Applying 6 Sigma Roadmap for Improving Quality

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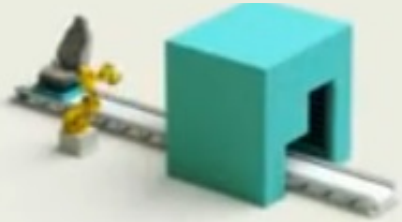
Peugeot 405 Seat Production Process

1. Forming of foam pad

2. Assembly of Cushion/ back frame

3. Assembly of injected parts

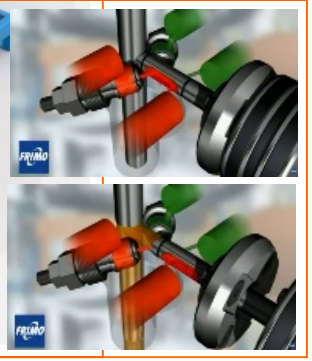
4. Heating
(Wrinkle removing)

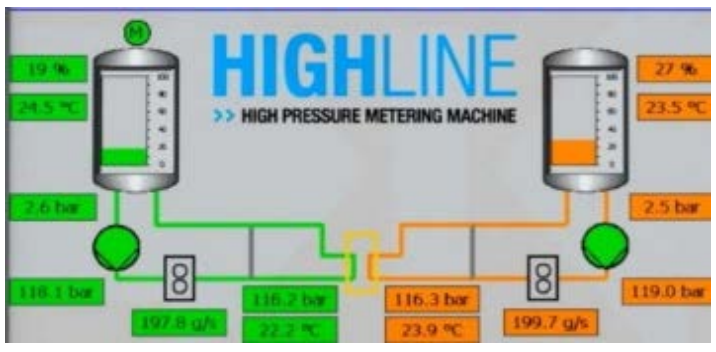


5. Inspection & electrical part test

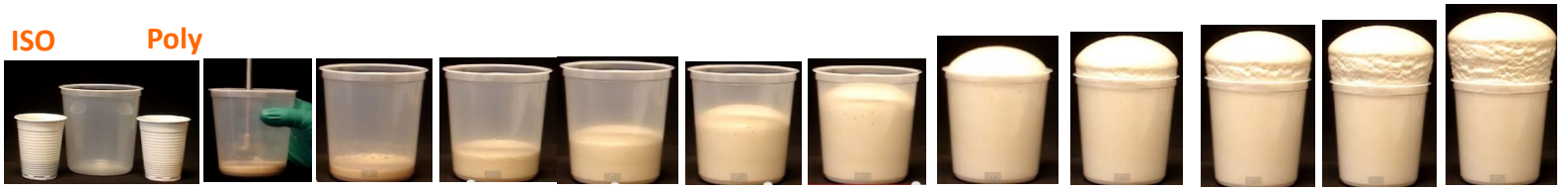
6. Delivery

What is the Polyurethane Foam?





ISO Poly



Mixing Process and Cream Time	Gel Time	Rise Time	Curing Time

Why was this project conducted?

Poor continues flow
(Internal Problem)

The defective percentage of *Peugeot 405 front seat back polyurethane flexible foam* (PUX26) was highest among other flexible foam products.

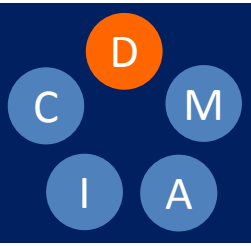
Poor DIFOT KPI
Delivered In-Full, On-Time

(External Problem)

Risk of loosing customers due to the poor delivery

Structure of this Study . . . . . .

- To Define the problem — D
- To measure the defective percentage — M
- To analyze the problem — A
- To improve the process parameters — I
- To control the process and go forward for restarting the 6 sigma roadmap for further improvement — C



Define Phase

Project Charter

Problem Statement

The major customer in Tehran was not satisfied with the delivery time. The DIFOT rate was bellow 90% on January while, other products DIFOT rate were above 98%.

Scope

Producing the seat back of Peugeot flexible foam product according to the required DIFOT KPI based on the defined lead time

Project Goals and Measures

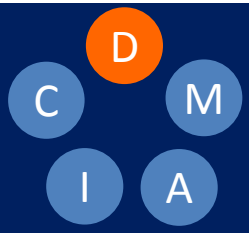
Reducing the defective percentage of ***PUX26****:*

- from 2σ to 4 σ level in 3 months
- from 4 σ to 5 σ level in another 5 months

Measures: 1-shaping the team, 2-providing required support 3-scheduling the project based on the 6 sigma principles

Expected Business outcomes

- Increasing customers' satisfaction by delivering on time
- Saving up to $330K per year by increasing σ level to 5



Measures in the Define Phase

Team Members

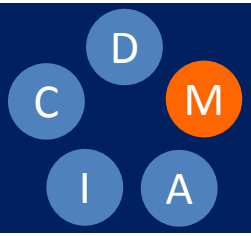
- Champion (Sponsor): Vali Aslani (QA Manager and ISO TS admin)
- Green Belt : Mohsen Shah Baghi
- Shift managers, Shift production line supervisors
- Maintenance and reliability, Engineering, QA & QC units representatives and OH&S officers

SIPOC

Suppliers	Inputs	Process	Output	Customer
External suppliers	Raw material	Set up	Production report	Internal Dep. and units
Production planning unit	Production plan	Production steps: -Mixing components -Chemical reaction and Curing -Demolding and pressing -Trimming and repairing	PUX26 Parts	Car manufacturer
Engineering Dep.	Machines, molds and equipments			
Maintenance Dep.	Energy			
Quality assurance and control Dep.	Technical documents, records and reports	Final control and stock		

CTQ Tree

Business Need	Drivers	Business Big Y's	Process y's
Fulfilling the external and internal customers' needs	- Improving DIFOT KPI - Producing products in an acceptable quality and time - Reducing cost	- increasing reliability - Reducing raw material consumption - Reducing operational cost	- Improving OEE KPI - Optimizing the new material formulation - Reducing defects & material waste



Data Collection Plan

Sub Process step	What	Data type	How Measured	Sampling notes	Sample size	Frequency	Who
mold preperation sub process	Mold Temperature	Continouos	Refer to the quality manual	Day- Night shift	250	Sampling in 10 Day & 10 Night shifts	Qualified QC Controller officer
Injection sub process setup	Iso Temp	Continouos	Refer to the quality manual	Day- Night shift	250		
Injection sub process setup	Poly Temp	Continouos	Refer to the quality manual	Day- Night shift	250		
Injection sub process setup	Polyol Pressure	Continouos	Refer to the quality manual	Day- Night shift	250		
Injection sub process setup	Iso Pressure	Continouos	Refer to the quality manual	Day- Night shift	250		
Injection sub process setup	Poly Ratio	Continouos	Refer to the quality manual	Day- Night shift	250		
Injection sub process setup	Product weight	Continouos	Refer to the quality manual	Day- Night shift	250		
QC sub process	Defects	Discerete	Refer to the quality manual	Day- Night shift	250		

Data Analyzing
Defect Concentration Diagram

Product code:	PUX26	Date:21/09/2005

Opportunities	Total number of samples	The total no. of opportunities	Defects	DPMO	Z_{ST}	Z_{LT}
26	250	6500	98	15076	3.67	**2.17**

Front side

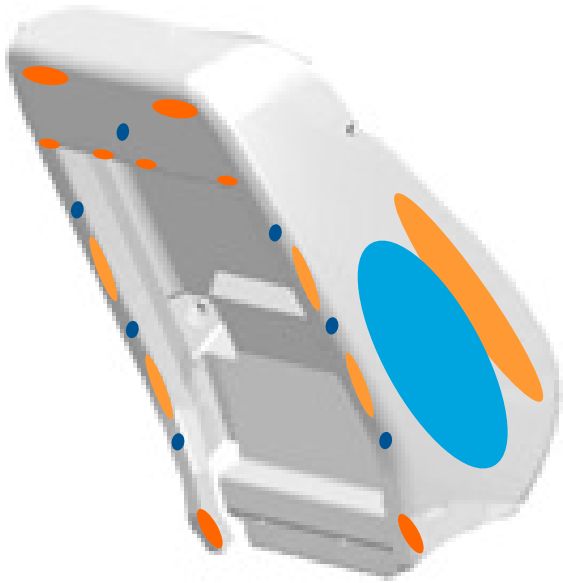
Air Trap

Under Filled Mould

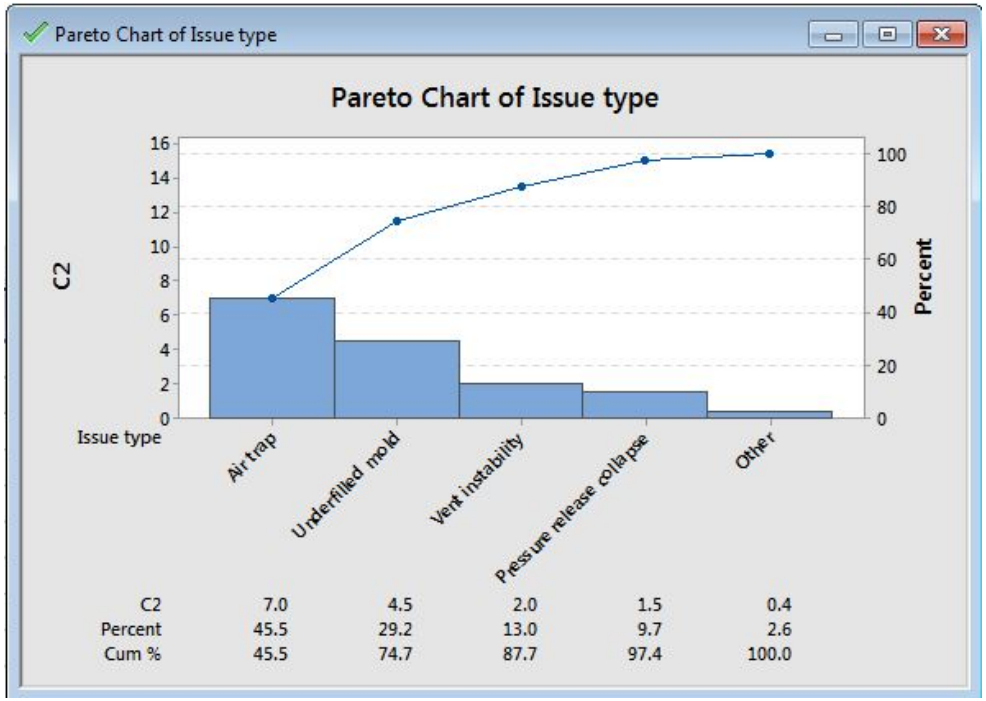
Vent Instability

P.R.C

Back side



Data Analyzing
Defect Concentration Diagram



5 Y's Analysis for Air trap problem:

Y1: Foam skin development prior air evacuation

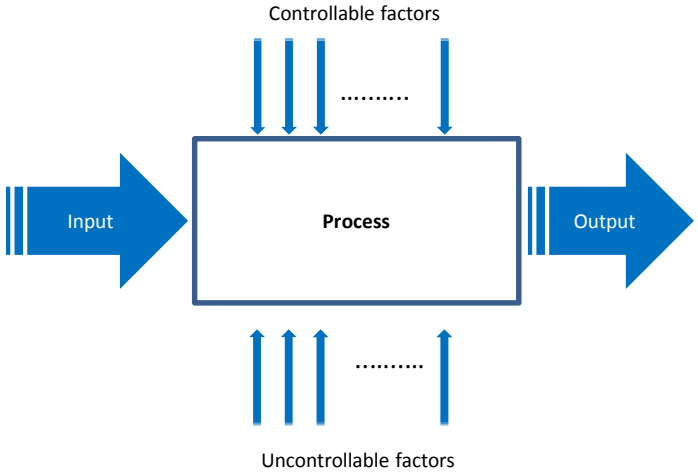
Y2: Cream and Gel time is not appropriate

Y3: Iso and Polyol formulation

Y4: Mechanical adjustment

Y5: Mold temp
Iso & Poly Temp
Pour Pattern
Vent type

Analysis Phase
Design of Experiment



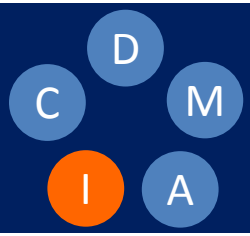
POSSIBLE CAUSES

PROBLEMS

PROBLEMS	Low temperature of iso and / or polyol	Substrate temperature too low	Loss of blowing agent from polyol	Off ratio - the amount of Isocyanate used is high	Insufficient mixing	Moisture in the polyol	Off ratio - the amount of polyol used is high	Moisture in the substrate	Moisture contamination - water in air supply	Check for contamination by silicone or grease lubricants	Check polyol reactivity	Raise temperatures of iso and polyol	Look for errors in machine metering	Catalyst deactivation	Check for lead/lag conditions	Mould temperature	Release agent quality	Wax-build-up	Optimize pour pattern and/or size of vent holes	Tilt the mould when pouring	Shot size	Increase rate of polymer gelation	Reduce air entrapment during liquid laydown	Lower temperature of components
Density is high	■	■	■	■	■																			
Density is low						■	■	■	■							■								
Underpacked cavity			■		■		■					■				■			■		■			
Friable- crumbles and lacks strength					■		■				■													
Voids				■	■	■	■	■		■	■		■						■				■	
Foam is slow to cure		■			■						■	■	■	■		■								

1	2	3	4	5	6	7	8
Mold Temperature	Polyol Pressure	Iso type	Iso Pressure	Poly type	Pour Pattern	Vent type	Product weight
40	110	1	110	1	1	64.5	740
46	115	2	115	2	2	66	750
	120	3	120	3	3	67.5	760

Number of experience in full factorial experiment: 2×3×3×3×3×3×3×3=4374



Analysis Phase
Taguchi Method

↓	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13
	Mold Temperature	Polyol Pressure	Iso type_1	Iso Pressure_1	Poly Type	Pour Pattern	Vent type	Product weight	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
1	40	110	1	110	1	1	1	740	1	2	1	1	0
2	40	110	2	115	2	2	2	750	2	0	2	0	1
3	40	110	3	120	3	3	3	760	3	1	0	1	0
4	40	115	1	110	2	2	3	760	2	2	3	3	2
5	40												
6	40												
7	40												
8	40												
9	40												
10	46												
11	46												
12	46												
13	46												
14	46												
15	46												
16	46												
17	46												
18	46												

Taguchi Analysis: Sample 1, Sample 2, ... versus Mold Tempera, Polyol Press, ...

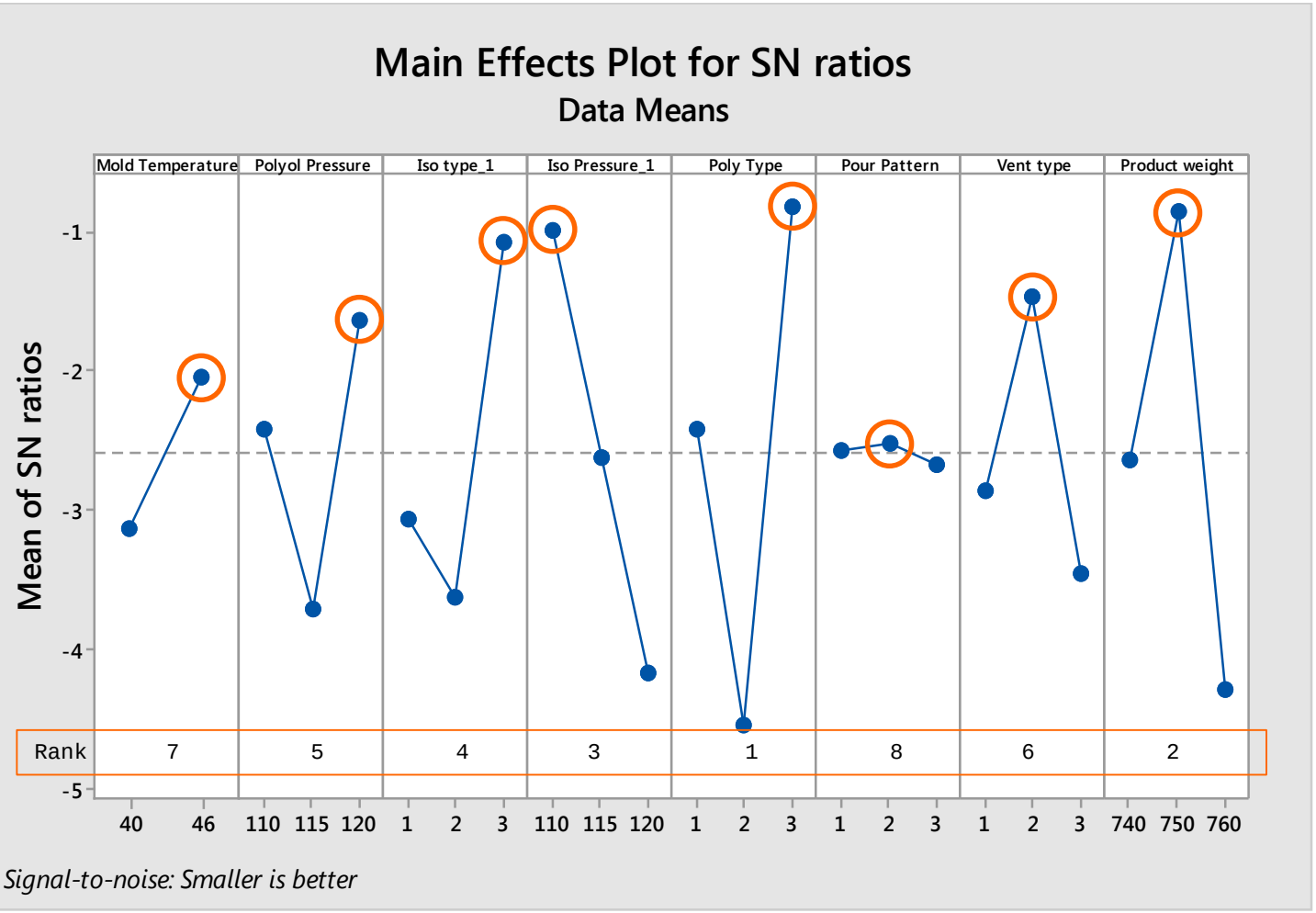
Response Table for Signal to Noise Ratios
Smaller is better

Level	Mold Temperature	Polyol Pressure	Iso type_1	Iso Pressure_1	Poly Type	Pour Pattern	Vent type	Product weight
1	-3.1333	-2.4104	-3.0574	-0.9797	-2.4104	-2.5734	-2.8585	-2.6313
2	-2.0430	-3.7167	-3.6288	-2.6150	-4.5409	-2.5233	-1.4537	-0.8404
3		-1.6373	-1.0782	-4.1698	-0.8131	-2.6677	-3.4522	-4.2927
Delta	1.0903	2.0794	2.5506	3.1902	3.7278	0.1443	1.9985	3.4523
Rank	7	5	4	3	1	8	6	2

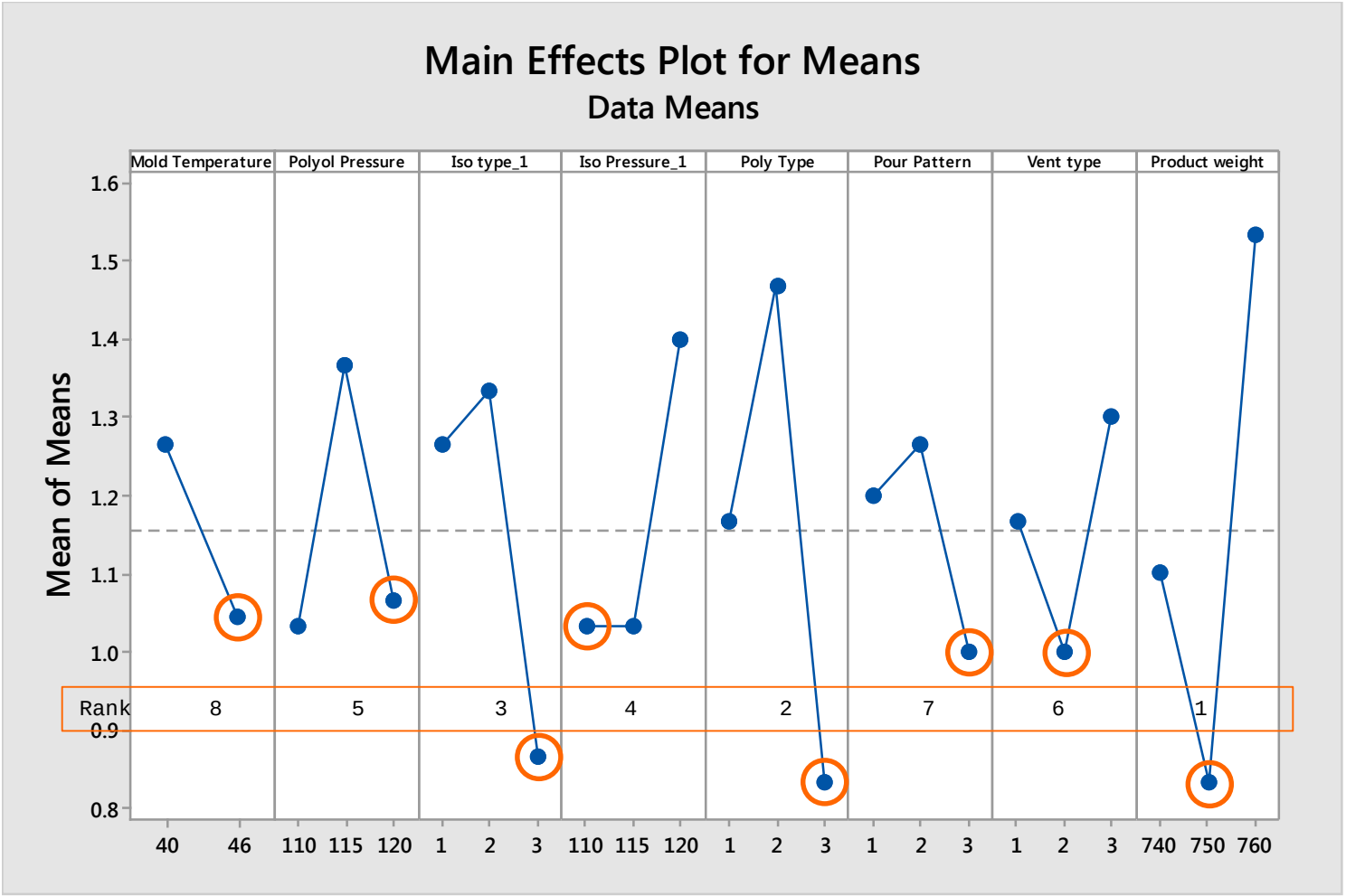
Response Table for Means

Level	Mold Temperature	Polyol Pressure	Iso type_1	Iso Pressure_1	Poly Type	Pour Pattern	Vent type	Product weight
1	1.2667	1.0333	1.2667	1.0333	1.1667	1.2000	1.1667	1.1000
2	1.0444	1.3667	1.3333	1.0333	1.4667	1.2667	1.0000	0.8333
3		1.0667	0.8667	1.4000	0.8333	1.0000	1.3000	1.5333
Delta	0.2222	0.3333	0.4667	0.3667	0.6333	0.2667	0.3000	0.7000
Rank	8	5	3	4	2	7	6	1

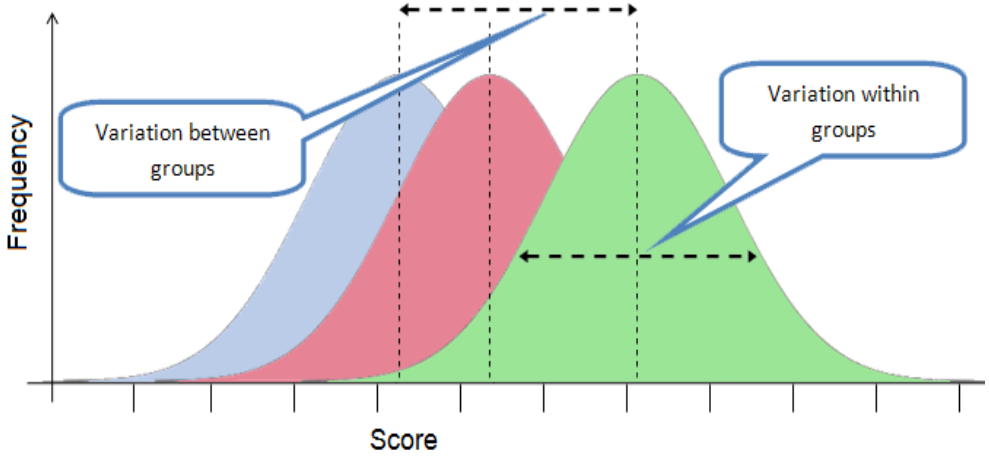
Analysis Phase
Taguchi Method

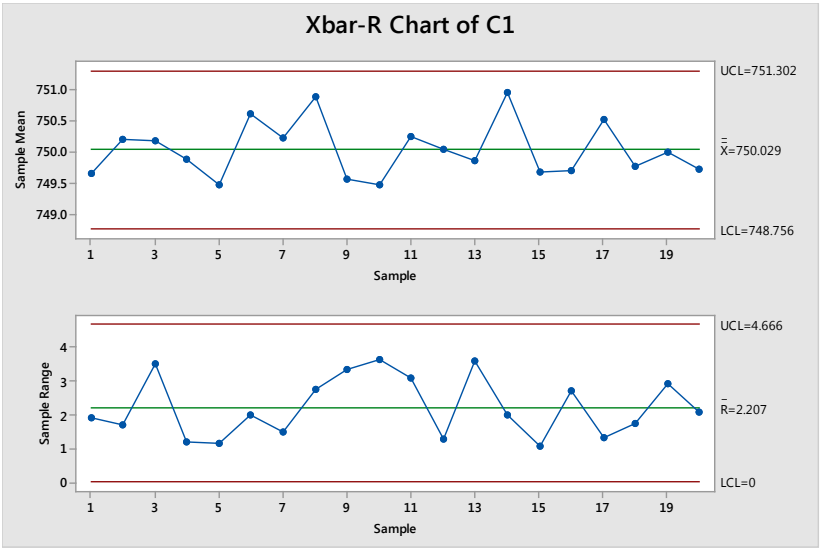


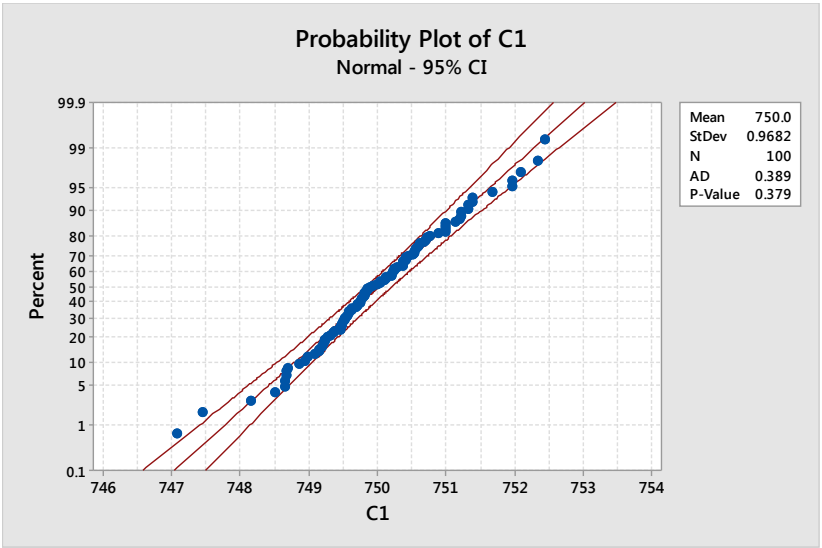
Analysis Phase
Taguchi Method



Control Phase
SPC







Outcome of the Study

Reducing defective percentage of PUX26
from 17% to below 1% in 3 months and 0.1% in another 2 months

Selected projects and actions:

- Performing MSA project on dosing system and increasing process capability above 5σ
- Designing new vent to reduce martial scrap
- Reducing variations in mold temperature
- Analysing the pour pattern
- Performing FMEA
- Running DOE using Taguchi method
- Performing DOE using full factorial analysis
- Study validating
- Using SPC (statistical process control) to control the key process parameters

Suggestions for future study:

- Using 3 mixing head for pouring 2 arms and body of back seat foam at the same time
- Working on other priorities which was highlighted on FMEA

Applying 6 Sigma Roadmap

for Improving Quality

Thank You!

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