

Assoc. Prof. Dr. Harald Störrle Danmarks Tekniske Universitet (DTU) COMPUTE Software Group

Requirements Engineering Tools Academic and Industrial Perspectives

Lund University, 21.4.2015

COMPUTE Software Group

- Many researchers create tools that have tremendous value and potential way beyond their initial setting.
 - Spreading and maintaining these tools is difficult and time consuming.
 - The CSG aims at providing services to all of DTU Compute to help them improve their tools and make them available to the world.
 - See csg.compute.dtu.dk for more.



Our doal is to reach out to science and industry to promote the use of the tools and

RE – a relevant topic?

Let's have a quick look at Google Trends for a first impression.



Requirements are a key factor



More (reliable) sources

- Requirements Engineering (or the lack thereof) is still the single most important reason for poor software quality
 - Lutz [1993] showed that 60% of errors in critical systems were the results of requirements errors.
 - Espiti [1996] conducted a survey of European companies and found that more than 60% of them considered requirements engineering problems as very significant.
 - Hall et al. [2002] carried out a case study of 12 companies at different CMM levels. They discovered that, out of a total of 268 development problems cited, almost 50% (128) were requirements problems."
- "Nonetheless, requirements engineering is still performed in an intuitive and chaotic way."

Sommerville, I., Ransom, J.: An Empirical Study of Industrial Requirements Engineering Process Assessment and Improvement. ACM Transactions on Software Engineering and Methodology 14(1), 85–117 (2005)

RE in the age of Agile

- Classic RE approaches are often associated to sequential development processes ("waterfall"), and sometimes frowned upon proponents of lightweight ("agile") methods.
- It is important to acknowledge, however, that the majority of concerns and techniques re-popularized in "agile" contexts are indeed concerned with requirements.
 - Test first
 - User stories
 - Customer on-site
 - Incremental releases
 - Backlog/grooming
 - Kanban-stages/buckets





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Industrial Perspective on RE Tools

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Tool Usage in RE



"I hate to be a cynic, but there are hardly any worthwhile tools. The overhead in learning to use them is too great for the payoff."

Luisa Mich, Mariangela Franch, Pierluigi Novi Inverardi: **Market research for requirements analysis using linguistic tools** Requirements Eng (2004) 9: 40–56, Springer

Tools

Do you use any tool supporting requirements analysis and	How many employees and consultants are there in your company?								
top-level design?	1–5	6–20	21-50	51-100	More than 100				
Yes No	16% 84%	18% 82%	33% 67%	33% 67%	51% 49%				



Luisa Mich, Mariangela Franch, Pierluigi Novi Inverardi: **Market research for requirements analysis using linguistic tools** Requirements Eng (2004) 9: 40–56, Springer

State of RE in Practice is Poor

"There is a lot of information available on solid RE practices but anecdotal evidence still indicates poor practices."

U. Nikula, J. Sajaniemi, H. Kälviäinen: A State-of-the-Practice Survey on Requirements Engineering in Smalland Medium-Sized Enterprises. Telecom Business Research Center Lappeenranta, Research Report 1, 2000



Improving RE Process Maturity is easy

- Here are some examples of the practices by maturity level defined by the REAIMS RE process maturity framework.
- Basic
 - 3.1 Define a standard document structure
 - 4.3 Identify and consult system stakeholders
 - 6.2 Use language simply, consistently and concisely
 - 8.2 Organize formal requirements inspections
- Intermediate
 - 4.10 Prototype poorly understood requirements
 - 9.6 Define change management policies
- Advanced
 - 10.6 Specify systems using formal specifications
 - 10.8 Collect incident experience

Prose for Requirements Engineering

 Alternatives exist, that can (mostly) replace NL, as various case studies have demonstrated.

Language Type Usage



- Natural Language Processing (NLP) and Information Retrieval (IR) technology can do amazing things:
 - generating sequence diagrams from natural language use case descriptions;
 - generating class diagrams from NL requirements specifications.
- However, if the performance is less than perfect, using tools is often worse than not using them.

Concurrent Requirements Stores

 In typical industrial settings, five to eight different media are used to store requirements.



Stefan Winkler: Information Flow Between Requirement Artifacts. Results of an Empirical Study P. Sawyer, B. Paech, and P. Heymans (Eds.): REFSQ 2007, LNCS 4542, pp. 232–246, Springer, 2007

Requirements Flow

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Stefan Winkler: **Information Flow Between Requirement Artifacts. Results of an Empirical Study** P. Sawyer, B. Paech, and P. Heymans (Eds.): REFSQ 2007, LNCS 4542, pp. 232–246, Springer, 2007

Industrial Perspective

Plain text prevails as the major RE "formalism".

Existing tools are expensive and poor.

- They are used out of despair or regulatory torture.
- Problems include ease of use, cost, and lack og (obvious) benefit.

Many long standing problems are still open.

- Transition to design phase, tracing
- Integration in "lightweight" approaches
- Team collaboration, version control
- Effort/Cost estimation
- Requirements validation

• Academia is sitting in an ivory tower.





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Academic Perspective on RE Tools

Should Academia Create Tools?

Should we as scientists really create tools?

- After all, we're academics, and our job is research and teaching, and creating products is really the job of industry, isn't it?
- Also, we don't have the resources to create tools with the degree of polishing required.
- I believe that there are just three ways we as academics can impact the industrial practice of software development.
 - Educate students better but we're doing that already as best as we can.
 - Conduct targeted research through industrial co-operations.
 - Create and publish tools that address practical needs.

• Actually, tools are instrumental to SE research.

- Conceptual research without validation is not any longer *de rigeur*.
- Tools are essential for running case studies.
- Tools that implement novel concepts are embodied hypotheses.

Academia Perspective on RE Tools

- Academia cannot hope to create "a better DOORS".
 - We should not attempt to, either—we should leap-jump industry.

• There are many clever ideas & algorithms. Here are just few examples:

- Natural Language processing (checking of style/grammar, document outline)
- Scenario enactment for validation
- Effort estimation based on Function Points
- Model Version Control to support group collaboration
- Trace-preserving transition to design
- These contributions are used neither in industry nor commercial tools.
- In order to achieve any kind of adoption, academic ideas will have to satisfy three conditions.
 - They must be nicely wrapped people are spoilt rotten by visual bling.
 - They must provide overkill benefit acceptance must be a no-brainer.
 - They must address bread and butter features no matter how boooring.
 - Advanced features must be fully automatic no training/knowledge needed.

Enactment

- Scenarios for Use Cases and Persona descriptions can validated through enactment.
 - With a formal scenario structure, text to speech processing can create an interesting effect.
 - Enactment can be done without tool support, as a "design game".



Harald Störrle RE State of the Art

Function Point Estimation

Function Point Analysis (FPA) allows cost estimation of use cases.

- FPA is not routinely used in practice, despite solid evidence in their favor.
- There is very little literature linking them to RE.
- The topic is usually not taught in academic courses, and the tools don't support it.

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Design Inspections

Inspections are a rather old QA technique that is particularly suitable for early phases.

- There is solid evidence to support the cost-effectiveness of code inspections.
- There is very little literature on or guidelines for the application of inspections to requirements, or analysis-level models.
- The topic is usually not taught in academic courses, and the tools don't support it.

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Visual Editors

- Many people like to complement their textual requirements by some visualization, with the aim to
 - provide better overview (over a set of goals and their relationships, say);
 - illustrate their otherwise dreary and boring texts; or
 - provide an alternative view to better explain what they mean.
- Observe that these drawings have a different status than both UML diagrams and fully informal doodles.



Group Collaboration

- Requirements specification is typically a team activity
 - Classical problems of distribution/replication, locking/version control arise.

Unfortunately, existing tools do not fit the case of RE very well.

- Collaborative editing in Word, Google Docs, CMS, and Wikis support proselike textual data spread out over a number of files.
- Collaborative programming projects use VCS's like CVS, Continuous, SVN, GIT, etc. for many small text files in a fairly static overall structure.
- In collaborative modeling, a single large DB (e.g., XMI-file) is created that captures a graph-like structure.

Requirements have unique characteristics, though:

- More than one person, but not that many either.
- Requirements exhibit characteristics of text and graphs.
- Conventional VC methods for code are not suitable

Collaboration Support in RED

The collaboration support in RED is made up of two feature sets.

- On the Client, RED offers multi-file projects with diff/merge by files/element.
- On the Server, RED offers a visual version history that focuses on major development activities rather than (small) individual commits of data files.

Cont	ext & C	hallenges		Realization & Examples						
Case	Files	Data	Users	Diff	Merge	Lock	Example			
Coding	10 ^k	Text	10 ^k	diff	patch	File	CVS, SVN, GIT, Continuous,			
Editing	1 (k?)	Text + Mark-Up	1k	Highlighting	?	File	GoogleDocs, Wiki, Word,			
Modeling	1	Graph-like	1k	Highlighting, Delta	global	Eleme nt	MagicDraw, VP, Rational Rose			
Requirements Engineering	1k	=Editing		per File	?	File	DOORS			
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	1k	Editing + Modeling	1	Per File	per File/ Element	File	RED			

where k is a small constant (maybe around 3...8)

Trace-respecting A/D-Transition

- Translating a (big) textual requirements specification into a design model is difficult.
 - The translation as such is difficult and requires guidance and expertise.
 - There are bound to be many decisions, some are genuine design decisions, others result from weaknesses of the specification (ambiguity, omissions, ...)
 - Domain experts and clients typically do not understand the design level language (e.g., UML), so they cannot validate the translation outcome.
 - Trace links must be established manually.

Idea: Translating individual requirement is much easier.

- Each requirement is translated into a small model fragment (lenient syntax).
- The translation as such uncovers errors by change-of-perspective.
- The resulting fragments are then woven automatically.
- Weaving diagnostics and manual inspection of the result uncover errors.
- Traces are generated automatically.

Individual Translation

Requirement MLC9a

Guest readers may inspect suggestions in the wishlist system.



Requirement MLC9b

Guest readers may inspect suggestions.



Requirement MLC9c Book suggestions may be inspected.

Fragment MLC9c-UC

inspect suggestion

Weaving Model Fragments

 Here is an excerpt from the LMS requirements specification, and how the features described may be captured as models.



Weaving Fragments Establishes Traces

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FORWARD TRACING







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The Requirements Editor RED

The Requirements Editor RED

RED is a stand-alone tool for requirements engineering

- RED is based on Eclipse RCP, and was developed mostly by students as their final thesis project (MSc, some BSc) plus some paid hands.
- Development has started in September 2011, a major re-engineering took place in 2013. Currently (04/15), we are preparing version 3.0.

RED is intended as a tool to support teaching

- We aspire to maximize conceptual clarity and coherence, while offering a comprehensive and practical toolbox with some cutting-edge features.
- The tool aspires to be conceptually consistent, in itself (UI, meta-model) and with regards to the course material (slides, case studies, samples, guidelines).

Development goes on, a first public release is scheduled for 09/15.

- RED now consists of over 1,860/650 classes (hand-written/generated) and over 114,000 Lines of Code (Java).
- The last major components (Collaboration Server) are close to completion.
- The main focus has shifted to quality rather than adding new features.
- One of the next steps is Bootstrapping, i.e. documenting RED in RED.

RED Features

Features in RED 3.0 (3/2015)

- Goals, stakeholders, visions
- Textual & multimedia requirements
- Informal requirements, assumptions
- Use cases, test cases
- External document integration
- Personas, storyboards
- Scenarios, enactment, Text2Speech
- Use case points effort estimation
- Cost/benefit annotation & analysis
- Full cross-referencing glossary
- UML Model Fragments
- Browsing, searching, and sorting
- Reporting, exporting, importing
- Multi-file projects, Merging
- Inspection support, locking
- Traceability, manual change history
- Visual modeling (Use Cases, Goals)
- Model fragments weaving

3.1 (9/2015)

- Online collaboration server
- Dynamic web service extensions
- More visual modeling (all of UML)
- Dynamic view filtering

3.2 (3/2016)

- Quantitative risk management
- Features, Issues, Bugs
- Releases, release planning
- AHP prioritization

Future Work (Options)

- More file formats (ReqIF, XLSX,...)
- CNL/Pattern checker
- semi-automatic text-to-model translation
- formal methods for checking
- Mobile elicitation device

Release Plan



https://hsto@bitbucket.org/hsto/red.git

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Conclusion



Academic Tool Development

Developing practical tools is possible.

Developing practical tools is not easy.

- Considerable effort and time for polishing is needed it's a long shot.
- But IT is a people industry and we have the most valuable resource.

Developing practical tools is useful.

Such a tool can serve as a proof-of-concept platform for individual ideas, it can be the basis for case studies, provide students with a realistic project environment...

Creating large scale software is the topic of Software Engineering.

- First we should get it right ourselves. Then, we should help scientists outside of SE to get their large scale developments right.
- That is the aspiration of the COMPUTE Software Group.
- Therefore, in SE, developing tools should be accepted as a scientific contribution per se – not just for proof-of-concept.

Upcoming Elections for ACM Europe Council

The ACM Europe Council aims to increase the level and visibility of ACM activities across Europe, e.g.

- fostering the visibility and relevance of ACM in Europe, and
- encouraging greater participation of Europeans in all

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