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AARHUS UNIVERSITY

BUSINESS & SOCIAL SCIENCES

**BUSINESS DEVELOPMENT & TECHNOLOGY and
INTERDISCIPLINARY CENTER FOR ORGANIZATIONAL ARCHITECTURE**

TITLE: SIX SIGMA DESIGN & INNOVATION 10 ECTS

AIM OF THE COURSE: *Six Sigma Design (DFSS) & Innovation (DMAIC)* methods provide complementary approaches. When strategically linked these yield customer-driven, highly resource efficient processes and products with almost perfect performance. Integrated DFSS, Innovation, and Lean approaches provide a highly structured strategy for acquiring, assessing, and activating customer, competitor, and enterprise intelligence that lead to superior product, system or enterprise innovations and designs that provide the organization with a sustainable competitive advantage. Useful background for this course includes exposure to introductory statistical methods and quality management principles. Relevant software will be provided.

MAIN ISSUES: Six Sigma integrates strategies and tools from Statistics, Quality, Business, and Engineering and has added billions of Euros to the bottom line of organizations across the financial, healthcare, military, manufacturing, and other economic sectors. Its focus divides into two significant branches that share a number of tools, techniques and objectives, but often apply the tools and techniques differently. The *Innovation* branch focuses on significant innovation / redesign in or of existing products, processes, and systems while the second branch, referred to as *Design for Six Sigma*, is directed at design of new products, processes or systems.

Six Sigma has developed largely in parallel with and complementary to Lean Enterprise Theory & Methods with a result often referred to as “*Lean Six Sigma*” wherein radical innovation in and / or design of products, processes and systems is approached through a “lean lens” that is intended to be highly resource sensitive. This course emphasizes both *Innovation* and *Design for Six Sigma* with a “lean and green” mindset and utilizes a team-based project focus.

- Innovation, Design and Lean Practices
- Six Sigma for Innovation & Design: Introduction to DMAIC & DMADV Approaches
- Elements of Project Management
- Change Management & Readiness: Motivations, Methods and Assessment
- Creativity Tools for Innovation & Design
- TRIZ: Theory of Inventive Problem Solving for Design Innovation
- Organization & Prioritization of Ideas: Affinity Diagrams, Interrelationship Digraphs, Matrix Diagrams, and Nominal Group Technique
- Competitor Intelligence: Benchmarking
- Innovation & Design: Concept Generation, Evaluation & Selection
- QFD: Quality Function Deployment for Innovation & Design
- Statistical Design Principles
- Failure Modes & Effects Analysis

TEACHING METHODOLOGY: Course material will mainly be presented as lectures that will be applied by course participants working in small groups. Groups will retain the same members throughout the course and will periodically present their work and ideas during the course.

PREREQUISITES: As Six Sigma approaches are applied in a team environment and integrate knowledge and strategies from quality management, engineering, business, and statistics it is helpful but not entirely necessary to understand basic vocabulary from each of these areas and, also, to have experience working in teams. All students should have had an introductory statistics course, should have a strong process-orientation, and should generally be customer-focused.

LEARNING OUTCOMES: Upon successful completion of the course participants will understand and will have applied Six Sigma's DMADV approach, or its DMAIC approach, or a hybrid of these two to a meaningful project. Student knowledge will well approximate that described in the Black Belt Body of Knowledge as provided by the American Society for Quality and will appreciate the synergy between Six Sigma and Lean approaches. Among the skills and tools those successfully completing the course will become familiar with are TRIZ; idea generation, organization, prioritization, and deployment; quality function deployment; creativity tools; lean enterprise methods; benchmarking; and failure modes and effects analysis.

EXAM: A three-hour written exam will count for 60% of the course grade. The remaining 40% of the course grade is be associated with the project completed during the course, which consists of a written report, formal presentation, and periodic formal updates. Project reports must be in a format to be specified and of length between 7,500 and 10,000 words with approximately equal contributions from each team member being expected.

GRADING:

GRADE 12:

The student demonstrates that she/he has outstanding theoretical insight into and understanding of the Six Sigma Innovation and Design DMAIC and DMADV approaches, is able to adeptly apply these, and is able to create and apply hybrid approaches by integration of these. Students earning this grade must demonstrate superior command of the varied tools and methodologies presented in the course and should be able to appropriately integrate their use across a comprehensive project, and as part of a product or process innovation-or-design-oriented examination. Similarly, command may in some cases be demonstrated by specific conscious, documented, and rationally argued choices not to use or misuse specific approaches. In general, the student documents an extraordinary general and specific competence to identify, analyze and provide proposals for solution to the problems covered in both the project and the written exam.

GRADE 02:

The student demonstrates overview and knowledge about the issues, theories and models covered in the course at a minimum acceptable level. The demonstration of the knowledge is not convincing, the knowledge is partial and the argumentation for the relevance is imprecise. The student documents some ability to identify, analyze and provide solutions to the problems covered in the written exam and in the project, but a considerable level of uncertainty and lack of precision characterizes the total performance.

APPROXIMATE COURSE SCHEDULE

Date	M / R	Topic
PRE-COURSE		
Prior to Course	PP: PR1, PR2, PR3 Reading: A0	Statistical Review: Descriptive Statistics / Probability / Hypothesis Testing & Confidence Intervals
COURSE		
16 July 2015 Thursday	PP: 1 Reading: A7	Six Sigma Overview & Summary: DMAIC/ Customer Needs / Team Charter / Project Scoping
17 July 2015 Friday	Reading: B1-B3	Six Sigma Overview & Summary: DMAIC/ Process Mapping / Project Management / FMEA / MSA
18-19 July 2015 WEEKEND	PP: WE 1A, 1B, 1C, 1D Reading: A1-A4, B4-B5	Toyota Production System / Value Stream Mapping / Lean / Statistics Review: Chi-Square & Regression
20 July 2015 Monday	Reading: A5	Six Sigma Overview & Summary: DMAIC/ Analyze / Improve / Control Phases.
21 July 2015 Tuesday	PP: 2, 2A, 2B, 2C Reading: B6	Ideation / Management & Planning Tools
22 July 2015 Wednesday	PP: 2, 2A, 2B, 2C Reading: B6	Ideation / Management & Planning Tools: Team Workshop.
23 July 2015 Thursday	PP: 3 Reading: A6, B7	Concept Generation and Selection / Quality Function Deployment
24 July 2015 Friday	PP: 3 Reading: A6, B7	Concept Generation & Selection – QFD: Team Workshop
25-26 July 2015 WEEKEND	PP: WE 2A, 2B, 2C PURPOSE: Enrichment	Change Management / Theory of Inventive Problem Solving / Reliability & Safety Analysis
27 July 2015 Monday	PP: 4 Reading: A8, A9	Benchmarking
28 July 2015 Tuesday	PP: 5 Reading: A10, A11, B8	Statistical Process Control
29 July 2015 Wednesday	PP: 5 Reading: A12, B9	Statistical Process Control
30 July 2015 Thursday	PP: 6 Reading: A13, B10-B12	Design of Experiments (DOE) Principles
31 July 2015 Friday	PP: 6 Reading: A14, B13-15	Design of Experiments (DOE) Principles
2-3 August 2015 WEEKEND	PP: WE 3A, 3B, 3C Reading: B32-B35	Statistical Process Control (Examples) / DOE – Screening Designs / CCD and Second Order Designs
3 August 2015	Monday	Project Presentations
4 August 2015	Tuesday	Project Presentations
5 August 2015	Wednesday	Project Presentations
KEY		
	M / R: Materials / Readings	READINGS:
	PP: PowerPoint	A: Articles A0 through A14 are primary reading
	WE: Weekend (Saturday/Sunday)	B: Briefs B1 through B15 are brief topical chapters that may be of value to you– supplemental / support reading.
	PR: Pre-Reading & Presentations	

LITERATURE LIST BEGINS ON FOLLOWING PAGE

LIST OF LITERATURE: ALL ARE OR WILL BE AVAILABLE FOR DOWNLOAD AT PROVIDED URLs, OR AT THE COURSE WEBSITE

ARTICLES:

FOUNDATION ARTICLE – EXPECTED READING

(A0) The Scientific Context of Quality Improvement. University of Wisconsin CQPI Report 25 (1987)
George E.P. Box and Søren Bisgaard (Abbreviated Version appeared in *Quality Progress* in 1988).

LEAN REFERENCES – SUPPORT ONLY – NOT REQUIRED

(A1) Shingo - Toyota Production System Basic Handbook
Art of Lean, Inc. www.artoflean.com

(A2) Shingo Model Handbook

(A3) Shingo Prize Applications Guidelines

PERFORMANCE, CUSTOMER FOCUS and QFD – STRONGLY RECOMMENDED

(A4) Linking the Balanced Scorecard to Strategy
California Management Review, Vol. 39, No. 1, pp. 53-79
Robert S. Kaplan and David P. Norton (1996)

(A5) How to Make Product Development Projects more Successful by Integrating Kano's Model of Customer Satisfaction into Quality Function Deployment.
Technovation, Vol. 18, No. 1, pp. 25-38 (1998). Kurt Matzler and Hans H. Hinterhuber.

(A6) Customer-Driven Product Development through Quality Function Deployment in the US and Japan. Journal of Production Innovation Management, Vol. 17, pp. 286-308 (2000).
J.J. Cristiano, J.K. Liker and C.C. White, III

SIX SIGMA ARTICLES – EXPECTED READING

(A7) An Overview of Six Sigma
International Statistical Review, Vol. 76, No. 3, pp. 329-346. D.C. Montgomery & W.H. Woodall.

(A8) Six Sigma: Definition and Underlying Theory
Journal of Operations Management, Vol. 26, pp. 536-554.
Roger Schroeder, Kevin Linderman, Charles Liedtke, and Adrian Choo.

(A9) The Science in Six Sigma
Quality Progress, January 2007, Vol. 40, No. 1, pp. 25-27. J. de Mast and Søren Bisgaard.

(A10) An Analysis of the Six Sigma DMAIC Method from the Perspective of Problem Solving
International Journal of Production Economics, Vol. 139, No. 2, pp. 604-614. (2012)
Jeroen de Mast and J. Lokkerbol

(A11) An Explanation and Critique of Taguchi's Contributions to Quality Engineering.
George E.P. Box, Søren Bisgaard and Conrad Fung (March 1988).
University of Wisconsin Center for Quality and Productivity Improvement Report No. 28.

(A12) Quality Quandries: Design for Six Sigma: Method and Application
Quality Engineering, Vol. 23, No. 2, pp. 204-211 (2011). J. de Mast, G. Diepstraten & R. Does

(A13) Six Triumphs and Six Tragedies of Six Sigma
Quality Engineering, Vol. 22, No. 4, pp. 299-305. (2010) T.N. Goh

(A14) After Six Sigma – What's Next?
Quality Progress, January 2006, Vol. 39, No. 1, pp. 30-36. Jeroen de Mast and Søren Bisgaard

LITERATURE (Continued):

BRIEF READINGS – THESE ARE SUPPORT DOCUMENTS – NOT REQUIRED READING

READING	PDF FILES TO BE PROVIDED
B1	Measurement Systems Analysis (MSA)
B2	Process Capability & Performance (Capability Indices)
B3	Failure Modes & Effects Analysis (FMEA)
B4	Simple Regression & Correlation Analysis
B5	Multiple Regression & Correlation Analysis
B6	Management & Planning Tools (New Tools) / Statistical Tools (Old Tools of Quality)
B7	Fishbone (Cause-and-Effect) Diagrams and Quality Function Deployment (QFD)
B8	Sigma Level Estimation & Process Yield
B9	Statistical Process Control Charts (SPC Charts)
B10	Analysis of Variance (Anova)
B11	Design of Experiments (DOE) Overview
B12	2 ^K Experimental Designs
B13	Planning 2 ^K Experimental Designs
B14	2 ^{K-P} Fractional Factorial Designs
B15	Response Surface Methodology
B16	Design Resolution and Evolutionary Operations

FREE BOOK DOWNLOADS (Further Reading for the Curious):

(A) FREE BOOK:

The Six Sigma Handbook: Revised and Expanded – A Complete Guide for Green Belts, Black Belts, and Managers at All Levels. By Thomas Pyzdek. McGraw-Hill 2003. ISBN: 0-07-141596-3.

FREE DOWNLOAD AT: <http://www.gmpua.com/QM/Book/The%20six%20sigma%20handbook.pdf>

(B) FREE BOOK:

Lean Six Sigma Demystified: A Self-Teaching Guide

By Jay Arthur. McGraw-Hill, 2007. ISBN: 0-07-150265-8 FREE DOWNLOAD AT:

<http://ir.nmu.org.ua/bitstream/handle/123456789/117430/29c613ed2a2e503c8236b0cec5991f8f.pdf?sequence=1>

(C) FREE BOOK:

Design for Six Sigma: A Roadmap for Product Development.

By Kai Yang & Basem El-Haik. McGraw-Hill, 2003. ISBN: 0-07-143599-9. FREE DOWNLOAD AT:

<ftp://mail.best-tech.com/eBooks/Quality/McGraw-Hill%20Osborne%20Design%20for%20Six%20Sigma%20A%20Roadmap%20for%20Product%20Development.pdf>

(D) FREE BOOK:

Lean Six Sigma: Research and Practice. Jiju Antony & Maneesh Kumar. ISBN: 978-87-7681-768-8

FREE DOWNLOAD AT: <http://www.gdufs.biz/lean-six-sigma-research-and-practice.pdf>