LSSA
lean six sigma academy

Green Belt

H.C. Theisens
A. Meek
D. Harborne

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LEAN SIX SIGMA
GREEN BELT SKILL SET

A GUIDELINE FOR LEAN SIX SIGMA
GREEN BELT TRAINING AND CERTIFICATION

H.C. Theisens; A. Meek; D. Harborne

VERSION 2.3

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Authors: H.C. Theisens; A. Meek; D. Harborne

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www.lssa.eu
info@lssa.eu

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CONTENT

INTRODUCTION 7
ASSESSMENT CRITERIA – THEORETICAL PART 8
CONTINUOUS IMPROVEMENT MATURITY MODEL (CIMM) 9
U1. WORLD CLASS PERFORMANCE 10
E1. Competitive strategies 10
E2. History of Continuous Improvement 10
E3. Philosophy & Principles 10
E4. Organizational Process Management 11
E5. Project selection process 11
U2. PROCESS IMPROVEMENT DEPLOYMENT 12
E1. Management of Change 12
E2. Leadership 12
U3. PROJECT MANAGEMENT 13
E1. Team Formation 13
E2. Process Improvement Roadmaps 13
E3. Voice of the Customer (VOC) 14
E4. Project Charter 14
E5. Project Management Techniques 15
U4. LEVEL I – CREATING A SOLID FOUNDATION 16
E1. Organized Work Environment 16
E2. Standardized work 16
E3. Quality Management 16
U5. LEVEL II – CREATING A CONTINUOUS IMPROVEMENT CULTURE 17
E1. Kaizen 17
E2. Basic Quality Tools 17
E3. Basic Management Tools 17
U6. LEVEL III – CREATING STABLE AND EFFICIENT PROCESSES 18
DEFINE 18
E1. Process Mapping 18
MEASURE 18
E2. Lean Performance Metrics 18

ANALYZE 19
E3. Value Stream Analysis 19
IMPROVE 19
E4. Reducing Muda (Waste) 19
E5. Reducing Muri (Overburden) 19
E6. Reducing Mura (Unevenness) 20
E7. Value Stream Improvement 20
CONTROL 21
E8. First Time Right 21
U7. LEVEL IV – CREATING CAPABLE PROCESSES 22
DEFINE 22
E1. Critical to Quality 22
MEASURE 22
E2. Six Sigma Performance Metrics 22
E3. Statistics 23
E4. Distributions 23
E5. Measurement Systems 23
ANALYZE 24
E6. Hypothesis Testing & Confidence Intervals 24
E7. Correlation and Regression 25
E8. Process Capability and Performance 25
IMPROVE 26
E9. Design of Experiments (DOE) 26
CONTROL 26
E10. Statistical Process Control (SPC) 26
U8. LEVEL V - CREATING WORLD CLASS PRODUCTS AND SERVICES 27
E1. Product Lifecycle Management (PLM) 27
E2. Innovation Management 27
ASSESSMENT CRITERIA – PRACTICAL PART 28
Appendix A – Bloom's Taxonomy for Performance Criteria 30
Appendix B – European Qualifications Framework (EQF) 31
Appendix B – Acronyms 32
Appendix C – References 33

INTRODUCTION

Within the domain of 'Continuous Improvement' individuals can be trained at four different levels. These levels are called Yellow Belt, Orange Belt, Green Belt and Black Belt.

Table 1. *Overview of Belt levels*

Belt level	Level
Yellow Belt	Awareness
Orange Belt	Foundation
Green Belt	Practitioner
Black Belt	Expert

The LSSA - Lean Six Sigma Academy® was established in September 2009 with the objective to develop an international recognized certification scheme for all Lean Six Sigma Belt levels. The LSSA Exam Board has developed four syllabi with clear criteria for skills and competences. These syllabi specify which of the overall Lean Six Sigma tools and techniques are expected to be included within certain Belt level competencies. Lean Six Sigma training is provided by a global network of 'Accredited Training Organizations' (ATOs). These ATOs provide training programs that are aligned to the LSSA syllabi.

Examinations are provided through a number of 'Examination Institutes' (EIs), which use the syllabi to develop exams. The exams are open to all. Individuals can apply directly to the EIs or sign up via one of the ATOs. It is recommended that candidates receive training through an ATO to prepare for certification. Alternatively, candidates who wish to self-study have the option to apply directly to an EI for certification.

Examinations are provided through the following three Examination Institutes (EIs):

- **APMG** APM Group Limited www.apmg-international.com
- **iSQI** International Software Quality Institute www.isqi.org
- **UT** University of Twente www.utwemte.nl

The LSSA Green Belt syllabus describes the assessment criteria for the theoretical and practical exams. Candidates are required to pass both elements to be recognized as a 'Certified Lean Six Sigma Green Belt'. Passing the theoretical exam is a pre-requisite to subscribe for the practical exam. The Green Belt certification can be achieved independently. There are no pre-requisites for Green Belt certification and therefore does not require any prior completion of any other Belt(s).

ASSESSMENT CRITERIA – THEORETICAL PART

The following chapters describe the assessment criteria for the theoretical part of the certification. The structure consists of a number of 'Units', 'Elements' and 'Performance Criteria'.

- **Unit:** The syllabus is presented by syllabus areas; each called a 'Unit'. The chapters in the book 'Climbing the Mountain' reflect the 'Units' described in this syllabus.
- **Element:** Each 'Unit' consists of a number of 'Elements'. The paragraphs in each chapter of the book 'Climbing the Mountain' reflect the 'Elements' in this syllabus.
- **Performance Criteria:** Each 'Element' consists of a number of 'Performance Criteria' and each 'Performance Criteria' has an explanation. These describe the tools, techniques and competencies that are required to be achieved by the Green Belt.
- **Level of Cognition:** A 'Cognitive Level' has been assigned to each 'Performance Criteria'-description according to Bloom's Taxonomy [5.]. This defines at which level the Green Belt is expected to apply the respective tool, technique or skill. This is the minimum level the Green Belt must be able to demonstrate in order to be assessed as competent.

The Green Belt assessment criteria for the theoretical exam are as follows:

- The theoretical exam consists of 60 multiple choice questions.
- The pass mark for this exam is set at 63% (38 marks or more required to pass).
- The duration of the exam is 180 minutes.
- This is an open book exam, where a maximum of 2 books are allowed.
  (eBook or Pdf's are not allowed)
- A calculator is allowed.
- Check with your ATO or exam institute if Minitab is allowed.
- You must be able to identify yourself with photographic ID.

If you pass you will receive a certificate from your EI that states you passed the theoretical exam. You will receive the full Green Belt certificate if you pass the practical assessment within a maximum period of two years after passing the theoretical exam.

The assessment criteria for the practical element are described on page 28.

CONTINUOUS IMPROVEMENT MATURITY MODEL (CIMM)

The LSSA syllabi are based on the 'Continuous Improvement Maturity Model' (CIMM). This is a framework that guides an evolutionary staged approach for process improvement from a very early stage till delivering world class products. CIMM incorporates the best practice methods and techniques of process improvement, quality management and new product development. It includes best practices from TQM, Kaizen, TPM, Lean, Six Sigma and Design for Six Sigma.

The 'Continuous Improvement Maturity Model' can support other maturity models or act as a stand-alone framework to guide the process of continuous improvement from a very early stage to the level of World class. The model describes five maturity levels. The levels will be identified as 'Level-I' to 'Level-V'.

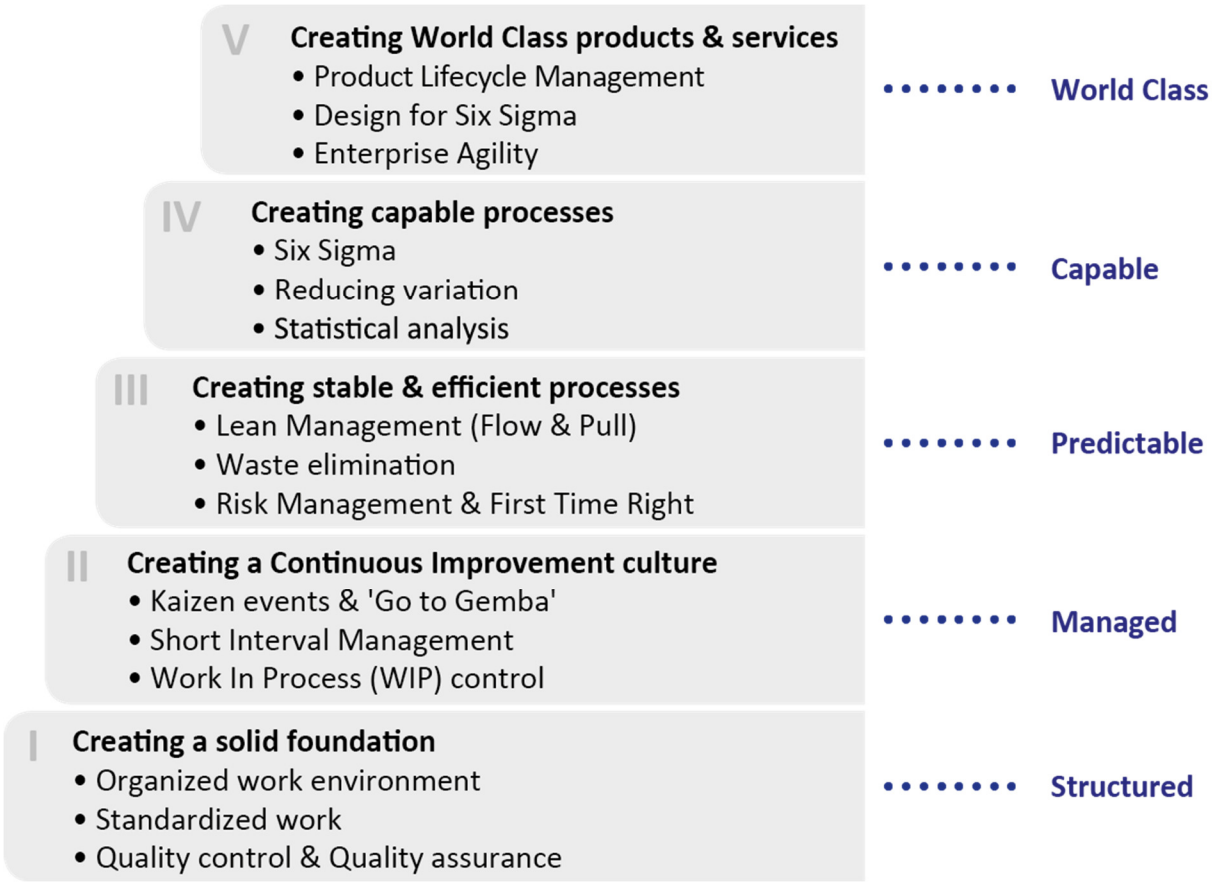

Figure 1 – Continuous Improvement Maturity Model (CIMM™).

U1. WORLD CLASS PERFORMANCE

The Unit 'World Class Performance' reviews the general philosophy of Process Improvement. It discusses the overview of different process improvement methods and the history of the most important methods. It also explains why process improvement is needed.

E1. COMPETITIVE STRATEGIES

The Learning Element 'Competitive strategies' explains Operational Excellence, Customer Intimacy and Product Leadership. It also explains how Operational Excellence can be applied to processes in different types of enterprises.

U1.E1.PC1 **Operational Excellence, Customer Intimacy & Product Leadership** **Understand**
Understand the three competitive strategies. Understand how Operational Excellence can be applied in different types of enterprises e.g. manufacturing, service, transactional, product and process design and innovation.

U1.E1.PC2 **Physical vs. Transactional processes** **Understand**
Understand the similarities and differences between physical processes and transactional processes.

E2. HISTORY OF CONTINUOUS IMPROVEMENT

The Learning Element 'History of Continuous Improvement' explains the history of process improvement and quality management.

U1.E2.PC1 **History of TQM, Lean and Six Sigma** **Understand**
Understand the origins of TQM, Lean and Six Sigma.

E3. PHILOSOPHY & PRINCIPLES

The Learning Element 'Philosophy & Principles' explains the values and principles of Lean and Six Sigma. Similarities and differences to other improvement methods are also reviewed.

U1.E3.PC1 **Value and foundations of Lean and Six Sigma** **Understand**
Understand the value of Lean and Six Sigma, its philosophy and goals. Describe the relationship between Lean and Six Sigma.

U1.E3.PC2 **Lean principles** **Understand**
Understand the Toyota philosophy, the 14 principles and the House of Quality. Understand the impact of the Toyota Production System (TPS) on strategy, quality and production.

U1.E3.PC3 **Six Sigma principles** **Understand**
Understand that Six Sigma philosophy and principles realize breakthroughs in quality performance.

E4. ORGANIZATIONAL PROCESS MANAGEMENT

The Learning Element 'Organizational Process Management' explains the cohesion between business strategy, systems, processes and performance.

U1.E4.PC1 **Business process management** **Understand**
Understand the relationships between various business processes e.g. design, production, purchasing, accounting, sales.

U1.E4.PC2 **Business processes performance measurement** **Understand**
Understand that various business processes have various key performance indicators (KPIs). Understand the basics of measurement systems in the organization.

U1.E4.PC3 **Process improvement planning** **Understand**
Understand which process improvement methods and techniques can be applied, based on the current maturity level of the organization.

E5. PROJECT SELECTION PROCESS

The Learning Element 'Project Selection Process' explains how projects are selected based on the strategy of the organization and financial measures.

U1.E5.PC1 **Financial measures** **Understand**
Understand financial measures, including cost of poor quality (COPQ) and return on investment (ROI).

U1.E5.PC2 **Project selection** **Understand**
Understand that project selection needs to be aligned with the strategy of the organization. Participate in the project selection process.

U2. PROCESS IMPROVEMENT DEPLOYMENT

The Unit 'Process Improvement Deployment' reviews how process improvement programs should be deployed across the organization. It explains the role and responsibilities of Leadership in its efforts to coach and inspire improvement teams. Also team development and change management aspects will be reviewed.

E1. MANAGEMENT OF CHANGE

The Learning Element 'Management of Change' reviews the dynamics that can occur during a project such as cooperation, resistance, escalation of problems and solving roadblocks.

U2.E1.PC1 **Organizational culture** **Understand**

Understand there are various techniques for facilitating management of change. Understand the impact an organization's culture and inherent structure can have on the success of Lean Six Sigma.

U2.E1.PC2 **Change Management approaches** **Understand**

Understand how deployment failure can result from the lack of resources or management support. Participate in both the Top-Down and Bottom-Up approach.

U2.E1.PC3 **Stakeholder analysis** **Understand**

Identify process owners, internal and external customers and other stakeholders in a project. Understand different stakeholders have different goals.

E2. LEADERSHIP

The Learning Element 'Leadership' explains the roles and responsibilities of executive leaders. This includes effective communication, motivating, coaching and rewarding improvement teams.

U2.E2.PC1 **Enterprise leadership responsibilities** **Understand**

Understand the role and responsibilities of leadership in the process improvement process.

U2.E2.PC2 **Effective communication** **Apply**

Use effective and appropriate communication for different situations to overcome barriers to project success.

U2.E2.PC3 **Team performance and motivation** **Apply**

Demonstrate team progress in relation to goals, objectives and other metrics. Apply techniques that motivate team members and support and sustain their participation and commitment.

U2.E2.PC4 **Coaching** **Understand**

Understand the importance of coaching.

U3. PROJECT MANAGEMENT

The Unit 'Project Management' outlines the way improvement projects should be executed. It starts with the identification of customers and its requirements. The Unit also covers a number of project management roadmaps, team formation, the project charter and a number of project management tools.

E1. TEAM FORMATION

The Learning Element 'Team Formation' reviews the different role and responsibilities within and around an improvement team. It also reviews how a team is formed.

U3.E1.PC1 **Roles and Responsibilities** **Understand**

Describe Lean Six Sigma levels of expertise: Master Black Belt, Black Belt, Green Belt, Orange Belt and Yellow Belt. Describe various team roles and responsibilities: Deployment leader, Champion, Project leader, Coach, and Team member.

U3.E1.PC2 **Team member selection** **Understand**

Understand the basic principles of team formation and team member selection.

E2. PROCESS IMPROVEMENT ROADMAPS

The Learning Element 'Process Improvement Roadmaps' reviews a number of roadmaps, including Plan-Do-Check-Act (PDCA) and Define, Measure, Analyze, Improve and Control (DMAIC).

U3.E2.PC1 **Kaizen Roadmap** **Apply**

Apply project management methods that can be used in the workplace for Kaizen initiatives e.g. PDCA, A3-report.

U3.E2.PC2 **Problem Solving Process (8D)** **Understand**

Understand the 'Eight Disciplines Problem Solving Method' used to approach and resolve problems.

U3.E2.PC3 **DMAIC Roadmap** **Apply**

Apply the DMAIC roadmap for Lean and Six Sigma breakthrough projects. Select the proper tools to use during the Process Improvement project.

E3. VOICE OF THE CUSTOMER (VOC)

The Learning Element 'Voice of the Customer' reviews customer identification (internal/external) and customer requirements.

U3.E3.PC1 **Customer identification** **Apply**

Demonstrate how the project will impact internal and external customers.

U3.E3.PC2 **Customer requirements** **Understand**

Understand the experience of customers linked to product features described in the range from dissatisfied, expected, satisfied and desired quality levels e.g. new KANO model.

E4. PROJECT CHARTER

The Element 'Project Charter' covers the description of the project such as problem description, objectives, scope, timing and benefits.

U3.E4.PC1 **Problem statement** **Analyze**

Develop and analyze the problem statement in relation to customer requirements and business goals.

U3.E4.PC2 **Project scope and goal** **Analyze**

Develop and review project boundaries to ensure that the project has value to the customer (scope). Develop the objectives and measurable targets for the project based on the problem statement and scope (goal).

U3.E4.PC3 **Project performance measures** **Apply**

Select performance measurements (Cost, Quality and Delivery) and establish key project metrics that relate to the voice of the customer.

U3.E4.PC4 **Project benefits calculation** **Apply**

Calculate the hard benefits of the project and describe the soft benefits of the project.

E5. PROJECT MANAGEMENT TECHNIQUES

The Element 'Project Management Techniques' reviews a number of tools that are used during execution of the project.

U3.E5.PC1 **Time management** **Apply**

Understand the importance and basic disciplines of time management. Apply the elements of time management.

U3.E5.PC2 **Project progress** **Apply**

Apply project planning tools such as Gantt charts, critical path method (CPM) and program evaluation and review technique (PERT) charts. Apply basic disciplines of time management e.g. attending meetings, arriving on-time, coming prepared, being punctual and to the point.

U3.E5.PC3 **Project risk management** **Apply**

Describe the purpose and benefit of project risk analysis. Attending risk assessment and assure useful contribution by identifying risks.

U3.E5.PC4 **Project documentation** **Apply**

Provide input and select the proper vehicle for presenting project documentation (e.g. spreadsheet output and storyboards). Create project documentation in line with standard organization templates.

U3.E5.PC5 **Lessons learned** **Understand**

Identify and document lessons learned from all phases of a project. Identify possible improvements and ownership.

U4. LEVEL I – CREATING A SOLID FOUNDATION

The Unit 'Creating a solid foundation' reviews how to achieve a solid foundation for further process improvement programs. This foundation consists of a proper and organized work environment, reliable equipment and standardized work.

E1. ORGANIZED WORK ENVIRONMENT

The Learning Element 'Organized work environment' is about good housekeeping and how to set up a proper and safe work environment in a structured manner.

U4.E1.PC1 **Organized work environment (5S)** **Apply**

Develop an organized work environment by applying 5S (Sort, Straighten, Shine, standardize, Sustain). Understand that an organized environment will improve safety and moral.

E2. STANDARDIZED WORK

The Learning Element 'Standardized work' is about implementing and improving standards.

U4.E2.PC1 **Standardized work and Documentation** **Apply**

Propagate the quality management system and procedures. Identify opportunities for improvement.

E3. QUALITY MANAGEMENT

The Learning Element 'Quality Management' is about developing procedures to identify and detect defects. Also preventing mistakes and avoiding problems will be discussed.

U4.E3.PC1 **Quality Management System** **Apply**

Propagate the quality management system and procedures. Identify opportunities for improvement.

U4.E3.P2 **Ongoing evaluation and auditing** **Apply**

Apply tools for the ongoing evaluation of the improved process, including auditing (internal / external), monitoring for new constraints and identification of additional opportunities for improvement.

U5. LEVEL II – CREATING A CONTINUOUS IMPROVEMENT CULTURE

The Unit 'Creating a continuous improvement culture' reviews how to create a continuous improvement culture at the shop floor. This Unit reviews setting up and facilitate Kaizen teams. It also reviews a number of problem solving techniques and tools.

E1. KAIZEN

The Learning Element 'Kaizen' reviews how to organize and facilitate improvement teams at the shop floor that work on Kaizen improvement initiatives.

U5.E1.PC1 **Short Interval Management** **Apply**
Implement and support Short Interval Management to drive continuous improvement initiatives.

U5.E1.PC2 **Visual Workplace** **Apply**
Apply the elements of Visual Workplace and describe how they can help to control the improved process.

U5.E1.PC3 **Root Cause Analysis** **Analyze**
Define and apply root cause analysis, recognize the issues involved in identifying a root cause. Apply problem solving process and tools.

U5.E1.PC4 **Kaizen events** **Apply**
Facilitate improvement teams and Kaizen events.

E2. BASIC QUALITY TOOLS

The Learning Element 'Basic Quality Tools' reviews a number of basic quality tools.

U5.E2.PC1 **Visualization of data** **Apply**
Propagate the purpose and use of data visualization, analysis and communication.

U5.E2.PC2 **Basic Quality Tools** **Analyze**
Apply and analyze the outcome of basic quality tools: Check sheet; Pareto chart; Scatter plot; Bar chart; Pie chart; Time Series Plot, Histogram and Box plot.

E3. BASIC MANAGEMENT TOOLS

The Learning Element 'Basic Management tools' reviews a number of tools that are very powerful in the problem solving process.

U5.E3.PC1 **Brainstorm Techniques** **Apply**
Apply brainstorm techniques: Affinity diagram, 5-Why's and Ishikawa.

U5.E3.PC2 **Decision making** **Apply**
Apply decision making techniques e.g. Cause & Effect matrix and multi-voting.

U6. LEVEL III – CREATING STABLE AND EFFICIENT PROCESSES

The Unit 'Creating stable and efficient processes' reviews how the logistical flow of processes can be improved and made more stable, predictable and efficient. This Unit also reviews tools which can be used to visualize and analyze the process flow. This unit also reviews a number of tools and techniques that can be used to improve efficiency, effectiveness, productivity and agility of processes. All Level III Learning Elements and Performance Criteria follow the DMAIC structure.

DEFINE

E1. PROCESS MAPPING

The Learning Element 'Process Mapping' reviews a number of tools to map the process flow that can be used in both Lean and Six Sigma projects.

U6.E1.PC1 **Process Flow diagram** **Apply**
Apply process mapping to visualize the flow of activities and decisions within a process.

U6.E1.PC2 **High level process description** **Analyze**
Distinguish between key process input variables and key process output variables based on a high level process map e.g. SIPOC.

MEASURE

E2. LEAN PERFORMANCE METRICS

The Learning Element 'Lean Performance Metrics' reviews different types of data, measurement scales and Lean performance metrics. This Element also reviews process flow analysis.

U6.E2.PC1 **Process Flow analysis** **Analyze**
Analyze process flow and utilization. Apply Little's Law.

U6.E2.PC2 **Lean Performance metrics** **Analyze**
Analyze Lean performance metrics e.g. takt time, cycle time, lead time, queue time, WIP, yield and OEE.

U6.E2.PC3 **Data types** **Apply**
Describe and review qualitative and quantitative data, continuous (variables) and discrete (attributes) data.

U6.E2.PC4 **Measurement scales** **Apply**
Define and interpret nominal, ordinal, interval and ratio measurement scales. Apply Likert scale to convert an ordinal scale into a discrete or continuous interval scale.

ANALYZE

E3. VALUE STREAM ANALYSIS

The Learning Element 'Value Stream Analysis' reviews how to create a Value Stream Map of the current situation.

U6.E3.PC1 **Value Adding versus Non Value Adding** **Analyze**
Distinguish value added from non-value added activities.

U6.E3.PC2 **Value Stream Mapping (Current State)** **Apply**
Apply Value Stream Mapping to construct a Current State Map of the process to identify waste and non-value added activities.

IMPROVE

E4. REDUCING MUDA (WASTE)

The Learning Element 'Reducing Muda' reviews how to identify Waste in the organization and in the processes.

U6.E4.PC1 **Waste identification (for the Operation)** **Analyze**
Identify and analyze the 8 types of waste (Muda); Overproduction, Waiting, Transport, Overprocessing, Inventory, Movement, Defects, Unused expertise.

U6.E4.PC2 **Waste identification (for the Customer)** **Analyze**
Identify and analyze the 7 types of customer waste (Muda); Opportunity Loss, Delay, Unnecessary Movement, Duplication, Incorrect inventory, Unclear Communication and Errors.

E5. REDUCING MURI (OVERBURDEN)

The Learning Element 'Reducing Muri ' reviews how to identify overburdening the organization and how to implement flow and work balancing to reduce overburden. This element also reviews the relations between Lean with TPM and TOC.

U6.E5.PC1 **Flow** **Apply**
Describe the importance of flow for reducing Muri. Implement flow in the organization.

U6.E5.PC2 **Work balancing** **Apply**
Describe the importance of Work balancing for reducing Muri. Implement Work balancing.

U6.E5.PC3 **Total Productive Maintenance (TPM)** **Understand**
Understand the eight pillars of TPM and understand how it can be used for process improvement..

U6.E5.PC4 **Competence Management (Skill Matrix)** **Understand**
Describe how competence management supports the reduction of Muri.

E6. REDUCING MURA (UNEVENNESS)

The Learning Element 'Reducing Mura ' reviews how to identify unevenness in the organization and in the processes. This element also reviews a number of techniques to reduce unevenness.

U6.E6.PC1 **Pull** **Apply**
Describe the importance of pull for reducing Mura. Implement pull in the organization by applying Kanban systems.

U6.E6.PC2 **Volume and Type leveling** **Apply**
Implement a balanced process flow by both volume leveling, type leveling and one piece flow.

U6.E6.PC3 **Quick Change Over (SMED)** **Apply**
Reduce change over times by implementing Single Minute Exchange of Die (SMED).

E7. VALUE STREAM IMPROVEMENT

The Learning Element 'Value Stream Improvement' reviews how the techniques and tools that reduce Muda, Muri and Mura can be applied in constructing a Future State Value Stream Map.

U6.E7.PC1 **Value Stream Mapping (Future State)** **Apply**
Define the gap between the current state and the target condition. Define a Future state map using Value Stream Mapping. Apply techniques to reduce Muda, Mura and Muri.

CONTROL

E8. FIRST TIME RIGHT

The Learning Element 'First Time Right' looks at how results that have been achieved in process improvement projects can be sustained. This element reviews the following techniques and principles: Process FMEA, Control plan, Jidoka and Poka Yoke.

U6.E8.PC1 **Process FMEA (pFMEA)** **Apply**

Prepare all elements of a Process FMEA, calculate the risk priority number (RPN) and review the effect of FMEA results on processes, products and services.

U6.E8.PC2 **Control plan** **Apply**

Prepare a control plan to document and hold gains. Define controls and monitoring systems. Transfer of responsibility from the project team to the process owner.

U6.E8.PC3 **Jidoka & Poka Yoke** **Apply**

Understand the line has to be stopped when there is a quality problem. Apply Poka Yoke to avoid quality problems.

U7. LEVEL IV – CREATING CAPABLE PROCESSES

The Unit 'Creating Capable Processes' focuses on reducing variation in a stable process with the objective to create a process capable of meeting customer requirements. This Unit reviews the application of Six Sigma and statistical tools used to assure a valid and reliable performance measurement system, to collect data and to analyze the performance of processes. Six Sigma focuses on quality breakthrough improvement projects. All Level IV Learning Elements and Performance Criteria follow the DMAIC structure.

DEFINE

E1. CRITICAL TO QUALITY

The Learning Element 'Critical to Quality' reviews how to translate the Voice of Customer (VOC) into a CTQ flowdown that represents the key measurable characteristics of the product or process.

U7.E1.PC1 **Critical requirements** **Apply**

Define and describe various CTx requirements (critical to quality (CTQ), cost (CTC), process (CTP), safety (CTS) and delivery (CTD)) and the importance of aligning projects with those requirements.

U7.E1.PC2 **CTQ Flowdown** **Apply**

Translate the Voice of Customer (VOC) into external CTQs and internal CTQs. Construct a CTQ flowdown that represents the key measurable characteristics of a product or process whose performance standards or specification limits must be met.

MEASURE

E2. SIX SIGMA PERFORMANCE METRICS

The Learning Element 'Six Sigma Performance Metrics' reviews a number of metrics that are often used in Six Sigma projects. The element also reviews a number of sampling methods for assuring data accuracy and integrity.

U7.E2.PC1 **Defects and Defectives** **Apply**

Calculate Six Sigma process performance metrics e.g. PPM, DPMO, DPU and RTY. Understand the difference between a defect and a defective.

U7.E2.PC2 **Sampling methods** **Apply**

Apply appropriate sampling methods that ensure representative data e.g. random sampling, stratified sampling and systematic sampling.

U7.E2.PC3 **Data collection tools** **Apply**

Define and apply tools for collecting data e.g. data sheets, check sheets, concentration diagrams and questionnaires.

E3. STATISTICS

The Learning Element 'Statistics' reviews the basic terms of sample and descriptive statistics.

U7.E3.PC1 **Descriptive statistics** **Apply**
Calculate population parameters and sample statistics e.g. proportion, mean and standard deviation.

U7.E3.PC2 **Variation** **Analyze**
Evaluate special cause and common cause variation.

U7.E3.PC3 **Basic probability concepts** **Understand**
Understand basic probability concepts such as independence, mutually exclusive events, multiplication rules, complementary probability and joint occurrence of events.

E4. DISTRIBUTIONS

The Learning Element 'Distributions' reviews a number of continuous and discrete distributions. The element also reviews the central limit theorem and a number of probability concepts.

U7.E4.PC1 **Continuous distributions** **Apply**
Interpret Probability Density Functions and Cumulative Distribution Functions. Apply and interpret continuous distributions: Normal, Student's t, Chi square, Weibull and F distributions. Apply normality test (Anderson-Darling; Skewness and Kurtosis).

U7.E4.PC2 **Discrete distributions** **Apply**
Interpret discrete distributions: Poisson, Binomial.

U7.E4.PC3 **Central limit theorem** **Apply**
Apply the central limit theorem.

U7.E4.PC4 **Data transformation on non-normal data** **Apply**
Identify non-normal data and use Box-Cox or Johnson transformation.

E5. MEASUREMENT SYSTEMS

The Learning Element 'Measurement Systems' reviews how to evaluate measurement systems.

U7.E5.PC1 **Measurement methods** **Apply**
Define and describe measurement methods for both continuous and discrete data.

U7.E5.PC2 **Measurement systems analysis** **Apply**

Apply measurement systems for continuous data. Interpret repeatability and reproducibility (R&R), stability, bias, linearity, precision to tolerance and number of distinct categories.

U7.E5.PC3 **Attributive Agreement Analysis** **Apply**
Apply measurement systems for qualitative properties. Establish attribute agreement within appraiser, between appraisers and appraisers vs. standard.

U7.E5.PC4 **Metrology** **Understand**
Describe elements of metrology, including calibration systems, traceability to reference standards, the control and integrity of standards and measurement devices.

ANALYZE

E6. HYPOTHESIS TESTING & CONFIDENCE INTERVALS

The Learning Element 'Hypothesis Testing & Confidence Intervals' reviews test methods that are used to test a hypothesis. This Learning Element also discusses Confidence Intervals that indicate the reliability of test conclusions.

U7.E6.PC1 **Hypothesis testing** **Apply**
Define and interpret the significance level, power, type I and type II errors in statistical tests. Understand the difference between statistical and practical significance.

U7.E6.PC2 **Confidence Intervals** **Apply**
Define and distinguish between confidence, prediction and tolerance intervals. Distinguish between statistical and practical significance.

U7.E6.PC3 **Sample size** **Apply**
Calculate power and sample size for common hypothesis tests.

U7.E6.PC4 **Tests for means, variances and proportions** **Apply**
Apply hypothesis tests for means, variances and proportions.

U7.E6.PC5 **Chi-square tests** **Apply**
Apply Chi-square goodness-of-fit test and Contingency tables.

U7.E6.PC6 **Non-parametric tests** **Understand**
Understand when to apply non-parametric tests, e.g. Mann-Whitney, Kruskal Wallis and Mood's median test.

E7. CORRELATION AND REGRESSION

The Learning Element 'Correlation and Regression' describes the predictive models using regression techniques to determine the relation between factors on a response.

U7.E7.PC1 **Correlation coefficient** **Apply**

Calculate and interpret the correlation coefficient. Determine its statistical significance (p-value) and recognize the difference between correlation and causation.

U7.E7.PC2 **Regression analysis** **Apply**

Apply linear regression analysis. Use the regression model for estimation and prediction. Interpret the residual analysis to validate the model.

U7.E7.PC3 **Analysis of variance (ANOVA)** **Apply**

Apply ANOVA and interpret the results and the main effect and interaction plots.

E8. PROCESS CAPABILITY AND PERFORMANCE

The Learning Element 'Process Capability and Performance' explains process capability and performance in relation to specification limits.

U7.E8.PC1 **Process capability studies** **Apply**

Apply process capability studies. Prepare sampling plans to verify stability.

U7.E8.PC2 **Process capability indices** **Apply**

Calculate and interpret process capability indices,: Cp and Cpk, to assess process capability.

U7.E8.PC3 **Short-term and long-term capability** **Understand**

Interpret the relationship between long-term and short-term capability.

U7.E8.PC4 **Process performance indices** **Apply**

Calculate and interpret process performance indices,: Pp and Ppk., to assess process performance. Interpret the relationship between capability and performance indices.

U7.E8.PC5 **Process capability for attributes data** **Apply**

Calculate the process capability and process sigma level for attribute data.

IMPROVE

E9. DESIGN OF EXPERIMENTS (DOE)

The Learning Element 'Design of Experiments' reviews efficient ways of experimenting. Design of Experiments examines the influence of factors and interactions on a process.

U7.E9.PC1 **Principles of experiments and terminology** **Apply**

Understand the limitations of One-Factor-At-a-Time (OFAT) experiments. Understand why Design of Experiments (DOE) is a more efficient way of experimenting. Apply DOE principles and terms: responses, factors, levels, transfer function, run order, randomization, balanced designs, residual error, main effects, interaction effects, replicates and repetitions.

U7.E9.PC2 **Planning experiments** **Apply**

Plan, organize and apply experiments by determining the objective, selecting factors and responses.

U7.E9.PC3 **Two-level Full factorial experiments** **Apply**

Design and apply full factorial experiments. Understand the meaning of contrast.

CONTROL

E10. STATISTICAL PROCESS CONTROL (SPC)

The Learning Element 'Statistical Process Control' explains the controls methods used to identify out-of-control situations and deviations over time. Different types of SPC charts are reviewed.

U7.E10.PC1 **SPC Objectives and benefits** **Apply**

Describe the objectives of SPC, including monitoring and controlling process performance and tracking trends. Apply SPC for reducing variation in a process.

U7.E10.PC2 **Control charts** **Apply**

Select and apply control charts: Xbar-R, Xbar-S, individuals and moving range (I-MR), p, np, c and u.

U7.E10.PC3 **Tests for Special Causes** **Analyze**

Interpret control charts and distinguish between common and special cause variation using rules for determining statistical control.

U7.E10.PC4 **Selection of variables** **Apply**

Identify and select critical characteristics for control chart monitoring.

U7.E10.PC5 **Acceptance sampling** **Understand**

Understand the basics of sampling plans. Describe how rational sub grouping is used.

U8. LEVEL V - CREATING WORLD CLASS PRODUCTS AND SERVICES

The Unit 'Creating World Class products and services' is about applying Lean Six Sigma tools in the product development process with the objective to design products and processes that will perform on a Six Sigma level from the earliest phase.

E1. PRODUCT LIFECYCLE MANAGEMENT (PLM)

The Learning Element 'Product Lifecycle Management' reviews the entire lifecycle of products from inception, engineering, and manufacturing to service and disposal.

U8.E1.PC1 **Product Lifecycle Management** **Understand**

Understand the lifecycle for products from creation, engineering, manufacturing to service and disposal.

E2. INNOVATION MANAGEMENT

The Learning Element 'Innovation Management' reviews frameworks and roadmaps for new product and process development, including the DMADV Design for Six Sigma roadmap.

U8.E2.PC1 **Product and Process Development** **Understand**

Participate in new product and process development.

U8.E2.PC2 **Design for Six Sigma** **Understand**

Describe the difference between the DMAIC roadmap and DfSS roadmap (e.g. DMADV).

ASSESSMENT CRITERIA – PRACTICAL PART

This chapter describes the assessment criteria for the practical part of Green Belt certification. Green Belts have to submit two practical projects that meet the following criteria:

- Two successful projects at Level-III or higher.
- Each project has resulted in significant savings (e.g. € 20,000.- on a yearly basis).
- Projects follow the DMAIC, DMADV or IDOV roadmap, and consists of a maximum of 25 pages. The LSSA review template can be downloaded at the LSSA website (www.lssa.eu).
- The candidate should complete the self-assessment criterion that are listed in the LSSA review template prior to submission (Figure 2).
- Each project has been signed by the Champion and Financial controller, thereby declaring that the project is carried out professionally and that the savings have been achieved.
- Projects must be submitted no later than three years after theoretical examination.

Both projects will be assessed by Master Black Belts assigned by the LSSA. The criterion listed in Figure 2 will be applied. It is advisable to use these criterion during your project. It is additionally strongly advised that the submission is also checked by an internal Master Black Belt or coach.

- A ‘Pass’ result will be awarded when all criteria are addressed within the submission and are deemed to be ‘Correct’ or ‘Not Applicable’.
- Any criteria that has a grey box in the ‘Not Applicable’ column is mandatory and may not be claimed as ‘Not Applicable’
- The submission must contain a justification of any criteria that is claimed to be ‘Not Applicable’.

The result of the practical assessment will be either Pass or Fail. No score will be given. In the event of a ‘Fail’ result, brief guidance will be given on those criteria that are deemed ‘Missing’ or ‘Incorrect’. Subsequently, a single retake resubmission is allowable.

			Missing	Incorrect	Correct	N/A
Define	1	Project addresses a clear problem or business opportunity (€20,000.- p/year).				
	2	Problem description has been clearly defined.				
	3	Goals have been clearly defined. Project objectives are measurable.				
	4	VOC and VOB have been defined clearly. Requirements have been understood.				
	5	Scope of the project has been clearly delineated.				
	6	Key stakeholders have been involved and informed.				
	7	Belt has shown to be able to manage the project adequately.				
	8	Project has been completed within time and budget.				
Measure	1	Relevant KPI's have been selected / CTQ-flowdown has been constructed.				
	2	High level process description has been made (e.g. SIPOC).				
	3	Data has been collected / selected properly.				
	4	The collected data has been proven to be representative for the project.				
	5	Quality of the data has been verified in an appropriate way (GR&R if applicable).				
	6	Historical data has been used to visualize performance over time (e.g. Time series).				
	7	Variation in the process has been considered (common cause or special cause).				
	8	Short term versus long term performance has been considered.				
	9	Performance against requirements has been checked (Ppk if applicable).				
Analyze	1	Process has been mapped in detail (e.g. Process Flow / VSM Current State).				
	2	Potential root causes have been identified properly.				
	3	Data has been collected and analyzed correctly.				
	4	Graphical and statistical techniques have been applied to investigate root causes.				
	5	Major root causes have been identified.				
	6	Conclusions have demonstrated strong evidence / statistically valid.				
Improve	1	Improved process meets the requirements of the VOC and VOB.				
	2	Risks have been assessed (e.g. pFMEA).				
	3	Resistance for change has been overcome / Risks have been mitigated.				
	4	Internal and external customers have accepted the new process.				
	5	Improvements have been proven to be successful. (Capability study if applicable).				
Control	1	Evidence of 'In-Control situation' available and sufficient.				
	2	Measures have been put in place to monitor process performance.				
	3	Documentation has been updated (pFMEA, CP, SOP's).				
	4	Training has been performed for the new process.				
	5	Improvements have proven to be sustainable.				
	6	Project report has been completed. Lessons learned have been communicated.				
	7	Champion has been involved and signed the project.				
	8	Controller signed that project savings / benefits have been achieved.				

Figure 2 – Practical Assessment Criteria

APPENDIX A – BLOOM'S TAXONOMY FOR PERFORMANCE CRITERIA

In addition to specifying content, each performance criteria in this skill set also indicates the intended complexity level of the test questions for each topic. These levels are based on 'Levels of Cognition' (from Bloom's Taxonomy – Revised, 2001), and can be used to create learning outcomes for students [6.].

The Taxonomy of Educational Objectives, often called Bloom's Taxonomy, is a classification of the different objectives that educators set for students (learning objectives). The taxonomy was proposed in 1956 by Benjamin Bloom, an educational psychologist at the University of Chicago. During the nineties, Lorin Anderson a former student of Bloom revisited the cognitive domain in the learning taxonomy [5.]. Bloom's Taxonomy divides educational objectives into three 'domains': Affective, Psychomotor and Cognitive. This Skill set only notices the Cognitive domain. The 'Levels of Cognition' are in rank order - from least complex to most complex. The Green Belt skill set only uses the levels 'Understand', 'Apply and 'Analyze'.

Remember
Recall or recognize terms, definitions, facts, ideas, materials, patterns, sequences, methods, principles, etc. The LSSA uses the following verb at this level: Recall.

Understand
Read and understand descriptions, communications, reports, tables, diagrams, directions, regulations, etc. The LSSA uses the following verbs at this level: Describe, Follow, Identify, Interpret, Participate, Understand.

Apply
Know when and how to use ideas, procedures, methods, formulas, principles, theories, etc. The LSSA uses the following verbs at this level: Apply, Assure, Calculate, Define, Demonstrate, Divide, Eliminate, Empower, Facilitate, Implement, Motivate, Organize, Plan, Prepare, Present, Promote, Propagate, Review, Select, Standardize, Support, Use.

Analyze
Break down information into its constituent parts and recognize their relationship to one another and how they are organized; identify sublevel factors or salient data from a complex scenario. The LSSA uses the following verbs at this level: Analyze, Construct, Design, Develop, Distinguish, Evaluate, Lead, Manage, Translate.

Evaluate
Make judgments about the value of proposed ideas, solutions, etc., by comparing the proposal to specific criteria or standards. The LSSA does not uses this level in their skill sets.

Create
Put parts or elements together in such a way as to reveal a pattern or structure not clearly there before; identify which data or information from a complex set is appropriate to examine further or from which supported conclusions can be drawn. The LSSA does not uses this level in their skill sets.

APPENDIX B – EUROPEAN QUALIFICATIONS FRAMEWORK (EQF)

The European Qualifications Framework (EQF) acts as a translation device to make national qualifications more readable across Europe, promoting workers' and learners' mobility between countries and facilitating their lifelong learning.

The core of the EQF are 'Learning outcomes' which are eight reference levels describing what a learner knows, understands and is able to do.

EQF Level	Knowledge	Belt level
Level 1	Basic general knowledge	-
Level 2	Basic factual knowledge of a field of work or study	-
Level 3	Knowledge of facts, principles, processes and general concepts, in a field of work or study	-
Level 4	Factual and theoretical knowledge in broad contexts within a field of work or study	Lean Six Sigma Yellow Belt
Level 5	Comprehensive, specialized, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge	Lean Six Sigma Orange Belt
Level 6	Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	Lean Six Sigma Green Belt
Level 7	• Highly specialized knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research • Critical awareness of knowledge issues in a field and at the interface between different fields	Lean Six Sigma Black Belt
Level 8	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	Lean Six Sigma Master Black Belt

APPENDIX B – ACRONYMS

Acronym	Description
APL	Accreditation of Prior Learning
APMG	APM Group Limited
ASQ	American Society of Quality
ATO	Accredited Training Organization
EQF	European Qualifications Framework
LSSA	Lean Six Sigma Academy (LSSA BV)
LSS YB	Lean Six Sigma Yellow Belt
LSS OB	Lean Six Sigma Orange Belt
LSS GB	Lean Six Sigma Green Belt
LSS BB	Lean Six Sigma Black Belt
iSQI	International Software Quality Institute (iSQI GmbH)
NVQ	National Vocational Qualification standard of England, Wales and N. Ireland

The LSSA has developed an abbreviation list with over 200 Lean Six Sigma terms and abbreviations. It is available online in four different languages at www.lssa.eu.

APPENDIX C – REFERENCES

[1.] Department of Trade and Industry UK, British Standards for Occupational Qualification, *National Vocational Qualification Standards and Levels.*

[2.] American Society for Quality (2008), *ASQ body of knowledge - Six Sigma Green Belt Certification*. Milwaukee: ASQ.

[3.] American Society for Quality (2008), *ASQ body of knowledge - Six Sigma Black Belt Certification*. Milwaukee: ASQ.

[4.] European Certification and Qualification Association (2009), *ECQA Guide, Version 3, Guidelines*. Krems: ECQA.

[5.] Bloom, B.S., Engelhart, M.D., Furst, E.J., Hill, W.H. & Krathwohl, D.R. (1956). *Taxonomy of Educational Objectives, The Cognitive Domain.* New York: Longmans.

[6.] Anderson, L.W. & Krathwohl, D.R. (Eds.) (2001). *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives.* New York: Longmans.

It is important for businesses and organizations to continuously focus on customer satisfaction by supplying products or services with outstanding quality, cost efficiently and within the agreed lead time. Improving quality and efficiency is the domain of ‘Process Improvement’.

Realising these objectives is effectively achieved by applying Lean Six Sigma: a combination of Lean Manufacturing and Six Sigma approaches. Within Lean Six Sigma, individuals can be trained at various ‘Belt levels’. These levels are called Black Belt, Green Belt, Orange Belt and Yellow Belt.

The LSSA – Lean Six Sigma Academy – was established in September 2009, with the main objective to determine a common certification standard for Lean Six Sigma job roles. This has been realised by developing four skill sets with clear criteria and an online exam portal. This document describes the second revision of the Green Belt skill set.

H.C. Theisens
Managing director Lean Six Sigma Academy