Engineering Process for Systems Testability Analysis.

Presentation of an Integrated Process
Contents

➢ The goal

➢ The problems encountered

➢ A Solution

➢ The implementation

➢ Synthesis - Conclusion
Contents

➢ The goal

➢ The problems encountered

➢ A Solution

➢ The implementation
What we want to achieve

- An Enhanced Testability & Diagnostics Modeling Process to:
  - Improved Fault Detection Confidence (FD)
  - Improved Fault Isolation to Optimum Repair Level (FI)
  - Reduced False Alarms / False Removals (FA)
  - Lower Mean Time To Isolate (MTTI)
  - Improved Safety Through Critical Fault Analysis (FMECA)
  - Improved System Availability
  - Reduced Cost of Ownership
Contents

➢ The goal

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➢ The implementation
Test and Safety Process

Availability

Reliability Requirements
To reduce the number of failures

Maintainability Requirements
To reduce Down Time

Reliability

Fault Detection Test
Fault Isolation Test

Fault Coverage

Testability
Diagnosability

Maintainability

Maintenance
Preventive
Corrective
Prognostics

Fault Coverage

Detection Rate
Isolation Rate

Test Definition
Diagnostic Development

Safety

Safety Requirements
To limit risk

Tests, BIT, BITE, Monitoring effectiveness

Safety Analysis

Severity Criticality

The missing link

To reduce Repair Time/Cost

To reduce the number of failures

To Reduce Down Time

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Engineering process without eXpress
No testability milestone and the missing link.

FD = 95%
FI = 90% T1
Contents

- The goal
- The problems encountered

A Solution

- The implementation
Model driven Engineering process
Testability & Safety processes integrated

Requirement Definition
Concept

System Definition

Design Development

Analysis BITE Software versus Hard.
Test Definitions based on Function
Test Definitions based on Failure Modes

Diagnostic Development

Test Strategy (Iteration)

Validation

Integration

Demonstration

Maintenance Procedures

Maintenance Requirements

Requirement Allocations
FD + FI prediction

Functional Modeling
Modeling Tests
Modeling with Test
System Functional Tests.
Integrated Diagnostic
Fault Injection

Preliminary FMECA
Critical FMECA

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The Integrated process between Safety & Test

- **Safety: Building the Faults Catalog through the entire process, combining Top-Down and Bottom Up approaches**
  - Top Down: From the early requirements down to the equipment definition
  - Bottom Up: From initial Validation up to Servicing the System
    - All new failure Modes found are integrated from each Test level.

- **Testability: Using the Faults Catalog through the entire process, combining Top-Down and Bottom Up approaches**
  - Top Down: From the early requirements down to the equipment definition
  - Bottom Up: The hierarchical Tests (BIT) roll-up to the highest level definition and the Tests are Updated to the latest Fault Catalog.
The Integrated process between Safety & Testability Analysis

Modeling phases

Testability Requirement Validation

Safety Analysis

Hierarchical Tests Definition

System Specification

Functional System Design

Equipments Specifications

Equipment Development

Diagnostic Development

Test Definition

System Integration

Functional Validation

Equipments Functional Validation

Equipment Validation

FMECA

Validation

Diagnostic Report

Diagnostic Environment

In Service

Integrated Diagnostic

Safety Analysis
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The goal is to reduce the risk of appearance of the critical loops.
Software Framework from Design to Testability

- System Engineering
- Safety Analysis
- Testability Diagnostic Developers

- Diagnostic Model Development
- Test Strategy Development
- Test Strategy Execution
- Test Results Analysis
- Test Results Collection

- Safety Analysis
- Diagnostic Analysis FMECA

- Embedded Diagnostic Level Support NTI1 O Level NTI2 I Level

- Production Operations Support
Software Framework from Design to Testability

Safety Analysis Tool as SIMFIA can feed the Testability tool with:
- the safety dependency model and the reliability data’s
- the Failure Modes and Hierarchical Effects
- the Severity

at the end of the Preliminary & critical FMECA
Software Framework from Design to Testability: Gateways

The CAD multi-schemas are merged through Estudio Pro and imported in eXpress as one Design. Igor Luvishis [igor@elgris.com]

The Safety Analysis Tools as Relex, Item Software, RAMS are feeding the Testability tool through Tabular FMECA
Software Framework from Testability to Test Engineering

- System Engineering
- Safety Analysis
- Diagnostic Model Development
- Testability Diagnostic Developers
- Test Engineering
- Test Operators
- Test Strategy Development
- Test Strategy Execution
- Test Results Collection

- System Design
- Safety Analysis
- Diagnostic Analysis FMECA

- Production Operations Support
- Embedded Diagnostic Level Support
- NTI1 O Level
- NTI2 I Level
A Testability tool as eXpress is forwarding to the Test Sequencer efficient Test Strategies, for the target System, exporting:

- the UUT Description (hierarchical)
- the Diagnostic Flow Diagram (Detection and Isolation)
- the Test Attributes which can be enhanced with a tool like TRD
- the global Diagnostic Information (Faults Group data).
Software Framework from Test Engineering to Test

System Engineering  Safety Analysis  Diagnostic Developers

System Design  Diagnostic Model Development

Safety Analysis  Diagnostic Analysis FMECA

Test Engineering  Test Strategy Development

Test Operators  Test Strategy Execution

Production Operations Support

Embedded Diagnostic
Level Support NTI1 O Level NTI2 I Level

Safety Analysis  Test Results Analysis  Test Results Collection
A Framework integrating an ATML compatible Information Pipeline

- which goal is to reduce development time and maintenance costs by facilitating information exchange
- based on XML Schemas description for information about
  - Test Station, Instrument, Test adaptor, Tests, Test results, UUT
  - Diagnostic, Maintenance Information Collection and Analysis
Software Framework from Test to In Service phase

- System Design
- Safety Analysis
- Diagnostic Model Development
- Diagnostic Analysis FMECA
- Test Strategy Development
- Test Results Analysis
- Test Results Collection
- Test Strategy Execution
- Embedded Diagnostic Level Support
- Production Operations Support

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Software Framework from Test to In Service phase

Test Operators

Test Strategy Execution

Test Results Collection

Test Results Analysis

Production Operations Support

UUT

Embedded Diagnostic

Level Support NTI1 O Level NTI2 I Level

Information Pipeline

A Visualization Interface

Hierarchical Level Indicator

Diagnostic Flow Diagram

Hierarchical Graphical Models Schema

Panel displaying Test / Isolation Results
Software Framework
Testability Requirements Validation

System Engineering
Safety Analysis
Diagnostic Developers
Test Engineering
Test Operators

Production Operations Support

System Design
Safety Analysis
Diagnostic Model Development
Test Strategy Development
Test Strategy Execution

Diagnostic Analysis FMECA
Test Results Analysis
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Software Framework

Testability Requirements Validation

System Designers

Diagnostic Developers

Test Developers

Production Operations Support

System Design

eXpress

Diagnostic Model Development

EADS TEST & SERVICES Sequencer

Test Results Analysis

Safety Analysis

FMECA

FRACAS Analysis tool

Failure Reporting, Analysis and Corrective Action System (FRACAS)

Learning from the critical loop

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Synthesis - Conclusion
Synthesis

➢ Testability tools allows
  ▶ Development of diagnostic models using CAD/CAEE data
  ▶ Diagnostic Model Development and Diagnostic Analysis with FMECA inputs through the V cycle
  ▶ Evaluation of diagnostic performance
  ▶ Generation of Diagnostic Test Strategies to be exported

➢ EADS T&S sequencers allow
  ▶ Test Executive and Run-time execution using multiple test environments
  ▶ Import Diagnostic Test Strategies and ATML XML format definition Schemas

➢ Validation
  ▶ Visualization of the Design and Diagnostic Test Strategies Results, RoEx information's
  ▶ Model Information’s, Diagnostic Test Strategies from an extended DIAG-ML
Conclusion

- The integrated process allows
  - Coherence between Functional Schematics, FMECA, Tests and Diagnostics
  - Reduction of the total cost of ownership of the system
  - Improved traceability and Quality of Test Coverage (Detection/Isolation) and Test Results Analysis

- An integrated process is possible in a software Framework including:
  - eXpress
  - EADS Test & Services tools