# How to Effectively Deploy Defect Prevention Methods

## in the Aero Engine Supply Chain

## October 9th 2019, Toulouse

## An AESQ Supplier Forum Event

# Bienvenue

**Ian Riggs**

Global Quality Executive

**Rolls-Royce Civil Aerospace**

**Chairman - AESQ**

**Olivier Castets**

Quality Manager Component & Accessories

**Safran Aircraft Engines**

# Agenda

AESQ STRATEGY GROUP
A Program of SAE ITC

- 08:00 Welcome & Introductions — Ian Riggs, Olivier Castets
- Safran Voice of the Customer — Olivier Balmat
- AIRBUS Maxime Heinisch Safety
- AESQ Overview & Objectives — Barbara Negroe, Lisa Claveloux
- BREAK
- Case Studies Overview — Barrie Hicklin
- Process FMEA — Ian Riggs, FACC
- Measurement Systems — Martin Schäffner, Mechachrome
- GROUP PHOTO
- LUNCH 12:00
- Welcome Back 12:45
- Process Control — Pete E Teti, PW Kalisz
- Problem Solving (8D) — Olivier Castets, Meggitt
- Human Factors — Catherine Catarina-Graca, Ludovic Chevet
- BREAK
- Let's Talk Deployment — Erika Grimm, Helen Djäknegren
- Closing Remarks — Ian Riggs, Barbara Negroe
- A380 FAL Tour Information
- 17:00 CLOSE & DEPART

# Toulouse Supplier Forum Delegate Pack

AESQ STRATEGY GROUP
A Program of SAE ITC


## Delegate Pack Contents

1) Agenda
2) Using PollEV and Wifi Details
3) Presentation Material
4) Case Studies
5) Speaker Biographies
6) AS13xxx Standard Training Provider Information
7) AESQ Website Details
8) Airbus A380 Tour Details

# The AESQ Steering Group Members

Barbara Negroe
Executive Sourcing Quality Leader
**GE Aviation**

Lisa Claveloux
Director Supplier Quality
**Pratt & Whitney**

Ian Riggs
Global Quality Executive
**Rolls-Royce Civil Aerospace**

Olivier Castets
Quality Manager Component & Accessories
**Safran Aircraft Engines**

Helen Djäknegren
Director Global Supplier Quality
**GKN Aerospace**

Barrie Hicklin
Director, Quality Systems
& Regulatory Compliance
**Honeywell**

Martin Schäffner
Senior VP Corporate Quality
**MTU Aero Engines**

James Clifton
VP Quality
**PCC Structurals**

Osa Omoruyi
Director of Quality
**Arconic**

# AESQ Members Introduction

# Who is in the Room Today?

AEROTECH PEISSENBERG
Aluminum Distributing, Inc. ADI METAL Metal For Marine And Industrial Use
AERO GEARBOX INTERNATIONAL
Bodycote
binder Technologie GmbH
FRANKE Franke Industrie AG
GE Aviation
AIRBUS
ACITURRI
AMETEK AIRTECHNOLOGY GROUP
BÖHLER
DD DONCASTERS
FAMAT
Forgital Italy FORGITALGROUP
KAMAN Composite Structures
cimtas PRECISION MACHINING INDUSTRIES AND TRADING LTD. CO.
APR
Aerospace Transmission Technologies
CURTISS-WRIGHT
International DATALYZER Partners in Continuous Improvement
DAHER
FACC
FIGEAC AERO
FRISA
GKN AEROSPACE
GI GENERAL INSPECTION
ARCONIC
IHI
JPB système the best way for easy locking
MTU Aero Engines
LIEBHERR Aerospace.
MOOG AIRCRAFT GROUP
MEGGiT
jean gallay sa
Nasmyth GROUP
ITP Aero
if Industry Forum
LEONARDO
MB AEROSPACE
MQI Metallurgy • Quality • Improvement
Industrie A MS Composites
NTN SNR
NORTHROP GRUMMAN
Honeywell Aerospace
instituteofaviation warsaw, since 1926
MJ SECTIONS LTD PRECISION FORMED AND MACHINED COMPONENTS FOR AEROSPACE
PRAXAIR
PS PRECI-SPARK
Leistritz
MECACHROME
Pratt & Whitney A United Technologies Company
oerlikon
ROLLS ROYCE
RECAERO GROUP
McBRAIDA AEROSPACE ENGINEERS
SAFRAN
Senior Aerospace Weston
thyssenkrupp
THALES
The University of Nottingham UNITED KINGDOM · CHINA · MALAYSIA
PIETRO ROSA TBM
SCHAEFFLER
TIMET
TECHJET AVIATION
UNISON
PCC
SPS TECHNOLOGIES A PCC Company
SPECIAL METALS A PCC Company
SAMWOO METAL INDUSTRIES CO., LTD
TEI TUSAŞ MOTOR SANAYİİ A.Ş. TUSAŞ ENGINE INDUSTRIES INC.
Tooltec
ZOLLERN
pattonair
SAE INTERNATIONAL
SKF
SMF Sheet Metal Fabrication srl
M+M TURBINEN-TECHNIK
TRELLEBORG
WINGSROM Flying Quality Products

# Voice of the Customer


**Olivier Balmat**

VP Industrial Quality

**Safran Aircraft Engines**

# AESQ SUPPLIER FORUM IN TOULOUSE
# SAFRAN INTRODUCTION

October 8th, 2019

# SAFRAN: TECHNOLOGY THAT BENEFITS OUR DAILY LIVES

**1 SINGLE-AISLE COMMERCIAL JET TAKES OFF** every **2 SECONDS,** powered by our engines**

**MORE THAN 62,000 LANDINGS** a day using our equipment

**80+ SUCCESSFUL ARIANE 5 LAUNCHES** in a row***

**3,000 MILITARY AIRCRAFT** fitted with our inertial navigation systems

**1 OUT OF EVERY 3 HELICOPTER TURBINE ENGINES** sold worldwide

**OVER 40,000 POWER TRANSMISSIONS** totalling over 1 billion flight-hours

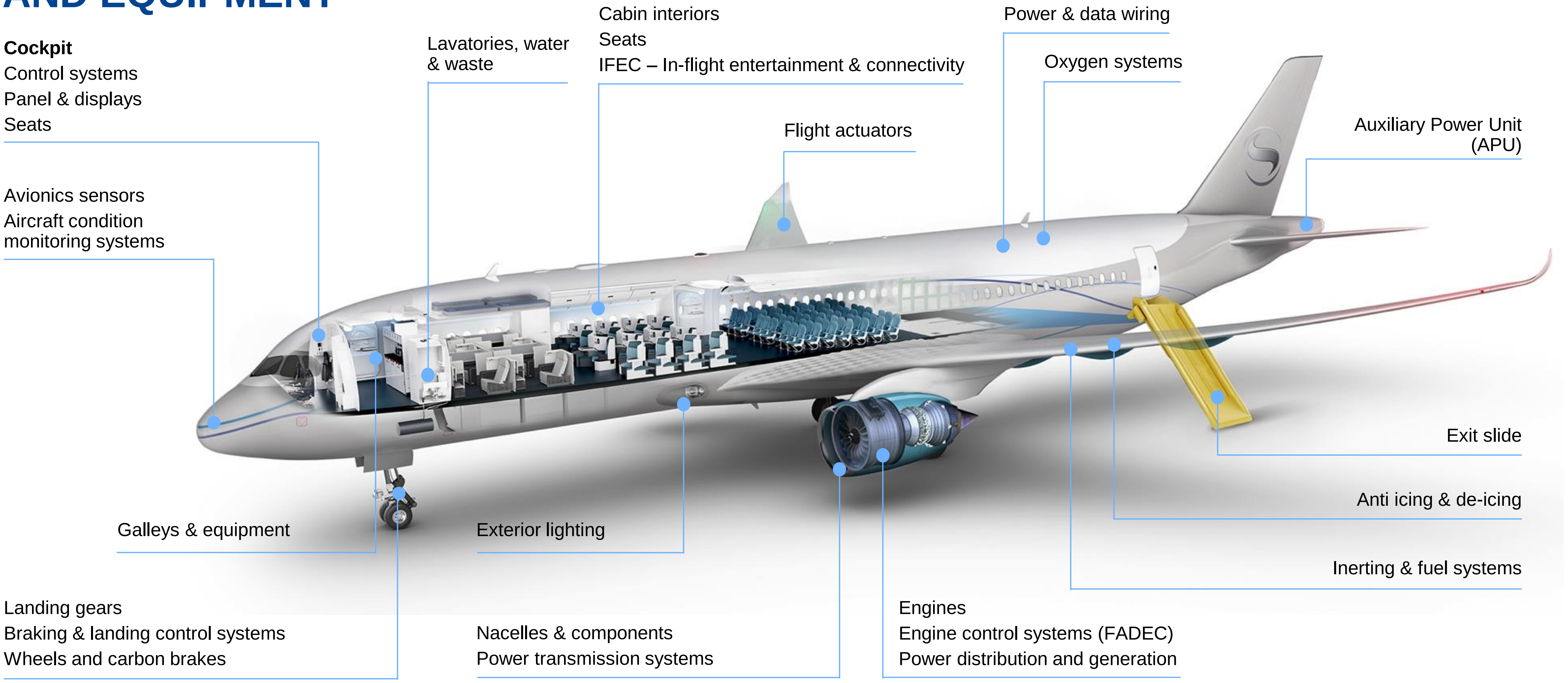
**MORE THAN 21,500 NACELLE COMPONENTS** in service

**MORE THAN 100 KM OF ELECTRICAL WIRING** on an Boeing 787 Dreamliner

**1 MILLIONSEATS** in service in airline fleets worldwide

**in partnership with GE, through CFM International
***in partnership with Airbus, through ArianeGroup

# A COMPREHENSIVE RANGE OF AIRCRAFT PROPULSION SYSTEMS AND EQUIPMENT



# PROPULSION:
# THE BROADEST POWER RANGE

(1) Rolls-Royce Turbomeca Ltd, a 50/50 joint company between Safran Helicopter Engines and Rolls Royce

(2) PowerJet is a 50/50 joint company between Safran Aircraft Engines and UEC Saturn (Russia)

(3) CFM International is a 50/50 joint company between Safran Aircraft Engines and GE (USA)

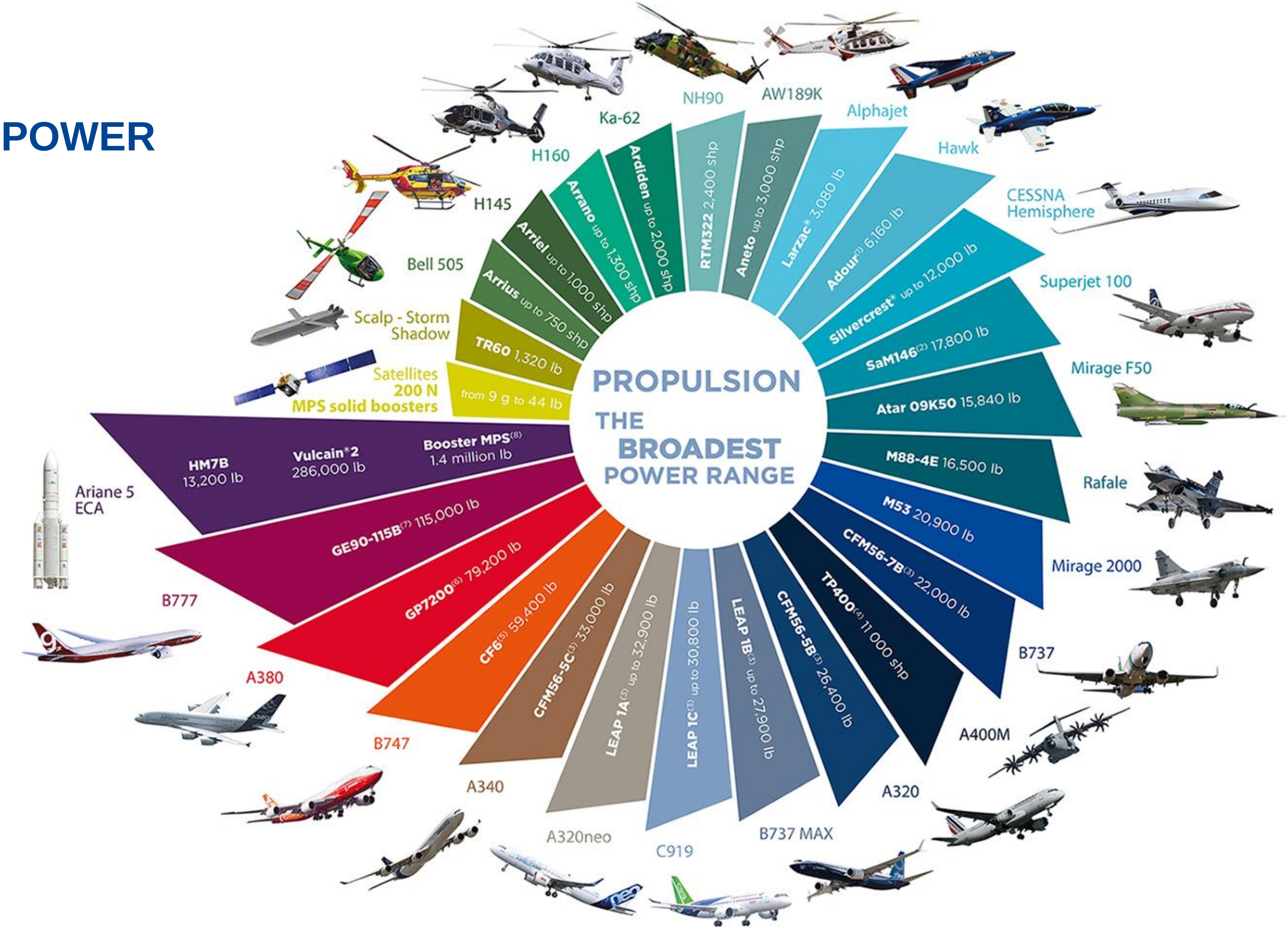
(4) By Europrop International (EPI), a consortium of Safran Aircraft Engines, Rolls-Royce, ITP and MTU Aero Engines

(5) In collaboration with GE (USA)

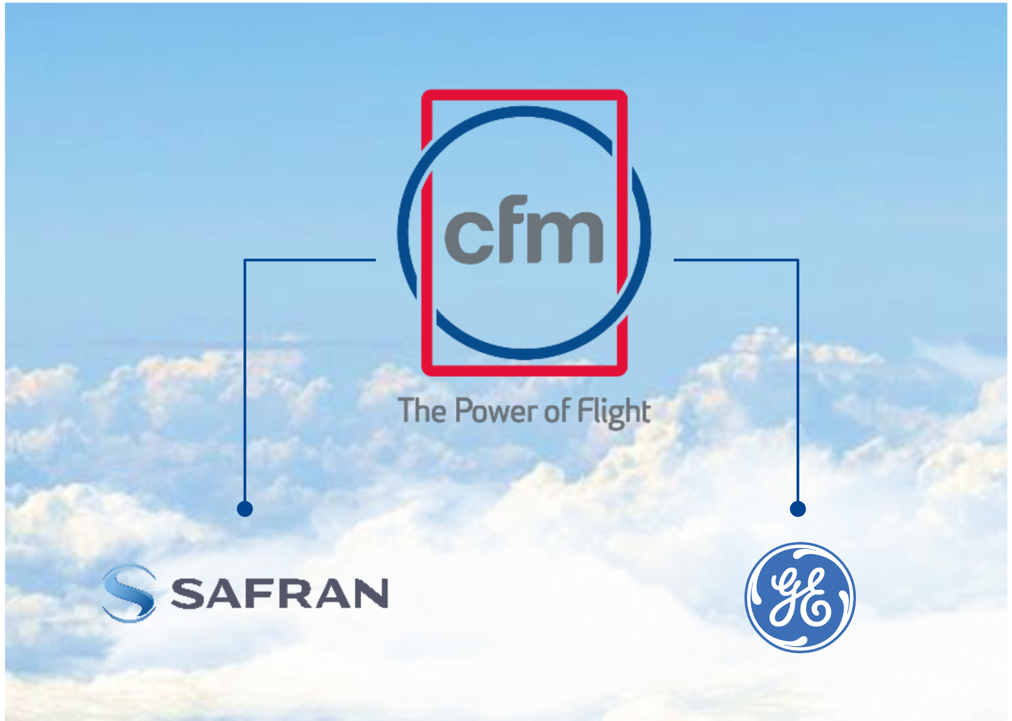
(6) Through the Engine Alliance (Safran Aircraft Engines 10%, Safran Aero Boosters 7.5%)

(7) In collaboration with GE (Safran Aircraft Engines 23.7%)

(8) Through Europropulsion, a 50/50 joint company between Safran and Avio (Italy)



# CFM® – A French-American alliance




**No. 1** engine supplier worldwide for mainline commercial jets (over 100 seats)

More than **570** customers worldwide

**Safran Aircraft Engines & GE,** successful partners for **over 40 years**

**50/50 joint company**
All activities are equally split: design, development, production, sales and support.

Partnership extended to **2040**

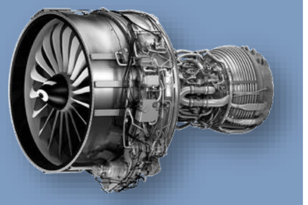
# LEAP® – Combining the best technologies from Safran Aircraft Engines and GE

AIRBUS

A320neo

LEAP-1A

Entry into service
in August 2016

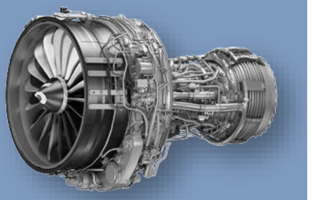


BOEING

737 MAX

LEAP-1B

Entry into service
in May 2017

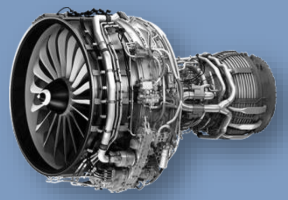


COMAC

C919

LEAP-1C

Entry into service
2018



cfm LEAP

**More than 17,000 orders and commitments as of July 2018**

**-15%** lower fuel consumption*

**-15%** reduction in $CO_2$ emissions*

* Compared with previous-generation engines





SAFRAN

# How can we manage the LEAP ramp up and ensure safety at the same time?


By fully endorsing the APQP process and the corresponding AESQ standards through 3 projects

| SPI | SPOC | SPRED |
|---|---|---|
| To manage the APQP and its tollgates<br>To ensure maturity at each steps of the development | To ensure the right level of requirements over the control plan | To ensure the capability of the production processes |
| Supported by<br>• AS9145 for APQP<br>• AS13004 for PFMEA<br>• AS13003 for MSA | Supported by<br>• AS13002 to qualify alternate inspection frequency plan | Supported by<br>• AS13006 for Process Control |

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SAFRAN

POWERED
BY TRUST

# AESQ Overview

**Barbara Negroe**

Executive Sourcing Quality Leader

**GE Aviation**

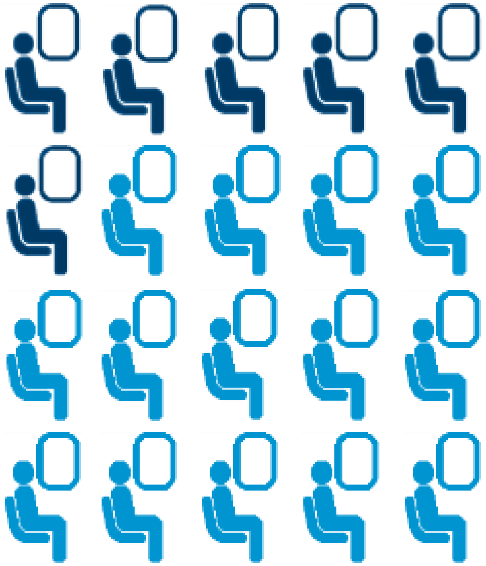
Vice Chair - AESQ

**Lisa Claveloux**

Director Supplier Quality

**Pratt & Whitney**

# Commercial Aviation – A Growth Market



In 2036

4.5% / yr Increase in Passenger Traffic

=

2 X active aircraft worldwide

7,100 billion passenger km in 2016

17,000 billion passenger km in 2036

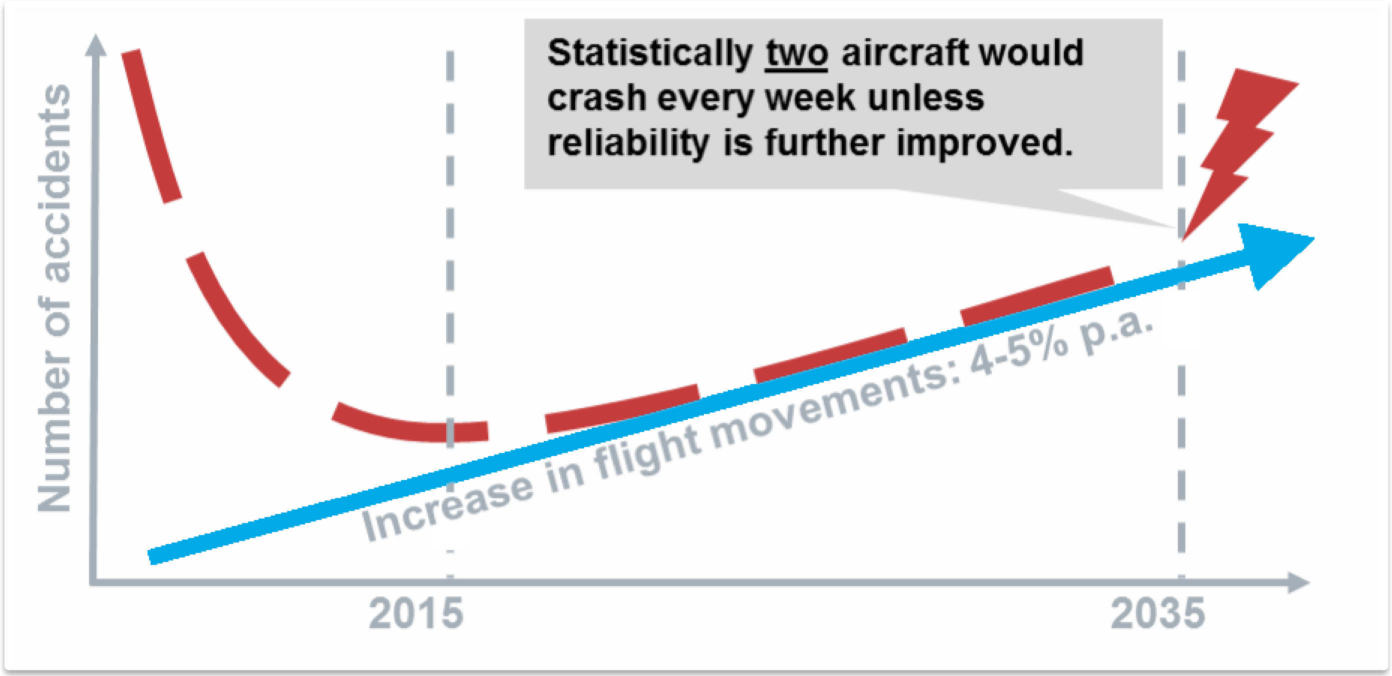
23,000 active aircraft in 2016

45,000 active aircraft in 2036

Quelle: Ascend, IATA, MTU

# Aviation Safety

The Quality of our products and services are extremely important.
Quality and continuous improvement are an absolute must!




# Aero Engine Supplier Quality (AESQ)

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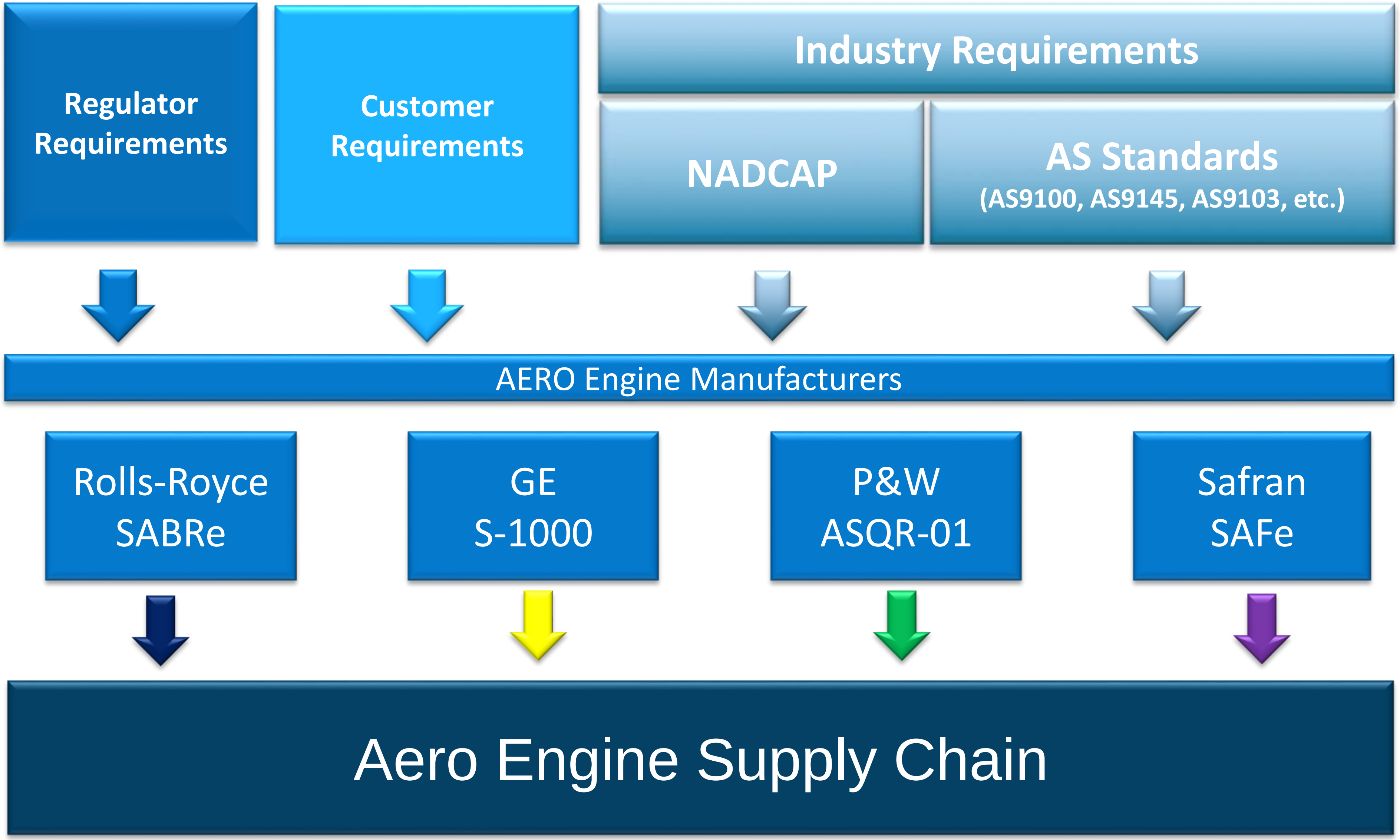
# Aero Industry Requirements Flowdown 2012



# AESQ Vision

To establish and maintain a common set of Quality Requirements that enable the Global Aero Engine Supply Chain to be truly competitive through lean, capable processes and a culture of Continuous Improvement.

# AESQ Vision

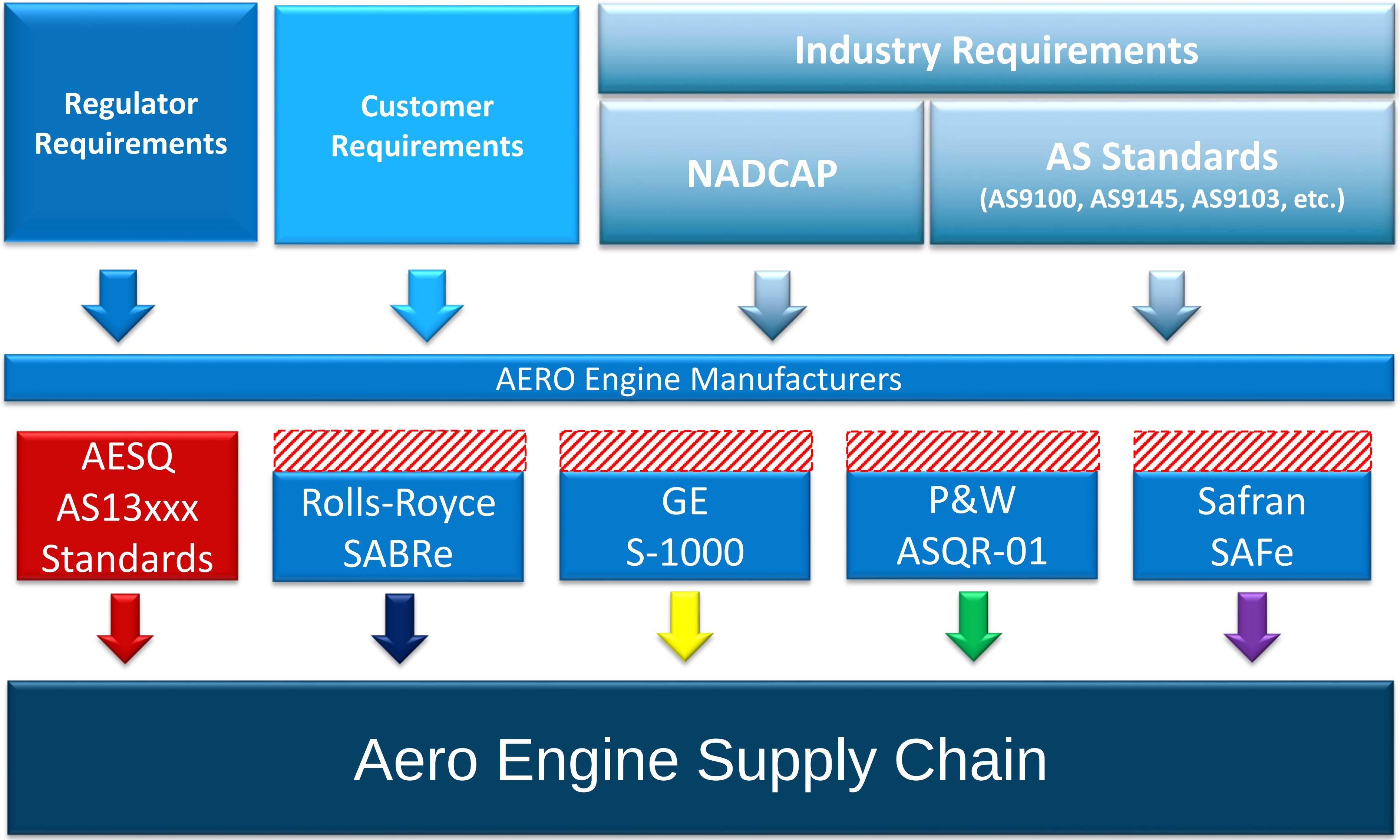
## In detail

- Create common standards within the engine manufacturers (OEM's) in regard to quality
- Deploy together the written standards throughout our supply chain
- Establish capable quality processes with a focus on Defect Prevention and a culture of continuous improvement

## Main targets

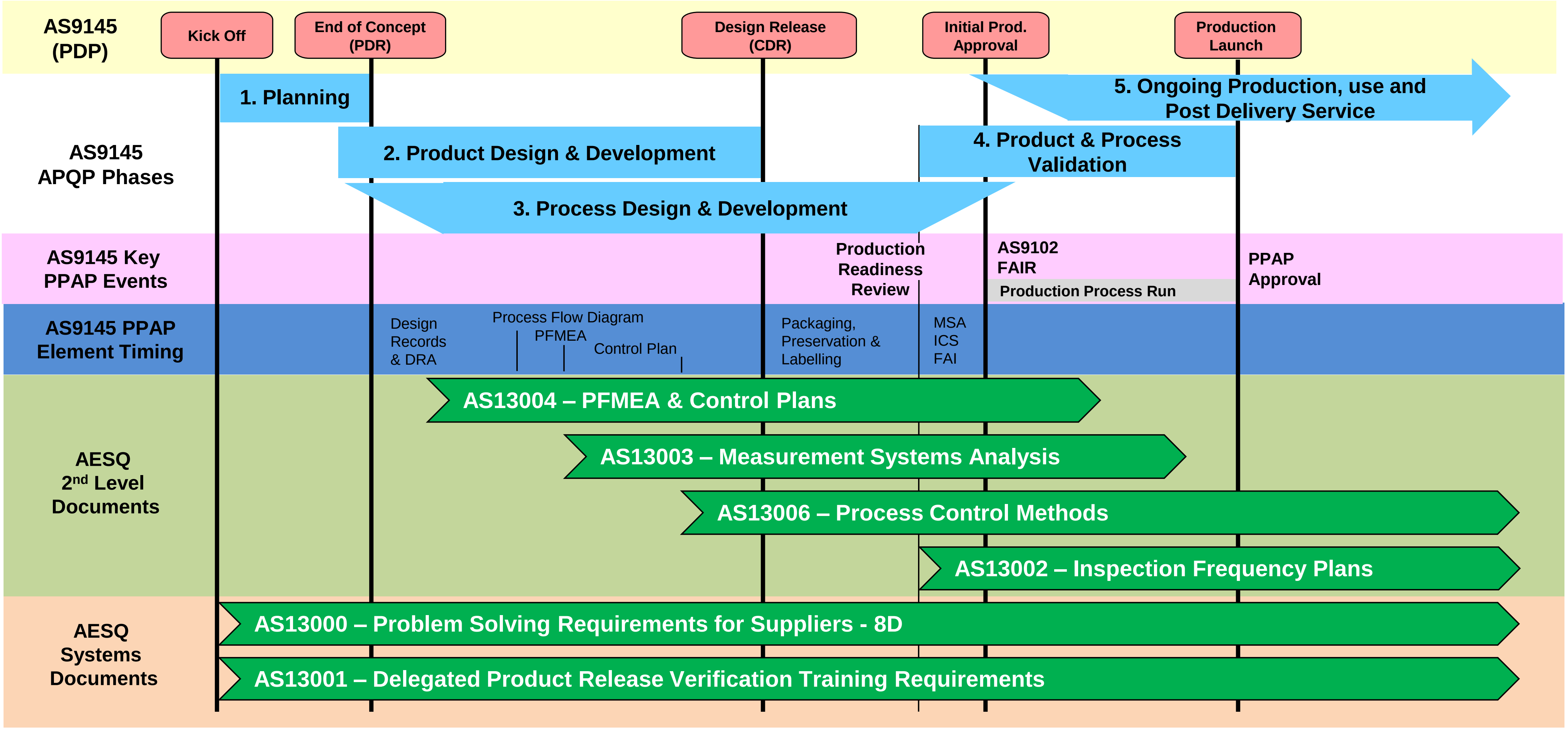
- To improve quality within the supply chain
- Improve on time delivery and minimize costs through a reliable quality performance
- Gain efficiency by standardized processes

# Aero Industry Requirements Flowdown 2019

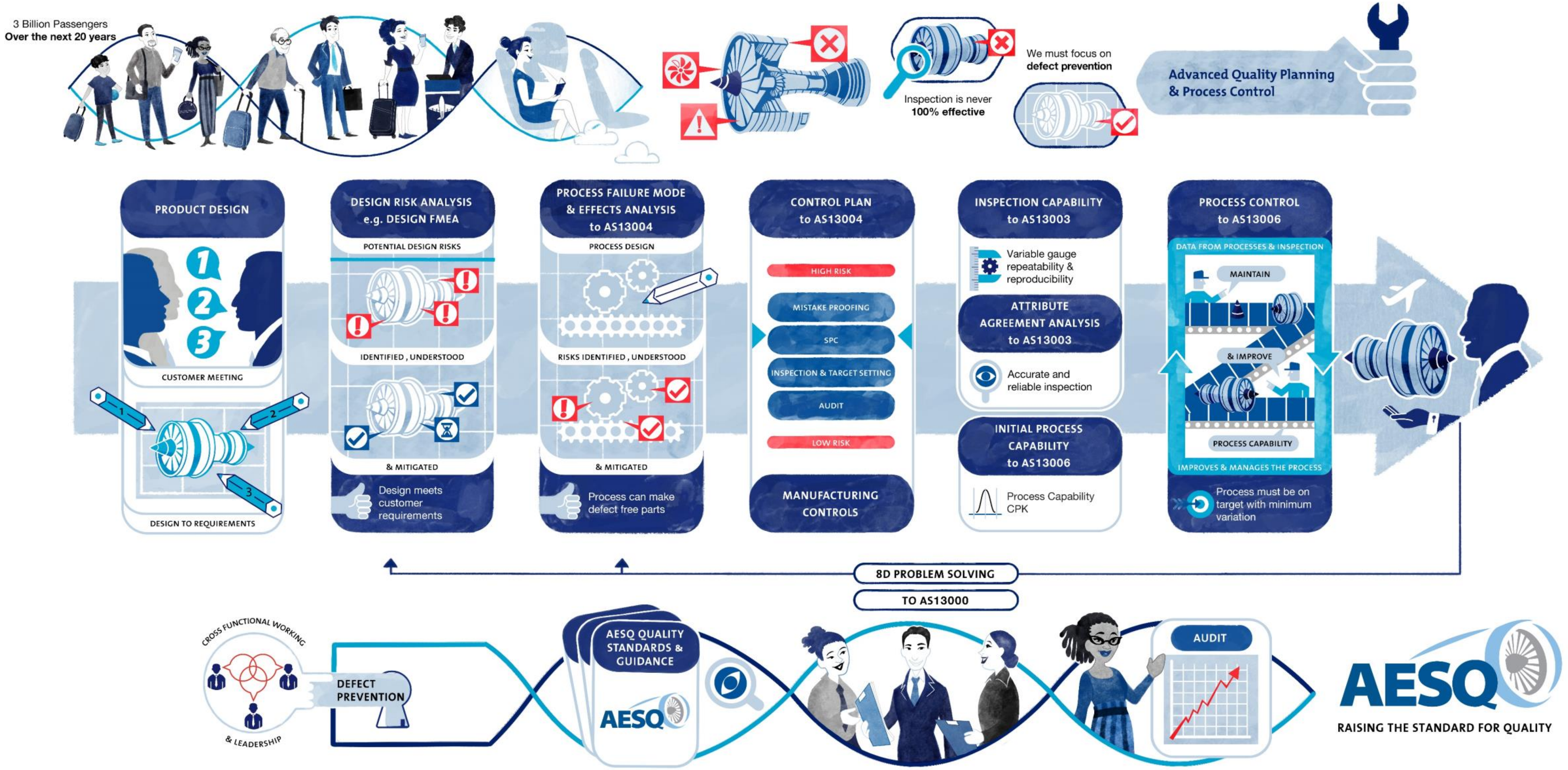


# Product Life Cycle & Document Interaction

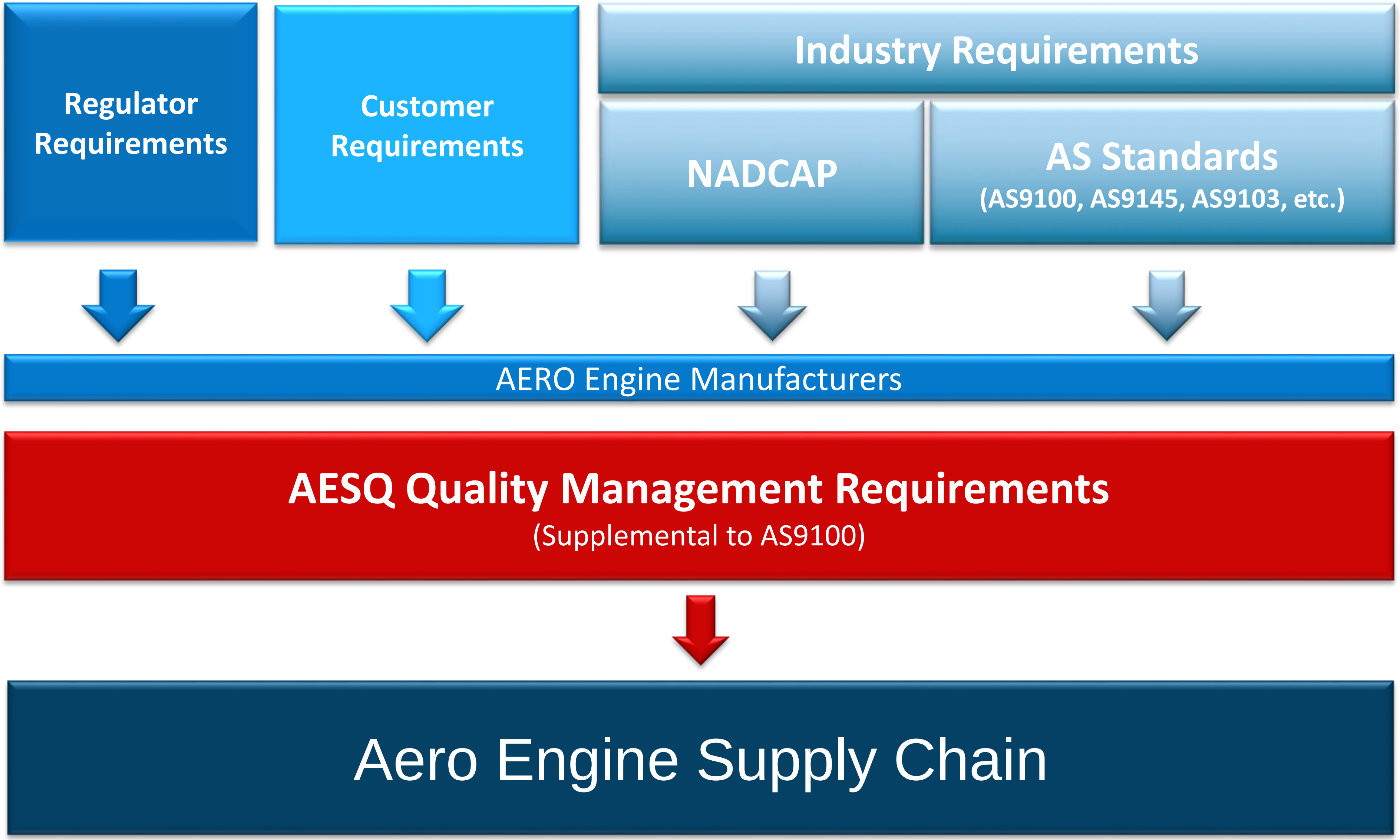
## AS9145 (APQP/PPAP) & AESQ Standards



# **Defect Prevention** Key Quality Tools for Zero Defects



# Aero Industry Requirements Flowdown Vision



# AESQ Website


Access AESQ Website to;

- Provide feedback on current and developing standards
- Share best practice deployment stories
- Get clarification of Standard deployment & interpretation

https://aesq.sae-itc.com

# AESQ Will Drive Progress

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AS13000, AS13001, AS13002, AS13003, AS13004 and AS13006 have all been flowed down by all AESQ members and are part of **your** Purchase Order.

ARCONIC
GE Aviation
Pratt & Whitney
A United Technologies Company
SAFRAN
PCC Structurals, Inc.
ROLLS ROYCE
Honeywell
MTU Aero Engines
GKN AEROSPACE

# Deployment Case Studies

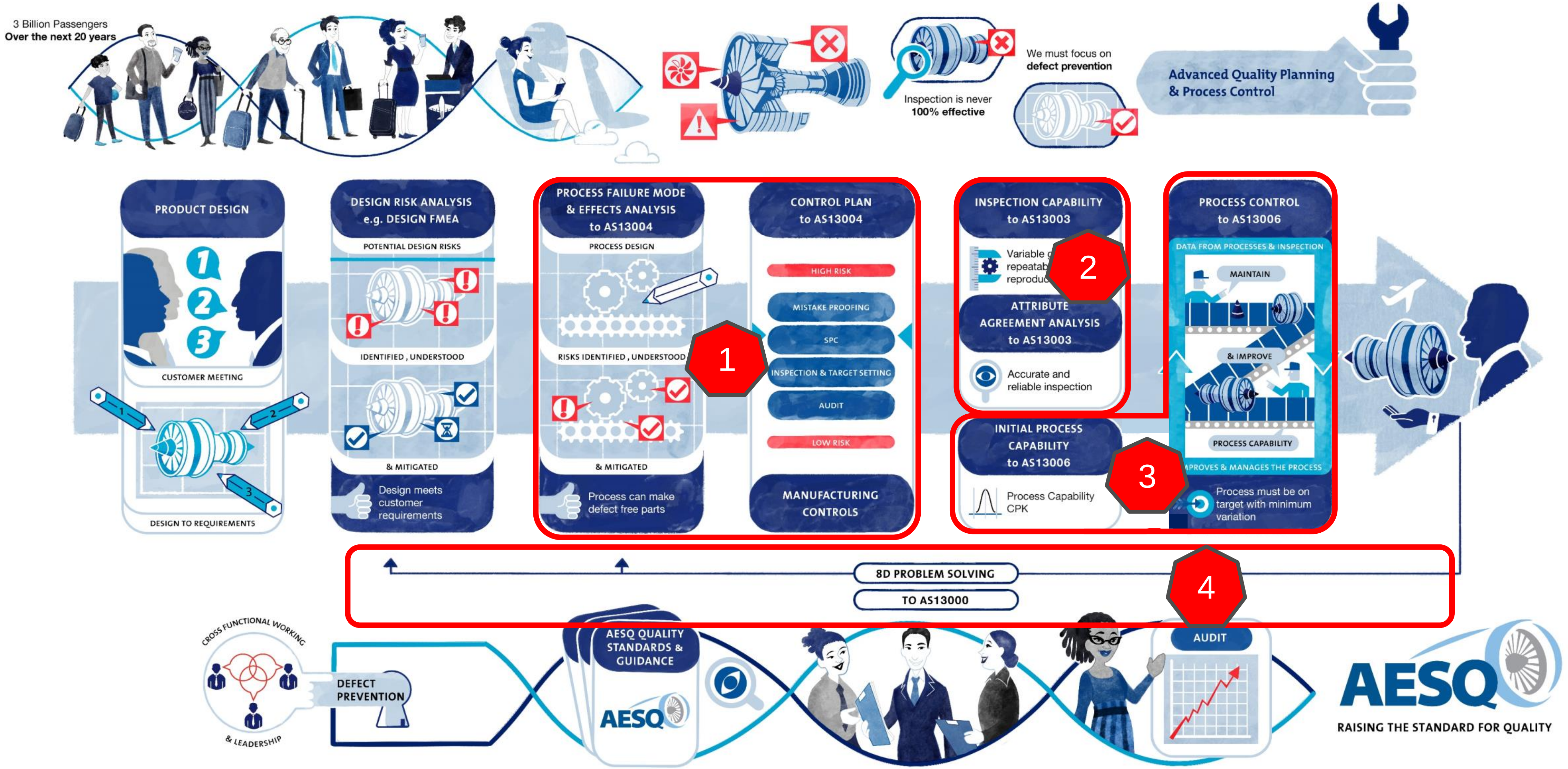
## AS13xxx Series Standards

**Barrie Hicklin**

**Director Quality Systems & Regulatory Compliance**

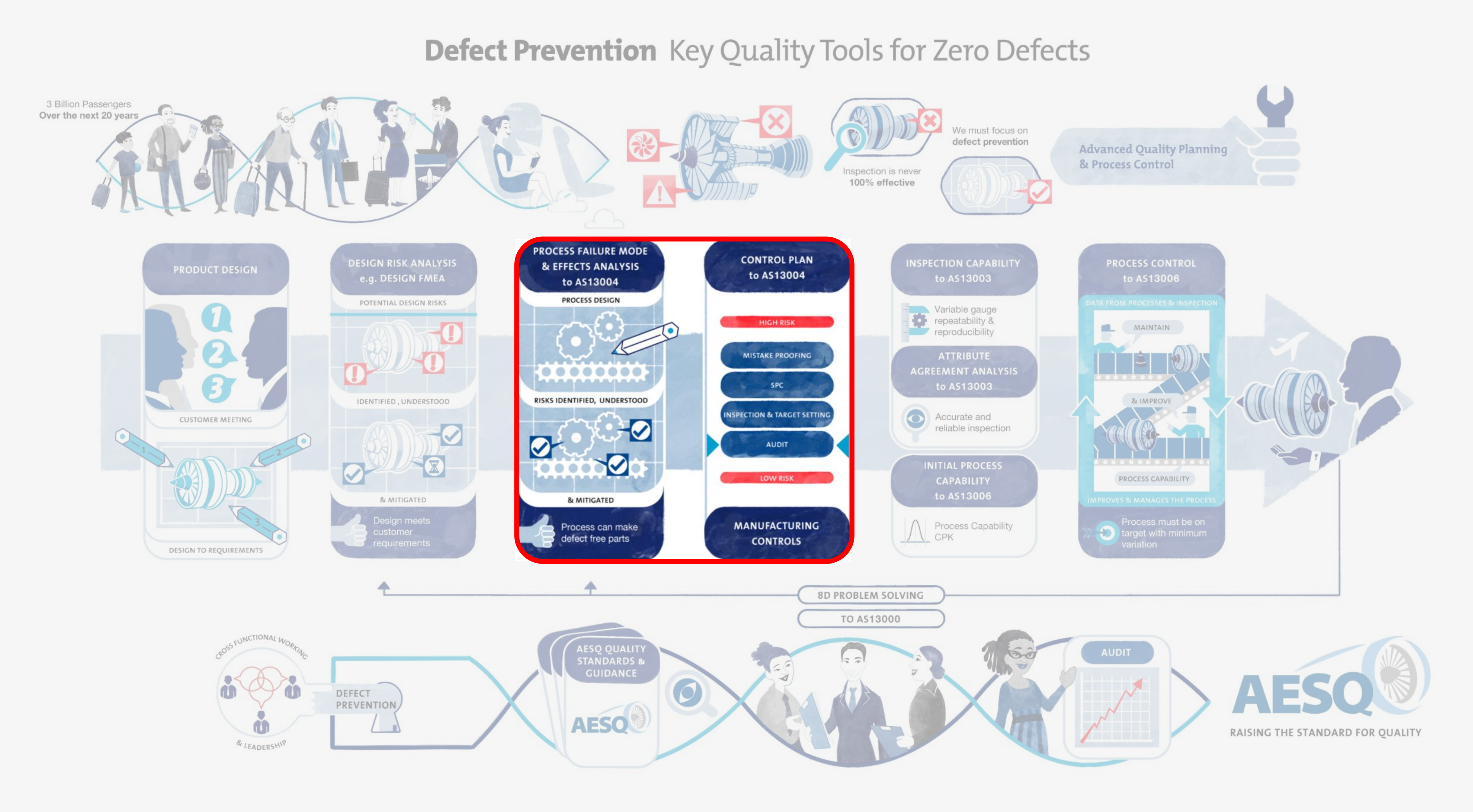
**Honeywell**

# **Defect Prevention** Key Quality Tools for Zero Defects



# Supplier Case Studies

| Case Study 1 | Case Study 2 | Case Study 3 | Case Study 4 |
| --- | --- | --- | --- |
| AS13004<br>PFMEA & Control Plan | AS13003<br>Measurement Systems Analysis (MSA) | AS13002 & AS13006<br>Process Control | AS13000<br>Problem Solving using 8D |
| Standard Highlights<br>Dr Ian Riggs | Standard Highlights<br>Martin Schäffner | Standard Highlights<br>Peter Teti | Standard Highlights<br>Olivier Castets |
| FACC<br>Case Study | Mechachrome<br>Case Study | PW Kalisz<br>Case Study | Meggitt<br>Case Study |
| Q&A | Q&A | Q&A | Q&A |


Defect Prevention Key Quality Tools for Zero Defects
3 Billion Passengers
Over the next 20 years
Inspection is never
100% effective
We must focus on
defect prevention
Advanced Quality Planning
& Process Control
PRODUCT DESIGN
CUSTOMER MEETING
DESIGN TO REQUIREMENTS
DESIGN RISK ANALYSIS
e.g. DESIGN FMEA
POTENTIAL DESIGN RISKS
IDENTIFIED , UNDERSTOOD
& MITIGATED
Design meets
customer
requirements
PROCESS FAILURE MODE
& EFFECTS ANALYSIS
to AS13004
PROCESS DESIGN
RISKS IDENTIFIED, UNDERSTOOD
& MITIGATED
Process can make
defect free parts
CONTROL PLAN
to AS13004
HIGH RISK
MISTAKE PROOFING
SPC
INSPECTION & TARGET SETTING
AUDIT
LOW RISK
MANUFACTURING
CONTROLS
INSPECTION CAPABILITY
to AS13003
Variable gauge
repeatability &
reproducibility
ATTRIBUTE
AGREEMENT ANALYSIS
to AS13003
Accurate and
reliable inspection
INITIAL PROCESS
CAPABILITY
to AS13006
Process Capability
CPK
PROCESS CONTROL
to AS13006
DATA FROM PROCESSES & INSPECTION
MAINTAIN
& IMPROVE
PROCESS CAPABILITY
IMPROVES & MANAGES THE PROCESS
Process must be on
target with minimum
variation
8D PROBLEM SOLVING
TO AS13000
CROSS FUNCTIONAL WORKING
& LEADERSHIP
DEFECT
PREVENTION
AESQ QUALITY
STANDARDS &
GUIDANCE
AESQ
AUDIT
AESQ
RAISING THE STANDARD FOR QUALITY

# Case Study

## AS13004 Process Failure Mode & Effects Analysis (PFMEA) & Control Plans

**Dr Ian Riggs**

Global Quality Executive

**Rolls-Royce Civil Aerospace**

# AS13004 Process FMEA & Control Plan Overview

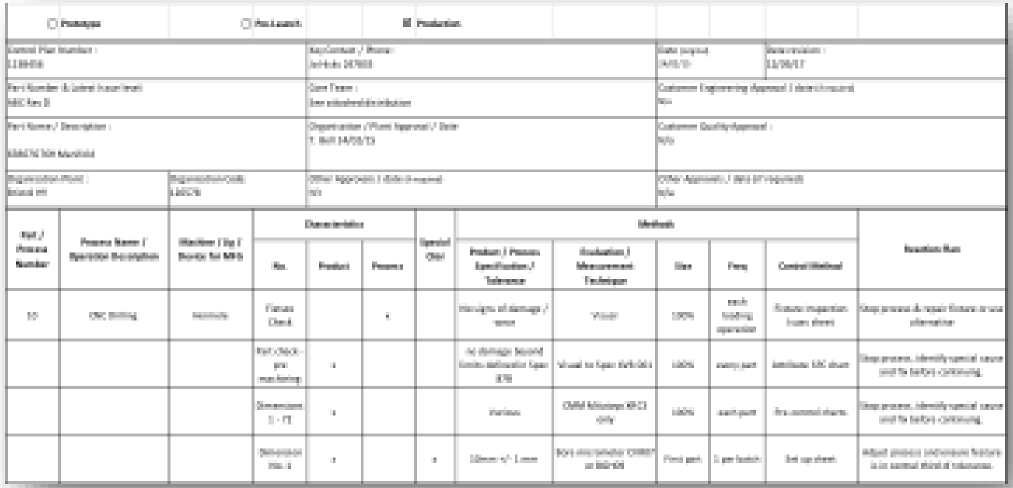
## 1. Process Flow Diagram

| OP | Step | Administration | Packaging | Lift | Load / Install | Fabrication / Transformation | Move | Store | Inspect | Rework | Other (Specify) | OP Description |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ● | ■ | ↑ | ↓ | ◆ | ○ | Δ | □ | X | | |
| 100 CNC Drill Set Up | 1 | ● | | | | | | | | | | Select correct NC program |
| 100 CNC Drill Set UP | 2 | | | | ↓ | | | | | | | Load tools into CNC |
| 100 CNC Drill load material | 3 | | | | ↓ | | | | | | | Load billet material |
| 100 CNC drill holes | 4 | | | | | ◆ | | | | | | Drill holes |
| 100 CNC Drill inspection | 5 | | | | | | | | □ | | | Visually inspect hole condition |
| 150 CNC drill deburr | 1 | | | | | ◆ | | | | | | deburr |

## 2. Process FMEA

| Process | Requirements | Potential Failure Modes | Potential Effects | SEV | Potential Causes | Prevention Controls | OCC | Detection Controls | DET | RPN |
|---|---|---|---|---|---|---|---|---|---|---|
| OP10 CNC Drilling | Drill Fuel Hole 50mm Diameter +/- 1.0 mm | Hole too Big | Fuel leak leading to explosion | 9 | Oversize tool | Tool pre-setting | 4 | Bore mic at OP 50 | 7 | 252 |
| | | | Scrap part | 6 | Spindle alignment error | Asset Care & Calibration | 3 | Weekly ball bar check | 8 | 216 |
| OP20 CNC Drilling | Drill Air Hole 150mm Diameter +/- 3.0 mm | Hole too Big | Slight increase in noise level | 3 | Oversize tool | Tool pre-setting | 2 | Bore mic at OP 50 | 7 | 56 |

## 3. Production Control Plan



# AS13004 Process FMEA & Control Plans : Maturity Checklist

AS13004 Assessment Checklist

**AS13004 Assessment Checklist**

| Ref # | Category | Clause Ref. | Question | Complies | | Comments |
|---|---|---|---|---|---|---|
| | | | | Yes | No | |
| 1 | 4.1 Process Risk Identification, Assessment, Mitigation and Prevention Overview | 4.1.1 | Have the tools and methods defined within this standard been deployed using a cross functional team? | | | |
| 2 | | 4.1.2 | Has the design organization completed a Design Risk Analysis (DFMEA) that identifies risks associated with safe and proper operation of the product? | | | |
| 3 | 4.2 Applicability | 4.2.1 | Has AS13004 been applied to all New Product Introduction programmes? | | | |
| 4 | | 4.2.2 | Has AS13004 been applied to products and/or services currently used in production following manufacturing process changes, transfer to a new location or being addressed for improvement? | | | |
| 5 | | 4.2.3 | Once invoked, is AS13004 being applied throughout the lifecycle of a product, process risk being reviewed on a continual basis and mitigation actions being taken and actioned on a frequent basis? | | | |
| 6 | | 4.2.4 | Has AS13004 been flowed to all suppliers that manufacture and/or supply products and services? | | | |

Editable file linked from the standard AS13004.

# What is a PFMEA?

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| Process | Requirements | Potential Failure Modes | Potential Effects | SEV | Potential Causes | Prevention Controls | OCC | Detection Controls | DET | RPN |
|---|---|---|---|---|---|---|---|---|---|---|

**What are you trying to create?**

**Defined by Engineering Drawings & Specifications**

**How could you get the Requirements wrong?**

**How bad would it be if was not to specification?**

**What would need to fail in the process to cause the Failure Mode?**

**How could this be prevented?**

**How likely is it to happen?**

**How will you detect the Cause and/or Failure Mode?**

**How likely are you to detect the Cause or Failure Mode?**

RPN: 252, 189, 56, 28

Product Focussed

Process Focussed

Risk Profile (RPN) = Severity x Occurrence x Detection

# Process FMEA & Control Plans : Critical Success Factors

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- Must be created & Maintained by a **CROSS FUNCTIONAL TEAM**
- Required for **EVERY** part number*
- Include **ALL** Process Steps
- **EVERY** Design Characteristic included in the PFMEA**


- PFMEA must be done at the **RIGHT TIME**
- PFMEA Failure Modes must describe **PRODUCT DEFECTS**
- PFMEAs must **DRIVE ACTIONS** to reduce risk
- Keep up to date – They are **LIVE** documents

***Typical deployment for NPI, Key Changes (Design or Process), Source Changes as well as Major Quality Issues Corrective Actions***
*****Rolls- Royce Requirement***

# Process FMEA Case Study


**Juergen Klinglhuber**

Director, Quality

**FACC Aerostructures**



**Andre Haertelt**

VP Operations Manufacturing Quality

**FACC Aerostructures**

# AS 13004 (PFMEA & CONTROL PLAN)

## BENEFITS OF DEPLOYING PREVENTION TOOLS AS PART OF APQP AND ZERO DEFECTS

**AGENDA**

1) WHO WE ARE
2) WHERE WE ARE NOW
3) HOW WE GOT THERE
4) WHERE WE WANT TO GO
5) HOW WE CHANGED
6) WHAT WE LEARNED

FACC

# WHO WE ARE

## OUR PARTS PORTFOLIO

## OUR CUSTOMERS

AIRBUS
BOEING
BOMBARDIER the evolution of mobility
COMAC
DASSAULT AVIATION
Pratt & Whitney A United Technologies Company
Engine Alliance
AIRBUS HELICOPTERS
DIEHL Aerospace
SAFRAN AEROSPACE · DEFENCE · SECURITY
UTC Aerospace Systems
Rolls-Royce
EMBRAER
SUKHOI
Hawker Beechcraft
Aviation Partners, Inc. Leaders in Advanced Winglet Technology
Gulfstream A GENERAL DYNAMICS COMPANY
LEONARDO

# WHO WE ARE

## FACC OVERVIEW – FIGURES & FOOTPRINT

**100%** Aerospace composite lightweight

**2** Engineering centers in Austria

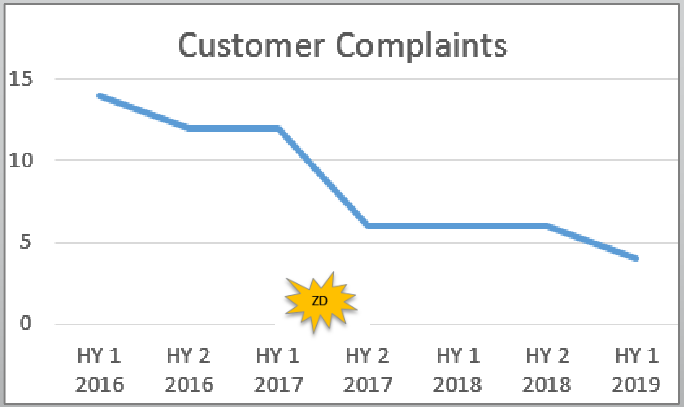
**5** Plants

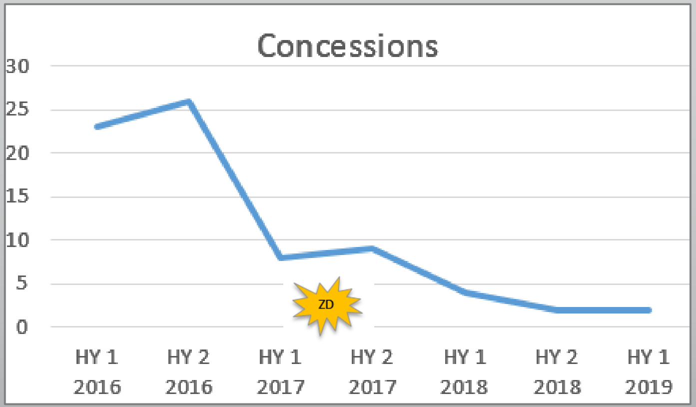
**20%** **YoY** average growth
EUR 780 Mio. revenue in 2018/19

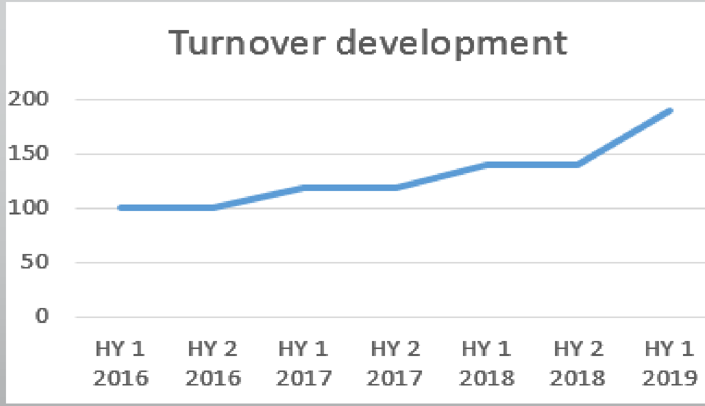
**3,500** Employees worldwide

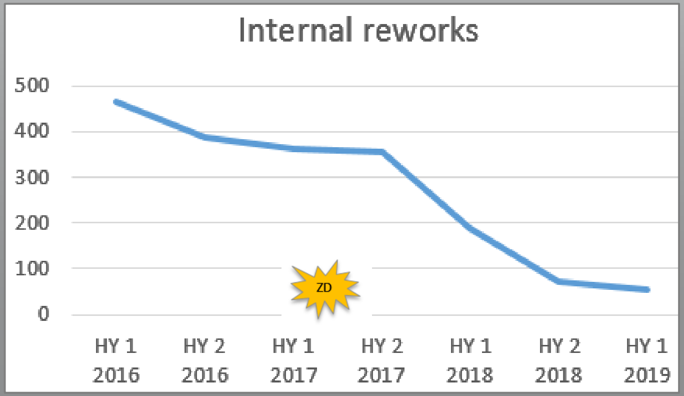
# WHERE WE ARE

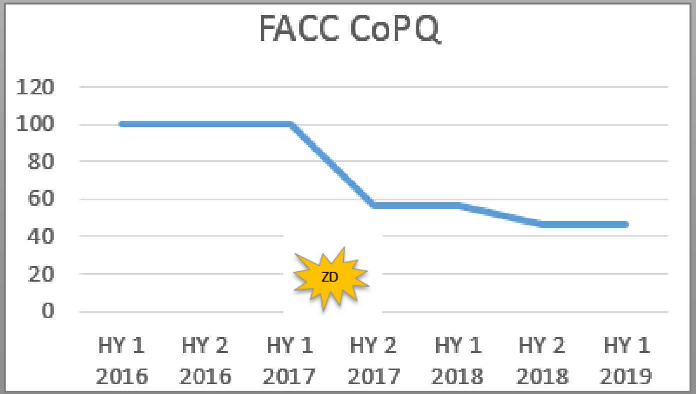
## THE EFFECT OF BIQ – THE HARD FACTS

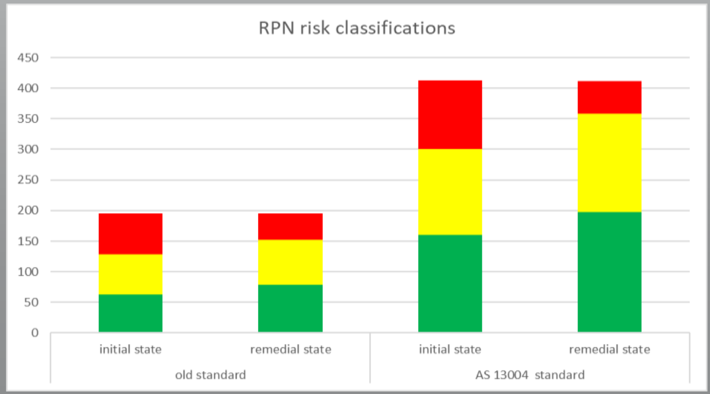


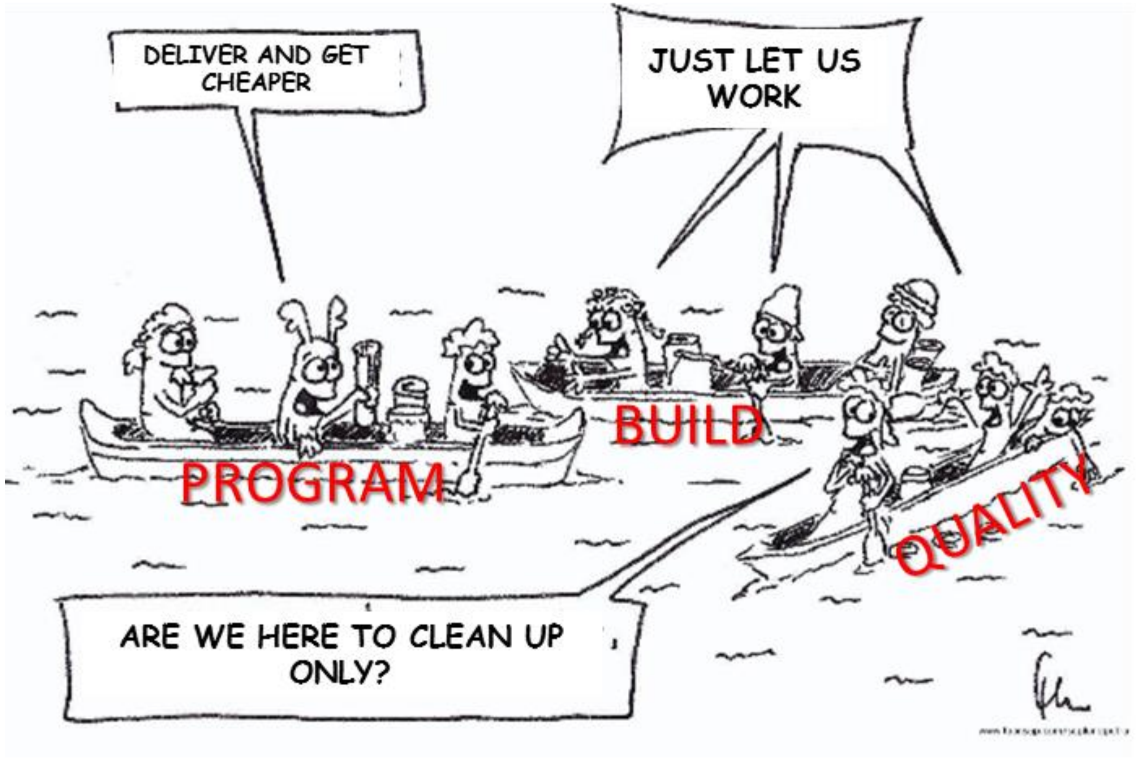



# WHERE WE WERE

## PFMEA TO AS13004 AS AN ENABLER – THE SOFT FACTS

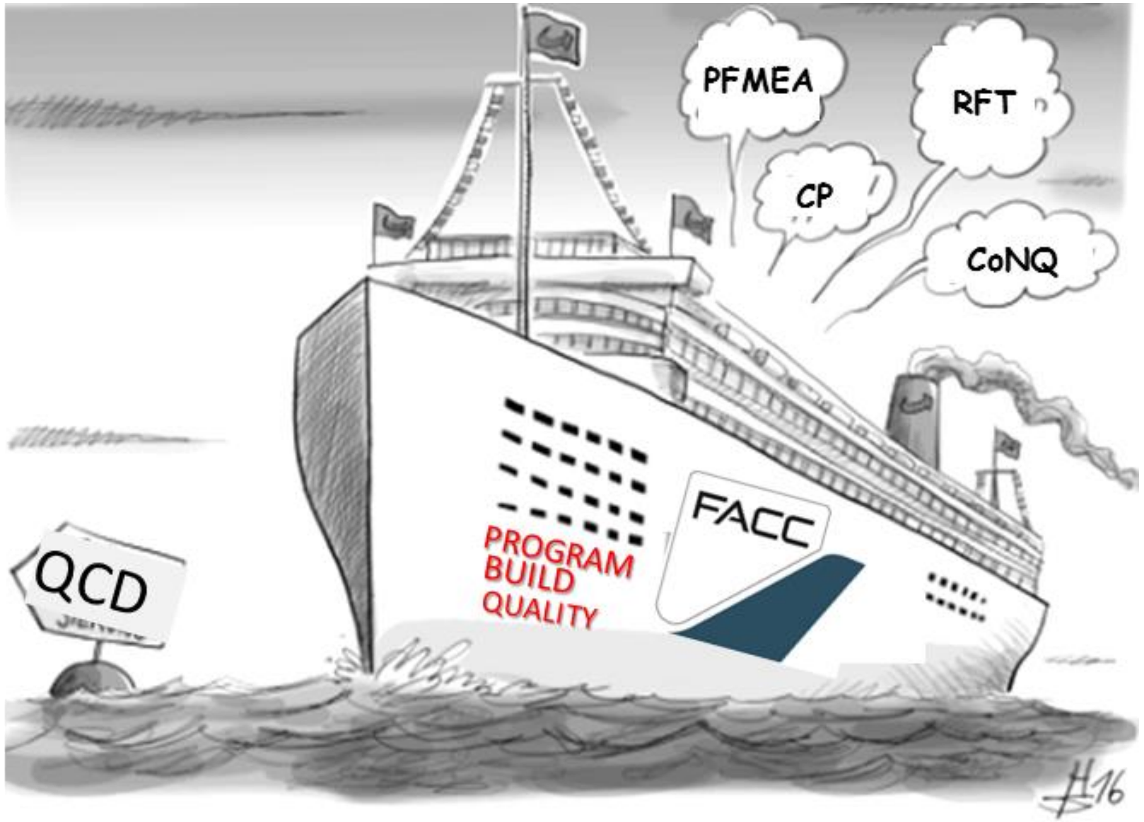



| PFMEA | Control Plan |
|---|---|
| ONE-OFF CHARACTER<br><br>FOR THE RECORDS<br><br>DONE IN ISOLATION (QUALITY) | FOR CUSTOMER SATISFACTION<br><br>RATHER INSPECTION PLANS<br><br>NOT ALIVE<br><br>NOT DERIVED FROM PFMEA |

**Late after FAIR**

# WHERE WE WANT TO BE

## PFMEA TO AS13004 AS AN ENABLER – THE SOFT FACTS




### PFMEA AS A "SCHOOL OF THOUGHT"

| | | |
|---|---|---|
| CROSS FUNCTIONAL COLLABORATION – COMMON GOALS | FROM ONE-OFF TICK BOX EXERCISE TO CULTURALLY EMBEDDED PLM ELEMENT | EARLY ENGAGEMENT WITH EFFECT ON DRAWING BY-OFF PROCESS |

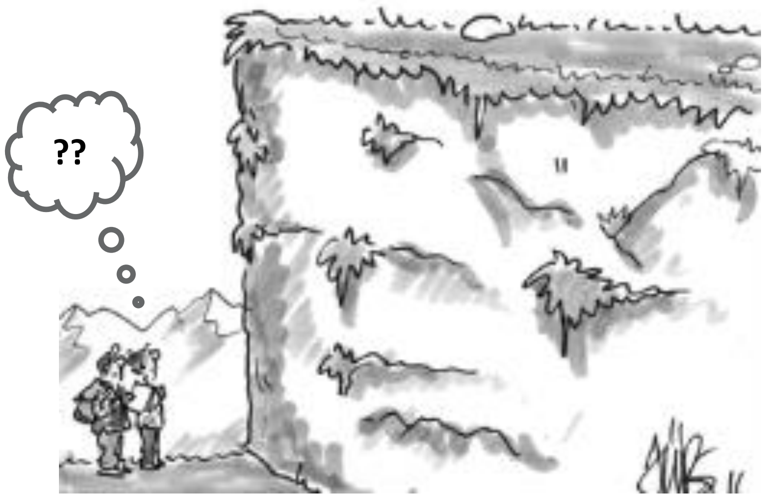
### PFMEA AS A TOOL

| | | |
|---|---|---|
| INCREASED PRODUCT UNDERSTANDING (DESIGN SEVERITY SCORING) | BUILDING BLOCKS FOR FORMAL RECORDING AND DEVELOPMENT OF PORTFOLIO COMMODITY KNOWLEDGE | STANDARD ALLOWING MORE EFFICIENT APPLICATION WITH EVERY TURN |

# HOW WE GOT THERE

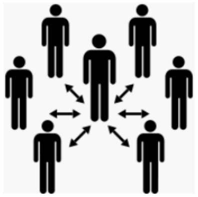
## THE CHALLENGING STARTING POINT

AS13004 FOR EVERYTHING AND NOW



# HOW WE GOT THERE

## DEPLOYMENT OF AS13004 @ FACC



RELEASE OF AS13004

RIED ZERO DEFECTS WORKSHOP

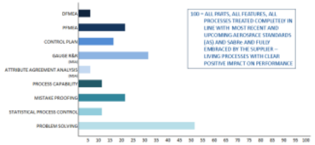

SABRe³ SELF-ASSESSMENT

SABRe³ GO LIVE

2017

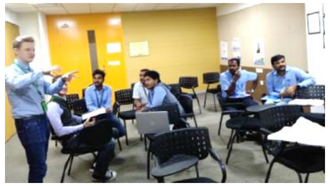
2018

2019



DERBY ZERO DEFECTS EVENT

PILOT PFMEA GOLD STANDARD



SUB-TIER FLOW-DOWN

REVISION OF FACC PEP

# WHERE WE WANT TO GO

## FULL PORTFOLIO COVERAGE – “INFECTION”

LIGHTHOUSE PROJECT TO GAIN EXPERIENCE

KNOWLEDGE TRANSFER

COMMODITY COMMONALITIES (PART FAMILIES)

DOMINO/SNOWBALL EFFECT

FIRST DEFINED PART OF RR

NPI RR

NPI RR

NPI RR

FLEET & LEGACY

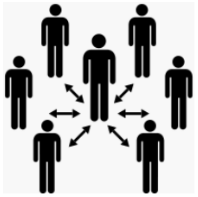
FLEET & LEGACY

FLEET & LEGACY

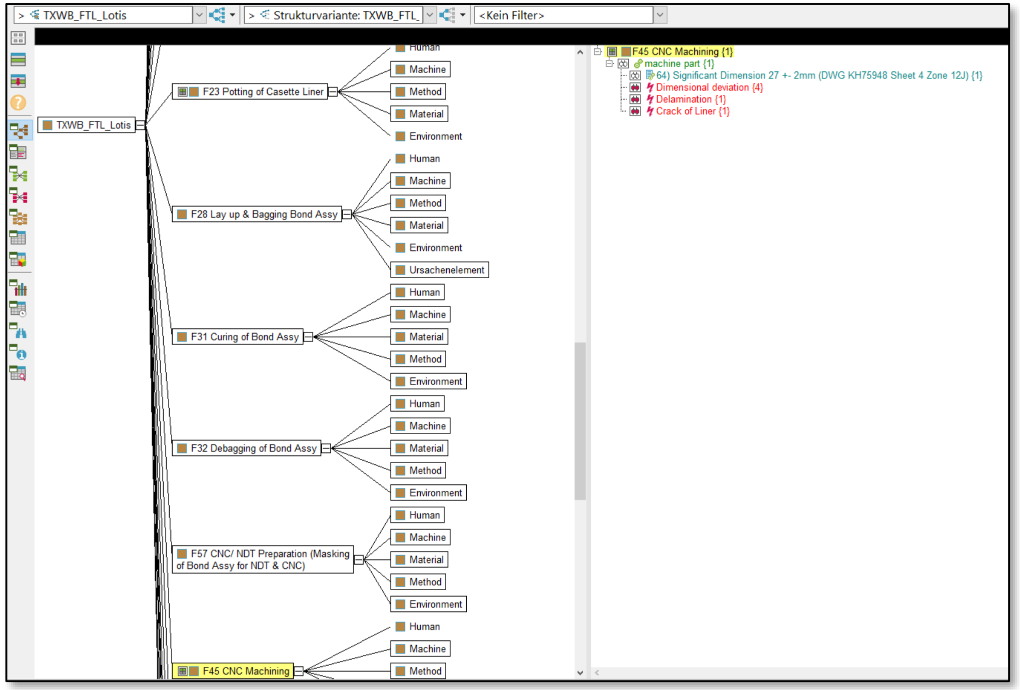
FLEET & LEGACY

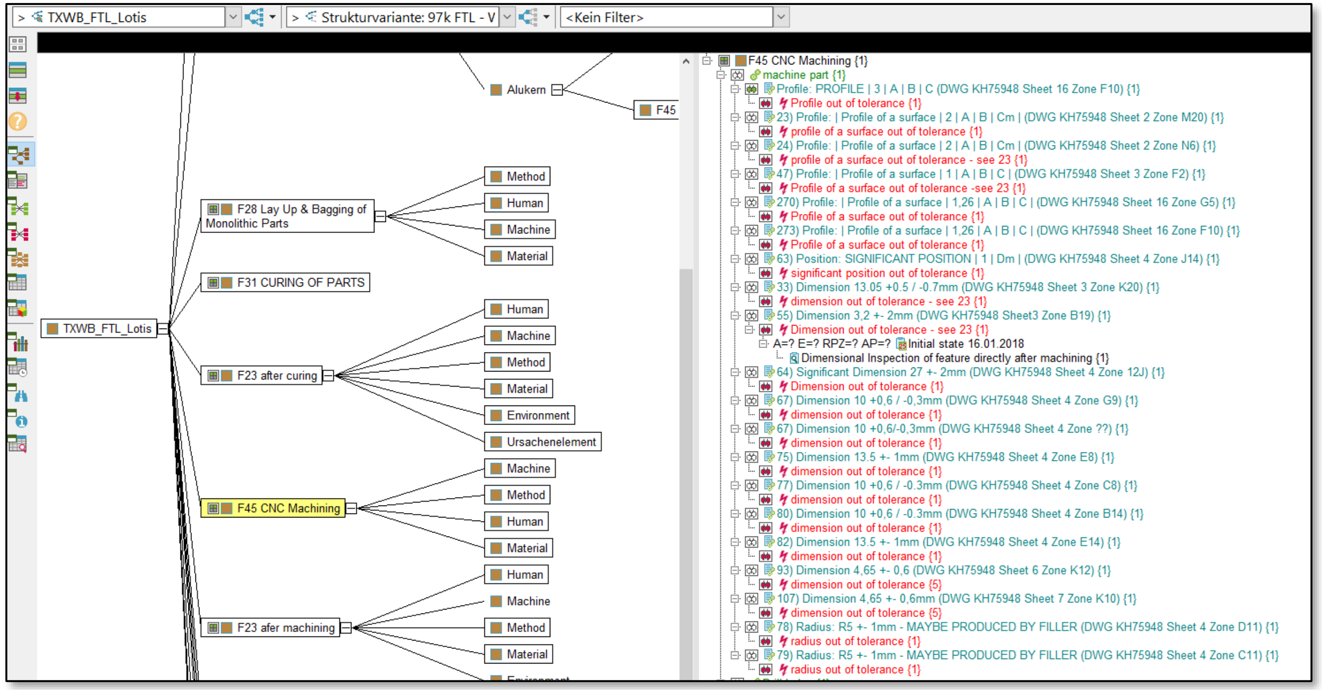
# HOW WE CHANGED

## AS13004 – THE QUALITY OF PFMEA



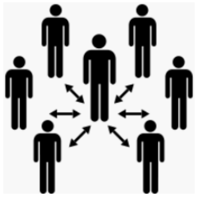
### OLD VS. NEW FACC PFMEA → MORE DETAILED FUNCTIONAL NET



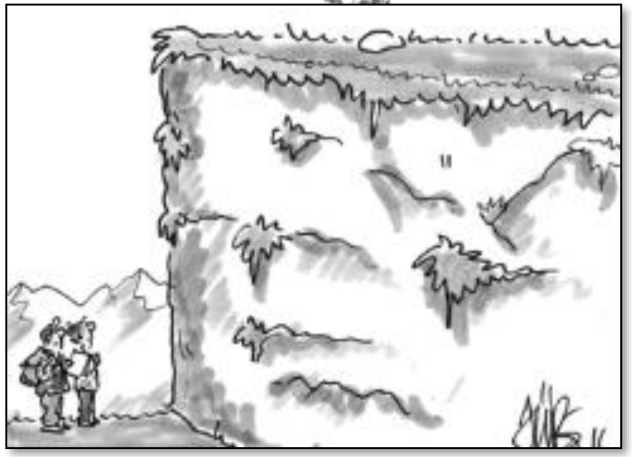
# HOW WE CHANGED

## AS13004 EMBEDDED IN THE ORGANISATION



- EXT & INT COLLABORATION
- PRODUCT UNDERSTANDING
- ELIMINATION OF PFMEA AMBIGUITY (FEATURE VS PROCESS)
- CROSS-PEOPLE AND CROSS-PROCESS INTERACTION
- MGMT UNDERSTANDING OF BENEFITS (UPFRONT INVESTMENT VS CoNQ)

**MORE FOCUS ON ZERO DEFECTS MINDSET SPREAD THROUGHOUT THE COMPANY**



# WHAT WE LEARNED

## STRONGER TOGETHER

- COLLABORATION IS KEY
- GOOD MODERATION DRIVES RESULTS
- COMMODITY DRIVES SCOPE (FEATURE & PROCESS)
- AS13004 BY MS EXCEL BEARS RISKS AND MEANS MANUAL EFFORT

→

- **NEW DEPARTMENT** WITH DEDICATED AND SKILLED FMEA HOST FOR FMEA SESSIONS
- **GROWING DATABASE** (REFERENCE FMEA FOR COMMON PROCESSES, FEATURE BASED FOR PRODUCT SPECIFIC ASPECTS → BUILDING BLOCKS / LEGO® SYSTEM FMEA)
- **UNIFYING SOFTWARE SOLUTION** COVERING FULL CIRCLE FMEA–CP–SPC IN EVALUATION

# WHAT WE LEARNED

## OBSERVATIONS ON AS13004


- AS13004 IDEAL FOR “ONE STOP SHOPS“ – MAKE2PRINT/OEM/SUB-TIER COORDINATION EFFORTS  –
- FEATURE FOCUS – RISK OF OMITTING COMMODITY RELATED PROCESS ASPECTS  –
- DEFINED STANDARD CREATES CLARITY, SUPPORTS RFT AND REDUCES EFFORT  +
- HELPS TO IDENTIFY CRITICAL MANUFACTURING FEATURES AND DRIVES PROCESS CONTROL VIA CONTROL PLAN – SUPPORTS ON TIME PRODUCTION READINESS  +
- ACTS AS TOOL KNOWLEDGE MGMT AND SHEDS LIGHT ON SIMILAR PRODUCT AND PROCESSES  +

# WHAT WE LEARNED

## RECOMMENDATIONS

- SHARE RESPONSIBILITIES (NOT QUALITY ONLY)
- GO STEP BY STEP AND ADHERE TO STRUCTURES
  - DEFINE LIGHTHOUSE PARTS
  - GRADUALLY INCREASE SCOPE

**SUCCESS**

- PLAN IN ADVANCE
  - PPAP
  - CHANGE MGMT
- EARLY COORDINATION WITH DESIGN OWNER

# THANK YOU

# AS13004 Success Stories

AESQ STRATEGY GROUP
A Program of SAE ITC

RR XWB Stub Shaft

Deployed AS13004 PFMEA on all Characteristics

Cross-functional teamwork

Zero Defects at Product Launch

APQP / PPAP Delivered in 50% of the time scheduled


Sam Suzhou make Engine Mounts for XWB.

16 Part Specific FMEAs in 3 months

Introduction of error proofing and prevention controls.

Defect Free since September 2017

Trent 7000 Fan Case Delivered Defect Free at PPAP after applying ZD Toolkit.

Parts now delivered Defect Free

Manufactured by GKN, Newington.

PPAP completed in 6 months instead of the usual 18 months.


Hanwha is a Structures & Transmissions supplier.

Feature based PFMEA using Reference PFMEAs

Cross-functional team (design, manufacturing & Hanwha)

This led to DPU reduction:

Trent XWB A-Frame: to 0.00.

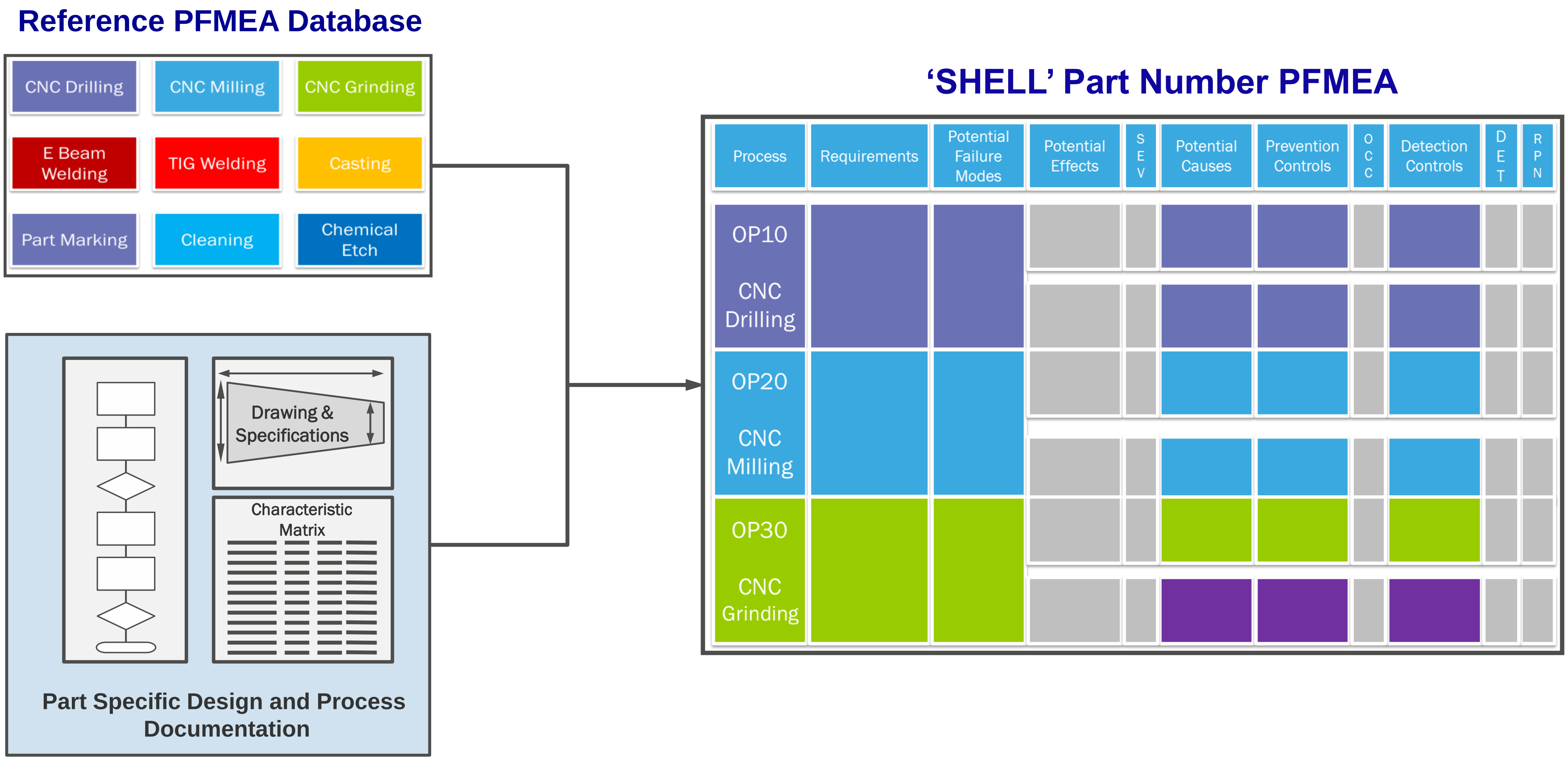
Trent 7000 A-Frame DPU improved to 0.0.

# Using
# REFERENCE PFMEAs
# to improve
# Effectiveness & Efficiency

| Process | Requirements | Potential Failure Modes | Potential Effects | SEV | Potential Causes | Prevention Controls | OCC | Detection Controls | DET | RPN |
|---|---|---|---|---|---|---|---|---|---|---|
| CNC Drilling | Drill ~~FUEL~~ Hole **DIAMETER** | Hole too Big / Too Small | Fuel leak leading to explosion | 9 | Oversize tool | Tool pre-setting | 4 | Bore mic at OP 50 | 7 | 252 |
| | | | Scrap part | 6 | Spindle alignment error | Asset Care & Calibration | 3 | Weekly ball bar check | 8 | 189 |
| CNC Drilling | Drill ~~FUEL~~ Hole **POSITION** | Out of Position | Stress on Fuel pipe leading to cracks | 9 | Incorrect manual offset | None | 2 | CMM at OP120 | 7 | 126 |
| | | | Concession | 4 | Machine calibration out of limit | Asset Care & Calibration | 1 | Weekly ball bar check | 8 | 28 |
| CNC Drilling | Drill ~~FUEL~~ Hole **DEPTH** | Hole too Deep / too Shallow | Fuel leak leading to explosion | 9 | Incorrect offset used | None | 2 | CMM at OP120 | 7 | 126 |
| | | | Concession | 4 | Spindle alignment error | Asset Care & Calibration | 1 | Weekly ball bar check | 8 | 28 |

# Creating a Part Specific PFMEA using Reference FMEAs

AESQ STRATEGY GROUP
A Program of SAE ITC



# Completing the Part Number Specific PFMEA

| Process | Requirements | Potential Failure Modes | Potential Effects | SEV | Potential Causes | Prevention Controls | OCC | Detection Controls | DET | RPN |
|---|---|---|---|---|---|---|---|---|---|---|
| OP10 CNC Drilling | Drill FUEL Hole 50mm Diameter +/- 1.0 mm | Hole too Big | Fuel leak leading to explosion | 9 | Oversize tool | Tool pre-setting | 4 | Bore mic at OP 50 | 7 | 252 |
| | | | Scrap part | 6 | Spindle alignment error | Asset Care & Calibration | 3 | Weekly ball bar check | 8 | 189 |
| OP20 CNC Drilling | Drill AIR Hole 50mm Diameter +/- 3.0 mm | Hole too Big | Slight increase in noise level | 3 | Oversize tool | Tool pre-setting | 2 | Bore mic at OP 50 | 7 | 56 |
| | | | Concession | 4 | Spindle alignment error | Asset Care & Calibration | 1 | Weekly ball bar check | 8 | 28 |

Additions & Subtractions by Teams as required

Additions & Subtractions by Teams as required

# Using the 'Bridge Tool' to create the SHELL PFMEA

# Real Time Demo


Developed by Rolls-Royce Bangalore

Equivalent Processes available from Quest Engineering Consultancy and Tata Consultancy Services (TCS)

# How long does it take?

AESQ STRATEGY GROUP
A Program of SAE ITC

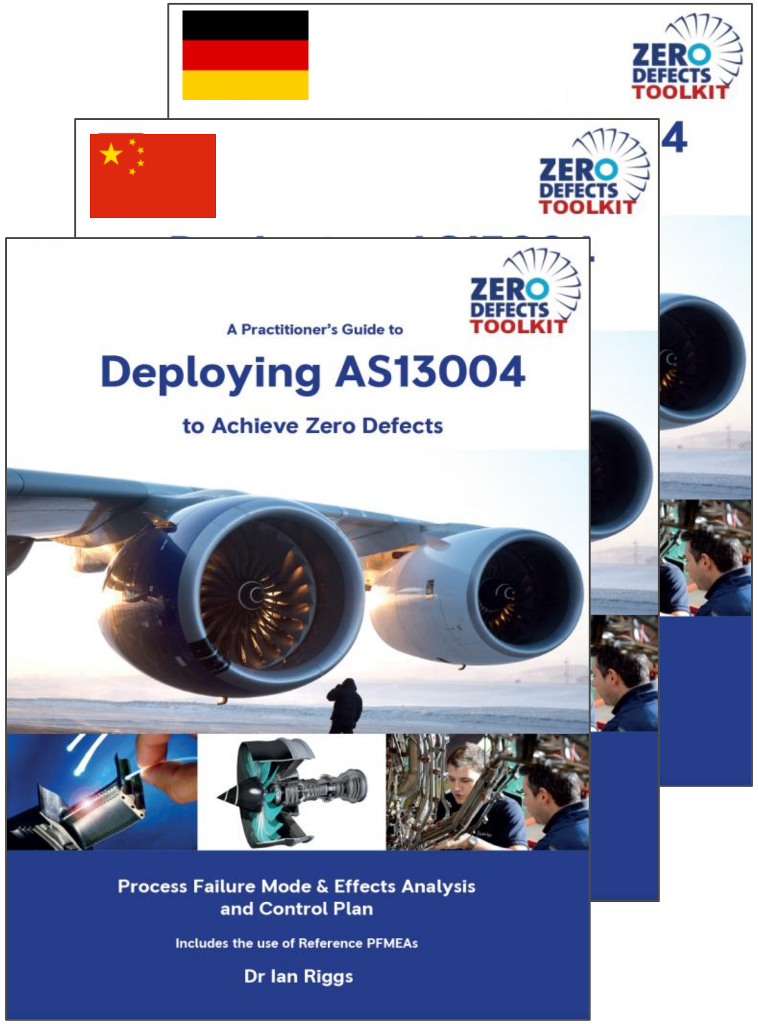
Create Reference PFMEAs — 30 man hours per REF PFMEA

Create Shell PFMEA — 30 man hours per Shell PFMEA (manual method):
<2 Hours using Bridge Tool

Complete 1st - 3rd Part Specific PFMEAs — 400 man hours per PFMEA

Complete future Part Specific PFMEAs — <100 man hours per PFMEA

# SOURCES OF FURTHER INFORMATION & GUIDANCE




1. Deploying AS13004 Practitioner Guide available free of charge on the RR Supplier Portal and the AESQ website
2. Available in English, German and Chinese
3. Selection of Rolls-Royce Reference PFMEAs available to external businesses via its Supplier Portal (open to all)
4. Invest in;
   - Dedicated FMEA IT software
   - Global PFMEA training is available to support this approach through SAE, Smallpeice Enterprises and Industry Forum

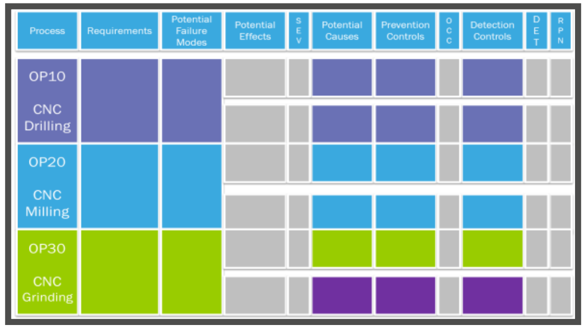
# AS13004 PFMEA Deployment Steps


**1.**
**Select the Cross Functional Team**


**2.**
**Upskill the Team using AS13004 Approved Training**

**3.**
**Create a Coaching network to develop the Team's capabilities**

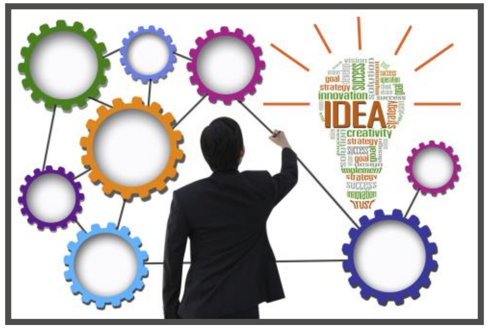

**4.**
**Develop your Reference PFMEA Database**




**5.**
**Use IT Solution to create 'Shell' PFMEA**

| Process | Requirements | Potential Failure Modes | Potential Effects | SEV | Potential Causes | Prevention Controls | OCC | Detection Controls | DET | RPN |
|---|---|---|---|---|---|---|---|---|---|---|
| OP10 CNC Drilling | Drill **FUEL** Hole 50mm Diameter +/- 1.0 mm | Hole too Big | Fuel leak leading to explosion | 9 | Oversize tool | Tool pre-setting | 4 | Bore mic at OP 50 | 7 | 252 |
| | | | Scrap part | 6 | Spindle alignment error | Asset Care & Calibration | 3 | Weekly ball bar check | 8 | 189 |
| OP20 CNC Drilling | Drill **AIR** Hole 50mm Diameter +/- 3.0 mm | Hole too Big | Slight increase in noise level | 3 | Oversize tool | Tool pre-setting | 2 | Bore mic at OP 50 | 7 | 56 |
| | | | Concession | 4 | Spindle alignment error | Asset Care & Calibration | 1 | Weekly ball bar check | 8 | 28 |

**6.**
**Complete the PFMEA with the Cross Functional Team**

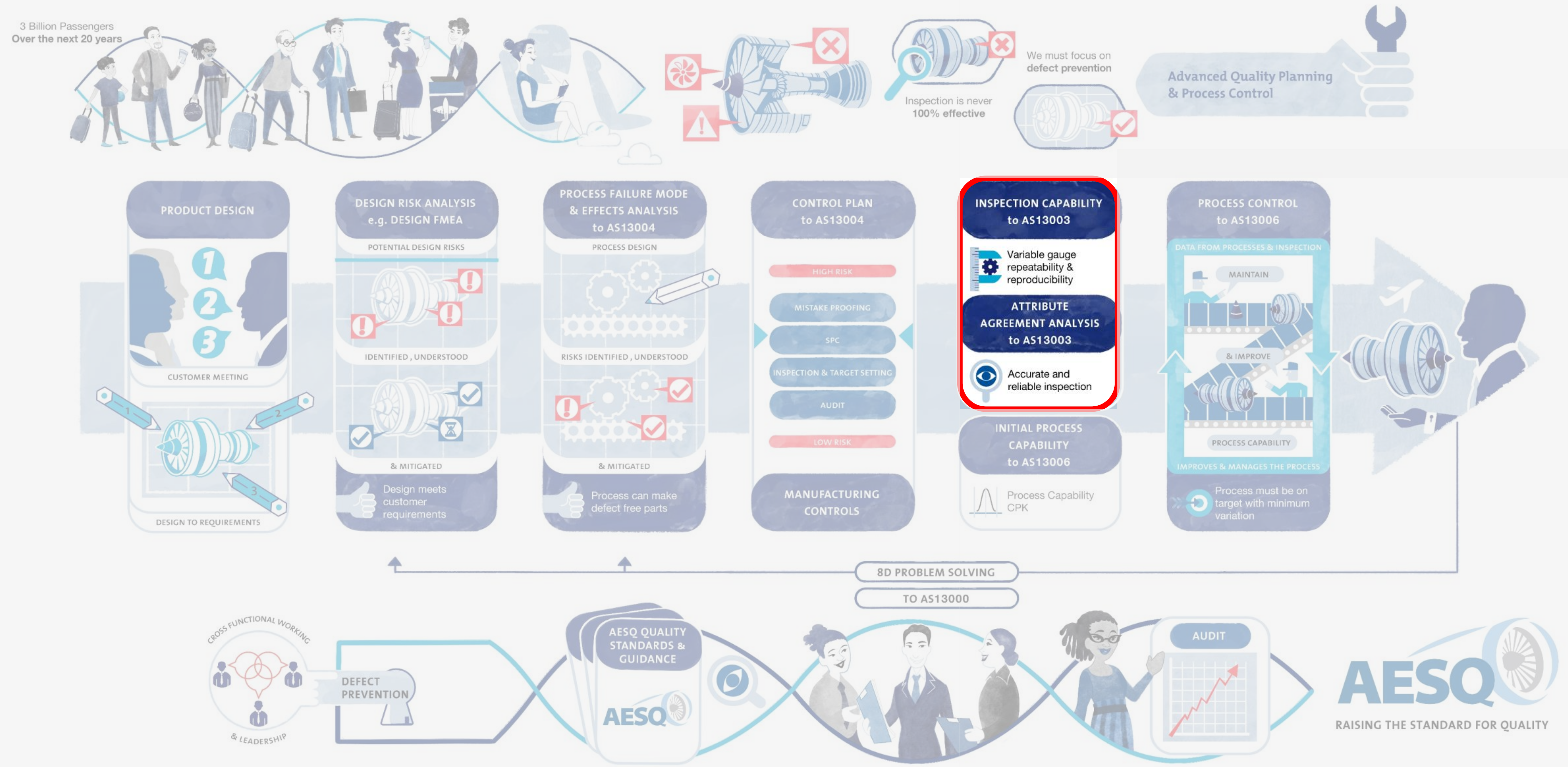



**7.**
**Identify and implement improvement actions from the PFMEA**



**Effective Process FMEAs will**
**TRANSFORM YOUR**
**QUALITY PERFOMANCE!**

# Defect Prevention Key Quality Tools for Zero Defects



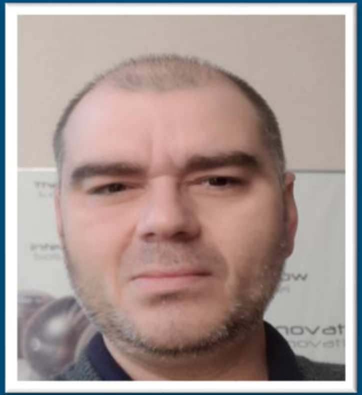
# Case Study

## AS13003 Measurement Systems Analysis


## Martin Schaeffner

Senior VP Corporate Quality

**MTU Aero Engine**

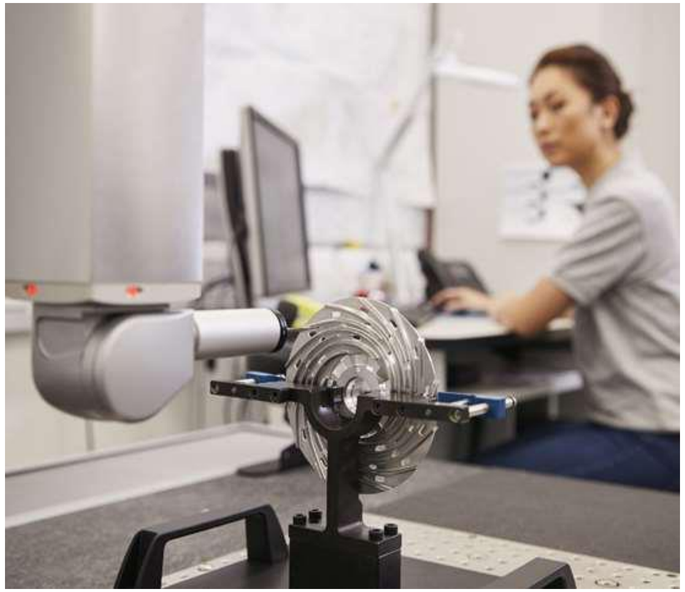

## Anthony Hartwig

Customer Quality Manager

**Mechachrome**

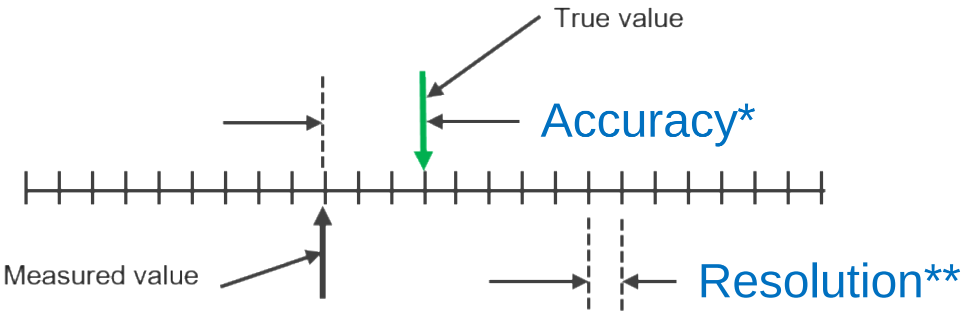
# Why is MSA so Important?

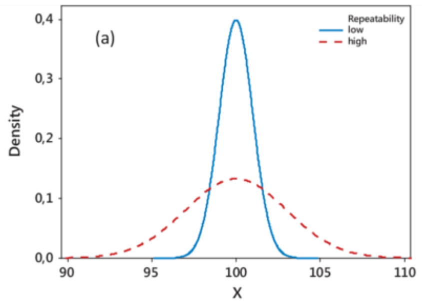
1. We are reliant upon Measurement & Inspection to ensure non-conforming products are detected
2. Data from Measurement and Inspection is required to identify changes to process stability
3. All Measurement Systems have error – we must ensure that this is as small as possible and within agreed thresholds



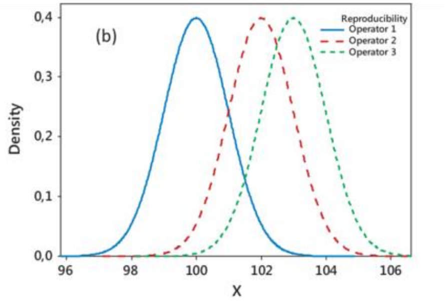
4. MSA allows us to measure the Capability of our Measurement and Inspection processes
5. It helps identify sources of variation so that mitigating / improvement actions can be taken to improve capability
6. Many of the required MSA Tests for Gauges is part of the Calibration Process

# What Types of MSA are there?

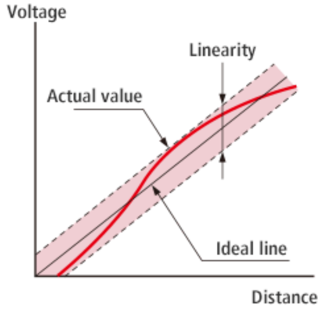


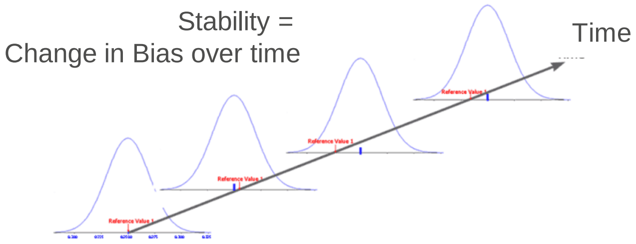

Repeatability



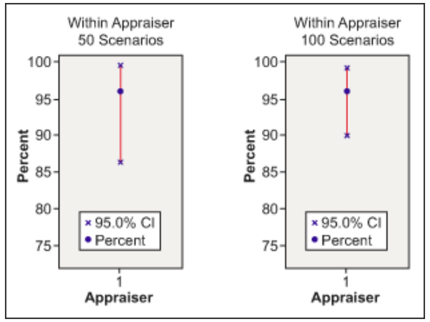

Reproducibility




Linearity*




Stability




Attribute Agreement Analysis

*Usually done as part of Gauge calibration **Gauge Selection Criteria

# AS13003 Measurement System Analysis Overview

**Section 7**
Measurement System Requirements

The When & the What
Acceptance Criteria

**Section 8**
Elements to Consider when conducting an MSA

MSA Design
Sample selection and size
Analysis of results, etc.

**Section 9**
MSA
Audit Checklist

**Section 10**
MSA Case Studies

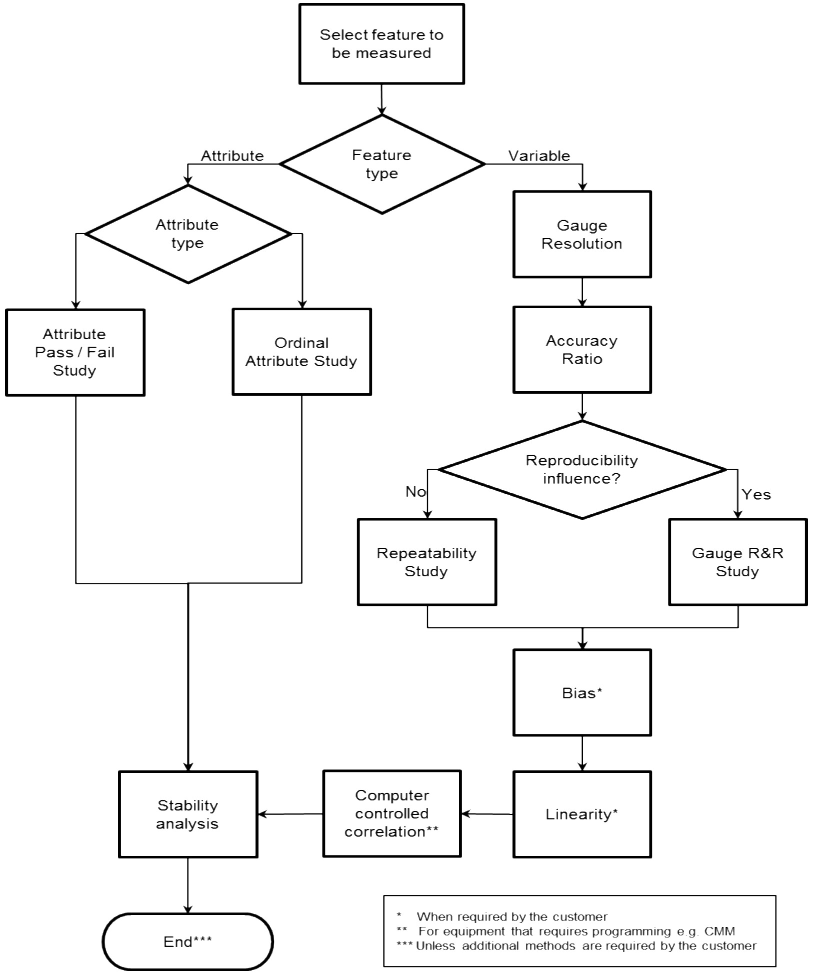
Gauge R&R
Gauge R&R for CMM
Attributes
Accuracy Ratio
etc.

# AS13003 Measurement Systems Analysis Overview

## Table 1: Defines when MSA needs to be done

| Event | Event Description | Action |
|---|---|---|
| 1 | New inspection device or method introduction. | Perform MSA |
| 2 | New/Changed Production Process. | Evaluate current or Perform MSA |
| 3 | Any significant change to the current inspection device or method:<br><br>i.e., equipment, operator, environment, location, sequence, calibration standard, Inspection house, CMM software or hardware change | Evaluate current or Perform MSA |
| 4 | Following a product escape related to (or suspected to be) from the Measurement System (nonconforming material left the facility). | Evaluate current or Perform MSA |
| 5 | Change in how an inspection device or method is used, or its application*.<br>For example:<br>1. When changing from simple geometry to complex. Moving from simple linear dimensions with flat parallel surfaces to non-flat (non-parallel) surfaces with geometric constructions required.<br>2. When changing from similar to non-similar product characteristics. Moving from visual inspection of edge breaks with dimensional requirements to visual inspection of cosmetic appearance requirements. | Perform MSA |
| 6 | Product requirements are changed to be more restrictive or tightened. | Recalculate from base data or Perform MSA |
| 7 | As part of a First Article Inspection (FAI) following a lapse in use of more than 24 months. | Evaluate current MSA |
| 8 | Existing inspection device or method is being used to accept product and has not previously been evaluated per this standard as directed by purchaser. | Perform MSA where required |
| 9 | Product audit non-conformance or product investigation when suspected to be from the measurement system. | Evaluate current or Perform MSA |
| 10 | To verify a measurement system is adequate before SPC. | Perform MSA |

## Figure 2 : Defines what type of MSA needs to be done




## Table 2 : Defines the acceptance thresholds for each type of MSA

| Method | Feature Category | | | Comments |
|---|---|---|---|---|
| | Critical | Major | Minor | |
| Resolution | ≤10% of total tolerance *** | | | Based on total tolerance. |
| Accuracy ratio** | Requirement = 10:1 | | Requirement = 4:1 | Values up to 4:1 may be acceptable when approved by the purchaser |
| Accuracy Error / Bias | ≤10% of total tolerance | | | Purchaser requirements may override this |
| Repeatability | ≤10% of total tolerance | ≤20% of total tolerance | ≤30% of total tolerance* | Purchaser requirements may override this |
| Gauge R&R | ≤10% of total tolerance | ≤20% of total tolerance | ≤30% of total tolerance* | Purchaser requirements may override this |
| Computer driven measurement systems correlation | ≤10% of total Tolerance | | ≤20% of total Tolerance | Purchaser requirements may override this |
| Linearity** | ≤1% of total tolerance | | - | |
| Attribute Study: pass/fail | Kappa ≥ 0.8 | | - | Only required on operator dependent interpretation |
| Attribute study: ordinal | ICC ≥ 0.75 | | - | Only required on operator dependent interpretation |

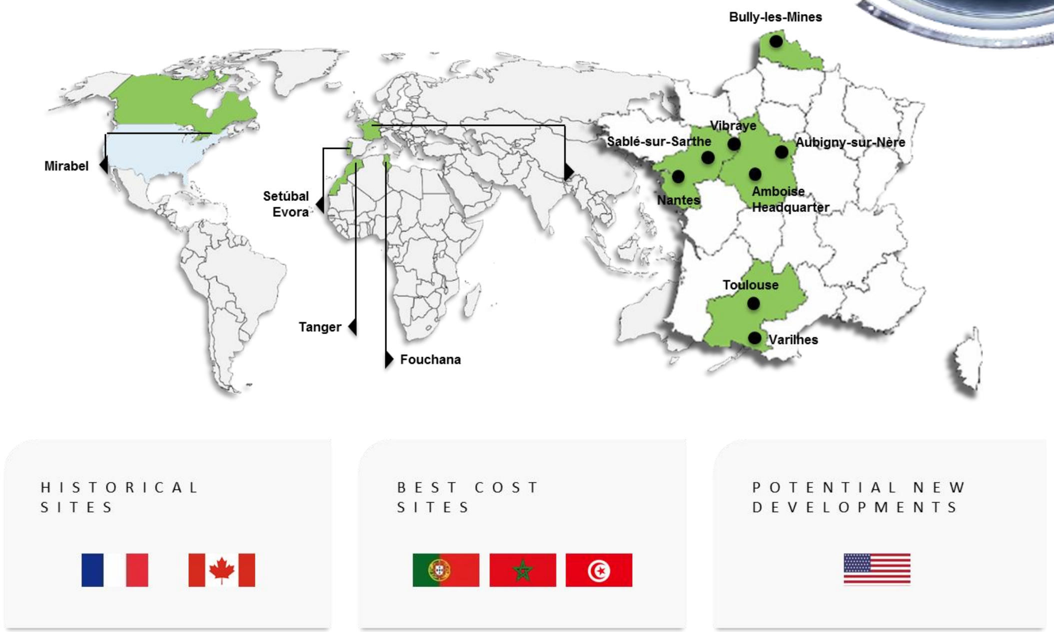
# AS13003 MSA implementation

Measurement System Analysis deployment

Anthony Hartwig Customer Quality Manager
Mecachrome FRANCE

# MECACHROME COMPANY OVERVIEW

- 3000 employees worldwide
- Locations France / Canada / Portugal / Tunisia
  Morocco /Potential Development in USA
- 400 Millions Euros in 2018
- Aerostructure / Aeroengine / Energy
  Space & defence / Automotive
  Sport Automotive




- 1000+ suppliers & sub-contractors
- Since 1937: Knowledge and innovation of our teams at the service of our customers for profitable growth

# A multisectoral know-how – Our Customers

## AEROSTRUCTURE

**56%** OF REVENUE 2017

Airbus Group, Stelia, Premium Aerotec, Boeing, Embraer, Sonaca, Dassault Aviation, Saab, Bombardier, Liebherr, GKN, CCA, Triumph Group, Inc., Alcoa, MHI Group, Norsk Titanium, Aries Manufacturing, Zodiac Aerospace, Spirit AeroSystems, Groupe Latecoere, Safran

## AEROENGINE

**20%** OF REVENUE 2017

Rolls-Royce, Safran, MTU Aero Engines, FAMAT, GKN, GE

## AUTOMOTIVE

**19%** OF REVENUE 2017

Daimler, Ferrari, John Deere, Porsche, PSA Peugeot Citroën, Deutz, Group GAZ, Renault, Volvo, BMW, Renault Trucks, Renault Sport F1, Red Bull, Yamaha, F2 FIA Formula 2 Championship

## ENERGY, SPACE & DEFENCE

**5%** OF REVENUE 2017

CEA, Air Liquide, MT Aerospace, Sodern, ArianeGroup, Airbus Defence & Space, CNIM, ArcelorMittal, Thales Alenia Space, Thales, Nexter, Iram, Trixell, CERN

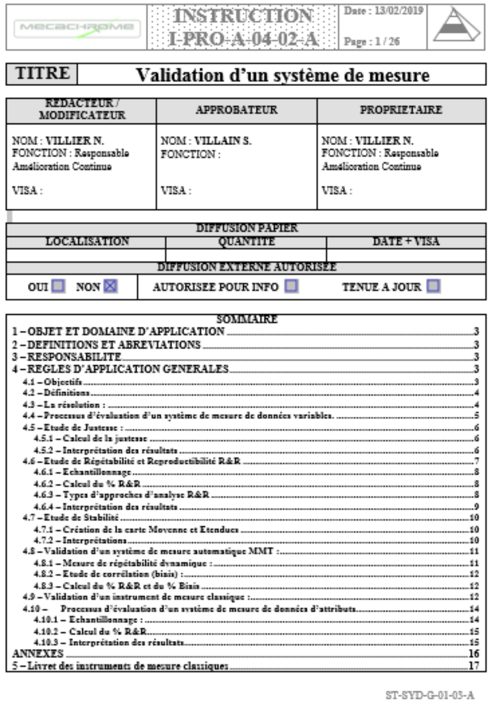
# AS13003 implementation

Calibrated
So OK to use
for what-ever
tolerances

Before MSA:

- Measurements systems choice and use based on historical industrial best practices.
- Pillar was the regular calibration.
- Data reliability linked to employees skills.
- Reoccurring discussions on data’s reliability.

# MSA Implementation



| MECACHROME | INSTRUCTION I-PRO-A-04-02-A | Date : 13/02/2019 Page : 1 / 26 |
|---|---|---|

| TITRE | Validation d'un système de mesure |
|---|---|

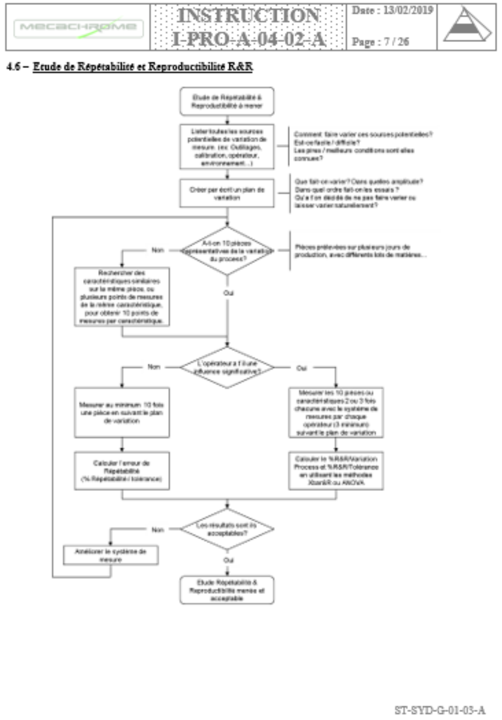
| REDACTEUR / MODIFICATEUR | APPROBATEUR | PROPRIETAIRE |
|---|---|---|
| NOM : VILLIER N. FONCTION : Responsable Amélioration Continue VISA : | NOM : VILLAIN S. FONCTION : VISA : | NOM : VILLIER N. FONCTION : Responsable Amélioration Continue VISA : |

| DIFFUSION PAPIER | | |
|---|---|---|
| LOCALISATION | QUANTITE | DATE + VISA |
| | | |
| DIFFUSION EXTERNE AUTORISEE | | |
| OUI ☐ NON ☒ | AUTORISEE POUR INFO ☐ | TENUE A JOUR ☐ |

SOMMAIRE



ST-SYD-G-01-03-A




- Mecachrome has decided to go on MSA implementation
- Inspection, Quality, Master Black Belt, Engineering, all operational people including customers were involved on the MSA implementation
  - Several months for the basis of our internal process.
  - Ongoing discussion with our customers
  - Key activities : agreement with customers & internal minds change process.
    *i.e.: Agreements for CMM on numbers of repetitions : mini 3 dynamics + 2 statics*

# MSA Implementation

Interprétation des tableaux :

Zone Rouge : Instrument non utilisable.
Zone Orange : Instrument utilisable pour caractéristique critique non majeure
Zone Verte : Instrument utilisable.

Exemple de tableau

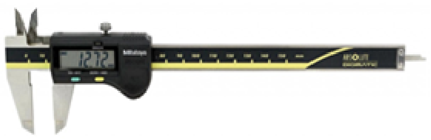
Tolérance de la caractéristique à contrôler

Pieds à coulisse à 0,02mm et à 0,01 mm :

| norme de référence | NF-E11-091 |
|---|---|

| | +/-0.005 | +/-0.010 | +/-0.025 | +/-0.05 | +/-0.1 | +/-0.25 | +/-0.5 | +/-0.75 | +/-1 |
|---|---|---|---|---|---|---|---|---|---|
| 150 | | | | | | | | | |
| 300 | | | | | | | | | |
| 500 | | | | | | | | | |
| 750 | | | | | | | | | |
| 1000 | | | | | | | | | |
| 1500 | | | | | | | | | |
| 2000 | | | | | | | | | |
| 3000 | | | | | | | | | |

Taille de la caractéristique



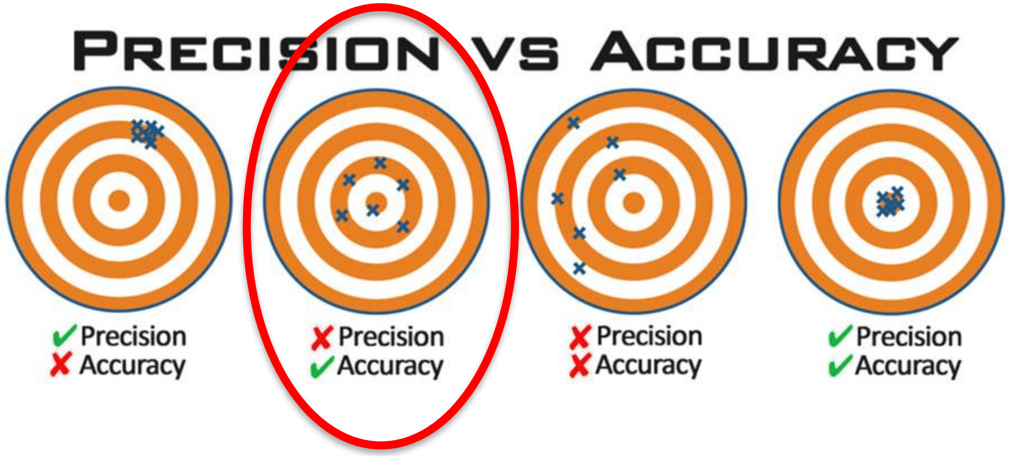
Pour un pied à coulisse digital, avec une résolution de 0,01mm, si sa longueur mesurée est de 300mm, cet instrument sera utilisable pour contrôler une caractéristique critique avec une spécification minimum de +/- 0.75mm.

Developing pragmatical approach on “classical devices”. We have more than 10000 of classical devices (just for Aubigny plant).

Not realistic to do R&R studies on each use. National standards applied to create choices matrix.

For adapted classical devices we apply R&R Study and sometimes this gave some surprises i.e. Results above 113%, so complete design was reviewed.

# What Results did we get?




Before

Today

- MSA allowed us to identify issues which weren't seen by "basic calibration" → variability root causes. i.e:
  - broken pin on tooling
  - design not efficient
- CMM is not capable to measure small diameters
- Last but not least: we can trust on our measurements when Gauge R&R is acceptable

# Insights


- What did we learn about the MSA deployment
  - Perform continuously
  - Face skilled people reaction, “why changing what we do since decades” ?
  - Lead with a multi functional team
  - Adapt internal communication. *“It is a useful tool not another thing to satisfy customers*”
  - Share openly with customers

# AS13003 Measurement Systems Analysis → Success Factors

- The goal is to make sure that every measurement system (gage + outside influences) used is **Fit for Purpose**
- The AS13003 method summarizes different tools and delivers a **standardized approach**.
- By using the MSA method you get a reliable and understandable statement if you can rely on your results or not
- **Don't touch your production processes before you are sure about your measurement**
- An MSA helps to eliminate influences coming from different measurement strategies
- A CMM measurement is not always reliable – accuracy and inspector variance matters
- A comparison to an independent reference measurement gives a valuable insight into the production line measurement;

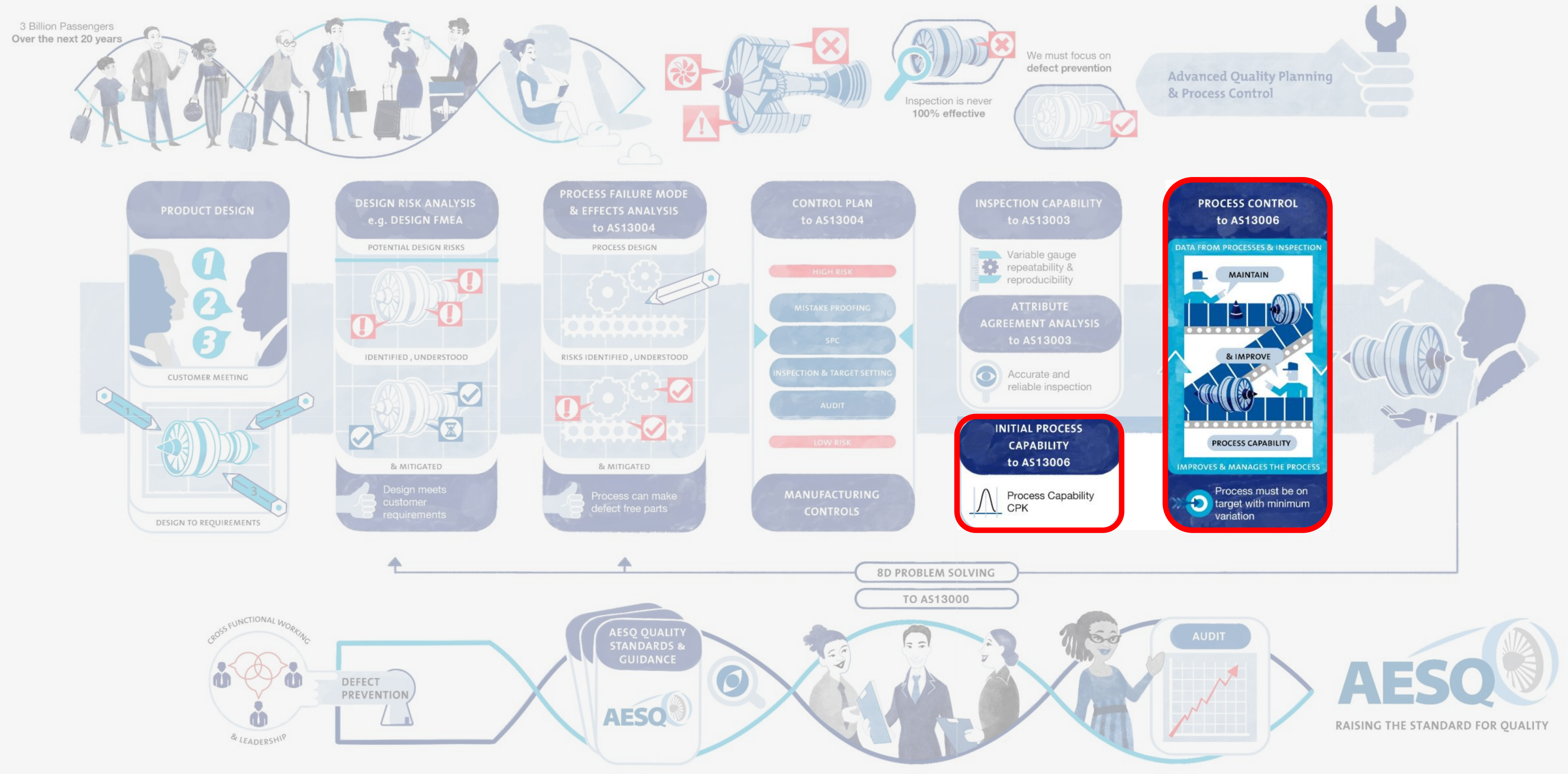
Nous saluons le retour

(Welcome Back)

# How to Effectively Deploy Defect Prevention Methods

## in the Aero Engine Supply Chain

# Defect Prevention Key Quality Tools for Zero Defects



# Case Study

## AS13006 Process Control Methods

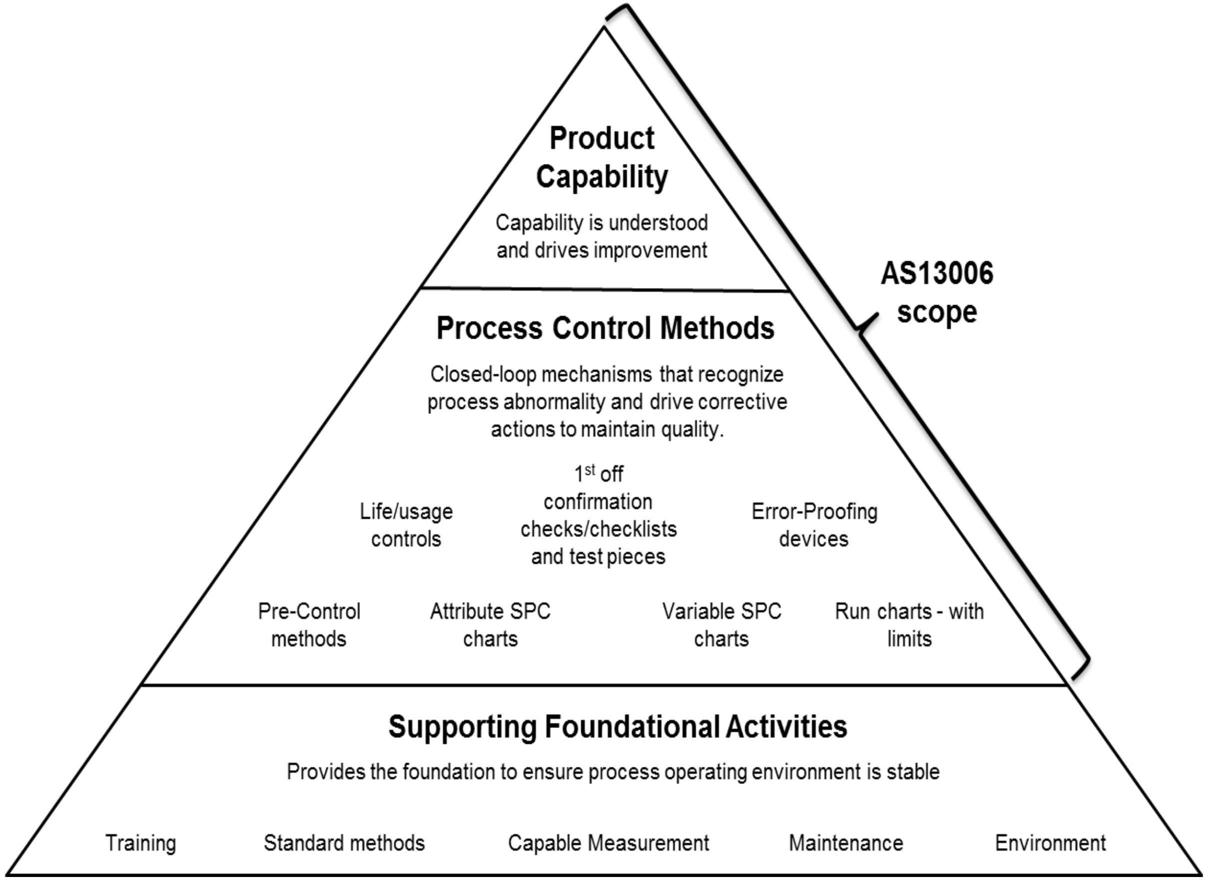
**Pete Teti**

Product & Process Validation Fellow

Pratt & Whitney

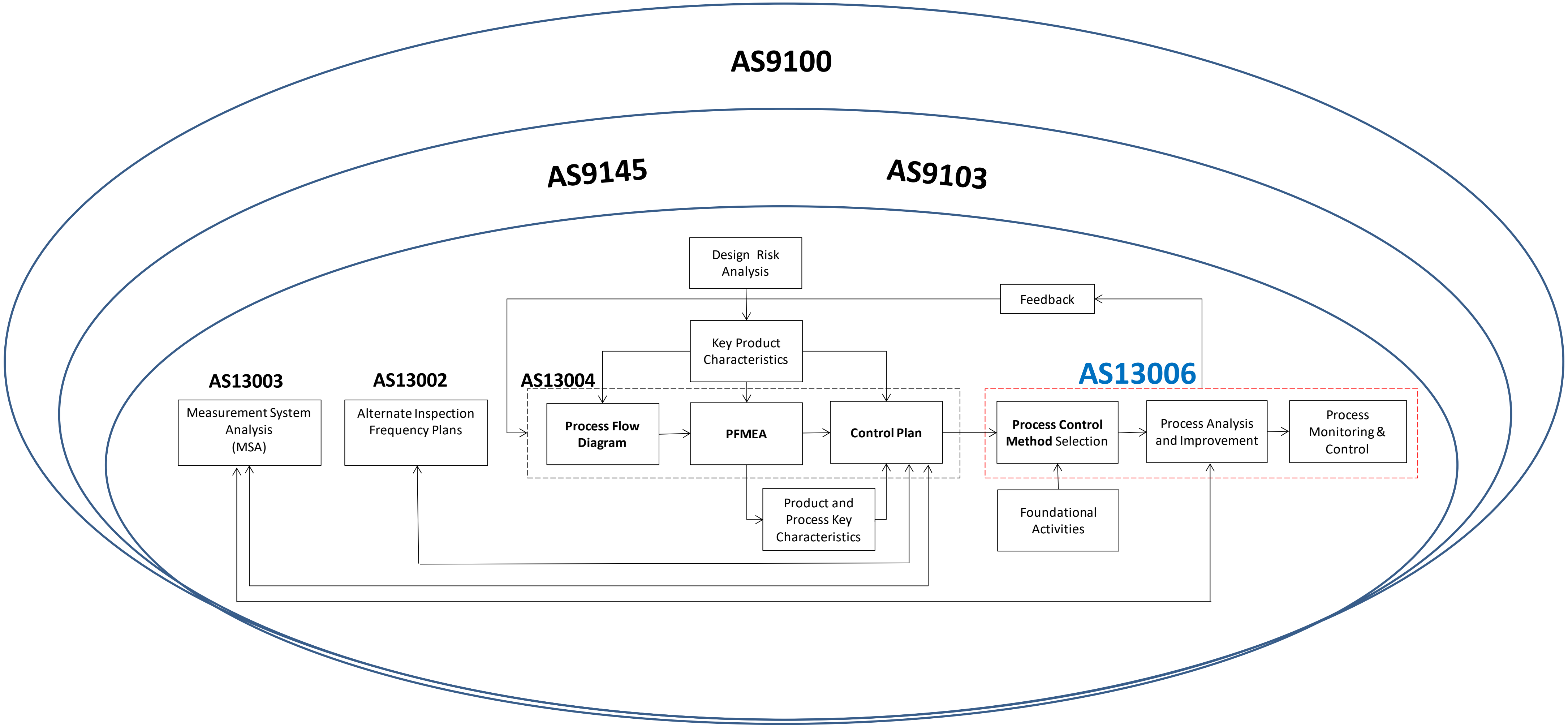

Nauset Light Beach, Cape Cod, Eastham, MA (2017)

# AS13006 Process Control Methods

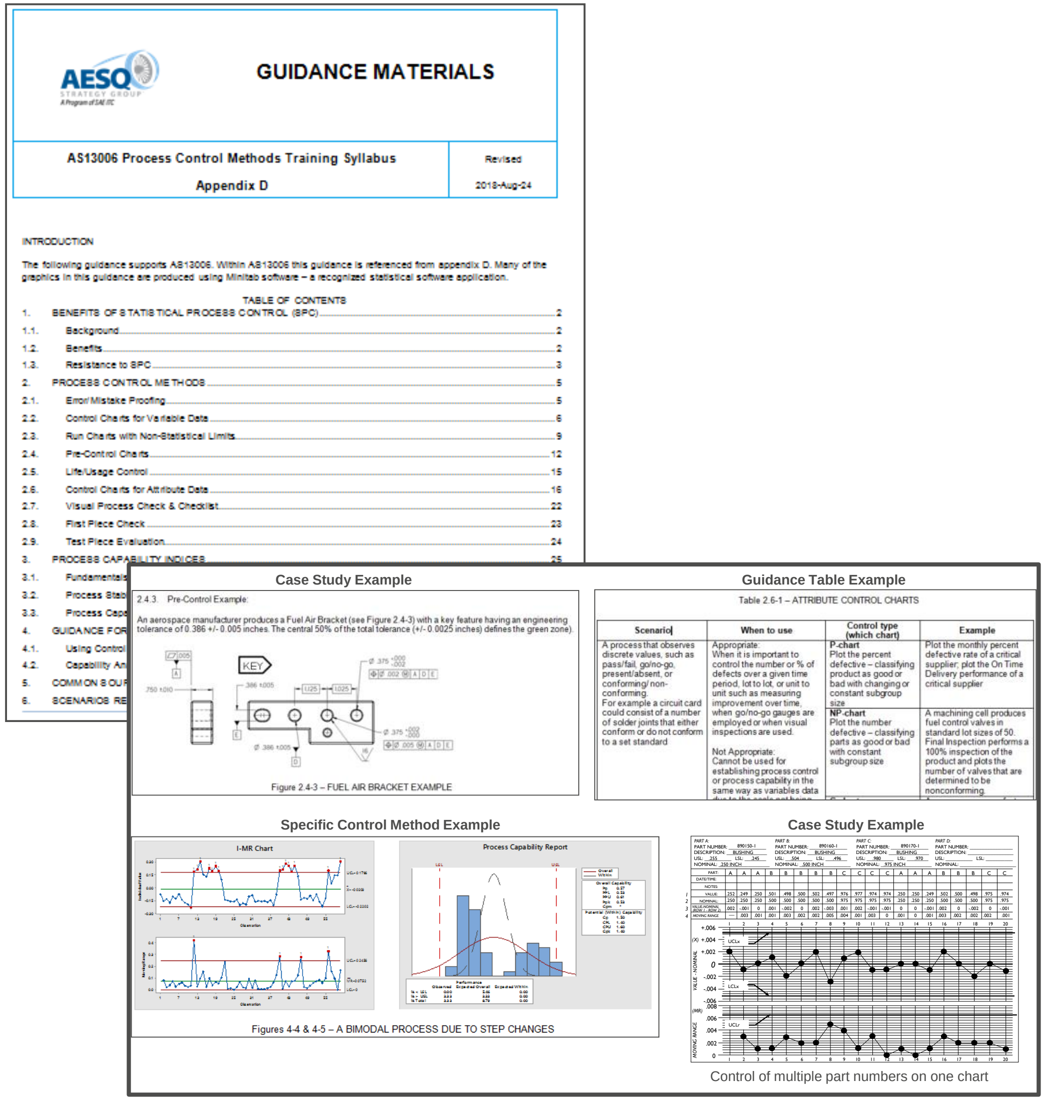



- Processes must be controlled to maintain stability and capability
- Using statistical concepts, processes can be managed to prevent defects
- Statistical Process Control is required for Key Characteristics but should also be considered for
  - Characteristics with marginal or poor capability
  - Visual inspection operations
- SPC allows variation to be identified, controlled and reduced.
- The best form of Process Control is Error Proofing
- There are a range of Process Control methods available to suit all process types

# Relationships to other Industry Standards



# Process Control Methods Guidance Materials




- Practical information to support the implementation of Process Control;
  - Benefits of process control
  - Overcoming resistance
  - Details on Process Control methods
  - Various control charts applications
  - Calculating process capability
  - Managing non-normal data
  - Associated formulas
- Case studies based on aerospace applications
- Assessment Checklist provides a method to measure the maturity of Process Control application within the business
- Defined Training Syllabus to help identify suitable courses to support deployment

# AS13006 Case Study

Pratt & Whitney Kalisz
A United Technologies Company


**Boguslaw Bac**

Quality Director

**Pratt & Whitney Kalisz**

**Agnieszka Kryściak**

Manager, Part & Process Approval

**Pratt & Whitney Kalisz**

# PRATT & WHITNEY KALISZ

## AS 13006
## OUTSIDE DIAMETER CONTROL CASE STUDY

# EXPORT CLASSIFICATION

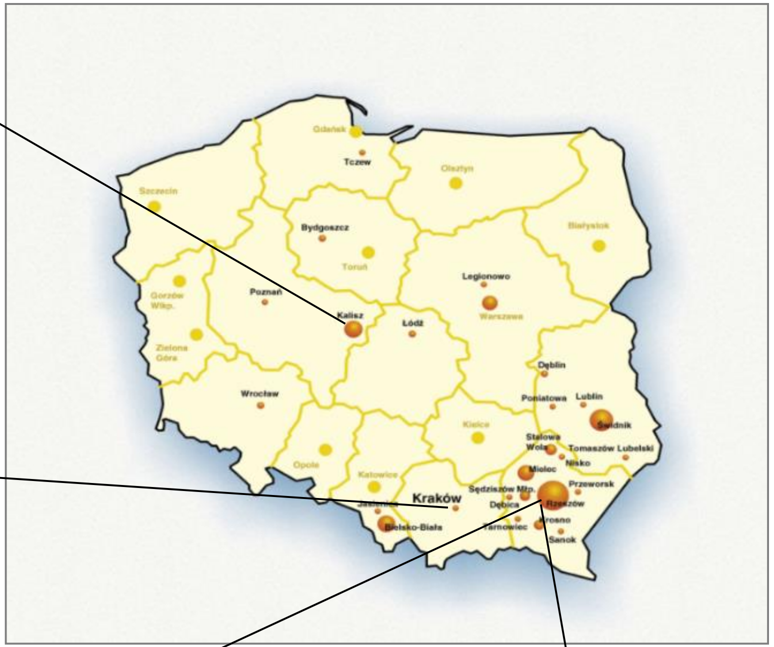
| X | Check this box if presentation contains "***no technical data***"<br>OR summarize the export classifications of all slides in this presentation as instructed below: |
|---|---|

| Instructions: Box 1 and one (1) of boxes 2-5 must always be completed | |
|---|---|
| | **Classification:** |
| 1. Canadian ECL(s): | |
| 2. ECCN(s) (EAR): | |
| 3. P-ECCN(s) : | |
| 4. USML (ITAR): | |
| 5. P-USML: | |

# PRATT & WHITNEY IN POLAND

P&W Kalisz

P&W Tubes




P&W Aero Power

P&W Rzeszów

PW 1000

PW 800

APS 5000

Airbus A320 NEO

Gulfstream 500

Boeing 787

# PRATT & WHITNEY KALISZ

| | |
|---|---|
| Produces | 1550 P/N |
| Area Land | 150 000 sqm |
| Buildings (production & offices) | 40 000 sqm |
| Sales | 185 M USD |
| Employment | 1608 |

Customers:
Pratt & Whitney East Hartford
Pratt & Whitney Canada
Pratt & Whitney Rzeszów
Collins Aerospace





**Bevel Gears**

**Carrier**

**Stators**

**Main Shaft**

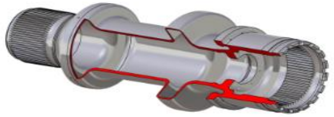
**Carrier FDGS**

**Input Coupling**

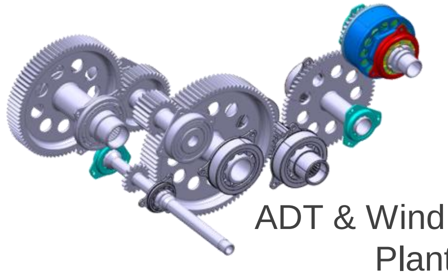
**BH#4 NEO**

**SMP**

# PRATT & WHITNEY KALISZ NGPF ENGINE CONTENT



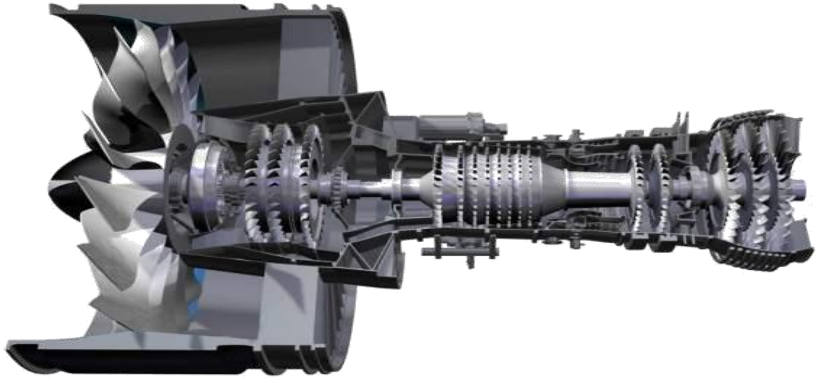
Input Cupling
Plant 3



ADT & Wind mill gears
Plant 1

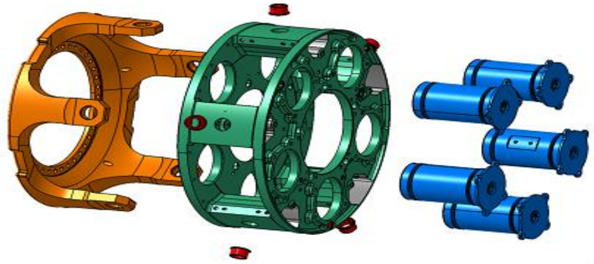
Small Machining Parts
+ Bearing housing
Plant 4

Fan Shaft
Plant 3



TIE Shaft
Plant 3

Front hub
Plant 2



Torque Frame
Plant 3

Carrier
Plant 3

Journal Pin
Plant 1

FDGS components

Cupling nuts
Plant 2

# PRATT & WHITNEY KALISZ

## INTRODUCING NEW PRODUCT

**Spring Bearing PW 1000 engine for  A320 NEO**

Challenges during product implementation:

- Assuming quick implementation
- Low cost = zero defects
- Thin-walled part and no experience in machining titanium parts
- PPAP full approval expectation

Implementation of AS 13006 with associated  AS 13004:

- Proactive process control
- Identification of Key Characteristics
- Selection of appropriate process control tools
- Based on Foundational Activities  (making process control achievable)

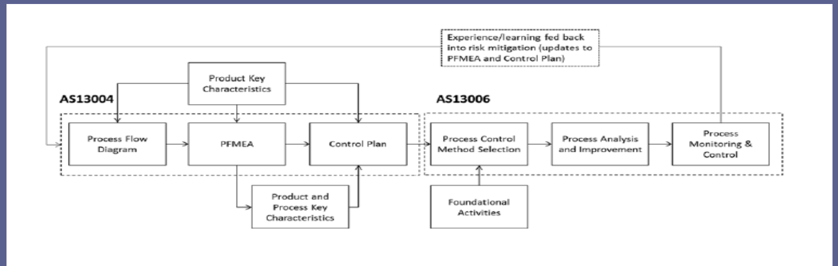



*Figure 2 - Overview of the key interfaces and inputs*

SAE International AS 13006 (2018, September)

# PRATT & WHITNEY KALISZ

## OUTSIDE DIAMETER CONTROL EXAMPLE

PROCESS FLOW

PFMEA

CONTROL PLAN

OUTSIDE DIAMETER CONTROL

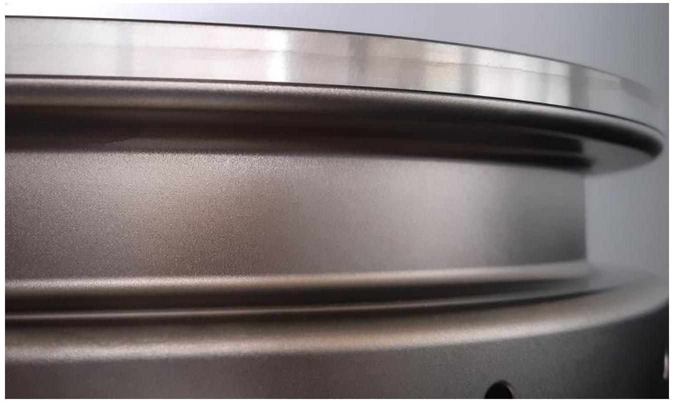
**TURNING OPERATION**

**SHOT PEENING OPERATION**

**HIGH RPN**

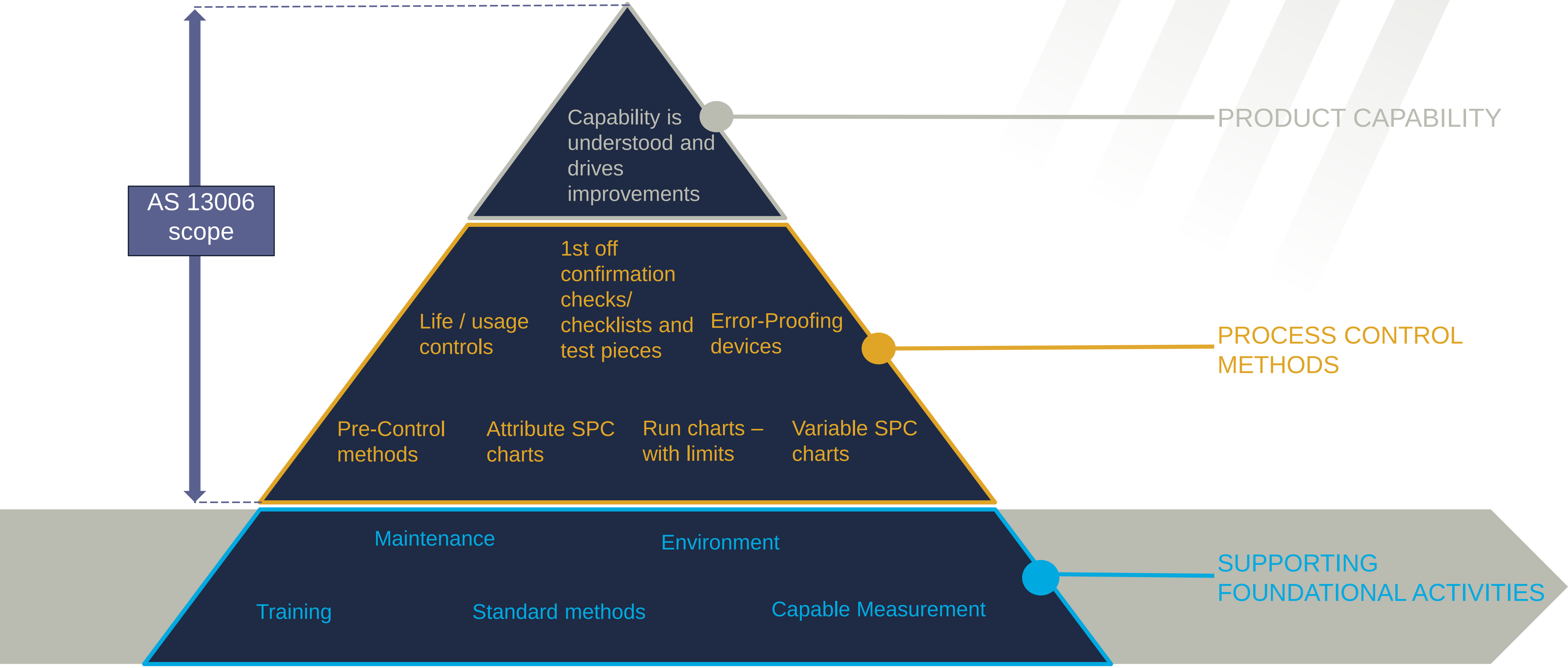
**KEY CHARACTERISTIC**

OUTSIDE DIAMETER DEFORMATION



# PRATT & WHITNEY KALISZ

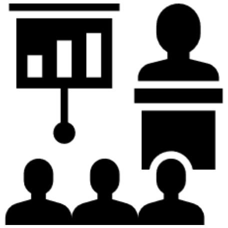
## OUTSIDE DIAMETER CONTROL EXAMPLE



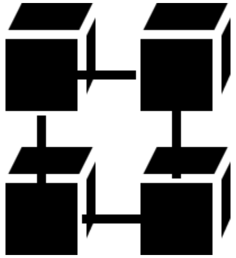

SAE International AS 13006 (2018, September) Figure 1 – Process control overview

# PRATT & WHITNEY KALISZ

## OUTSIDE DIAMETER CONTROL EXAMPLE



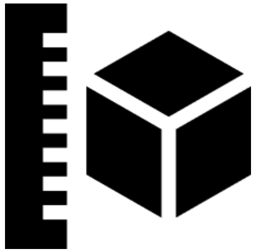
Dedicated training program for engaged parties



Standard method along with utilization of continuous improvement tools

TPM sessions scheduled

Environmental factors identified and controlled



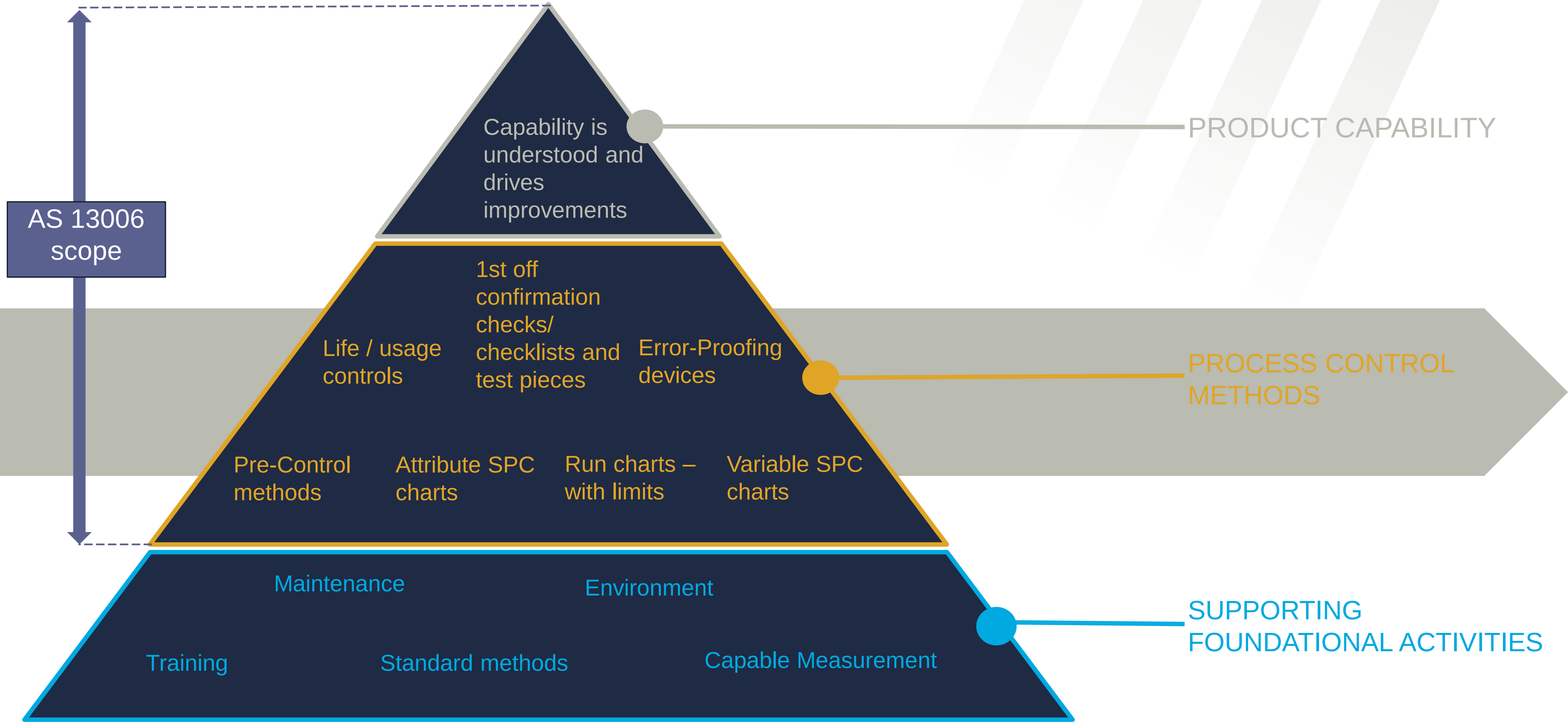
Gauge control system in place (calibration and MSA)


SUPPORTING FOUNDATIONAL ACTIVITIES

EXPORT CLASSIFICATION: NO TECHNICAL DATA

# PRATT & WHITNEY KALISZ

## OUTSIDE DIAMETER CONTROL EXAMPLE




SAE International AS 13006 (2018, September) Figure 1 – Process control overview

# PRATT & WHITNEY KALISZ

## OUTSIDE DIAMETER CONTROL EXAMPLE

### TURNING

automatic offset adjustment based on tool measurement results saved on a chip

tool life time management - tool blocking after defined wear

automatic inspection of tool condition after machining

machine probing - automatic correction of tool paths based on in-process measurements

### Process Control Method

Mistake Proofing

Life usage controls

EXPORT CLASSIFICATION: NO TECHNICAL DATA

### SHOT PEENING

process parameters indicated by CNC program

embedded parameters control with automatic switch off

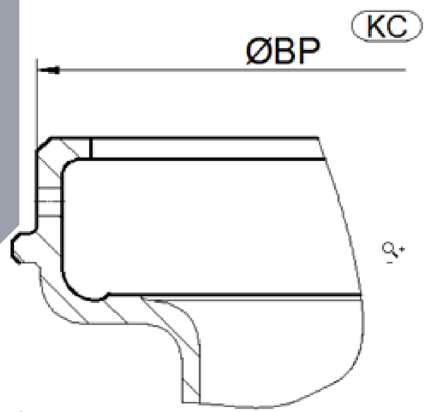
robotic arm ensuring positioning repeatability

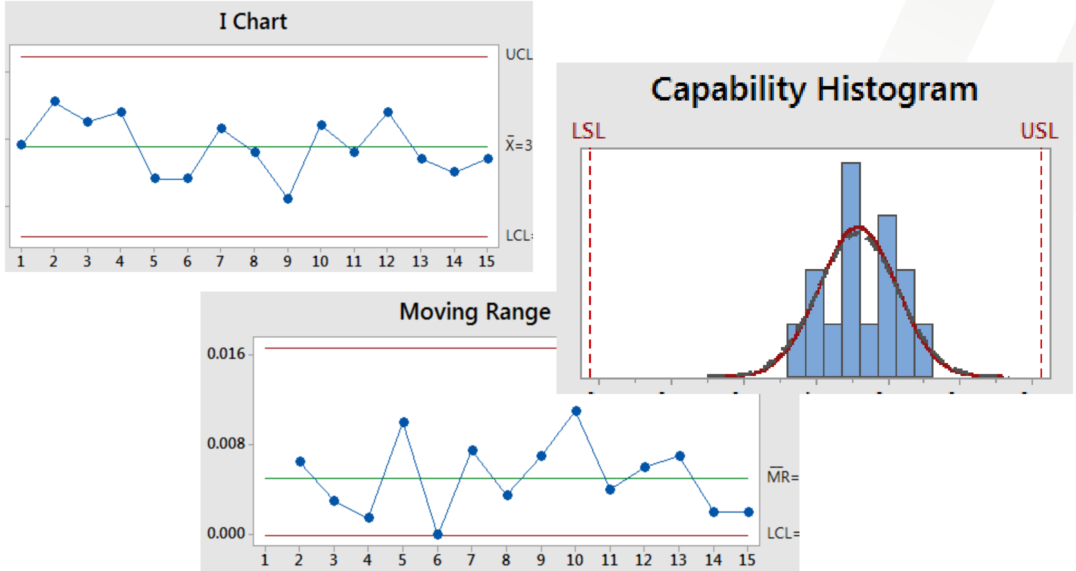
media verification system scheduled and maintained

# PRATT & WHITNEY KALISZ

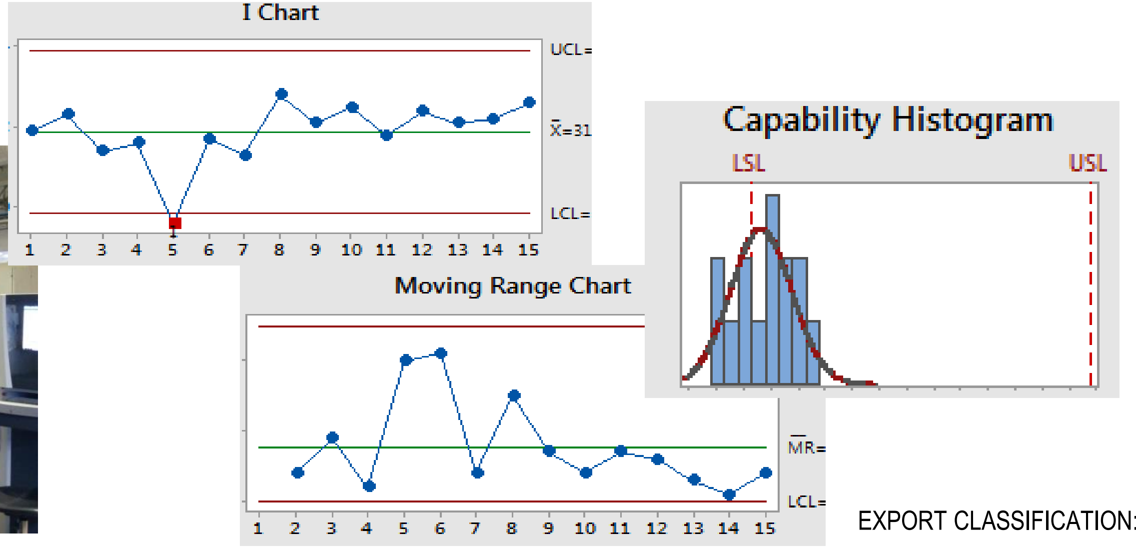
## OUTSIDE DIAMETER CONTROL EXAMPLE

### TURNING OPERATION




### SHOT PEENING




**MAIN RULE**

Implement data collection from production runs at the production source

CP = 1.85
CPK=1.50

CP = 1.82
CPK=0.11

# PRATT & WHITNEY KALISZ

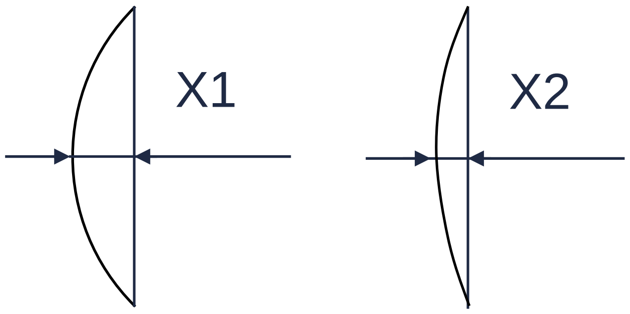
## IMPROVEMENT

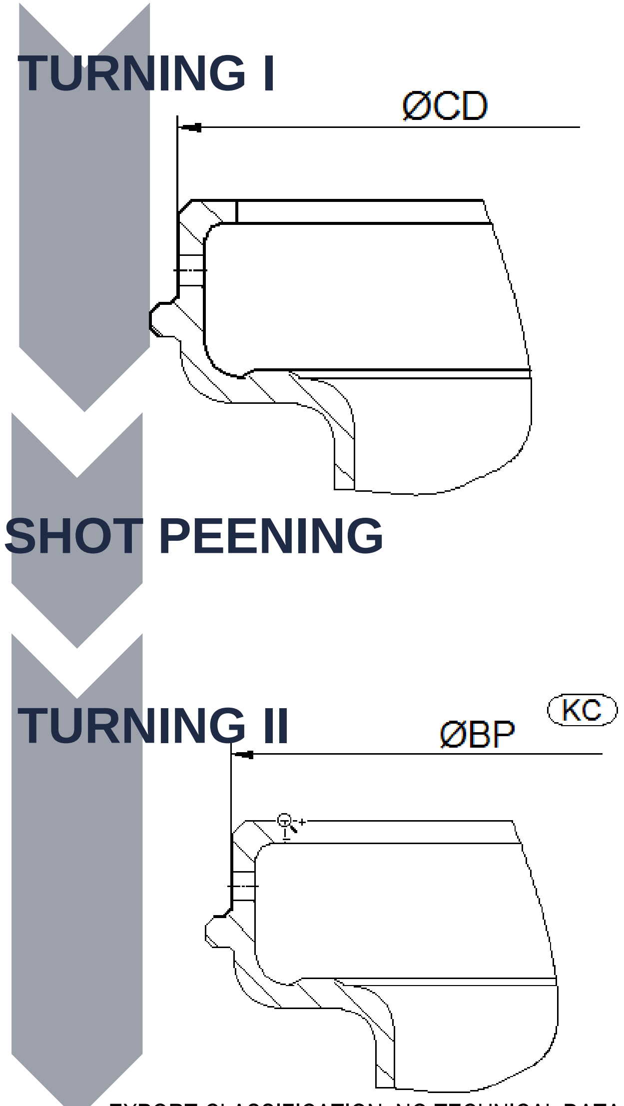

PRODUCT CAPABILITY

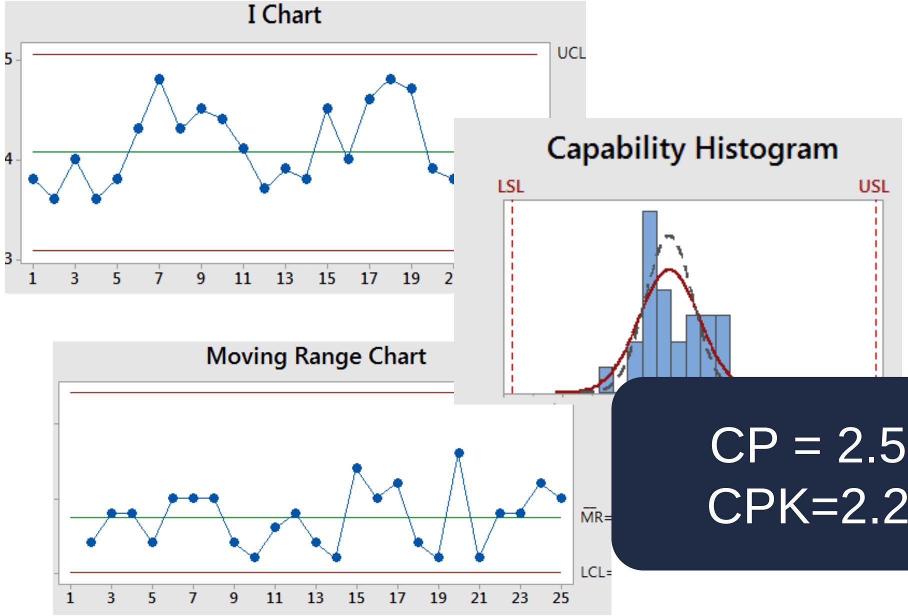
### SHOT PEENING:

Fixture modification

Process parameters change




CP = 2.53
CPK=2.20

# PRATT & WHITNEY KALISZ

## SUMMARY

### Customer Benefits

- Fulfillment of project assumptions
- Customer satisfaction
- On time delivery
- PPAP full approval

### Internal Benefits

Zero Nonconformance

Proactive process monitoring

Quick identification of possible source of nonconformance

FPY first pass yield

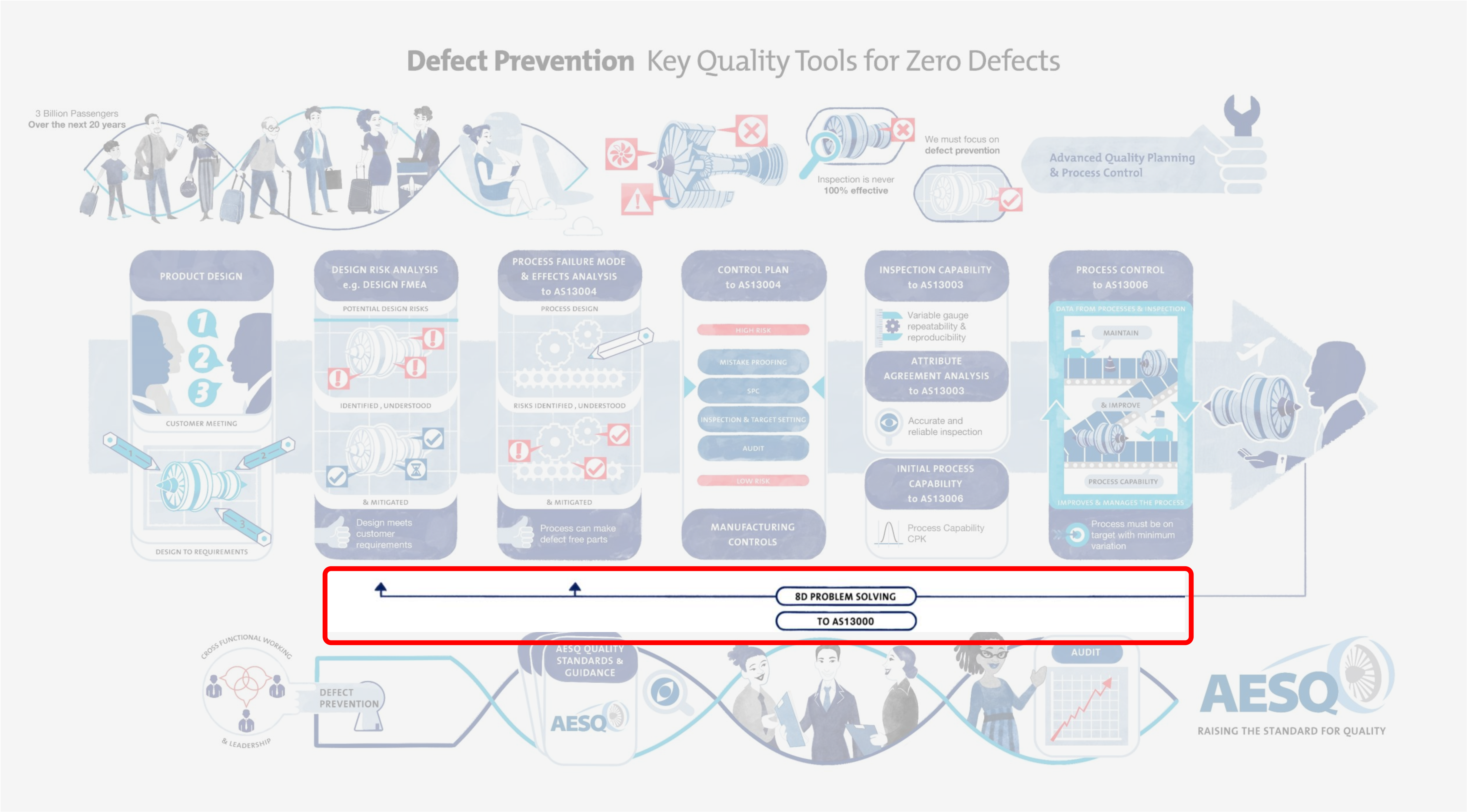
### Lesson Learnt

- Implementation of process control as close as possible to production source
- Employee engagement on every step of Process Control Activities
- Results prove effectiveness of the method

GO BEYOND

# AS13006 Process Control – Success Factors

1. Strive for Error-Proofing wherever possible
2. Apply SPC where it is required because of the process capability not just because it is a KC
3. Quick feedback from the process to determine if the process has changed – Process Control not Process Analysis!
4. Select the right calculation to determine Process Capability
5. Don’t forget to apply to attribute data too!
6. Ensure you have people in the organisation that are qualified in Statistical Techniques



Defect Prevention Key Quality Tools for Zero Defects
3 Billion Passengers
Over the next 20 years
Inspection is never
100% effective
We must focus on
defect prevention
Advanced Quality Planning
& Process Control
PRODUCT DESIGN
CUSTOMER MEETING
DESIGN TO REQUIREMENTS
DESIGN RISK ANALYSIS
e.g. DESIGN FMEA
POTENTIAL DESIGN RISKS
IDENTIFIED , UNDERSTOOD
& MITIGATED
Design meets
customer
requirements
PROCESS FAILURE MODE
& EFFECTS ANALYSIS
to AS13004
PROCESS DESIGN
RISKS IDENTIFIED , UNDERSTOOD
& MITIGATED
Process can make
defect free parts
CONTROL PLAN
to AS13004
HIGH RISK
MISTAKE PROOFING
SPC
INSPECTION & TARGET SETTING
AUDIT
LOW RISK
MANUFACTURING
CONTROLS
INSPECTION CAPABILITY
to AS13003
Variable gauge
repeatability &
reproducibility
ATTRIBUTE
AGREEMENT ANALYSIS
to AS13003
Accurate and
reliable inspection
INITIAL PROCESS
CAPABILITY
to AS13006
Process Capability
CPK
PROCESS CONTROL
to AS13006
DATA FROM PROCESSES & INSPECTION
MAINTAIN
& IMPROVE
PROCESS CAPABILITY
IMPROVES & MANAGES THE PROCESS
Process must be on
target with minimum
variation
8D PROBLEM SOLVING
TO AS13000
CROSS FUNCTIONAL WORKING
& LEADERSHIP
DEFECT
PREVENTION
AESQ QUALITY
STANDARDS &
GUIDANCE
AUDIT
AESQ
RAISING THE STANDARD FOR QUALITY

# Case Study

## AS13000 Problem Solving Requirements for Suppliers (8D)


**Olivier Castets**

Quality Manager Components & Accessories

Safran Aircraft Engines

**Brett Withington**

Quality Director

Meggitt

# Before AS13000 Problem Solving using 8D?

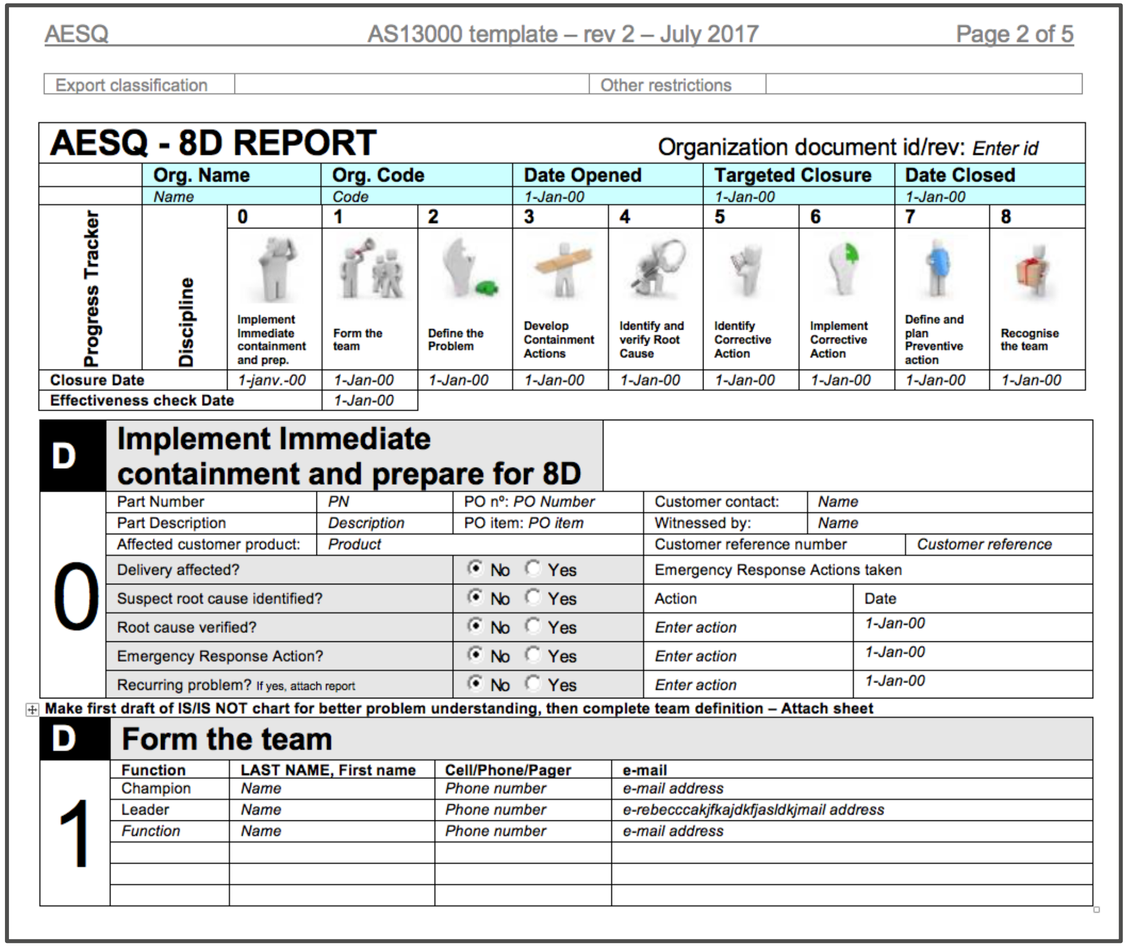

**Every body was doing Problem Solving in different flavor…**

**…Sometimes in a very poor way**

- Solving the wrong problem
- Just doing 5 whys (and then what?)
- Jumping to solutions (because the root causes are known for a long time…)
  - Forgetting why the containment (control plan) did not work
- Forgetting to read across
- Forgetting to close the loop back to the FMEA

**Difficult to find a effective training**

# AS13000 Standard Overview





| Export classification | | Other restrictions | |
|---|---|---|---|

**AESQ - 8D REPORT** Organization document id/rev: *Enter id*

| | Org. Name | Org. Code | Date Opened | Targeted Closure | Date Closed |
|---|---|---|---|---|---|
| | *Name* | *Code* | *1-Jan-00* | *1-Jan-00* | *1-Jan-00* |

| Progress Tracker | Discipline | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Implement Immediate containment and prep. | Form the team | Define the Problem | Develop Containment Actions | Identify and verify Root Cause | Identify Corrective Action | Implement Corrective Action | Define and plan Preventive action | Recognise the team |
| Closure Date | | *1-janv.-00* | *1-Jan-00* | *1-Jan-00* | *1-Jan-00* | *1-Jan-00* | *1-Jan-00* | *1-Jan-00* | *1-Jan-00* | *1-Jan-00* |
| Effectiveness check Date | | | *1-Jan-00* | | | | | | | |

**D0 Implement Immediate containment and prepare for 8D**

| | | | | |
|---|---|---|---|---|
| Part Number | *PN* | PO nº: *PO Number* | Customer contact: | *Name* |
| Part Description | *Description* | PO item: *PO item* | Witnessed by: | *Name* |
| Affected customer product: | *Product* | | Customer reference number | *Customer reference* |
| Delivery affected? | | ◉ No ○ Yes | Emergency Response Actions taken | |
| Suspect root cause identified? | | ◉ No ○ Yes | Action | Date |
| Root cause verified? | | ◉ No ○ Yes | *Enter action* | *1-Jan-00* |
| Emergency Response Action? | | ◉ No ○ Yes | *Enter action* | *1-Jan-00* |
| Recurring problem? If yes, attach report | | ◉ No ○ Yes | *Enter action* | *1-Jan-00* |

**Make first draft of IS/IS NOT chart for better problem understanding, then complete team definition – Attach sheet**

**D1 Form the team**

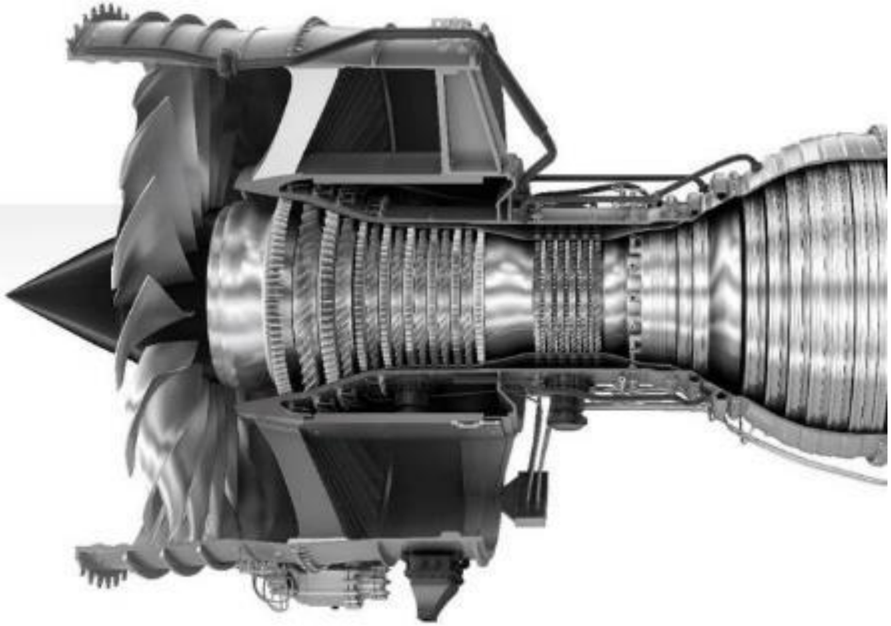
| Function | LAST NAME, First name | Cell/Phone/Pager | e-mail |
|---|---|---|---|
| Champion | *Name* | *Phone number* | *e-mail address* |
| Leader | *Name* | *Phone number* | *e-rebecccakjfkajdkfjasldkjmail address* |
| *Function* | *Name* | *Phone number* | *e-mail address* |
| | | | |
| | | | |
| | | | |

- Overview of the structure problem solving process
- Explanation of the requirements of each of the 8 Steps
- Prescriptive Template to drive standardization and learning from best practice
- 8D Check List for each step to use during problem investigation
- Standard Training Syllabus & Methods Training
- AS13000 also available in French.

MEGGiTT

Enabling the Extraordinary
To Fly To Power To Live

# AS13000 8D IMPLEMENTATION




**Meggitt**
presented by Brett Withington,
Quality Director


**October 2019**

# Company overview – Organisation structure

## Customer-focused organisation aligned to end markets

### Airframe Systems

- Braking Systems
- Fire & Safety
- Power & Motion
- Avionics & Airframe Sensing
- Polymer Seals
- Fuel Systems & Composites

### Engine Systems

- Flow Control
- Thermal Systems
- Engine Composites
- Engine Sensors

### Energy & Equipment

- Defense Systems
- Training Systems
- Heatric
- Energy Sensors & Controls

### Services & Support

- Americas
- UK & Europe
- Asia Pacific

# Company overview – Our global footprint

## 11,000 staff worldwide

**USA**
Employees: 6,211
Sites: 23

**UK**
Employees: 2,674
Sites: 9

**Rest of Europe**
Employees: 1,241
Sites: 7
Denmark, France and Switzerland

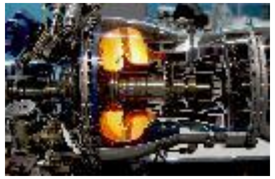
**Rest of World**
Employees: 1,100
Sites: 6
China, Mexico, Singapore and Vietnam

# Company overview – Technology

## Pioneering research in differentiated technology

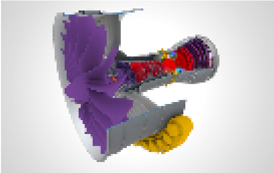

Braking Systems


Fire Protection


Thermal Systems


Engine Composites


Flow Control


Sensing & Monitoring

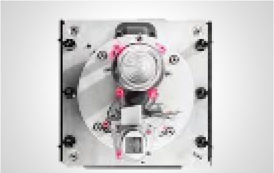

Fuel Containment


Defence Systems


Electrical Power


Avionics


Training Systems


Digital Manufacturing

# Overview of problem solving activites

**AS13000 – 8D problem solving**

Meggitt is split into 4 customer focussed divisions supporting Airframes, Energy & Equipment, Engines, Services & Support

Divisional approaches are different based on the industry and customer approach, leading to a multi-faceted approach to problem solving

As each site has a different product / customer family, then there is a significant difference in

- The format used to report RCCA
- The depth of problem solving techniques
- The capability of the sites to effectively problem solve

This gives the central quality function difficulty in training the sites in a consistent manner

# Deployment of AS13000

MEGGITT

**MEGGITT PROCEDURE**

**Control of Nonconforming Outputs**

**Company Confidential**

| | |
|---|---|
| Document: | MQA-10 Control of Nonconforming Outputs |
| Version: | 2 |
| Function: | Quality Assurance |
| Process Owner: | Group Quality Director |

**MQA-10 Control of Nonconforming Outputs**

**10.0 REFERENCED DOCUMENTS**

- MOPS-12 Meggitt Product Performance Issues Escalation Procedure
- MQA-20 Documented Information Procedure
- MQA-24 Internal Audit Procedure
- Meggitt Quality Clinic and CAPA training materials
- AS13000 Problem Solving Requirements for Suppliers
- AS13004 PFMEA & Control Plan
- MGU-1 Abbreviations and Definitions dictionary
- MFT-4 8D Template
- MFT-40 Meggitt Group Quality Alert/ knowledge sharing

1. **Acceptance of the standard, as a Whole Meggitt Standard**
   - AS13000 was introduced by the Engines sites to the Central Quality function
   - Group Quality reviewed the standard to determine the applicability for ALL Meggitt sites
2. **Systemise the Standard**
   - Meggitt has been developing a ‘Global QMS (Quality Management System)’ to standardise the use of quality tools across all divisions & sites
   - Meggitt procedure MQA-10 Control of Nonconforming outputs embedded the AS13000 standard directly into the Meggitt central procedure
   - The Meggitt 8D template MFT-4 is the AS13000 8D template

# Deployment of AS13000

3. **Whole Business deployment**

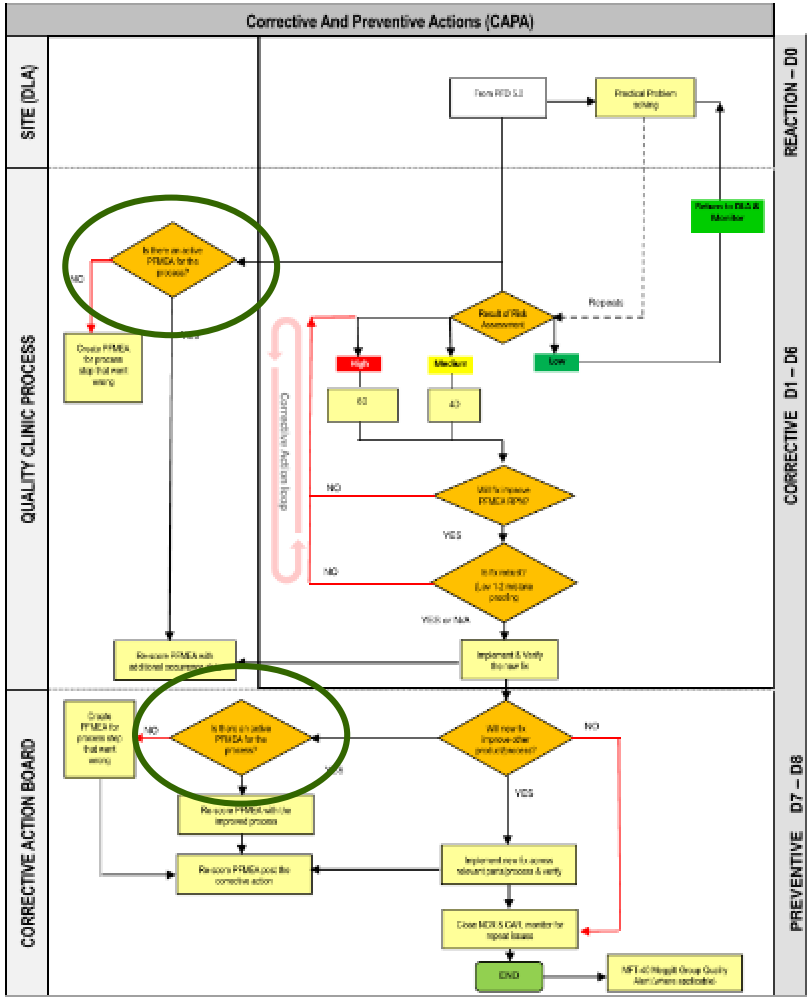
- The control of NC outputs procedure resides on the Q-Pulse database, making the process accessible to ‘ALL’ staff
- The system requires Quality leaders to accept the process for adoption into all sites
- ALL sites are required to adopt the Global QMS within their businesses
- Divisional leadership supports the sites in the deployment of the tool

4. **Governance**

- Central quality complete internal audits of all sites against the Global QMS to ensure compliance

MEGGiTT

# Results




## Current situation

The deployment of the AS13000 standard is still fairly early in its deployment across Meggitt in its entirety

Our Engines Division have taken a lead in this and are working to develop the tools to help with the wider Meggitt deployment

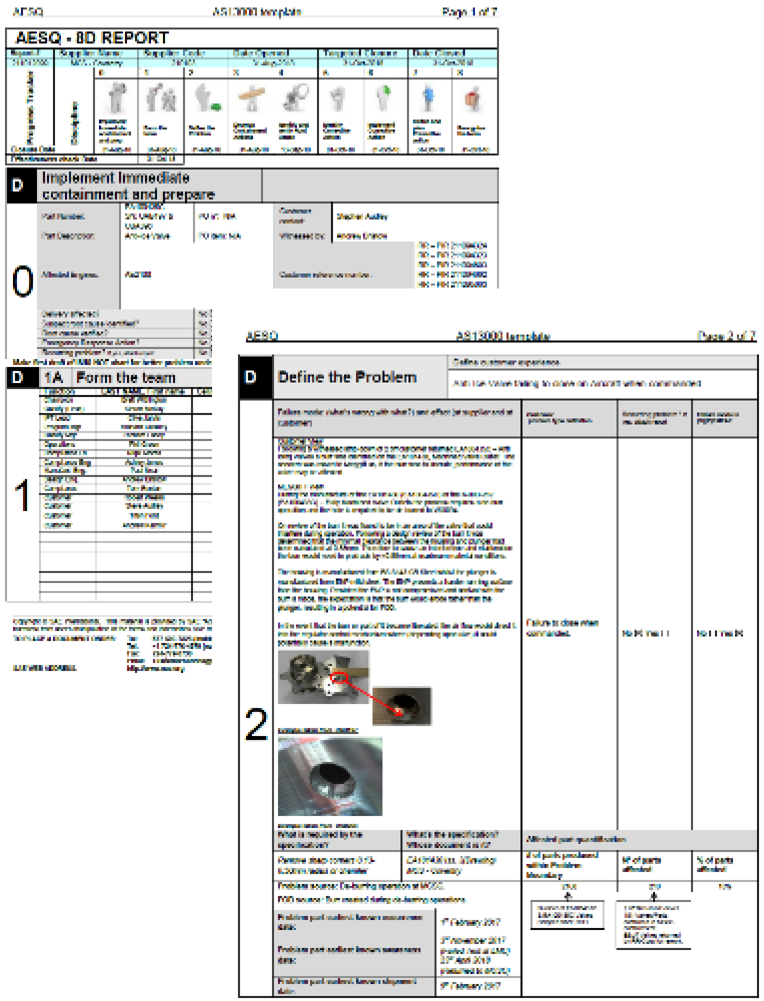
The Division is responding more fully to the customer expectation of utilising the AS13xxx series of standards

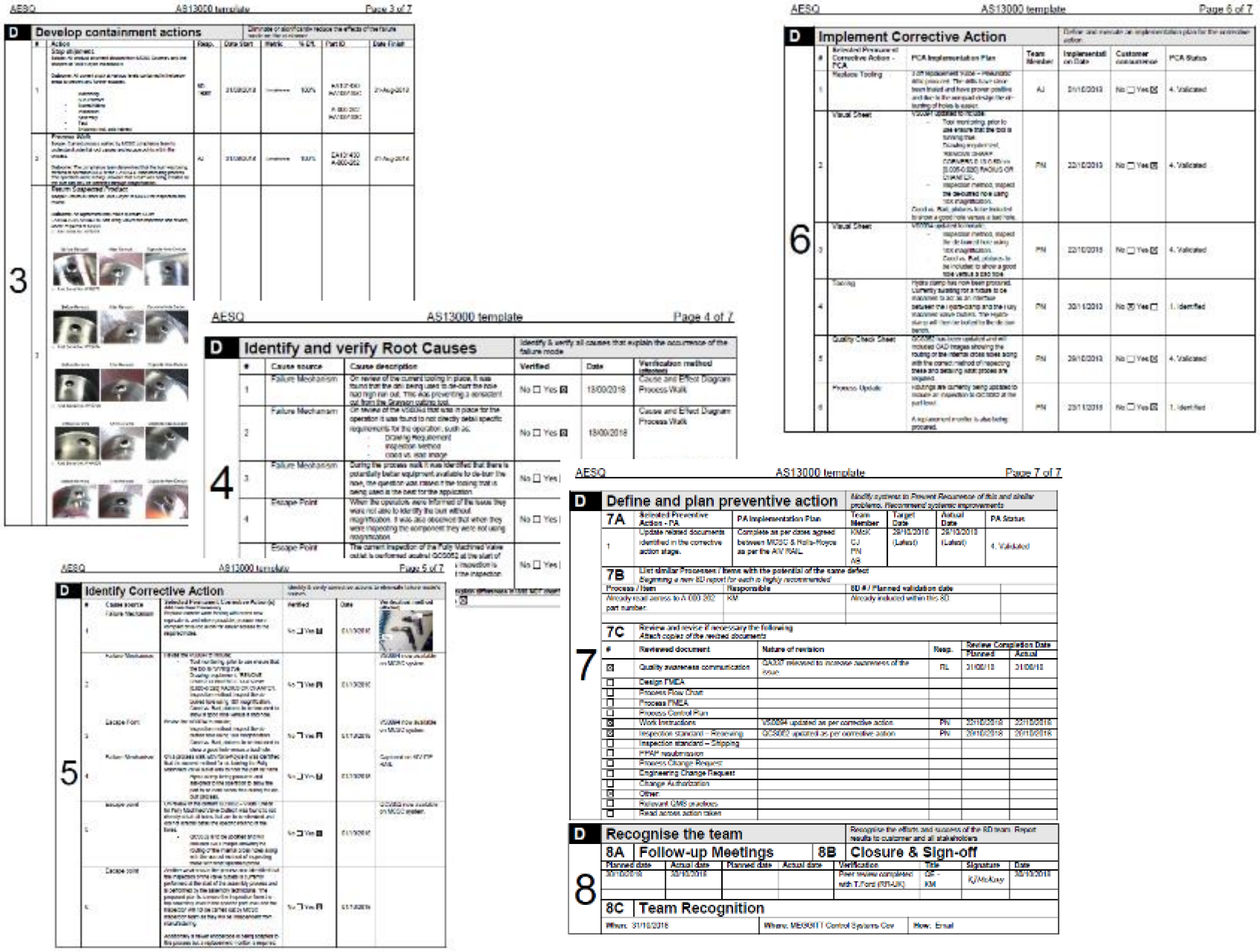
## Lessons Learned

The Meggitt procedure for the Control of Nonconforming outputs has the 8D process defined, but during the construction of the process, the use of AS13004 (PFMEA) has been utilised to further strengthen the full process approach to problem solving

MEGGITT

# AS13000 - Example



# Insights

The adoption of the AS13000 8D is a major shift across the whole of Meggitt, with 11,000 employees this will take time, effort, and consistent messaging to implement a whole corporation change

Some employees are sceptical, especially those that are not within sites that have the standard flown down by customers, they sometimes do not see the need or benefit

Leadership is imperative for a global distribution and use of the tool, the leaders are setting the expectation, and then supporting the up skilling of the sites

Making a change is difficult, but a tool that adds benefit to the business is worth investing the time and energy in deploying

# Benefits of the AS13000 8D Approach

**Standardization of a well known and effective method**

Not just ‘Another Problem Solving Method!’

Easy change management if your organization was already doing some sort of **Root Cause Investigation**

Called, accepted and prescribed by every customer

Standardization of the vocabulary around 8D (escape point, generation point…)

Standardization of the template

Problem Solving is a Team Sport!

**Provide a training syllabus**

Choose your training provider wisely

SAE Offer Training in AS13000 Globally

# AESQ Supplier Forum

## Human Factors


Catherine CATARINA-GRACA
Senior Supplier  Quality Manager
Safran Aircraft Engines

Ludovic CHEVET
Lead Supply Chain & Quality Manager
Airbus


AIRBUS

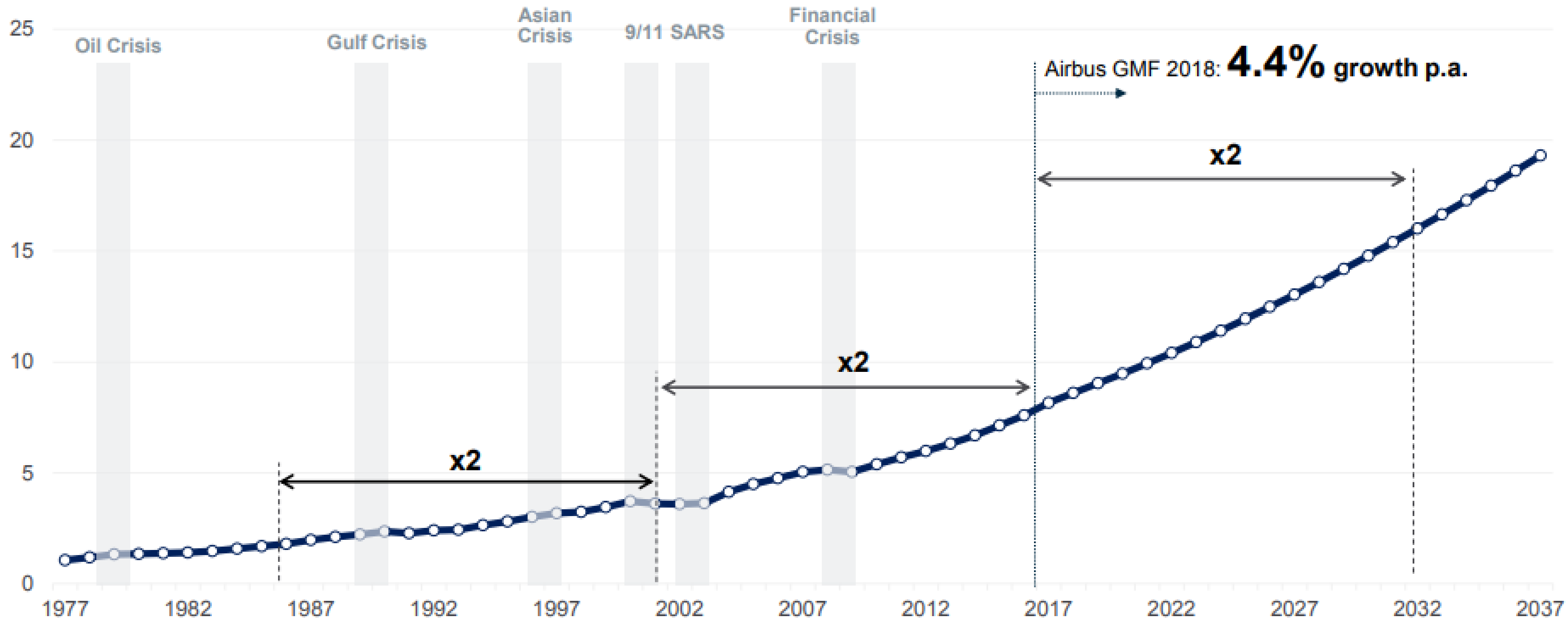
An **Airbus**
takes off or lands
**every 1.4 seconds**

| | | |
|---|---|---|
| **19 340** | **11 763** | **7 577** |
| Orders | Deliveries | Backlog |


End December 2018

# The Market

*Source: Airbus GMF 2018*



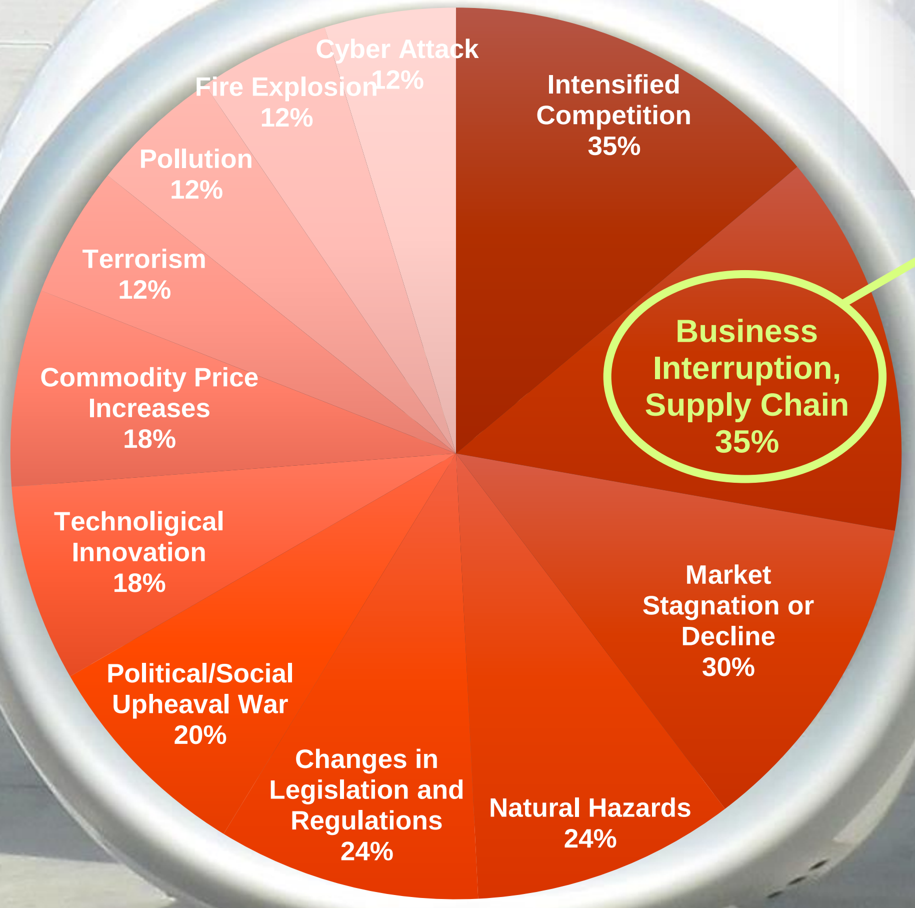

# Air traffic doubles every 15 years

World fleet wil double in the next 20 years



AIRBUS

# Supply Chain risks are today one of the greatest concern for aviation stakeholders




Source:
Allianz Risk Barometer 2014

Note:
Respondents could select more than one risk



AIRBUS

# Supply Chain Risks… Business Interruption

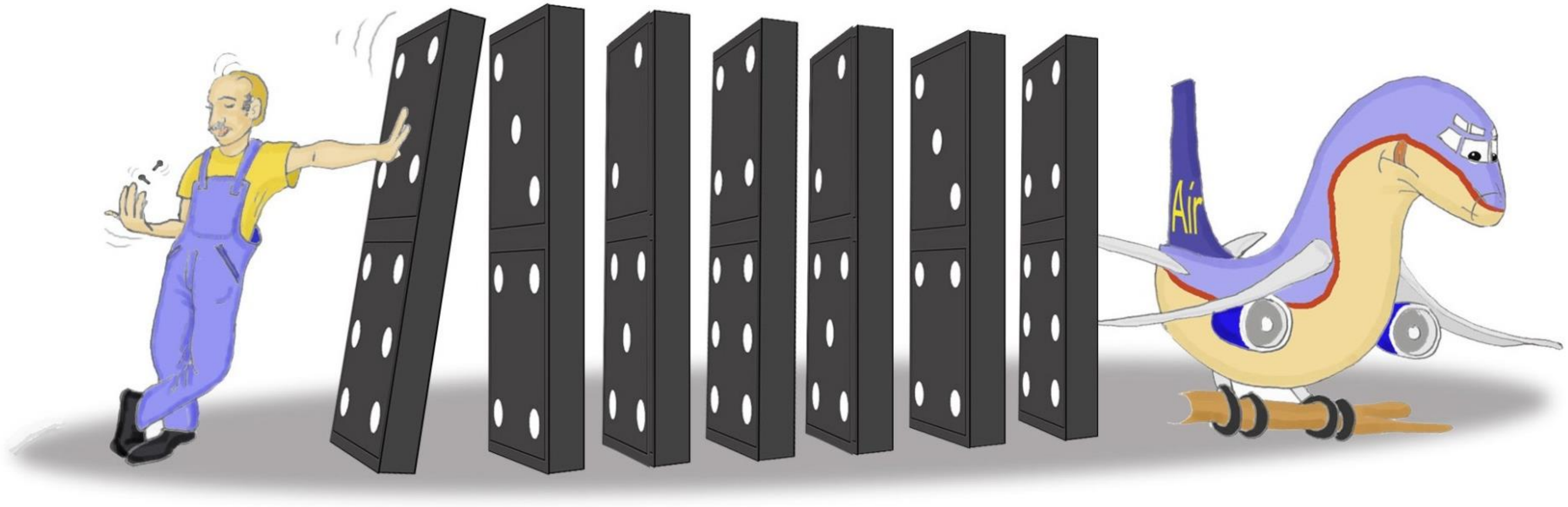



Illustration by courtesy of ScandiAvia

Any link in the chain can stop propagation of NC to the end customer



AIRBUS

# Human Errors

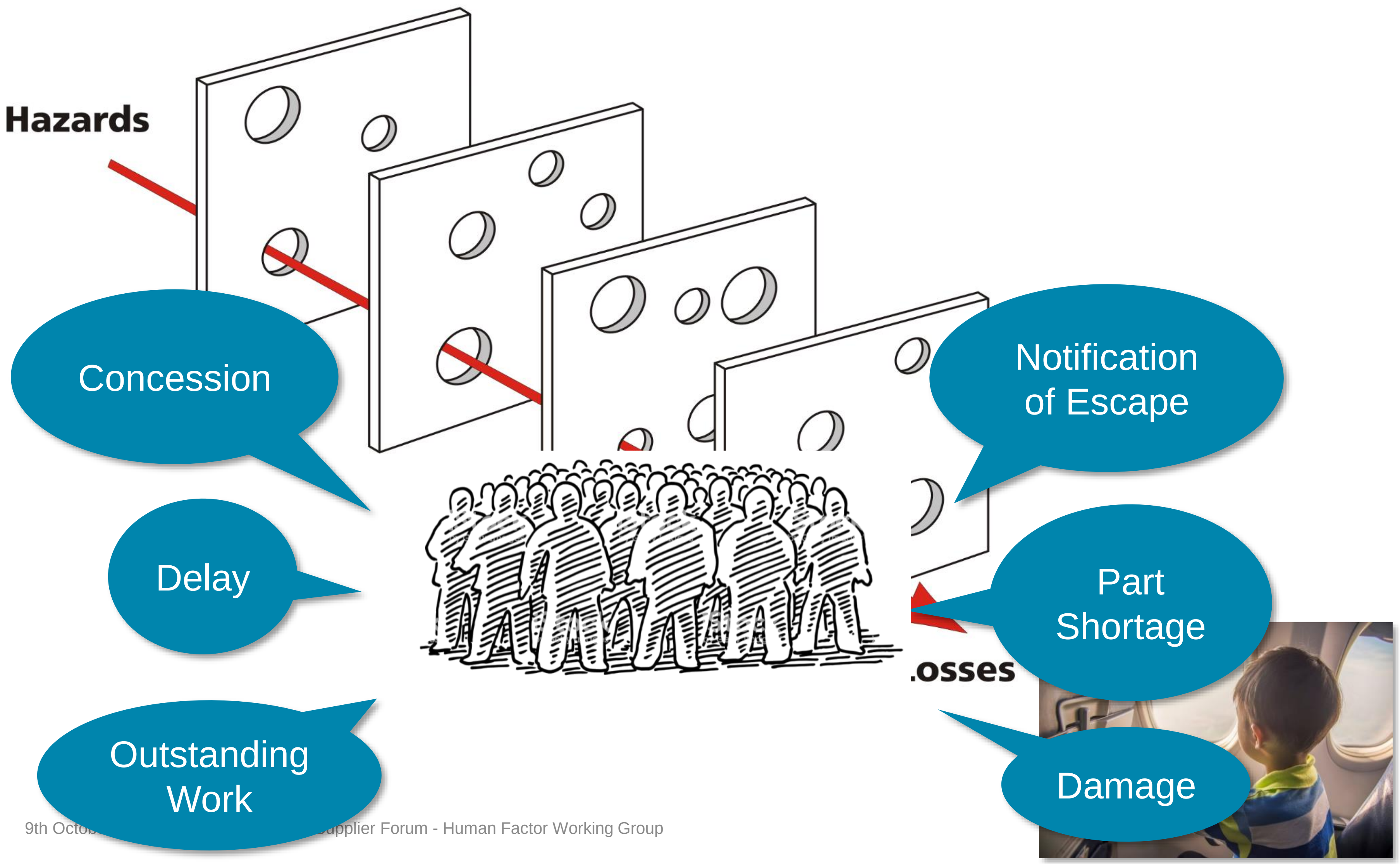

## Human Errors are the origin of most supply chain issues

Minimizing human errors in the supply chain is key toward product safety, quality and delivery



AIRBUS

# Latent Errors




## Latent Errors are the origin of most supply chain issues



AIRBUS

# Aviation safety will continue to evolve, always putting safety of passengers first

## by a global understanding of humans’ behaviour and impact on work performance



AIRBUS

# What is Human Factor ?

## Human Factor is a science studying how errors occur

# What is Human Factor ?

## Human error is not a root cause



AIRBUS

# The Dirty Dozen


## Dirty Dozen are primary causes of human error

# Just Culture

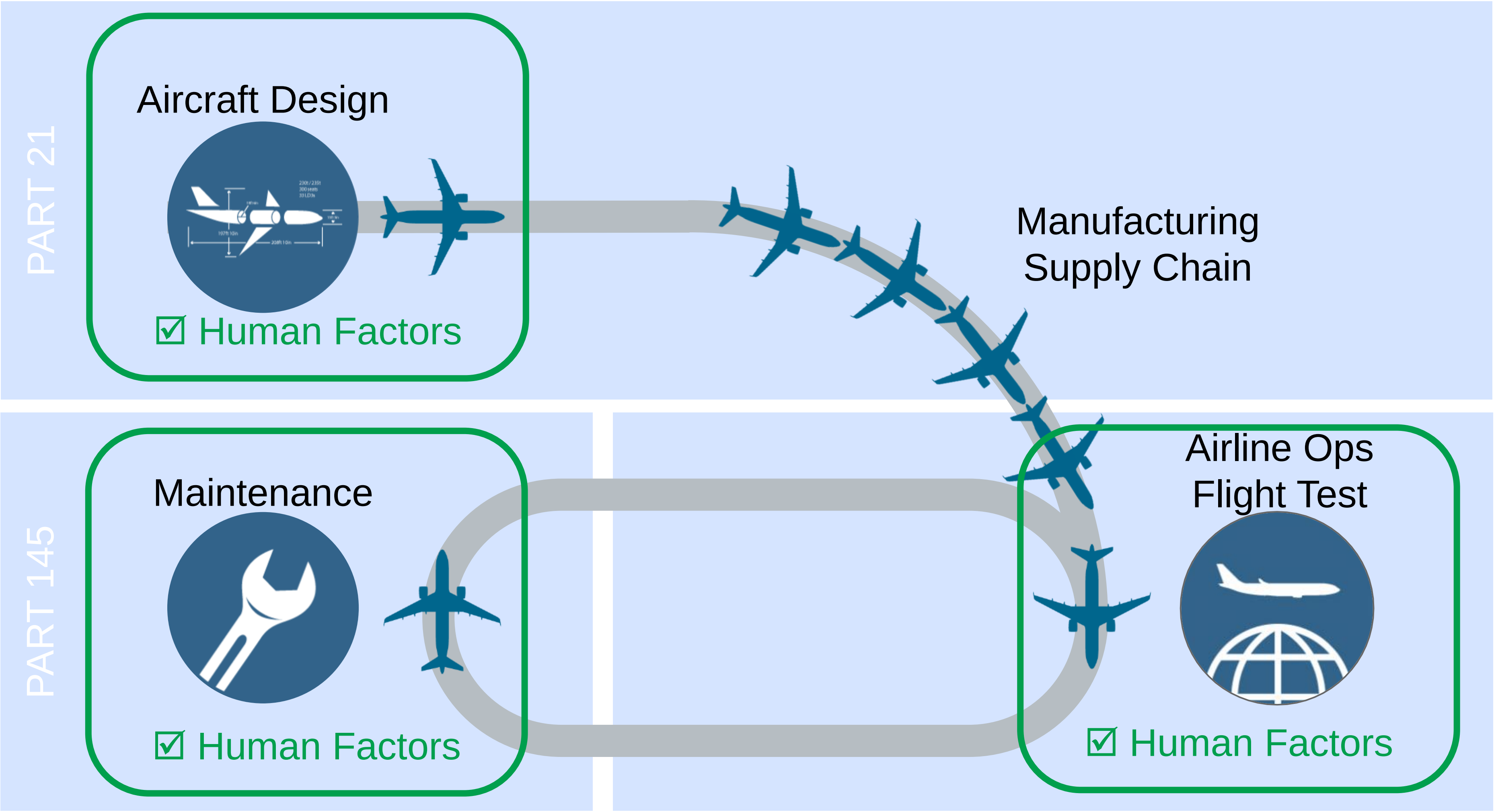

In your work, an error, something forgotten or bad workmanship can cause the death of one or more people. A person who makes an error must report it. An error is a repairable and pardonnable mistake, but hiding it is a crime

## Trust based SMS supports human errors identification



AIRBUS

# Human Factor in Aviation Value Stream




## Human Factor approach shall be reinforced in production organisations

Several projects within Airbus



AIRBUS

# and Human Factors

## Original State

**Maintenance Organisations (Part 145)**

Human Factors Approach

**Original Equipment Organisations (Part 21)**


## Future State


Clarity on Human Factors in Part 21 areas

Free Issue Guidance & Training Material


Human Factors Reporting Process as an Acceptable Means of Compliance

Human Factors Investigation Process as an Acceptable Means of Compliance

Requirements to be included in AS13100.
Guidance & Acceptable Means of Compliance material to be free issue from AESQ website

## AESQ Principles

- ☑ Standardise
- ☑ Simplify
- ☑ Adopts Existing Industry Standards
- ☑ Prescriptive, Auditable
- ☑ Common Language
- ☑ Supported by 3rd Party Training & Consultancy

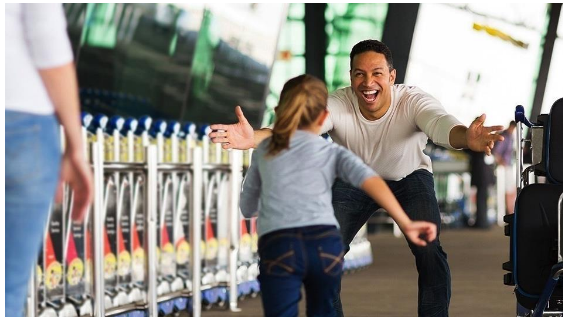
## Expected Benefits

1. Common understanding and language of Human Factors across supply chain
2. Aligns to AS13100 and other industry standards
3. Provides Acceptable Means of Compliance for AS9100, AS13100 and future Regulation (Human Factors element of Safety Management System)
4. Free issue guidance and training material that can be used by supply chain

# AESQ project is matching Airbus strategy

Airbus is taking active role in it

# Take Away



We are in growth industry

We put safety of passengers first

End to End human factor approach is key for collective success

AESQ and Airbus will support the supply chain

Game

Thank you

# Let’s Talk Deployment…

**Erika Grimm**

Supplier Quality

**GE Aviation**

**Helen Djäknegren**

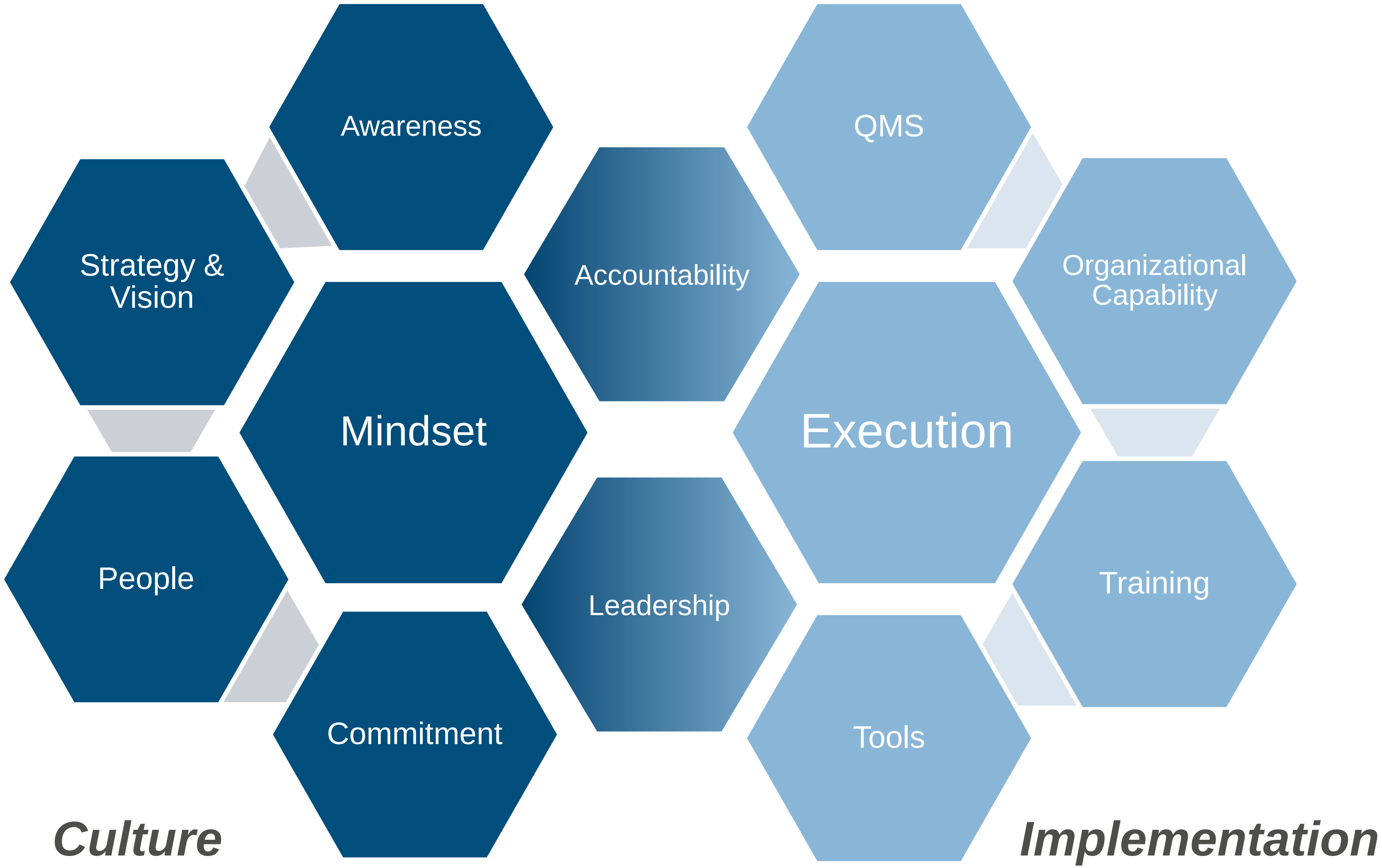
Director Global Supplier Quality & Development

**GKN Aerospace**

# AESQ journey for proactive quality


AESQ driving unified approach to defect prevention

# Elements of Effective Change Management



# AESQ Deployment Tools

There are several tools currently available to suppliers to assist in your defect prevention journey … find them on our website (https://aesq.sae-itc.com/)

## Mindset:

- ***AESQ Zero Defect Video*** – help your organization understand defect prevention and how the AESQ standards support that culture
- ***Industry Impact Page*** – see real examples of how AESQ and supplier deployment is having an impact on the industry

## Execution:

- ***Standard Guidance and Support Material*** – find guidance material and templates for issued AESQ standards
- ***Training Resources*** – see a list of providers that offer training for each AESQ standard

# CLOSING REMARKS

**Ian Riggs**

Global Quality Executive

Rolls-Royce Civil Aerospace

**Barbara Negroe**

Executive Sourcing Quality Leader

GE Aviation

# A380 Final Assembly Line Tour Logistics

AESQ STRATEGY GROUP
A Program of SAE ITC

| Group 1 | Description | Group 2 |
|---|---|---|
| 08:30 | Coach pick up at **Radisson Blu Hotel** Toulouse Airport | 10:00 |
| 08:45 | Coach Arrives at Museum Aeroscopia (you may store luggage at Museum) | 10:15 |
| 09:00 | Tour start A380 FAL Professional Tour by Manatour | 10:30 |
| 10:00 | Tour Ends | 11:30 |
| 10:15 | Coach takes Group back to the Radisson Blu Hotel | 11:45 |
| 10:30 | Arrive at Hotel | 12:00 |

# Agenda



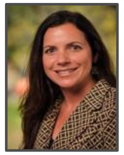
Ian Riggs
Olivier Castets

08:00
Welcome & Introductions


Olivier Balmat

Safran Aircraft Engines Welcome Address

AIRBUS
Airbus Voice of the Customer



Barbara Negroe
Lisa Claveloux

Overview & Objectives


BREAK


Barrie Hicklin

Case Studies Overview

Process FMEA


Ian Riggs

FACC

Measurement Systems


Martin Schäffner

Mechachrome


GROUP PHOTO


LUNCH
12:00


Welcome Back
12:45

Process Control


Pete E Teti

PW Kalisz

Problem Solving (8D)


Olivier Castets

Meggitt



Catherine Catarina-Graca
Ludovic Chevet

Human Factors


BREAK



Erika Grimm
Helen Djäknegren

Let's Talk Deployment



Ian Riggs
Barbara Negroe

Q&A And Closing Remarks


A380 FAL Tour Information


17:00
CLOSE & DEPART

# Reflections on the Day

# Thank You for Attending

# Please Return Home Safely