<table>
<thead>
<tr>
<th>Courses</th>
<th>Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering Statistics and Data Analysis</td>
<td>3</td>
</tr>
<tr>
<td>Design of Experiments</td>
<td>2</td>
</tr>
<tr>
<td>Mixture DOE</td>
<td>1</td>
</tr>
<tr>
<td>Robust Optimization and Tolerance Design</td>
<td>2</td>
</tr>
<tr>
<td>Measurement Systems Analysis</td>
<td>1</td>
</tr>
<tr>
<td>Reliability Analysis</td>
<td>1</td>
</tr>
<tr>
<td>Process Control Design using SPC</td>
<td>2</td>
</tr>
<tr>
<td>Quality Risk Management and FMEA</td>
<td>1</td>
</tr>
<tr>
<td>Root Cause Analysis and Problem Solving</td>
<td>2</td>
</tr>
<tr>
<td>Business Statistics and Data Analysis</td>
<td>2</td>
</tr>
<tr>
<td>Advanced Business Statistics and Data Analysis</td>
<td>2</td>
</tr>
</tbody>
</table>
About Thomas A. Little Consulting

Thomas A. Little Consulting (TLC) is an internationally recognized scientific and engineering consulting firm with a proven record for achieving results. TLC has an extensive SAS/JMP based curriculum for product and process development, data analysis, characterization, optimization and control. TLC is a strategic partner of SAS/JMP.

TLC offers specific courses in analytics, data analysis, design of experiments, performance modeling, statistical process control, assay development and method validation, measurement systems analysis, mixture design of experiments, quality risk management and failure modes and effects analysis. These courses are used by a variety of fortune 500 companies to train their scientists and engineers. TLC has extensive experience in the biotechnology, pharmaceutical and medical device industries and have trained over 80,000 scientists, engineers and business professionals globally.

Thomas A. Little has consultants located in the United States and globally and offers training in English and Mandarin.  www.dr-tom.com

Recommended Software Tools

JMP version 11 is a world-class analytical engine for general data visualization and analysis, problem solving and design of experiments. JMP, a business unit of SAS, is a strategic business partner of TLC and a preferred solution for statistical and analytical methods. www.jmp.com

Although TLC prefers the use of SAS/JMP for engineering and business performance application work, TLC will support the training and deployment of Minitab as an analytical engine alternative on a limited basis and for select clients. www.minitab.com
ESDA

Course Description
ESDA is specifically designed to meet the analytical needs of those individuals working within a variety of industries. Areas of focus include: JMP basics, analysis of data for basic engineering and scientific applications including statistics, distribution analysis, capability assessment, variation analysis, comparison tests, sample size selection, hypothesis testing, confidence intervals and multiple factor modeling. Presentation of the course material is designed for 24 hours of instruction.

Attendees
ESDA is required for all scientists, engineers and quality professionals who actively work on all aspects of discovery, product and process development where the goal is to characterize, optimize and improve product and process performance.

Prerequisites
There are no prerequisites for this course.

Course Objectives
1. Use data to solve engineering and scientific problems.
2. Understand the ideas associated with sampling and data collection.
3. Demonstrate the ability to evaluate distributions.
4. Select appropriate sample sizes for performance evaluation.
5. Conduct comparative tests using data.
6. Use regression techniques in order to analyze data and make process/product improvements.
7. Select appropriate analysis technique based on type of data.
8. Apply JMP to data analysis problems.

Detailed Course Outline
Section I  Introduction to JMP
Table commands
Column commands
Row commands
Subset commands
Saving Scripts, Journals and Projects

Section II  Statistics Foundations & Distribution Analysis
Measures of center and spread
Standard error and central limit theorem
Normal distribution
t distribution and confidence intervals
Test for normality
Individuals and tolerance intervals (normal)
Process capability (normal)
Nonnormal distribution fitting and process capability

Section III Nominal X, Continuous Y
Contour plots, Components of Variance, REML and POV
Sample size for the mean and standard deviation
t test – one sample
t test – two sample
Test for differences in variances
t test – paired
One-way ANOVA and F test
N-way ANOVA
Nonparametric data analysis (optional)

Section IV Continuous X, Continuous Y
Simple linear regression, correlation
Multiple regression
ANCOVA

Section V Nominal X, Nominal Y
Mean and sigma for proportion defective
Sample size and statistical tests for proportion defective
Mean and sigma for defect per unit
Chi-square test for defects and proportion defective
Pareto graphs and cross tabs analysis

Section VI Continuous X, Nominal Y and Partition
Logistic regression
Nominal logistic regression (optional)
Recursive partitioning

Section VII Nonlinear Modeling
Nonlinear modeling
DOE

Course Description

Design of Experiments is specifically designed to meet the analytical needs of those individuals working within a variety of industries. Instruction covers both basic and advanced concepts for the design and analysis of experiments. Presentation of the course material is designed for 16 hours of instruction.

Attendees

Design of Experiments is required for all scientists, engineers and quality professionals who actively work on all aspects of discovery, product and process development where the goal is to characterize, optimize and improve product and process performance.

Prerequisites

Engineering Statistics and Data Analysis is a recommended prerequisite for this course.

Course Objectives

1. Select factors and responses for experiments.
2. Design experiments appropriate for the information of interest.
3. Use and apply the structures of orthogonal arrays for product and process development and problem solving.
4. Ensure the experimental design is efficient.
5. Use regression techniques in order to analyze the results and make process/product improvements.
6. Use JMP software to design and analyze experiments.

Detailed Course Outline

Section I  Introduction to DOE

Section II  Experimental Preparation

Section III  Full Factorial Designs

Section IV  Screening Designs

Augment design

Section V  Custom Designs
Generating custom designs
Evaluating custom designs
Analysis of custom designs
Simulation for full distribution modeling
Strategies to minimize experimental size
Adding covariate and uncontrolled factors
Life or repeated measures experiments
Disallowed combinations (nested DOEs)
Split Plot designs
Adding dummy variables
Blocking designs
Mixtures in custom designs
Setting constraints in a DOE

Section VI  Response Surface Designs

Section VII  Special Topics In DOE (optional)
    Supersaturated designs
    Strip plot designs
Mixture Design of Experiments

MDOE

Course Description
Mixture Design of Experiments is specifically designed to meet the analytical needs of those individuals working within a variety of industries. Instruction covers all aspects of mixture design including pre-DOE, simplex lattice, centroid, screening and custom mixture designs. Presentation of the course material is designed for 8 hours of instruction.

Attendees
Mixture Design of Experiments is required for all scientists, engineers and quality professionals who actively work on all aspects of discovery, product and process development where the goal is to characterize, optimize and improve product and process performance.

Prerequisites
Engineering Statistics and Data Analysis and Design of Experiments are recommended prerequisites for this course.

Course Objectives
1. Apply the principles of robust design to Mixture Experiments.
2. Design mixture experiments appropriate for the information of interest.
3. Use and apply the structures of simplex and optimal designs for product and process development and problem solving.
4. Ensure the mixture design is efficient.
5. Use regression techniques in order to analyze the results and make process/product improvements.
6. Use JMP software to design and analyze experiments.

Detailed Course Outline
Section I Introduction and Two Factor Mixture Designs
   Experimental preparation and pre-DOE
   Two Factor Mixture Designs
Section II Simplex Lattice Designs
Section III Simplex Centroid and ABCD Screening Designs
   Simplex Centroid
   ABCD Screening Designs
Section IV Extreme Vertices Designs
Section V Optimal Designs
Section VI Custom Design
ROTD

Course Description
ROTD is specifically designed to meet the analytical needs of those individuals working within a variety of industries. Robust Optimization and Tolerance Design presents the methods and practices associated with designing and optimizing products and processes and to discuss tolerance design methods to protect product quality and clinical benefits. Presentation of the course material is designed for 16 hours of instruction.

Attendees
Robust Optimization and Tolerance Design is required for all scientists, engineers and quality professionals who actively work on all aspects of discovery, product and process development where the goal is to characterize, optimize and improve product and process performance.

Prerequisites
Engineering Statistics and Data Analysis and Design of Experiments are recommended prerequisites for this course.

Course Objectives
1. Learn and apply the principles of robust product design.
2. Design experiments appropriate for the information of interest.
3. Use and apply the structures of orthogonal arrays for product and process development and problem solving.
4. Ensure the experimental design is efficient.
5. Use regression techniques in order to analyze the results and make process/product improvements.
6. Optimize the response at its most robust condition.
7. Tolerance the factors and responses.
8. Use JMP software to design and analyze experiments.

Detailed Course Outline

Section I Distribution and Tolerance Design Foundations
- System, parameter, and tolerance design
- Tolerance design methods
Section II DOE review and robust design principles
Eight robust design principles

Section III DOE using custom designs
Custom designs
Strategies to minimize experimental size
Adding covariate and uncontrolled factors
Special topics for custom designs (optional)
  Blocking designs
  Setting constraints in the design

Section IV Robust optimization methods
  Tighten the tolerance of X
  Design to the flats
  Use interactions to tune out sensitivities
  Use parameter combinations

Section V Tolerance design and margin analysis
  Tolerance design procedure
  Tolerance stack up analysis
MSA

Course Description and Audience:
Measurement Systems Analysis is designed for Engineers, Scientists and Managers who have direct responsibility for measurement evaluation, selection and control. This course covers the basic concepts associated with measurement systems analysis, repeatability, reproducibility, accuracy, linearity, stability, standards selection and use, calibration and compensation and measurement control.

Course Objectives:
As a result of the course the participant will be able to:
1. Determine gage capability.
2. Assess accuracy, linearity, stability, repeatability and reproducibility in test equipment.
3. Design and deploy SPC for measurement control.
4. Select and establish standards.
5. Describe proper methods for instrument calibration and compensation.
6. Conduct gage capability for inspection activities.
7. Discuss how MSA impacts customer satisfaction.

Detailed Course Outline:

Section I  Introduction to MSA
MSA is a key to systematic product development
Background statistical principles
Sources of error
Focus on the measurement process

Section II  Terms and Definitions
Repeatability
Reproducibility
Accuracy
Linearity
Stability
Section III  R&R, Linearity, & Accuracy
  2 factor crossed design for Variables MSA
  Repeatability & Reproducibility
  R&R and Capability Example
  Accuracy example
  Linearity example

Section IV  Correlation, Calibration and Compensation
  Correlation and compensation
  Soft compensation versus standard calibration
  Scatterplot Method
  Problems with $r^2$

Section V  SPC for Measurement Control
  Selection and utilization of Standards
  SPC for Measurement Control
  SPC using stable standards
  SPC using unstable standards

Section VI  MSA for Attributes
  Operational Definitions
  Effectiveness, $P(\text{miss})$, $P(\text{false alarm})$
  Kappa, escape rate and bias
Reliability Analysis

RA

Course Description
Reliability Analysis is specifically designed to meet the analytical needs of those individuals working within a variety of industries. Areas of focus include: distribution analysis, area under the curve estimation, hypothesis testing, life and survival estimation, thermal sensitivity, confidence intervals and multiple factor modeling. Presentation of the course material is designed for 8 hours of instruction.

Attendees
Reliability Analysis is required for all scientists, engineers and quality professionals who actively work on all aspects of discovery, product and process development where the goal is to characterize, optimize and improve product and process performance.

Prerequisites
Engineering Statistics and Data Analysis is a recommended prerequisite for this course.

Course Objectives
2. Understand and apply non-parametric reliability analysis.
3. Understand and apply parametric reliability analysis.
4. Perform multivariate reliability assessment.
5. Understand and apply recurrence analysis.
6. Use Arrhenius transformations in reliability modeling.
7. Select appropriate sample sizes for MTBF studies.
8. Model reliability improvement using reliability growth models.

Detailed Course Outline
Introduction to reliability analysis and basic statistics
Nonparametric reliability analysis (Kaplan-Meier)
Parametric reliability analysis (LogNormal, Exponential, Weibull)
Competing Causes
Lifetime distribution analysis
Fit Life by X
Multivariate reliability analysis (Parametric Survival)
Recurrence analysis
MTBF analysis
Reliability growth analysis
Process Control Design using SPC

PCD-SPC

Course Description
This course is specifically designed to meet the analytical needs of those individuals working within a variety of industries. Course covers the basic concepts and methodologies associated with designing closed loop process controls using statistical process control for variables and attributes data. Variation assessment, subgroup formation, sample size selection, SPC control chart selection, out of control action plan generation are presented along with measures of process capability. The course requires 16 hours of instruction.

Attendees
This course is required for all scientists, engineers and quality professionals who actively work on all aspects of discovery, product and process development where the goal is to characterize, optimize and improve product and process performance.

Prerequisites
ESDA and DOE are recommended courses prior to taking PCD-SPC.

Course Objectives
1. Understand the language and compute the basic statistics associated with SPC.
2. Apply the ten process control requirements to achieve process control.
3. Determine rational subgroup formation, sample size and frequency.
4. Select appropriate control chart for process control requirements.
5. Compute appropriate control limits.
6. Develop appropriate SPC Charts and associated OCAPs.
7. Determine process capability.
8. Describe the roles and responsibilities for using SPC.
9. Use JMP to analyze process variation patterns, generate SPC charts and determine process capability.

Detailed Course Outline
Section I Introduction and Basic Statistics
SPC a basis for control
Basic statistics
Normal distribution
Standard error of the mean
Central limit theorem

Section II Ten Requirements for Designing Effective Process Control
1. Clear product specifications
2. Effective metrology
3. Process characterization
4. Sampling plan
5. Control chart selection (variables and attributes)
6. Alarms, closing the loop and out-of-control action plans (OCAP)
7. Process documentation
8. Operator and engineering training
9. Database
10. Routine line audits

Section III Process Capability
Determining process stability prior to computation of capability
Cp and Cpk
Sigma and z as measures of process capability
Tests for normality
Distribution fitting for nonnormal parameters

Section IV Process Control Implementation Roles and Responsibilities
Management
Process engineer
Process control specialist
Supervisor
Operator
Quality Risk Management and FMEA

QRM-FMEA

Course Description
This course is specifically designed to meet the analytical needs of those individuals working within a variety of industries. Areas of instruction cover the topics associated with risk management including risk management definitions, risk management process and risk assessment tools including Failure Modes and Effects Analysis. The course requires 8 hours of instruction.

Attendees
This course is required for all scientists, engineers and quality professionals who actively work on all aspects of discovery, product and process development where the goal is to characterize, optimize and improve product and process performance.

Prerequisites
There are no prerequisites for this course.

Course Objectives
1. Understand the definitions, process and tools associated with Quality Risk Management.
2. Identify potential design, process or test issues associated with product and performance risk.
3. Understand the tools and methods for risk assessment and prioritization.
4. Understand the various types of FMEAs.
5. Apply the basic steps for FMEA generation.
6. Know when and how to apply FMEA to product and process development.
7. Prioritize and manage risk reduction opportunities from FMEA results.

Detailed Course Outline

Section I Quality Risk Management Principles and Process
Risk management principles
Risk management process
Responsibilities
Risk assessment
Risk control
Risk communication
Risk review
Section II  Risk Analysis Tools
Basic quality tools and risk weighted analysis
Cause and effect diagrams
Process flow and risk assessment
Pareto and Risk Weighted Pareto analysis
Histograms, capability, simulation and Margin
Control charts
Regression
DOE (product and process) and MSA

Section III  Failure Modes and Effects Analysis
Application areas for FMEA
FMEA preparation
FMEA generation workshop

Section IV  Methods for Reducing Risk
FMEA action plans and risk reduction
BDPS

Course Description
This course is specifically designed to meet the analytical needs of people working within a variety of industries. This course is designed for those individuals working directly on product and process development and corrective / preventative action. It is assumed they come from a variety of backgrounds and disciplines and will be working on a variety of process improvement areas across the company. The course is designed for 16 hours of presentation.

Attendees
This course is required for all scientists, engineers and quality professionals who actively work on all aspects of discovery, product and process development where the goal is to understand the root cause of performance problems and implement appropriate CAPA procedures to assure the problem never occurs again.

Prerequisites
There are no prerequisites for this course.

Course Objectives
1. Identify a problem that requires action.
2. Define a problem in measurable terms.
3. Contain the problem while developing a durable solution.
4. Measure core performance and establish metrics.
5. Collect and analyze data relevant to the problem of interest.
6. Analyze the system of causes and determine root cause.
7. Plan and implement corrective and preventative relevant to the root cause of the problem.
8. Evaluate the effectiveness of the solutions.
9. Establish controls to sustain solutions.
10. Use Excel or JMP for basic statistics and data analysis.

Detailed Course Outline
Section I Introduction to root cause analysis
Need for improvement
Savings associated with root cause analysis
Eight+ basic quality tools

Section II Define and contain the problem
- Define the problem
- Contain the problem
- Determine scope, objectives and goals
- Project leadership and planning

Section III Measure the problem
- Map the process
- Determine data collection plan
- Establish metrics and capability

Section IV Analyze data and determine root cause
- Analyze and summarize the data
- Analyze and summarize the process map

Determine root causes and summarize all findings

Section V Improve performance
- Brainstorming solutions and CAPA
- Benefit, cost, risk and complexity determination
- Measuring solution effectiveness

Section VI Control and standardize improvements
- Process owner
- Select controls
BSDA

Course Description
This course is for all Marketing, Sales, HR, Business Analysts and Managers who routinely analyze data for business application. Areas of focus are foundation statistics, distribution analysis, capability assessment, graphing, comparison tests and sample size selection. This course is designed for 16 hours of presentation.

Attendees
This course is required for all Marketing, Sales, HR, Business Analysts and Managers who routinely analyze data for business application.

Prerequisites
There are no prerequisites for this course.

Course Objectives
1. Understand the ideas associated with sampling and data collection.
2. Demonstrate the ability to evaluate distributions.
3. Select appropriate sample sizes for performance evaluation.
4. Conduct comparative tests using data.
5. Use regression techniques in order to analyze the results and make performance improvements.
6. Select an appropriate analysis technique based on the type of data.

Detailed Course Outline
Section I: Introduction to JMP
- Table commands
- Column commands
- Row commands
- Subset, Stack and Join commands
- Saving data and graphs

Section II: Statistics Foundations & Distribution Analysis
Measures of center and spread  
Standard error and central limit theorem  
Normal distribution, t distribution and confidence intervals  
Test for normality  

Process capability normal and non-normal distribution fitting  
Trend Analysis  

**Section III  Nominal X, Continuous Y**  
Sample size for the mean  
t test – one sample, two sample and paired  
Test for differences in variances  
One-way ANOVA  
Customer Satisfaction and Nonparametric data analysis  

**Section IV  Continuous X, Continuous Y**  
Simple linear regression, correlation  

**Section V  Nominal X, Nominal Y**  
Test for proportion data  
Chi-square test for defects and proportion defective  
Pareto graphs and analysis  

**Section VI  Continuous X, Nominal Y**  
Logistic regression
Advanced Business Statistics and Data Analysis

ABSDA

Course Description
This course is for all Marketing, Sales, HR, Business Analysts and Managers who routinely analyze data for business application. Areas of focus are analysis of data for business planning, forecasting, data mining, variation analysis and multiple factor modeling. This course is designed for 16 hours of presentation.

Attendees
This course is required for all Marketing, Sales, HR, Business Analysts and Managers who routinely analyze data for business application.

Prerequisites
Business Statistics and Data Analysis

Course Objectives
1. Use data to solve business and transactional problems.
2. Select appropriate analysis technique based on type of data.
3. Analyze complex multifactor data sets.
4. Estimate the effect size from the data relative to the business case of interest
5. Generate prediction equations to predict business behavior based on critical inputs.
6. Use multiple regression techniques in order to analyze data and make business process improvements.

Detailed Course Outline
Section I  Advanced Graphs
Advanced Pareto Plots
Confidence Intervals and Tests
Stacked Bar Graphs
Graph Builder

Section II  Variation Analysis
EMS and REML
POV Analysis
MSA for Attributes

Section III  Data Mining
Recursive Partitioning

Section IV  Time Series and Forecasting
UWMA and EWMA
Seasonal ARIMA
Learning Curves
Nonlinear Regression

Section V  Multiple Factor Analysis
N-way ANOVA
Multiple Regression
ANCOVA
Please contact Thomas A. Little Consulting for quotation of training and consulting services.

12401 North Wildflower Lane
Highland, UT 84003
1-925-285-1847
drlittle@dr-tom.com
Website: www.dr-tom.com