Software Construction

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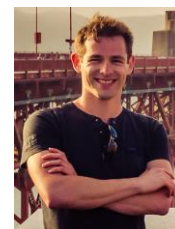
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Overview

Our research focuses on the development of new methods, tools, and techniques in the broad area of software construction. Since real software engineering is done in industry, we always aim to develop research results that are applicable under industrial software development conditions. Hence, most of our research projects are performed in close cooperation with industrial partners. Currently, we are actively working in the following areas:

- *Reusing Domain Engineered Artifacts for Code Generation.* Model-driven engineering uses certain diagrams to foster code generation but these diagrams are rarely reused; overcoming this is one of the goals of this project.

- *Metric-based Project and Process Management.* Like in other engineering disciplines, measuring is a prerequisite to determine the performance of processes and products. We are aiming to develop an integrated highly customizable measurement infrastructure.

- *Model-supported Process Adoption and Assessment in the Context of Multiple Practice Repositories.* Practice repositories (e.g., CMMI) are used to improve software processes. A systematic approach is developed to decide which parts of them are best suited for the intended improvement and how to work with multiple practice repositories.

- *Model-based Software Architecture Evolution and Evaluation.* Software tends to evolve independently from their architecture description. We are developing an approach to monitor and evaluate the current state of the architecture and to support its evolution.

- *Technical Debt Management.* An organization cannot avoid incurring a technical debt. A systematic approach will be proposed to tackle and manage the debt (e.g., structural quality problems) while monitoring software evolves.

- *Regression Test Selection.* Techniques that minimize the set of regression test cases are desirable. While such techniques are researched, they are often not applicable in and are not known to the industry. We investigate how these techniques can be applied to and integrated into industry projects.

Since appropriate tools are often the door opener to transfer research ideas to practice, we are developing dedicated tool support for those areas. Currently, we offer the following tools:

- HERMES (Harvest, Evolve, and Reuse Models Easily and Seamlessly)

- EMI (Enterprise Measurement Infrastructure) and SCREEN

- MosAIC (Model supported Adoption and Assessment of Improvement Concepts)

- ARAMIS (Architecture Analysis and Monitoring Infrastructure)

Last year, we organized the 1st International Workshop on Quantitative Approaches to Software Quality which was held in conjunction with APSEC 2013 in Bangkok in December. As it was successful, a follow-up workshop will be organized at APSEC 2014 in South Korea.

In March, Chayakorn Piyabunditkul passed his Ph.D. defense. Congratulations! The official bestowal of his doctoral will take place in November. In September, Simona Jeners left our team; she is now with ITERGO Düsseldorf. She completed her research project on Model-supported Process Adoption and Assessment in the Context of Multiple Practice Repositories; the Ph.D. defense will be in December 2014. Last but not least, we are happy to welcome Andreas Steffens in our team. He has a long background in professional software development and plans to establish operational thinking in research.

Research Projects

Reusing Domain Engineered Artifacts for Code Generation

A. Ganser, H. Lichter

Model driven architecture (MDA), and model driven engineering (MDE) are promising approaches to increase reuse and to reduce development time and effort. Both comprise of several methods which include domain specific modeling (DSM). These methods brings about figures which map objects under consideration to models. Among these models are class diagrams as know from UML. They are called domain models in these contexts.
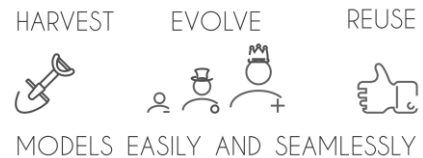
Both approaches take these domain models as inputs for code generation, but only MDE includes reuse in DSM. Yet, this reuse remains rather rudimentary. Taking a closer look at model repositories one might suppose that these repositories are meant to store models so they can be reused rather easily in different projects. But the goals for these repositories are totally different! All the available repositories (by and large) only consider versioning, migration, transformation, conflict detection, merging and querying. This means, models are not related to each other, there is barely a description of models, no examples are present how the models could be used or no interfaces are defined which point to the most important aspects that could help reusing a particular model.
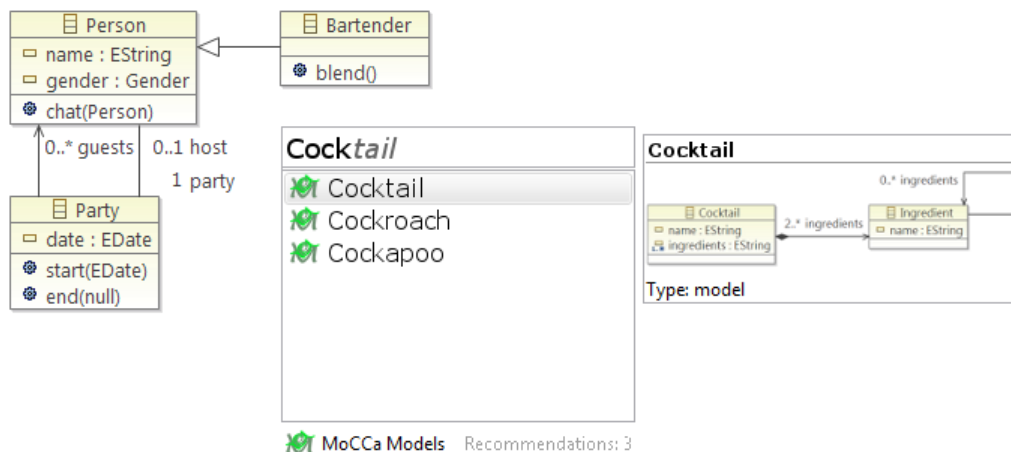
The goal of this research project is to bolster model reuse by providing mechanism to harvest, evolve, and reuse models. Therefore approaches for gleaning reusable artifacts into a model library, evolving them, and producing recommendations are under research. Therefore, models should not be treated as in an isolated world, but related to each other, knowing not only that these models worked together but even how they did. These relationships cross borders and overcome the usual reuse obstacles and unleash the full power of previously modeled knowledge.

For more information please visit: http://hermes.modelrecommenders.org

Metric-based Project and Process Management

M. Vianden, H. Lichter

External cooperation: Generali Informatik Services, Aachen

It is commonly known, that projects management greatly benefit by the application of metrics. However, research shows that it is demanding to find the right metrics; 58% of all project managers and 50% of all senior managers find it difficult to collect, analyze, and use the right metrics. On the one hand, metric frameworks like GQM help to derive metrics from abstract goals for the project. On the other hand, defining measures just for one project (in a multi project organization with a lot of similar projects) is costly and ineffective. Hence, it is wise to reuse metric experience (metric definitions, evaluations, and models) as all experience can and should be reused.

Although considerable research has been devoted to the modeling of metrics and metric frameworks, rather less attention has been paid to investigating how the results of this research (metric meta models, metric frameworks, and metric experience bases) can lead to a sound concept for metric reuse. Therefore, the aim of this project is to develop such a concept for

metric reuse. The concept should be enriched by metric processes which include metric reuse as well as dedicated tool support for metric documentation, metric reuse and metric calculation.
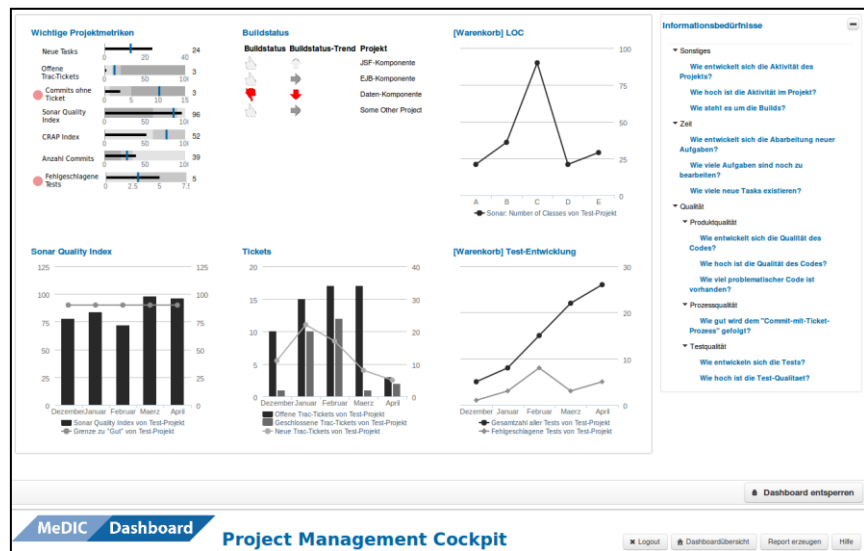
Model-supported Process Adoption and Assessment in the Context of Multiple Practice Repositories

S. Jeners, H. Lichter

External cooperation: ITERGO GmbH

Nowadays, the software market is expanding and clients are requesting better, faster, and cheaper software products. One important impact factor to project success is the quality of the applied IT-processes. Hence, more and more organizations are obligated to identify, structure, and improve their processes systematically. There is a variety of practice repositories (PRs) known as maturity-, process- and quality-models as well as standards, norms, etc. that can be

used. Organizations have to decide which of these models they want to use. The adoption of multiple PRs allows an organization to exploit synergy effects between them. On the one hand organizations can address co-coordinately different and common areas. On the other hand the weaknesses of single PRs can be overcome by the strengths of others.

The aim of this project is to develop a model-based approach that supports the adoption and assessment of multiple PRs in an organization. First, it provides an objective and semiautomatic selection of improvement practices of multiple PRs that best fit to an organization. To select the best suited practices the organizations resp. the context of software projects have to be considered. Based on factors that describe the software project context, improvement practices can be selected. For an efficient implementation of the PRs, the traces between the improvement practices and their corresponding PRs practices are also given. Secondly, the dependencies between the improvement practices and similarities with other practices from multiple PRs are identified to reveal the synergy effects and coordinate in an efficient way the adoption and assessment. Therefore, the approach supports a time efficient and effective adoption and assessment of improvement practices from multiple PRs.


Model-based Software Architecture Evolution and Evaluation

A. Nicolaescu, H. Lichter

External cooperation: Generali Informatik Services, Aachen

The architecture of software systems directly influences crucial quality attributes and therefore should be considered whenever important decisions regarding their evolution must be taken. However, up-to-date descriptions that correctly reflect the system's architecture rarely exist. Architecture descriptions are usually elaborated at the beginning of a software project. After the initial version of the system has been constructed, the system tends to evolve independently from its architecture description. Changes to the system are rarely documented properly and originally imposed rules are gradually violated.

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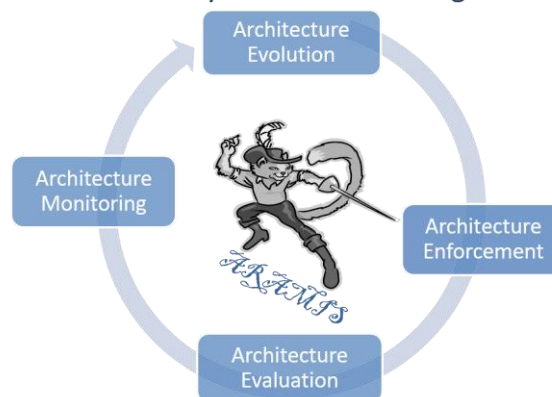
To help architects manage this situation, we have developed ARAMIS, a general concept and architecture for building tool-boxes for the monitoring of software on different levels of abstraction. Furthermore, we have developed an instantiation of ARAMIS, called ARAMIS-CIC, to validate the communication inside a software system during the execution of some scenarios of interest. The resulted calls are mapped on architecture units and checked against predefined architecture rules. The results are then visualized to support the architect to discover the architectural weaknesses of the analyzed system.

We currently work on extending our solution to increase the level of support given to the architects by, e.g., offering them possible solutions to improve the current state of the architecture.

Technical Debt Management

M. Firdaus Harun, H. Lichter

External cooperation: KISTERS AG, Aachen

Incurring technical debt is unavoidable due to software projects need to satisfy business goals. The debt is invincible which resides and evolves in the structural/abstraction of the software i.e. code/architecture-level. To repay (e.g., fixing and refactoring) it, we have to quantify and measure which debt are more risky and more costly. After that, the prioritization of refactoring activities based on most risky debt will be implemented first. It will be monitored continuous in order to make sure that the debt has been reduced/repaid at some point. However, a research on investigating how to manage the debt while software evolves still low. Plus, the questions regarding what are really debts in software, and how to measure and characterize the "indebtness" in structural of software still remain unclear.
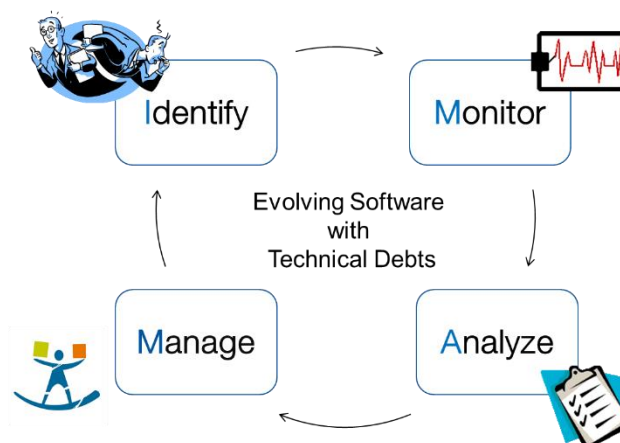
Therefore, in this project, we aim to propose a systematic approach to tackle and manage the debt. Firstly, the debt should be visible, characterize and highlight first to make sure that stakeholders concern about that. Then, the highlighted and measured debt could give a good indicator how much the debt that the organization incurs and how much the effort (e.g., refactoring or maintaining) that should be used to reduce the debt. In addition, analyzing the growing and declining trend of debt for each product release, possibly indicate a hint which hotspot in the software. Afterwards, a list of refactoring strategies could be suggested to an organization to choose based on given effort and time constraint. Finally, the repaid debt should be assessed continuously to support software evolution and avoid any debt incurs either directly or indirectly in the future.

Special Events

**International Workshop on Quantitative Approaches to Software Quality (QuASoQ)**
Bangkok, Thailand, December 2, 2013

Collocated with the 20th Asia-Pacific Software Engineering Conference (APSEC 2013), we organized the 1st International Workshop "Quantitative Approaches to Software Quality" (QuASoQ). This workshop aims at gathering together researchers and practitioners to discuss experiences in the application of state of the art approaches to measure, assess and evaluate the quality of both software systems and software development processes. Quantitative approaches are important means for software development organizations to assess their current level of quality and to perform goal-oriented improvement initiatives.

Even though approaches, methods, and techniques are known for quite some time, little effort has been spent on the exchange on the real world problems with quantitative approaches. For example, only limited research has been devoted to the setup and maintenance of large scale measurement systems in industrial environments.

Hence, the goals of the workshop are to exchange experiences, present new and promising approaches and discuss how to set up, organize, and maintain quantitative approaches to software quality.
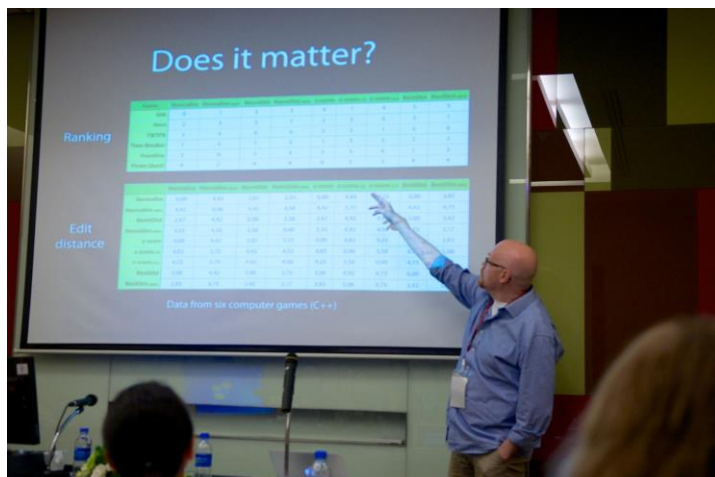
The program committee selected the papers based on their quality and novelty, and finally accepted four papers covering the following topics: code analysability, the impact of data normalization to information quality, lessons learned from a CMMI level 3 metrics program, and a tool support for agile estimation techniques. The workshop proceedings are published in volume 2 of APSEC 2013 proceedings at IEEE Digital Library.

Based on the discussions and the feedback the organizers got from the participants the 2nd International Workshop "Quantitative Approaches to Software Quality" (QuASoQ) will be held in December 2014 in conjunction with 21st Asia-Pacific Software Engineering Conference in Jeju, South Korea.

Tackling real-world problems in a teaching lab

This year, our software project lab was performed in cooperation with IVU Traffic Technologies AG. They develop IT solutions for public passenger and goods transport. After initial discussions they proposed the challenging problem to build a prototype for an innovative e-Ticketing solutions based on real-time data. The core of the problem was to support the CheckIn-BeOut scenario in which the exit of a passenger from a public bus needs to be detected automatically without an interaction of the passenger. The main focus of the lab was to proof that a detection based on the available data from a local public passenger transport provider is possible. A concrete solution to the problem, however, was left open to the participating students.

The whole lab was organized as an agile software project. The students formed three teams. Each consisting of five to six members. Every team individually came up with different solutions for the proposed problems after facing the initial problem of getting familiar with the different implementation technologies consisting of Android for the mobile client, NodeJS for a scalable middleware and Java Enterprise Edition with AngularJS as the backend system.

During the lab, IVU provided a project manager who participated in discussions and approved certain milestones, as well as access to the real-time data of the local public passenger transport provider. At the end of the project, each student team presented a working prototype and important insights into the problem domain to IVU.

Based on this lab, we plan to contribute this successful student project to software engineering conferences in form of a paper and a live demo. In addition, the students will present their work on the annual "Tag der Informatik". Last but not least, IVU decided to continue tackling this problem with SWC; three bachelor thesis will form the start for this cooperation.

Other Activities

- Member of the international program committee, First International Workshop on Combining Modelling with Search- and Example-Based Approaches, Valencia, Spain, September 28, 2014, *H. Lichter*

- Member of the international program committee, 6th Asian Conference on Intelligent Information Systems and Database Systems, Bangkok, Thailand, April 7-9, 2014, *H. Lichter*

- Organization and chair of the international program committee, International Workshop on Quantitative Approaches to Software Quality, Bangkok, Thailand, December 2, 2013, *H. Lichter, M. Vianden*

- Member of the program committee, Modellierung 2014, Vienna, Austria, March 19-21, 2014, *H. Lichter*

- Member of the international program committee, 29th Annual ACM Symposium on Applied Computing, Software Engineering Track, Gyeongju, Korea, March 24-28, 2014, *H. Lichter*

- Member of the international program committee, 8th IEEE International Conference on Software Security and Reliability (SERE), San Francisco, USA, June 30 – July 2, 2014 *H. Lichter*

- Member of the working group "Scientific software engineering, software eco-system and programmability" of the European Exascale Software Initiative 2, *H. Lichter*

- Reviewer for dpunkt-Verlag Heidelberg and computing reviews, *H. Lichter*

- Organization of the Computer Science Department's mentors program, *H. Lichter*

- Member of the Computer Science Department's committee for Lehre and Service-Lehre, *H. Lichter*

- Member of the examination board of Computer Science, *H. Lichter*

- Member of workgroup "Zusammenarbeit Hochschule und Industrie", GFFT, Gesellschaft zur Förderung des Forschungstransfers, *H. Lichter*

- Lecturer for the "Kara, der programmierbare Marienkäfer" course at Helle Köpfe in der Informatik 2014, *H. Lichter*

- Organization of the Universal / Specialized Preparatory Courses in Computer Science 2014, *H. Lichter, A. Dyck, A. Steffens*

- Member of the discussion panel at EDNA meeting, Kisters AG, Aachen, October 28, *Horst Lichter*

Talks and Publications

Talks

M. Firdaus Harun: *Release Readiness Measurement: A Comparison of Best Practices.* MySEC 2014, Langkawi, Malaysia, September 23, 2014.

C. Plewnia: *On the Influence of Release Engineering on Software Reputation*, 2nd International Workshop on Release Engineering, Mountain View, CA, USA, April 11, 2014.

A. Dragomir: *Systematic Architectural Decision Management – A process-oriented Approach.* WICSA 2014, Sydney, Australia, April 11, 2014.

A. Dragomir: *On Bridging the Gap between Practice and Vision for Software Architecture Reconstruction and Evolution - A Tool Perspective.* SAEroCon 2014, Sydney, Australia, April 8, 2014.

H. Lichter: *Foundations and Infrastructures for Large-scale Software Measurement*, Mahidol University, ICT Faculty, Bangkok, March 24, 2014.

M. Firdaus Harun: *An Architecture for Toolbox-based Software Architecture Reconstruction Solutions.* MMSM 2014, Vienna Austria, 19. March, 2014.

H. Lichter: *Zusammenhänge zwischen SW-Architektur und Organisationsarchitektur*, Kisters Ag, Aachen, January 23, 2014.

A. Ganser: *A Framework for Model Recommenders - Requirements, Architecture and Tool Support*, Modelsward 2014, Lisbon, Portugal, January 9, 2014.

A. Dyck: *On Designing Recommenders for Graphical Domain Modeling Environments*, Modelsward 2014, Lisbon, Portugal, January 9, 2014.

S. Jeners: *MosAIC Model supported Adoption and Assessment of Improvement Concepts*, ICSQ 2014, Dallas, TX, USA, February 26, 2014.

H. Lichter: *Software-Evolution und Architektur-Erosion*, ITERGO Düsseldorf, December 12, 2013.

A. Dragomir: *Run-time Monitoring and Real-time Visualization of Software Architectures.* APSEC 2013, Bangkok, Thailand, December 5, 2013.

M. Vianden: *History and Lessons Learnt from a Metrics Program at a CMMI Level 3 Company.* QuASoC, Bangkok, Thailand, December 2, 2013.

M. Vianden: *Theorie und Anwendung unserer Enterprise-Measurement-Infrastruktur*, Tutorial, MetriKon 2013, Kaiserslautern, November 15, 2013.

M. Vianden: *Enterprise-Measurement-Infrastructure – An Overview*, OODACH 2014, Hamburg, September 19th, 2014.

A. Ganser: *Proactive Quality Guidance for Model Evolution in Model Libraries.* MoDELS 2013, Miami, Florida, September 30, 2013.

A. Ganser: *Enabling Model Recommenders for Command-Enabled Editors.* MoDELS MDEBE 2013, Miami, Florida, September 29, 2013.

M. Vianden: *Enterprise-Measurement-Infrastructure – An Overview*, Kisters AG, Aachen, October 21, 2014.

Publications

N. Koprowski, M. Firdaus Harun, Horst Lichter (2014): *Release Readiness Measurement: A Comparison of Best Practices*. In 8th Malaysian Conference on Software Engineering, MySEC 2014, 23-24 September, Langkawi, Malaysia.

C. Plewnia, A. Dyck, H. Lichter (2014): *On the Influence of Release Engineering on Software Reputation*. In 2nd International Workshop on Release Engineering, April 11, 2014, Mountain View, CA, USA.

A. Dragomir, F. Harun, H. Lichter (2014): *An Architecture for Toolbox-based Software Architecture Reconstruction Solutions*. In Softwaretechnik-Trends, GI, Bonn, Vol. 34 (2), 36-37.

A. Dragomir, F. Harun, H. Lichter (2014): *On Bridging the Gap between Practice and Vision for Software Architecture Reconstruction and Evolution - A Tool Perspective*. In SAEroCon, First Workshop on Software Architecture Erosion and Architectural Consistency, co-located with the Working IEEE/IFIP Conference on Software Architecture (WICSA) 2014, Sydney, Australia, April 8, 2014, ACM, New York, NY, USA, 10:1–10:4.

A. Dragomir, H. Lichter, T. Budau (2014): *Systematic Architectural Decision Management – A process-oriented Approach*. In WICSA 2014, Proceedings of Working IEEE/IFIP Conference on Software Architecture, Sydney, Australia, April 7-11, 2014, IEEE, 291-299.

A. Dyck, A. Ganser, H. Lichter (2014): *On Designing Recommenders for Graphical Domain Modeling Environments*. In Modelsward 2014, Proceedings of the 2nd International Conference on Model-Driven Engineering and Software Development, Lisbon, Portugal, 7.-9. January 2014, SCITEPRESS – Science and Technology Publications, 291-299.

A. Dyck, A. Ganser, H. Lichter (2014): *A Framework for Model Recommenders - Requirements, Architecture and Tool Support*. In Modelsward 2014, Proceedings of the 2nd International Conference on Model-Driven Engineering and Software Development, Lisbon, Portugal, 7.-9. January 2014, SCITEPRESS – Science and Technology Publications, 282-290.

S. Jeners, R. V. O'Connor, P. Clarke, H. Lichter, M. Lepmets, L. Buglione (2013): *Harnessing Software Development Contexts to Inform Software Process Selection Decisions*. In Software Quality Professional, American Society for Quality, Milwaukee, WI 53203, USA, Vol. 16 (1), 35-36.

A. Dragomir, H. Lichter (2013): *Run-time Monitoring and Real-time Visualization of Software Architectures*. In 20th Asia-Pacific Software Engineering Conference (APSEC 2013), Pullman Bangkok King Power Hotel, Bangkok, Thailand, December 2-5, 2013, Vol. 1, 396-403.

M. Vianden, H. Lichter, S. Jeners, K. Neumann (2013): *History and Lessons Learnt from a Metrics Program at a CMMI Level 3 Company*. In International Workshop on Quantitative Approaches to Software Quality (QuASoC), in conjunction with 20th Asia-Pacific Software Engineering Conference (APSEC 2013), Pullman Bangkok King Power Hotel, Bangkok, Thailand, December 2, 2013, Vol. 2, 73-78.

A. Roth, A. Ganser, H. Lichter, B. Rumpe (2013): *Proactive Quality Guidance for Model Evolution in Model Libraries*. In Models and Evolution, Proceedings of the Workshop on Models and Evolution, co-located with ACM/IEEE 16th International Conference on Model Driven Engineering Languages and Systems (MoDELS 2013), September 30, 2013, Miami, Florida, CEUR, 50-59.

A. Dyck, A. Ganser, H. Lichter (2013): *Enabling Model Recommenders for Command-Enabled Editors*. In MoDELS MDEBE – International Workshop on Model-driven Engineering By Example 2013 co-located with ACM/IEEE 16th International Conference on Model Driven Engineering Languages and Systems (MoDELS 2013), September 29, 2013, Miami, Florida, CEUR, 12-21.

J. Ludewig, H. Lichter (2013): *Software Engineering – Grundlagen, Menschen, Prozesse, Techniken,* dpunkt.verlag, Heidelberg.