GoedelWorks and The ASIL project

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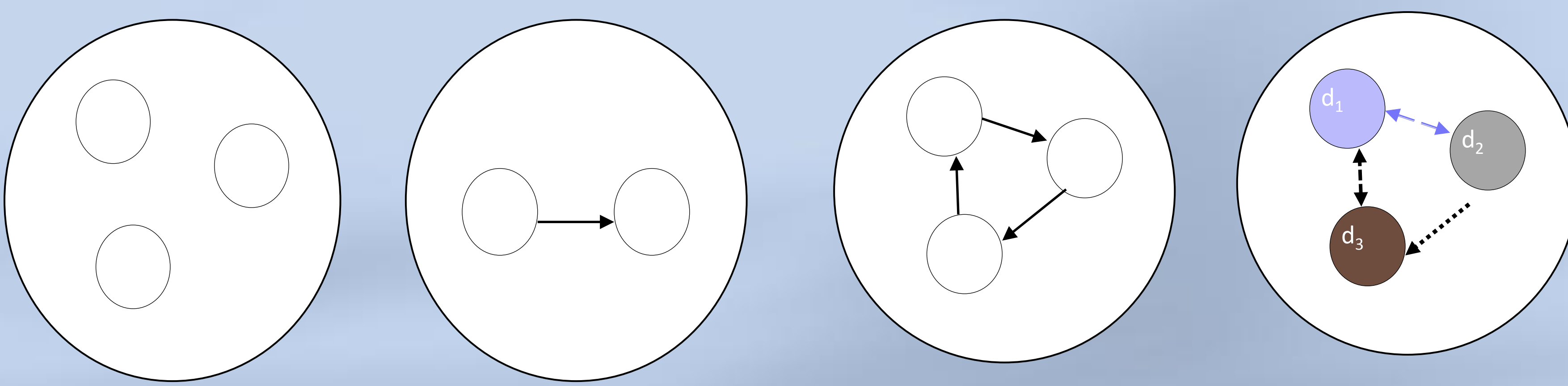
Some history

- R&D project of Open License Society:
  - Metamodel for systems engineering: “systems grammar”
  - OpenSpecs and OpenCookBook prototype web portal
- **EVOLVE** ITEA project
  - **Evol**utionary **V**alidation, **V**erification and C**e**rtification
- **ASIL**: Flanders Drive project on developing a common safety engineering methodology for automotive and related domains
- Currently commercialised and redeveloped by Altreonic under **GoedelWorks** by Altreonic

Refinement approach

- Refinement by adding structure and properties
- Avoids overlapping in concepts

Domain | Metamodel | Model | Instance



Entities | Entities and Interactions | Structure & Architecture | System / Process

Meta-levels for different users and different application domains

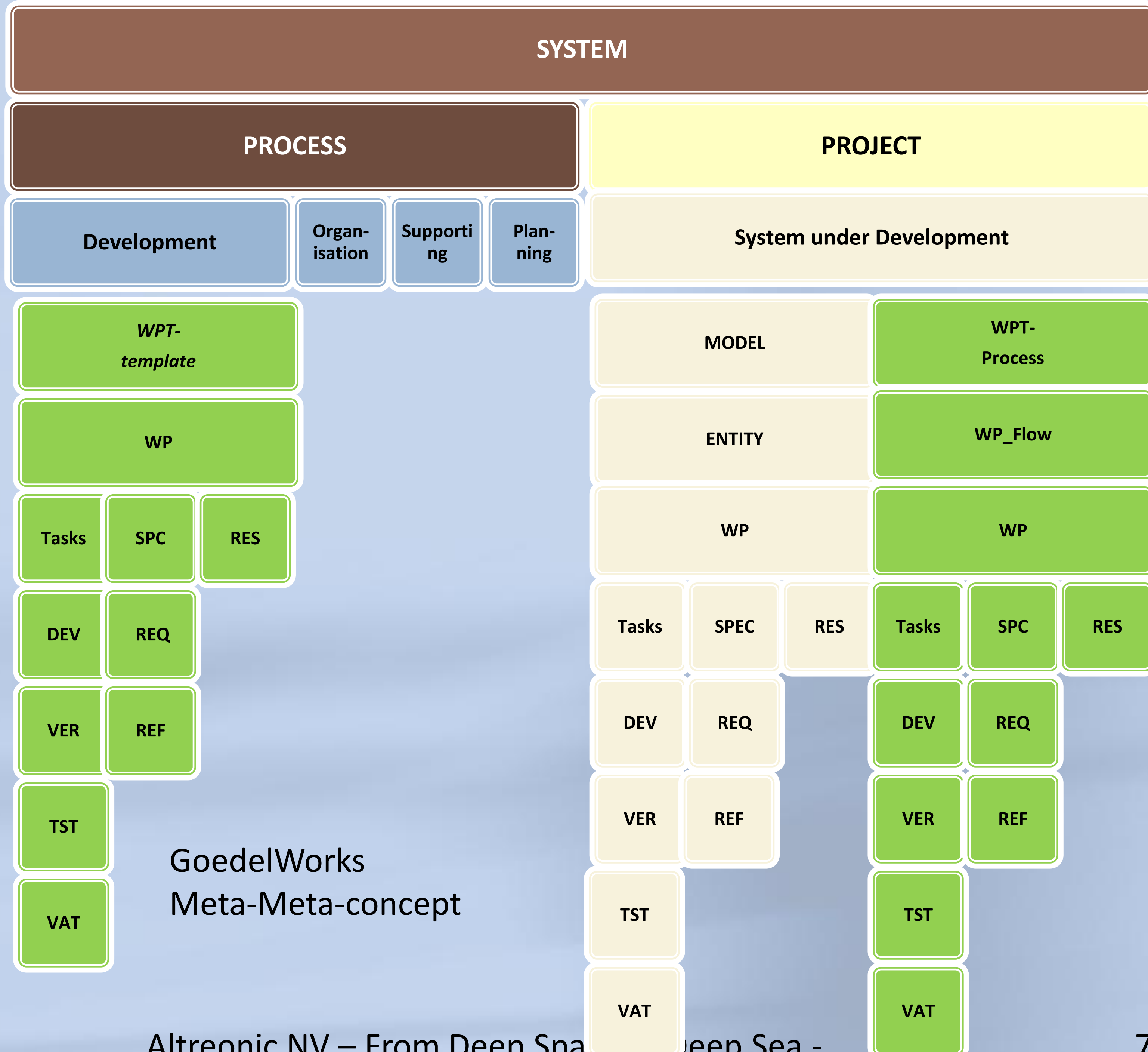
User levels	Abstract meta-levels	RTOS domain
M4: Mathematician	M4: element (of set) meta-meta-type	M4: Kernel and libraries
M3: Expert	M3: Metatypes declarations (inheritance of the M4 element meta-meta-type)	M3: Virtual machine executing M2 methods for M1 data
M2: Engineer	M2: types declarations (inheritance of M3 meta-types with domain specific attributes)	M2: domain specific declarations (types, grammar, methods)
M1: User	M1: Instances of M2 types with concrete values of attributes	M1: Data

The different views on a system

- View 1:
  - System = Processes + Architecture
  - or: the ”right” System = “how” + “what”
- View 2:
  - A process is a meta-system
  - Has to be developed as well
- In practice different views correspond to complementary domains:
  - Process, Engineering, Modeling, Simulation, Testing, Software, Hardware, Safety, …

Systems engineering with just 16 meta-concepts

System	Sub-systems
Project	Sub-Project
Process	Sub-Process
Reference	
Requirement	Sub-Requirement
Specification	Sub-Specification
Resource	
Work Package	Development, Verification, Test, Validation Task
Work Package Flow	Work Package
Work Product	Process type (“evidence”) or development (“Model”)
Model	Sub-Models
Entity	Sub-Entities
Change Request	
Issue	



GoedelWorks
Meta-Meta-concept

Relationships

- Dependency links:
  - E.g. a SPC depends on REQ (n)
  - etc.
- Precedence links:
  - A WP preceeds a WPT (n)
  - etc.
- Structural links:
  - A WP is composed of Tasks (n)
  - A Model is composed of Entities (n)
  - etc.

State Transitions in a Process

- During the life-time of a Project/Process entities go through states:
  - Defined => In Work => Frozen For Approval => Approved
- Dependency and structural relationships create a partial order for Approval
- **REF=>REQ=>SPC // RES // Tasks =>WP=>WPT (MOD)**
- A Project is a collection of Processes producing Work Products. Not one V-model but 100’s.
- Overall Process follows from respecting states
- WorkProducts morphe (Resource at input is always result of previous Project)

Some differences

- Explicit difference between Requirements and Specifications
- Distinction Process (how) and Project (what)
- Verification = verifying the work done
- Testing = verifying the system meets specifications
- Validation = verifying it meets requirements (includes integration)
- Process/Project is not seen as flow but as a cellection of steps producing WorkProducts
- System = Implementation model
- Safety case is seen as Specification-Fault case
- Domain agnostic

Trustworthiness as goal

Trustworthy system

Safety	Security	Usability	Privacy
no physical fault can cause harm	no injected fault can cause harm	no interface fault can cause harm	no personal data loss can cause harm

Specification has subtypes:

Normal Case, Test Case, Fault Case

Safety and Security case are subtypes of Fault Case

Application and validation using a Safety Engineering process

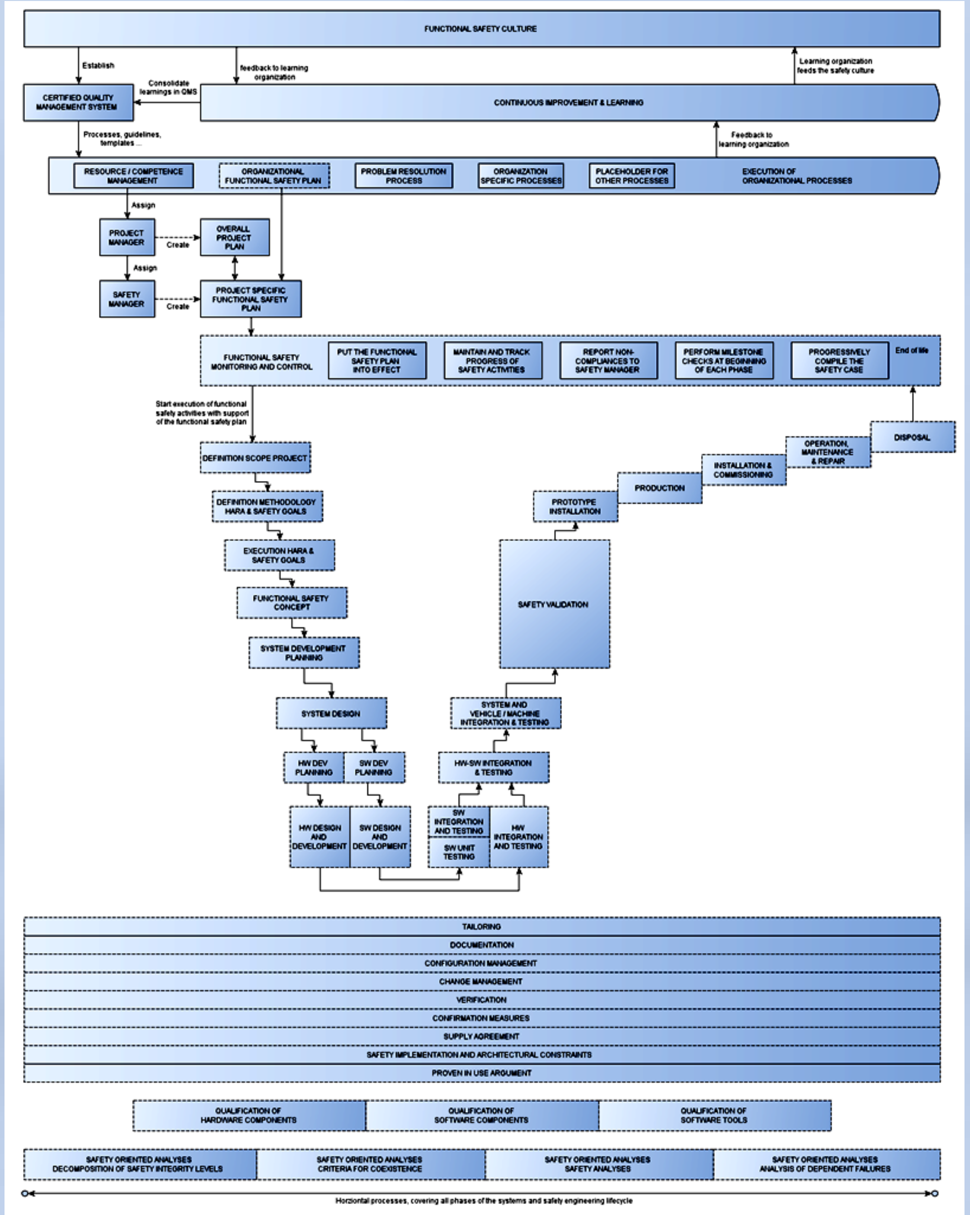
- Input: ASIL project of Flanders Drive
  - **A**utomotive **S**afety **I**ntegrity **L**evel
- Goal: develop common safety engineering process based on existing standards:
  - Automotive: off-highway, on-highway
  - Machinery
- IEC 61508, IEC 62061, ISO DIS 26262, ISO 13849, ISO DIS 25119 and ISO 15998
- Partners:
  - Altreonic, DANA, EIA, Flanders Drive, Punch Powertrain, Triphase, TüV Nord

Process followed

- Acquiring general understanding of Safety and Systems Engineering standards.
- Development of ASIL process flow:
  - Dissecting standards in semi-atomic statements
  - Tagging according to activity domain
- Development of ASIL V-model with 3 Process domains:
  - Organisational Processes ("safety culture")
  - Supporting Processes
  - Safety and Engineering Development Processes.
- Completion
  - Identification of Work Products and RACI Roles
  - Development of templates for Work Products (.doc or .xls)
  - Development of Guidelines (e.g. HARA)
  - Development of Glossary

ASIL V-model

- Organisational
- Safety and Engineering/ Development
- Supporting



ASIL Results

- Effort: approx. 21000 personhours (over 3 years.)
- Semi-atomic process requirements extracted: 3800
- Work products defined: 98 => templates
- Types of roles identified: 17 => HR responsibility
- Guidelines developed: 34 => templates
- ASIL process flow has 355 steps
  - Organisational processes identified:19
  - Supporting processes identified: 75
  - Safety and Engineering processes identified: 261
- Work is not finished! (validation using use cases + organisation specific mapping) + iterative!

ASIL import (1)

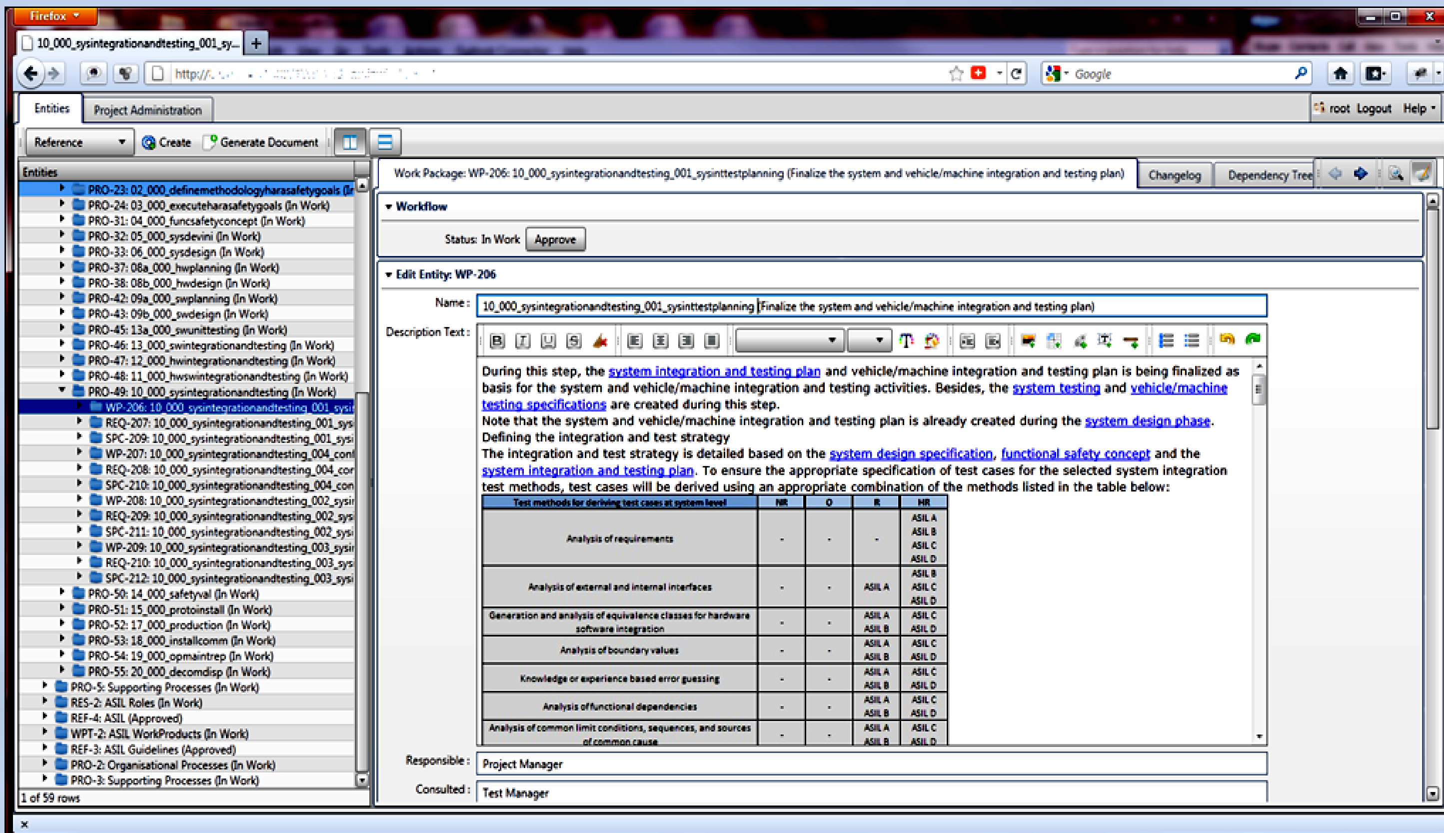
GoedelWorks	ASIL
Process	Process
Flow	Flow
Work Package	Step with descriptive text
Tasks (DEV, VET, TST, VAT)	Not defined
Project	Not defined
Model/Entity	Not defined
Reference	Standards' requirements attached to Step
Requirement	Not defined, Step description
Specification	Not defined
Resource	Roles, Work Product template, Guidelines
Work Product	Work Product (input and output of Step)
Change Request	Not defined, but Change Management Step
Issue	Not defined, but Change Management Step
State	Not defined
Relationships	Net defined, except as WPT input and Roles

ASIL import (2)

- V-model respected by following order:
  - Steps become Work Packages
  - Dependencies and structural relationships inserted but left empty
  - State: most often “In Work” upon creation.
- Benefits from import:
  - All Process (and Project) Entities user-editable
  - Project entities and Process entities can be linked
  - Organisation specific instance of Processes can be created and new processes added
  - Dependency analysis and reporting

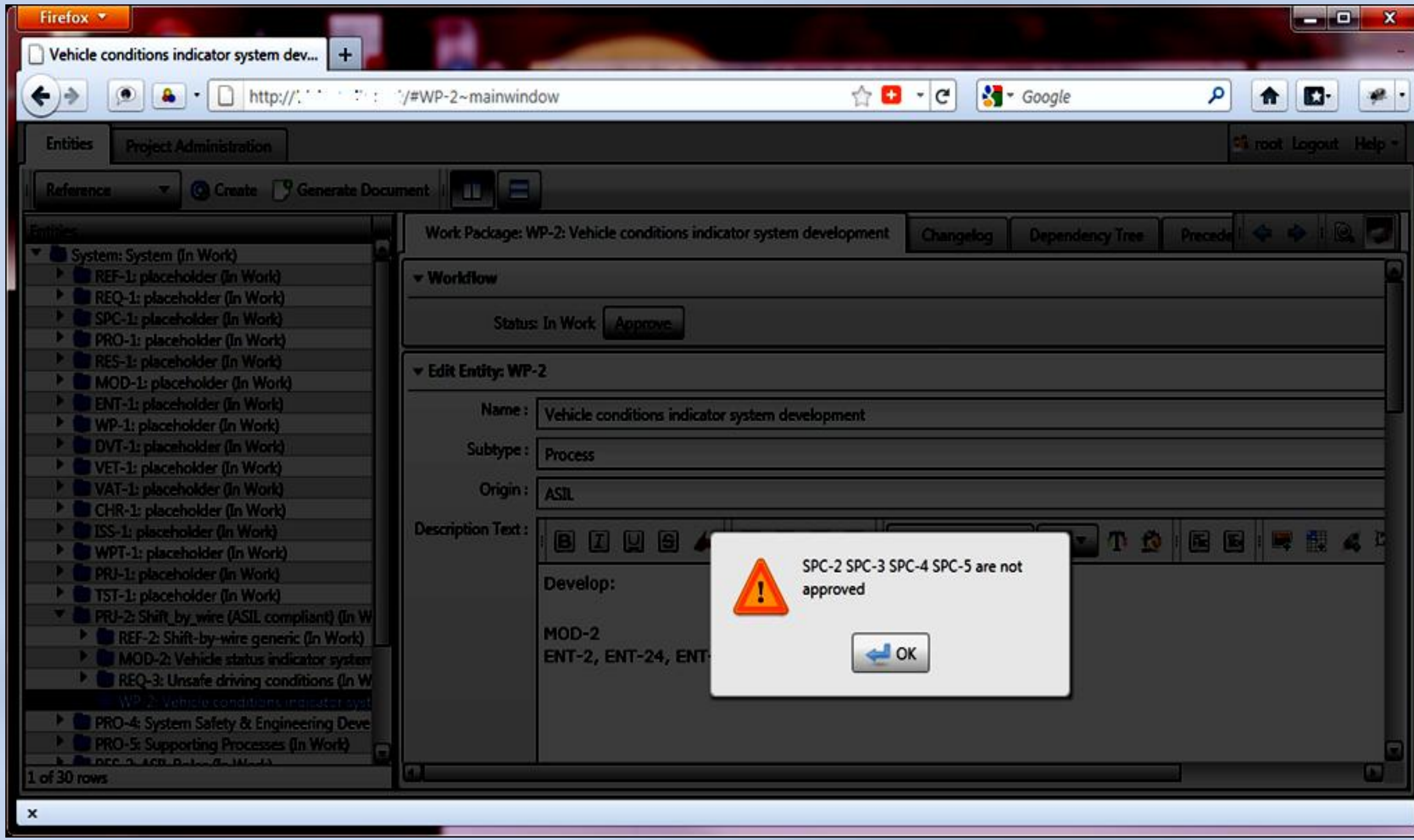
Example project (1)

- ASI imported reference



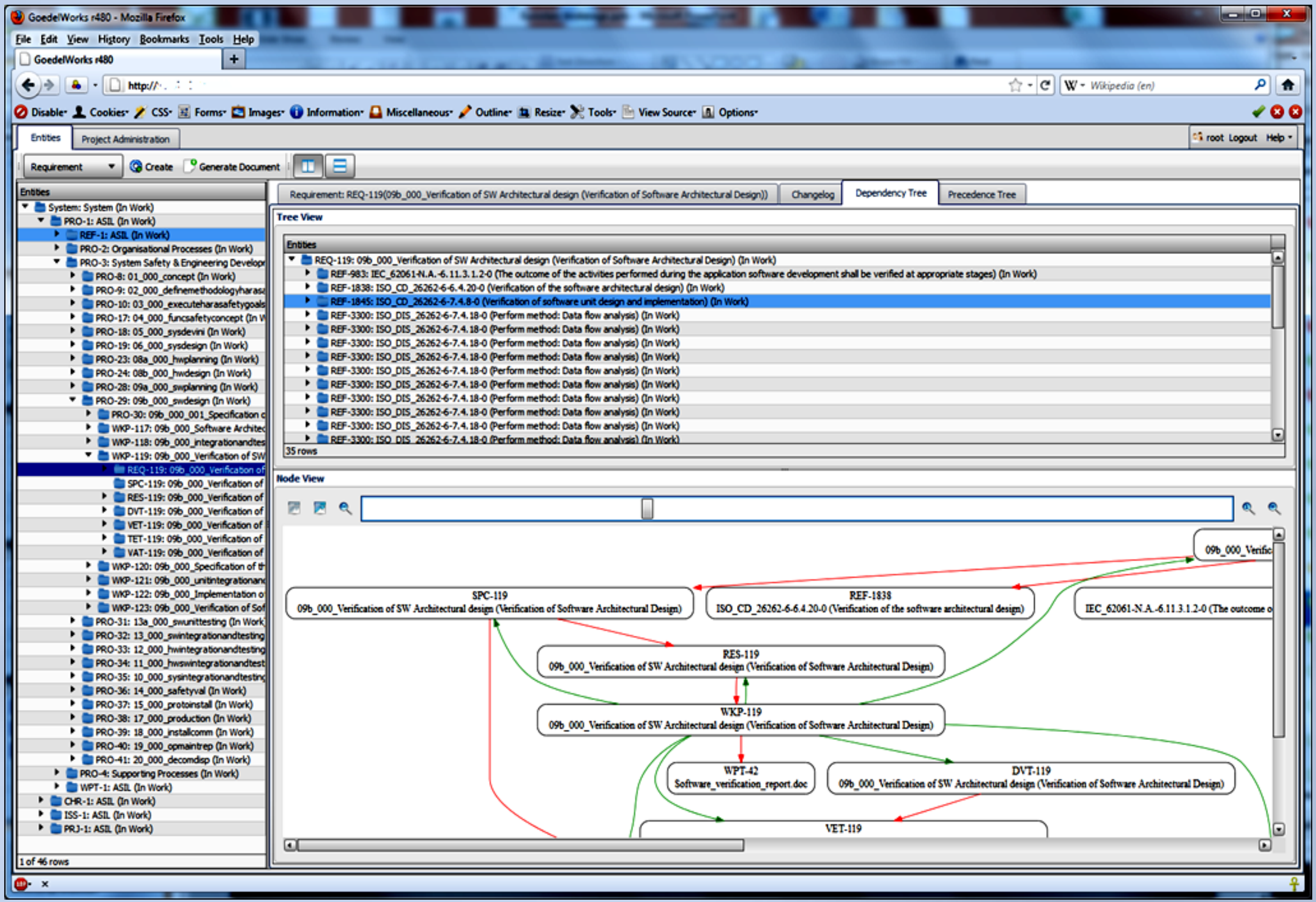
Example project (2)

- Example of state verification (Approval)



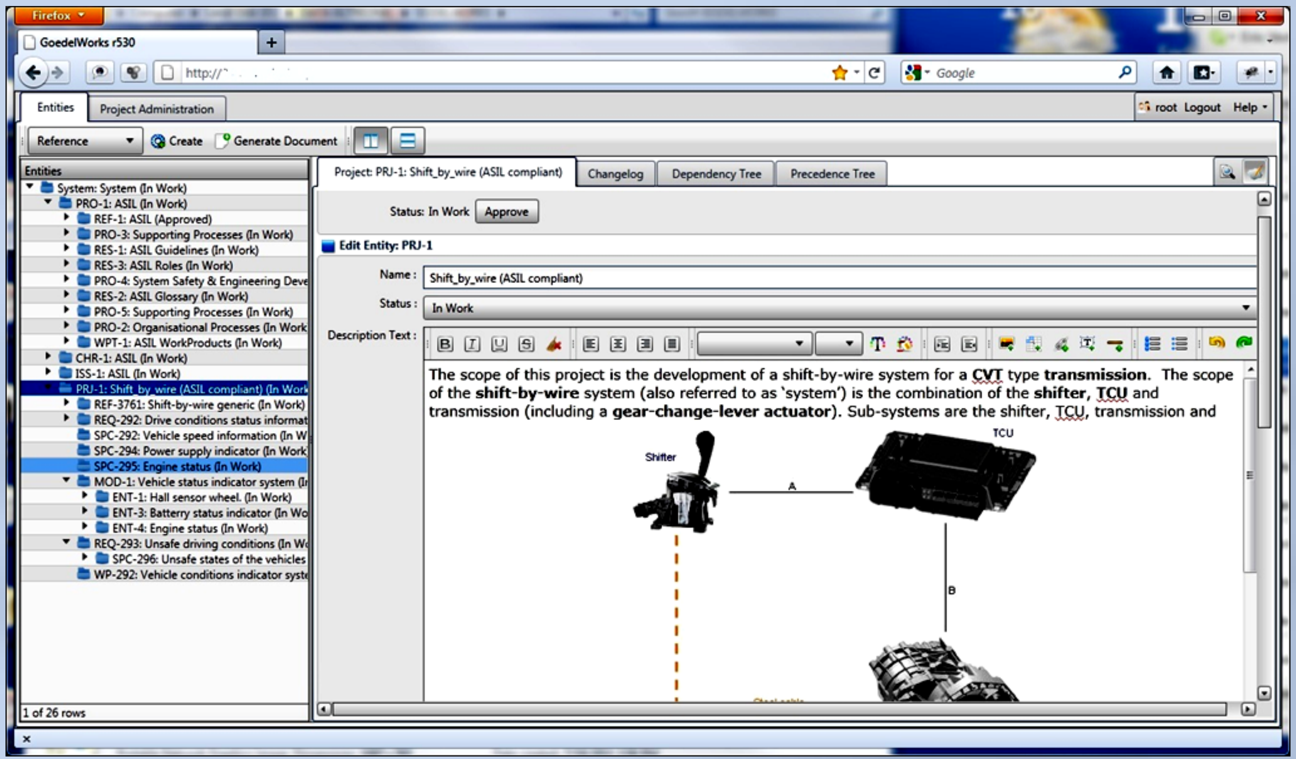
Example project (3)

- Dependency graph (Process)



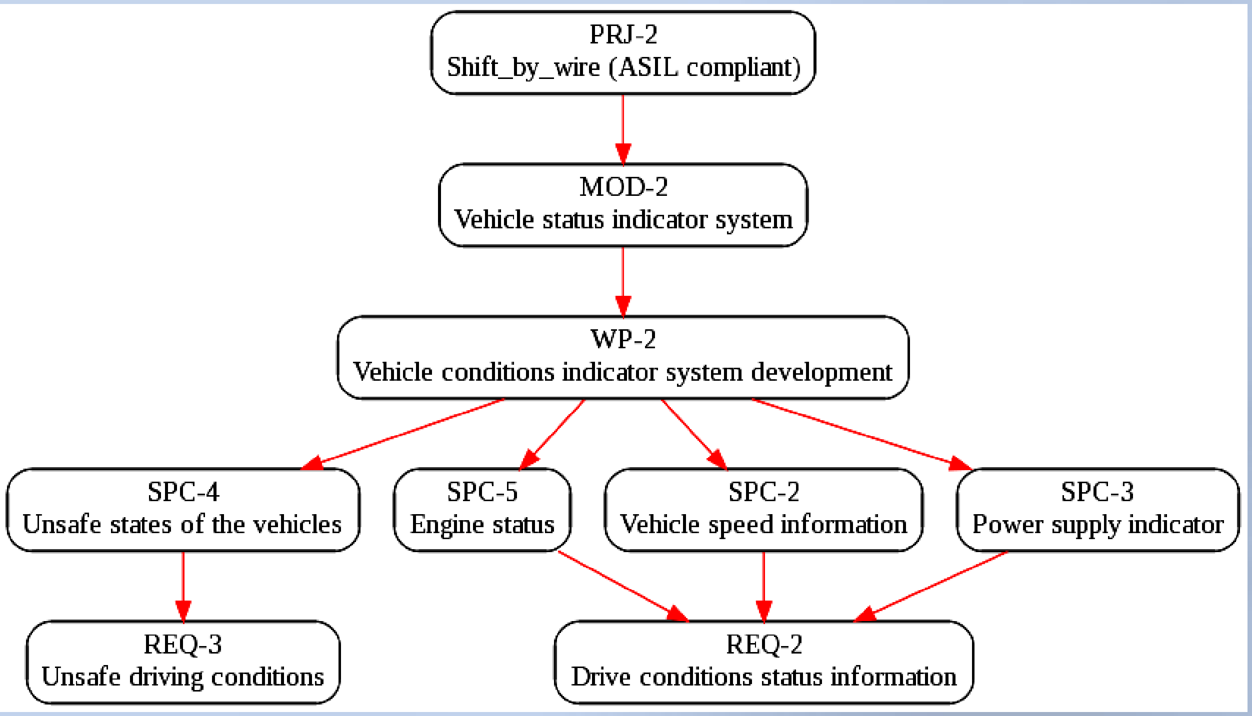
Example project (4)

- Example: shift-by-wire example



Example project (5)

- Generated precedence graph

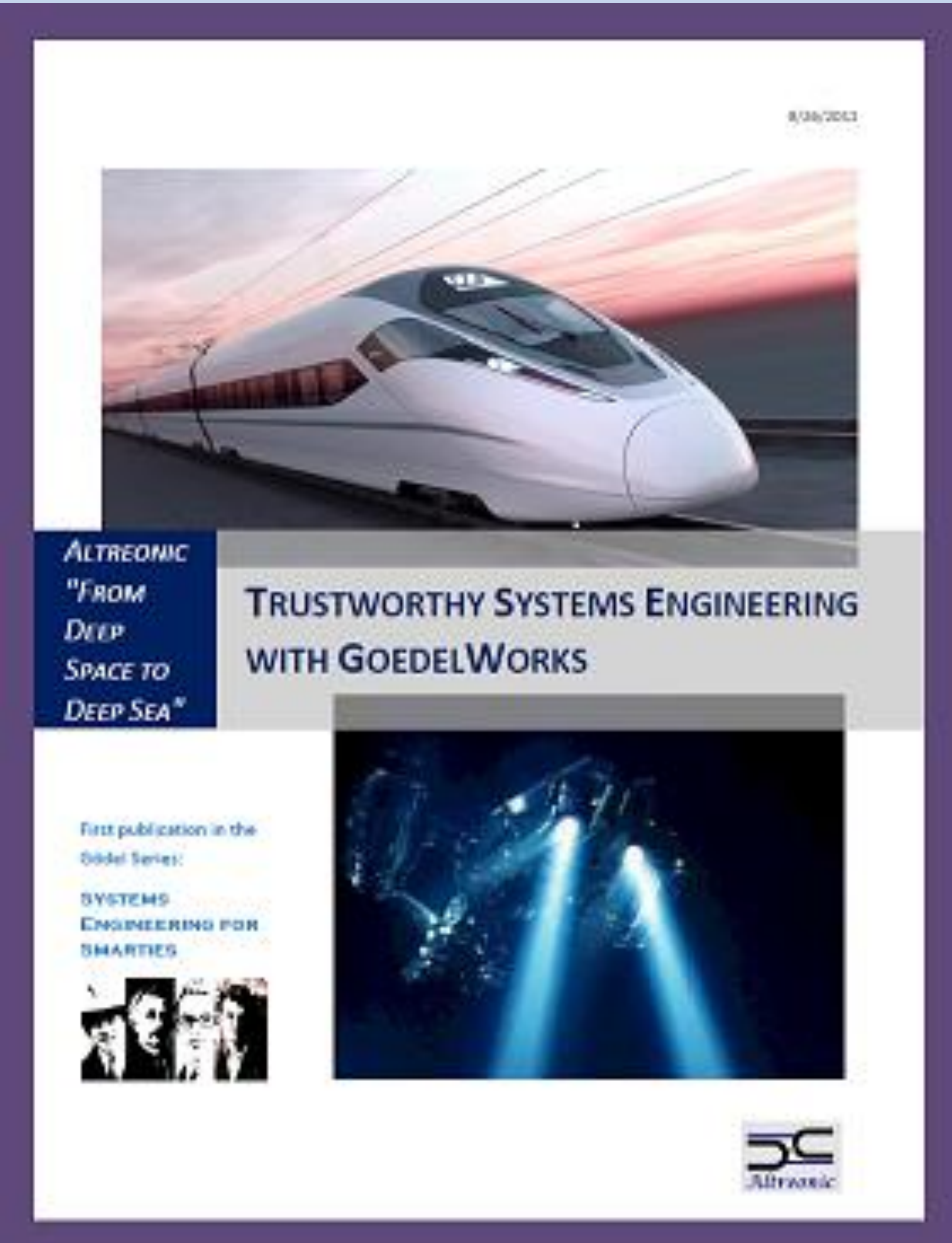


OpenCookBook2GoedelWorks

- Main lessons learned:
  - Bridging different domains: semantic differences
  - Safety engineering standards are subsets of systems engineering
  - Certification requires “evidence” (artifacts)
- Major problems:
  - Find a common language
  - Find a clean language: orthogonality
  - Usability aspects prime requirement for tool
    - Difficult in a web based environment
  - Standards’ license terms!

Conclusion

- Systems engineering process can be formalised using a common metamodel
- Booklet available from Altreonic website
- Challenges
  - Integration of different domains
    - Concepts, Architectural design, WorkFlow
    - System Engineering processes (“standards”) are heuristic
- Progress through formalisation
  - Reduction of design space give reliability
  - Modular architecture and unified semantics essential for incremental/evolutionary verification/validation/certification
  - Automated support is feasible
- Work will continue in OPENCOSS FP7 project
  - (cover avionics, railway, automotive)
  - Focus on re-use of certification evidence



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