Manufacturing Process & Quality Control

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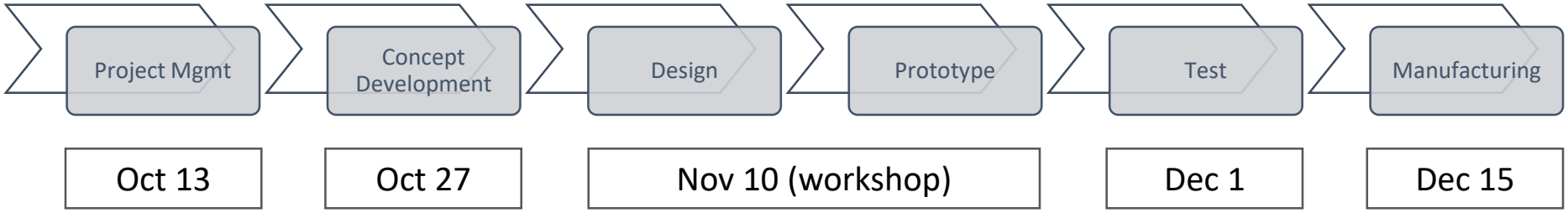
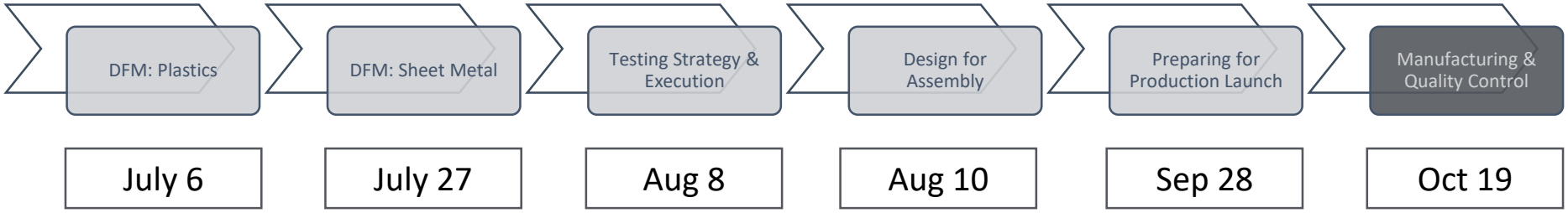
mHUB Programming: Product Development

- 2017 Introductory Classes:



- 2018 Advanced/Deeper Dive Classes:



Manufacturing & Quality Control

Today's Agenda

- What is Quality and how do we manage it?
  - Defining Quality
  - Quality Management
  - Various Quality Methodologies
  - Deeper Dive in to Six Sigma
- Chat with an expert!
  - Nathan Jones – Master Black Belt in Six Sigma at Ford

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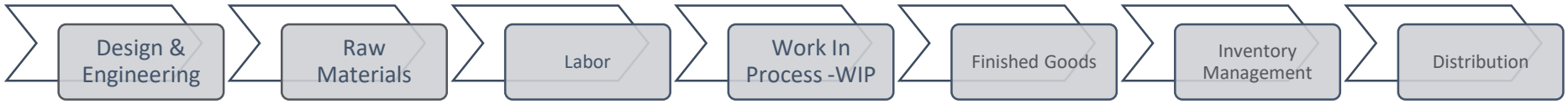
- Defining Quality
  - “How well does every product you deliver to the customer perform as advertised?”
- Defining your Product:



- Quality = Process
- The Key is Consistency

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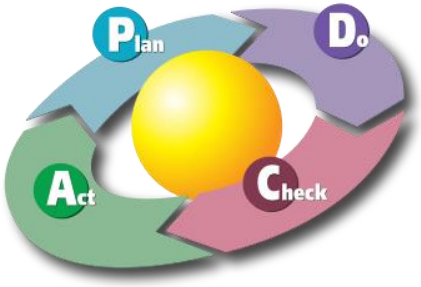
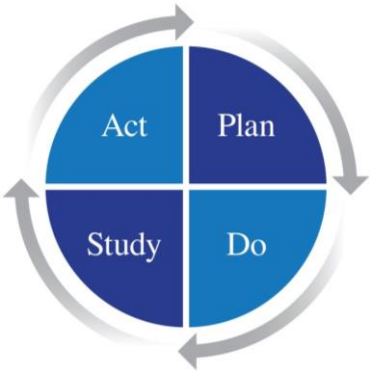
- Managing Quality
  - It is a continuous cycle of activity
    - Depends on measuring and analyzing various factors of your production process
    - Known as Statistical Process Control (SPC)
  - 4 Main Aspects
    - **Quality Planning** – Making all attempts to meet or exceed the customers expectations
    - **Quality Assurance** – Preventing mistakes during manufacturing and avoiding problems during delivery.
    - **Quality Control** – Measuring whether or not the quality level has been met.
    - **Quality Improvement** – Solving the problems that arise, and minimizing future occurrences.



The Shewhart Cycle
named after Walter Shewhart, considered to be "The Father of SPC"



The Deming Cycle
named after W. Edwards Deming, considered to be "The Father of Quality"

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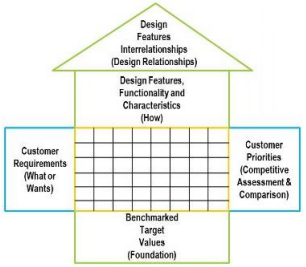
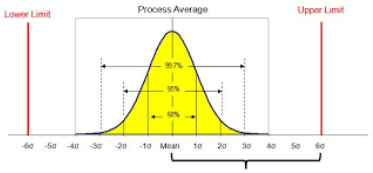
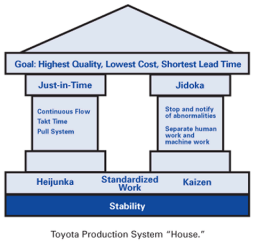
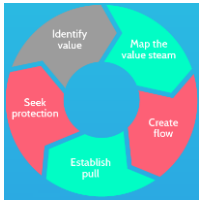
- There are dozens of Quality Management Methodologies!
  - International Standards Organization (ISO)
  - QFD – Quality Function Deployment
  - Kaizen – Japanese “Continuous Improvement”
  - Zero Defect Program – used in NASA, military, aerospace
  - Six Sigma (6s) – Framework for Process Improvement
  - Taguchi Method
  - The Toyota Production System
  - TQM – Total Quality management
  - TRIZ – Theory of Inventive Problem Solving
  - Lean Manufacturing

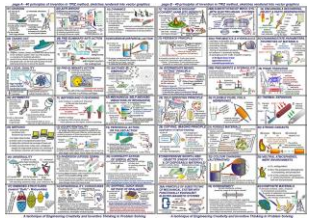






Toyota Production System “House.”





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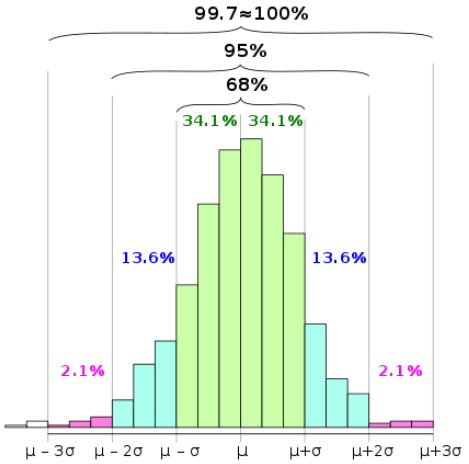
- Six Sigma (6σ)
  - Framework for Process Improvement
  - Developed by Motorola in 1986
  - Relies heavily on statistical analysis
  - Sigma = “Standard Deviation” of a histogram = Measurement of the variability



Histogram showing 3 sigma

Range	Expected fraction of population inside range	Approximate expected frequency outside range	Approximate frequency for daily event
μ ± 0.5σ	0.382 924 922 548 026	2 in 3	Four or five times a week
μ ± σ	0.682 689 492 137 086	1 in 3	Twice a week
μ ± 1.5σ	0.866 385 597 462 284	1 in 7	Weekly
μ ± 2σ	0.954 499 736 103 642	1 in 22	Every three weeks
μ ± 2.5σ	0.987 580 669 348 448	1 in 81	Quarterly
μ ± 3σ	0.997 300 203 936 740	1 in 370	Yearly
μ ± 3.5σ	0.999 534 741 841 929	1 in 2149	Every six years
μ ± 4σ	0.999 936 657 516 334	1 in 15 787	Every 43 years (twice in a lifetime)
μ ± 4.5σ	0.999 993 204 653 751	1 in 147 160	Every 403 years (once in the modern era)
μ ± 5σ	0.999 999 426 696 856	1 in 1 744 278	Every 4776 years (once in recorded history)
μ ± 5.5σ	0.999 999 962 020 875	1 in 26 330 254	Every 72 090 years (thrice in history of modern humankind)
μ ± 6σ	0.999 999 998 026 825	1 in 506 797 346	Every 1.38 million years (twice in history of humankind)
μ ± 6.5σ	0.999 999 999 919 680	1 in 12 450 197 393	Every 34 million years (twice since the extinction of dinosaurs)
μ ± 7σ	0.999 999 999 997 440	1 in 390 682 215 445	Every 1.07 billion years (four times in history of Earth)

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- Nathan Jones – Ford Motor Company
  - Master Black Belt in 6 Sigma
  - Chicago Assembly Plant (Explorer & Taurus)
- "It is important to connect the interests of everybody to your process improvement efforts"
  - Executives: Company Profitability
  - Assembly Workers: Job Stability
- Use the DMAIC framework to solve production quality issues (and save $$)
  - D – Define
  - M – Measure
  - A – Analyze
  - I – Improve
  - C – Control
- Advice for communicating to potential Contract Manufacturers: Ask "What is your Cpk"?
  - Cpk: Process Capability Index
  - Cpk = ½, means that your process has repeatable failures
  - Cpk = 1, means you have no room for error in your process
  - Cpk = 2, means you have a buffer, but this also means that your process may be overly cautious/slower/more expensive than needed
- Cpk = 1.33 (4 sigma) is a common goal for many customers

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Thank You!

1. Next Class is… next year!
2. Submit Topic requests to myself, Jenna, Cynthia
3. Please Remember: Sign-in Sheet & Class Survey
4. Additional Reading: