IN COLLABORATION WITH

THE OHIO STATE UNIVERSITY
FISHER COLLEGE OF BUSINESS

Lean Six Sigma Black Belt Body of Knowledge

Mastery Requirement Key Bloom's Taxonomy	
RE	**Remember** terminology, facts, and definitions
UN	**Understand** and explain ideas and concepts
AP	**Apply** information, methods, and procedures in a new way or in a different context
AN	**Analyze** critically to compare and contrast, discriminate through experimentation, and identify inter-relationships
EV	**Evaluate** to draw conclusions and reach judgements through interpretation of analytical work
CR	**Create** new methods, processes, systems, concepts, and ideas

Topic Area	Topic	Mastery Requirement*	Mastery Assessment
General			
	Lean Six Sigma Defined	**UN**	Describe nature and purpose of Lean Six Sigma
	Integration of Lean and Six Sigma	**UN**	Compare and contrast focus and approaches (Process Velocity and Quality)
	Y=f(X) Input Determines Output	**EV**	Express business processes as a transfer function
	The Business Case for Lean Six Sigma	**AP**	Describe value proposition of Lean Six Sigma as a methodology
	Origins of Lean and Six Sigma	**UN**	Understand historical perspective and evolution
	Lean Principles	**UN**	Describe the fundamental principles of lean.
	8 Wastes	**AP**	Identify different types of waste in a process.
	DMAIC - The Lean Six Sigma Improvement Process	**EV**	Apply DMAIC methodology to organize project thinking and work
	Lean and DMAIC	**AP**	Apply DMAIC methodology at varying levels of complexity based on project requirements and mix of "Lean" vs "Variation Reduction" activities.
	Thought Process Mapping	**AN**	Employ Question->Action->Answer approach to guide critical thinking
Topic Area	**Topic**	**Mastery Requirement***	**Mastery Assessment**
Project Management			
	Organizing for Success	**UN**	Understand critical organizational success factors

	Working Relationships & Responsibilities	**UN**	Understand typical work role definitions and structure
	Balanced Scorecard Analysis	**AP**	Develop high level metrics to present comprehensive representation of performance across critical dimensions
	Project Selection	**AP**	Select projects based on systematic analysis of key organizational performance metrics, comparing actual to imperative to identify
	Project Charter	**CR**	Create project charter with compelling business case, clear objectives, and appropriate scope of action
	Project Tracking	**EV**	Systematically plan and execute project work activities
	Leading Project Teams	**AP**	Provide positive leadership energy to accomplish project goals through people: communicate, convince, coordinate and compel
	Leading Change	**AP**	Apply change management techniques to accomplish project objectives
	Leader Standard Work	**AP**	Formulate appropriate leader standard work to build organizational habits that support institutional process improvement activities
	Stakeholder Analysis - RACI Matrix	**AP**	Recognize stakeholders, their needs, possible conflicts or resistance, and plan and communicate accordingly

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Define Phase of DMAIC			
	Process Thinking and The Value Stream	**UN**	Define high level value streams
	Process Mapping - Overview	**AN**	Understand alternate forms of process mapping and apply criteria to select the appropriate type of map for the situation
	SIPOC Maps	**AP**	Construct SIPOC map incorporating relevant elements
	Process Flow Charts and Swim Lanes	**AP**	Construct Flow Chart using standard symbols and with activities identified by department or function
	Value-Added Flow Charts (7/8 Wastes)	**AP**	Construct Flow Chart which identifies non-value-added activities
	Spaghetti Charts	**AP**	Construct chart to map the physical flow of materials or virtual flow of information
	Value Stream Mapping (Current State, Takt Time)	**AP**	Construct Value Stream Map of current/future process state, showing order flows, processing time by step, inventories, delays, set-up times, takt time, and overall cycle time (lead time), waste and bottlenecks.
	Voice of The Customer	**UN**	Express importance of customer-driven activities
	Understanding Customer Requirements (Kano Model)	**AP**	Apply Kano Analysis to identify opportunities to "delight" customers
	Sources of Customer Data	**UN**	Recognize sources for VOC data
	Conducting Surveys	**UN**	Recognize situations calling for a survey to collect customer data
	Surveys - Sampling Frame	**AP**	Incorporate sample frame considerations to achieve representative sample
	Structuring Survey Questions	**AP**	Structure survey questions to achieve desired results and avoid bias

	The Degree of Uncertainty in Sampling	**AP**	Factor uncertainty into survey analysis
	Guideline for Margin of Error	**AP**	Incorporate margin of error into analysis of survey results
	Affinity Diagram Toolset	**AP**	Use Affinity Diagram to sort and group customer data
	CTQC Tree Diagram	**AP**	Develop Tree Diagram to refine general customer requirements into Critical To Quality Requirements.
	Operational Definitions	**CR**	Craft operational definitions to express customer requirements in clear and objective terms
	Voice Of The Customer As Specifications	**AN**	Translate customer requirements into internal process/product specifications
	Quality Function Deployment (QFD)	**EV**	Employ Quality Function Deployment to develop the internal process parameters necessary to meet customer requirements
	Define Phase Tollgate Review	**EV**	Review critical questions for the Define Phase to ensure that answers have been developed

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Measure Phase of DMAIC			
	Measurements and Basic Statistics	**UN**	Describe the role of measurements and basis statistics in the Measure phase of a DMAIC project
	Business Problem Solving Using Statistics	**AN**	Express practical problems as statistical question, and translate statistical answers into practical answers
	Basic Statistical Terms	**AP**	Describe basic statistical terms in structuring actions to answer critical questions
	Descriptive and Inferential Statistics	**AP**	Differentiate between Descriptive and Inferential Statistics
	Discrete vs. Continuous Measurements	**AP**	Identify the most useful type of data to collect to meet project requirements
	Measurement Subjects	**AP**	Distinguish between type of measures subjects
	Graphical Summaries	**AN**	Interpret the information conveyed by graphical representations of data
	Statistical Software (Minitab, EngineRoom, JMP, or other)	**AP**	Demonstrate use of statistical software to analyze data
	Pareto Chart	**AN**	Use Pareto Charts to rank by frequency and interpret the output
	Measuring Central Tendency	**AN**	Calculate and interpret appropriate measures of central tendency in analyzing process performance (mean, median, mode)
	Quantifying Process Variability	**AN**	Calculate and interpret appropriate measures of variation in analyzing process performance (variance, standard deviation, range)
	The Normal Distribution	**AN**	Apply normal distribution concepts to assessments of capability and employ Z-scores to model probability
	Cause & Effect Matrix Toolset	**EV**	Systematically identify process inputs which potential to significantly affect output of interest

	Measurement System Analysis (MSA)	**UN**	Appreciate the important role of measurement system analysis
	Measurement As A Process	**AP**	Apply the study of measurement system capability as a process
	Requirements of Measurement Systems	**AP**	Execute measurement analysis to address the requirements of a reliable system
	Gauge R & R (Variable Data)	**EV**	Evaluate systems used to collect variable data
	MSA - Graphing	**EV**	Apply graphical analysis to enhance MSA evaluation
	Attribute Measurement System Analysis	**EV**	Evaluate systems used to collect variable data
	Calibration of Measurement Systems	**AP**	Apply calibration guidelines to ensure measurement system reliability over time
	Collecting Data	**EV**	Develop a data collection plan
	Developing a Sampling Plan	**AP**	Incorporate effective sampling guidelines
	Establishing Baseline Performance	**EV**	Select and apply the appropriate measurement and interpret results
	Throughput Yield and Rolled Throughput Yield	**EV**	Calculate and interpret results
	The Process Sigma Level	**EV**	Calculate and interpret results
	Charting Process Behavior (SPC) Background	**UN**	Describe origin and purpose of Control Charts
	Trend Charts (Run Charts)	**EV**	Create and interpret this type of chart
	SPC Concepts & Control Limits	**AP**	Employ Control Limits to evaluate process stability
	Types of SPC Charts	**AP**	Recognize which chart should be applied in a given situation
	Rational Subgrouping	**EV**	Develop a rational sampling plan to represent the entire process output
	X and Moving Range Charts	**EV**	Create and interpret this type of chart
	Attribute Control Charts	**EV**	Create and interpret this type of chart
	X bar and R Charts, Xbar and S	**EV**	Create and interpret this type of chart
	Process Capability (Cp, Cpk, Pp, Ppk)	**EV**	Assess process capability, factoring in prerequisites of process stability and normality
	Normality Assessment, Transformation of Non-Normal Data	**EV**	Recognize impact of non-normality and take actions as required to transform data
	Performance Baseline: Sigma Level		Use the Sigma Level to establish a reference value for process performance.
	Rapid Improvements - Leading Kaizen Events	**EV**	Organize and execute rapid improvement events (Kaizen Blitz)
	Future State VSM - Line Balancing	**EV**	Create future state Value Stream Maps, incorporating balancing of resources
	MEASURE - Tollgate Review	**EV**	Review critical questions for the Measure Phase to ensure that answers have been developed

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Analyze Phase of DMAIC			

	Finding The Root Cause - Basic Concepts	**AP**	Recognize and apply alternate methods of root cause identification and validation
	Cause & Effect Diagram	**EV**	Draw upon process experience to systematically identify potential root causes
	5-Why, 1-How	**EV**	Use sequential questions to uncover causal relationships
	Box Plots	**EV**	Stratify a data set by any attribute and compare the subgroups both visually and statistically.
	Scatter Plots	**EV**	Evaluate correlation between variables graphically
	Root Cause Tree	**AN**	Establish the links between an effect and a branching system of causes.
	Correlation and Regression Analysis	**EV**	Evaluate correlation between variables statistically
	Multiple Regression	**EV**	Identify relationships between multiple inputs and a continuous output and build a mathematical model of the relationship
	Logistic Regression	**EV**	Identify relationships between multiple inputs and a discrete binary output and build a mathematical model of the relationship
	Estimating Population Proportion	**AP**	Determine required sample size to estimate population proportion
	Estimating Population Mean	**AP**	Determine required sample size to estimate population mean
	Hypothesis Testing: Purpose, Concepts and Language	**AP**	Recognize situations where a formal test of hypothesis is warranted
	Formatting the Hypothesis to be Tested	**EV**	Properly format null and alternate hypotheses
	Types of Error - Alpha and Beta	**AN**	Understand types of error and incorporate into testing plan
	Power Analysis	**AN**	Design test to meet Power requirements
	Confidence Intervals	**AN**	Apply confidence intervals to interpret the results of a test
	Treatment Comparisons using Control Charts	**EV**	Recognize the role of control charts in evaluating process changes
	Comparing One Proportion to a Standard	**EV**	Select the correct test, structure null and alternate hypotheses, satisfy underlying assumptions, analyze for statistically significant difference, and interpret results
	Comparing Two Proportions - Z-test	**EV**	Select the correct test, structure null and alternate hypotheses, satisfy underlying assumptions, analyze for statistically significant difference, and interpret results
	Comparing Multiple Proportions - Chi-Square	**EV**	Select the correct test, structure null and alternate hypotheses, satisfy underlying assumptions, analyze for statistically significant difference, and interpret results

	Comparing One Mean to a Standard - t-test	**EV**	Select the correct test, structure null and alternate hypotheses, satisfy underlying assumptions, analyze for statistically significant difference, and interpret results
	Comparing Two Means - t-test	**EV**	Select the correct test, structure null and alternate hypotheses, satisfy underlying assumptions, analyze for statistically significant difference, and interpret results
	Comparing Multiple Means - ANOVA /F-test	**EV**	Select the correct test, structure null and alternate hypotheses, satisfy underlying assumptions, analyze for statistically significant difference, and interpret results
	Confidence Intervals - Least Significant Difference	**EV**	Employ confidence intervals to evaluate observed differences
	Comparing One Variance to a Std. - Chi-Square	**EV**	Select the correct test, structure null and alternate hypotheses, satisfy underlying assumptions, analyze for statistically significant difference, and interpret results
	Comparing Two Variances - F-test	**EV**	Select the correct test, structure null and alternate hypotheses, satisfy underlying assumptions, analyze for statistically significant difference, and interpret results
	Parametric vs. Non Parametric Tests	**AN**	Recognize the difference between types of hypothesis test and apply the correct test to fit the situation
	Non Parametric Tests: Sign, Wilcoxon Signed-Ranks, Mann-Whitney-Wilcoxon, Kruskal-Wallis, Friedman,	**EV**	Select the correct test, structure null and alternate hypotheses, satisfy underlying assumptions, analyze for statistically significant difference, and interpret results
	Design of Experiments (DOE): Purpose, Principles	**UN**	Describe purpose and principles of DOE
	DOE: Process, Components, Guidelines	**AN**	Recognize the correct circumstances to employ DOE and follow the experimental process in doing so
	Selecting the Right Experimental Design	**EV**	Select a design to balance experimental objectives
	DOE: Blocking	**EV**	Determine proper use of blocking
	DOE: Power Analysis	**EV**	Use of replicates to achieve required level of Power
	DOE: Single Factor Experiments	**EV**	Compare effectiveness of 3 or more alternative treatments or methods, including blocking for sources of known variation.
	DOE: Two Level Full Factorial Designs	**EV**	Identify main effects and interactions, construct model, analyze model diagnostics and evaluate model quality, interpret results and relate to subject process in practical terms.
	DOE: Two Level Fractional Factorial Designs	**EV**	Identify main effects and interactions, construct model, analyze model diagnostics and evaluate model quality, interpret results and relate to subject process in practical terms.

	DOE: General Factorial Designs	**EV**	Identify main effects and interactions, construct model, analyze model diagnostics and evaluate model quality, interpret results and relate to subject process in practical terms.
	ANALYZE - Tollgate Review	**EV**	Review critical questions for the Analyze Phase to ensure that answers have been developed

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Improve Phase of DMAIC			
	Design for Six Sigma (DFSS) Overview	**UN**	Recognize the complementary role of Design for Six Sigma
	Benchmarking	**AN**	Conduct benchmarking studies for comparative purposes
	Brainstorming	**AP**	Facilitate effective brainstorming
	Multi-voting	**AP**	Employ multi-voting to prioritize actions
	FMEA	**EV**	Prioritize, evaluate and resolve potential risks
	Error-proofing	**EV**	Implement process changes to prevent the root cause of errors
	Prioritizing and Selecting a Solution	**EV**	Systematically select improvement solution sets
	The A3 One-Page Report	**AN**	Employ the A-3 approach when necessary to organize and communicate project activities
	Continuous Flow & Little's Law	**AN**	Analyze and resolve constraints to move process toward continuous flow
	Quick Changeover Toolset Viewed	**EV**	Improve process flow by reducing changeover or set-up time
	Cellular Processing Toolset Viewed	**EV**	Implement work-cells to improve process flow
	Theory of Constraints (TOC) - Line Balancing	**AN**	Use TOC principles to identify, elevate, and resolve bottlenecks
	A-B-C Work Stratification	**EV**	Determine inventory levels based on stratification
	Internal Pull Systems	**AN**	Set up internal pull system to improve flow and reduce inventories
	External Pull Systems	**AN**	Set up external pull to improve flow and reduce inventories
	Corrective Action Matrix	**AP**	Organize and track improvement activities while driving accountability for implementation
	Piloting a Solution	**AP**	Trial and evaluate solutions on a small scale prior to full implementation
	System Dynamics	**EV**	Identify potential unintended consequences and while develop robust process knowledge of balancing and reinforcing forces
	IMPROVE - Tollgate Review	**EV**	Review critical questions for the Improve Phase to ensure that answers have been developed

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Control Phase of DMAIC			
	Verifying Improvements with Control Charts	**AN**	Evaluate "before" vs "after" data to validate process improvements, and employ control charts for ongoing process management
	The Process Control Plan	**EV**	Establish a process management system for ongoing data collection, monitoring, and reaction
	Visual Control	**AN**	Institute visual control techniques to improve process management
	5-S Approach	**AN**	Apply 5-S techniques to organize and streamline the workplace
	Total Productive Maintenance	**AP**	Implement TPM practices to improve process reliability and eliminate downtime
	Best Practices and Lessons Learned	**EV**	Evaluate successful actions and proactively share lessons learned with the broader organization
	Standardized Work - Documenting Process Changes	**AP**	Establish and document standard work to reduce variability
	Ending the Project Viewed - Project Hand-off	**AP**	Employ a systematic process to transfer responsibilities to the process owner and close the project
	CONTROL - Tollgate Review	**EV**	Review critical questions for the Control Phase to ensure that answers have been developed