



Web-Based Reporting on Turbine Engine Stress Test Data

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Introduction

- Overview of turbine engine testing at AEDC
- Description of test reporting system
- Lessons learned
- XML test data



Turbine Testing Overview



98-047810



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Testing of Aircraft Turbine Engines at AEDC

- **Simulated Altitude Test Cells**
- **Sea-level, Ambient and Ram, Test Cells**
- **Test Cell Capacity Ranges from Small Cruise Missile Engines to Largest Commercial Aircraft Engines**
- **Simulated Altitude Test Conditions Range from Sea-level, Subsonic Flight to near 100,000 Feet, Supersonic Flight**
- **Some Engine Test Programs Exceed 2000 Measurements**



Turbine Testing Overview

- New engine test programs require significantly more dynamic data channels (~300)
- Current AEDC capabilities for comprehensive analysis and reporting on engine stress test data can take a few days to weeks
- An automated stress test data reporting system has been developed to deal with the large amounts of data



Turbine Testing Challenges

- **Handle large amounts of data**
(~300 dynamic data channels)
- **Timely and comprehensive analysis and reporting**
(Reports available within 30 minutes of test event)
- **Timely *delivery* of resulting analysis and reporting**
(Test customers can be on-site and/or geographically distant — use the Internet and web interfaces to make reports available 1) to the appropriate people; 2) where ever they are needed; and 3) as soon as they are generated)
- **Non-standardized information and data interchange with test customers**
(Time consuming, labor intensive, and error-prone test data setup processes)



Test Reporting

- Timely reports
 - Provide critical test results information on-line during engine testing
 - Improve the ability to direct subsequent testing
 - Increase the efficiency of the engine testing process
 - Reduce the chances of engine structural failures



Data Reduction Process

- Dynamic stress test data acquired, processed, and stored in real-time
- Stress test data reviewed and electronic noise is tagged
- Mode peaks analysis process applied to the noise-filtered stress test data files
- Analysis data stored in the AEDC engine structural test information database
- Stress test data summary reports accessible through a web-based interface



Automated Test Reporting

- An automated system has been developed to generate stress test data summary reports from information stored in a database
- A secure web-based interface is provided that allows both local and remote generation and viewing of the engine component stress test data summary reports
- Engine manufacturer can monitor tests from their remote facilities
- These capabilities improve test direction and reduce test costs and cycle times.
- Prototype system developed using MS Excel



Reporting Software

- Crystal Reports XI
 - Graphical report designer
 - ODBC (“live”) Connection to Oracle Database
 - Visual Design Environment
 - Drag-and-drop, “wizards” and “experts” for common tasks, object-oriented explorers
 - Dynamic and cascading parametric selection filtering
 - Page-on-demand technology expedites viewing
 - Powerful, yet fairly minimal learning curve for basic reports



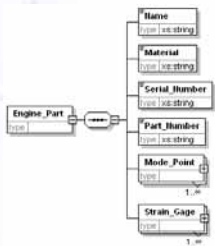
Reporting Software

- BusinessObjects XI
 - Makes reports available via a web-based report
 - Management tools
 - Controls access and security
 - Provides auditing and logging
 - Repository for other types of data
 - Collaboration tools (messages, discussion)
 - J2EE and .NET with consistent user interface
 - System repository
 - Report scheduling



System Architecture

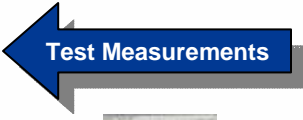
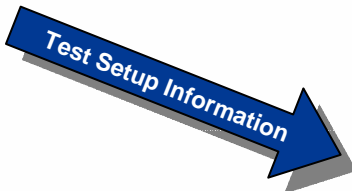
Standardized Test Data Format (XML)



Structural Test Database (Oracle)



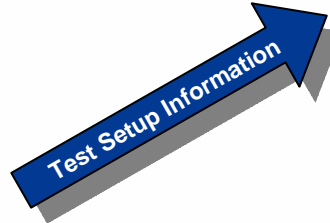
Test Measurement Data



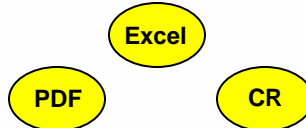
DatWizard II



Database Input Tool



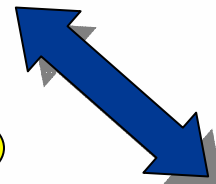
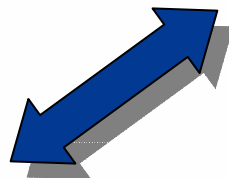
Crystal Reports / BOE



Interactive Web-Based Test Reports using Excel



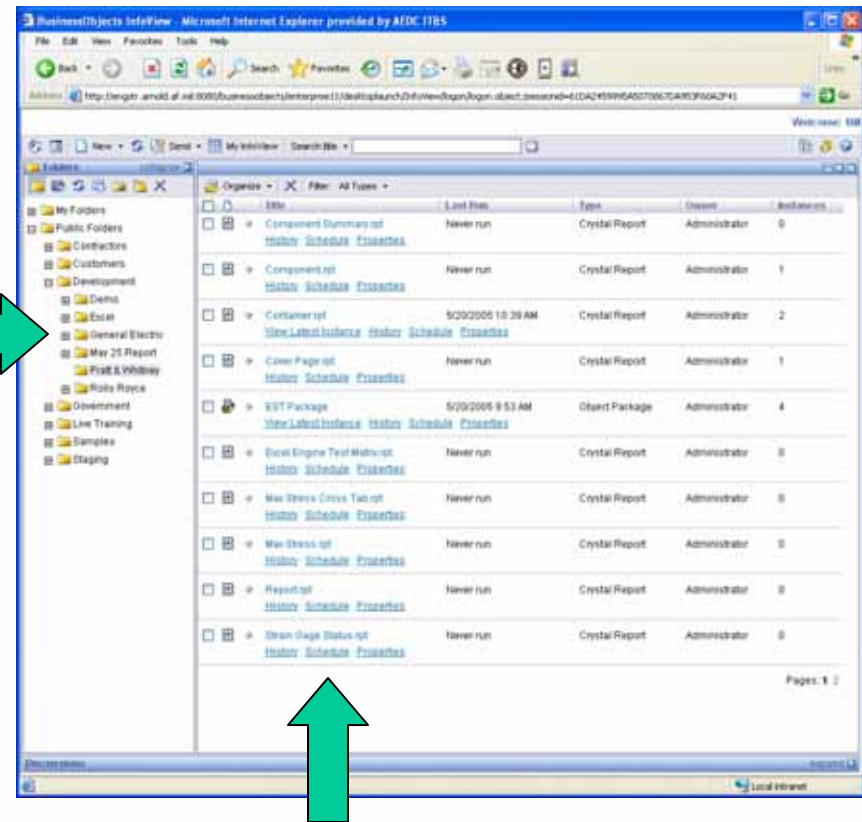
External Test Customer Access





Web Interface to Reports

- Web-based report viewer
- Folder tree on left
- Reports on right
- Several viewers available
 - HTML
 - DHTML
 - ActiveX
 - Java





Input Parameters

- Parameters
 - Engine Component
 - Test Period / Data Point
- Dynamic Cascading Parameters

The screenshot shows a dialog box titled "Enter Values" with three main sections for selecting parameters:

- Select Engine Component(s):** This section is for selecting engine components. The "Available Values" list includes ECMP10_EBLD1, ECMP11_EBLD1, ECMP12_EBLD1, ECMP13_EBLD1, ECMP14_EBLD1, ECMP15_EBLD1, ECMP16_EBLD1, and ECMP17_EBLD1. The "Selected Values" list contains ECMP1_EBLD1 and ECMP4_EBLD1.
- Select Data Point(s):** This section is for selecting data points. It is further divided into two sub-sections:
 - Select Test Period(s):** The "Available Values" list includes TPD1_TOBJT, TPD2_TOBJT, and TPD3_TOBJT. The "Selected Values" list contains TPD1_TOBJT and TPD2_TOBJT.
 - Select Data Point(s):** The "Available Values" list includes DPNT11_TPN11_TPD1, DPNT12_TPN12_TPD1, DPNT13_TPN13_TPD1, DPNT11_TPN11_TPD1, and DPNT12_TPN12_TPD1. The "Selected Values" list contains DPNT11_TPN11_TPD1, DPNT13_TPN13_TPD1, and DPNT12_TPN12_TPD1.

At the bottom of the dialog box, there are "Remove" and "Remove All" buttons for each section, and "OK" and "Cancel" buttons at the very bottom.



Report Contents

- Test program information
- Description of the test engine
- Engine components and parts information
- Description of the test conditions
- Planned test matrix and test points
- Strain gage locations and operational status
- Summary of the highest vibratory stresses per mode
- Vibratory responses summary chart
- Bar chart that summarizes the highest vibratory stresses



Report Contents

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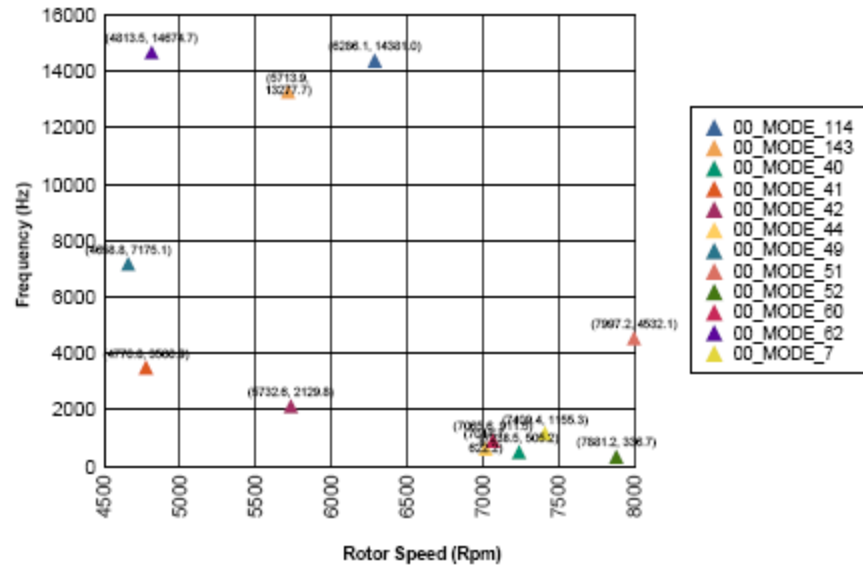
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Highest Measured Vibratory Responses
(Frequency for Highest Stress per Mode)

ECMP7_EBLD1

Modes Summary Diagram





Lessons Learned

- Good
 - Web access
 - No client software required
 - Flexible output file formats (Excel, Word, and PDF)
 - Security features
 - Parameters (including cascading)
- Bad
 - Learning curve for complex reports and system administration
 - Lacks some “spreadsheet-like” capabilities and ease-of-use
 - Limited charting capabilities



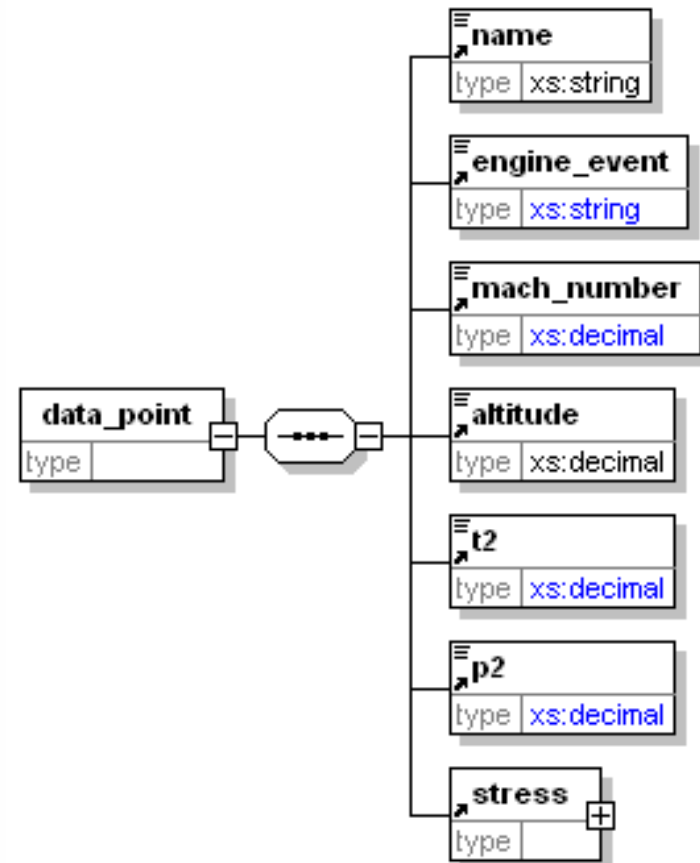
Extensible Markup Language

- Effort to define test data standards and business interfaces with the test customer using the eXtensible Markup Language (XML)
- XML is a flexible way to create self-describing data and share both the format and content
- XML is quickly becoming a state-of-the-art practice in business processes.



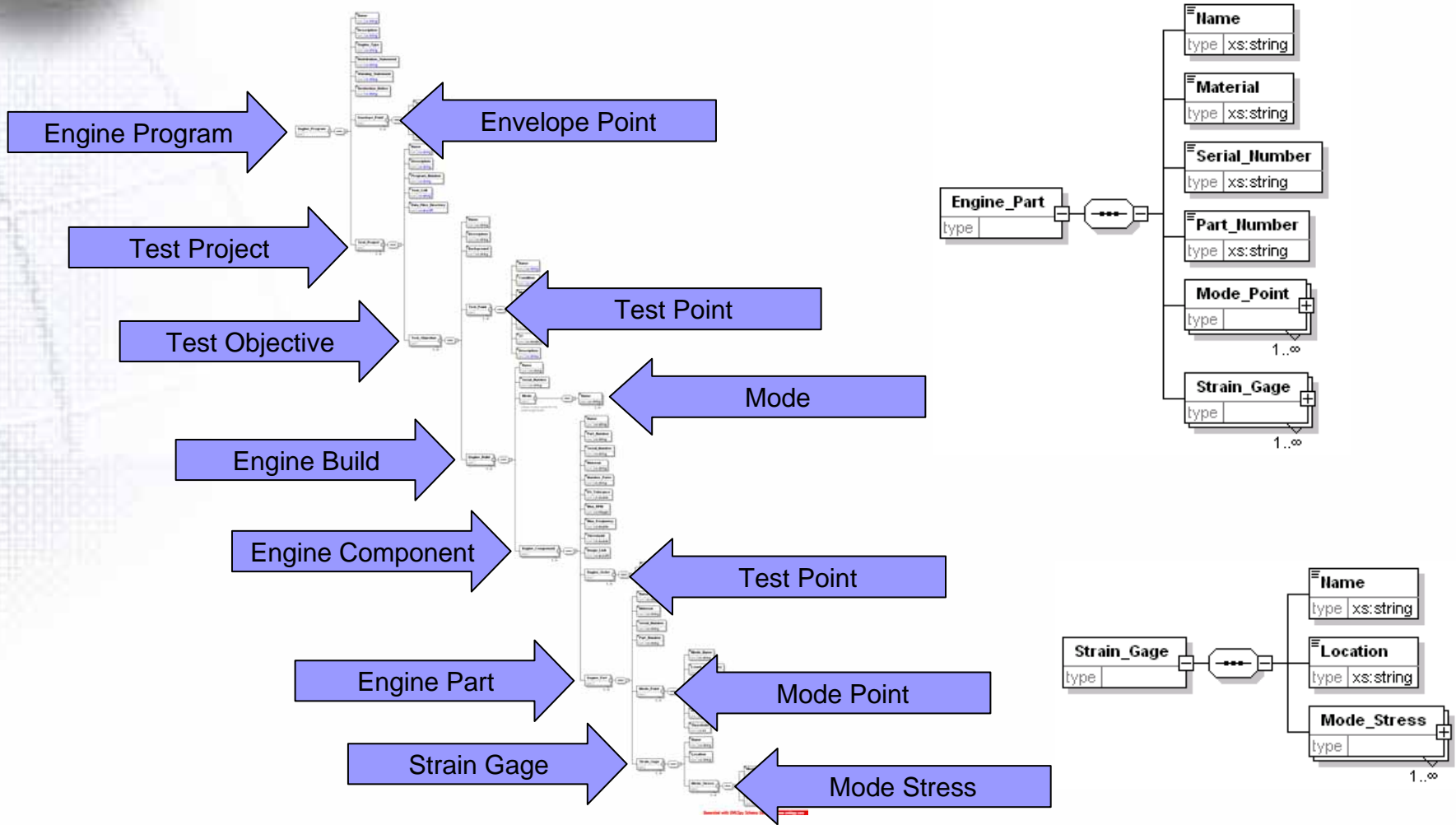
Extensible Markup Language

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<data_point test_point="">  
  <name>9500055A</name>  
  <engine_event>  
    Accel  
  </engine_event>  
  
  <mach_number>0.87</mach_number>  
  <altitude>1000.0</altitude>  
  <t2>60.0</t2>  
  <p2>14.7</p2>  
  <stress>  
    :  
  </stress>  
</data_point>
```





Extensible Markup Language





Summary

- New engine test programs require significantly more dynamic data channels (~300)
- An automated test reporting system has been developed to deal with the large amounts of data and “real-time” requirements.
- Timely reports
 - Provide critical test results information on-line during engine testing
 - Improve the ability to direct tests
 - Increase the efficiency of engine testing
 - Reduce the chances of engine structural failures