In this paper I briefly describe my research goals and plans by answering a set of ten questions taken from the ICSE (IEEE International Conference on Software Engineering) doctoral symposium I participated in May 2004.

1. What is the main goal of your work?

The goal of this research is to define and validate (theoretically and empirically) requirements management measures connected to the attributes stability and volatility of requirements. With theoretical validation we prove that the relationships between the entities in the empirical world are still valid in the mathematical/formal world. With empirical validation we prove that a measure is a predictor of some attribute.

2. What are the tangible benefits to society of achieving that goal (i.e. why should anyone pay for this work)?

As described in the Chaos report [18], the management of customer requirements is one of the main problem areas in software development. Requirements engineers and project managers would benefit from my research because the measures defined, proven to be predictors of volatility and stability, will help in understanding how the requirements will change and consequently predicting costs and schedule of the software development.

3. What are the technical problems that make the goal difficult to achieve (i.e. why hasn’t this been done already)?

The reason for the lack of validated measures is due to the immaturity of the measures validation field. Several validation methods have been presented in the literature, but there is not yet a standardised accepted way of validating measures. Some of these methods are discussed in [6]. Furthermore, people in the software engineering area are not sensitive to the importance of measures validation.

4. What are the main elements of your approach?

Requirements, measures, theoretical and empirical validation, case studies, stability, volatility, software processes.

5. How does your approach handle the technical problems that have prevented progress in the past (i.e. what makes you think that you can do it when no one else could before)?

The low sensitivity among software engineers regarding the importance of validated measures has prevented progress in this area. I am applying theories and methods to define and validate measures and this has not been done for requirements management measures. The second problem is the immaturity of the measure validation field. I will handle this problem by applying two approaches to theoretically validate the measures (“key stages of formal measurement” [2] and the “theoretical validation” [3]), but there are no warranties that the methods applied are the best ones.

6. What are the unique, novel, and/or critical technologies developed in your approach?

Very few measures have been validated, mainly in the object orientation field (to predict maintainability). To my knowledge, there are no validated requirements management measures.
7. What are the potential spin-off or other applications of your work?

My work can help decision makers in many application areas (maintenance, configuration management, change management, project planning and tracking, defining baselines). Through my validated measures project managers can quantify the amount of changes to requirements and predict requirements volatility, thus having better information to make decisions.

8. How can progress be measured (i.e. how can anyone tell if/when you have succeeded)?

For the definition and theoretical validation of the measures, the only way to validate my work is by expert judgement (i.e. by publishing the work in conferences or journals).
The empirical validation of the measures is done through case studies, therefore the replication and success of the case study is the way to validate.

9. What have you accomplished so far?

9.1. Requirements Management Measures Definition [4], [5], (paper 1)

Autumn 1999 - Autumn 2000: The first contribution of my research is the definition of a general and wide set of 38 software measures for the management of requirements [5]. The method used to define the measures was to apply the Goal Question Metrics (GQM) paradigm [1] to the Requirements Management Key Process Area of the Capability Maturity Model for Software [17]. This set constitutes a “pick list” that can be tailored to the specific company, offering small-medium enterprises the freedom to choose a suitable subset of software measures.

9.2. Theoretical validation [6], [7] (papers 2 and 3)

January 2001 - March 2002: I theoretically validated one measure and discussed measures validation definitions [6].

March 2002 - July 2003: I theoretically validated ten measures [7], by applying two validation definitions to the measures. In particular I applied the “key stages of formal measurement” [2] and the “theoretical validation” [3].

9.3. Using the measures in an academic environment [7], [9] (papers 3 and 4)

August 2002 - February 2003: Case study one. One academic case study has been performed with the goal of showing that cost estimations of changes to requirements based on historical data are better than intuitive cost estimations. Unfortunately this study was not successful because the number of changes to requirements reported by the students was too small to be able to perform statistical analysis. However, some lessons learned are presented in [7], for example: effort should be spent in pushing students and customers to discuss their requirements.

August 2003 - January 2004: Case study two. Another case study was performed in an academic environment whose goal was to show that cost estimations of changes to requirements based on detailed impact analysis are better than intuitive cost estimations. While developing software projects in a course, five groups of students, estimated the cost of changes to requirements. Three groups analyzed the impact of change by using a checklist to support cost estimation. Two groups analyzed the impact of changes to requirements in an intuitive way. Unfortunately this study was not successful as well because the number of changes to requirements reported by the students was too small. The results are presented in [9]. My conclusions from these two studies is that student projects are too short and too stable to investigate changes to requirements and students are too unreliable when reporting changes.

9.4. Empirical validation [8] (paper 5)

January 2004 - 14 February 2005 (was 20 december 2004): Case study three. I have analyzed the available requirements specifications and function specifications of one historical project. I have performed an industrial case study to empirically validate some of the measures in [5]. I have collected data on one project in a company in Sweden for a set of requirements volatility measures [5]. The data analysis showed a high correlation between our measures of size of requirements and total number of changes, indicating that the measures of size of requirements are good indicators of requirements volatility. No correlations was found between subjective and objective volatility. These results sug-
gest that project managers at this company should measure their projects because of the risk to take wrong decisions based on their own and the developer’s perceptions.

February 2005 — April 2005: Case study three (deeper analysis). The goal is to empirically validate a set of requirements volatility measures by performing a deeper analysis (relative size of change) of the data collected in the previous study. Data analysis show correlation in one case i.e. one measures is empirically validated. The results show also that it is necessary to check the reasons of changes to requirements for late changes because the subjects’ view seems to be affected by major late changes.

9.5. Miscellaneous
Other publications produced during my Ph.D. studies: a doctoral symposium paper [10]; a report on the conference Metrics 2001 [13], and a student conference paper [14].

10. What is your schedule for the remaining work?

10.1. Empirical validation (paper 7)
April — June 2005 (was January 2005 — 30 March 2005): Case study four (replication of the third). Since it is always necessary to make replicas of experiments in order to obtain conclusive results, I have started the case study replication above in the context of another project. I will summarize the replicated case study and compare it with the previous one in a (journal?) paper that will be ready on June 30, 2005.

10.2. Construction and validation of a prediction model (paper 7)
April - December 2005: Case study four (replication of the third). A prediction model of requirements volatility is build based on the data collected in case study three. The prediction model is validated with the data collected in case study four. A preliminary description of the prediction model constructed is available [12], and will be submitted to Journal of Information and Software Technology, in January, 2006.

10.3. Other contributions
November 2004 -?? 2005: The software engineering group in Umeå belongs to SiREN (Swedish Requirements Engineering Research Network). All the Universities member of this group will perform an experiment on requirements abstraction levels. Currently, the experiment has been performed by Bleckinge University and by Umeå University. The national results are described in two papers submitted for journal publications [15], [16].

10.4. Thesis deadlines
My plan is to write a “sammanslagningavhandling” made of six papers (in table 2), five of them are published. The Ph.D. defence is planned in March 2006
Table 1: Planned activities

<table>
<thead>
<tr>
<th>Deadlines</th>
<th>Activities</th>
</tr>
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<tbody>
<tr>
<td>May 14</td>
<td>First version of the kappa ready</td>
</tr>
<tr>
<td>Jan. 15</td>
<td>Internal distribution of kappa v.2, papers 1-6 and outline of paper 7.</td>
</tr>
<tr>
<td>Jan. 15</td>
<td>Contact opponent</td>
</tr>
<tr>
<td>Jan. 30</td>
<td>Paper 7 ready</td>
</tr>
<tr>
<td>Feb 28</td>
<td>Send thesis to opponent</td>
</tr>
<tr>
<td>March 31</td>
<td>Ph.D. defence</td>
</tr>
<tr>
<td>Feb 28</td>
<td>Paper 5: An Industrial Case Study on Requirements Volatility Measures [8]</td>
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Table 2: Papers state (can be downloaded at ~bella/PhD)

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<th>Papers</th>
<th>Authors</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper 5: An Industrial Case Study on Requirements Volatility Measures [8]</td>
<td>Annabella, Jürgen</td>
<td>accepted</td>
</tr>
<tr>
<td>Paper 7: Construction and validation of a prediction model of requirements volatility</td>
<td>Annabella, Jürgen</td>
<td>Draft available</td>
</tr>
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References


