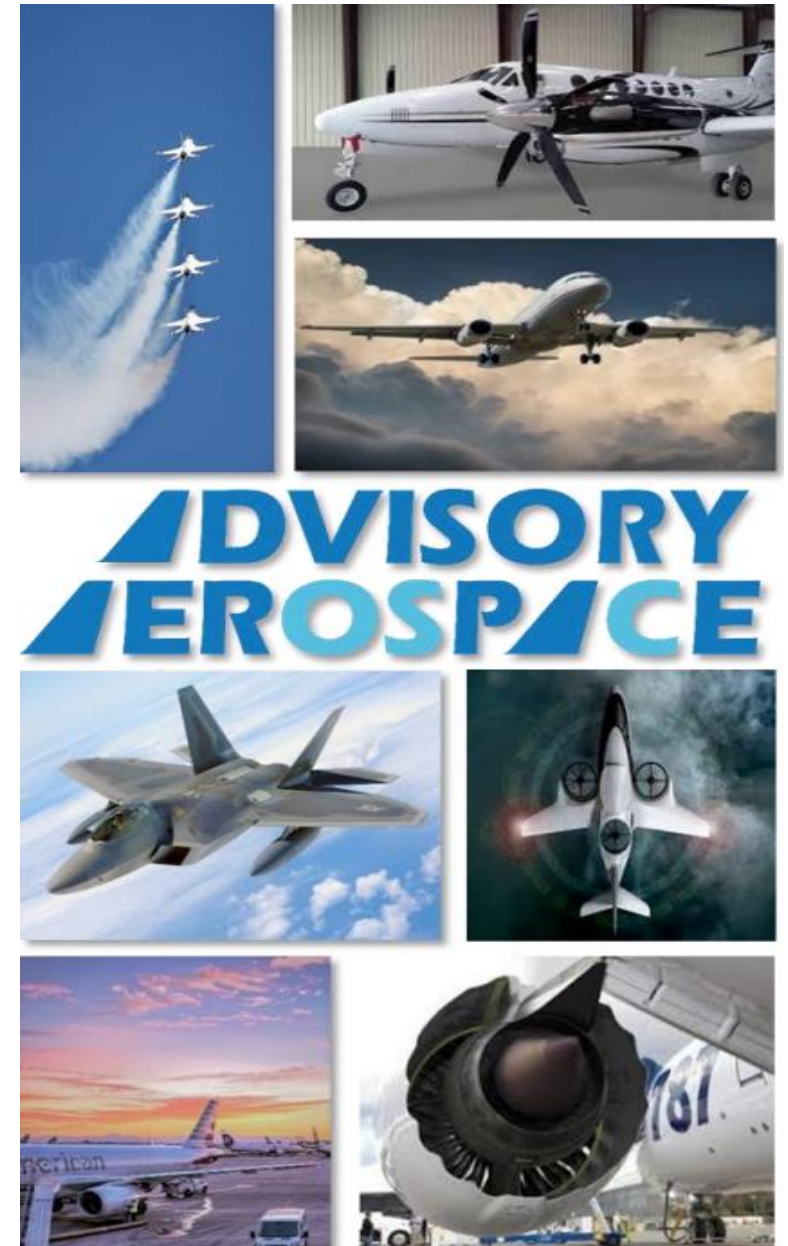


# near The Future of Aerospace Manufacturing

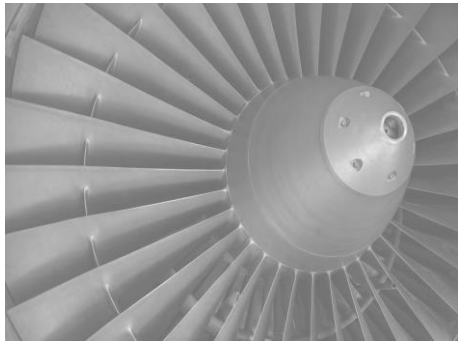
A Keynote for:



Vivek Saxena, PhD  
Managing Director



# AdvisoryAero combines hands-on operational expertise of executives with deep analytical rigor of consultants



## Expertise

- Transaction Support
  - Due diligence (Market & Ops)
  - Integration
- Cost Reduction
  - Plant cost structure
  - Product cost reduction
- Operations Transformation
  - Lean Six Sigma, Agile
  - IIoT, Data Analytics, Optimization
- Advanced Technologies & Tools
  - Affordable 4.0 (Trade Marked)
  - Composites, Additive Mfg.
- Aerospace Cluster Development

## Experience



MARKETS



eVTOL Air Taxi & Cargo Drones



Rotorcraft



Business & General Aviation

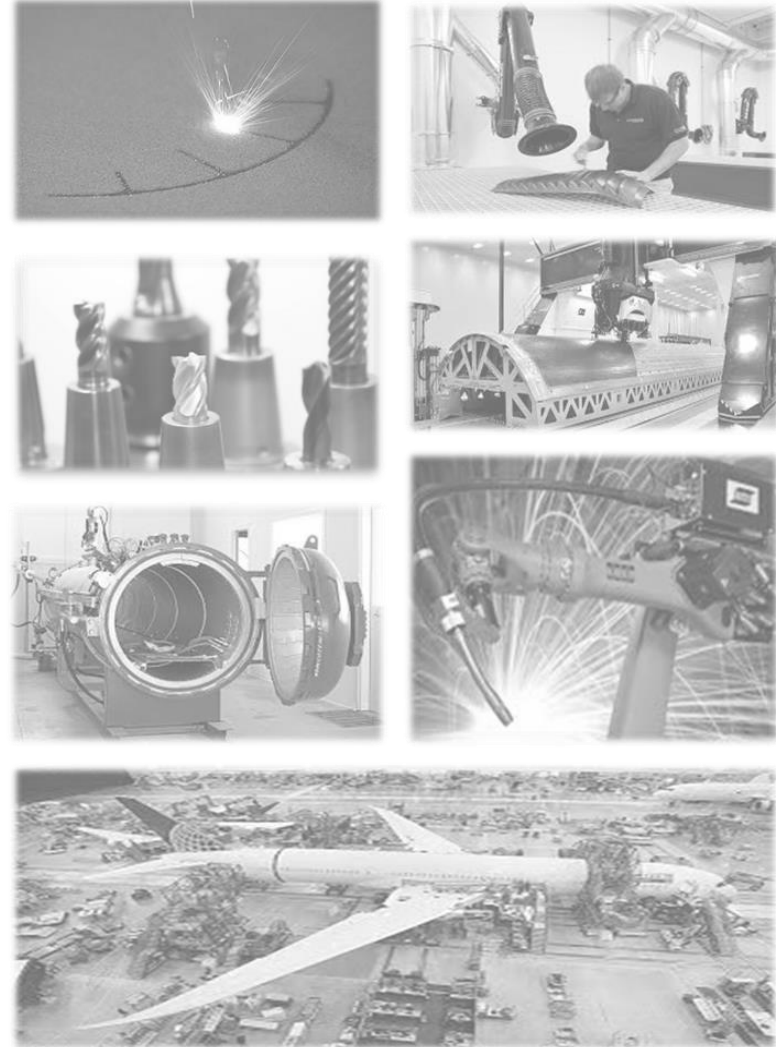


Military



Commercial Transport

# Speech Content



New products will be disruptive for select manufacturers

New materials' adoption will step up

Lean, Six Sigma, Agile.... What next?

New enabling technologies....Industry 4.0 / Affordable 4.0<sup>TM</sup>

Back to Basics

# Exciting times in aerospace vehicle development today will impact manufacturing in the medium to long term



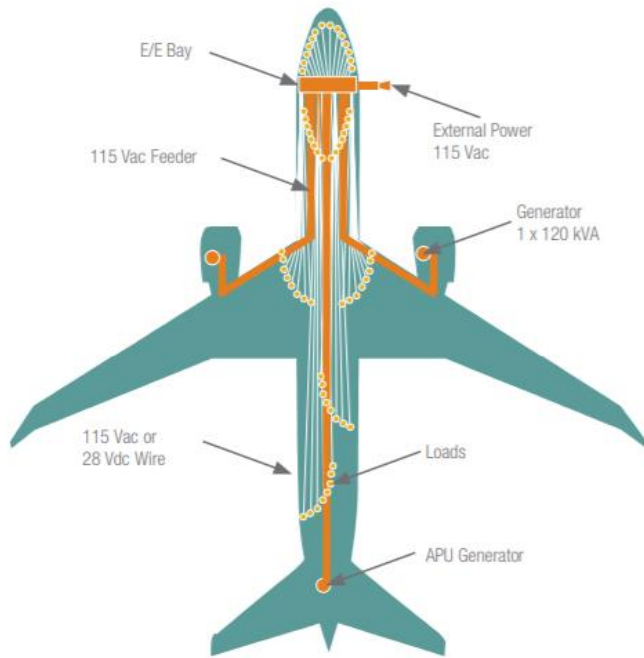
NMA & Single Aisle Replacement  
eVTOL / Urban Air Mobility  
Nano Satellites & launch vehicles  
Cargo Drones  
Electric & Supersonic Transport

More Electric content  
More Autonomy (Sensor & Actuators)  
Connectivity, Electronics & Software  
Affordable Aerostructures

Very bullish Morgan Stanley projects a \$1.5 Trillion market for eVTOL aircraft by 2040

# More electric and smarter systems are already a trend in air transport; Step change expected for smaller aircraft

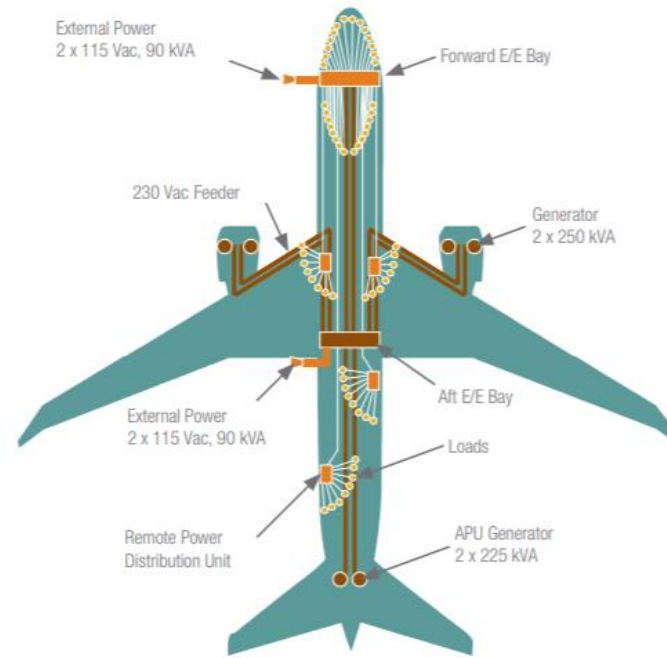
## Traditional



Centralized Distribution:  
Circuit Breakers, Relays,  
and Contactors

More Electric  
Boeing NMA

## B787



Remote Distribution:  
Solid-State Power Controllers  
and Contactors

Hybrid Electric  
Regional

Fully Electric  
eVTOL, Drones

Aircraft	Traditional	B787
Sensor Count	2,000	5,000
Data (/FH)	1 MB	100 MB
Download	ACARS/QAR	SatCom/WiFi

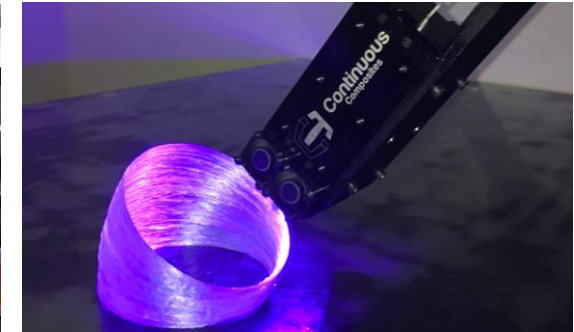
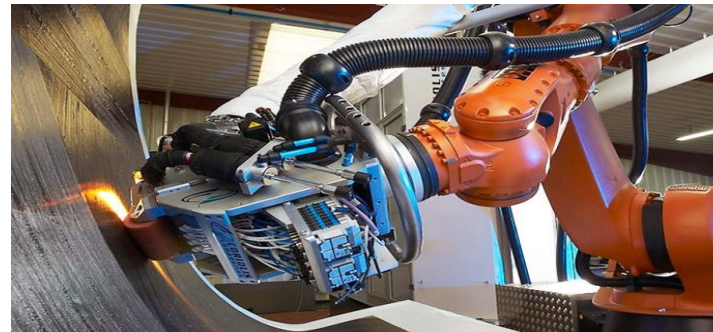
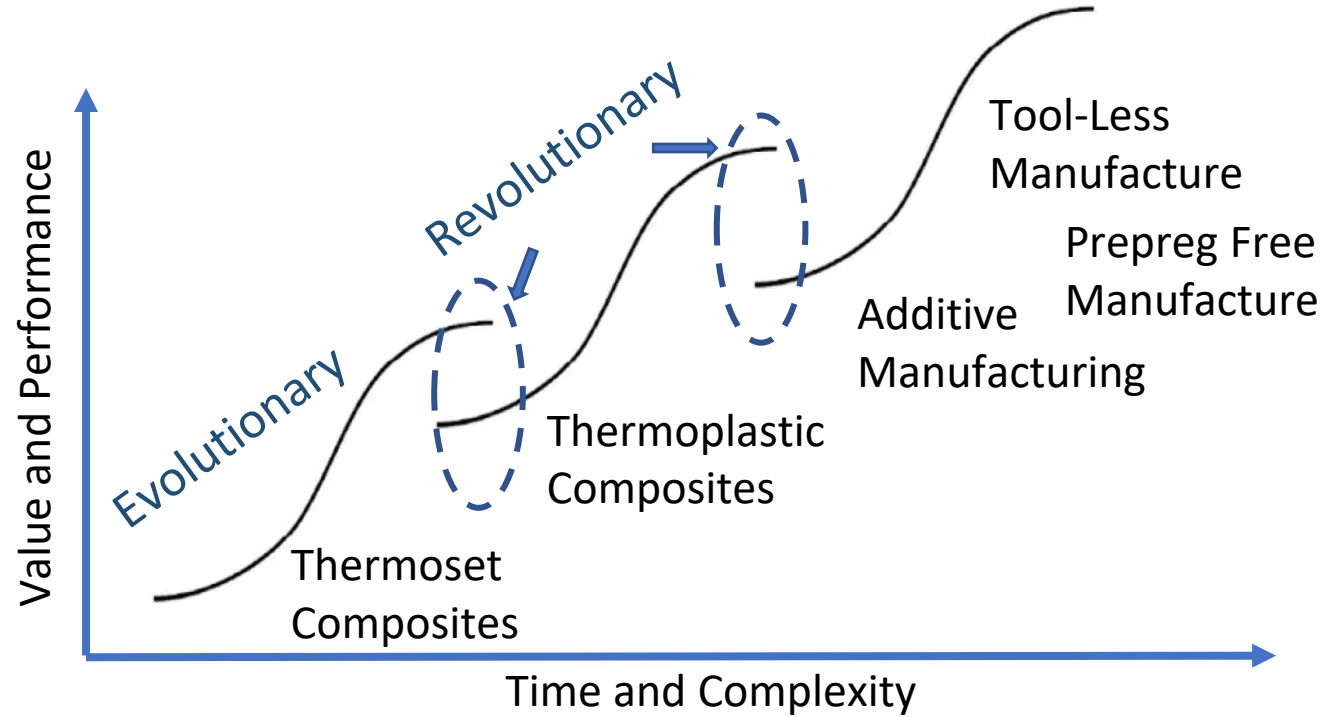
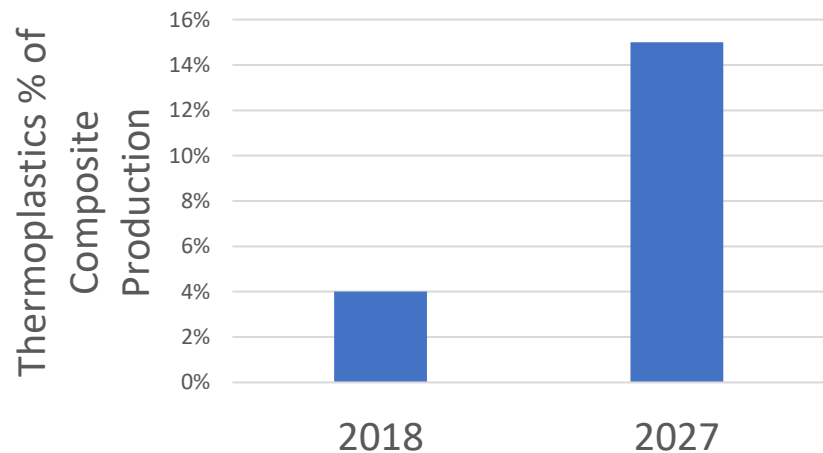
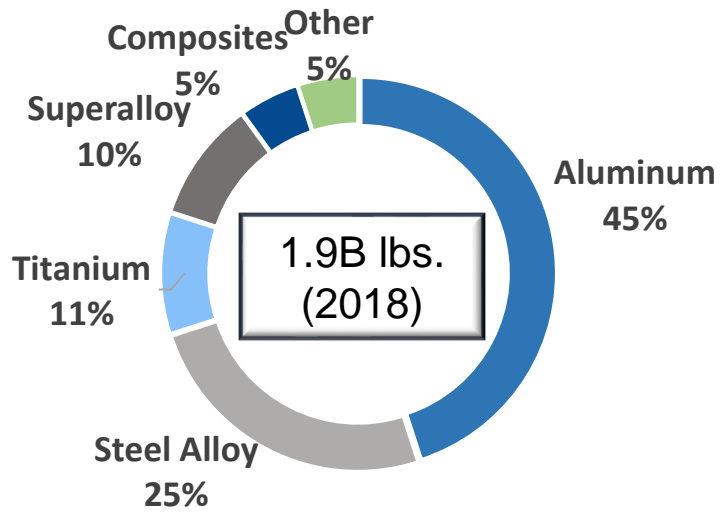
Example of innovation:  
3 Phase Active Power Factor  
Correction in one step  
Size, weight, cost benefit  
Replaces traditional ATRUs



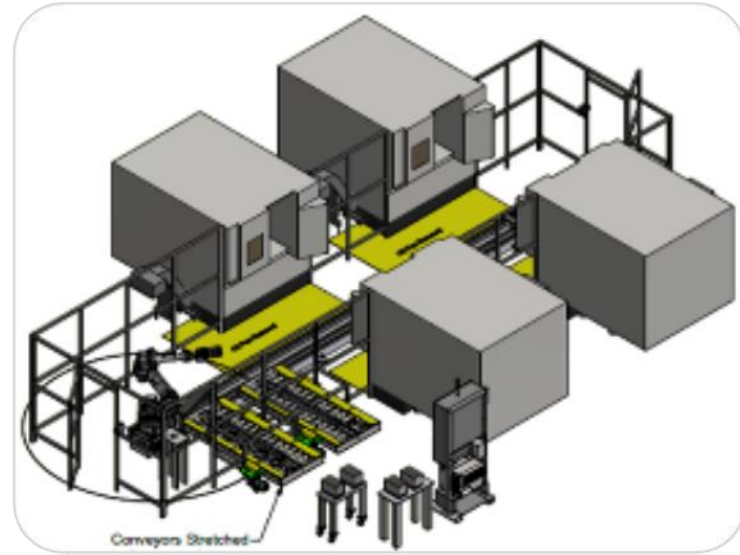
Component manufacturers from adjacent industries and innovative smaller players will compete aggressively

# Need for affordable and light aerostructures will drive more innovation in composite manufacturing & 3D Printing

Aerospace Material Consumption



# Metal machining and fabrication will also adopt more automation, IoT and data analytics



20 year old technology

50% reduction in direct labor

Zero changeover time

Production flexibility



IoT for machine monitoring  
Lights out machining  
IoT for preventive maintenance  
IoT for coolant control  
Shop optimization using analytics



Robotic de-burring remains an opportunity

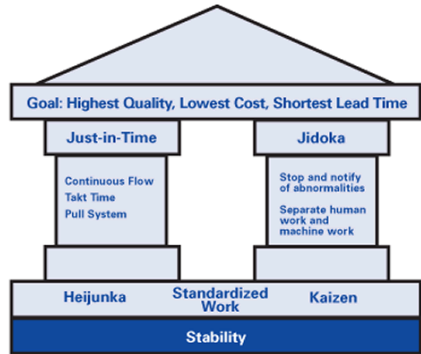
# The journey from Lean to Agile is all about increasingly more scientific approach to running operations

## Lean

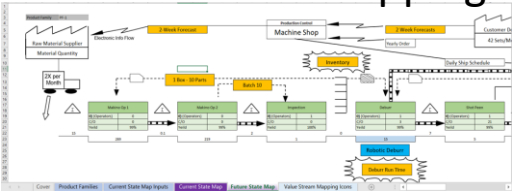
### 8 Wastes of Lean



### Toyota Production System



### Value Stream Mapping



## Six Sigma

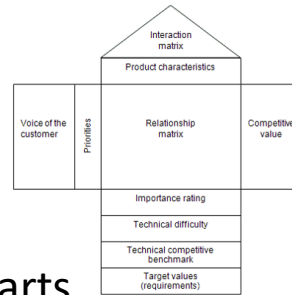
### DMAIC



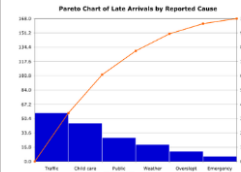
### DMADV



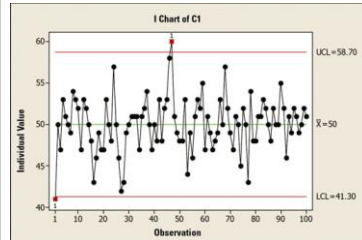
### QFD



### Pareto



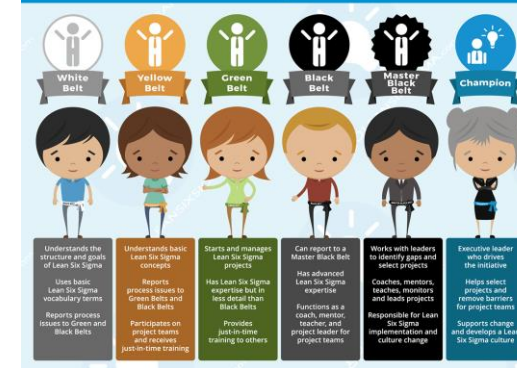
### Control Charts



## Lean-Six Sigma



### Lean Six Sigma Roles

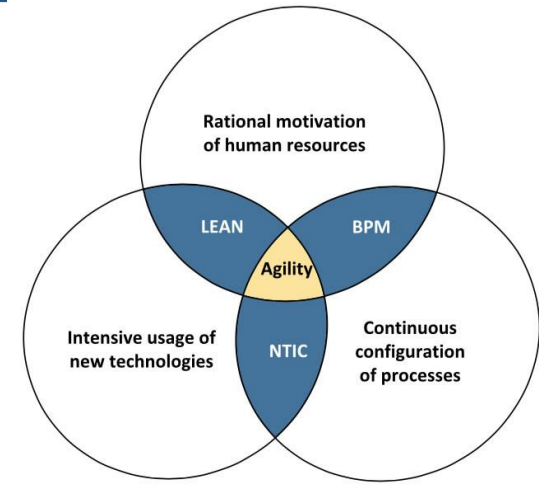


### Toyota Kata



## Agile

### Agile Manufacturing

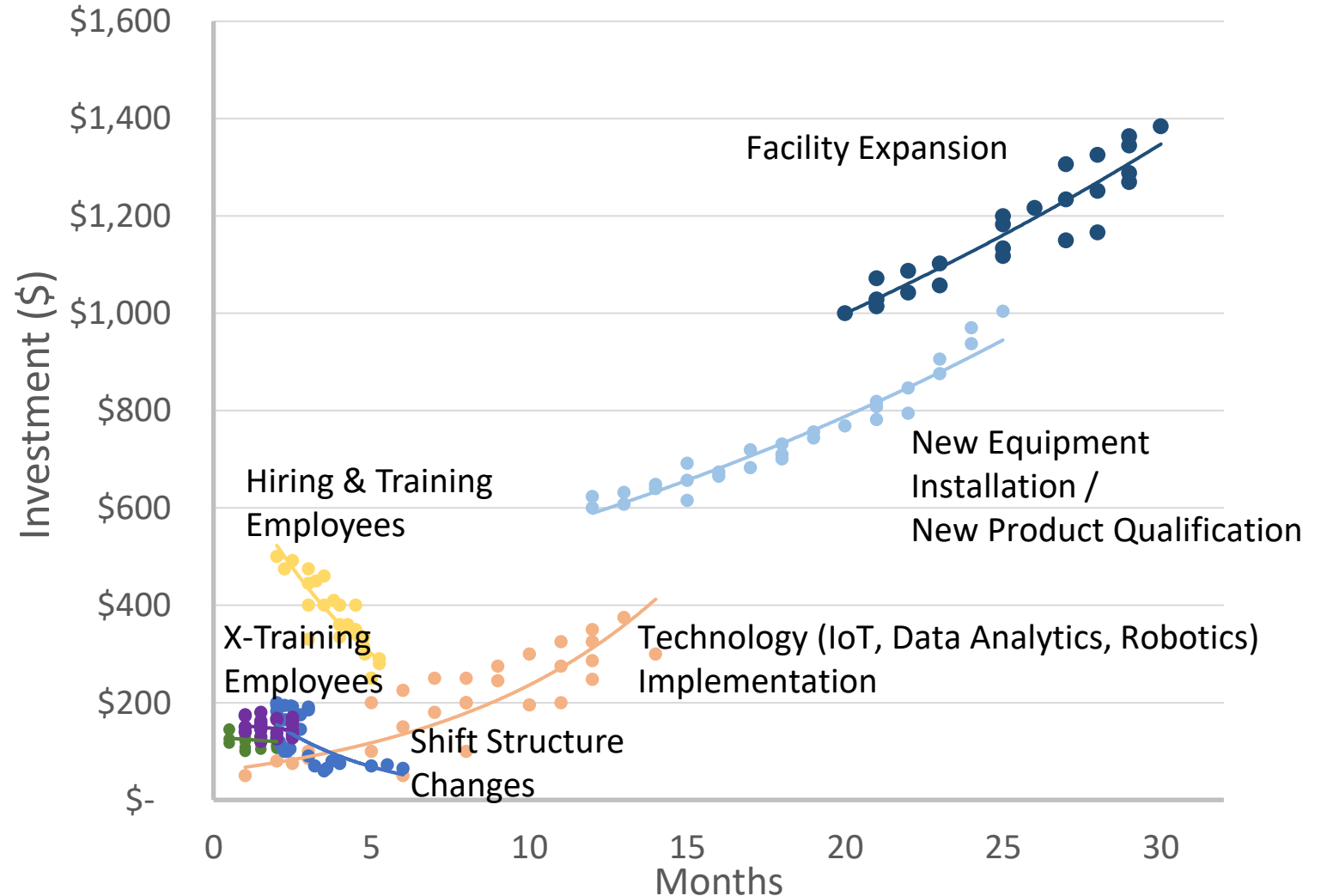




# Agility in the context of timescales of possible responses; Flexible operations and technology are keys to agility

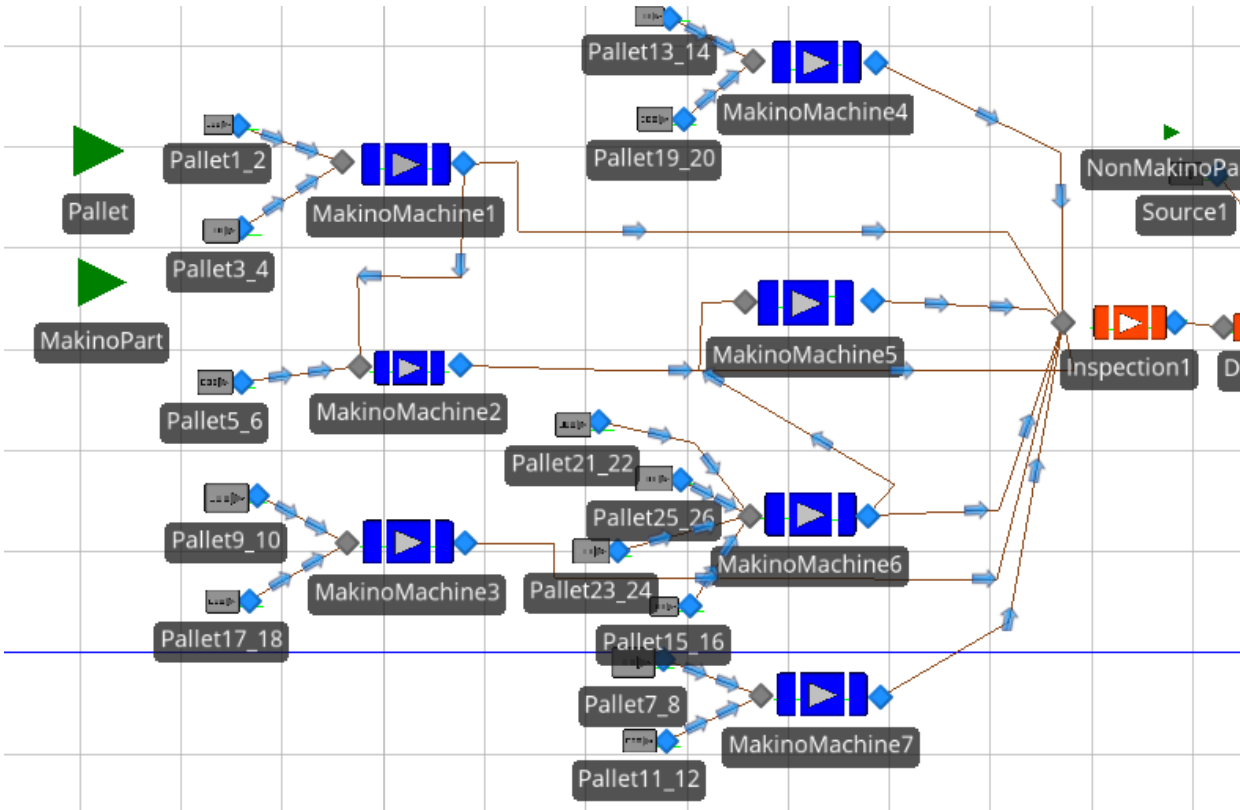
Flexible Operations  
Resource & Time Buffers  
Analytics Tools  
Flexible Contracts

Real Time Sensing  
Rapid Analysis and  
Scenario Planning  
Response Aligned w/ LT



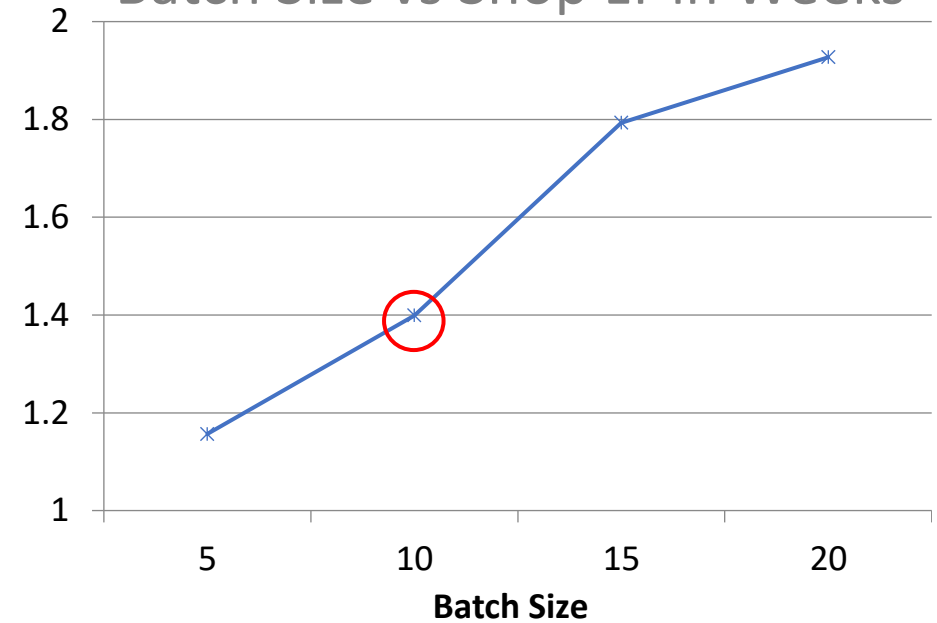
# Lean principles are simplified factory physics; Economics must be coupled with physics to get best results for the business

## Stochastic Simulation of a Vertically Integrated Shop



Three month project can give up to 20% margin improvement, 20% cash flow & 10 points in delivery improvement in 6 months

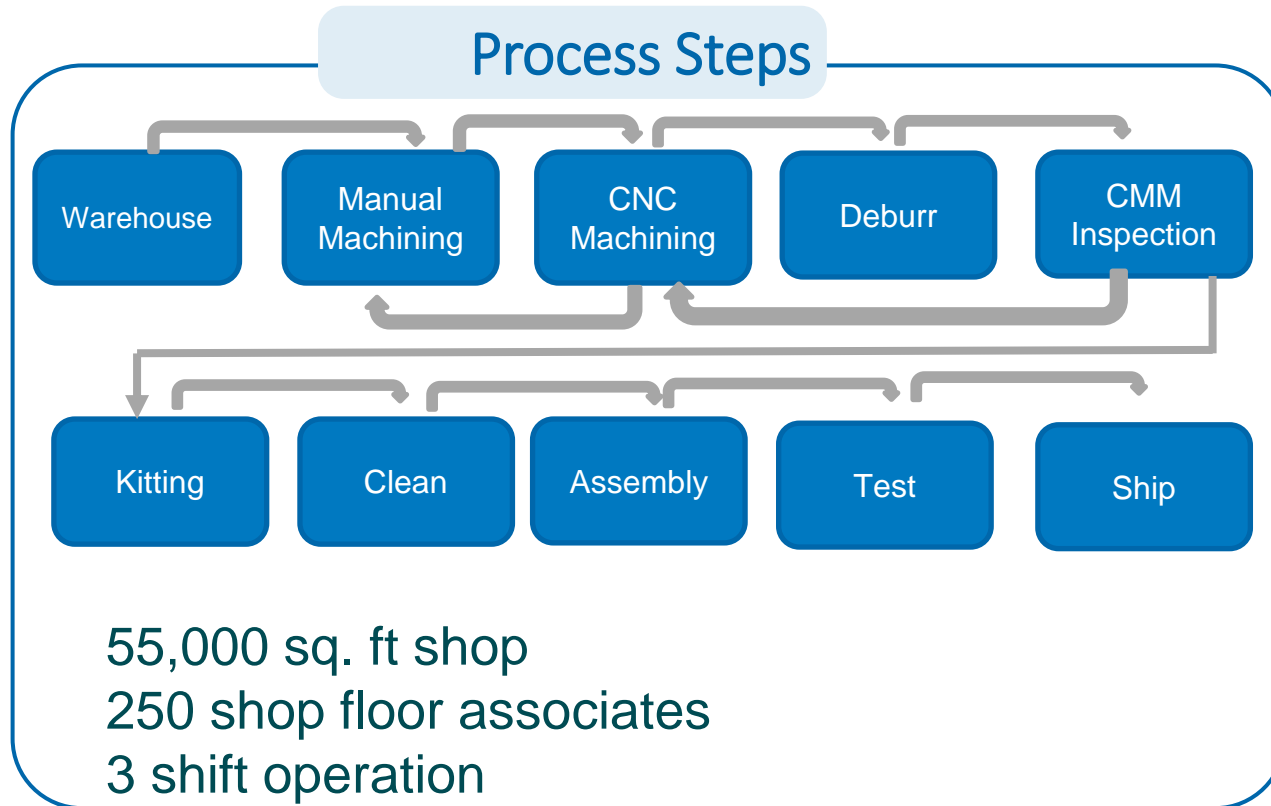
## Batch Size vs Shop LT in Weeks



Lean + Economics

- EOQ Considerations
- Shift Structure
- Product Mix
- Optimization Objective

# Power of Data Analytics - \$70M aerospace shop demonstrated massive OTD jump while undergoing historic growth



## Product / Customer Mix

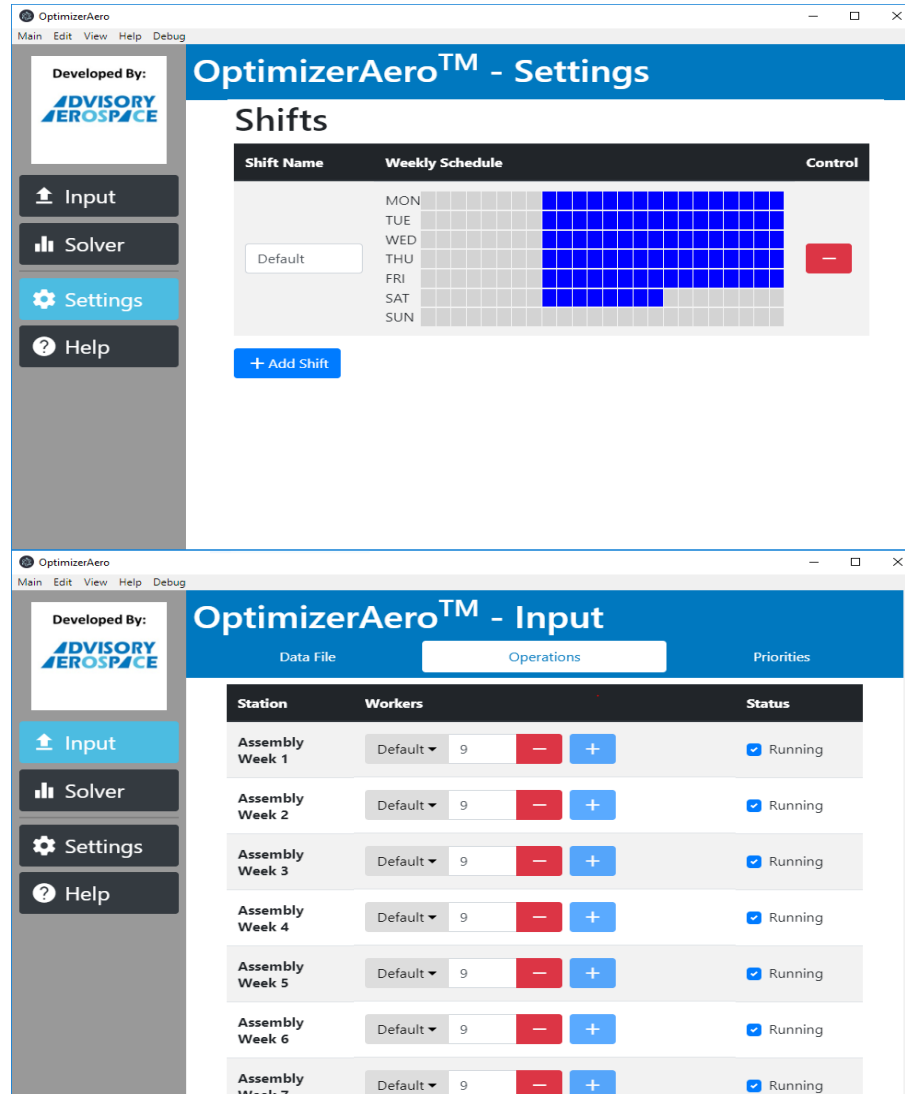
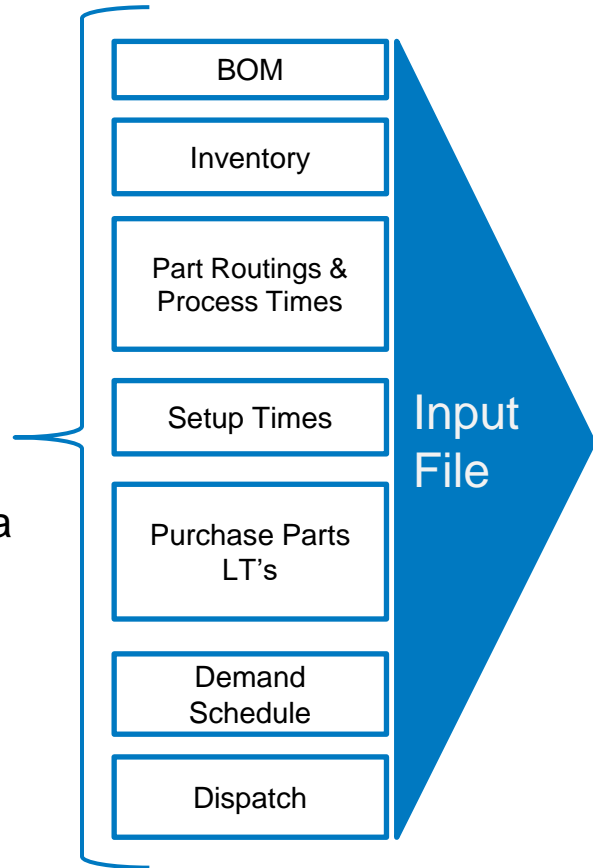
### Product Offerings:

1. Precision Valves
2. Manifolds
3. Motor Drives
4. Control Actuation Systems

Customers: Major A&D  
OEMs, DoD

# OptimizerAero interface has been designed to be user friendly for all stakeholders

- ERP System
- Other Data Sources



## OUTPUTS:

- Capacity Utilization
- Optimized Schedule
- Performance Metrics

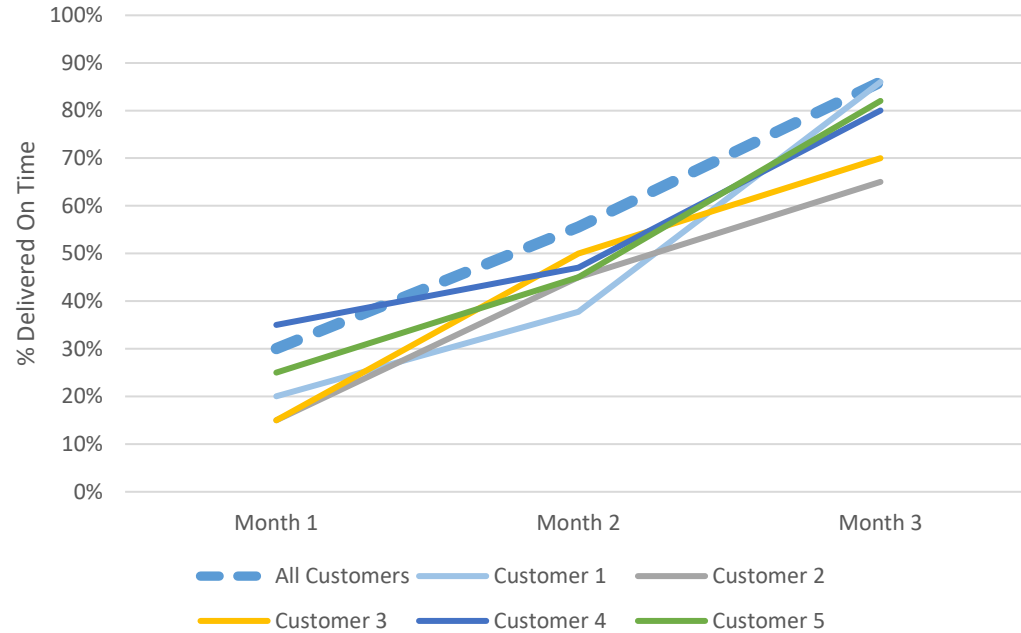


## USER INPUTS:

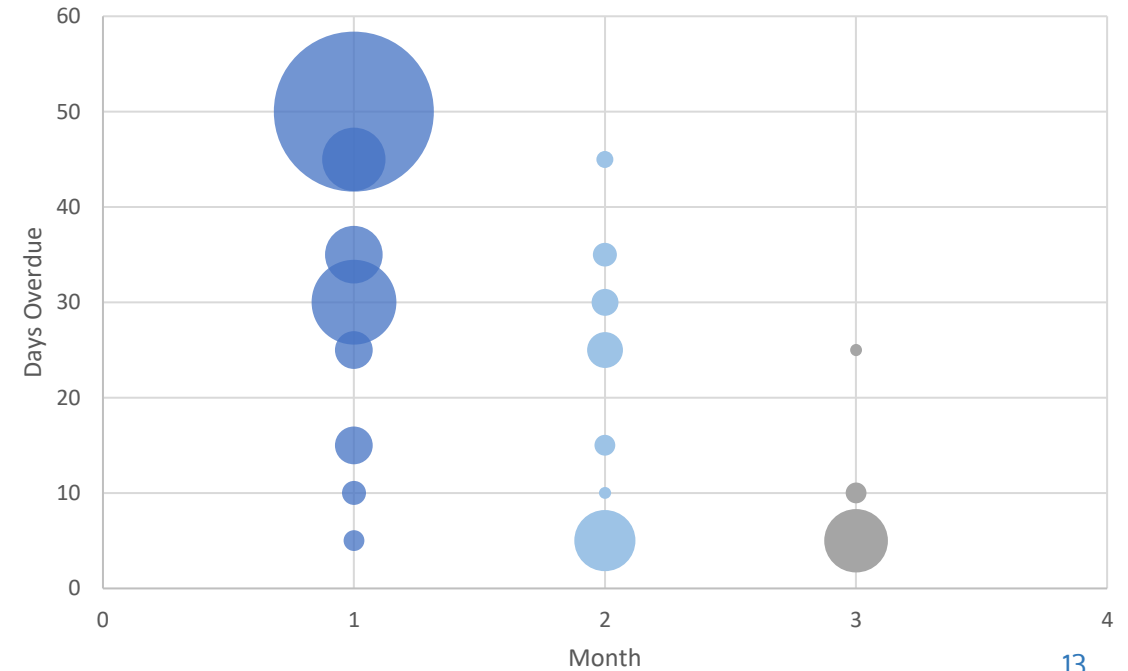
- Shift Structure
- Capacity Constraints
- Objective:
  1. Max OTD
  2. Max Revenue
  3. Customer Priority
  4. WO Priority

# Visual output gives critical shop metrics to quantify improvement

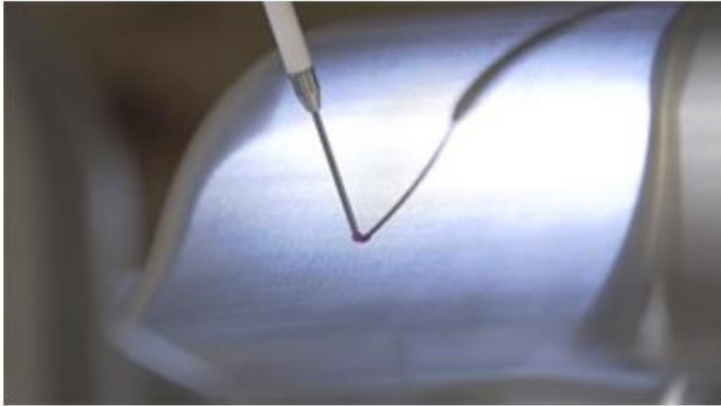
## Order OTD All Customers



## Number of Orders and Days Overdue across All Customers



# Let's not forget inspection & quality control – Both dimensional and visual inspections are getting transformed



In Process Measurements

Breakthrough systems available  
Helps realize the dream of  
'in process quality assurance'  
Highly automated  
Closed loop correction



Machine Vision

Plus

Machine Learning



Eliminates subjectivity & operator to operator variation  
Brings the rigor of Gage R & R concept to subjective pass / fail criteria  
Brings objectivity to the dreaded 'visual specs' of our industry

# Fundamentals of Manufacturing & Factory Physics do not change; Culture plays a big role during transformations

## Boeing tanker jets grounded due to tools and debris left during manufacturing

Originally published February 28, 2019 at 11:00 am Updated February 28, 2019 at 3:51 pm



The Boeing KC-46 tanker program, built on the frame of a Boeing 767, is assembled in Everett. (Seattle Times)

Boeing is not alone in simultaneously addressing the basics of manufacturing and quality control while also embracing the transformational technologies

AEROSPACE

## Boeing signs \$1 bn contract with Dassault Systemes

by Staff Writers  
Paris (AFP) July 25, 2017

US aerospace giant Boeing has signed a billion-dollar contract with French industrial software company Dassault Systemes to modernise its production system, French media said Tuesday.

"Boeing has signed a 30-year contract worth a billion dollars, renewable every 10 years," said Le Figaro newspaper, which is owned by the Dassault group.

The partnership will focus on the use of 3D software "to design future products, to modernise the entire production system and to deploy new services".

The software allows all stages of production, from the design to the management of subcontractors, to be organised across a single interface.



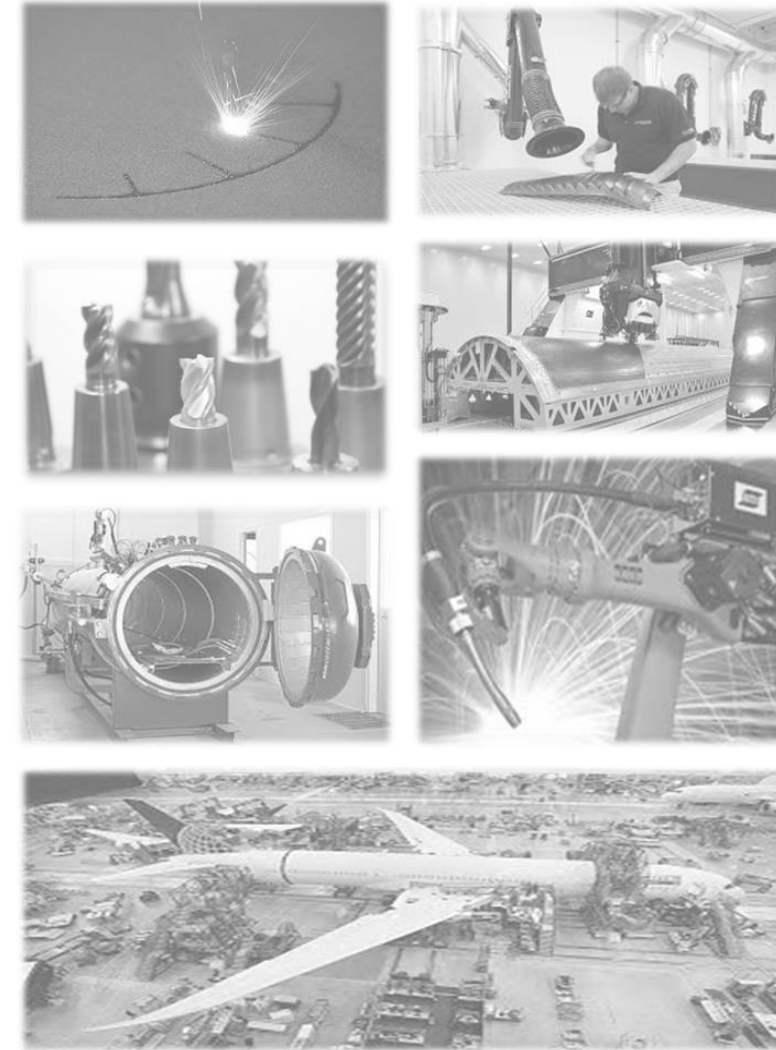
# Summary

Back to basics – Principles of factory physics do not change, no matter what buzzwords trend on social media

Technology alone is not enough – Does your organization value the ‘scientific method’?

Implementation of data analytics reveals process deficiencies and opportunities just like lean implementation did in the 90s

Only when the tide goes out, do you discover who's been swimming naked – Warren Buffet





# Thank you!

ABOUT

TEAM

EXPERTISE

INDUSTRY

CAREERS

CONTACT



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# ADVISORY AEROSPACE

*Enabling Transformations and Transactions in Aerospace™*