Quality as Competitive Advantage

How the LEGO Group work with Quality and Product Safety

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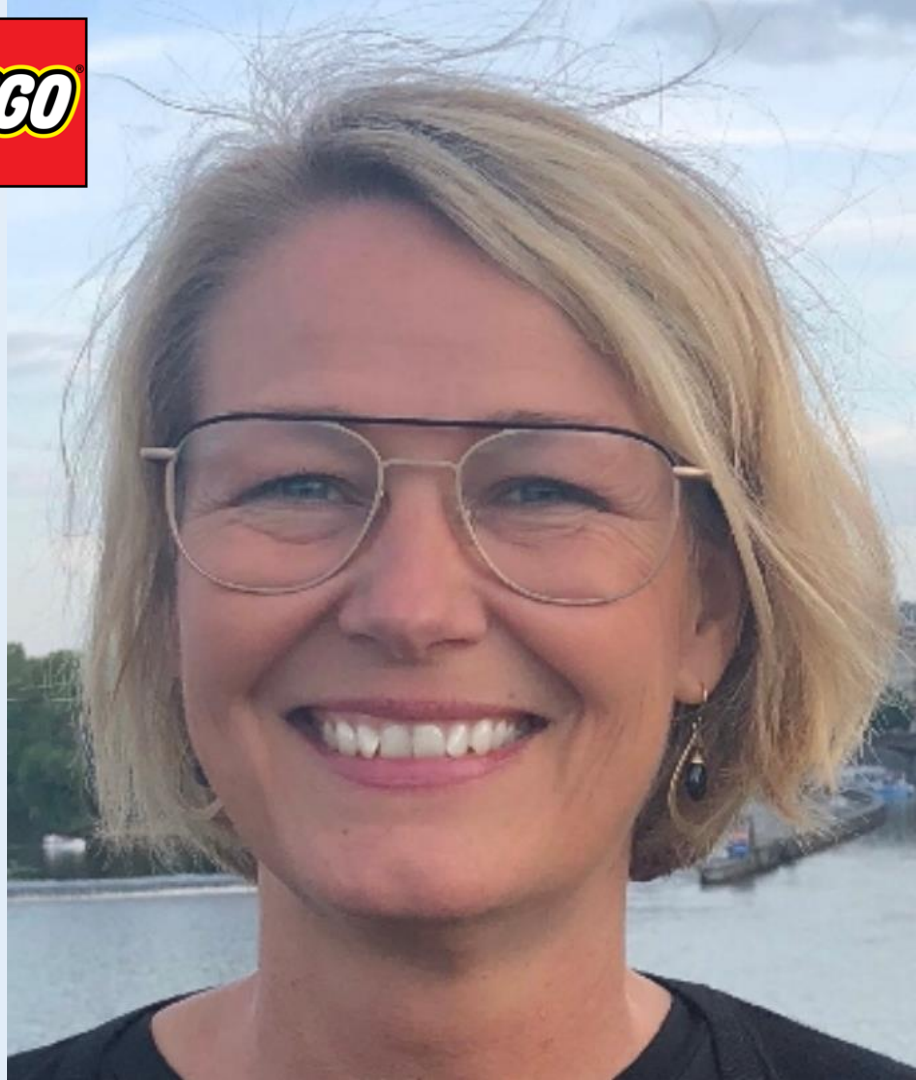
- Lean Six Sigma Master Black Belt
- APQP, D/P-FMEA, Control Plan, Certified Supplier Auditor from AIAG in Detroit
- Engineering background
- Solid track record of LSS improvement projects.
- Profound utilization of Design for Six Sigma
- Implementing Business Process Management (BPM) in parts of LEGO System A/S.

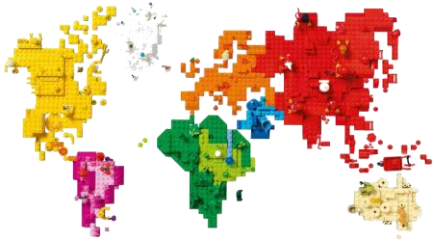


Who is the LEGO Group and what is important to us?

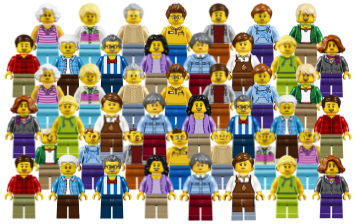
Family owned
Danish

Founded

#1
Toy company



140
Countries



17,000
Colleagues

#1
Reputable brand

When children play - they learn

21st century skills

- Emotional
- Cognitive
- Physical
- Social
- Creative

65% of all kindergarten children will conduct jobs that are not created yet.

Quality as Competitive Advantage

How the LEGO Group work with Quality and Product Safety

In-House Training

Awareness Training	Why would I as a manager want to use Lean Six Sigma?
Statistics	4 days training program linking to DMAIC for ”rusty” belts
Yellow Belt	4 days training program Lean Six Sigma Yellow Belt IASSC
Green Belt	Lean Six Sigma for leaders Green Belt IASSC

Financial Result of Lean Six Sigma Green Belt Certification Projects

1,018,000	Improve validation of index of jig
5,300,000	Optimize visual quality inspection method of molded elements
258,000	Reduce the rework cost of moulds
522,000	Remove 1 week lead time
2,600,000	Improve yield of the Model Build Process

Problem Solving Approaches/ Methodology	Know the problem	Know the causes	Know the solution	Single incident	Data availability/ obtainability	Urgency/ Time to solve	Business Impact/ Ressources	Document/ template
Design for Six Sigma (DFSS)	✗	✗	✗	✗	✓	According to LDP etc.	High	LSS Project Charter
Lean Six Sigma DMAIC	✗	✗	✗	✗	✓	3-9 months	High	LSS Charter
Lean Continuous Improvement Thinking	✓	✗	✗	✓	✓	1-2 months	Low-medium	LCI Thinking Template
Practical Problem Solving	✓	✗	✗	✓	✗	5-30 days	Low-medium	PPS Template
Plan, Do, Check, Act (PDC)	✓	✓	✗	✓	✗	1-20 days	Low-medium	PDCA Template
Kaizen Process Rapid Improvement Event (RIE, Sprint)	✓	✓	✗	✓	✗	1-5 days	Low	None
Kaizen Event (Kaizen week, Blitz, Burst)	✓	✓	✗	✓	✗	5-7 days	Medium-high	None
Just Do It (JIT)	✓	✓	✓	✓	✗	1 -5 days	Low	None

PRO-ACTIVE
(before-the-event)

- New elements
- New platforms
- New technology
- New equipment
- New processes

Design something new
Design For Six Sigma

Improve existing
DMAIC/LEAN

Quality:

$$Y = f(x_1 + x_2 + x_n)$$

RE-ACTIVE
(after-the-event)

- Improve
- Reduce
- Optimize
- Problem Solving

Management & Leadership day by day

- **Business Process Management**
- **Employees, Mentoring, Training & Coaching**
- **Technology and data**

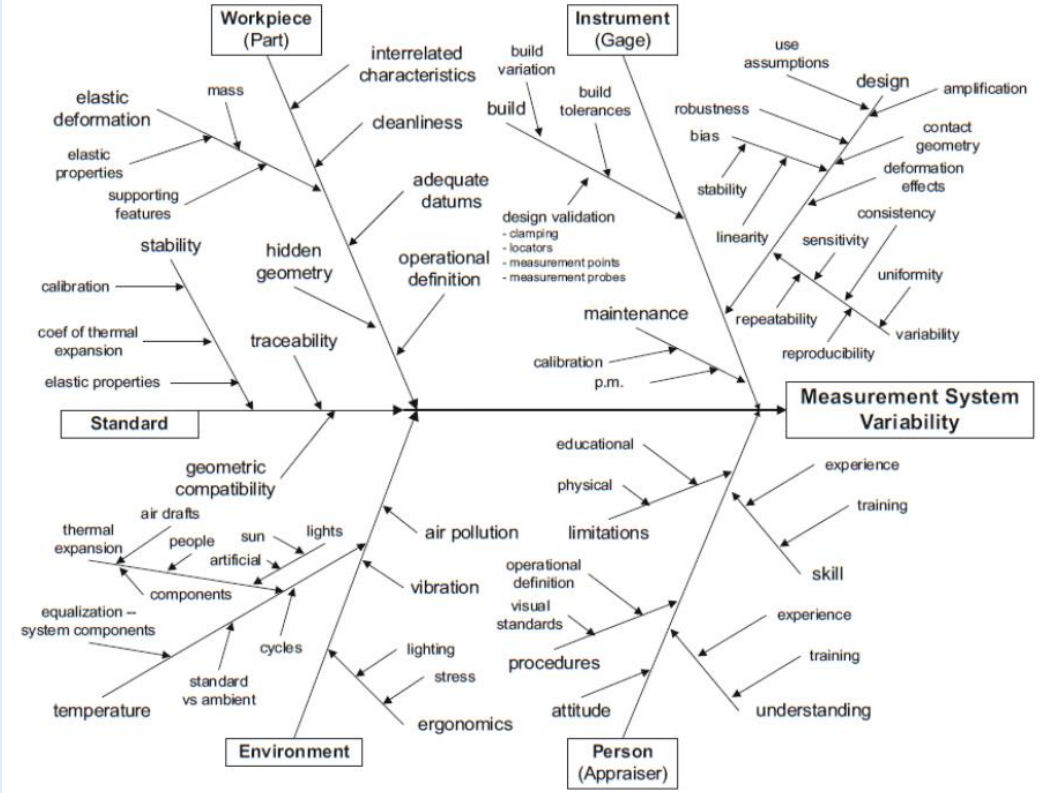
Data Quality

General Process

Measurement Process

	Measurement System Analysis	Descriptive Statistics	Inferential Statistics	Predictive Analytics	Prescriptive Analytics
Purpose	• Make sure measuring works • Do we agree on how we assess things? • Are we able to repeat and reproduce our measurements? • How much of the total variation is due to variation in the measurement system?	• Concise summary of data reporting *"state of the nation"* • Visualization of problems/ • opportunities	• Use a random sample of data from a population • Compare and conclude	• Improve process • Make predictions based on historical data • Focus on relation between two variables • Modelling	Prescriptive Analytics anticipate what will happen, when it will happen and why
Tool	• Gauge Reproducibility & Repeatability • Attribute Agreement Analysis	Boxplot, Histogram, Pareto, Scatter Plot, Capability, Control Charts etc.	Hypothesis Test	• Correlation • Simpel/Multiple Regression • Design of Experiment	• Optimization • Simulation

Sources of variation in measurement systems



Don´t believe you have valid measurement systems

- PROVE IT

Visual Inspection

Visual Inspection

Minitab - Minitab MSA operatør.MPJ1 (12).MPJ - [Worksheet 1 ***]

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↓	C1	C2-T	C3	C4-T	C5-T	C6-T
	RunOrder	Appraisers	Trials	Test Items	Results	Standards
1	1	Appraiser 1	1	Item 24	Bad	Bad
2	2	Appraiser 1	1	Item 26	Bad	Bad
3	3	Appraiser 1	1	Item 38	Bad	Bad
4	4	Appraiser 1	1	Item 7	Bad	Bad
5	5	Appraiser 1	1	Item 32	Good	Good
6	6	Appraiser 1	1	Item 48	Bad	Bad
7	7	Appraiser 1	1	Item 42	Bad	Bad
8	8	Appraiser 1	1	Item 8	Bad	Bad
9	9	Appraiser 1	1	Item 35	Bad	Bad
10	10	Appraiser 1	1	Item 4	Bad	Bad
11	11	Appraiser 1	1	Item 19	Bad	Good
12	12	Appraiser 1	1	Item 16	Bad	Bad
13	13	Appraiser 1	1	Item 6	Bad	Bad
14	14	Appraiser 1	1	Item 23	Bad	Bad
15	15	Appraiser 1	1	Item 33	Bad	Bad
16	16	Appraiser 1	1	Item 18	Good	Good
17	17	Appraiser 1	1	Item 37	Good	Good
18	18	Appraiser 1	1	Item 25	Good	Good

Attribute Agreement Analysis for Results

Within Appraisers

Assessment Agreement

Appraiser	# Inspected	# Matched	Percent	95% CI
Appraiser 1	50	44	88,00	(75,69; 95,47)
Appraiser 2	50	36	72,00	(57,51; 83,77)
Appraiser 3	50	29	58,00	(43,21; 71,81)

 # Matched: Appraiser agrees with him/herself across trials.

Fleiss' Kappa Statistics

Appraiser	Response	Kappa	SE Kappa	Z	P(vs > 0)
Appraiser 1	Good	0,839886	0,0816497	10,2865	0,0000
	Bad	0,839886	0,0816497	10,2865	0,0000
Appraiser 2	Good	0,615103	0,0816497	7,5334	0,0000
	Bad	0,615103	0,0816497	7,5334	0,0000
Appraiser 3	Good	0,305556	0,0816497	3,7423	0,0001
	Bad	0,305556	0,0816497	3,7423	0,0001

Visual Inspection

Each Appraiser vs Standard

Assessment Agreement

Appraiser	# Inspected	# Matched	Percent	95% CI
Appraiser 1	50	43	86,00	(73,26; 94,18)
Appraiser 2	50	35	70,00	(55,39; 82,14)
Appraiser 3	50	27	54,00	(39,32; 68,19)

 # Matched: Appraiser's assessment across trials agrees with the known standard.

Assessment Disagreement

Appraiser	# Bad / Good	Percent	# Good / Bad	Percent	# Mixed	Percent
Appraiser 1	0	0,00	1	4,00	6	12,00
Appraiser 2	1	4,00	0	0,00	14	28,00
Appraiser 3	0	0,00	2	8,00	21	42,00

 # Bad / Good: Assessments across trials = Bad / standard = Good.
 # Good / Bad: Assessments across trials = Good / standard = Bad.
 # Mixed: Assessments across trials are not identical.

Fleiss' Kappa Statistics

Appraiser	Response	Kappa	SE Kappa	Z	P(vs > 0)
Appraiser 1	Good	0,866549	0,0816497	10,6130	0,0000
	Bad	0,866549	0,0816497	10,6130	0,0000
Appraiser 2	Good	0,771136	0,0816497	9,4445	0,0000
	Bad	0,771136	0,0816497	9,4445	0,0000
Appraiser 3	Good	0,480766	0,0816497	5,8882	0,0000
	Bad	0,480766	0,0816497	5,8882	0,0000

Between Appraisers

Assessment Agreement

# Inspected	# Matched	Percent	95% CI
50	13	26,00	(14,63; 40,34)

 # Matched: All appraisers' assessments agree with each other.

Fleiss' Kappa Statistics

Response	Kappa	SE Kappa	Z	P(vs > 0)
Good	0,524341	0,0235702	22,2459	0,0000
Bad	0,524341	0,0235702	22,2459	0,0000

Gage Repeatability & Reproducibility

Gage R&R

Variance Components

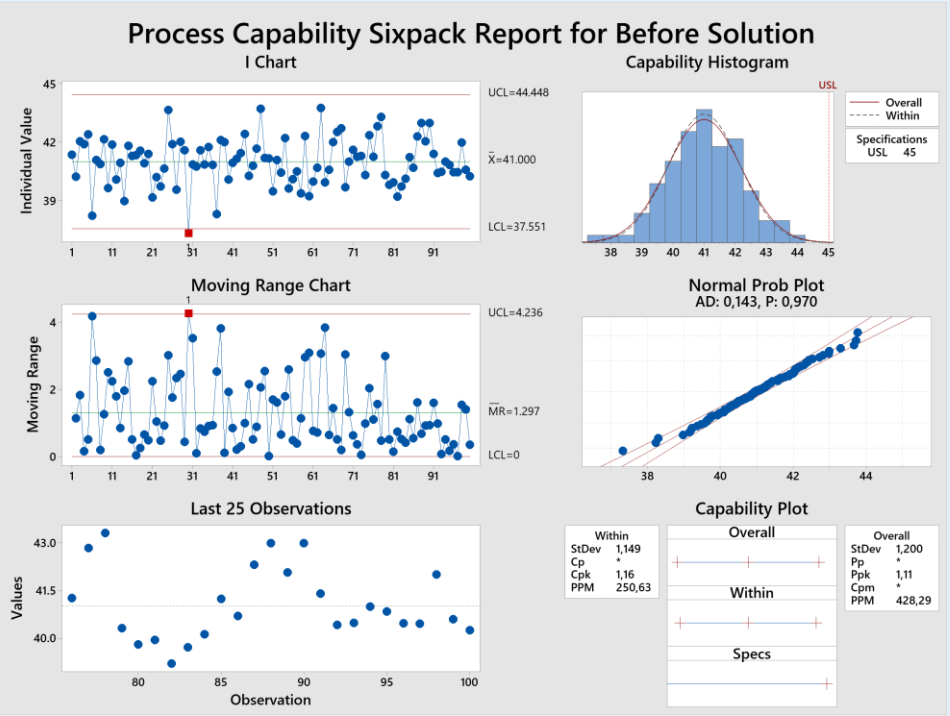
Source	VarComp	%Contribution (of VarComp)
Total Gage R&R	0,128	0,06
Repeatability	0,128	0,06
Reproducibility	0,000	0,00
Operators	0,000	0,00
Part-To-Part	229,770	99,94
Total Variation	229,898	100,00

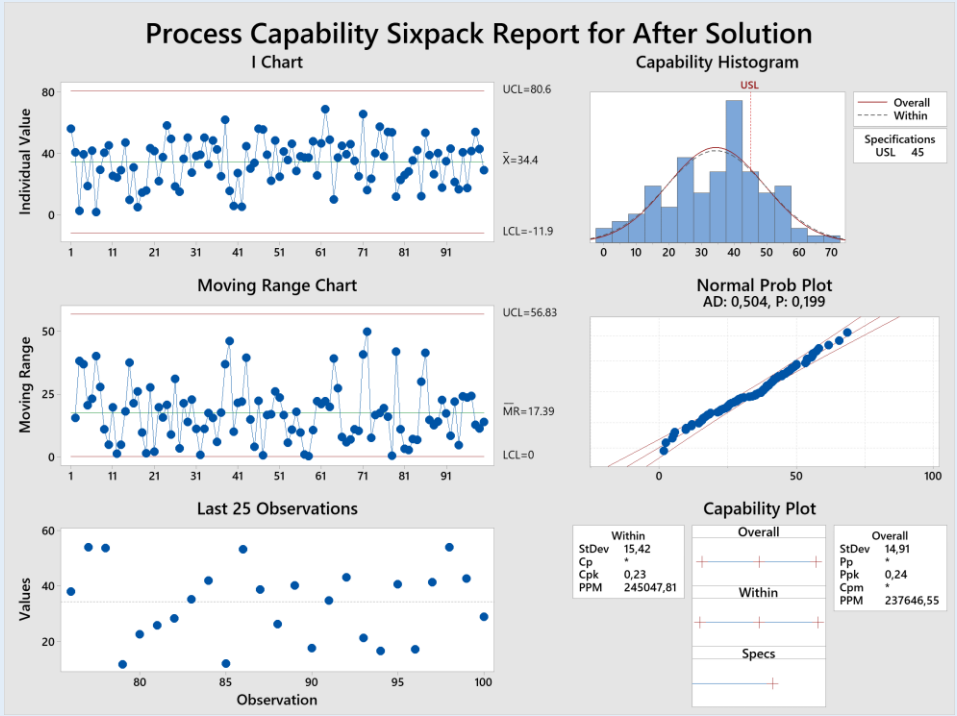
Gage Evaluation

Source	StdDev (SD)	Study Var (6 × SD)	%Study Var (%SV)
Total Gage R&R	0,3581	2,1488	2,36
Repeatability	0,3581	2,1488	2,36
Reproducibility	0,0000	0,0000	0,00
Operators	0,0000	0,0000	0,00
Part-To-Part	15,1582	90,9490	99,97
Total Variation	15,1624	90,9743	100,00

Number of Distinct Categories = 59

Is the optimized process performing better?





- Know your sampling theory
- Validate your data before you use them for anything – MSA
- Make sure your process is in control before improvements – BPM
- Measure your baseline/capability so you know if you are improving – Cpk/Ppk
- The mean is meaningless
- Involve leaders/managers
- Be preventive instead of reactive

“If you don’t measure, you don’t know if you are improving”

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