

MIT OpenCourseWare
<http://ocw.mit.edu>

16.660 / 16.853 / ESD.62J Introduction to Lean Six Sigma Methods
January (IAP) 2008

For information about citing these materials or our Terms of Use, visit: <http://ocw.mit.edu/terms>.



**LEADING IMPROVEMENT
ACROSS A COMPLEX
AEROSPACE ENTERPRISE**
Dick Lewis, COO Rolls-Royce
Corporation 2001-2004
© 2007 Dick Lewis, used with permission

Presentation Contents

- **Key components which drive enterprise improvement**
- **Essential tools for business improvement**
- **Typical business improvement metrics**
- **Improvement as a process rather than an end state**

Rolls-Royce Corporation

- **Founded in 1915 by James Allison**
- **Produced over 110,000 engines powering P38, P-51, A7, OH-6, OH-58, C-130, C-2, P-3, E-2, ERJ145, V-22**
- **First true multi-application engine, the AE Family: Fan, Propeller, and Shaft Driven**
- **Over 50 regional airline systems and hundreds of corporate operators in five continents**
- **Approximately 30,000 engines currently in service for civil, military, helicopter, energy, and naval applications**
- **Acquired by Rolls-Royce plc in 1995**

Rolls-Royce Corporation Key Statistics - 2004

- 4 Business Sectors**
(Civil Aerospace, Defense, Energy, Marine)
- 3 Major Product Families (AE, T56/501, 250)**
- 2 Engines/day**
- \$1M Spares/day**
- 4,400 People, including 1950 UAW members**
- 3,000,000 Sq. Ft. Active Floor Space**
- 2,700 Active Machine Tools**
- 7,000 Active Part Numbers**
- \$1.5B Annual Sales**
- \$250M Rolls-Royce Plant Improvement**
- 4 Years Into Lean Journey**

Rolls-Royce Stakeholders

- **1000's of users and maintainers**
- **100's of buying customers**
- **10's of partners**
- **4400 employees**
- **300 suppliers**
- **Federal, state, and local governments**
- **1000's of shareholders**
- **Rolls-Royce plc leadership**
- **United Autoworkers Union**
- **Community neighbors**

Improvement That Flows to the Bottom Line Requires

- **Vision**
- **Focus on Customers and Employees**
- **Active Leadership Involvement and Alignment with Workforce**
- **Willingness to Break Established Paradigms**
- **Hierarchy of Trained, Empowered, and Incentivized Employees**
- **Constancy of Improvement Activity**
- **Celebrate and Reward Success**

Rolls-Royce Corporation Vision

- **Trusted to Deliver Excellence**
 - **As determined by customer satisfaction**
 - **And measured by a few understandable metrics**
 - **Supported by a workforce trained and empowered to deliver improvement**
 - **Across the entire business**

Leadership From the Top

- **Motorola - John Galvin**
- **GE - Jack Welsh**
- **Allied-Signal - Larry Bossidy**
- **ITT - Lou Giuliano**
- **Boeing – Jim McNerney**
- **Rockwell Collins – Clay Jones**

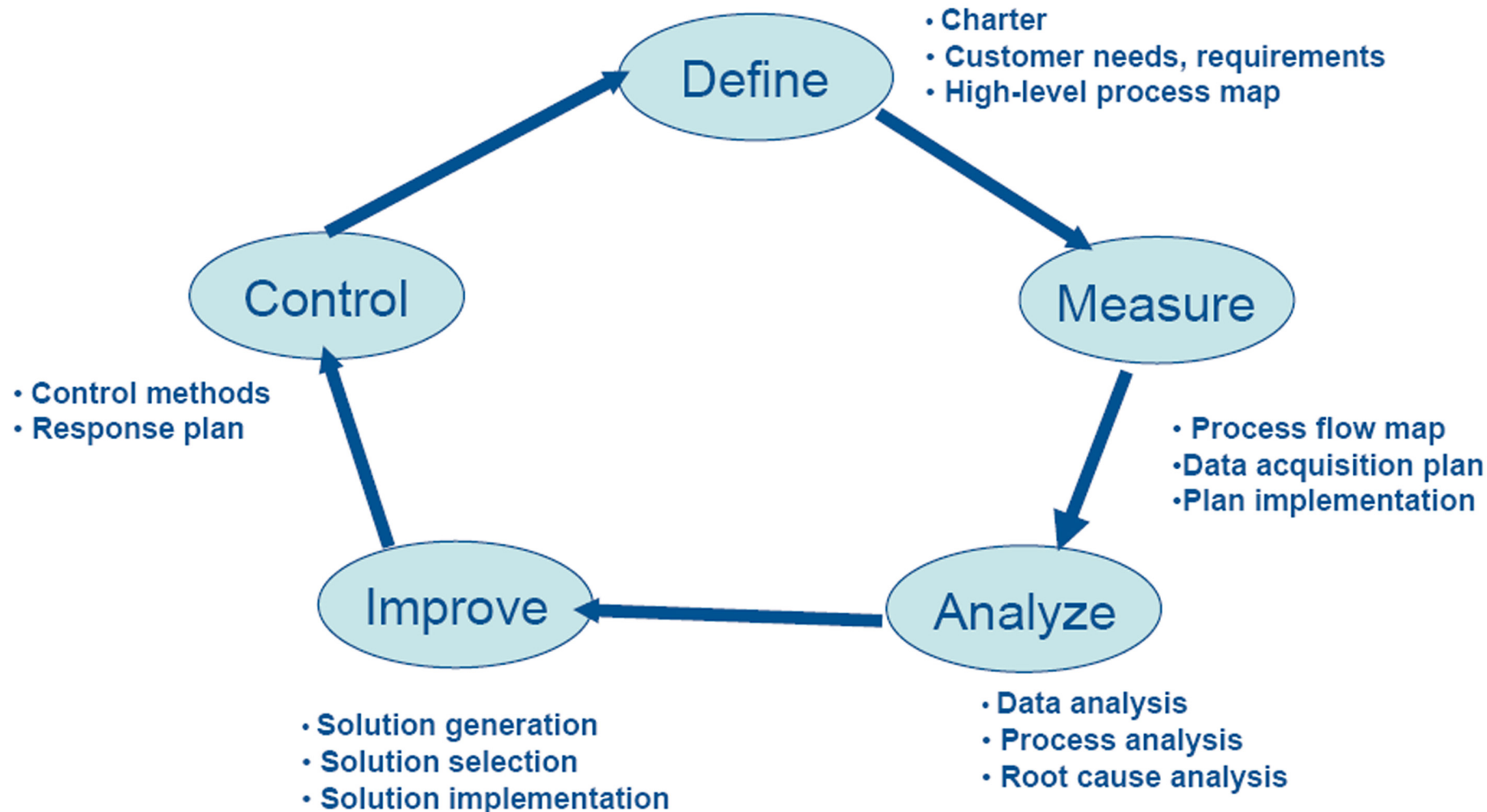
Knowledge is Required to Deliver

- **Capable, world-class processes**
- and**
- **Streamlined, value-adding activity**

Hierarchy of Knowledge

- **Team and Leadership Skills**
- **Knowledge-based “Belts” - Yellow, Green, Black – in lean and six sigma**
- **Certified Mastery - ASQ**
- **Sensei - e.g. Genichi Taguchi at ITT**

Essential Tools for Business Improvement



Essential Tools for Business Improvement

- **Define**
 - High level process map
 - Problem definition
 - Metrics
 - Improvement goals
- **Measure**
 - Process analysis
 - Probability and statistics
 - Data collection and analysis
 - Measurement systems
 - Process capability

Essential Tools for Business Improvement

- **Analyze**
 - Data analysis
 - Hypothesis testing
 - Lean concepts and tools
 - Quality function deployment
 - Fault tolerant design
 - Failure mode and effects analysis
 - Design for X
- **Improve**
 - Non-value added elimination
 - Kaizen
 - Design of Experiments
 - Taguchi methods

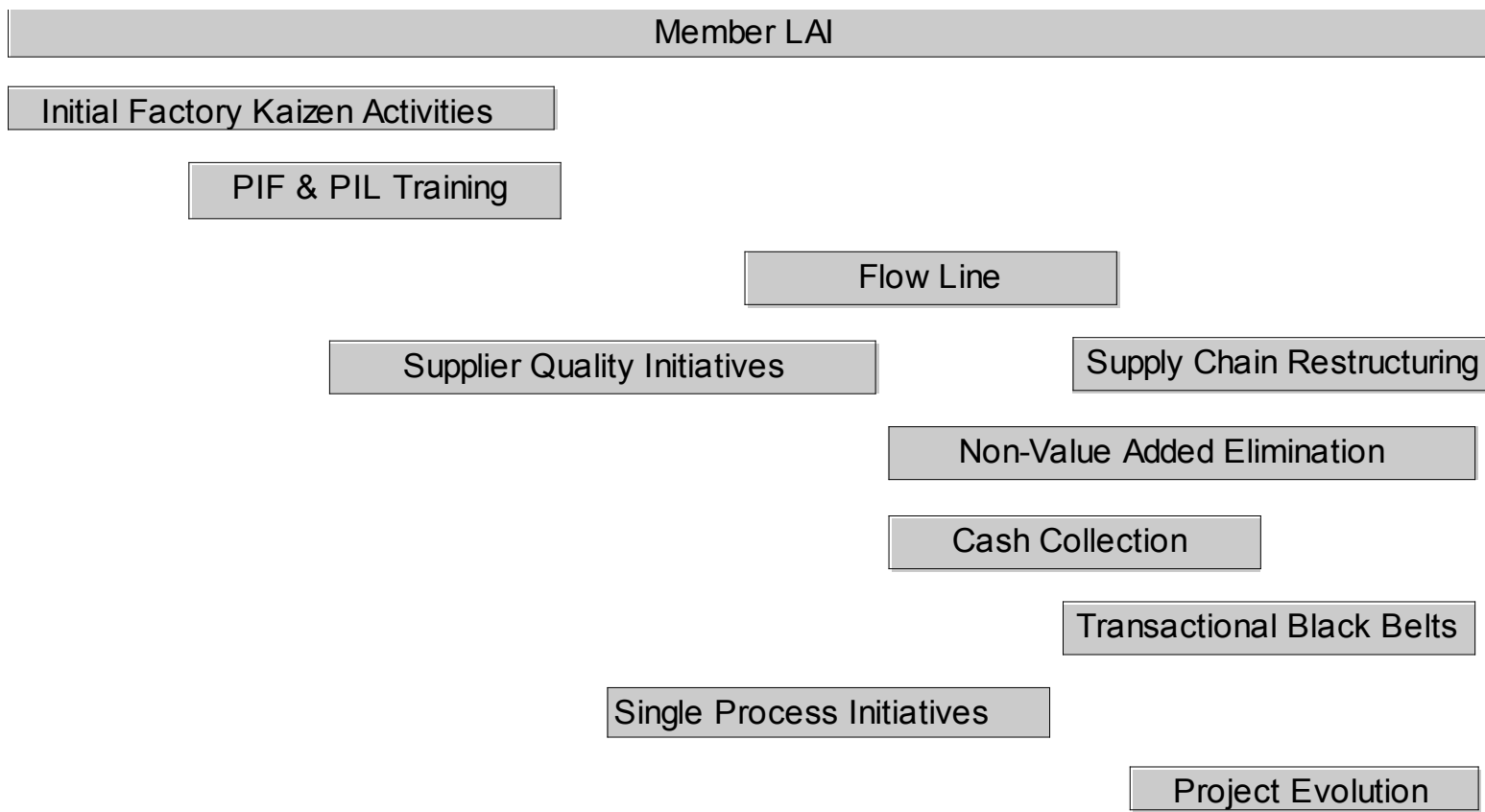
Essential Tools for Business Improvement

- **Control**
 - **Statistical process control**
 - **Poka-yoke**
 - **5S**
 - **Visual factory**
 - **Andon**
 - **Kanban**
 - **Muda**
 - **Total productive maintenance**

Rolls-Royce Metrics Focus on Stakeholder Issues

- **On-time delivery**
- **Delivered product quality**
- **First pass test yields**
- **Past due receivables**
- **Return on Invested Capital**

Lean Initiatives at Rolls-Royce



First Year Actions

- Mobilized leadership team
- Agreed on vision
- Set priorities
- Established metrics
- Reassigned key leaders
- Streamlined process flows
- Focused on attributes data
- Invested to remove bottlenecks

First Year Results

- **Significantly improved on-time delivery**
- **Step improvement in delivered product quality**
- **Increased 1st pass test yields by 4%**
- **Reduced cost of nonconformance by 3%**
- **Eliminated 500 obsolete machine tools**
- **Halved overage government contracts**
- **Eliminated 25% of chart of accounts**
- **Contributed significant profit and cash to Rolls-Royce plc**
- **Earned significant incentive compensation for all employees**

Second Year Actions

- **Reaffirmed prior year priorities**
- **Initiated cash collection team**
- **Began assembly flow line**
- **Hired third party parts supplier**
- **Began training workforce in lean, continuous improvement**
- **Increased working with suppliers**

Second Year Results

- **On-time delivery approached acceptable levels**
- **A second stepwise improvement in delivered product quality**
- **Reduced cost of non-conformance by 10%**
- **Eliminated overage government contracts**
- **Reduced delinquent receivables by 50%**
- **Initiated formal customer satisfaction measurement across business**
- **Delivered record profit and cash to Rolls-Royce plc**
- **Earned incentive compensation for all employees**

Third Year Actions

- **Fine tuned priorities**
- **Multi-skill training for 50% of shop floor employees**
- **Completed assembly flow line**
- **Razed 800,000 sq ft of obsolete facilities**
- **Began third party logistics efforts**
- **Trained transactional (office) black belts**

Third Year Results

- **Significant volume reduction post 9/11**
- **On-time delivery and delivered product quality stalled**
- **Cost of non-quality reduced by 18%**
- **Customer satisfaction index improved by 2%**
- **Halved engine assembly cycle time**
- **Achieved world class cash collection results**
- **Delivered significant profit and cash to Rolls- Royce plc**
- **Earned significant incentive compensation for all employees**

Fourth Year Actions

- **Increased emphasis on quality**
- **Completed shop floor multi-skill training**
- **Began third party logistics implementation**
- **Completed majority of factory renovation**
- **Changed COO but not vision**

Fourth Year Results

- **On-time deliveries improved**
- **Delivered product quality and cost of non-quality static**
- **Customer satisfaction improved**
- **Profit and cash generation ahead of targets**
- **Earned significant incentive compensation for all employees**

Fifth Year Actions

- **Negotiated breakthrough contract with UAW**
 - **But this distracted leadership from many components of enterprise business improvement**
- **Leadership team changes – planned and unplanned**
 - **Loss of momentum in key areas of Operations, Manufacturing and Quality**

Fifth Year Results

- **Implemented new labor contract which increases competitiveness within aerospace industry**
- **Sustained improvements in business metrics and customer satisfaction with new leadership team**
- **Awarded multi-billion F-136 engine contract for Joint Strike Fighter**
- **Earned incentive compensation for all employees**

Other Beneficial Results

- **Active Charge Numbers from 22,930 to 6,593**
- **Monthly Aircraft on Ground Claims from 701 to 153**
- **Open Material Review Board Folders from 390 to 195**
- **Monthly Financial Report Pages from 630 to 120**
- **SAP Exception Messages from 18,000 to <6,000**
- **Part Numbers in SAP from 42,087 to 25,390**
- **Cost centers from 544 to 442**
- **Eliminated over 500 procedures by adopting Rolls-Royce Quality Management System**
- **Reduced accounts payable transactions from 80,000 to 50,000 per year**

More Beneficial Results – A 5-year Journey

- **Inputs**
 - Annual employee training increased 10%
 - Transitioned to a multi-skilled hourly workforce
 - Modernized over 50% of facility
 - Employees empowered to earn significant incentive compensation
- **Outputs**
 - Cycle times reduced by >2/3
 - Inventory turns improved 40%
 - Cost of non-quality halved
 - On-time deliveries reach benchmark levels
 - Customer satisfaction improved 50%

Benefits to Rolls-Royce

- **Eliminated chronic customer dissatisfaction**
- **Reversed pattern of mediocre financial performance and generated record cash and profit**
- **Secured future lines of business**
- **Contributed several “best practices” which have been deployed world-wide**

Barriers to Change

- **Underground resistance**
- **Skepticism**
- **“Just another initiative”**
- **“It will pass”**
- **Upsets the status quo**
- **Takes people out of their comfort zone**

Breaking Down the Barriers

- **Define the “burning platform”**
- **Work to obtain buy-in from key stakeholders**
- **Communicate, communicate, communicate**
- **Dispatch the resistance**
- **Reward results**

Observations

- **Improvement is a journey – not a destination**
- **Business conditions will change along the way**
- **Constancy of leadership intent is key**
- **The better you get – the more there is to do**