NDIA Test & Evaluation Conference

Producing Anywhere, Anytime Test, Evaluation and Diagnostics Capable Products to Eliminate the T&E Logistic Burden

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Introduction

What is Agilent?

- Although Agilent sells a diverse number of products, my part of the company designs, manufactures, and sells extremely complicated & state-of-the-art RF instruments
- Even though we are an industry leader and our core competency is test & measurement, we struggle with “sustainment”

Agilent Technologies

Who am I?

- I am the product manager for an Agilent software product named Fault Detective
- My background is software development

What is “Anywhere, Anytime Diagnostics”?

Anywhere

A single diagnostics technology used across the entire product lifecycle

1. Manufacturing/production
2. Service centers/depots
3. In the field (Both remote and local)

Anytime

Fast, accurate diagnostics regardless of location and operator skill

Agilent Vision

- One of our instruments fails on a customer’s manufacturing line… halting production
- The instrument self-diagnoses and notifies an Agilent service center
- An Agilent repair technician contacts the customer knowing exactly how to fix the problem

A/D Vision

- A failure occurs on a jet in mid-flight
- The jet self-diagnoses and communicates the failure to a ground crew
- The ground crew is prepared by the time the jet lands

“Anywhere, Anytime Diagnostics” in Action

Two Agilent instruments are equipped with “Anywhere, Anytime Diagnostics”:

E6601A Wireless Communications Test Set

Functionality of a base station

Number of printed circuit assemblies: 7

Number of interconnects: 16

Push a button and the instrument automatically troubleshoots itself.

N9020A MXA Spectrum Analyzer

Frequency range: 20 Hz to 26.5 GHz

Number of printed circuit assemblies: 12

Number of interconnects: 25

Challenges We Faced

1. **Design a product with adequate diagnosability**
   If a product is too difficult to repair, any sustainment strategy will be a challenge. Typically, diagnosability is not known until production, when it's often too late to fix the problem.

2. **Create a test plan with appropriate coverage & diagnostic resolution**
   Poor test coverage puts faulty products in the field. Poor diagnostic resolution produces test results that provide little insight into failures. Quantifying the effectiveness of functional test is notoriously difficult, making it hard to know when your test process is "good enough".

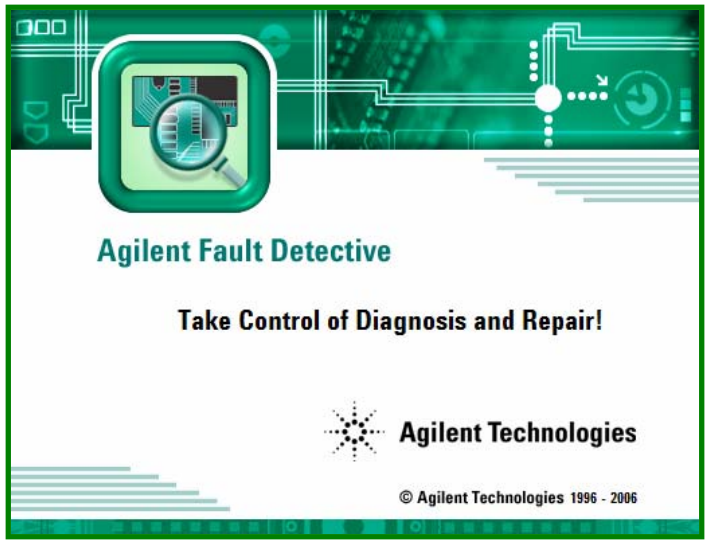
3. **Automate trouble-shooting**
   A worthy goal, but difficult to achieve without a lot of investment.

4. **Embed the entire solution in the product**
   How do you create an effective test solution without any external test equipment?

Agilent Fault Detective Software

Q: The issues on the previous slide are really tough to address, so how did we do it?

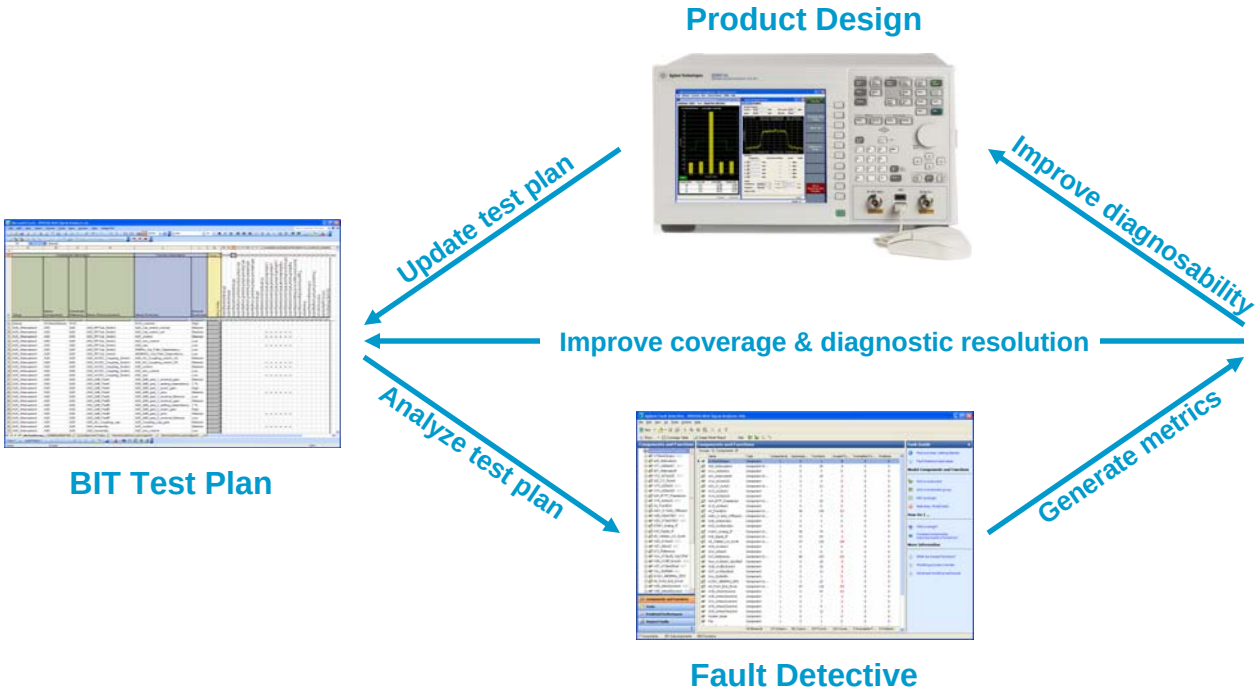
A: We used an in-house software tool named *Fault Detective.*



***Fault Detective*:**

1. Create/document your test plan
2. Assesses the effectiveness of a functional test plan
3. Assesses the diagnosability of a product
4. Automatically troubleshoots defective products

Process Overview



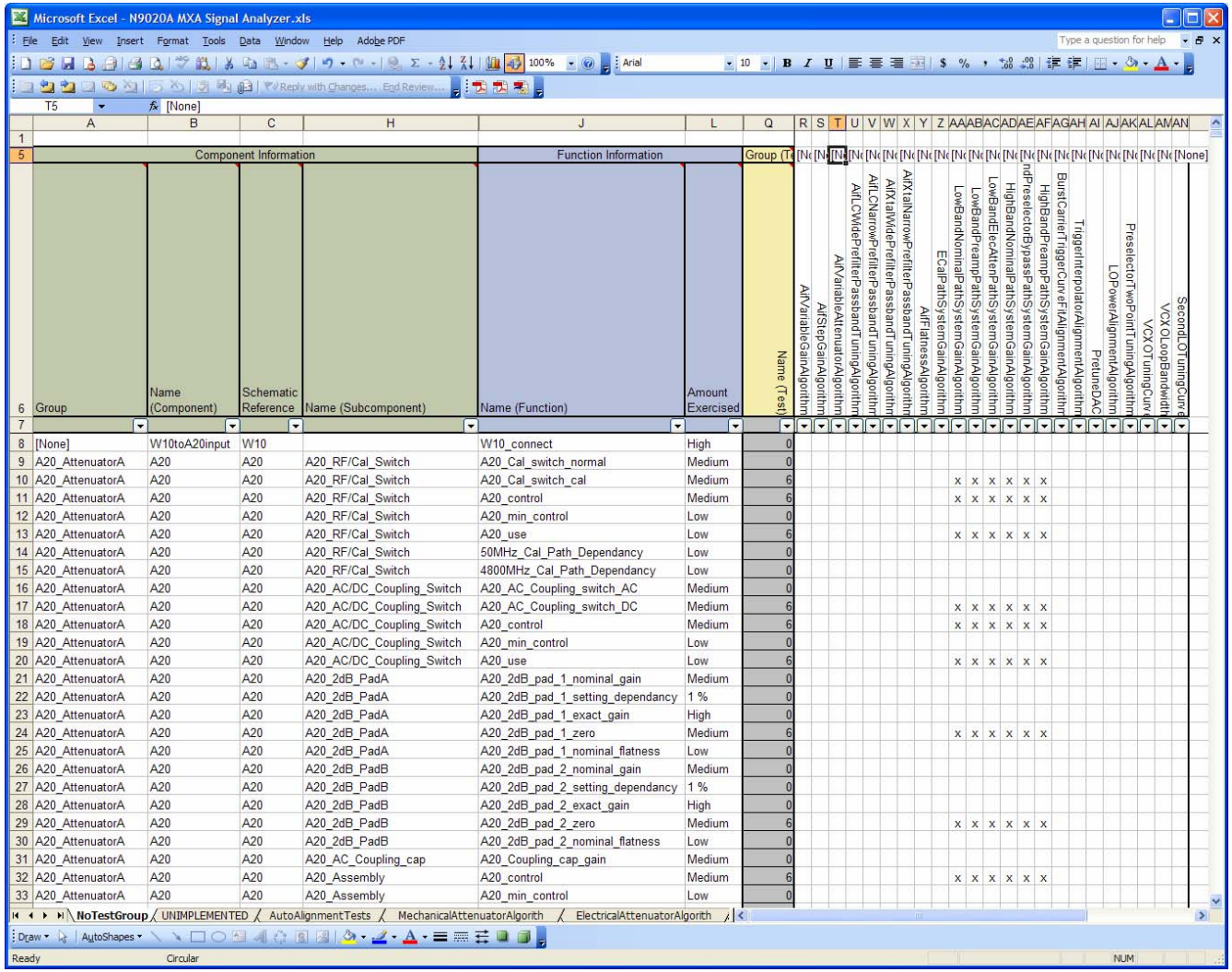
Two Key Metrics

1. **Detection**
   How well do I detect failures during functional test
2. **Isolation**
   If a product fails functional test, how much effort is required to troubleshoot

Process Overview

1. Create/capture test plan in Fault Detective
2. Analyze the test plan in Fault Detective to generate metrics
3. Use metrics to improve product diagnosability
4. Use metrics to improve test coverage and diagnostics resolution

Creating/Documenting Your Test Plan



Key Benefits

Standardized process for documenting functional test.

Step 1
List tests

Step 2
List hardware components (nouns)

Step 3
List functionality (verbs) of each hardware component

Step 4
For each function, assign “amount of component exercised” (High, Medium or Low)

Step 5
For each test, put an ‘X’ for the functions it exercises

Assessing Functional Test & Product Diagnosability

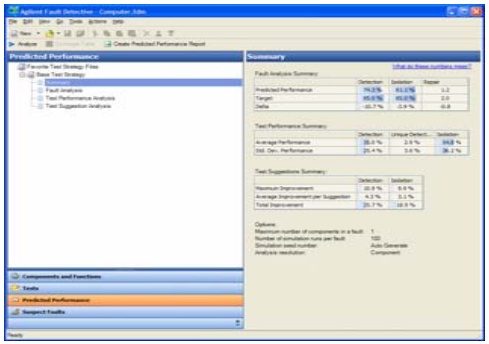
Key Benefit

Using the model, Fault Detective generates metrics needed to:

1. Improve the product: *diagnosability*
2. Improve functional test: *coverage & diagnostics resolution*

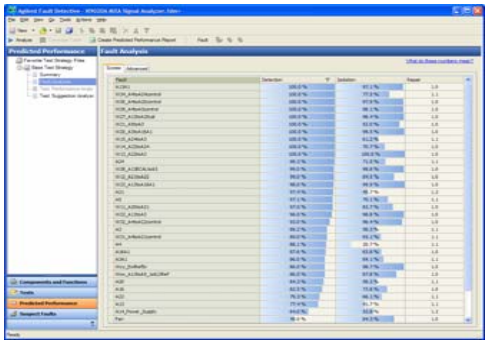
Summary

1. Overall, how likely are test escapes?
2. Overall, how difficult is it to troubleshoot this product?



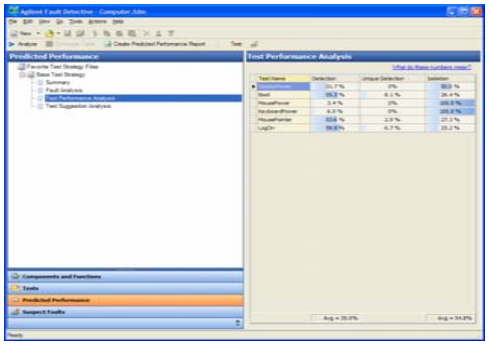
Fault Analysis

1. How likely are specific failures to escape?
2. How difficult is it to troubleshoot specific failures?

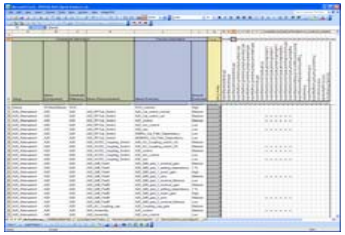


Test Performance Analysis

1. How good is a specific test at catching escapes?
2. How much does a test contribute to diag resolution?



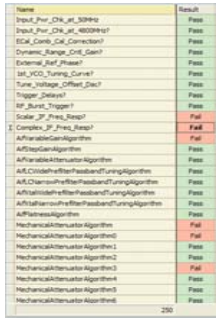
Automating Diagnostics



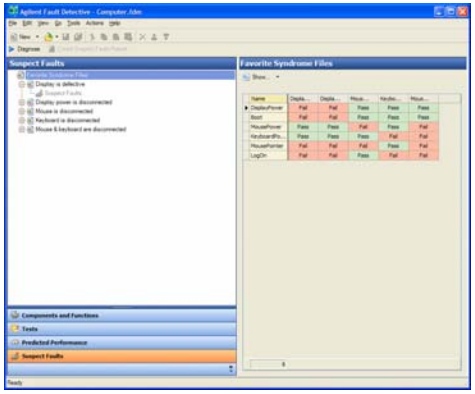
Fault Detective Model

Key Benefit

Automated diagnostics are fast & accurate, yielding consistent results, and can be embedded directly in the product.



Test Results



Fault Detective Diagnostics Engine

Score	Sch...	Fault	Detail
83.9	A16A1	A16A1	A16A1,A16A1_Anti_Alias_N_Filter + FO:A16A1_Anti_alias_filter_N_stopband
7.3	A13	A13	A13,A13_3rdLO_Detector + PF:A13_322MHz_CW_Cal_Use_Relative
5.1	A16	A16	A16,A16_PRN_Generator + PF:A16_Dither_on
1.7	W28	W28_A13ECAL...	W28_A13ECALtoA3
<1	W23	W23_A13toA1...	W23_A13toA16A1 + PF:W23_Connect
<1	A3A1	A3A1	A3A1,A3A1_LPF + PF:A3A1_5.1GHz_Offboard_filter_passband
<1	A3	A3	A3,A3_4.8GHz_LO_Cal_in + PF:A3_ECal_In_to_AIF_In
<1	W20	W20_A3toA16A1	W20_A3toA16A1 + PF:A3_ECal_In_to_AIF_In

Diagnosis

Summary of Benefits/Results

Near 100 percent diagnostic accuracy

Incremental effort is minimal (for A/D, coverage requirement is mandatory on most programs)… "it's a no-brainer"

Manufacturing/Production

Perform self-diagnosis after final assembly, before final verification.

1. Standardized test documentation → Consistency across the company
2. Coverage assessment → Fewer test escapes
3. Diagnostics assessment → Predictable time-to-volume
4. Automated diagnostics → Fewer resource requirements (fewer repair technicians & less capital equipment)
   → IP protection

Service Centers/Depots

Perform self-diagnosis before manual troubleshooting.

1. Automated diagnostics → Fewer resource requirements (less time ramping-up technicians at each service depot)
   → Faster turn-around time
2. Coverage assessment → Fewer no-trouble-founds

In the Field

Peform diagnostic from anywhere in the world.

1. Automated diagnostics → Fewer resource requirements
   → Increased product up-time
2. Coverage assessment → Fewer failures in the field