



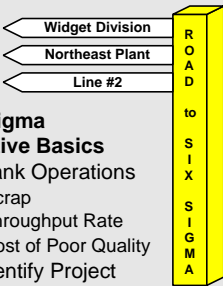

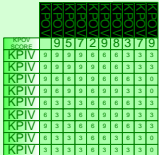
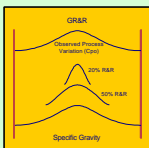
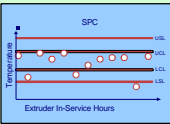
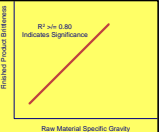
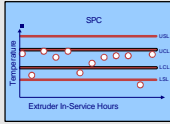
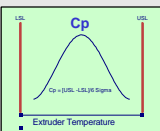








# SIX SIGMA DMAIC PROJECT PHASES

Project Phases	DEFINE	MEASURE	ANALYZE	IMPROVE	CONTROL																																																																																
Project Phase Highlight	<b>Project Selection</b>	<b>Process Evaluation</b>	<b>The Critical Few</b>	<b>Optimization</b>	<b>Lock-In Gains</b>																																																																																
Project Phase Purpose/Focus	 <ul style="list-style-type: none"> <li>&gt; Survey Organization</li> <li>&gt; Evaluate Performance</li> <li>&gt; Identify Improvement Opportunities</li> </ul>	$Y = f(X_1, X_2, X_3, \dots, X_n)$ <ul style="list-style-type: none"> <li>&gt; Identify Critical-to-Quality Process Variables</li> <li>&gt; Conduct Measurement System Analyses</li> </ul>	 <ul style="list-style-type: none"> <li>&gt; Analyze CTQ Variables</li> <li>&gt; Determine Link Between Defect &amp; Variable (Cause)</li> </ul>	 <ul style="list-style-type: none"> <li>&gt; Optimize Processes via Design of Experiment (DoE)</li> <li>&gt; Conduct Screening &amp; Characterization DoE</li> </ul>	 <ul style="list-style-type: none"> <li>&gt; Mistake-Proof Operations</li> <li>&gt; Pursue Continuous Improvement</li> </ul>																																																																																
Project Phase Key Elements	 <p><b>Six Sigma Initiative Basics</b></p> <p>(1) Rank Operations</p> <ul style="list-style-type: none"> <li>- Scrap</li> <li>- Throughput Rate</li> <li>- Cost of Poor Quality</li> </ul> <p>(2) Identify Project Locations</p> <p><b>Project Charter</b></p> <ul style="list-style-type: none"> <li>- Scope</li> <li>- Target</li> <li>- Value</li> <li>- Metrics</li> </ul> <p><b>Project Team</b></p> <ul style="list-style-type: none"> <li>- Champion</li> <li>- Black Belt</li> <li>- Operations</li> <li>- Finance</li> <li>- IT</li> </ul>	<p><b>Process Mapping</b></p> <ul style="list-style-type: none"> <li>- Key Process Input &amp; Output Variables</li> </ul>  <p><b>Cause &amp; Effects Matrix</b></p>  <p><b>Measurement System Analysis</b></p> <ul style="list-style-type: none"> <li>- Gage</li> <li>- Repeatability &amp; Reproducibility</li> <li>- Precision-to-Tolerance</li> <li>- Bias</li> <li>- Linearity</li> </ul>  <p><b>Process Stability &amp; Capability</b></p> 	<p><b>Hypothesis Testing</b></p> <p><math>H_0: X_1 = X_2</math> or <math>X_1 - X_2 = 0</math></p> <p><math>H_A: X_1 \neq X_2</math> or <math>X_1 - X_2 &lt;&gt; 0</math></p> <p>alpha = 0.05 (Type I Error) beta = 0.30 (Type II Error)</p> <p>If <math>P \leq 0.05</math>, Then Reject <math>H_0</math></p> <p><b>Continuous (Variable) Data</b></p> <ul style="list-style-type: none"> <li>- Parametric (Means) <ul style="list-style-type: none"> <li>- t-Test (2 Groups)</li> <li>- Paired t-Test (2 Groups)</li> <li>- ANOVA (&gt; 2 Groups)</li> </ul> </li> <li>- Non-Parametric (Medians) <ul style="list-style-type: none"> <li>- Wilcoxon Rank Sum</li> <li>- Wilcoxon Signed Rank-Paired</li> <li>- Non-Parametric ANOVA</li> </ul> </li> </ul> <p><b>Discrete (Attribute) Data</b></p> <ul style="list-style-type: none"> <li>- Chi Square</li> <li>- Fisher's Exact Test</li> <li>- McNemar's Test</li> </ul> <p><b>Correlation/Regression Analyses</b></p> 	<p><b>Design of Experiment (DoE)</b></p> <ul style="list-style-type: none"> <li>- Factors and Levels</li> <li>- <math>X^k</math></li> <li>k = Factors</li> <li>X = Levels</li> <li>- <math>2^2</math></li> <li>2 Factors</li> <li>2 Levels per Factor</li> <li>- Full Factorial</li> <li>- Fractional Factorial</li> </ul> <table border="1"> <thead> <tr> <th>Run</th> <th>A</th> <th>B</th> <th>C</th> <th>D</th> </tr> </thead> <tbody> <tr><td>1</td><td>0.000</td><td>0.000</td><td>0.000</td><td>-2.000</td></tr> <tr><td>2</td><td>1.000</td><td>-1.000</td><td>-1.000</td><td>-1.000</td></tr> <tr><td>3</td><td>1.000</td><td>1.000</td><td>1.000</td><td>1.000</td></tr> <tr><td>4</td><td>0.000</td><td>0.000</td><td>2.000</td><td>0.000</td></tr> <tr><td>5</td><td>0.000</td><td>0.000</td><td>0.000</td><td>0.000</td></tr> <tr><td>6</td><td>1.000</td><td>1.000</td><td>1.000</td><td>-1.000</td></tr> <tr><td>7</td><td>0.000</td><td>0.000</td><td>0.000</td><td>0.000</td></tr> <tr><td>8</td><td>-1.000</td><td>1.000</td><td>-1.000</td><td>-1.000</td></tr> <tr><td>9</td><td>0.000</td><td>0.000</td><td>0.000</td><td>0.000</td></tr> <tr><td>10</td><td>-1.000</td><td>-1.000</td><td>-1.000</td><td>1.000</td></tr> <tr><td>11</td><td>-1.000</td><td>1.000</td><td>1.000</td><td>1.000</td></tr> <tr><td>12</td><td>0.000</td><td>0.000</td><td>0.000</td><td>0.000</td></tr> <tr><td>13</td><td>1.000</td><td>1.000</td><td>-1.000</td><td>-1.000</td></tr> <tr><td>14</td><td>1.000</td><td>-1.000</td><td>1.000</td><td>-1.000</td></tr> <tr><td>15</td><td>-1.000</td><td>-1.000</td><td>1.000</td><td>1.000</td></tr> </tbody> </table> <p><b>Screening Experiments</b></p> <ul style="list-style-type: none"> <li>- Fractional Factorial</li> </ul> <p><b>Characterization Studies</b></p> <ul style="list-style-type: none"> <li>- Full Factorial</li> </ul> <p><b>Optimization Studies</b></p> <ul style="list-style-type: none"> <li>- Response Surface Methods</li> </ul>	Run	A	B	C	D	1	0.000	0.000	0.000	-2.000	2	1.000	-1.000	-1.000	-1.000	3	1.000	1.000	1.000	1.000	4	0.000	0.000	2.000	0.000	5	0.000	0.000	0.000	0.000	6	1.000	1.000	1.000	-1.000	7	0.000	0.000	0.000	0.000	8	-1.000	1.000	-1.000	-1.000	9	0.000	0.000	0.000	0.000	10	-1.000	-1.000	-1.000	1.000	11	-1.000	1.000	1.000	1.000	12	0.000	0.000	0.000	0.000	13	1.000	1.000	-1.000	-1.000	14	1.000	-1.000	1.000	-1.000	15	-1.000	-1.000	1.000	1.000	<p><b>Poka-Yoke</b></p> <ul style="list-style-type: none"> <li>- "Fail Safe" (Japanese)</li> <li>- Involves More Than SOPs</li> <li>- "Hard-wiring" Process Variables to Prevent Mistakes</li> <li>- Color Coding Wires and Plumbing Fittings</li> <li>- Tooling Electrical Connectors and Plumbing Fixtures with Pins/Notches to Prevent Incorrect Alignment/Configuration</li> </ul> <p><b>Continuous Monitoring of CTQ Process Variables</b></p>  <p><b>Process Stability &amp; Capability</b></p>  <p><b>Continuous Improvement via Evolutionary Operation (EVOP)</b></p> 
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Project Phase Outcome	 <p><b>Project Launch</b></p>	<ul style="list-style-type: none"> <li>&gt; Ranked Critical-to-Quality Variables</li> <li>&gt; Reliable Measurement Systems</li> </ul> 	<ul style="list-style-type: none"> <li>&gt; Proven Statistically Significant Relationship Between CTQ Variable(s) and Defects</li> </ul> 	<ul style="list-style-type: none"> <li>&gt; Proven Statistically Significant Relationship Between Process Changes (Fixes) and Improved Performance</li> </ul> 	<ul style="list-style-type: none"> <li>&gt; Customer Delight</li> <li>&gt; Realized Savings</li> <li>&gt; Maintained, Stable/ Capable Processes</li> </ul> 																																																																																
Project Phase Duration	1 to 2 Weeks	4 to 8 Weeks	4 to 6 Weeks	4 to 6 Weeks	4 to 6 Weeks																																																																																