FMEA
Failure Mode and Effects Analysis

1st Workshop on „QA Issues in Silicon Detectors"
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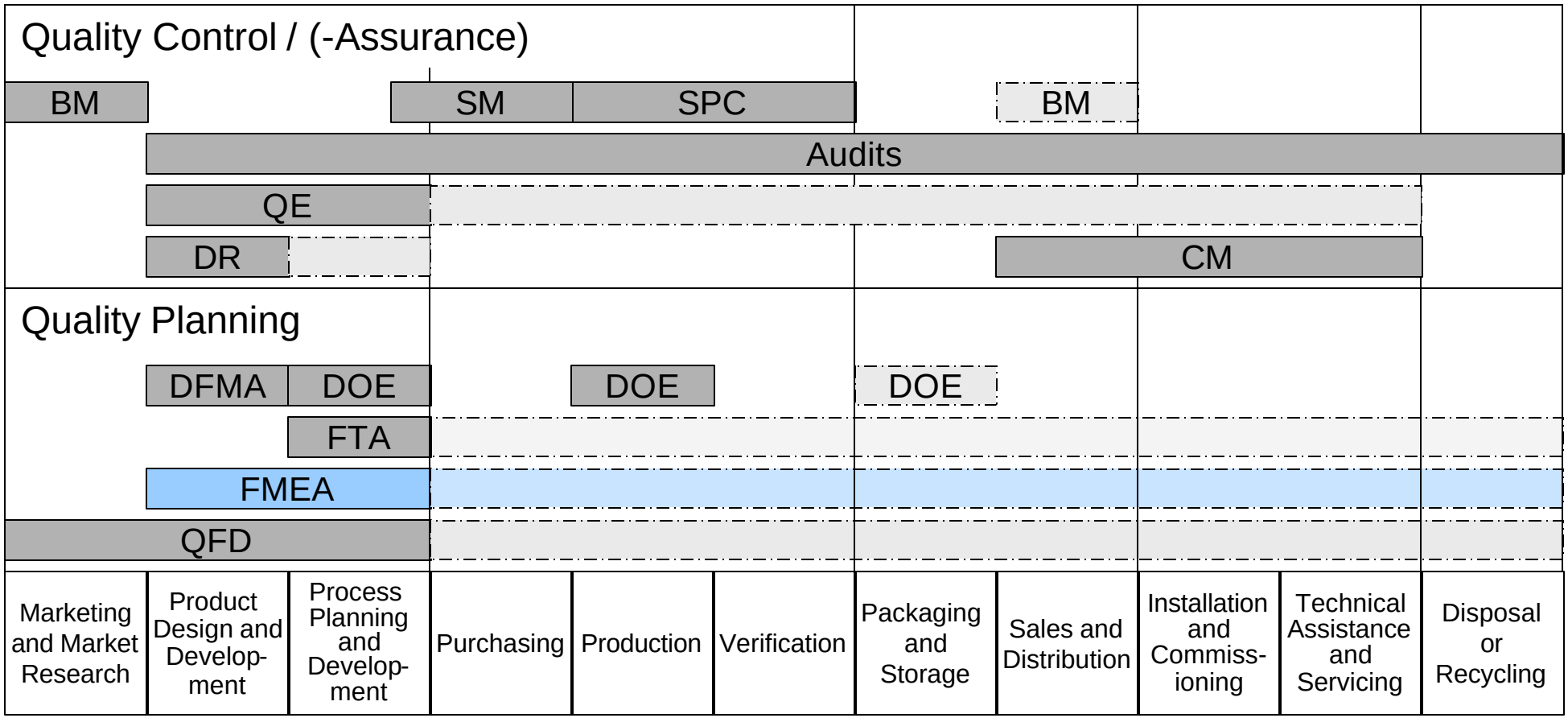
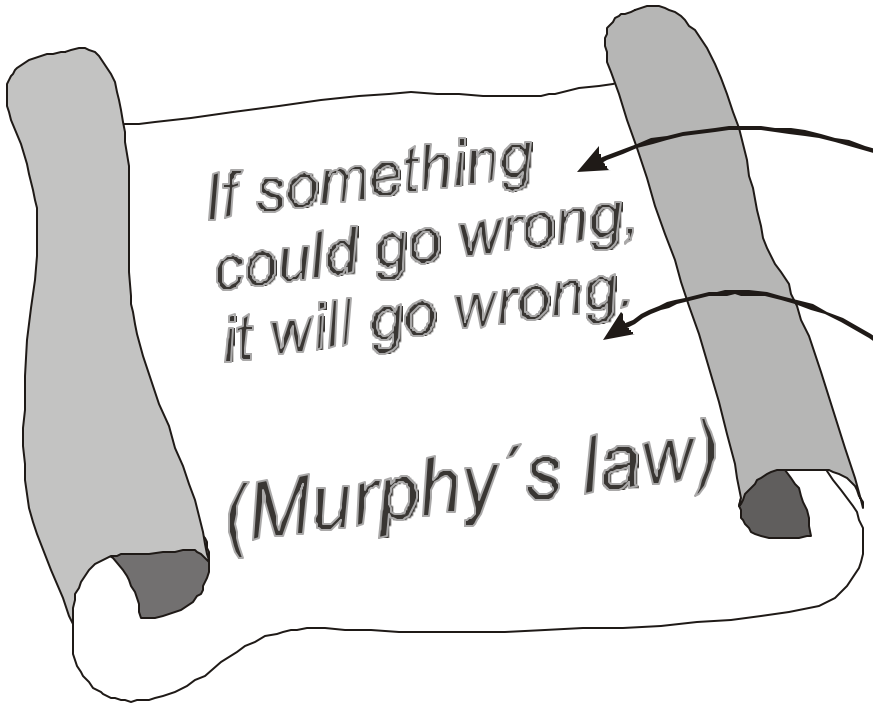


Use of Quality Management Methods



FMEA
prevents things
from going wrong.

1. Find out, what
could go wrong

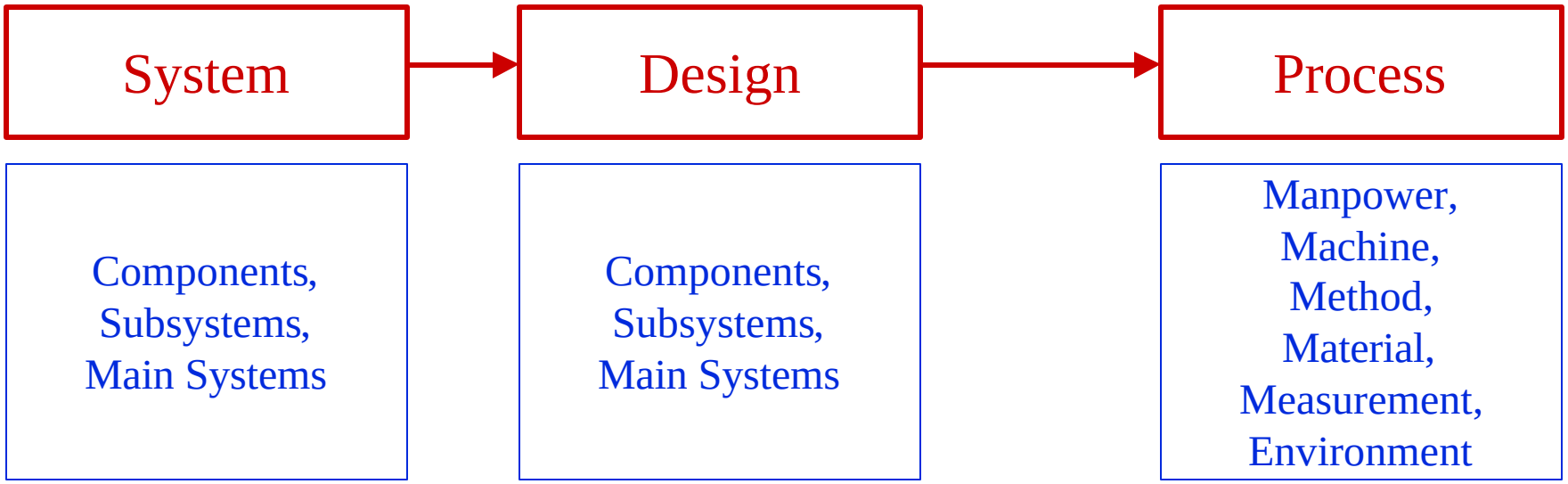
2. What can be
done about it ?

[Source: WZL]

FMEA is ....

an Advanced Quality Planing tool used to evaluate potential failure modes and their causes.

- Prioritizes Potential Failures according to their Risk and drives actions to eliminate or reduce their likelyhood of occurance.
- Provides a discipline for documenting this analysis for future use and continuous process improvement.



Focus:

Minimize failure effects on the System.

Objective/Goal:

Maximize System quality, reliability, cost and maintainability.

Focus:

Minimize failure effects on the Design.

Objective/Goal:

Maximize Design quality, reliability, cost and maintainability.

Focus:

Minimize process failures effects on the Total Process.

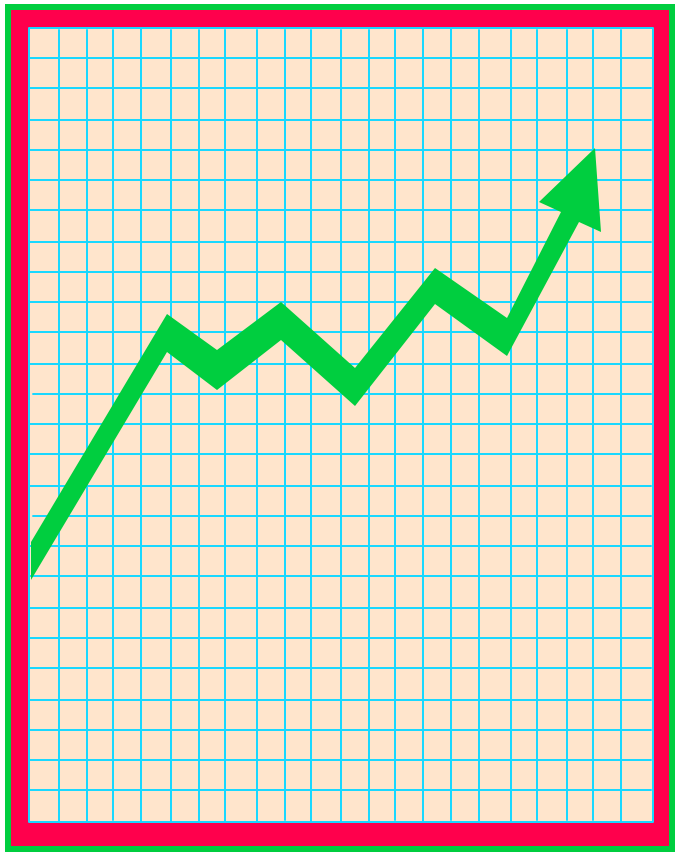
Objective/Goal:

Maximize Total Process quality, reliability, cost, productivity and maintainability.

Types of FMEAs

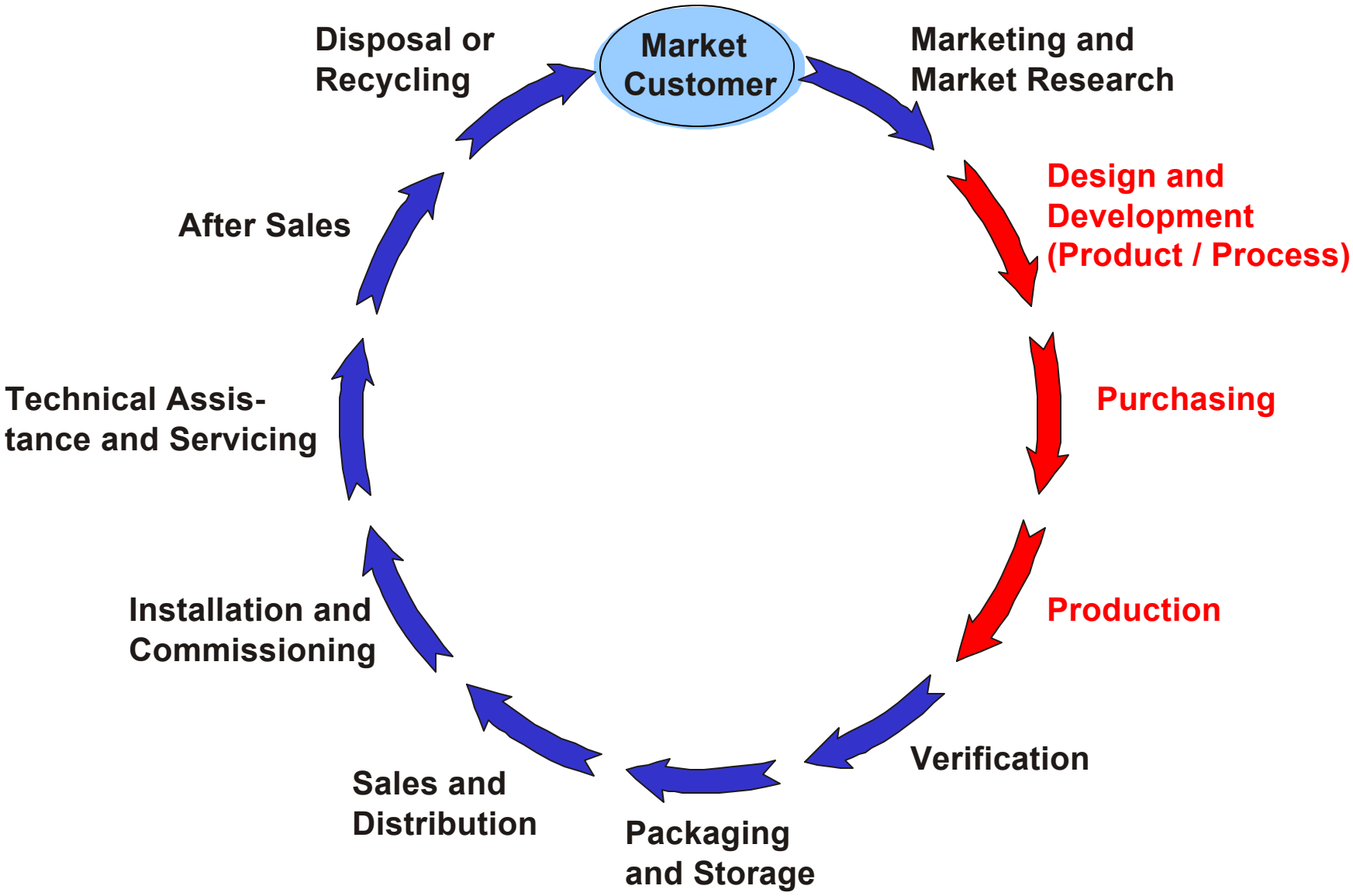
Advantages:

- Prevention Planning
- Identifies change requirements
- Cost reduction
- Increased through-put
- Decreased waste
- Decreased warranty costs
- Reduce non-value added operations



Before starting a FMEA:

- Select proper team and organize members effectively
- Select teams for each product/service, process/system
- Create a ranking system
- Define the customer and customer needs/expectations
- Design/Process requirements
- Develop a process flow chart


Market Customer
Marketing and Market Research
Design and Development (Product / Process)
Purchasing
Production
Verification
Packaging and Storage
Sales and Distribution
Installation and Commissioning
Technical Assis-tance and Servicing
After Sales
Disposal or Recycling

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(PROCESS FMEA)

FMEA Number 1450 (1)

Page 1 of 1

Item Front Door L.H./H8HX-000-A (2)

Process Responsibility Body Engrg./Assembly Operations (3)

Prepared By J. Ford - X6521 - Assy Ops (4)

Model Years(s)/Vehicle(s) 199X/Lion 4dr/Wagon (5)

Key Date 9X 03 01 ER 9X 08 26 Job #1 (6)

FMEA Date (Orig.) 9X 05 17 (Rev.) 9X 11 06 (7)

Core Team A. Tate Body Engrg., J. Smith-QC, R. James-Production, J. Jones-Maintenance (8)

Process Function / Requirements (9)	Potential Failure Mode (10)	Potential Effect(s) of Failure (11)	Sev (12)	Class	Potential Cause(s)/ Mechanism(s) of Failure (13)	Occur (14)	Current Process Controls (15)	Detec (17)	R.P.N.	Recommended Action(s) (18)	Responsibility & Target Completion Date (19)	Action Results: Actions Taken (20)	Sev (21)	Occ	Det	R.P.N. (22)
Manual application of wax inside door	Insufficient wax coverage over specified surface	Deteriorated life of door leading to: • Unsatisfactory appearance due to rust through paint over time • Impaired function of interior door hardware	7		Manually inserted spray head not inserted far enough	8	Visual check each hour-1/shift for film thickness (depth meter) and coverage	5	280	Add positive depth stop to sprayer	MFG Engrg 9X 10 15	Stop added, sprayer checked on line	7	2	5	70
										Automate spraying	Mfg Engrg 9X 12 15	Rejected due to complexity of different doors on same line				
To cover inner door, lower surfaces at minimum wax thickness to retard corrosion					Spray heads clogged - Viscosity too high - Temperature too low - Pressure too low	5	Test spray pattern at start-up and after idle periods, and preventative maintenance program to clean heads	3	105	Use Design of Experiments (DOE) on viscosity vs. temperature vs. pressure	Mfg Engrg 9X 10 01	Temp and press limits were determined and limit controls have been installed - control charts show process is in control Cpk=1.85	7	1	3	21
					Spray head deformed due to impact	2	Preventative maintenance programs to maintain head	2	28	None						
					Spray time insufficient	8	Operator instructions and lot sampling (10 doors / shift) to check for coverage of critical areas	7	392	Install spray timer	Maintenance 9X 09 15	Automatic spray timer installed - operator starts spray, timer controls shut-off control charts show process is in control Cpk=2.05	7	1	7	49

Example: Process FMEA [QS 9000]

Process Function (9) Requirements	Potential Failure Mode (10)	Potential Effect(s) of Failure (11) (12)	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure (13) (14)	Occur	Current Process Controls (15) (16) (17)	Detec	R.P.N.	Recom Acti (18) (1
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To cover inner door, lower surfaces at minimum wax thickness to retard corrosion					Spray heads clogged - Viscosity too high - Temperature too low - Pressure too low	5	Test spray pattern at start-up and after idle periods, and preventative maintenance program to clean heads	3	105	Use Des Experim (DOE) or viscosity temperat pressure
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Core of a FMEA

Do NOT mix up:

Design Failures & Causes

with

Process Failures & Causes

Design Failures	Process Failures
Insufficient lubrication capability	Insufficient lubrication applied
Incorrect material specified	Incorrect material used

Effect	Criteria: Severity of Effect	Ranking
Hazardous-without warning	May endanger machine or assembly operator. Very high severity ranking when a potential failure mode affects safe vehicle operation and/or involves noncompliance with government regulation. Failure will occur without warning.	10
Hazardous-with warning	May endanger machine or assembly operator. Very high severity ranking when a potential failure mode affects safe vehicle operation and/or involves noncompliance with government regulation. Failure will occur with warning.	9
Very High	Major disruption to production line. 100% of product may have to be scrapped. Vehicle/item inoperable, loss of primary function. Customer very dissatisfied.	8
High	Minor disruption to production line. Product may have to be sorted and a portion (less than 100%) scrapped. Vehicle operable, but at a reduced level of performance. Customer dissatisfied.	7
Moderate	Minor disruption to production line. A portion (less than 100%) of the product may have to be scrapped (no sorting). Vehicle/item operable, but some Comfort/Convenience item(s) inoperable. Customers experiences discomfort.	6
Low	Minor disruption to production line. 100% of product may have to be reworked. Vehicle/item operable, but some Comfort/Convenience item(s) operable at reduced level of performance. Customer experiences some dissatisfaction.	5
Very Low	Minor disruption to production line. The product may have to be sorted and a portion (less than 100%) reworked. Fit & Finish/Squeak & Rattle item does not conform. Defect noticed by most customers.	4
Minor	Minor disruption to production line. A portion (less than 100%) of the product may have to be reworked on-line but out-of-station. Fit & Finish/Squeak & Rattle item does not conform. Defect noticed by average customers.	3
Very Minor	Minor disruption to production line. A portion (less than 100%) of the product may have to be reworked on-line but in-station. Fit & Finish/Squeak & Rattle item does not conform. Defect noticed by discriminating customers.	2
None	No effect.	1

Criteria: Severity

Probability of Failure	Possible Failure Rates	Cpk	Ranking
Very High: Failure is almost inevitable	≥ 1 in 2	<0.33	10
	1 in 3	≥0.33	9
High: Generally associated with processes similar to previous processes that have often failed	1 in 8	≥0.51	8
	1 in 20	≥0.67	7
Moderate: Generally associated with processes similar to previous processes which have experienced occasional failures, but not in major proportions	1 in 80	≥0.83	6
	1 in 400	≥ 1.00	5
	1 in 2,000	≥1.17	4
Low: Isolated failures associated with similar processes	1 in 15,000	≥ 1.33	3
Very Low: Only isolated failures associated with almost identical processes	1 in 150,000	≥ 1.50	2
Remote: Failure is unlikely. No failures ever associated with almost indentical processes	≤ 1 in 1,500,000	≥1.67	1

Criteria: Occurence

Detection	Criteria: Likelihood the Existence of a Defect will be Detected by Process Controls Before Next or Subsequent Process, or Before Part or Component Leaves the Manufacturing or Assembly Location	Ranking
Almost Impossible	No known control(s) available to detect failure mode	10
Very Remote	Very remote likelihood current control(s) will detect failure mode	9
Remote	Remote likelihood current control(s) will detect failure mode	8
Very Low	Very low likelihood current control(s) will detect failure mode	7
Low	Low likelihood current control(s) will detect failure mode	6
Moderate	Moderate likelihood current control(s) will detect failure mode	5
Moderately High	Moderately high likelihood current control(s) will detect failure mode	4
High	High likelihood current control(s) will detect failure mode	3
Very High	Very high likelihood current control(s) will detect failure mode	2
Almost Certain	Current control(s) almost certain to detect the failure mode. Reliable detection controls are known with similar processes.	1

Criteria: Detection

Risk Rriority Number (RPN)

RPN = (S) x (O) x (D)

S = Severity

O = Likelihood of Occurrence

D = Likelihood of Detection

- 1000 is the maximum and 75 is considered „OK“
- High and low numbers are the important ones to consider

R. P. N.	18 Recommended Action(s) 19	Responsibility & Target Completion Date 20	Action Results 22					
			Actions Taken 21	Sev	Occ	Det	R. P. N.	
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Action(s) Planning and Results