

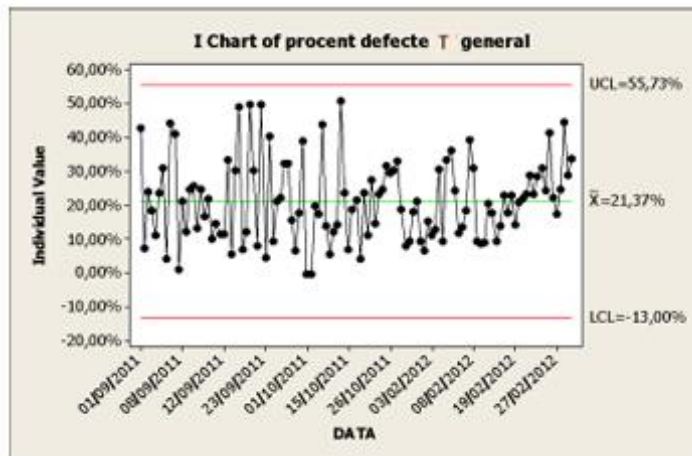
# Case Study

## Process Optimization Through Six Sigma Methodology

### Initial Situation:

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- The client was experiencing a high incidence of cosmetic defects on one of their products.
  - These defects originated during the plastic injection molding process performed on a vertical injection machine
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### Activities performed:

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- The client participated in Six Sigma training with EFFECTIVE FLUX and, in parallel, worked on the project between training modules
- The consultant monitored and provided support throughout the project implementation over a six-month period

### Project Implementation:

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- The improvement project was carried out following the Six Sigma DMAIC methodology.
  - Define > Measure > Analyze > Improve > Control
  - To ensure fast and accurate data processing, the MINITAB software was used
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# Case Study

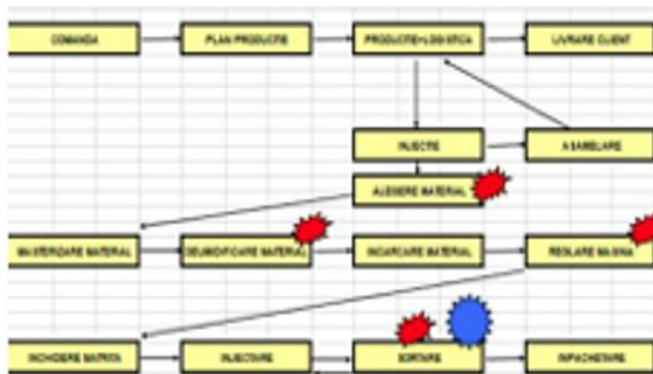
## Define

### Define:

- Design the project charter.
- Define the project objective: Decrease the reject rate from 21% to 13%
- Estimate the savings: 18000 Euro / year

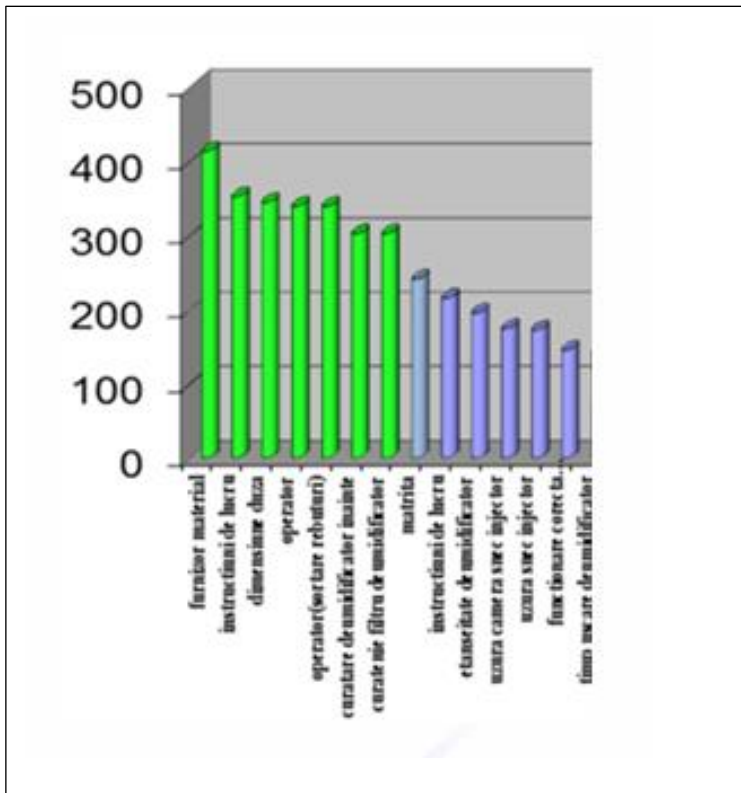
Project Charter

Titlu proiect: Inalta		Proiect care va reduce rata de rejectare		Localitate		1101 Ploiesti 1918	
Conducatorul proiectului		1500000 Euro		Data inceperii proiectului		21.11.2012	
Data inceperii		01.02.2012		Data planului de finalizare		01.02.2012	
Data finalizării		31.01.2012		Data planului de finalizare		31.01.2012	
Mantuire		70.000.000 Euro		Tipul proiectului		Proiect de dezvoltare	
Durata		11.000.000 Euro		Tipul proiectului		Proiect de dezvoltare	
Costul		11.000.000 Euro		Tipul proiectului		Proiect de dezvoltare	



### Measure:

- In this phase, the process was described and the areas where the root causes would be investigated were identified.
- Potential causes were identified using the IPO diagram and the Prioritization Matrix
- The 7 most significant factors were selected out of the 44 initially identified
- The accuracy of defect inspection was verified using MSA, and actions were taken to improve it



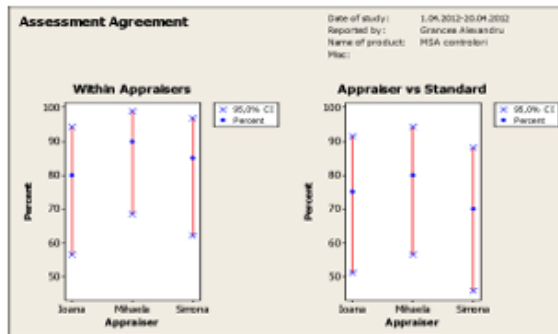
# Case Study Measure

## Measure:

- We defined the data collection plan.
- Each variable was described in detail, including how, where, by whom, and with what it would be collected.

DATA COLLECTION PLAN									
Project name: Raduceni reabilitare la specialitate ca ET									
Process name:									
Data plan prepared by: George Vancea									
Period from and to: 15.05.2012-14.07.2012									
Variable Name	Sample Size Required	Variable Type	Operational Definition	Who is responsible for collection	When will data be collected	How will data be collected	Where will the data be collected	MSA if applicable	
Dimensiune cuca (nr. matrice)	100%	Attributiv	Se numara numarul matriti pe care se lucrasa/lec 9-12"	Operatori	24h/24h	observare si fotografare	Faza de colectare date	Faza de aplicatie	None
Familie material	100%	Attributiv	Se numara functional materialul de ce calitate si cu care se lucrasa/lec ET B&SF	Operatori	24h/24h	observare si fotografare	Faza de colectare date	Faza de aplicatie	None
Procentaj defecte	100%	Continuu	Se numara pe fiecare colectare date fiecare piesa defecta conform procedurilor de control	Operatori	24h/24h	observare si fotografare	Faza de colectare date	Gage M&R	None

## Measure:



- We collect data.

- To prevent measurement errors, the accuracy of defect inspection was verified using MSA.
- It was found that improvements to the measurement system were necessary, and corrective actions were taken
- The measurement system accuracy was re-evaluated and found to be capable

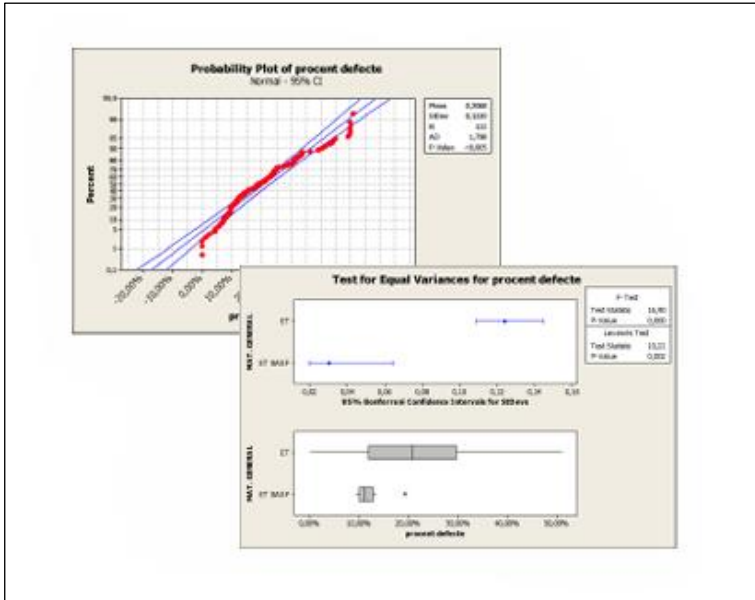
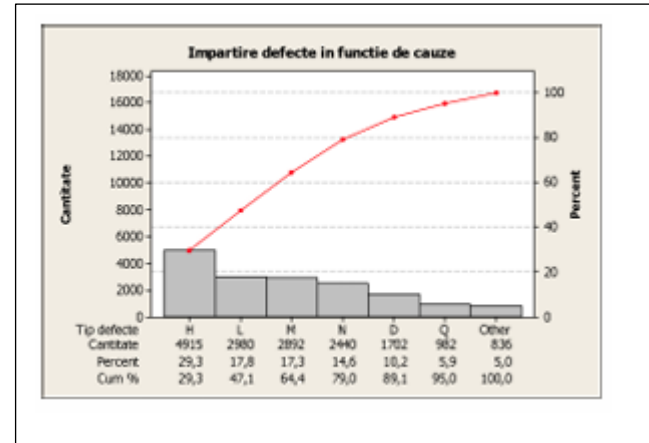
DATA	MESE	NR COMI	NR BUCINA	A/B/D/O	STAMPO	STAMPO GENERAL	NLT GENERAL	MATERIALE	COD COLORE	DESCR COLORE	TAGLIA	QTA DOPPI
01.08.2011	9	00876	7-8h	09.2047.00.18h	802	GT	7h	PSO sprink 50	07.455	gr 0 0% gr 0 0	235	116
01.08.2011	9	00875	7-8h	09.2033.00.18h	802	GT	ET	MS 2p.080m	07.444	gr 0 0% gr 0 0	235	172
01.08.2011	9	00876	7-8h	09.2047.00.18h	802	GT	7h	PSO sprink 50	07.455	gr 0 0% gr 0 0	235	272
01.08.2011	9	00893	14-18h	09.2903.00.18h	801	BC	7h	gr 80-80	07.208	gr 0 0% gr 0 0	245	216
01.08.2011	9	00876	9-10h	09.2046.00.22h	801	BC	7h	gr top 55-tr top 45	07.442	gr 0 0% gr 0 0	245	264
01.08.2011	9	00876	9-10h	09.2046.00.22h	801	BC	7h	gr top 55-tr top 45	07.442	gr 0 0% gr 0 0	275	80
01.08.2011	9	00875	14-18h	09.2033.00.18h	802	GT	7h	gr top 55-tr top 45	07.508	gr 0 0% gr 0 0	255	352
02.08.2011	9	00875	7-8h	09.2033.00.18h	802	GT	ET	MS 2p.080m	07.444	gr 0 0% gr 0 0	235	172
02.08.2011	9	00875	7-8h	09.2033.00.18h	802	GT	ET	MS 2p.080m	07.444	gr 0 0% gr 0 0	275	208
02.08.2011	9	00893	14-18h	09.2903.00.18h	801	BC	7h	gr 80-80	07.208	gr 0 0% gr 0 0	265	312
02.08.2011	9	00892	9-10h	09.2903.00.18h	801	BC	7h	gr 80-80	06.874	gr 0 0% gr 0 0	255	064
02.08.2011	9	00893	14-18h	09.2903.00.18h	801	BC	7h	gr 80-80	07.208	gr 0 0% gr 0 0	255	456
02.08.2011	9	00893	14-18h	09.2903.00.18h	801	BC	7h	gr 80-80	07.208	gr 0 0% gr 0 0	235	124
02.08.2011	9	00892	9-10h	09.2903.00.18h	801	BC	7h	gr 80-80	06.874	gr 0 0% gr 0 0	235	182
02.08.2011	9	00879	7-8h	09.2047.00.18h	802	GT	7h	PSO sprink 50	07.507	gr 0 0% gr 0 0	255	682

# Case Study

## Analize

### Graphical analysis:

- Based on the collected data, graphical analyses were performed.
- Graphical tools such as Pareto charts, Box Plots, and Histograms provided stronger insights into the potential causes.



### Analytical analysis:

- Analytical analysis was performed using Hypothesis Testing techniques.
- Tools used: Normality Test, ANOVA, Mood's Median Test.
- Only two factors were proven to be actual causes (with a statistically significant impact on the defect rate): the machine and the supplier.

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Mood median test for percent defects
Chi-Square = 5,73      DF = 1      P = 0,017

MAT.
GENERAL  N<=  N>  Median  Q3-Q1  Individual 95,0% CIs
ET        59   65   0,206  0,177  -----+-----+-----+-----+
ET BASF   8    1    0,109  0,028  {--+-----}  {-----+-----}
                                         0,120    0,160    0,200    0,240

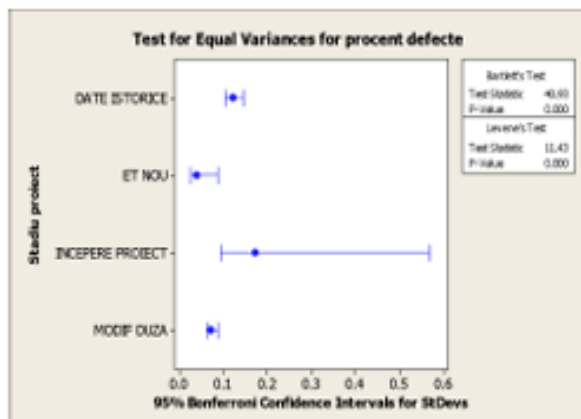
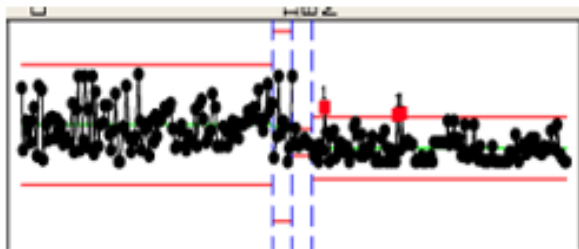
Overall median = 0,189

A 95,0% CI for median(ET) - median(ET BASF): (0,057;0,114)
    
```

# Case Study Improvement

## Implemented measures:

- For the machine: the injection rod length was adjusted.
- For the suppliers: the supplier was changed.
- Other measures: periodic checks of the humidifier and periodic verification of the inspection accuracy



## Verification of the impact of the measures:

- Using the control chart, it was observed that after implementation, the average defect rate decreased from 21% to 8%.
- Hypothesis testing tools were used to demonstrate whether the improvement was statistically significant.
- It was thus proven that, after the final implemented measures, the improvement is statistically significant
- Recalculated annual savings: €32,500

### Mood Median Test: procent defects versus Stadiu proiect

Mood median test for procent defects  
Chi-Square = 63.02 DF = 3 P = 0.000

Stadiu proiect	N<=	N>	Median	Q3-Q1	Individual 95.0% CIs
DATE ISTORICE	30	90	0.208	0.177	{--*}
ET NOU	8	2	0.099	0.033	{--*}
INCEPERE PROIECT	2	4	0.155	0.216	{--*}
MODIF DUZA	85	28	0.071	0.100	{--*}

Overall median = 0.118

# Case Study

## Control. Project closure

### Measures to Sustain Improvements:

- Updating instructions/procedures for determining the nozzle size and selecting the material supplier.
- Modifying the procedure for inspector evaluation.

### Deployment:

- The deployment of the measures to other processes was evaluated.
- It was decided to implement the same measures in a similar process at another plant within the group.

PARTICOLARE: <u>GC 301</u>		MATERIALE: <u>EVC 210/30</u>							
DATA: <u>16/08/05</u>	MACCHINA N°: <u>10-10H</u>	GRUPPO: <u>CIMA 500</u>	DATA FINE: <u>9/08/05</u>						
COLORE: <u>GR-GR-GR/GR-GR-GR</u>	VELOCITÀ: _____	PARA FINE: _____							
PARAMETRI TECNICI DI LAVORAZIONE									
TEMPERATURE °C		ESIBIZIONE							
JAWA 1:	<table border="1"><tr><td>180</td><td>190</td></tr></table>	180	190	ANCONE n°:	<table border="1"><tr><td>17</td><td>20</td></tr></table>	17	20		
180	190								
17	20								
JAWA 2:	<table border="1"><tr><td>190</td><td>180</td></tr></table>	190	180	P/air:	<table border="1"><tr><td>51</td><td>55</td></tr></table>	51	55		
190	180								
51	55								
JAWA 3:	<table border="1"><tr><td>190</td><td>185</td></tr></table>	190	185	VELOCITÀ ANCONE:	<table border="1"><tr><td>50/21</td><td>65/20</td></tr></table>	50/21	65/20		
190	185								
50/21	65/20								
JAWA 4:	<table border="1"><tr><td>180</td><td>185</td></tr></table>	180	185	CONDIZIONE n°:	<table border="1"><tr><td>20</td><td>20</td></tr></table>	20	20		
180	185								
20	20								
MODELLO:	<table border="1"><tr><td>220</td><td>210</td></tr></table>	220	210	N. GRVITE:	<table border="1"><tr><td>75</td><td>65</td></tr></table>	75	65		
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(2-10)	(2-10)								
55	75								
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TEMPO PRESSIONE P:		TEMPO FINISCHIAMANTI:							
TEMPO OCIO:	<table border="1"><tr><td>15</td><td></td></tr></table>	15							
15									
PESCI STAMPATI (in pezzi) - Da inviare sempre									
MATERIALE P:	<table border="1"><tr><td></td><td></td></tr></table>			ESAMINATA P:	<table border="1"><tr><td></td><td></td></tr></table>				
PARA FINE/GRUPPO:		PESCI RIFORNITI:							
ANCONE FREDA USI ATTILATORI CHE POSSONO TALLARE LA PEGRA									

### Project closure:

- Documented with a Sign-Off Sheet.
- This document includes the objective – defect rate, initial state (21%), target (13%), and achieved value (8%).
- It was approved by the hierarchical manager, the financial representative, and the General Manager