Six Sigma for Chemical Processes – Syllabus

Summer 2017

Instructor: Dr. George Liebermann, P. Eng.
E-mail: george.liebermann@gmail.com
Phone: 416-578-5087

Course Dates: Start: July 11 (Tuesday) to August 17 (Thursday), 2017

Course Time: Tuesdays and Thursdays: 6:15 PM - 9:15 PM

Course Location: Rosebrough Building, Room 208

Final Report due date: Friday, August 25, 2017

Course Description:

Six Sigma is a proven project execution methodology being employed across nearly every type of business and industry including numerous Chemical Process Industry companies.

This course will provide a working know-how of the *Six Sigma (DMAIC)* problem solving and process improvement protocol for *existing processes/products* and of *Design for Six Sigma* methodology for *development of new processes/products*, tailored for chemical products/ processes and chemical engineers. It focuses on *project execution* based on Six Sigma roadmaps, and selective use of work process and statistical tools from the Six Sigma "tool box". The course will include workshops, part of each class, in order best familiarize the students with the practical value of Six Sigma in manufacturing processes and R&D.

Course Learning Objectives:

At the end of the course, the student will be able to:

- have a solid command of Six Sigma methodologies
- use Six Sigma/DMAIC tools and processes for improvement, optimization or problem solving of *existing* chemical processes
- use Design for Six Sigma (DfSS) tools and processes for the development of *new* chemical products and processes
- apply Six Sigma methodology work process and statistical tools
- examine/analyze chemical procedures/processes in a structured approach and apply Six Sigma tools to various functions, operations of current processes or in the design of new processes
- use Six Sigma principles in day to day tasks

Class Format:

Twelve 3 hours classes will be held for a duration of six weeks. Each class will consist of a lecture (1.5 - 2 hours) and a workshop (1 - 1.5 hours). Each student (or a group of 2-3 students) will be asked to select a chemical or related process, or part of it, in which he/she is or has been involved with. As part of the workshops each student will apply 10 Six Sigma/DMAIC and 10 DfSS tools, to the project selected by themselves. The statistical tools will be Excel based and will be provided by the instructor, therefore each participant is **required to bring a laptop to class.**

A mid-term in-class test will be given following a review of the material covered up to that point. An overall review and workshop will be held at the end of the course.
The final report that will summarize the work performed by each participant throughout the course will be due one week after the last class.

Topics (per class/workshop)**:**

1. Introductions, logistics (including projects selection), Introduction to Six Sigma/DMAIC and Design for Six Sigma (DfSS)

2. Six Sigma/DMAIC - DEFINE Phase: implementing Six Sigma for improvement of current processes, project assessment; project definition (charter); project definition details: problem statement, expected impact, goal, scope, schedule, resources; special process maps: SIPOC, High level and Value Stream maps and their adaptation for chemical engineering diagrams; key inputs and outputs; cause and effect/ transfer function Y=f(x); voice of the customer (VOC) and voice of business (VOB), critical customer requirements; project planning.

3. Six Sigma/DMAIC - MEASURE Phase: Value Stream map and measurements; key input, process and output variables – what to measure; Ishikawa cause and effect diagram, measurement stratification tools; operational definitions/measurement procedures; validation of measurement system; Measurement System Analysis (MSA) tools; data collection plan; data organizing tools - control charts, Pareto charts; baseline capability analysis tools; project plan update.

4. Six Sigma/DMAIC - ANALYZE Phase: data analysis – measurement system confirmation, problem stratification, process variations assessment; hypotheses for root causes of the problem; data analysis basic tools – descriptive statistics, distribution of data, normality test, control charts details, regression analysis, hypothesis testing; process tools – brainstorming, non-value added analysis, risk/failure mode and effects analysis (FMEA); root cause experimental proof; project plan check.

5. Six Sigma/DMAIC – IMPROVE and CONTROL Phase: *Improve*: generation and development of potential solutions - brainstorming; evaluation criteria – quality, cost, delivery, safety; selection of best solutions – Pugh matrix; risk assessment – Improve phase specific FMEA; “to be” process mapping; pilot – solution demo, basic DOE; results assessment; implementation plan. *Control*: standard operating procedure (SOP), control plan – measurements, sampling, monitoring plans and tools, response plan – sustaining the improvements.

6. Six Sigma/DMAIC review and mid-term test.

7. Design for Six Sigma: Six Sigma in chemical engineering research and development; Design for Six Sigma (DfSS) for development of new processes compared to Six Sigma/DMAIC for existing processes, main DfSS roadmaps and common principles; Define/Measure/Explore/Develop/Implement (DMEDI) roadmap; DEFINE: comparison with Define in DMAIC, strategic planning tools.

8. Design for Six Sigma/DMEDI - MEASURE: voice of external and internal customer (VOC) vs. voice of business (VOB); Kano analysis for VOC; translation of VOC to critical customer requirements; Quality Function Deployment (QFD) methodology and House of Quality #1; operational definitions and MSAs; other tools: affinity diagrams, tree diagrams, Pareto charts, box plots; scorecards/specifications.

9. Design for Six Sigma/DMEDI - EXPLORE: generation of design concepts; selection of best concepts – pair-wise comparison and Pugh matrix tools; House of Quality #2 in QFD for determining target specifications; risk analysis for new concepts – adapted FMEA; SIPOC and 'to be" process map; design of experiments (DOE) - introduction, DOE types/options, screening DOEs; DfSS scorecards.

10. Design for Six Sigma/DMEDI – DEVELOP and IMPLEMENT: *Develop*: Design of Experiments for modeling and/or optimization; "mistake proofing" – redundancy design; non-value added analysis for new processes; capability analysis; final risk analysis, pilot – process optimization and debugging. *Implem*ent: House of Quality #3 in QFD for process control; standard operating procedure (SOP), tolerances/specification; process control plan; QC plan; optimized process demonstration – pilot or full scale.

11. Six Sigma/DMAIC and Design for Six Sigma/DMEDI review.

12. Final report discussion and initiation: report subject for class groups; tasks and tools to be used; use of DMAIC or DMEDI roadmap for project (report) planning/execution.

Assessment:

The following criteria will be used to determine the final grade for each of the groups preparing the report.

Participation/homework in/for the workshops (1-1.5 hr, each class)	20%
Mid-term quiz (open book/laptop)	20%
End of term quiz (open book/laptop)	20%
Final report (due August 25)	40%

Reference Materials:

While there are a large number of books on Six Sigma, the students will be given as references only information available free on the web. A list of recommended books and articles is available and will be provided if there is interest to acquire them. A selection of references is shown below:

1. iSix Sigma - http://www.isixsigma.com – “New to Six Sigma” tab or http://www.isixsigma.com/index.php?option=com_content&view=article&id=201&Itemid=27
2. www.pmi-uny.org/download/Six_Sigma_Intro_Jan_2005.ppt
3. Sigmazone - http://www.sigmazone.com/
4. BPI Consulting, http://www.spcforexcel.com/spc-for-excel-software - use of Excel for statistical tools
5. BPI Consulting, http://www.spcforexcel.com/msa-and-spc-for-excel - MSA example
6. FMEA Info Centre, http://www.fmeainfocentre.com - risk analysis
7. Lean Software Engineering, http://leansoftwareengineering.com/pugh-decision-matrix