence of an effect and better understand it.***

Index Terms: ***Cost estimation Software Psychology, requirements Specifications***

I. INTRODUCTION

Software projects frequently overrun their effort estimates. This is a major concern for the software industry, because the quality of software effort estimates directly affects companies' ability to compete. Poor estimation performance often causes budget overruns, delays, lost contracts and low-quality software.

A recent review summarizes findings suggesting that expert judgment-based estimation is the most popular estimation method in the software industry. Typically, studies report that 70-80% of industrial estimates are made by experts without using formal estimation models. The review summarizes studies of expert judgment- and model-based effort estimates and concludes that the evidence does not support a replacement of expert judgment with estimation models. Although there are studies that have identified factors that affect the judgment-based effort estimates, our understanding of the steps and biases involved in expert estimation is limited.

The popularity of the method, and the lack of knowledge about it, indicates that a better understanding of expert estimation may be required to meet the software industry's demand for more accurate effort estimates. There are many factors that are relevant to the effort of software development, e.g., amount of functionality, focus on cost control in the project and implementation technology. In an ideal world, we would like the estimate to be based on only relevant factors and not be affected by information that has no relation to the actual effort. Information about the choice of GUI colors in a web system should, for example, not affect the estimate of the effort required to develop a new order engine. Neither should the font size and margins of a requirement specification affect the estimate. However, an unpublished experiment conducted by the second author of this paper on computer science students found that this could be the case! In that experiment, half of the students estimated development effort based on a short requirement specification, and the other half estimated based on a long specification.

The text in the two specifications was identical, but line-spacing, page set up and font size were adjusted so that the long version of the specification was seven pages and the short version only one page long. The students exposed to the long version provided on average 16% higher effort estimates. This effect caused by irrelevant information is consistent with research in other fields [7-11]. Hristova et al. [10], for example, report that the colour of the text influenced price judgments, and, Gaeth and Shanteau report that experienced soil judges are influenced by irrelevant factors in soil judgment. When planned budget and duration have been overrun, many projects are forced to abort; missing implementing some minor modules; quality will be sacrificed; or delivered without thorough debugging. In 1984, a survey study was carried out by Jenkins and the developers of 72 information system development projects in 23 major US corporations were interviewed (Jenkins *et al.*1984). The results showed that the average cost and schedule overruns were 36% and 22%, respectively. Similar study was carried out by the researchers of the University of Arizona and yielded 191 responses. They claimed that the average cost overruns were 33% and very close to the findings reported by Jenkins and Phan (Jenkins *et al* 1984; Phan *et al.* 1988).

To address the problem, many estimating tools have been developed. However, the low level use of these tools was found by several recent survey studies (IPL 1989; Heemstra *et al*. 1989; Moores and Edwards 1992). This paper is concerned with investigating the reasons why the level of use is so low. The study is divided into two stages,

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In Several of The above studies, independent software professionals established that the information was irrelevant for actual effort usage and/or the estimators were explicitly instructed not to use that information in their estimation work. For example, we asked the software professionals whether or not they had used the client's effort expectations as input to their estimates. The software professionals claimed that they did not use this information at all or that it had only a minor impact on their estimates.

However, the measured impact of the information was very large. This supports the claim that essential steps in judgmental effort estimation are based on unconscious processes. We discuss the unconscious steps of judgment based effort estimation in. Similar impacts on judgment from clearly irrelevant information have been found in numerous other professions, e.g., among professionals who are involved in judicial decision making and property pricing decisions. Software professionals clearly do not differ from other people with respect to the extent to which they are influenced by irrelevant information.

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We discuss the unconscious steps of judgment-based effort estimation in (Jørgensen 2005). Similar impacts on judgment from clearly irrelevant information have been found in numerous other professions, e.g., among professionals who are involved in judicial decision making (Englich, Mussweiler et al. 2006) and property pricing decisions (Northcraft and Neale 1987). Software professionals clearly do not differ from other people with respect to the extent to which they are influenced by irrelevant information.

The effect that irrelevant and misleading information has on software professionals can have unfortunate consequences. It can, for example, lead to effort estimates that are too low, and hence to loss-inducing bids, project management problems, and low client satisfaction.

II. DESIGN OF THE STUDY

We did not inform the companies that their estimates would be used in a research study. This was because we wanted our request to be treated as ordinary estimation work, which it was from the viewpoint of the software companies. We informed the companies that if they did high-quality estimation work for us, we might offer them other opportunities, such as more estimation work. We have already hired for further work several of the companies whose estimation work we assessed to be of high quality. The companies were given all of the information about the estimation work before they accepted it and were paid a fee that reflected their work effort and that was agreed upon by both parties. None of the individual companies can be identified by the reported data and, as far as we can see, the companies could do nothing but benefit from having participated in the study. The companies not only delivered an effort estimate, but also provided descriptions of the proposed architecture, the development platform, essential estimation assumptions, a work break-down of the project, an assessment of the uncertainty of the estimate, and a description of the estimation process they used.

Previous research on the effect of irrelevant information on effort estimates does not include field studies. Here we give the motivation for the field study. While it may be reasonable to generalize, to a certain extent, from the results of previous studies to some types of real-life estimation situations, e.g., small maintenance tasks and early project effort estimates that are based on limited information, laboratory-based results are not necessarily relevant for field settings of the type in which carefully selected experts spend several work-days estimating a project. For example, it is possible (a) that the high time pressure on estimation in the laboratory-based studies increased the use of surface indicators that usually correlate with use of effort, e.g., the number of pages in the specification, and (b) that spending more time on the estimation work would lead to the use of a greater number of causal variables.

The use of a greater number of causal variables may, in turn, make software professionals better able to resist the influence of irrelevant information. In short, field studies may be required to assess the effect sizes of irrelevant and misleading information in typical effort-estimation field settings.

2.1. Objectives & Scope

The effect that irrelevant and misleading information has on software professionals can have unfortunate consequences. It can, for example, lead to effort estimates that are too low, and hence to loss-inducing bids, project management problems, and low client satisfaction. Therefore, better knowledge about what type of, when, and how irrelevant and misleading information affects effort estimates is essential if software effort estimation is to become more accurate.

We use the term 'estimation-irrelevant information' to denote information that is not causally related to the actual use of effort and consequently should not influence the estimate. This information is frequently relevant for other purposes, e.g., bidding or planning, and may well correlate with the actual use of effort. For example, it is likely that the clients' expectations about cost or the length of a requirement specification correlate with the actual use of effort, although the clients' expectations of low cost or a short requirement specification do not themselves act causally to reduce the actual use of effort. We do not discount the possibility that there are real-world estimation situations in which the information that we term estimation irrelevant is

relevant for the actual use of effort, e.g., situations in which an expectation that the cost will be low implicitly say something about a client's expectations about the quality of the software. Consequently, the actual relevance of information may be difficult to determine without knowledge of the intentions of whoever is providing the information.

2.2. Data Collection

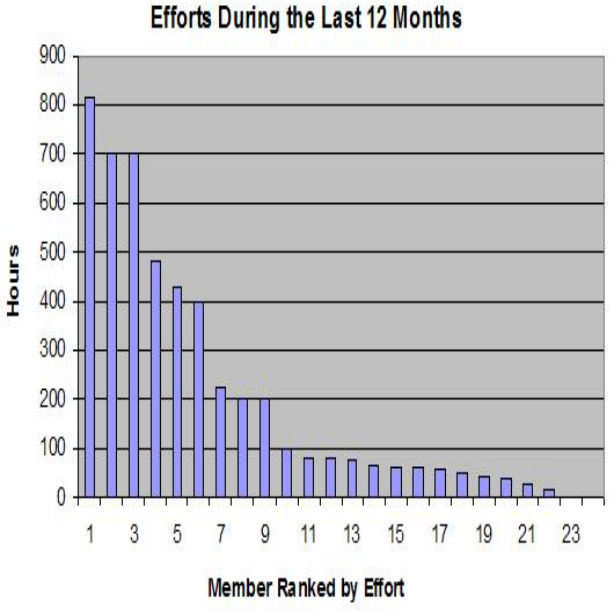
The invited companies were encouraged to ask for more information about the work, if needed. For each of the four requirement specifications S2, S3, S4, and S5, a company was randomly allocated to either the original or the manipulated version. All companies received all specifications.

The companies that were interested in the estimation work responded by e-mail and sent us the curriculum vitae of the person(s) supposed to be in charge of the estimation work, the required price, and the date by which they would complete the estimation work

The companies completed the estimation work for the five projects, in the sequence they wanted, typically within the following two weeks. They sent us questions by e-mail when they needed clarification about the requirements. We tried to respond as similarly as possible to all companies and the responses were made without our knowing whether the company had received the original or the manipulated version of a requirement specification ("blind" responses). The companies sent us their estimation work for approval once they had completed it. Most companies needed one or two revisions before we approved the estimation work.

2.3. Participants

There were more software professionals participating in the experiment. On average, the participants each had 10 years of experience as software developer. This suggests that the participants might be more than averagely interested in estimation. This, in turn, may imply that any biases in the sample of participants are likely to be in the direction of better than average estimation expertise.



The randomized allocation of treatment is likely to have eliminated systematic differences in personal characteristics within the sample.

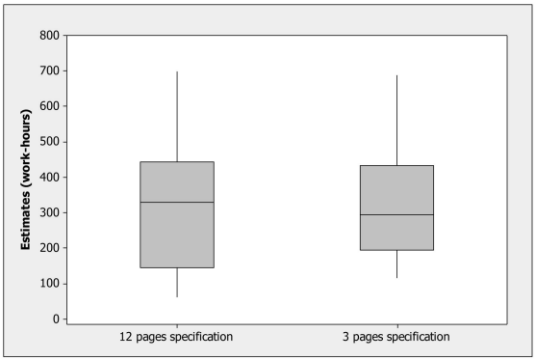
2.4. Distributions of Effort Estimates

The effort estimates varied a great deal from company to company, Differences in effort estimates are the results of differences in productivity, use of the development environment, properties of the produced software, and levels of experience and optimism. We have repeatedly found differences in effort estimates in field settings of the size.

One company said it did not have the competence to estimate and, for that reason, did not deliver an estimate for that system. As stated earlier, the allocation of treatment before the companies accepted to participate or not to participate made some of the groups larger than the others. The following sections provide more information about each of the groups' differences in effort estimates.

2.5. Manipulation of the Length of the Specification

The data, in spite of the difference in median values, do not give much support to an effect from the manipulation of specification length in field settings. The effect, if it exists, seems to be much lower than the one we found in the previous study with students.

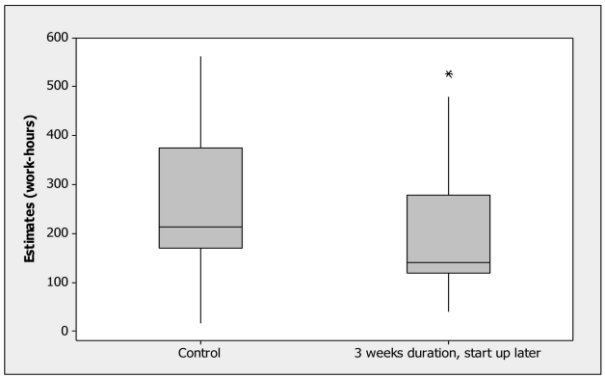


2.6. Unrealistic Client Budget

The preliminary budget is not built on any knowledge about the actual cost of developing the new system, and will, if needed, be extended to cover the expenses necessary to build a quality system with the desired functionality.

2.7. Short Development Time

The data provide strong support for an effect of the three week development time with start-up several months ahead on The data suggest a substantial effect from the manipulation. The actual effort of the four companies that previously developed this system was from about 300 to 900 work hours.



Thus, most of the estimates provided by the companies in our study seem to be optimistic. Above, we argued that it is rational to think that a shorter development period should lead to more, rather than less, use of effort. Yet it may be argued that the information about the schedule is relevant to effort in the sense that a company may want to simplify the solution to make it possible to develop within a short time frame. However, contrary to this, a follow-up analysis of the proposed solutions and the estimation work suggests that it is not likely that the reduced estimates were caused by a simplification of the solutions.

Algorithm:

1. First Create a XML file with SRS headers.
2. Load the file in tree with headings as root node & sub topics as child nodes.
3. As user selects a node, appropriate GUI tab is loaded.
4. If the template contains data, the components of GUI are updated with data.
5. If user makes any change previous value will be appended with # and pushed to lower rank node.
6. Change value will become the higher rank node.

The Process models are adopted using a well-accepted Software Process Engineering Meta-Model (SPEM) v2.0 by OMG. It presents profound descriptions on a systematic process flow of propagating the requirement changes in the software design.

III. CONCLUSION

Previous studies on the effect of estimation-irrelevant information on the effort estimates have systematically shown large effect sizes. Our study is, as far as we know, the first to investigate the effect sizes in a controlled field setting. We find that the field setting typically led to irrelevant information having smaller impact on the effort estimates than in the more artificial experimental settings.

The effect sizes in field settings were not only smaller, but the differences were in the situations with low effect sizes based on statistically non significant results. We do, however, also find that the effects in field setting can be substantial and of practical importance. In particular, we found that unrealistic budget information and receiving the information that the system had to be developed in a three week period starting a specified date several months ahead in time produced effort estimates that were much lower than those produced by a control group that did not receive this information.

We propose elements of a model that may explain the difference in effect sizes between laboratory and field settings. A possible consequence of our findings is that researchers should be more aware of the different roles of laboratory and field experiments. While a meaningful role of laboratory experiments is to demonstrate the existence of an effect and understand its nature, we should be careful to base statements about the effect size, i.e., the importance of an effect on laboratory studies alone. For the purpose of establishing knowledge about the importance of an effect, we need field studies.

IV. FUTURE ENHANCEMENT

The magnitude of the effect differed and we currently have a quite incomplete understanding of how, when and how much different irrelevant information affects cost estimation. Consequently, further research is needed.

Until we have a better understanding of the impact of irrelevant information on expert judgment-based effort estimates, we believe it to be essential that irrelevant information is removed from requirement specifications before presented to the estimators. If this is impossible, it may be a good idea to highlight and present early the most relevant information to avoid incorrect first impressions. The removal of irrelevant information is important even when using formal estimation models, i.e., formal estimation models are typically based on expert judgment-based input. This input may also be affected by irrelevant information.

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