AS9145/AS13002/AS13003 Workshop including:

- **Advanced Product Quality Planning (APQP)**
- **Production Part Approval Process (PPAP)**
- **Measurement Systems Analysis / Gage R&R (MSA and GRR)**
- **Statistical Process Control (SPC) with Short-Run SPC**
- **Capability Analysis (Cp, Cpk, Pp, Ppk)**
- **Minitab Step-by-Step SWIs for SPC, GRR, and Capability Analysis**

2-Day Workshop

Overview and Purpose
This 2-day hands-on workshop will provide you with fundamental knowledge and practice on the Advanced Product Quality Planning (APQP) methodology and tools, the Production Part Approval Process (PPAP) deliverables, and related Capability Analysis requirements and methods, including the Cp, Cpk, Pp, and Ppk indices. Participants experience an integrated overview of the APQP process and key tools, the PPAP documents and their development, and the purpose and techniques for conducting Capability Analysis on appropriate product characteristics. Participants will create and interpret Average and Range (X-bar&R) Charts, Individual and Moving Range (I-MR) Charts, Variable and Attribute Gage R&R studies, and Capability Analysis for Normal, Non-Normal, and Multi-feature data. The program is designed for all levels of quality, design and manufacturing personnel, as well as more experienced quality, engineering, and management personnel.

Recommended Resources:
- Participants are responsible for obtaining and bringing their own copies of the related AS standards to class for reference purposes; AS9145 and related standards are referenced, but are not provided in the course materials.
- Participants are also encouraged to bring a notebook or laptop computer loaded with Microsoft Excel 2010 or higher and Minitab 16 or higher; a computer is not mandatory but is highly recommended to be able to participate in classroom exercises. A trial version of Minitab is available at http://www.minitab.com/en-us/products/minitab/ .

Here are some of the things that you'll learn:
- Key inputs and outputs for APQP and PPAP
- APQP phases, milestones, and deliverables
- The relationship between APQP and PPAP
- Levels of evidence and PPAP submission criteria
- Capability Analysis requirements and methodology related to special characteristics
- Common pitfalls, options, and negotiating strategies related to APQP, PPAP, and Capability Analysis
- Analysis of time series data, types of variation, types of data, and the power of control charts.
- How to select, develop, and analyze variables control charts, including the X-bar&R and Individual & Moving Range
- Key Measurement Systems Analysis (MSA) concepts, including Bias, Uncertainty, Repeatability, and Reproducibility.
- How to conduct a variety of Gage R&R studies for both variable and attribute data.
- How to conduct a variety of capability studies including Cp, Cpk, Pp, and Ppk.
- How to conduct all the related studies within the Minitab environment.

NOTE: This workshop will not focus on AS13004 related tools including PFD, PFMEA, and Control Plan, which are covered in a separate workshop.

Who should attend?
This course is designed for aerospace and aviation personnel with minimal experience with the SPC and its related key tools. However, many experienced individuals attend the course to refresh their knowledge, gain advanced strategies, and practice development and application of these tools with an experienced facilitator.

Quality Engineers, Quality System Managers, Program managers, design-responsible engineers or managers, and team members such as quality personnel, and other product design and manufacturing personnel who must understand and apply SPC, MSA, and Capability Analysis to their products and processes will all benefit.

Course Outline

Day 1

Introduction – Advanced Product Quality Planning (APQP) and Production Part Approval Process (PPAP) for Aerospace (Focus Module)

- Introductions
- Pre-Assessment
- Goals, Objectives, and Course Expectations
- Related Aerospace Standards including AS9145, AS13002, AS13003, AS13004
- APQP Purpose, Goals, and Phases
- APQP and PPAP Deliverables
- APQP and PPAP Checklists
- Risk and Gap Analysis
- APQP and PPAP Project Management
- Application Exercise
- Key Points, Review, and Q&A

Module 1 – Basic Statistical Concepts (Focus Module)

- Fundamentals of Statistics and Variation
- Sources of Variation
- Common Cause vs. Special Cause Variation
- Variable vs. Attribute Data
- Basics of Distributions
- Frequency Distribution and Histogram
- Measures of Dispersion and Central Tendency: Range, Standard Deviation, Mean, Median, and Mode
- Characteristics of the Standard Normal Distribution
- Types of Distributions
- Application Exercise
- Key Points, Review, and Q&A

Module 2 – Problem Solving Tools (Supplemental Module)

- Overview of the Seven Problem Solving Tools
- Frequency Distribution and Histogram
- Check Sheet
- Pareto Chart
- Cause and Effect Diagram
- Concentration Diagram
- Scatter Diagram
- Control Chart
- Application Exercise
- Key Points, Review, and Q&A

Module 3 – Initial Process Studies and Control Charts (Focus Module)

- Time Series vs. Static Variation Analysis
- Local vs. System Action
- Purpose, Power, and Characteristics of Control Charts
- Types of Control Charts
- Overview of Control Chart Development Steps
- Sample Size and Frequency
- Application Exercise
- Key Points, Review, and Q&A

Module 4 – X-bar and R Charts (Focus Module)

- Popularity and Characteristics of Control Charts
- Determining Sampling Strategy
- Setting up the Chart and Collecting Data

- Selecting Scales and Plotting Points
- Calculating and Plotting Control Limits
- Control Chart Formulas and Constants
- Checking for Process Control
- Addressing Special Causes of Variation, Recalculating and Plotting
- Nine Rules for Assessing Process Stability and Normality
- Application Exercise
- Key Points, Review, and Q&A

Module 5 – Short-Run SPC and Other Variable Charts (Focus Module)
- X-bar and S Charts
- Median and Range Charts
- Individuals and Moving Range Charts
- Control Chart Formulas and Constants
- CUSUM and EWMA Charts
- Application Exercise
- Key Points, Review, and Q&A

Module 6 – Attribute Control Charts (Supplemental Module)
- Types and Uses for Attribute Charts
- Introduction to the p Chart
- Determining Sampling Strategy
- Setting up the Chart and Collecting Data
- Selecting Scales and Plotting Points
- Calculating and Plotting Control Limits
- Control Chart Formulas and Constants
- Checking for Process Control
- Addressing Special Causes of Variation, Recalculating and Plotting
- Nine Rules for Assessing Process Stability and Normality
- Application Exercise
- Key Points, Review, and Q&A

Module 7 – Capability Analysis (Focus Module)
- In Control, Out of Specification
- Stability vs. Capability
- List of Capability Indices, Ratios, and Formulas
- The Key Difference Between Cpk and Ppk: Estimations of Standard Deviation
- Indices of Potential: Cp and Pp
- Indices of Performance: Cpu, Cpl, Cpk, Ppu, Ppl, and Ppk
- Potential vs. Performance
- Parts Per Million (PPM) Calculations Using Cpk or Ppk
- Capability Analysis Applications and Assumptions
- Stability and Capability Application Exercises

Day 2
- Capability Analysis for Non-Normal Distributions
- Data Transformation
- Percent Non-Conforming Using Percentiles
- Capability Analysis for Position Tolerances with the Maximum Material Condition (MMC) Modifier
- Application Exercises
- Key Points, Review, and Q&A

Module 8 – Measurement Systems Analysis (MSA) Concepts (Focus Module)
- Acknowledgement of Measurement Error
- Effects of Measurement Error
- Statistical Requirements for Measurement Systems
- Standards and Traceability

- General MSA Guidelines and Phases
- Sources of Measurement Error
- The Six Major Types of Measurement Error
- Discrimination and Data Categories
- Control Chart Analysis for Discrimination
- Bias, Stability, and Linearity
- Repeatability
- Reproducibility
- Measurement Uncertainty
- Application Exercise
- Key Points, Review, and Q&A

Module 9 – Gage Repeatability and Reproducibility Studies (Gage R&R) (Focus Module)

- Bias vs. Repeatability
- Types of Studies and Assumptions
- Study Preparation
- Guidelines for During the Study
- Stability Study Guidelines
- Bias Study Guidelines
- Gage R&R Guidelines and Requirements
- Range Method (Short Study) Steps and Examples
- Average and Range Method (Long Study) Steps and Examples
- Control Chart Analysis Guidelines and Exceptions for Gage R&R
- Data Collection Guidelines
- Variable GRR Application Exercise
- Example of Results from Excel and Minitab
- GR&R vs. Process and Tolerance
- Chart Formulas and Constants
- Attribute Gage Study (Short Method)
- Attribute Gage Study (Long Method)
- Attribute Agreement Exercise
- Relationship of GRR results to Process Capability Results
- Key Points, Review, and Q&A

Course Summary

- Key Points, Review, and Q&A
- Risk and Gap Assessment and Project Planning Exercise
- Post Assessment
- Course Evaluation