Before we begin:

- Turn on the sound on your computer. There is audio to accompany this presentation.
- Audio will accompany most of the online presentation materials throughout the semester.

TECH 50800/58100
QUALITY and PRODUCTIVITY in
INDUSTRY and TECHNOLOGY

Week 1
Introduction to Lean Philosophies and
Creating a Quality Culture

SIX SIGMA and LEAN OVERVIEW
LEAN vs. SIX SIGMA

- Lean is a management philosophy derived mostly from the Toyota Production System. Lean essentially became a concept only in the 1990s is centered on preserving value with less work.
- Six Sigma is a business management strategy, originally developed by Motorola, USA in 1981 that is widely used in many sectors of industry. Six Sigma seeks to improve the quality of process outputs by identifying and removing the causes of defects (errors) and minimizing variability.

LEAN SIX SIGMA

- Lean Six Sigma is a synergized managerial concept of Lean and Six Sigma that results in the elimination of waste/muda and a rate of 3.4 defects per million opportunities.
- Lean Six Sigma (LSS) concepts were first published in the book titled "Lean Six Sigma: Combining Six Sigma with Lean Speed" authored by Michael George in the year 2002.

LEAN or SIX SIGMA

<table>
<thead>
<tr>
<th>Known Cause</th>
<th>Simple Solution</th>
<th>Complex Solution</th>
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<tbody>
<tr>
<td>False</td>
<td>Lean/Kaizen Just-do-it</td>
<td>Lean 6-σ Green Belt</td>
</tr>
<tr>
<td>True</td>
<td>Systems Engineering</td>
<td>Lean 6-σ Black Belt</td>
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SIX SIGMA OVERVIEW

• Six Sigma is a business management strategy originally developed by Motorola, USA in 1981.
• Six Sigma seeks to improve the quality of process outputs by identifying and removing the causes of defects (errors) and minimizing variability.
• It uses a set of quality management methods, including statistical methods, and creates a special infrastructure of people within the organization (Black Belts, Green Belts, etc.) who are experts in these methods.

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The term six sigma originated from terminology associated with manufacturing. Specifically, the success of a manufacturing process can be described by a sigma rating indicating the percentage of defect-free products created. A six-sigma process is one in which 99.99966% of the products manufactured or services provided are free of defects or errors. Motorola set a goal of "six sigma" for all of its manufacturing operations and this goal became a byword for the management and engineering practices used to achieve it.

Six Sigma Certification

Six Sigma Levels:
1. White Belt
2. Yellow Belt
3. Green Belt
4. Black Belt
5. Master Black Belt

ASQ – American Society for Quality
http://www.asq.org

Green Belt

Required Experience: The Six Sigma Green Belt requires three years of work experience in one or more areas of the Six Sigma Green Belt Body of Knowledge.

Examination: Each candidate is required to pass a written examination that consists of multiple choice questions that measure comprehension of the Body of Knowledge. The Six Sigma Green Belt Certification is a four-hour, 100 multiple-choice question examination. It is offered in the English language only.

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Green Belt

Minimum Expectations:
- Operates in support of or under the supervision of a Six Sigma Black Belt
- Analyzes and solves quality problems
- Involved in quality improvement projects
- Participated in a project, but has not led a project
- Has at least three years of work experience
- Has ability to demonstrate their knowledge of Six Sigma tools and processes

Black Belt

Required Experience: Six Sigma Black Belt requires two completed projects with signed affidavits or one completed project with signed affidavit and three years of work experience in one or more areas of the Six Sigma Body of Knowledge.

Examination: Each certification candidate is required to pass a written examination that consists of multiple-choice questions that measure comprehension of the Body of Knowledge. The Six Sigma Black Belt Certification is a four-hour, 150 multiple-choice question examination. It is offered in English.

BLACK Belt

Minimum Expectations:
- Will be able to explain six sigma philosophies and principles, including related systems and tools (lean, quality, process/continuous improvement, etc.), and will be able to describe their impact on various business processes throughout the organization.
- Will understand the various leadership and six sigma roles and responsibilities. Will recognize organization roadblocks and be able to use change management techniques to manage organizational change.
Minimum Expectations (continued):

- Will be able to define benchmarking and will understand various financial and other business performance measures. Will be able to identify customer requirements and describe the impact that Six Sigma projects can have on various types of customers.
- Will have a fundamental understanding of the components and techniques used in managing teams, including time management, planning and decision-making tools, team formation, and performance evaluation and reward. Will know how to use appropriate techniques to overcome various group dynamics challenges.

Minimum Expectations (continued):

- Will understand the elements of a project charter (problem statement, scope, goals, etc.) and be able to use various tools to track the project progress.
- Will be able to use customer feedback to determine customer requirements.
- Will have a basic understanding of data collection techniques, process elements, and process analysis tools.
- Will have a basic understanding of measurement systems.

Minimum Expectations (continued):

- Will have a basic understanding of probability concepts and distributions.
- Will be able to perform statistical and process capability calculations.
- Will be able to analyze the results of correlation and regression analyses. Will be able to interpret multi-vari study results and interpret attributes data to find sources of variation.
- Will be able to define multivariate tools.

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Minimum Expectations (continued):

- Will be able to perform hypothesis testing and analyze their results.
- Will understand the elements and purpose of FMEA and be able to use root cause analysis tools.
- Will be able to identify and interpret the 7 classic wastes.
- Will be able to use gap analysis tools.
- Will be able to plan design of experiments (DOE) and be able to analyze their results.

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Minimum Expectations (continued):

- Will be able to use various tools to eliminate waste and reduce cycle-time.
- Will be able to define kaizen, kaizen blitz, and theory of constraints.
- Will have a fundamental understanding of how to implement an improved process and how to analyze and interpret risk studies.
- Will be able to implement statistical process control (SPC).

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Minimum Expectations (continued):

- Will understand total productive maintenance (TPM) and visual factory concepts.
- Will be able to develop control plans and use various tools to maintain and sustain improvements.
- Will understand common DFSS and DFX methodologies, robust design and processes, and techniques for strategic and tactical design.
LEAN OVERVIEW

- The Toyota Production System or Lean Production was developed in the early 1950's in Toyota Motor Corporation.
- Japan was recovering from WWII
- Taiichi Ohno was Toyota's chief of production and tasked with growing the company in the tough economic environment
- Lean includes several fundamental improvement tools that can be applied to a process

TOYOTA PRODUCTION SYSTEM

Key Lean Concepts developed at Toyota

- Single Piece Flow
- Pull Production
- TAKT Time

- Level Loading
- Sequencing
- Stability

- Digitalization
- Built-In Quality
- Stop at Abnormalities
LEAN THINKING

A principle driven, tool based philosophy that focuses on eliminating waste so that all activities/steps add value from the customer’s perspective.

Lean Thinking is all about continuous waste elimination.

LEAN THINKING

A strategy, philosophy, process and leadership approach for operating in a superior way. Results include:

- Reduced cycle times (development and implementation)
- Increased quality
- Reduced costs and inventory
- Increased capacity potential
- Improved customer service
- High levels of personnel involvement, ownership and commitment
- Improved financials

LEAN CERTIFICATION

Lean Bronze:

Required Experience: Submit a portfolio within the three years from completing the exam documenting:

- Completion of 80 hours minimum of education / training requirements.
- Five (5) tactical projects: events, projects and/or activities to which specific lean principles and tools were applied*
- Portfolio reflection: results of the events, projects and/or activities.

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http://sme.org
Lean Bronze:

Examination: Each candidate is required to pass an open book written examination that consists of 170 multiple choice questions. Questions will be one of three types with the majority being knowledge questions:
- Knowledge: Fact-based
- Application: You have to apply lean
- Judgment: You have to use your judgment

Lean Silver:

Required Experience: Complete Lean Bronze certification. Provide documentation that you have led a lean transformation of a complete value stream and show that you have led or participated in 5 lean events, projects or activities that applied and integrated lean principles, along with their results.

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Lean Silver:

Required Experience: Documentation includes:
- Completion of 160 hours (80 hours from Bronze + 80 additional hours) minimum education / training.
- Three tactical projects and two Integrative (Value Stream) projects: events, projects and/or activities to which specific lean principles and tools were applied
- Mentoring/Coaching
- Integrative Portfolio reflection: results of the events, projects and/or activities.

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Lean Silver:
Examination: Each candidate is required to pass an open book written examination that consists of 150 multiple choice questions. Three hour time limit.

Lean Gold:
Required Experience: Complete Lean Silver certification. Documentation includes:
- Completion of 200 hours (160 hours from Silver + 40 additional hours) minimum education / training.
- (1) tactical project, (2) Integrative (Value Stream) projects and (2) Strategic (Enterprise) projects, events, projects and/or activities.
- Mentoring/Coaching
- Integrative Portfolio reflection: results of the events, projects and/or activities.

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LEAN CERTIFICATION

Lean Knowledge Expectations:
- Mistake proofing (poka-yoke)
- Plan-Do-Study-Act cycle (PDSA)
- Problem solving (5 whys)
- Pull systems (kanban)
- Quality methods
- Quick changeover, setup reduction
- Root cause, corrective action
- Standard work
- Total productive maintenance
- Autonomation (jidoka) (continued on next slide)

LEAN CERTIFICATION

Lean Knowledge Expectations: (continued)
- Cells, one-piece flow
- Continuous improvement (kaizen)
- Cost, productivity results
- Customer demand pace (takt time)
- Customer requirements, satisfaction
- Distribution, logistics, delivery
- Identifying value added / non-value added work / waste
- Load leveling (heijunka)
- Value stream mapping

LEAN SIX SIGMA (LSS)
DEFINE PHASE OVERVIEW
The organization as a System:

Suppliers ---------> Processes ---------> Customers

Are service processes more or less complex than manufacturing processes? Why or Why Not?

LEAN SIX SIGMA BASICS

LSS Process:
- Define
- Measure
- Analyze
- Improve
- Control

LEAN SIX SIGMA BASICS
DEMING CYCLE vs. DMAIC

Relationships between DMAIC and PDCA

LEAN SIX SIGMA ORGANIZATIONAL STRUCTURE

L6a Roles & Responsibilities

LSS ORGANIZATIONAL STRUCTURE
**LSS ORGANIZATIONAL STRUCTURE**

- **Board/Executive Team**
- **Management/Champion Teams**
- **LSS Teams**

**Regional Program Director**
- **Responsibilities:**
  - Oversight of regional L6σ Program
  - Regional Training Coordination
  - Leads Executive LSS Steering Team
  - Insures program deadlines are met
- **Time Commitment:** 4 hours/week for each on-going project
- **Training Requirements:** completion of LSS Black Belt training program

**ROLES and RESPONSIBILITIES**

**Project Champion**
- **Responsibilities:**
  - Establishes clear & measurable goals for the project
  - Drafts initial project charter for approval by the Executive Steering Team
  - Provides resources and removes roadblocks
  - Responsible for project oversight and advocacy
  - Insures project deadlines are met
  - Conducts periodic reviews with Black Belts
  - Conducts Tollgate Reviews with Project Team
- **Time Commitment:** Champions devote approximately 4 hours/week for project duration
- **Training Requirements:** 24 hours of Champion Training
ROLES and RESPONSIBILITIES

Six Sigma Black Belt
- Responsibilities:
  - Project managers / team leaders
  - Drives team through implementation
  - Trains and mentors Green Belts and Yellow Belts
  - Time Commitment: 10 hours/week for each ongoing project
  - Certification requirements:
    - 200 hours of training
    - Leadership of two L6σ projects
    - Passing score on certification exam

ROLES and RESPONSIBILITIES

Lean Six Sigma Project Team
- Ideal team size 8-12 people
- Recommended Team Composition:
  - Six Sigma Black Belt
  - Process Owner – Department Manager/Supervisor
  - Six Sigma Green and Yellow Belts
  - Process Subject Matter Experts (SMEs)
  - Front Line Staff

NOTE: Project Team remains together through implementation and until successful handoff to process owner

ROLES and RESPONSIBILITIES

Six Sigma Process Owner
- Responsibilities:
  - LSS Project or Champion Team Member
  - Owns project implementation
  - Responsible for long term process control following implementation
  - Time Commitment: 10 hours/week for project duration
  - Training Requirements: Completion and/or participation in Lean Six Sigma Green Belt Training
ROLES and RESPONSIBILITIES
Lean Six Sigma Green Belt/Yellow Belt

- **Responsibilities:**
  - Ideally Subject Matter Experts (SME) in the project area
  - Collects data and performs basic analyses
  - Time commitment: 10 hours/week for project duration

- **Certification requirements:**
  - Green Belt: 80 hours of training
  - Yellow Belt: 40 hours of training
  - Participation in one L6σ project
  - Passing Score on certification exam

LSS INFRASTRUCTURE

Why do we emphasize roles and responsibilities?

- Organizational **Infrastructure** needed!
- Infrastructure is the KEY enabler to sustainability of systems improvement initiatives:
  - Infrastructure = Accountability
- Transition from ‘Improvement Projects’ to ‘Improvement Program’ to ‘Improvement Culture’
- Attempts to diffuse LSS without the appropriate infrastructure will lead to program **FAILURE** becomes “flavor of the month”...

LEAN SIX SIGMA CHALLENGE
THE CHALLENGE...

To improve profitability:
Lower costs below the Pricing level

What causes variability in costs?

Product or Service Costs

Profitability Region

Loss Region

THE CHALLENGE...

To improve profitability:
Lower costs below the Pricing level

Profitability Region Increases

Loss Region Decreases

Product or Service Costs

THE CHALLENGE...

- However, it’s not that simple...
- A standard level of quality is required to:
  - Meet customer specifications
  - Insure product reliability
  - Reduce risk of liability
  - Maintain highest levels of Customer Satisfaction
THE CHALLENGE…

After costs have been lowered as far as possible without negatively affecting quality:

- The Cost of the minimum level of quality must be reduced.
- Variation in Costs Must Be Addressed.

THE CHALLENGE…

The Result:

- Meeting and exceeding minimum quality
- Increased profitability
THE DESIGN, ANALYSIS AND CONTROL OF COMPLEX SYSTEMS...

...ensuring that the Process does not violate the Customer requirements.

WHAT IS LEAN SIX SIGMA?

LEAN PROCESS DESIGN...

IDENTIFYING AND ELIMINATING WASTE WITHIN A BUSINESS PROCESS FLOW

CONSTRAINT MANAGEMENT

CREATING MORE EFFICIENT PROCESSES BY IDENTIFYING AND MANAGING CONSTRAINTS.
REDUCING SOURCES of VARIATION ... 

Every step in the process flow contributes to the:
- Outcome
- Customer Satisfaction
- Cost

Var(Process) = Var(Step 1) + Var(Step 2) + Var(Step 3) + ...

Var(Process Step) = Var(Methods) + Var(Materials) + Var(Environment) + Var(People) + Var(Equipment) + Var(Information)

Every employee must be active in reducing variation.

CHAMPION

Identify Opportunities
- Select Project
- Select Project Team
- Create Preliminary Project Charter
- Tollgate Reviews

DEFINE

Review Project Charter
- Determine Voice of the Customer (VoC)
- Identify Key Process Output Variables (KPOVs)
- Define Tollgate Review
What is a Tollgate (Milestone) review?

- Periodic review of project results with the Champion team.
- Review after each phase of DMAIC process.
- Opportunity for buy-in for project progress/results.

### TOLLGATE REVIEWS

#### MEASURE

**Flow Chart Process**

1. Collect baseline KPOV data
2. Identify possible Key Process Input Variables (KPIVs)
3. Measure Tollgate Review

#### ANALYZE

**Collect KPIV data**

1. Determine relationships Between KPIVs and KPOVs
2. Identify THE Key Process Input Variables (KPIVs)
3. Analyze Tollgate Review
IMPROVE

- Develop Solutions
- Test Solutions - Pilot
- Pre-Pilot Improve Tollgate Review
- Development Final Implementation Strategy
- Post-Pilot Improve Tollgate Review

CONTROL

- Develop Control Plan
- Monitor Long Term Improvement
- Apply Best Known Method
- Control Tollgate Review

LEAN SIX SIGMA PROCESS...
Additional Reading:
- None
Assignment:
- None
Due Date:
- None