



Requirements Evolution of an Avionics Safety-Critical Industrial Case Study Predictive Changes Risk/Cost Analyses

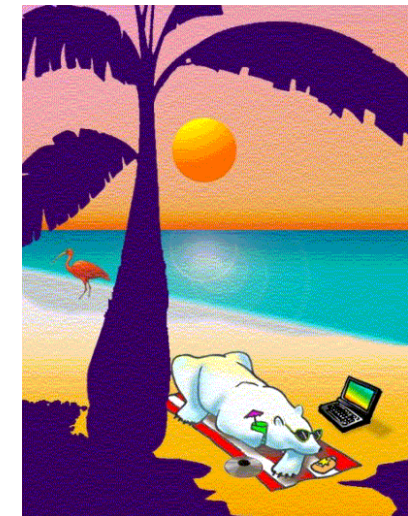
Massimo Felici, Stuart Anderson

Abstract. Recent research in requirements engineering has identified two strong drivers of requirements evolution:

- environmental turbulence mediated by system stakeholders: designers, software specialists, engineers, end-users, project managers
- the process of requirements definition that accompanies the design process.

Moreover, practical experience shows that requirements need to be represented from different viewpoints and with different formalisms/approaches in order to be comprehensible by different system stakeholders. Without this, further turbulence arises due to disagreements between stakeholders. We have started to investigate requirements evolution in practice through an industrial case study.

Results suggest new predictive changes risk/cost analyses.



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Why Requirements?

- The recovery activity is more cost-effective during the specification of the requirements than during the other phases of the software life cycle
- Requirements represent the trade-off among the viewpoints of the stakeholders (e.g., software engineers, project managers, end-users, etc.) involved in the development process
- Errors into requirements fall down into all the other deliverables of a project (e.g., design documents, program code, etc.)

Why Requirements Evolution?

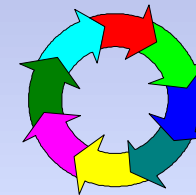
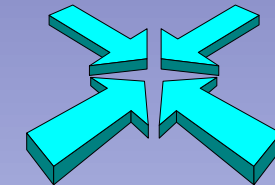
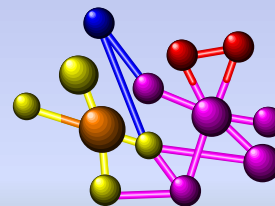
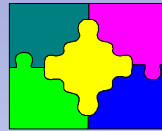
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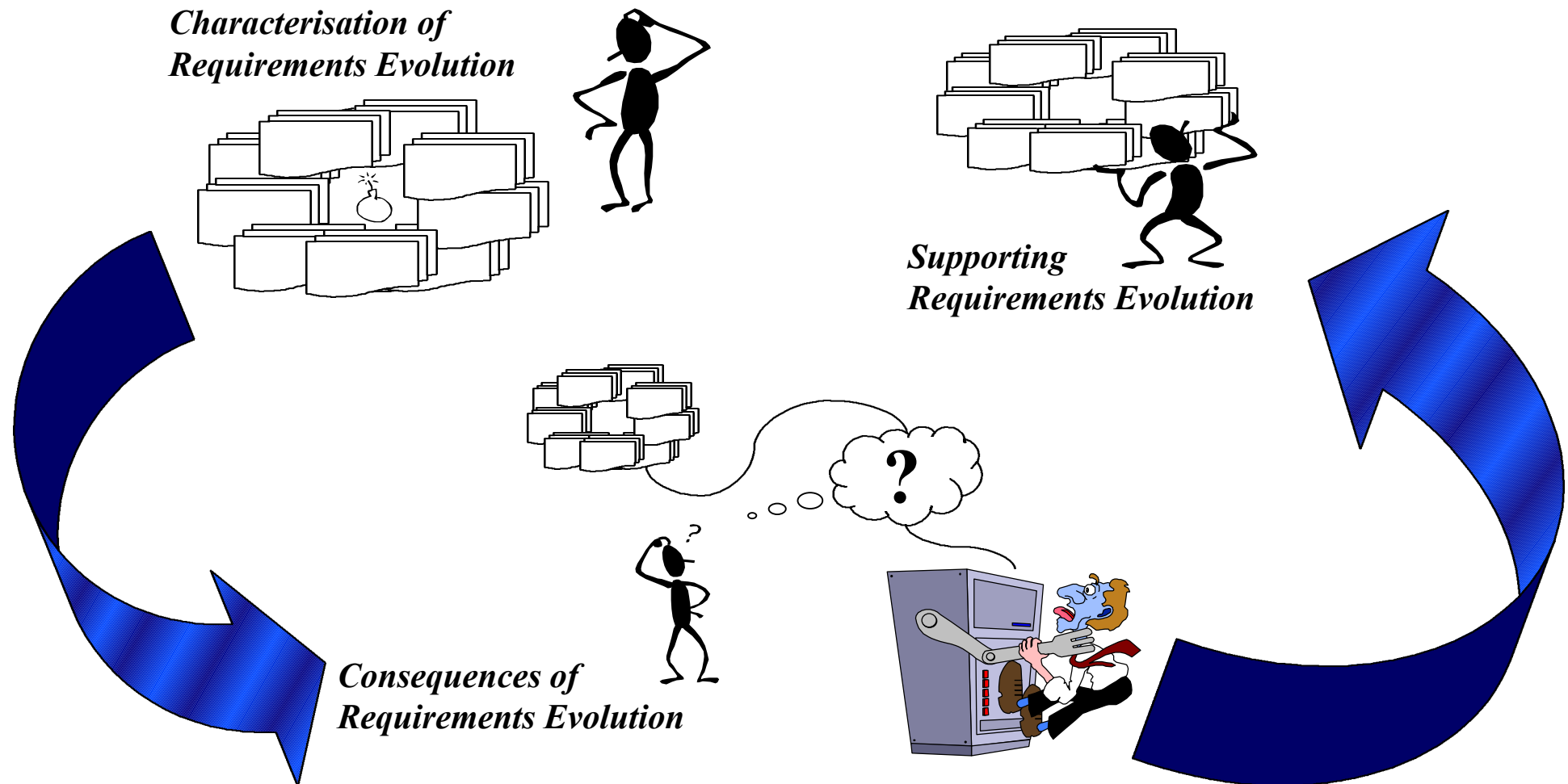
Past Experiences in Requirements Engineering

Requirements need to:

- integrate different viewpoints corresponding to different stakeholders
- be represented using different models (formal and non-formal)
- evolve to accommodate environmental turbulence
- be structured



Understanding Requirements Evolution

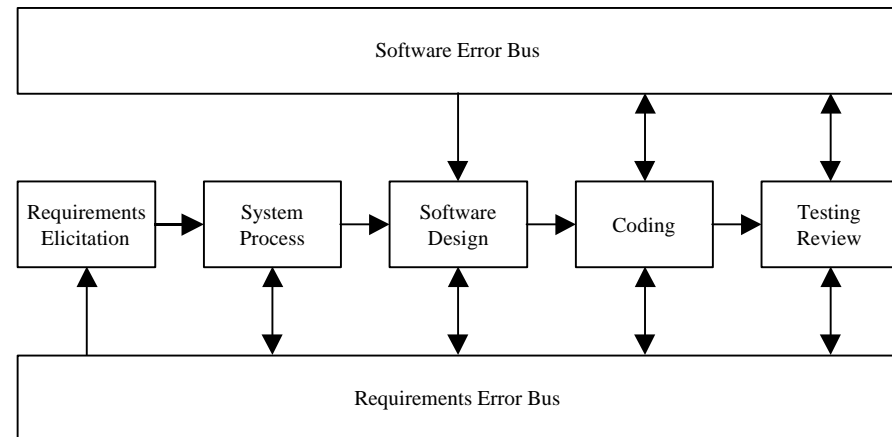


An Avionics Safety-Critical Industrial Case Study

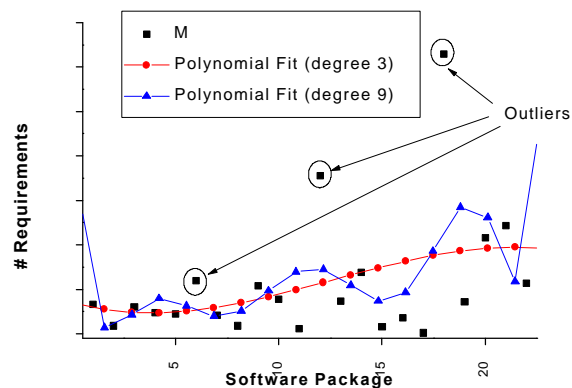
General Information

- Software for Electronic Engine Control
- Business Stakeholders: Customers who order the software for specific hardware with stringent requirements; Suppliers who produce the software
- The software is certified according to avionics safety-critical standards
- The software consists of modules verified by formal methods

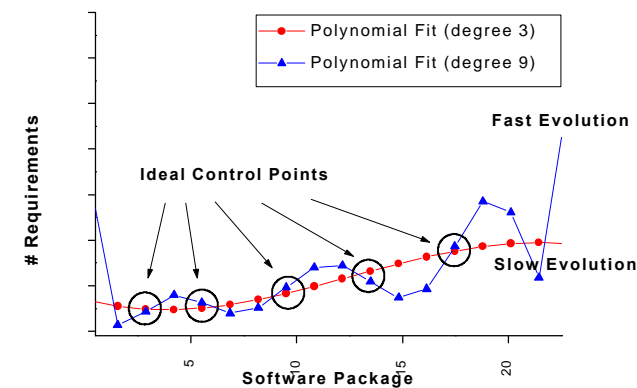
The Safety-Critical Software Life Cycle



Requirements Evolution



Fast Evolution, Slow Evolution and Control Points of the Requirements Process



Predictive Changes Risk/Cost Analyses

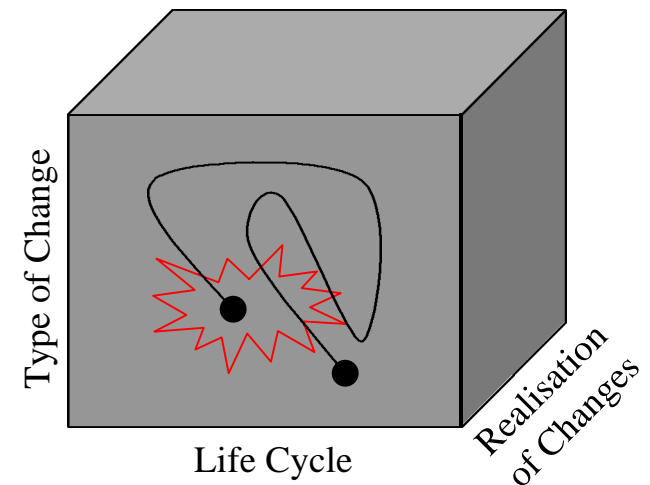
Type of Changes

Changes fall down into three categories

| Type of Change | Change | Description |
|-----------------|--|--|
| General | add, delete and modification of requirements | Requirements are modified due to the specification process maturity and knowledge |
| | explanation | The paragraphs that refer to a specific requirement are changed for clarity |
| | Traceability | The traces to other deliverables are changed |
| Domain Specific | non-compliance | A requirement that is not applicable for a new software package. This is the case when the requirements specification is based on that one of a previous project |
| | partial compliance | A requirement that is not applicable for a new software package. This is the case when the requirements specification is based on that one of a previous project |
| Product Line | hardware modification | Several changes are due to hardware modifications. This type of changes applies usually to hardware dependent software requirements |
| | range modification | The range of the variables within the scope of a specific requirements is modified |
| | add, delete and rename of parameters/variables | The variables/parameters to which a specific requirement refers can change |

A point within the 3D space represents the risk/cost of changing requirements. Requirements engineers have to plan effectively, safely and costly a path within the 3D space. The 3D space could be the base for a “black-box analysis” that joined with requirements’ attributes and traceability information could be a base for a “white-box analysis”. Both analyses could provide useful tools for predicting the risk/cost of changing requirements.

A Three-Dimensional Space



Requirements’ Attributes

- Parameters/Variables
- Function/Task
- Statement
- Track
- Dependencies

