Improving the Management of the Software Acquisition Process: a Methodological Approach in Automotive

Fabrizio Fabbrini, Mario Fusani, Giuseppe Lami
System & Software Evaluation Centre – I.S.T.I. / C.N.R. Pisa (Italy)

Edoardo Sivera

Fiat Auto S.p.A. - DT - SIEE – PDE - R.D.E. Software Torino (italy)

Issues in Automotive

- The number of software-based components in automotive systems is increasing:
  - Comfort electronics
    - Seat and window movement
  - Real-time critical functions
    - Cruise control
    - Antilock brakes
    - Engine management
  - Multimedia applications
    - GPS, DVD
    - Internet
  - **Wireless applications**
    - Tyre pressure control
    - Access control

- Need to control the development cost of software-based component.
- Need to manage the development of the software-based component, to increase the quality of the final products.
- Need to define new relationships with the suppliers, to better manage sw-based component.

System & Software Evaluation Centre

- The System & Software Evaluation Center (SSEC) performs independent certification activity in the area of Information Technology since 1984. In particular:
  - **Software Product Evaluation [ISO/IEC 9126 & ISO/IEC 14598]**
  - **Software Product Evaluation and Certification according to defined requirements and standards**
  - **Software Process Assessment (*process improvement*, *capability determination*) [ISO/IEC 15504, SPICE]**
- SSEC is part of ISTI, an Institute of the Italian National Research Council that performs research in Computer Science, Information Technology and related application areas, mostly within the framework of national and international research projects. SSEC staff members participate in national and international Working Groups for ISO standard definition in the field of Software Engineering

Fiat Auto

Product & Process Engineering
Electronic & System Engineering

Tasks

- To define requirements (HW, SW, communication, reliability, etc.) for the electronic systems and components used in all Fiat, Lancia and Alfa Romeo vehicles.
- To define requirements for the vehicle “body” electronic systems
  - *Lock-unlock doors, passive entry system, anti-thief system, seat movement, windows, mirrors, etc.*

Objectives

- To monitor the Software technologies used in the embedded electronic systems
- To use standard methodologies in order to evaluate the “process capability” of the suppliers
- To control the software life-cycle of the embedded systems
- To define and apply methodologies to validate functional requirements of the embedded systems.
- To define the SW architecture used in embedded systems

The ESCAPE Project Goals

- To set up a methodology supporting the management of software projects and suppliers
- To improve FIAT process to select suppliers
- To improve the software development process of suppliers
- To provide FIAT with methods to determine the risks associated to software suppliers
- To give FIAT a better control on the software development project and on the quality of the resulting product

The ESCAPE Project
Action Plan

- Phase 1: FIAT Suppliers' Capability Determination
- Phase 2: Monitoring Plan Definition
- Phase 3: Methodology Validation

Reasons for SPA

- Software Process Assessment is a way to better understand (and manage) the software process development of a supplier. The assessment is done to:
  - define a "capability" level and a "risk" level for each supplier
  - have a criterium to choose suppliers based on their "capability"
  - understand weak and strong areas of the development process
  - define better functional requirements
  - define better system verification and validation procedures

Assessment Preparation

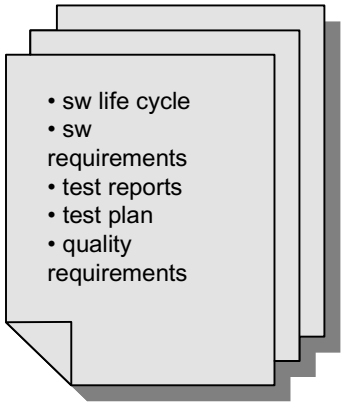
- **Planning the Assessment**
  - On-site visit
  - Time/Cost constraints
  - Technical constraints
  - Assessment risk identification
- **Defining the Assessment Purpose**
  - Capability Determination
  - [Process Improvement]
- **Defining the Assessment Scope**
  - **Requirements elicitation process (CUS.3)**
  - **System requirements analysis and design process (ENG.1.1)**
  - **Software design process (ENG.1.3)**
  - **System integration and testing process (ENG.1.7)**
  - **Project management process (MAN.2)**

Project implementation

pre-assessment activities

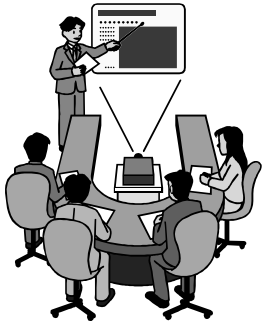
- Introductory meeting
  - To introduce the SPICE (ISO15504) approach
  - To review the assessment purpose, scope and constraints
  - To introduce the assessment activities and the provisional assessment plan

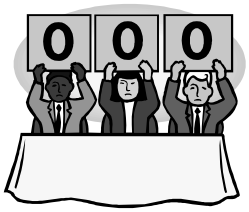
- Pre-assessment questionnaire
  - To gather preliminary information on the projects to be used as process instances



Project implementation

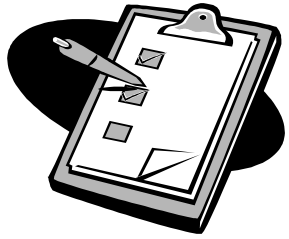
on-site activities





- Briefing
  - Assessment purpose, scope, constraints and model
  - Confidentiality policy
  - Assessment schedule
- Data Acquisition & Validation
  - Presentations
  - Document analysis
  - Interviews

} **Checklist-based**



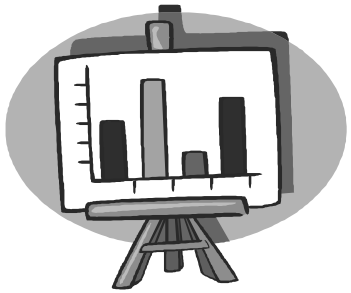
- Process rating (provisional)
- Debriefing

The Rating Dilemma

- Different *rating methods* can be applied
- ranging from the mere processing of measured indicators up to the unaided assessor's judgement
- Need to establish the *requirements* to be satisfied for a rating method to be valid
- Trade-off: assessor's judgement driven by checklists

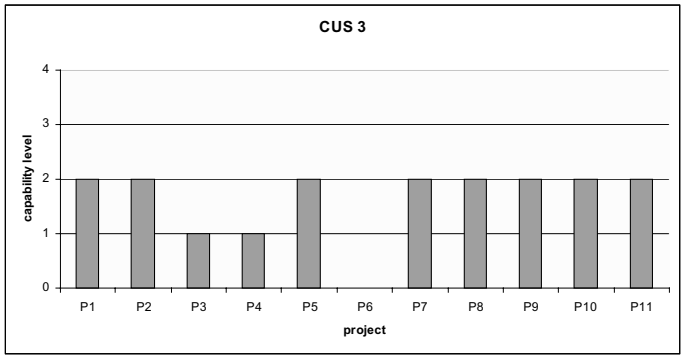
Project implementation
post-assessment activities

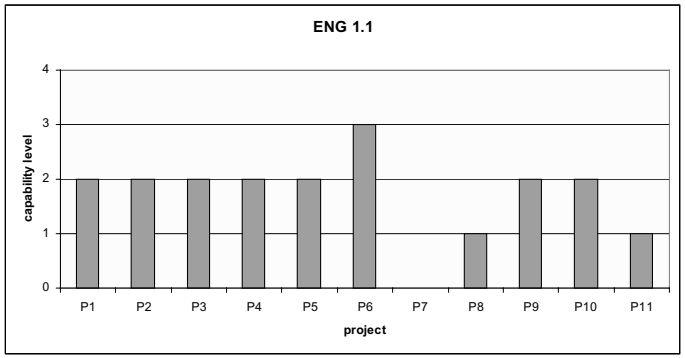
- Process rating (final)
  - For each process assessed, assign a rating to each process attribute
  - Record the set of process attribute ratings as the process profile and calculate the capability level rating

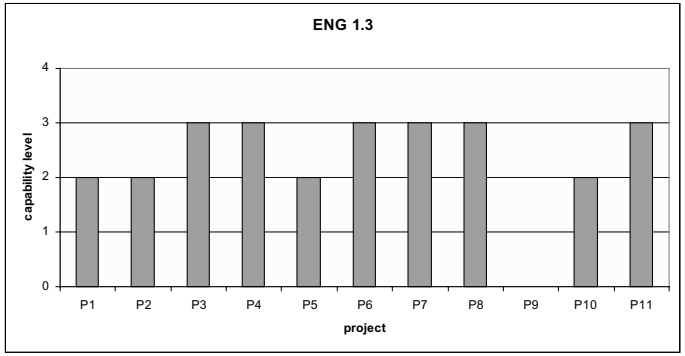


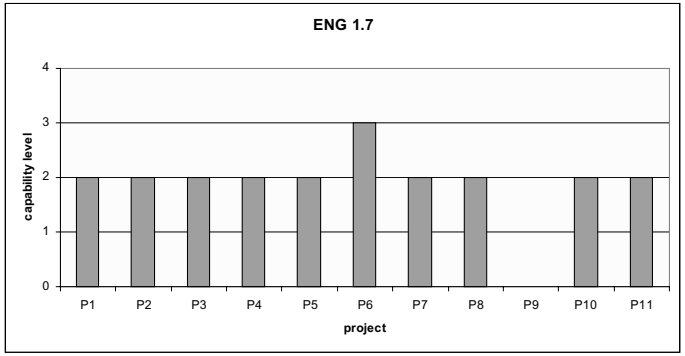
- Reporting the results
  - Prepare the assessment report
  - Present the assessment results
  - Finalize and distribute the assessment report

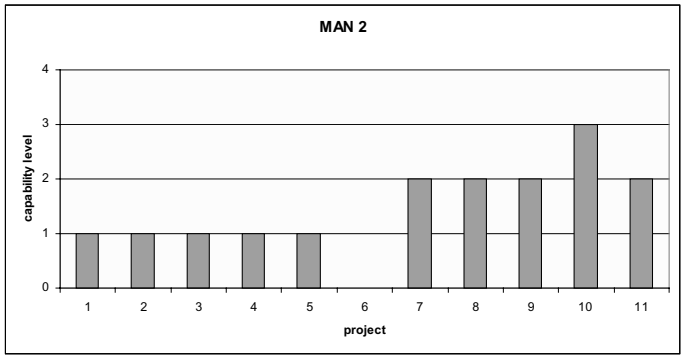
Phase 1 Outcomes (I)

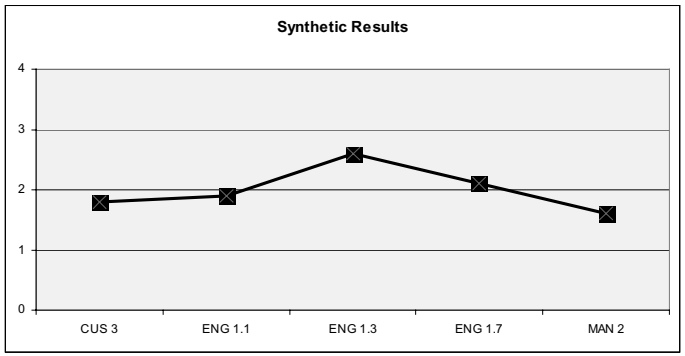












Phase 1 Outcomes (II)

- Trends
  - Requirement analysis as a key issue
  - Awareness of the customer role in the acquisition process
  - Need for new SW development models
- Trade-offs
  - Platform-oriented vs customer-oriented
  - Resource (memory size, processor performance, design complexity) saving vs maintainability and reliability
- Open issues
  - Interoperability at subsystem level (ECU)
  - Safety and security implications

Phase 2: Objectives

- This phase aims at defining a plan for monitoring a software project at different development phases to obtain quantitative measurements of the quality of the related work products and perform predictive evaluations of the quality of the final product.
- For this purpose, a sample project is selected and used to identify key processes to be assessed in order to derive their capability and define an evaluation plan for achieving quantitative data.
- The plan provides structured joint reviews and a set of characteristics and metrics along with the correspondant expected values.

Identification of Key Processes for Monitoring

- Requirements Elicitation and Analysis
- Software Design
- Coding
- Software Testing

Motivation

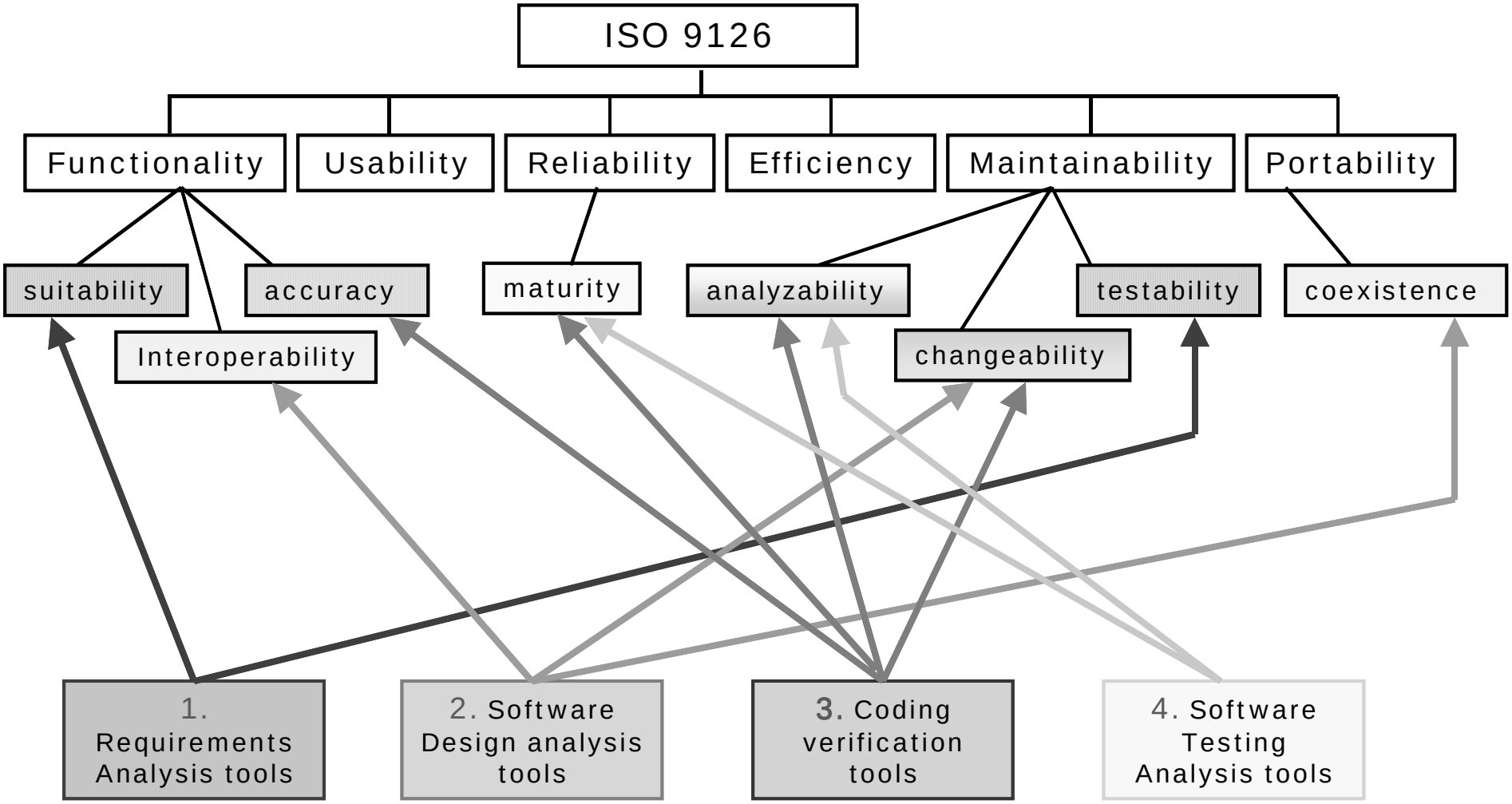
- Common milestones of the software process of most FIAT Auto's suppliers
- Correspondence with the Assessment Scope of the Phase 1. A relevant amount of information has been already collected

Selection of the Pilot Supplier

Adopted Criteria for the selection of a pilot project:

- High capability levels resulting from Phase 1 in order to get confidence in suitable work products
- Medium-small dimension of the project (100-150 Kloc)
- Development process at an appropriate stage
- Belonging to the Body Computer/Comfort Electronics business area to maintain the same application domain as Phase 1

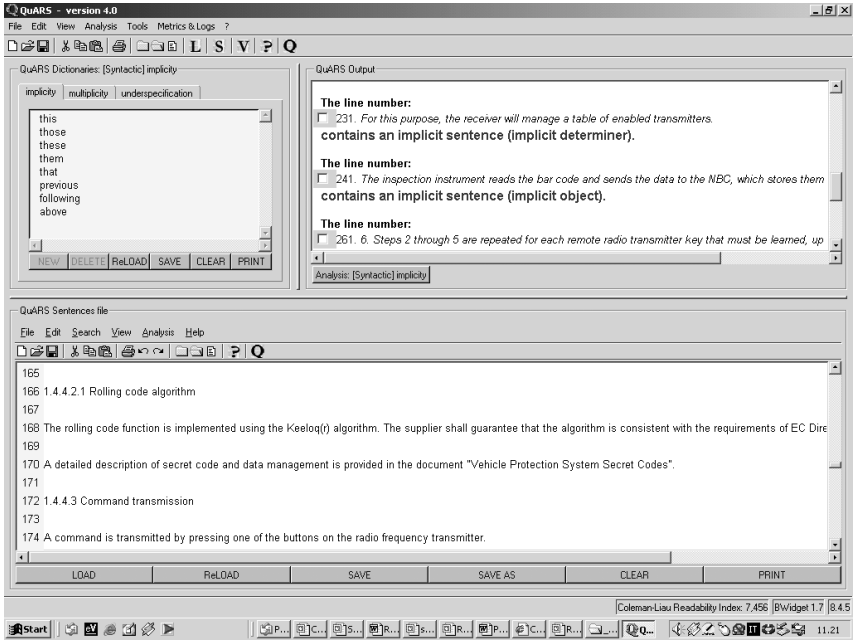
Quality Evaluation Methodology



Monitoring Techniques and Tools

- **Requirements analysis => Ambiguity and Expressiveness analysis made by means of the QuARS tool**
- **Software Design analysis => Checklists + QA-C tool**
- **Coding Style => SPLINT / QAC MISRA tools**
- **Software Testing analysis => Checklists**

Requirements Analysis Tool: QuARS



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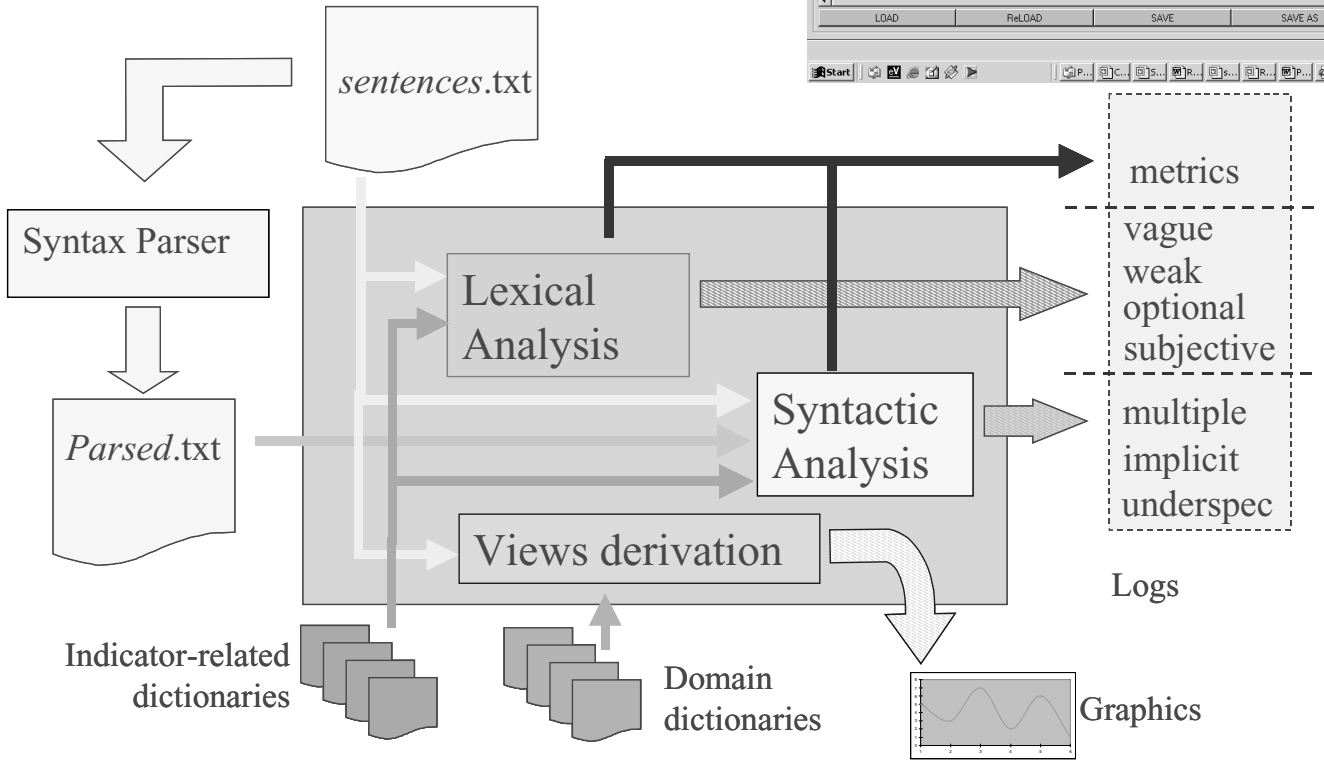


Requirements Analysis

- Suitability evaluation: the presence of potential ambiguity and vagueness defect in the requirememts is measured
- Testability evaluation: the requirements testability is evaluated by identifying requirements expressed in a non-imperative way, being too much complex or difficult to be understood.

Software Design analysis tools

- QA-C MISRA
- Checklists aiming at verifying:
  - The completeness and precision of the software architecture design and interfaces
  - The documentation of the software units and iterfaces
  - The definition of test requirements
  - The satisfaction of software design requirements

- Interoperability evaluation: the accuracy and precision of the component's interfaces description is evaluated.
- Changeability evaluation: the degree of modularity of the software.
- Co-existence evaluation: the completeness of the component's interfaces description is evaluated.

Software Coding analysis tools

- SPLINT
- QA-C MISRA
- Checklists aiming at verifying:
  - The conformace to the best practices in software coding

- Accuracy evaluation: the data type definition is checked out.
- Maturity evaluation: programming errors are measured
- Analyzability evaluation: the readability of the code and the degree of explanatory information provided in it is measured.
- Changeability evaluation: the readability of the code is measured.

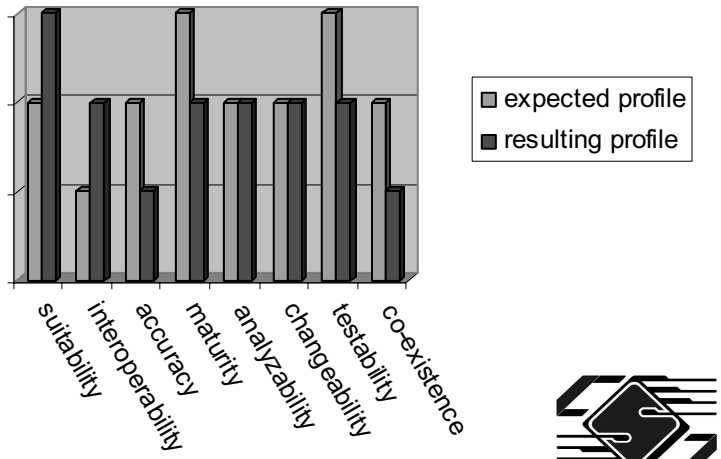
Software Testing analysis tools

- Checklists aiming at verifying:
  - The development of test cases covering the software requirements
  - The existence and the application of a regression test strategy
  - The existence and application of an integration testing strategy
  - The understandability and completeness of test logs
- Maturity evaluation: test adequacy and fault detection metrics are calculated.
- Analyzability evaluation: the accuracy and the completeness of test logs is evaluated.

Definition of the measurement scale and profiles

- The measurement scale is common for all the sub-characterisitcs to be evaluated:
  - T: top (the sub-characteristic has to reach the top score in all the related measurements)
  - H: high (the sub-characteristic has to reach at least 75% of the top score)
  - M: medium (the sub-characteristic has to reach at least 25% of the top score)
  - N: not relevant

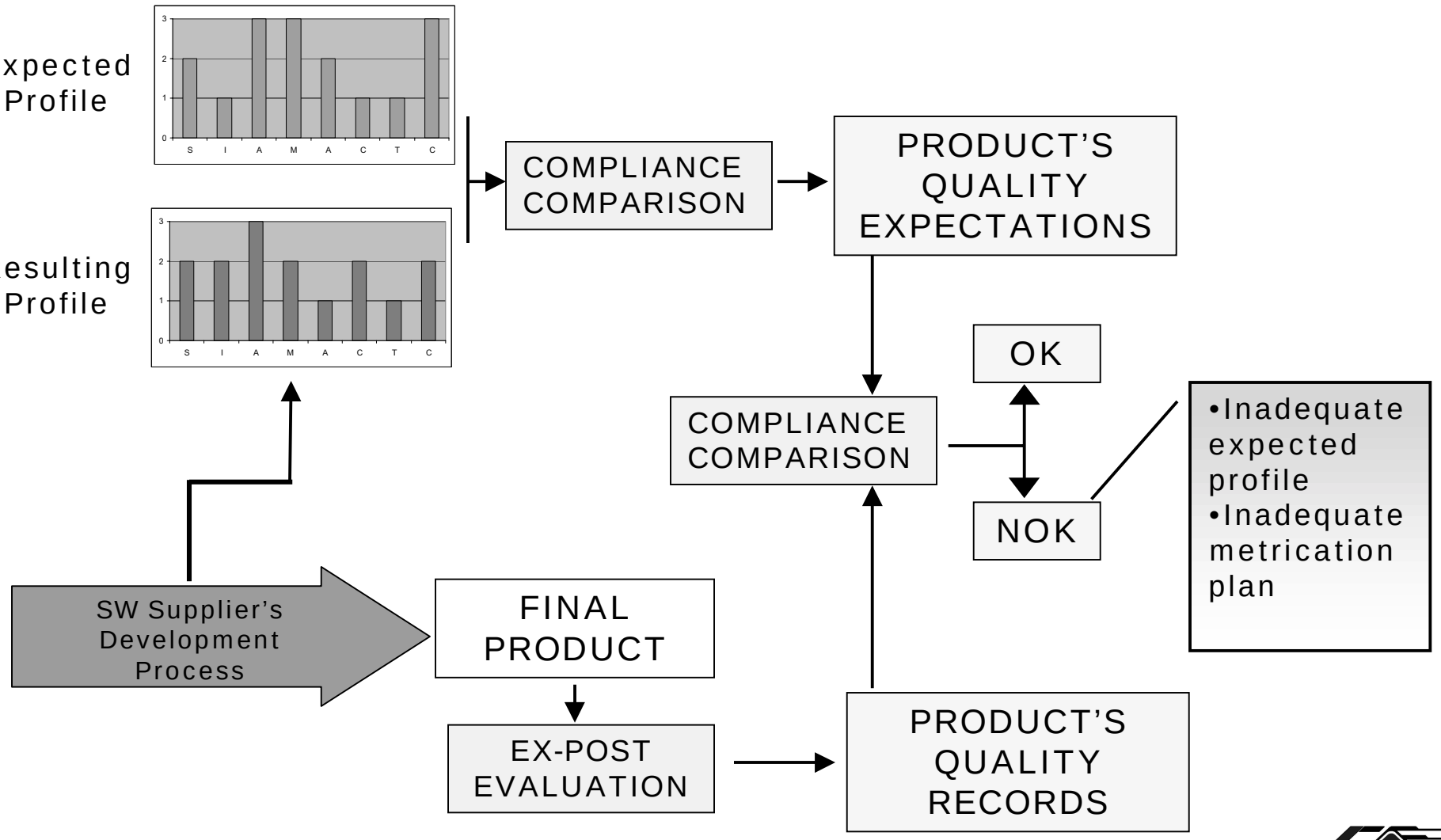
- The collection of the evaluation results of the sub-characteristics (resulting profile) is compared with the expected profile.



Phase 3: Objectives

- The third phase of the ESCAPE project aims at validating the evaluation plan defined in the previous phase, by providing a general methodology to allow FIAT Auto to monitor in a quantitative way a supply during the development process and ask for possible corrective actions earlier.
- Possible critical factors in Phase 3:
  - it takes a long time, especially in the verification of quality characteristics such as reliability or maitainability;
  - it needs a comparison between products having a different metrics profiles in order to determine if and which correlation exists between metrics and quality;
  - it needs a large set of product quality reports to achieve a sound statistic evaluation

Validation mechanism



Thank you.
Questions?

giuseppe.lami@isti.cnr.it
fabrizio.fabbrini@isti.cnr.it
mario.fusani@isti.cnr.it
edoardo.sivera@fiat.com