A New approach to Requirements Elicitation Using Paper Prototype

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Abstract

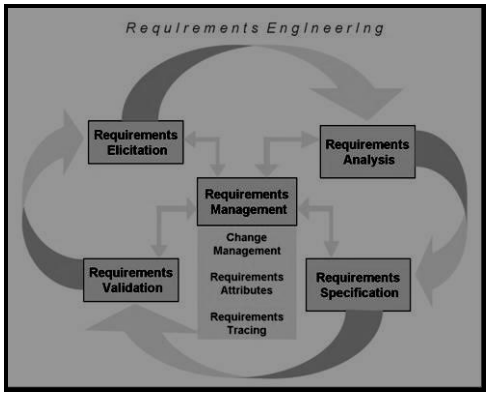
Requirement elicitation is a critical activity in the requirement development process and it explores the requirements of stakeholders. The common challenges that analysts face during elicitation process are to ensure effective communication between analyst and the users. Mostly errors in the systems are due to poor communication between user and analyst. This paper proposes an improved approach for requirements elicitation using paper prototype. The paper progresses through an assessment of the new approach using student projects developed for various organizations. A case study project is explained in the paper.

Keywords*: Requirements Engineering, Elicitation, Paper prototype*

1. Introduction

Requirements engineering is an important and fundamental aspect of software development. Regardless of the techniques used the basics still remains the same. Requirements engineering is described in 5 steps

- Requirement elicitation
- Requirement Analysis
- Requirement Specification
- Requirement Validation
- Requirements Management



(Fig -1 The requirements engineering process)

Over the past years, many systems development methodologies have been proposed to address the problem of identifying user requirements. However, these methodologies generally focus on the analysis of user requirements rather than the elicitation of those requirements from the users. They also make an implicit assumption that users know and can articulate their requirements – possibly with the help of an analyst. Research has shown that many users have difficulty articulating their requirements until they see them. It is really impossible for a client, even working with a software engineer, to specify completely, precisely, and correctly the exact requirements of a software product before trying some version of the product [9]

This paper proposes a new approach for requirements Elicitation using paper prototyping. However, most prototype evaluations simply provide users access to the prototype and ask for their feedback. Little or no structure is provided. Developers may also have difficulty reconciling the often-conflicting feedback from multiple users

The organization of the paper is as follows:

Section 2: Requirements elicitation & Gathering process.
Section 3: The Challenges in requirements elicitation & Analysis .
Section 4: The paper prototype approach
Section 5: Explanation of the Case study.
Section 6: Performance analysis of the proposed approach.
Session 7: Summary & Conclusion.

2. Requirements Elicitation and gathering

The elicitation of requirements is perhaps the activity most often regarded as the first step in the RE process. One of the important goals of elicitation is to find out what problem needs to be solved [4].

The choice of elicitation technique depends on time & resources available to the requirements engineer, and of course the kind of information that needs to be elicited. The classes of elicitation techniques are as follows:

- Interviewing and questionnaires
- Requirements workshops
- Braining Storming and idea reduction
- Storyboards
- Use Cases
- Role Playing
- Prototyping

3. Challenges in Requirements Elicitation and Analysis

Requirements elicitation is both the hardest and most critical part of software development, since errors at this beginning stage propagate through the development process and are the hardest to repair later. Requirements elicitation is a difficult process in which one has to deal with ambiguity, informality, incompleteness and inconsistency, in which the "knowledge" of the requirements is not clear.

Problems in requirements elicitation

Errors in requirements elicitation are, overall, most serious in software development, and the hardest to repair. 70% of the systems errors are due to inadequate system specification [1]

Classification of elicitation problems

- **Problems of scope**. The boundary of the system is ill-defined, so that unnecessary design information may be given, or necessary design information left out.
- **Problems of understanding**. Users have incomplete understanding of their needs; analysts have poor knowledge of the problem domain; user and analyst speak different languages (literally or figuratively); "obvious" information may be omitted; different users may have conflicting needs or perceptions of their needs; requirements are often vaguely expressed, e.g., "user friendly" or "robust".
- **Problems of volatility**. Requirements evolve over time, either because of changing needs or because of changing perceptions by the stakeholders [1].

4. Method Overview

Prototyping is one of the techniques used in requirements engineering. Instead of expensive Prototypes, ***a throwaway paper prototype*** method is suggested for requirements engineering.A paper prototype is a visual representation of what the System will look like. It can be hand drawn or created by using a graphics program. Usually paper prototype is used as part of the usability testing, where the user gets a feel of the User Interface.

The entire approach is divided into the following Steps:

- Domain Knowledge acquisition
- System understanding
- Requirements elicitation
- Prototype Validation
- Requirements Stabilization

4.1 Domain Knowledge Acquisition

As a prerequisite to the elicitation activity the analyst have to perform a domain study. He/She has to understand the basic terms and processes in the domain before moving on to details of the system.

4.2 System Understanding

The business analyst has to procure knowledge about the existing system through the manuals and users of the system. Once the system study is complete the analyst will get a fair idea about the system to be developed and can proceed for the elicitation and requirements gathering process.

4.3 Requirements Elicitation

After the initial meeting with the user and the preliminary investigation about the system the analyst gets a fair idea about the major requirements of the system. He/She has to accordingly build a throwaway paper prototype of the system. The paper prototype should concentrate on the main requirements and is to be presented before the users. The analyst with the aid of the prototype discusses with the user and gathers more requirements. The gathered

requirements are recorded in a tabular format in the paper which will be used for tracing back in the next iterations. Details of the users, the requirement details, origin of the requirement and feedback details are recorded in the tabular format. The analyst gets the feedback from the users there itself. If the analyst comes across conflicting feedbacks on the requirements he/she has to discuss with the users who have given the conflicting views and has to come to a consensus.

4.4 Paper Prototype Validation

Once requirements have been gathered, it is categorized and organized into related subsets. The activity in this step is validation of prototype. The prototype is validated for omissions, ambiguity etc...

4.5 Requirements Stabilization

The paper prototype is changed according to the user feedback and clarifications. It is refined till the user is satisfied with the prototype and all the requirements are gathered. Once the prototype is finalized requirement are stabilized. The requirements specification is done after the stabilization process and the prototype can be discarded. Throwaway prototyping is suggested because once the requirements are gathered the prototype is thrown away and the rest of the phases are performed as usual so that the quality of the system is maintained.

Before finalizing the requirements an approval from the users can be sought so that the amount of rework on requirements can be minimized. **S**amples of paper prototypes are given below.

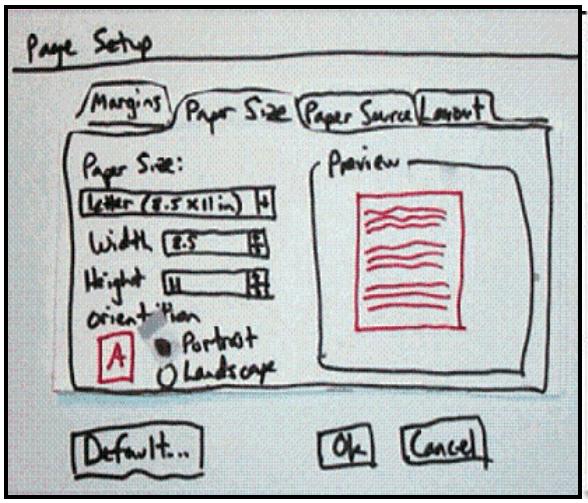


Fig-2.1 A sample Paper prototype of the Page setup Dialog of Microsoft windows

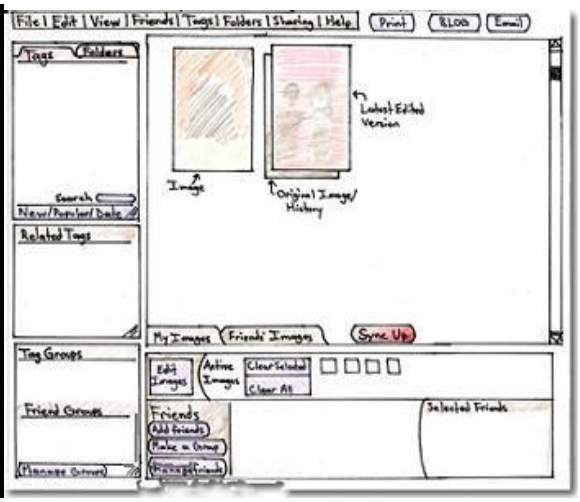


Fig 2.2- Sample Paper Prototype

5. Case study

In order to examine the merits of using paper prototype for requirements elicitation technique, several case studies were conducted through student projects. We have trained a group of Post graduate students in using the paper prototype approach and have made them to use the same in their projects. The data from one of the studies is presented in this paper in order to help analyze the usefulness of this technique.

"Safety and Compliances Software" Package called abcSAC Suite is an integrated software solution for helping organizations in USA, to stay in compliance with their government's safety regulations for specific categories and activities, along with helping them track various other desirable safety related issues The project consists 40 different modules. The modules selected for the project are Worker Safety, Exposure Management, Training Management. This package is developed for ABC Systems, Inc., Connecticut, USA. abcSAC suite is being developed as a windows application using Microsoft .Net technology, CSLA framework and Microsoft SQL Server 2005 technologies. It will be capable to reduce the risk factors in organizations by using this application to schedule trainings to its employees or other staff in proper time by analyzing existing database, on various safety and related issues. ABC Systems Inc. expects that after the full development of "Safety and Compliances Software" Package, they will be the big player in the USA Safety and Compliance Software domain.

a) Worker Safety Module

Typical applications fall into two categories named as OSHA Compliance Applications and Safety Program Applications. The first category involves applications designed to help meet the United States government's OSHA (Occupational Safety and Health Administration, U.S. Department of Labor) requirements and regulations, and the second category of applications are those that can help with instituting work place safety programs that help analyze and reduce future worker injuries and incidents.

b) **Exposure Management**

The purpose of the Exposure Management System is to provide a facility to help identify whether people are exposed to specific hazards and whether they have received appropriate training. The Exposure Management System works cooperatively with the Training Management System to accomplish its goals. Exposure Module consist the following processes.

1. Exposure Identification and Entry
2. Exposure Reviews and Reports

c) Training Management

The purpose of the Training Management System is to provide a facility to help identify whether people are exposed to specific hazards and whether they have received appropriate training. The Training Management System works cooperatively with the Exposure Management System to accomplish its goals. This means whenever a new type of accident occurs in the organization, they are getting the exposure to its various effects (when it happened, reasons for this accident, how long it lasted, whom it is affected etc….). That is, once an accident happens, the organization is getting familiar to the different consequences of it. And they are planning to prevent the next occurrence of the same accident again. So they will give proper training to the people. Training Management module consist the following processes.

a. Training
b. Training Report Generation

The Users who took part in the elicitation process were the technical staff of the organization.

The process for this project was completed in 1-3 iterations and the amount of change in requirements was less than 20%.Some of the sample paper prototypes used in this project are as follows

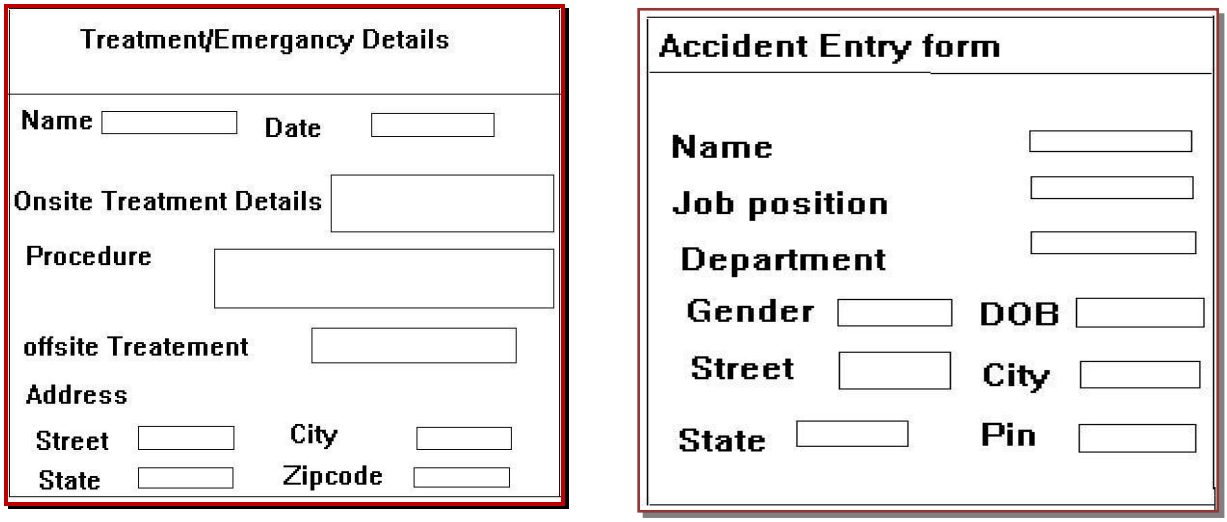


Fig-3.1 Samples of the Paper prototype used for the elicitation activity of this Project

6. Performance Analysis of the Proposed Approach.

We have conducted a study based on a group of students who have used paper prototype for requirements gathering. Feedbacks were gathered from students who have used the paper prototype for elicitation activity. A questionnaire was used for the assessment of the approach. The questionnaire addressed the openness of the users towards the approach, the number of iterations taken to complete the requirements gathering, the % of rework required at the design phase and also the effectiveness of the method.

Most of the respondents have done medium sized database projects. About 60% of users were partially open towards the use of this method for elicitation and 40% were open. Most of the respondents have completed their elicitation activity in 1-3 iterations. Only few have taken more than 3 iterations to complete their elicitation. The amount of rework suggested by the respondents was between 10-15% only. Majority of the users and respondents have strongly recommended this method for elicitation for small and medium sized projects. The ***questionnaire*** used for gathering feedbacks from the group of students is given in the Appendix (**Table 1)**

6.1 Advantages

The participants are not caught up in the look of the system, Paper allows imagination to work.There is no technology barrier for the user; he/she can easily understand and use the paper prototype. A more user friendly way of requirements elicitation.

7. Conclusion

In this paper we have proposed a novel approach of using paper prototype for requirements elicitation. The paper focuses on the effectiveness of using Paper Prototype method for requirements elicitation and the major benefits of using the same. The paper prototype technique has been analyzed with the help of a group of student who has adopted this method for requirements Elicitation. We acknowledge that the data from the projects might not be sufficient to conduct the test, however, the feedback of persons who have used the method is an indicator that well-planned and meticulously used paper prototype will be an effective technique for elicitation for small and medium sized projects. The analysis of the approach has indicated that the paper prototype method for requirements elicitation is a suitable method for Small and medium sized projects. The method need to be tested for industry projects for further results.

Our further research is extended to find out the following

- Whether the technique can be applicable for all Categories of projects?
- Can it be effectively employed for small, medium and large projects?
- The Cost & time factor of the approach.

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APPENDIX

TABLE I- (Questionnaire)

Dear Respondents,

Hope all of you have used Paper prototyping for your requirements gathering process. Please fill in the questionnaire for assessing the effectiveness of the paper prototyping technique.

Name :

Title of your Project :

1. In which category does your project fall
   ☐ Database project
   ☐ Concept Development project
   ☐System level Project
   ☐Hardware project

2. What is the size of your project
   ☐ Small ☐Medium ☐Large

3. Whether the users were open to the concept of using paper prototype for system study?
   ☐Not open ☐ Partially open ☐ Open

4. Whether the users were satisfied with the paper prototype as a requirements gathering tool?
   ☐Not Satisfied ☐ Not sure ☐ Fully satisfied

5. How many iterations did it take for you to complete the system study using this technique?

   ☐ 8 or above ☐ 4-7 ☐ 1-3

6. What is the % of rework you had to do at the design phase on the requirements gathered?
   ☐ 50% or above ☐ 20-40% ☐ 10-15%

7. How do you rate this technique compared to the traditional methods of requirements gathering?
   ☐Poor ☐ Fair ☐ Good

8. Will you recommend this method for requirements elicitation?
   ☐ Not Recommend ☐Not Sure ☐ Recommend

9. While eliciting requirements using this method have you ever confused it as a design tool?
   ☐Frequently ☐ Sometimes ☐ Not at all

10. Do you think that this method can be applied to medium sized and large sized projects?

    ☐ Cannot Apply ☐Not sure ☐ Apply

    Comments If Any