

**REPORT ON THE EVALUATION OF  
THE DOCTORAL DISSERTATION OF CANDIDATE  
ALEKSANDAR BULAJIĆ**

**I INFORMATION ABOUT THE COMMITTEE**

The committee appointed by the University Senate on the meeting dated on 26th of June 2013.

1. Dr Dragan Domazet, Professor, Metropolitan University, Belgrade  
Scientific area: Computer Integrated Systems, Computer analysis of the product.  
Committee chair
2. Dr Milan Stamatović, Professor, Metropolitan University, Belgrade  
Scientific area: Management
3. Dr. Radoslav Stojic, Associate Professor, Metropolitan University, Belgrade  
Scientific area: Computer Science  
Dissertation supervisor
4. Dr. Olga Timcenko, Associate Professor, Aalborg University, Copenhagen  
Scientific area: Mathematics and human-computer interaction
5. Dr. Samuel Sambasivam, Professor & Chair, Azusa Pacific University, USA  
Scientific area: Computer Science

**II INFORMATION ABOUT THE CANDIDATE**

**Aleksandar, Miloša, Bulajić**

Born 29. Oct. 1955, Zenica, Bosnia and Hercegovina.

Doctoral student in Software Engineering at Belgrade Metropolitan University.

Employed at IBM, Borupvang 1, 2750 Ballerup, DENMARK.

**III TITLE OF THE DOCTORAL DISSERTATION:**

**CONTRIBUTION TO SOFTWARE DEVELOPMENT METHOD BASED ON  
GENERALIZED REQUIREMENT APPROACH**

## IV REVIEW OF THE DOCTORAL DISSERTATION

As indicated by its title, Aleksandar Bulajic's dissertation is primarily practically motivated. Its purpose is to attempt to increase effectiveness of a business software development process by proposing a new approach with a focus on validation of requirements during negotiation process.

The overall aim thus is one of the applied science rather than of a classical academic treatise.

This determines both the general disposition of the dissertation as well as its basic mode of argumentation.

The dissertation is based upon 16 peer-reviewed papers, all of which have been published (or accepted for publication) in international journals and conference proceedings.

Nine of these papers are international journal papers (7 have been already published and 2 are accepted for journal publication), including one published in journal indexed on the ISI Thomson Reuters list with impact factor.

Seven of these papers are international conferences papers ( 5 have been presented at conferences and published in the proceedings, 2 are accepted for publication).

As to the disposition, it falls in 16 short chapters, which may be grouped in five major parts:

- i) **Introductory part**, with description of the research problem and survey or related work;
- ii) **Central part** with description of proposed Generalized Requirement Approach (GRA) and design concept of appropriate framework (GRAF)
- iii) Part devoted to **description of developed software and Validation of GRA** for the class of business applications by implementing example;
- iv) **Concluding part** with comparison of the proposed concept to other similar approaches, summary of its features and limitations, as well as drawing final conclusions and cited references;
- v) Part containing **appendices**, clarifying aspects of implementation and testing of software developed to support the thesis - example of business application.

More detailed presentation of dissertation chapters is following.

### i) **Introductory part**

Ch 1. Introduction addresses the domain for research to be well-known fact that defects introduced in software specification are more critical than those introduced in other phases of the project. It announces new approach based on requirement validation during the requirement negotiation process by using tool which generates program code in automatic way, without manual programming. Then, content of the each chapter is briefly described.

Ch 2. Research problems describe requirement elicitation, verification and validation issues in current practice and point to the lack of appropriate tools for effective support.

Ch 3. Related Work presents methods and tools that are currently used for software development

### ii) **Central part**

Ch 4. Traditional Software Development Method (SDM) presents process structure that is common for the software development methods presented Ch 3.

Ch 5 “Generalized Requirement Approach (GRA)” describes the proposed method for improving the software development process based on using tool (framework) which automatically generates source and executable code.

Ch 6. Generalized Requirement Approach Framework (GRAF)” describes the framework responsible for guiding a user to specify requirements, store requirement descriptions in the structured text format, and generate source and executable code that are used for requirement validation.

### iii) Description of developed software and Validation of GRA

Ch 7. GRA Framework Validation describes the Retail Store, a fictitious E-commerce application, which is used to validate the GRA Framework implementation.

Ch 8. Summary of GRA Features and Comparison to other Approaches describes the differences between the solution proposed in this dissertation and other techniques exploited in various software development methods.

### iv) Concluding part

Ch 9. Generalized Requirement Approach (GRA) Limitations describes what is beyond the scope of the described GRA Framework, namely non-functional requirements (performances, security, robustness, etc.) as well as business (and other) applications requiring complex data models, relations and algorithms.

Ch 10. Research Contribution summarizes what is offered by the proposed approach, primarily from the practical point of view.

Ch 11. Conclusion summarizes the mayor contributions od dissertation and comparison to other approaches.

Ch 12. List of References gives 65 items, representative for the studied problem.

### v) Appendices,

ch 13. Appendix A – Definition of Terms not covered IEEE Standard Glossary of Software Engineering Terminology

ch 14. Appendix B – Generating Source Code illustrates the process of generating source code in example of GRA Framework, devoted for the purpose of the dissertation.

ch 15. Appendix C – Retail Store Example describe the example of application, developed by example of GRA Framework, for illustration the proposed solution and its verification and validation.

ch 16. Appendix D – Retail Store Test Documentation describes validation of the generated source code and testing of the Retail Store application.

In order to demonstrate feasibility of the proposed approach, candidate develops a software, available on line at <http://www.port85.com/>, which implements principal functionality of the GRA framework described in thesis. This software represents integral part of the dissertation and may be used not only for the testing and evaluating of the dissertation results, but also as a basis for further studies and upgrades to meet needs of software industry.

## V EVALUATION OF THE DOCTORAL DISSERTATION

Research work and results covered by the dissertation belongs to area of Software Engineering, that is a bridge between theoretical discipline and practical applications, always expecting the better and improved solutions.

Starting from the well-known fact that improper requirement formulation and -validation is a weak point of software engineering projects, candidate analyses various Software Development Methodologies (SDM) and practices and concludes that there is still a need for better -approach and new propositions. Citing the most of the relevant references in the field (both theoretically and practically oriented), candidate shows that these improvements are objectives of scientific research.

Candidate postulates that the major source of improper requirement formulation lies in the communication problems between two communities: 1. Computer (generally represented by software engineering staff), speaking its own (very mathematical and logical oriented) language and 2. Customers, speaking so called native language which is very adapted to real life and various professional, national, cultural and other social environments. -Candidate sees requirement validation by testing using automatically generated program code, driven by customer description expressed by its native (or domain) language as a solution to these problems.

On the other hand this requires to automatically generate executive code based on native (non-computer) language description, which is not easy task to solve, at least not in the area -of software industry know-how.

From this reason, several restrictions (or assumptions) are introduced in the thesis to make solution of the task feasible.

- Executive code is generated as a collaborative activity of a customer and a software engineer during requirement elicitation and negotiation. This process is guided by predefined set of questions and guidelines which specify sufficient level of details in order to generate executable code which is able to validate each of the requirements. No manual programming is assumed in this phase.

- Application domain is narrowed to business domain applications, where variety of specific goals and original ideas (often very obscure) dominate in the final software product. There is a -lot of potential misunderstandings between a customer and a software engineer, however these application do not use -complex math, -algorithms, any specifics to simulation and control of systems, game theory or artificial intelligence.

- Document of customer requirements should be transformable to structured text format, in order to be represented by a tree structure by avoiding recursive evaluation schemes which may or may not converge.

- Only functional requirements are considered in solution. Non-functional requirements are handled by already existing techniques.

Based on above assumptions, thesis proposes Generalized Requirement Approach (GRA) featured by:

- Requirements are described via customer language and stored in the structured text format
- Source code is generated from a requirement description without manual programming
- Working software is available during the requirement negotiations process

*The thesis then elaborates design of software development environment, called GRA Framework (GRAF), which supports practical use of the proposed approach. GRAF top level architecture is described in the thesis and explanations are given on how each of the GRA features are implemented.*

In order to validate proposed concept, candidate develops working prototype of GRAF, software available on-line. This implementation is sufficient for the purpose of the thesis, but additional development is necessary to achieve industry standard conformity level. The latter is not in the scope of the thesis, since it is not viewed as a research but rather as an industrial development task.

Candidate spent a considerable effort in developing and testing of working GRAF prototype. In the appendices of the thesis is presented example of business (e-commerce) application in order to illustrate use-case and potential of the proposed solution, as well as test documentation.

Concluding part of the thesis summarizes major points of the research work and its results.

## **VI CONCLUSIONS, I.E RESEARCH RESULTS**

The contributions of the research project covered by dissertation can be summed up as follows:

- The thesis gives overview of the various approaches and methodologies to software development and a list of relevant references. This gives a good starting point for further research in the field of SDM, as well as refreshment of educational material in the university courses.
- The strength of the thesis is the thorough presentation of a new requirement validation approach, which is illustrated with an implementation example case.
- The thesis proposes a new approach called Generalized Requirement Approach (GRA) for requirement validation with automatically generated program code in software development for business applications. Therefore, application of GRA offers more efficient project realizations in terms of development time, project scope, budget, risks and other efficiency indicators compared to available tools and techniques.
- The GRA is formulated as improvement of the Waterfall model with a note indicating how GRA may be incorporated in other Traditional or Agile methods.
- GRAF, software development environment appropriate for GRA application in practice, is elaborated up to architecture level. Author developed limited implementation of GRAF - working prototype, with the primary goal to prove feasibility of the proposed approach.
- Applicability of the proposed approach in practice is illustrated by example of business application (Retail Store). Both Graf implementation and Retail Store examples are available online, as indicated in references of the thesis.
- Based on results presented in the thesis it is possible to develop GRAF conform to industry standards with no additional scientific research. GRAF may be developed as collaborative environment and integrated with other software project management and related software engineering tools.
- As described in the thesis, GRAF is suited for functional requirements but not quite well for non-functional requirements (eg. performances, security, and robustness). Thus, final deliverable should

be created manually improving code generated during requirement negotiation phase.

Research work described in the thesis resulted in published 16 articles (9 in the international journals 7 in international conferences). Four of those articles (two in the international journals two in international conferences) closely related to the principal results and contribution of the thesis, giving in this way additional arguments for positive evaluation of the thesis.

## **VII EVALUATION OF THE METHOD OF PRESENTATION AND INTERPRETATION OF RESEARCH RESULTS**

The first part of dissertation empirically identifies a range of potential causes for the lack of proper requirement validation in software development projects.

The overall layout of the dissertation following the practical construction and testing of the proposed hypotheses is reflected in writing style. It is direct, with moderately-strong rationale but also often governed more by subjective judgment, based on rich experience of candidate and reported industrial experience, rather than scientific argument.

Dissertation provides an overview of existing literature, but is focused wider than the research problem presented in the thesis.

Most pertinent results are reported in fairly clear and concise manner. Figures and tables are labeled appropriately and include legend.

Conclusions and summary is generally based on findings and outcomes. Discussion is in some places more detailed than necessary.

The dissertation is sufficiently clear. Wording choice, grammar, punctuation, and spelling are adequate. The narrative is logical and coherent, and rarely lacks focus.

## **VIII FINAL EVALUATION OF THE DOCTORAL DISSERTATION**

The contribution of dissertation belongs to the field of Software Engineering.

This dissertation displays a committed and well-informed attempt at articulating an idea on how to improve the requirement validation during the requirement negotiation process for the class of business applications.

It formulates the Generalized Requirement Approach and proposes it in order to improve requirement validation.

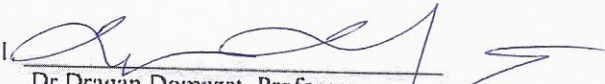
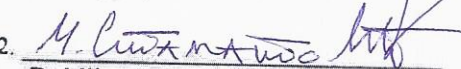
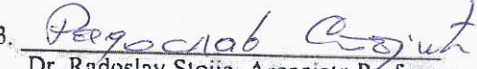
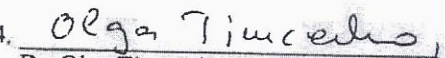
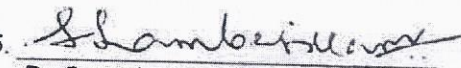
The approach is verified by the realistic example, representative for the class of business applications and is sufficiently elaborated to serve as a basis for upgrades to meet the needs of software industry.

The results presented in the dissertation are original contribution of the author, as indicated by the publications in numerous peer reviewed journals and conferences.

**IX RECOMMENDATION**

Therefore, the committee recommends that the Senate of Belgrade Metropolitan University accepts the dissertation the field of Software Engineering as successfully completed, conform to the University Statute and the Law on Higher Education.

SIGNATURES OF THE COMMITTEE MEMBERS:

1.   
Dr Dragan Domuzet, Professor
2.   
Dr Milan Stamatović, Professor
3.   
Dr. Radoslav Stojic, Associate Professor
4.  07/03/2014  
Dr. Olga Timcenko, Associate Professor
5.  March 9, 2014  
Dr. Samuel Sambasivam., Professor & Chair

Belgrade, 3 March 2014