

Forging Industry Technical Conference

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Paradigm Shift for Aerospace Forging Industry Oversight

Brian Streich, Honeywell Aerospace



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Introduction

- ◆ Most of us partake in the everyday miracle that is modern air travel
 - 2017, an all-time high of 849.3 million passengers traveled through air¹
- ◆ We all assume that when we take off from location A, we will arrive safely on the ground in location B
 - We are correct!
- ◆ 2016, air travel had the lowest number of fatalities in the US²
 - 37,461 via highway
 - 733 via rail
 - 730 via water
 - 412 via air
- ◆ Air travel is safe, and it is made that way through the diligence of the supply base, OEMs, Airlines and Regulatory Agencies

¹Bureau of Transportation Statistics, T-100 International Market and T-100 International Segment

²National Transportation and Safety Board

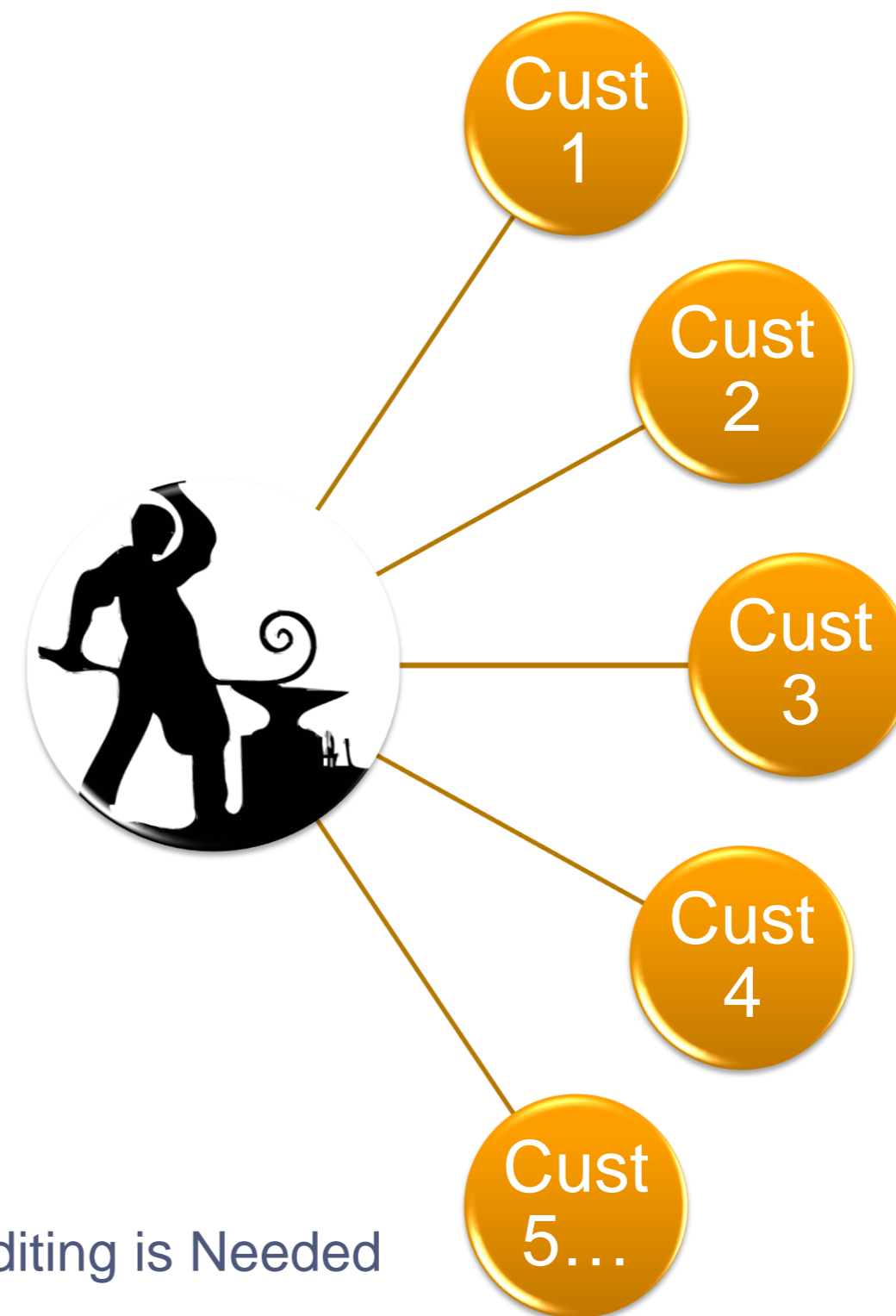
Why Audit?

- ◆ The Federal Aviation Administration (FAA) requires customer oversight of their supply base – FAR Part 21
- ◆ As a result, the suppliers of aerospace product are regulated and monitored by numerous organizations and customers
- ◆ Goal: Ensure reliable, high quality products are flown on aircraft
- ◆ Periodic audits are performed by aircraft and engine manufacturers (OEMs) on their supply base, including the Aerospace Forging Industry
- ◆ Specific to this presentation – the forging process

Passenger, Pilot and Crew safety is key – aircraft must take off, fly and land without failure of components

Current State

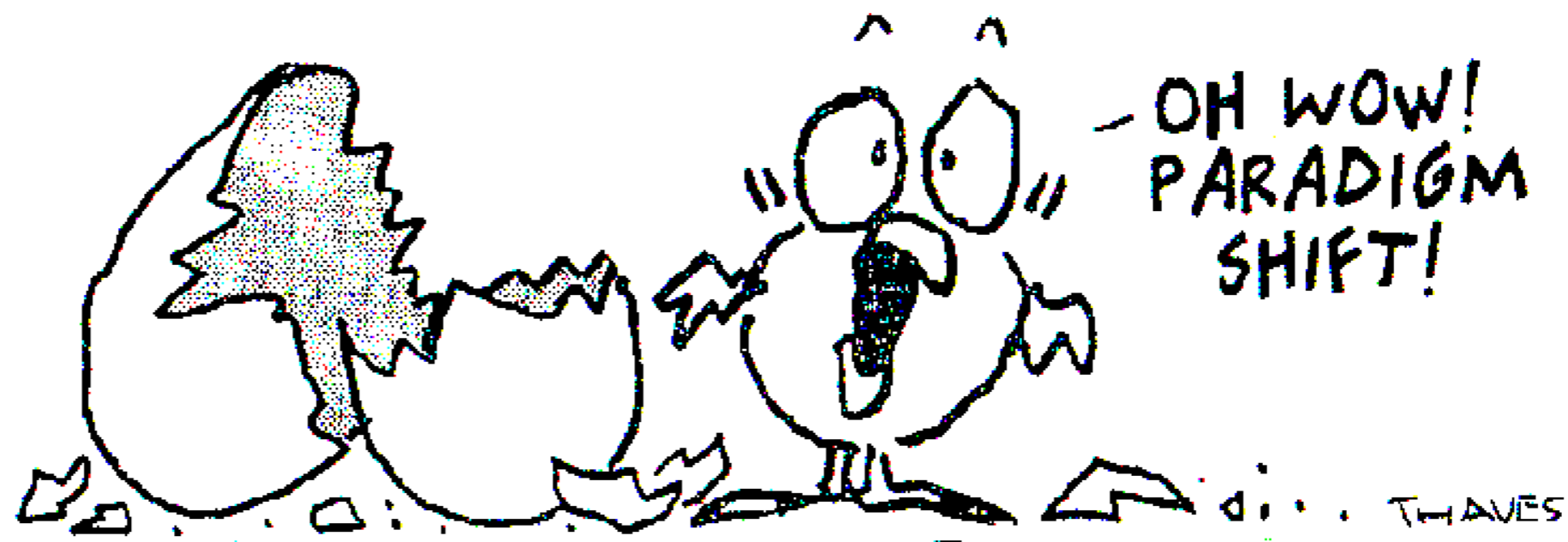
- ◆ Aerospace forging suppliers are audited by each customer, independently
- ◆ Audits vary:
 - Frequency
 - Duration
 - Audit scope
 - Type of audit (live vs. paperwork)
- ◆ For a forging supplier with 10 aerospace customers there are:
 - 10 audits to prepare for
 - 10 different auditors
 - 10 different audit checklists
 - Etc.....



A unified Standard Approach to Auditing is Needed

Why is it This Way?

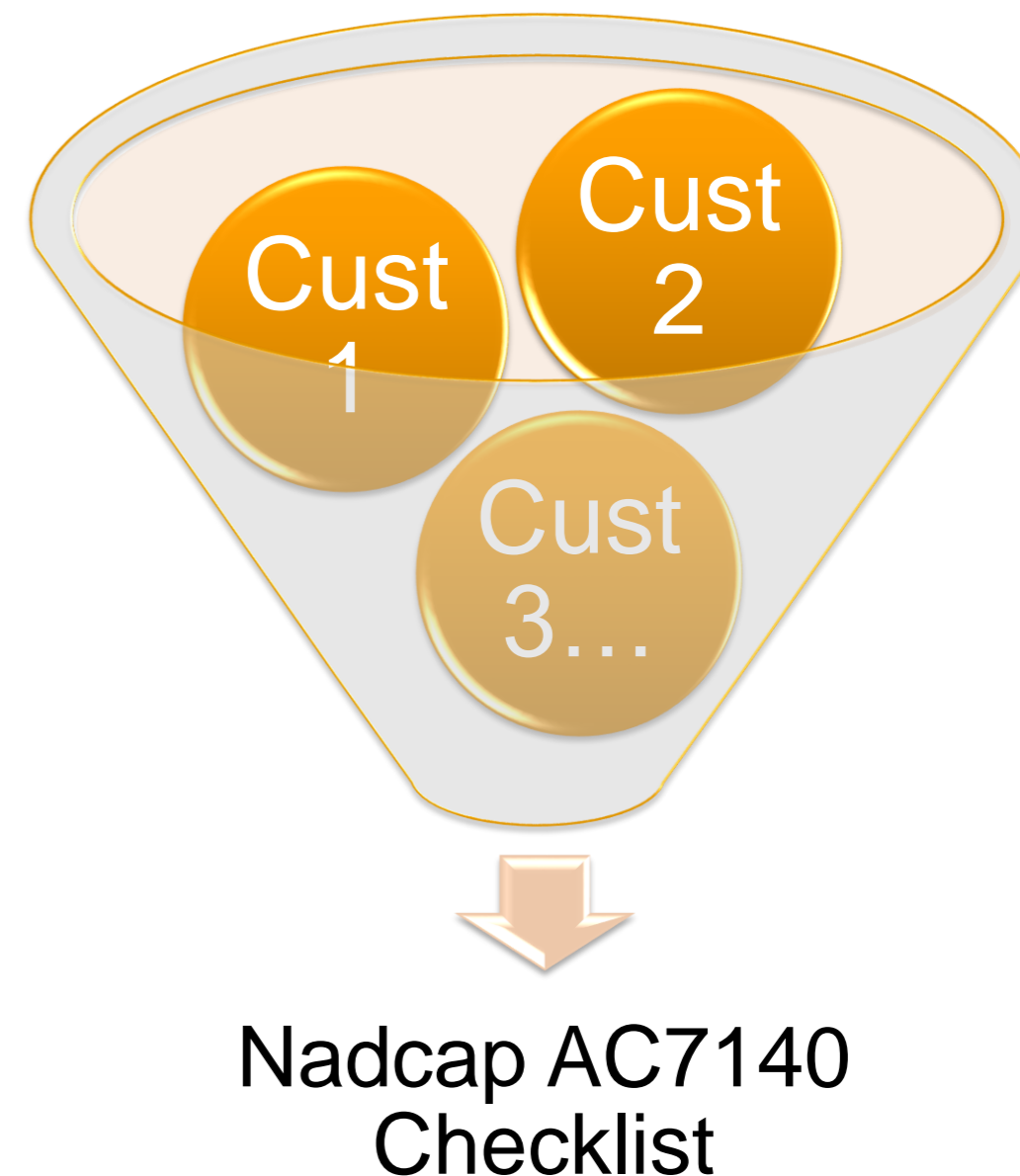
- ◆ Proprietary Information
- ◆ Companies believe that a unified approach to auditing cannot be achieved without divulging proprietary information.
- ◆ Paradigm Shift
- ◆ There are many, many requirements that are similar across companies
- ◆ Information can be shared without divulging proprietary information



As He is...so are we - WordPress.com

New Approach

- ◆ In 2014 a group of Aerospace Aircraft and Engine Manufacturers (OEMs) decided to align with the Nadcap method of supplier oversight
- ◆ The Metallic Materials Manufacturing task group was chartered to create standard audit criteria of the forging process
- ◆ By 2016, the audit requirements from nine Aerospace Forging Customers were combined into a single audit checklist that covers:
 - Pre-forging operations
 - Heating and Forging
 - Post forging operations



Who Is Involved?

◆ Aircraft and Engine Manufacturers

- Honeywell Aerospace (Chair)
 - Airbus Commercial Aircraft (Vice-Chair)
 - UTC Aerospace – Hamilton Sundstrand (Secretary)
 - UTS Aerospace – Goodrich
 - Rolls Royce
 - SAFRAN
 - MTU Aero Engines AG
 - GKN Aerospace Sweden AB
 - Spirit AeroSystems
-
- Bell Helicopter
 - Leonardo S.p.a. – Helicopters
 - Airbus Defense and Space
 - COMAC
 - And others...

◆ Aerospace Forging Suppliers

- PCC
 - Arconic
 - Otto Fuchs KG
 - Doncasters Group
 - ATI
 - BOHLER Aerospace GmbH
 - Forgital Italy S.p.A.
-
- FRISA Aerospace
 - Independent Forgings & Alloys Ltd.
 - Fucine Umbre
 - Charles E. Larson & Sons
 - Aubert and Duval
 - TECT Power
 - SIFCO Forge
 - Aluminum Precision Products, Inc.
 - And others...

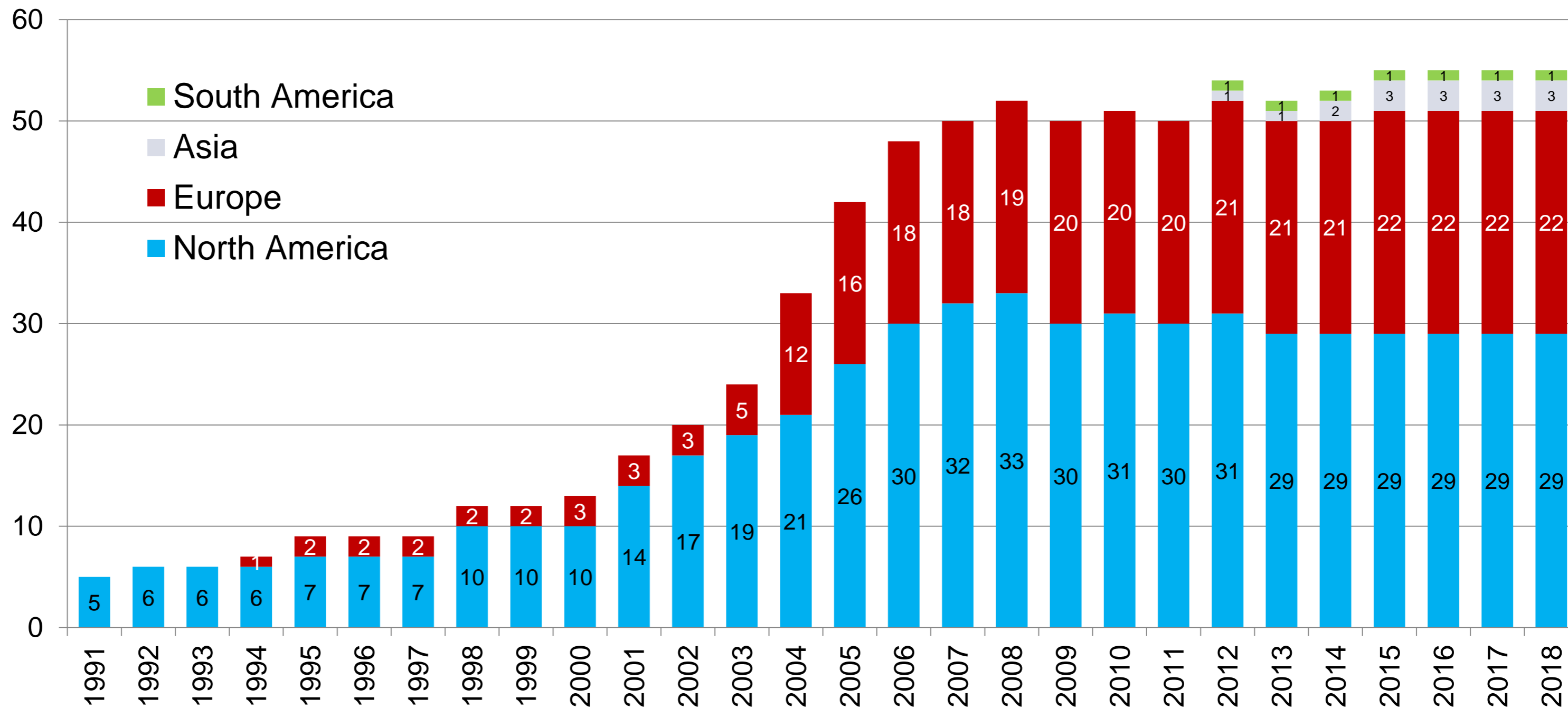


What is Nadcap?

- ◆ Nadcap is a program of international Aerospace Industry companies (a.k.a. subscribers) designed to manage and perform supplier audits
- ◆ It is independently operated by the Performance Review Institute (PRI) whose headquarters are in Pittsburgh, PA
- ◆ Subscribers pay a fee to PRI to be part of the Nadcap program
- ◆ Nadcap was started in July of 1990 with the first audits taking place in 1991
- ◆ Nadcap started with 5 subscribing members in the US and has since grown to 55 subscribers located in North America, Europe, Asia and South America



Timeline of Subscribers



Nadcap has grown into a worldwide auditing program

Nadcap Mandates

- ◆ If a Nadcap subscriber determines that they want Nadcap to perform audits for a special process, they send out a mandate letter to their supply base
- ◆ The mandate letter provides information to the suppliers on the timeline for Nadcap accreditation
- ◆ Suppliers must:
 - Enroll with PRI
 - Download the appropriate audit checklist and handbooks
 - Schedule an audit
 - Pay for the audit
 - Prepare for the audit by performing a self audit and providing all pertinent information to the assigned auditor

Suppliers do this once for all subscribers they make parts for – whether the subscribers mandate or not

Nadcap Audits

- ◆ Nadcap audits cover a large number of special processes, including:
 - Conventional and Nonconventional Machining
 - Composites
 - Chemical Processing
 - Coatings
 - Electronics
 - Heat Treatment
 - Materials Testing Laboratories
 - Nondestructive Testing
 - Surface Enhancement
 - Seals and Sealants
 - Welding
 - and Others... for 21 total

5810 Audits Planned for 2018

Metallic Materials Manufacturing

- ◆ Metallic Materials Manufacturing (MMM) is a task group within the Nadcap program that focuses on auditing suppliers of Forgings, Castings and Raw Material
- ◆ Forging (part)
 - A product with a specific reference number (e.g. part number), which is controlled by a drawing, manufactured by heating and bulk material deformation process
- ◆ Casting (part)
 - A product with a specific reference number (e.g. part number), which is controlled by a drawing, manufactured by a casting process
- ◆ Raw Material
 - Product that directly goes to manufacture a forging, casting or additive manufacture part

Mission: To develop a focused audit process, capable of verifying the manufacture of Forgings, Castings and Raw Materials within the aerospace supply chain

MMM Forging Scope

- ◆ Forging Processes:
 - Open die
 - Closed die
 - Radial forging for parts

- ◆ Types of Forging Equipment:
 - Hammers (drop, steam, air, etc.),
 - Mechanical presses
 - Screw presses
 - Hydraulic presses
 - Isothermal presses
 - Ring rolling equipment
 - Radial forges

Alloys Include: Aluminum, Nickel, Steel and Titanium

MMM Forging Scope

- ◆ Associated Equipment (as applicable)
 - Cutting equipment
 - Tooling/Dies
 - Heating furnaces
 - Cooling equipment

- ◆ The forging audit scope does not include:
 - Cold bulk deformation processes
 - Flash-butt welded rings
 - Forging of industry standard fasteners
 - Conversion of ingot to forging stock, bar, plate, sheet, extruded section or any other form that is considered for general use and does not have a customer part number associated with it

Heat it, beat it, and give it a customer part number

Forging Audit Checklist

- ◆ Goal: A unified approach to auditing forging suppliers
- ◆ The checklist was developed by combining requirements and audit questions from Aerospace Engine and Aircraft manufacturers that participate in the MMM Task Group
- ◆ Proposed audit questions were discussed and were either accepted, modified or deleted as determined by the Task Group – including suppliers

Audit Checklist Development is a Group Effort

Supplier Capability Matrix

- To be filled out by the supplier prior to the audit and provide to the auditor – Summarizes Aerospace capability in scope of the audit

	Hammer	Mechanical Press	Screw Press	Hydraulic Press	Isothermal Press	Ring Roll	Radial Forge
Open Die?	Y/N	Y/N	Y/N	Y/N	Y/N		
Closed Die?	Y/N	Y/N	Y/N	Y/N	Y/N		
Aluminum Alloy							
Nickel Alloy							
Steel Alloy							
Titanium Alloy							
Other Alloys							

Must list all equipment that will be in scope for the audit

Forging Audit Content – AC7140

- ◆ Audit checklist contains questions that are grouped into sections based on the forging process timeline, and includes:
 - General Requirements (preventative maintenance, training, quality system, documentation, tooling and dies manufacturing and storage)
 - Purchase Order Review
 - Purchasing and Verification of Product (forging stock and consumables)
 - Forging Stock Preparation
 - Heating Process prior to Forging
 - Forging Process
 - Post Forging Processes (flash removal, visual inspection, scale removal, conditioning, bending/straightening)
 - Test Material Removal and Inspection
 - Long Job Audit (Paperwork Audit)
 - Eight live job audits (1 pre-forging, 6 forging and 1 post-forging)

For every live forging job audit that can't be completed, two paperwork audits are performed (minimum 3 live job audits required)

Who is Mandating Nadcap MMM?

- ◆ To date, four Aircraft and Engine Manufacturers (OEMs) have mandated MMM accreditation to their forging suppliers:
 - Honeywell Aerospace (accreditation by end of 2018)
 - Airbus Commercial (accreditation by end of 2019)
 - SAFRAN (accreditation by end of 2019)
 - MTU (accreditation by end of 2018)
- ◆ One OEM is using Nadcap to perform forging audits using the AC7140 checklist, and will be sending out mandate letter in 2018 for supplier accreditation by 2020:
 - Rolls Royce
- ◆ Two additional OEMs are in the process of establishing a mandate:
 - UTC Aerospace – Hamilton Sundstrand
 - UTC Aerospace – Goodrich

Other OEMs are looking into the feasibility of using Nadcap to perform audits

Summary

- ◆ Aircraft safety is the highest priority – parts must work as designed
- ◆ Supplier oversight is required by the FAA – audits are used as a method for this oversight
- ◆ A unified approach to auditing forging suppliers was developed
- ◆ Nadcap AC7140 checklist was written to combine requirements and audit questions from multiple Aircraft and Engine companies
- ◆ Audit scope covers equipment and processes used to make parts that are heated and forged and have a customer part number
- ◆ The forging audit checklist contains questions covering the entire forging process (PO review to test piece removal)



Conclusion

- ◆ The Nadcap MMM Task Group has developed a unified approach to forging supplier auditing that will benefit the Aircraft and Engine manufacturers as well as the forging suppliers.

