

GE Inspection Technologies

X-ray Inspection in the Aerospace Industry

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State of the Art, Challenges, and Emerging Technologies

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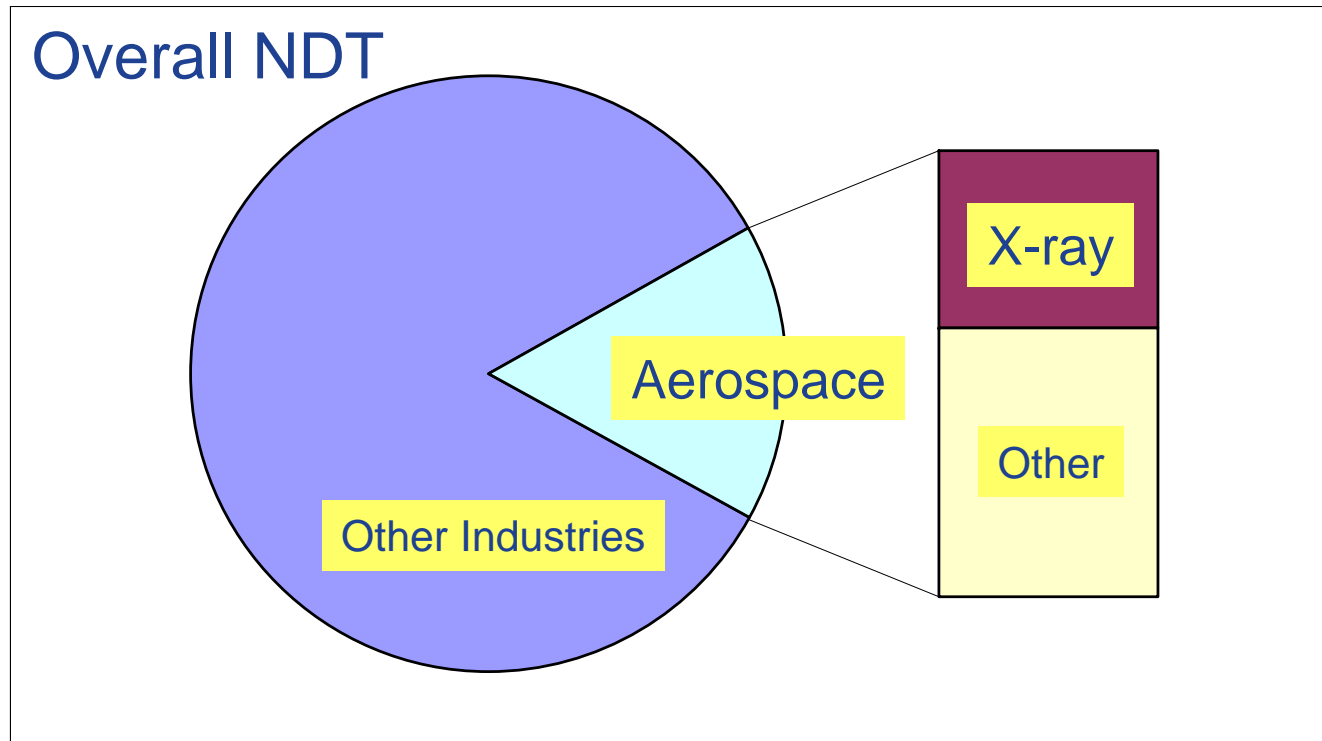
imagination at work

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Products

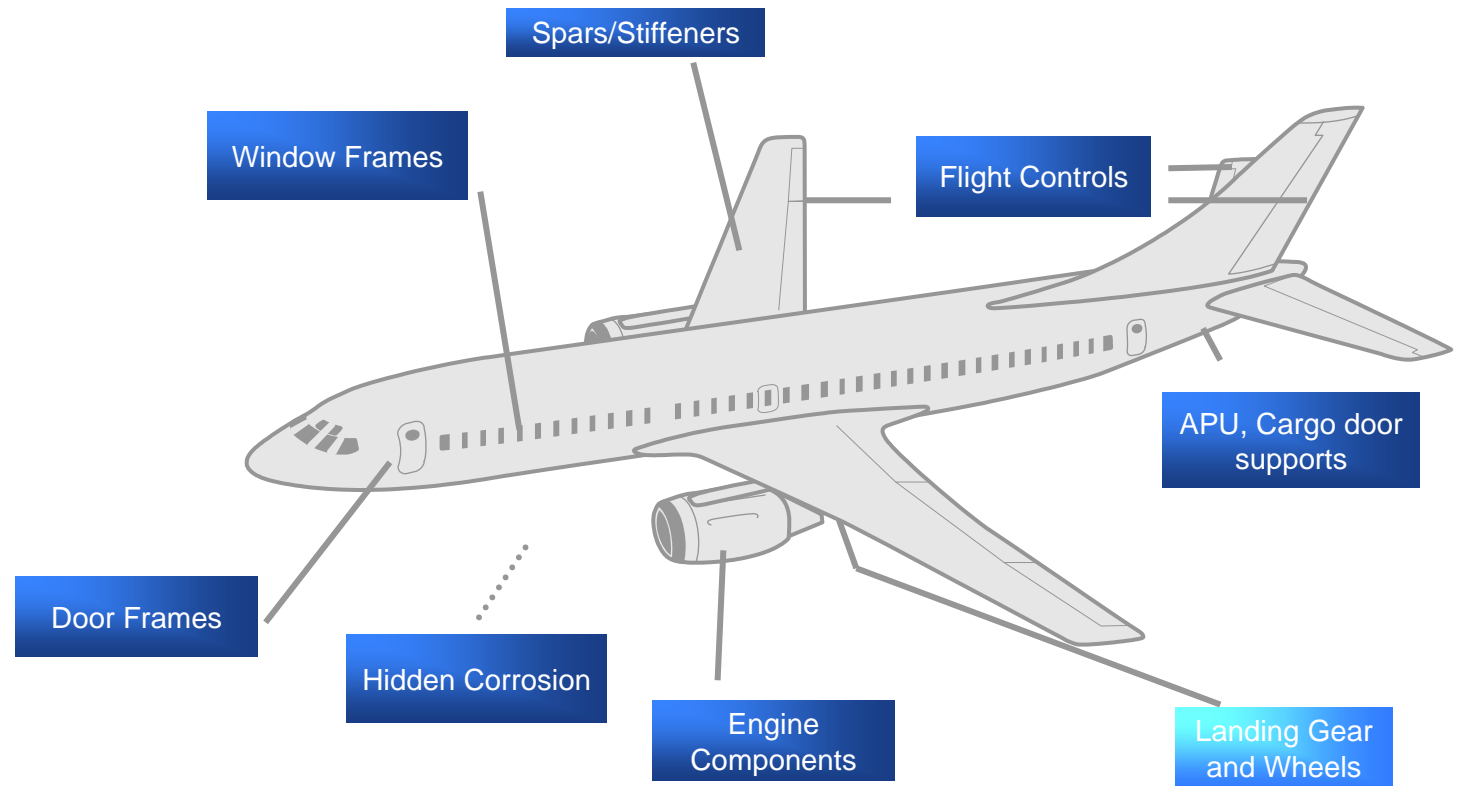
X-ray Inspection in Aerospace



Large population of aerospace x-ray inspection applications => significant and growing opportunities for efficiency improvements

Typical Aerospace X-ray Applications

- ◆ Airplane applications include:
Welds
Castings
Structural
Engines
- ◆ In-process, final manufacturing, in-service
- ◆ Commercial and Military



An Effective Life Cycle Management Tool

How can advanced technology help?

Two major classes of efficiency improvement:

- Operational
- Financial

All improvements provide value by enhancing ultimate mission of flying more at reduced costs

Value from Operational Benefits

Time and Productivity:

- Additional Throughput
- Reduced Cycle Time (e.g.,)
 - Process Simplification ...
Eliminating Steps in the Process
- Reducing Time to Perform Tasks



Targets:

- ~50% Additional Throughput



- 50% reduction in process steps



- 10x improvement in exposure time

Quality:

- Probability of Detection...Equivalent to Film in Targeted Applications



- 100% equivalence in defect indication detectability

**Improved speed/quality trade-off
allows realization of benefits**

Value from Financial Benefits

Customer's Income Statement

Sales	1,000
Variable Costs	600
Contribution Margin	400
Depreciation/Amort	20
Fixed Costs	300
Operating Margin	80
Other Inc/(Exp)	5
Interest Inc/(Exp)	(21)
Taxes	26
Net Income	38

1. Reduced Inspection Labor
2. Reduced Rework Labor
3. Reduced Variable Manufacturing Overhead – Film and Chemicals Procurement, Handling & Storage

1. Reduced Dark Room Maintenance

Customer's Balance Sheet

Cash	20
Receivables	250
Inventories	300
Other Assets	500
Total Assets	1,070
Trade Payables	280
Other Liabilities	190
Borrowings/Debt	300
Equity	300

1. Faster Cycle Time...Less WIP Inventory and Carrying Costs
2. Reduced Film and Chemical Inventory

Financial Metrics: Representative Customer Experiences

1. Net Present Value (NPV) – 2 Times Initial Investment
2. Internal Rate of Return (IRR) - 30% IRR
3. Payback Period – from < 1 to 2 Year

EACH APPLICATION IS DIFFERENT AND NEEDS ANALYSIS

Representative Aerospace Solutions

Four examples of using technical advantages to achieve measurable benefits:

- Image intensifier to digital real-time
- Conventional Film to CR
- Conventional Film to Static DR
- Conventional Film to Automated DR

DXR Digital Solution – Real-time Radioscopy

Application: Fabricated tanks/coolers for engines – In-service Inspection



Customer Situation:

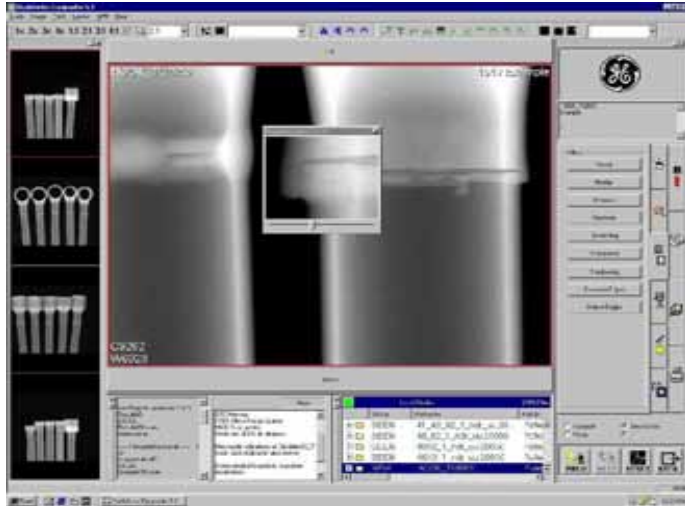
- Image intensifier approaching end-of-life

The Solution:

- GE Revolution™ Flat Panel Detector (DXR-250RT)
- GE Inspection Management Software
- Retrofitted into existing inspection system

Operational Benefits:

- Significant Image Quality Improvement
 - Faster identification and call-out
 - Reduction from double- to single-shift
- Improved documentation and communication
 - Reduction in “missed” and unnecessary repairs



CR Digital Solution – Film Replacement

Application: Wax inserts for turbine blade casting – mfg. in-process inspection



Customer Situation:

- Customer was looking for higher throughput in “lost wax” casting process

The Solution:

- CR Tower scanner with Premium imaging plates
- GE Inspection Management Software- Rhythm
- Retrofitted into existing inspection process

Operational Benefits:

- Faster exposure times
 - Improved throughput.
- Improved documentation and distribution of results through the network
 - Improved process control

DXR Digital Solution – Film Replacement

Application: Brazed/Welded assemblies – mfg. in-process and final inspection



Customer Situation:

- Productivity and throughput improvements needed in conventional film x-ray inspection.

The Solution:

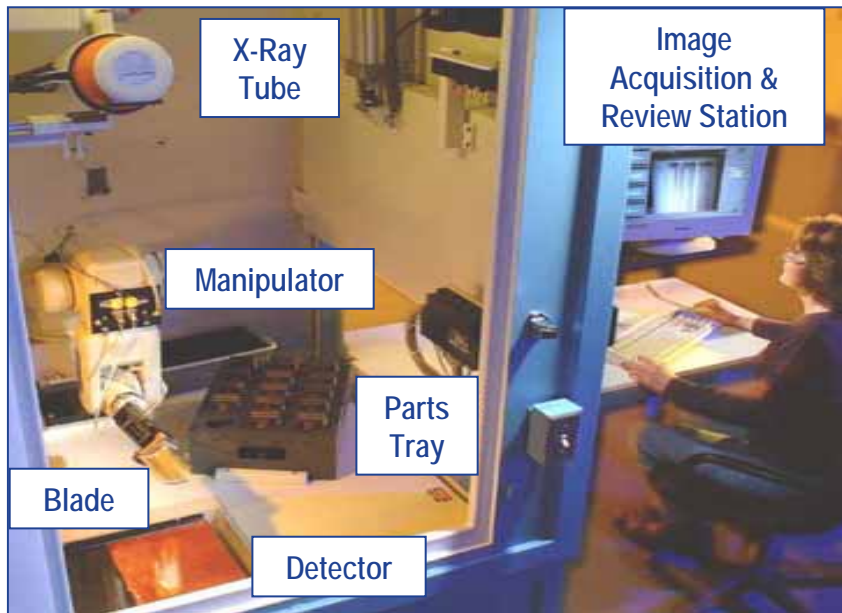
- GE Revolution™ DXR-500 detector
- GE Inspection Management Software
- Retrofitted into existing inspection system

The Benefits:

- 2x inspection throughput increase
 - Allowed additional in-process inspections to sort prior to performing additional high-cost processing steps
- Fast transmission of imagery for off-site engineering reviews
 - Reduced review cycle time from days to hours
 - Reduced inventory costs

DXR Digital Solution – Small Parts System

Application: High Pressure Turbine Blades – Weld Inspection



Customer Situation:

- Customer was looking for additional opportunities to meet productivity targets.
- HPT blade repair was targeted as an opportunity to increase capacity of the inspection process.

The Solution:

- GE Inspection Management Software
- GE Revolution™ Flat Panel Detector (DXR-500)
- GE Seifert Isovolt X-ray Equipment
- Integrated Part Manipulator
- X-Ray Protection Cabinet

The Benefits:

- 50% reduction in Inspection Cycle Time
- Significant TAT reduction by addition of pre-sort inspection
- Improved final test acceptance rate
- Reduction in film and chemicals use



Challenges

Identification of overall process bottlenecks

Ensuring operational readiness

End customer and standards acceptance

Barriers can be overcome through careful
planning and technical understanding

Summary

Many aerospace x-ray applications are candidates for efficiency improvement.

Measurable benefits result from thorough analysis of customer operations and careful solution selection.

Key requirements for effective implementation include:

- Technology + Software + Service = **Solutions**
- World-wide presence
- Expertise in process and technology improvement

<http://www.GEInspectionTechnologies.com>