Software Quality Assurance Dashboard for Renault Software Robustness plan with SQUORE tool

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ABSTRACT

Software is becoming one of the main challenge of the vehicle development process. To boost the Renault/Nissan embedded software transformation, a Software Robustness Breakthrough Plan was launched from 2015, with 6 levers of actions. Lever n°5 addresses Software Quality Assurance (SW QA). One of the main action of this lever is to gather and calculate the SW QA key performance indicators (KPI) within the Software Qualimetry project (SOQUAL). SOQUAL mission is to provide a software quality dashboard with relevant indicators. It includes source code and model analysis and other software metrics. SW QA KPI calculation was chosen as a use case to test a Qualimetry tool and to optimize the workload and the cost of Quality assurance activities. SQUORE [1] tool was selected for a quick development applied on one vehicle project (Start of production 2019). Renault has yet enlarging project scope: SW QA SQUORE tool is being deployed on several vehicle projects. Renault is also writing the specification to select a tool to implement a full Quality model: all software metrics (cost, model, code, schedule, anomalies, SW QA KPI…) should be gathered and aggregated to give the health status of software at vehicle project level, ECU level, function level..

Keywords: Qualimetry, Software Metrics, Key Performance Indicators (KPI), Software Quality Assurance (SW QA), SQUORE, Dashboard, Embedded Software.

1. Introduction

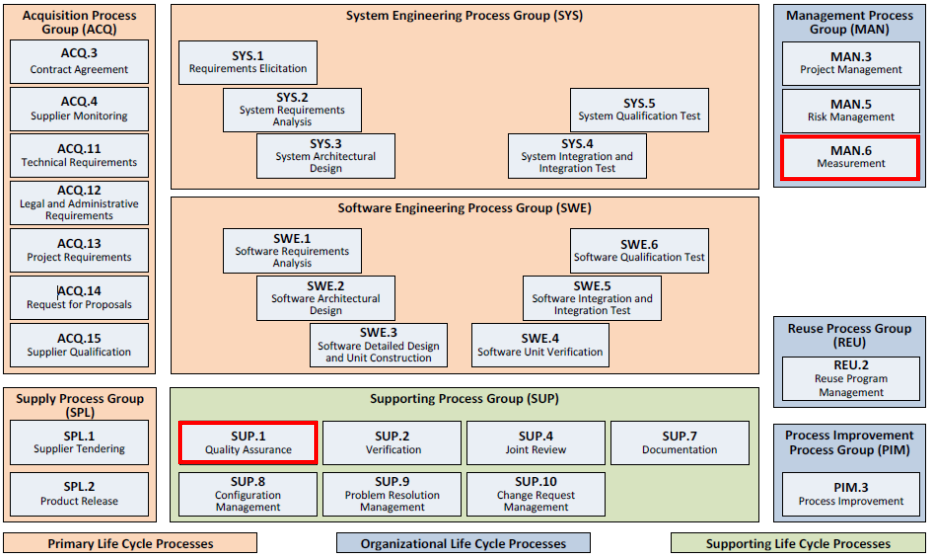
Embedded software in Electronic Control Units (ECUs) is continuously growing in size and software is becoming crucial in a vehicle. Renault/Nissan identified the need to ensure Software quality by 1) qualimetry analyses providing relevant indicators in order to measure software robustness and process capabilities, and 2) a tool providing a dashboard synthetizing these indicators to evaluate the processes (software development) and product (software) health. In 2015, a Software Robustness Plan was launched with 6 levers: System engineering, Software Design Process, Validation and Tuning, Standards and Seamless tools, Software Quality Assurance (an updated Quality Management System fully deployed both internally and at suppliers), Organization and competencies. A specific project called SOQUAL was directly related to Lever n°5 actions. This paper focuses on how SOQUAL contributed to gather measurement, calculate metrics and provide relevant dashboards to contribute to the Renault Software Quality Assurance plan.

2. Context

Within the Software Quality Assurance Lever, Renault has defined 3 indicators to evaluate the quality of embedded software development in the vehicles. The principles were inspired from ASpice [2] which is an industry-specific standard derived from the ISO 15504 [3] for software process assessments. It is also compliant with ISO 12207 [4] which is a standard for software lifecycle processes.

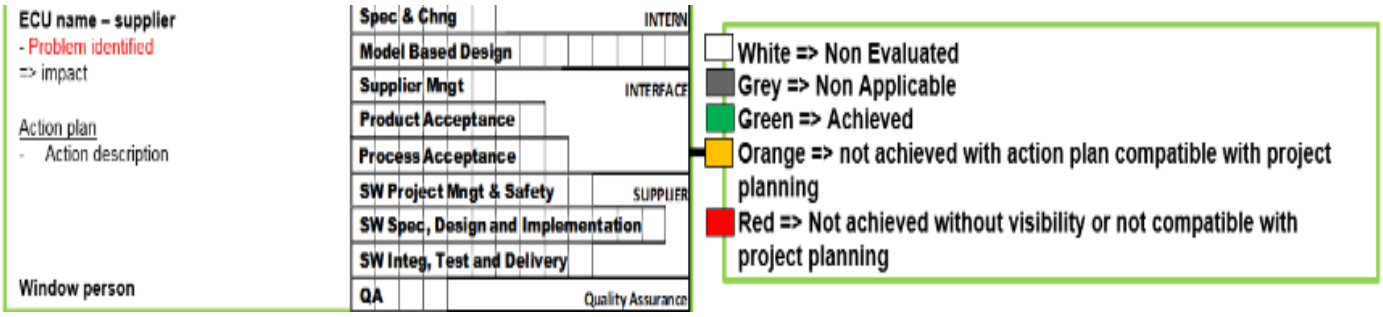
In the current study, we will focus on SUP.1 (Quality Assurance) and MAN.6 (measurement) activities (Figure 1):

Figure 1: Automotive SPICE process reference model - Overview



- ✓ the measurement of process outcomes, which are defined in Automotive Spice as the result of a successful implementation of the process,
- ✓ the requirements for process or product expected from internal teams or suppliers.

Table 1: Scorecard: Outcome statuses



The outcome statuses colors were defined in Table 1. White for not evaluated, grey for not evaluated, green for achieved, orange for not achieved with action plan compatible with project planning, red for not achieved without visibility or not compatible with project planning.

Until June 2017, no automatized dashboard tools were available at Renault to gather outcomes and requirements statuses and calculate the different indicators that Renault needed for Lever n°5:

- ✓ Coverage: it reflects the ratio of Software Quality Assurance plan levels (called in this context "SW QA strategies") decided for each ECUs with the number of ECUs. The possible SW QA strategies are :
  1. "Software QA": all outcomes should be checked
  2. "Anomaly Report Only": no check of quality assurance outcomes. But we follow anomalies reports. It is applied for carry-over parts with no software modification.
  3. "No activity": it is applied for hardware parts without software, or Software COTS (commercial *off-the-shelf*).
- ✓ Completeness : this is the ratio of evaluated outcomes (green, orange, red) with expected outcomes
- ✓ Consistency : this is the ratio of non-failing outcomes (green, orange) with expected outcomes

Each outcome is mapped to one or several requirements as example in Table 2.

Table 2: Example of outcome/requirement

Outcome	Milestone Id	Engine Milestone Id	°Requirement Name
Standards to be complied with are defined for the embedded software product and its development process in consistency with Renault-Nissan's	CF VPC	CF	Define Applicable Standard Software Process and Product Requirements

CF: Concept Freeze milestone, VPC: Vehicle Pre-Contract milestone, Id: identifier

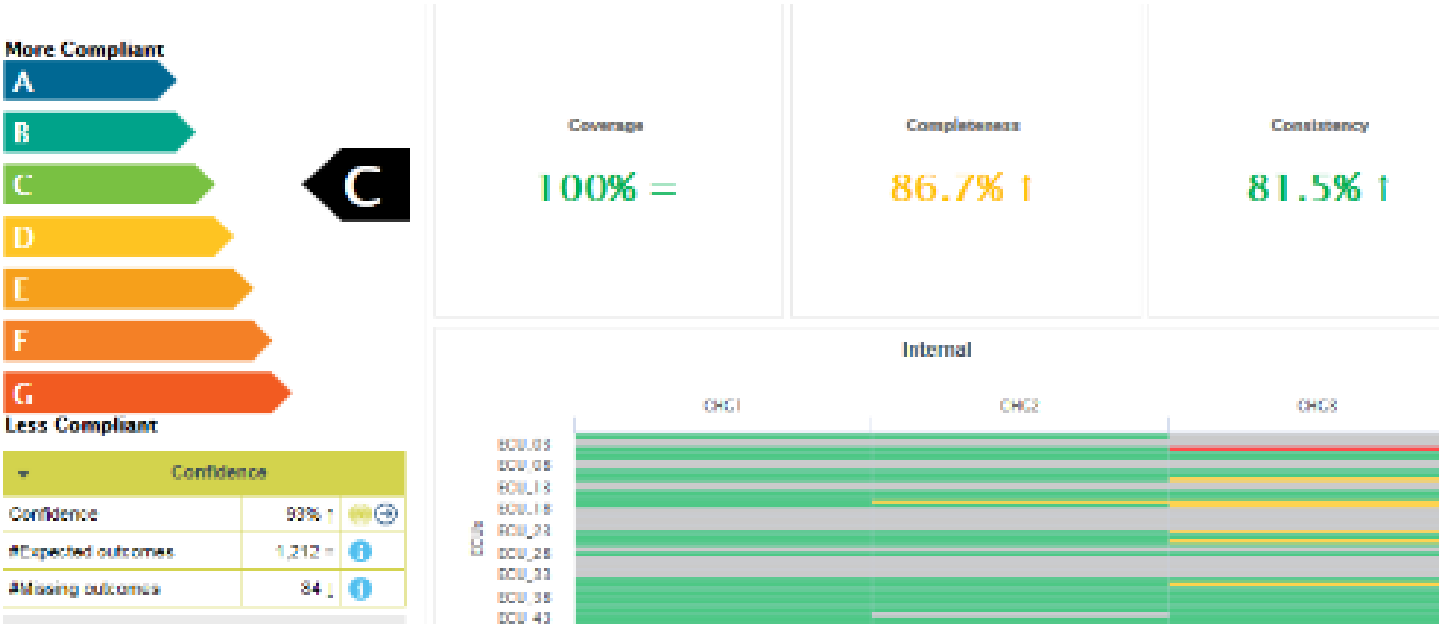
Outcomes are associated with project milestones. The final result of the outcomes statuses check is called "Score Card". Given the described Model Based Design development process at Renault, the Quality Assurance covers both internal and external activities [5]. The corresponding KPIs should be visualized in the tool, allowing management to monitor the project and make key decision [6].

Few solutions for Software Qualimetry are available on the market: SQUORE (SQUORING Technologies), TICS Framework (TIOBE), Cast, Klocwork, Sonar, and others. Other dashboards for general utilization like Necto (Panorama), Visual KPI

(TRANSPARA), etc. [7], are not relevant to Renault, but can give an insight about up-to-date dashboarding techniques, in terms of data visualization for example. The SQUORE tool was chosen to implement this dashboard.

In the context of Quality Assurance at Renault, the highest priority was to ensure that the dashboard tool was able to collect all the data from Renault QA process. The software information comes from different sources (Multimedia ECU, Electronic Control Unit, Underwood switching module, etc.), in various formats (SQL database, Excel tables, etc.). The dashboard had to adapt its interface to collect these kinds of data automatically.

Figure 2: SQUORE dashboard for Project manager



The type of data measured are outcomes statuses. At some vehicle milestones, Renault perform Quality Reviews, in compliance with ASPICE. Those reviews give the status for Quality Software outcomes and the outcome statuses measurement is used to calculate indicators for Quality Software for project vehicle milestones decision. The previous manual workflow using Excel files had lot of manual handling from different people, with large number of excel macros in big Excel files, in different formats, and exposed to manual errors.

3. SQUORE tool for Quality Software indicators

A standard and market tool had to be upgraded with appropriate Renault customization, to establish innovative follow up and decision indicators with sufficient autonomy for Renault administrators and tool flexibility to adapt the tool to urgent modification requests. This configuration of the tool had to illustrate how software quality dashboards can offer an automatic status shared with IQM (Quality engineers) and Quality software specialists. Moreover, another requirement for the tool was to be able to provide code and model analysis functionalities in order to enlarge the scope of software qualimetry later on.

A solution was proposed using SQUORE tool, implemented as a Proof of Concept for a current project at Renault and being deployed on several projects (Figure 2). The goal was to use only one tool to gather all the measurements from different sources (from databases or raw data in excel files), to unify the database and calculate metrics and provide graphics.

Calculation automatization benefits are quick refresh, no errors, low maintenance and time-saving: from 1 day manually with Excel tools to 15 minutes automatized with SQUORE: **96% of time-saving for weekly calculation**.

The tool provides faster data analysis (with added benefits of reliability and update historization). Allowing continuous access to always up-to-date graphics and metrics, the tool provides features in decision-making (filters, action plans, and version comparison), collaboration (shared access, automatically generated standard report), granular navigation down to outcomes (Figure 3) and anomalies (Figure 4)

Figure 4: SQUORE dashboards from synthesis down to detailed information

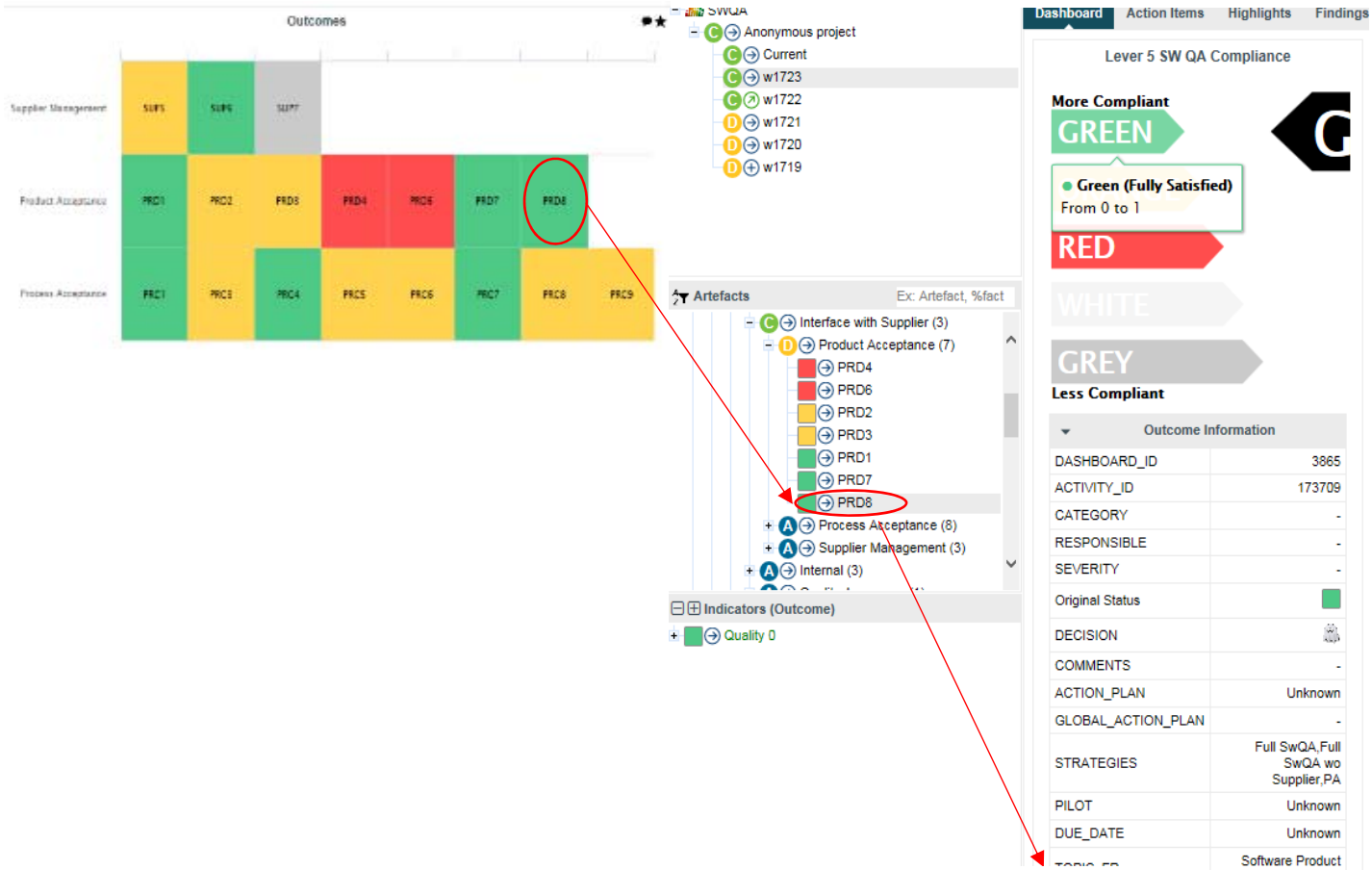
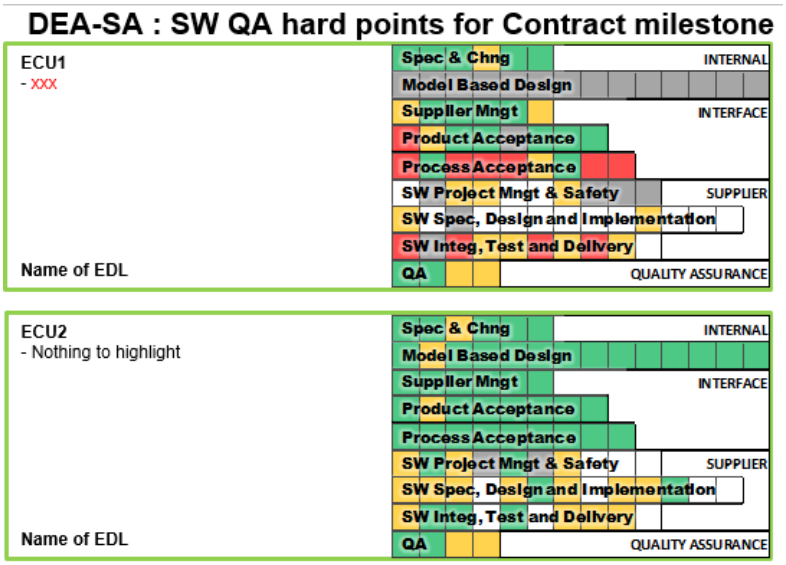


Figure 3: Dashboards from synthesis to anomalies

The workflow was simplified, by reducing the number of Excel files, macros and manual operations. A complete Quality report in PowerPoint format was configured and it can be generated at any time (Figure 4).

Figure 5: Power point report generated by SQUORE tool



As shown in Table 3, a mapping file was created to configure the mapping of the process (outcomes per activities, strategies and milestones). It gives flexibility: quality strategies and outcomes per milestone are very easily configurable.

Table 3: mapping file

Mileston	Scope	Activity	Strategies	Out	nes	
ALL	Internal	ECU Specification & Change Mgt	Full SwQA,Full SwQA wo Supplier	SPE1	SPE2	SPE3
ALL	Internal	Model Based Design	Full SwQA,Full SwQA wo Supplier, MBD	DEV1	DEV2	DEV3
ALL	Internal	Supplier Qualification & Selection	Full SwQA,Full SwQA wo Supplier	QUA1	QUA2	SEL1
ALL	Interface with Supplier	Supplier Management	Full SwQA,Full SwQA wo Supplier	SUP1	SUP2	SUP3
ALL	Interface with Supplier	Product Acceptance	Full SwQA,Full SwQA wo Supplier,PA	PRD1	PRD2	PRD3
ALL	Interface with Supplier	Process Acceptance	Full SwQA,Full SwQA wo Supplier	PRC1	PRC2	PRC3
ALL	Supplier	SW Project Management and Safety Assura	Full SwQA	M1	M2	M3
ALL	Supplier	SW Specification, Design and Implementati	Full SwQA	R1	R2	R3
ALL	Supplier	SW Integration & Testing and Delivery	Full SwQA	V1	V2	V3
ALL	Quality Assurance	Quality Assurance	Full SwQA,Full SwQA wo Supplier,PA	SQA1	SQA2	SQA3
CF	Internal	ECU Specification & Change Mgt		SPE1	SPE2	SPE3
CF	Internal	Model Based Design				
CF	Internal	Supplier Qualification & Selection		QUA1	QUA2	
CF	Interface with Supplier	Supplier Management		SUP1		
CF	Interface with Supplier	Product Acceptance				
CF	Interface with Supplier	Process Acceptance		PRC1		
CF	Supplier	SW Project Management and Safety Assurance				
CF	Supplier	SW Specification, Design and Implementation				
CF	Supplier	SW Integration & Testing and Delivery				
CF	Quality Assurance	Quality Assurance				
OPF	Internal	ECU Specification & Change Mgt		SPE1	SPE2	SPE3
OPF	Internal	Model Based Design		DEV1	DEV2	DEV3
OPF	Internal	Supplier Qualification & Selection		QUA1	QUA2	SEL1
OPF	Interface with Supplier	Supplier Management		SUP1	SUP3	SUP4

4. Conclusion

This use case study shows that we can solve the problems related to the old process of calculation of Software Quality Assurance indicators with a qualimetry dashboard tool.

First feedback came from Quality Engineers who are the main users of this tool. They still spend too much time to create the input data files. This task should be automatized as soon as all data will be in databases which is not currently the case. But now calculation is more robust. They also appreciate that the tool will be maintain by tool teams instead of having to spend time to maintain excel macros. They appreciate the fact that we can give access to the dashboards to the managers and teams they want, and that they can access anywhere as this is a web interface. They are satisfied that this tool will be

able to connect to all databases and that it is flexible for the calculations and dashboards. They request full availability of the tool. We will have to transfer the responsibility of this prototype to computer specialists to industrialize the tool. After this step, Quality Engineers will be able to focus more on quality tasks.

However, when it comes to Quality assessment, this case study covers only Quality Assurance process-oriented KPIs. We look forward covering a larger perimeter of Software Quality in introducing product-oriented KPIs, such as functional coverage, test coverage and indicators from source code and Matlab/Simulink models analysis, etc. Combining and aggregating these metrics into a well-defined quality model [5] could provide a comprehensive image of the real quality of a software development at each project milestone, which is the Software Qualimetry tool aim.

The current SQUORE tool is already able to analyze source code, to check code compliance to coding rules like MISRA [8], and to provide code metrics such as cyclomatic complexity [9] and so on. On the other hand, to assess Simulink model quality, the tool could use functionalities to import model metrics such as COSMIC tool [10], complexity, etc. These metrics have to be gathered in qualimetry tool.

Next step is to define a quality model for Renault according ISO 25010 [5], including all the metrics about the development of the ECU software, from the design to the coding and testing phases, including Simulink model, validation plan, project schedule, cost of the project, respect of the development process, change management metrics. A specification is being finalized to launch a new consultation to select a tool in which this Quality model will be implemented. SQUORE will be one of the supplier consulted.

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