GE Aviation Perspectives on Sustainable Manufacturing

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The Challenge

"Sustainability has become a common currency in describing proactive plans

and solutions in many scientific, engineering, and social science disciplines

with no consensus on what sustainability means."

(ICOSSE 2009 structure statement)

GE Focus on new energy efficient products

- design, make, recycle, reuse just beginnin

Engine Designs

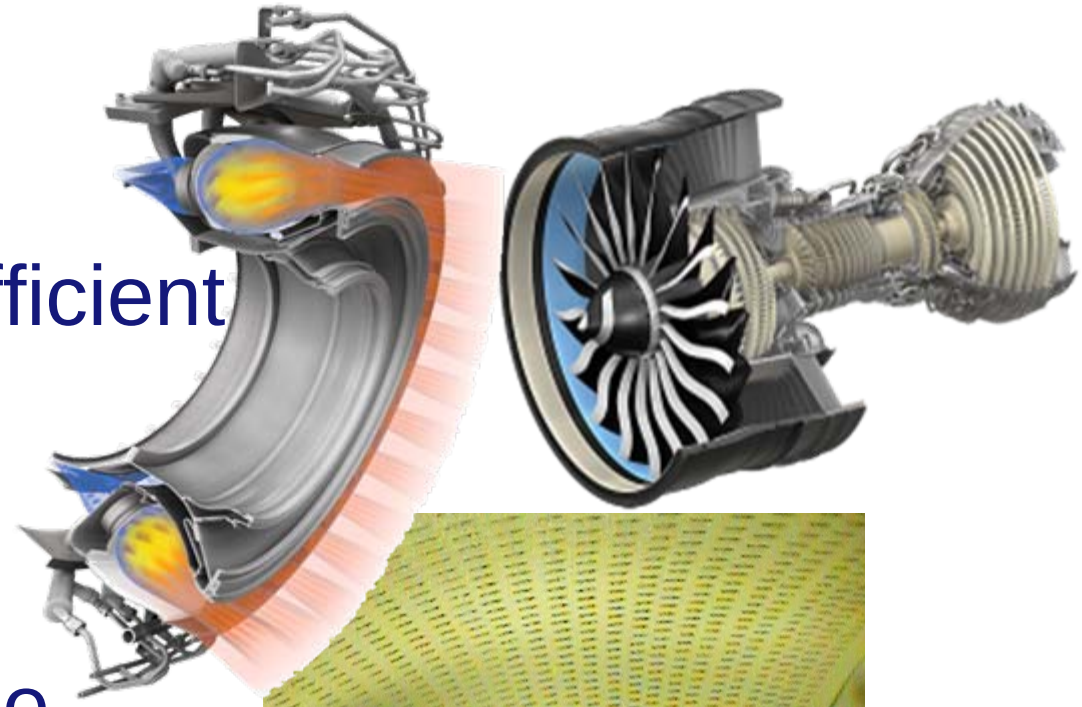
- 20% more fuel efficient

- 30% fewer parts

- Less maintenance

- Emissions < 2020 reqts.

- Noise << most strict airports

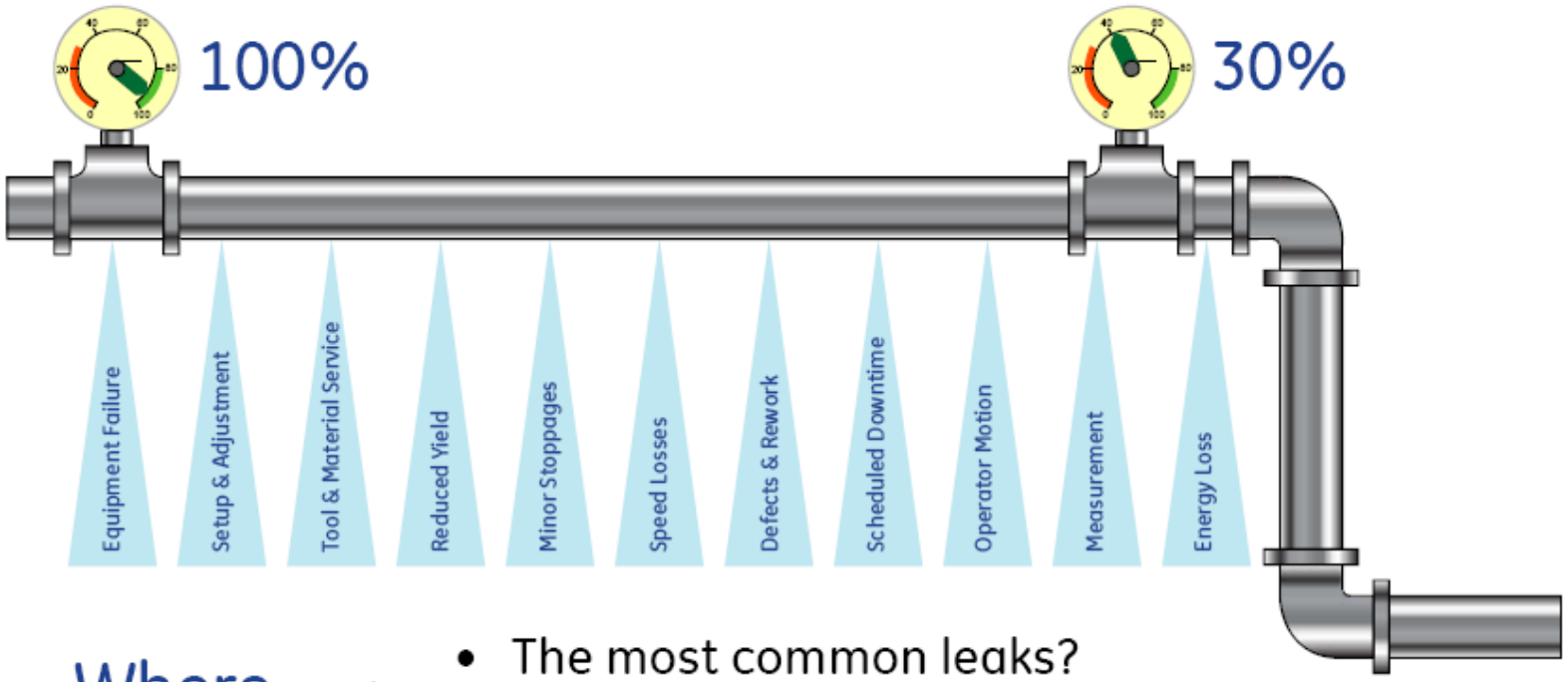


What do these aircraft (engines) have in common

Both machines have parts made on this machine.

Not necessarily a bad thing, but how to measure sustainability & footprint?

Overall Equipment Efficiency (OEE) is One Affordable Soluti



Where are?

- The most common leaks?
- The most expensive leaks?
- The equipment vs process leaks?

FANUC

Typically Can Find Significant Capacity if Measured

Intelligent/Smart Manufacturing

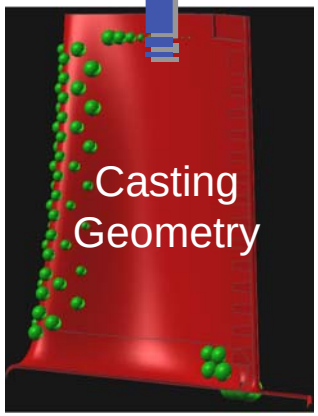
Columns Gage

IP Airflow

Coatings

Data/Information Infrastructure

Data Feedback



Breakthru Data

Final Airflow

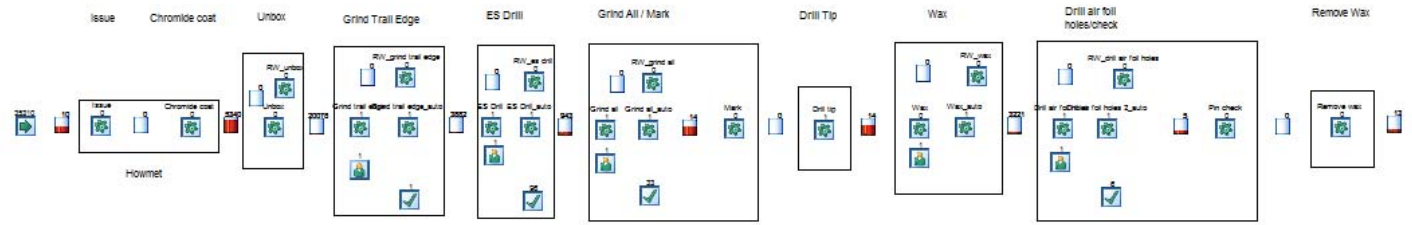
Data Legend:
- As-cast shape
- Columns gage
- IP Airflow
- Breakthru data
- Final Airflow

Use upstream information to reduce rework, scrap, & variation

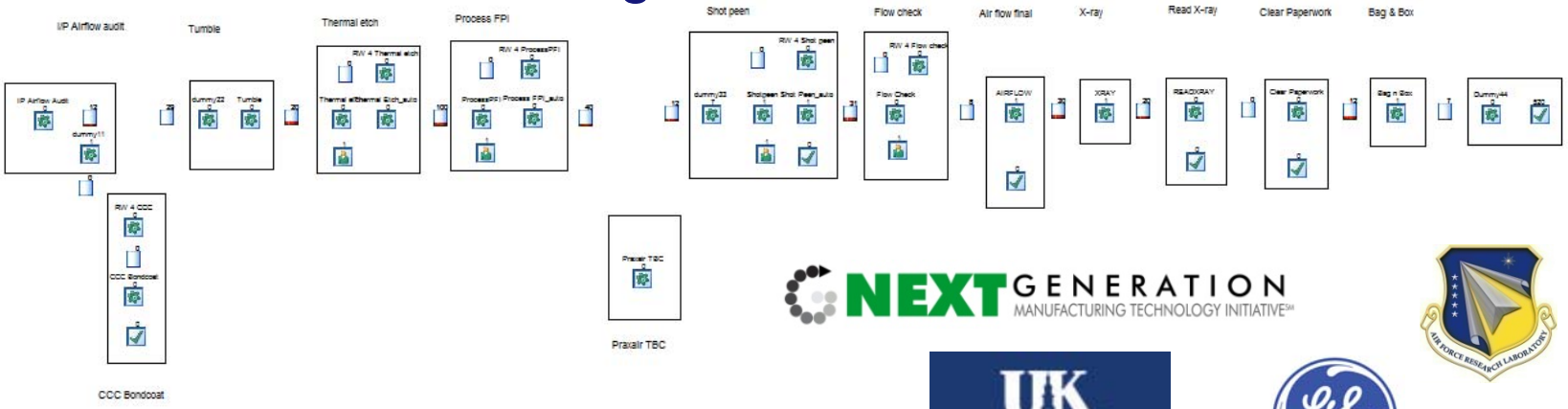
Process models good, need on machine measurements

Shop Floor Modeling and Monitoring:

Teaming with Kentucky to map the floor,
then supply chain, then map energy consumption



Turbine airfoil manufacturing line



RANGER Program
(Risk Assessment for Next Generation Manufacturing Readine

GE Initatives: Additive Fabrication

Reduce raw material, least machining (energy) to make a part

Simplifying large components

Combining multiple small components

A New National Initiative, New Design Space
Competitive Product Performance Levels

GE Summary / Challenges (A Regulated Industry)

- Working on lower energy consumption products

- Need tools to assess carbon impact when changing manufacturin
  50,000 foot view tool(s) regarding:
  - raw materials
  - forming processes (e.g. casting, forging)
  - finishing machining

- Need tools to assess risks of changing manufacturing

- Need tools to assess financials of changing manufacturing

Models are Nice, but…
Capability to Use Live on Line
Identify Measurement Touch Points

Backups

OEE Example

Cell Leader Report

- OEE between 80% and 110%
- Machines running 3-shifts/6-7 days a week
- Not able to meet demand
- Need more machines

Problem is Performance!

- Some machines producing at rate
- Little consistency
- 3rd shift most productive!
- Best practices to share?
- Bad practices to eliminate?

Unit	%OEE	Availability Rate %	Performance Rate %	Quality Rate %	Net Production	Run Time
MC8085	17.0%	95.8%	17.8%	100.0%	2.4 -	07:39
	87.6%		49.6%	100.0%	- -	-

Time: 11/28/2006 7:00:00 AM To 11/28/2006 3:00:00 PM

Unit	%OEE	Availability Rate %	Performance Rate %	Quality Rate %	Net Production	Run Time
			39.6%	100.0%	2.5 -	03:54
			65.7%	100.0%	5.3 -	07:14
		7%	100.0%	100.0%	3.6 -	07:37
		98.2%	5.0%	100.0%	1.7 -	07:51
		94.7%	26.0%	100.0%	- -	-

Time: 11/28/2006 3:00:00 PM To 11/28/2006 11:00:00 PM

3rd Shift

Unit	%OEE	Availability Rate %	Performance Rate %	Quality Rate %	Net Production	Run Time
MC7554	28.6%	99.7%	28.7%	100.0%	3.3 -	06:59
MC7555	62.7%	100.0%	62.7%	100.0%	4.4 -	06:48
MC8084	98.8%	98.8%	100.0%	100.0%	2.2 -	07:23
MC8085	92.7%	92.7%	100.0%	100.0%	2.6 -	06:54
Summary	-	97.7%	57.2%	100.0%	- -	-

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Inexpensive Devices Can Accurately Map Flow

GE ecomagination Commitments

- Double GE's investment in R&D, growing our research in cleaner technologies from $700 million in 2005 to $1.5 billion by 2010

- Increase revenues from eco products to $25 billion in 2010

- Reduce our greenhouse gas emissions and improve the energy efficiency of our operations

- Reduce our global water use 20% by 2012

- Engage and inform the public