

FMEA – New Ideas for Greater Effectiveness

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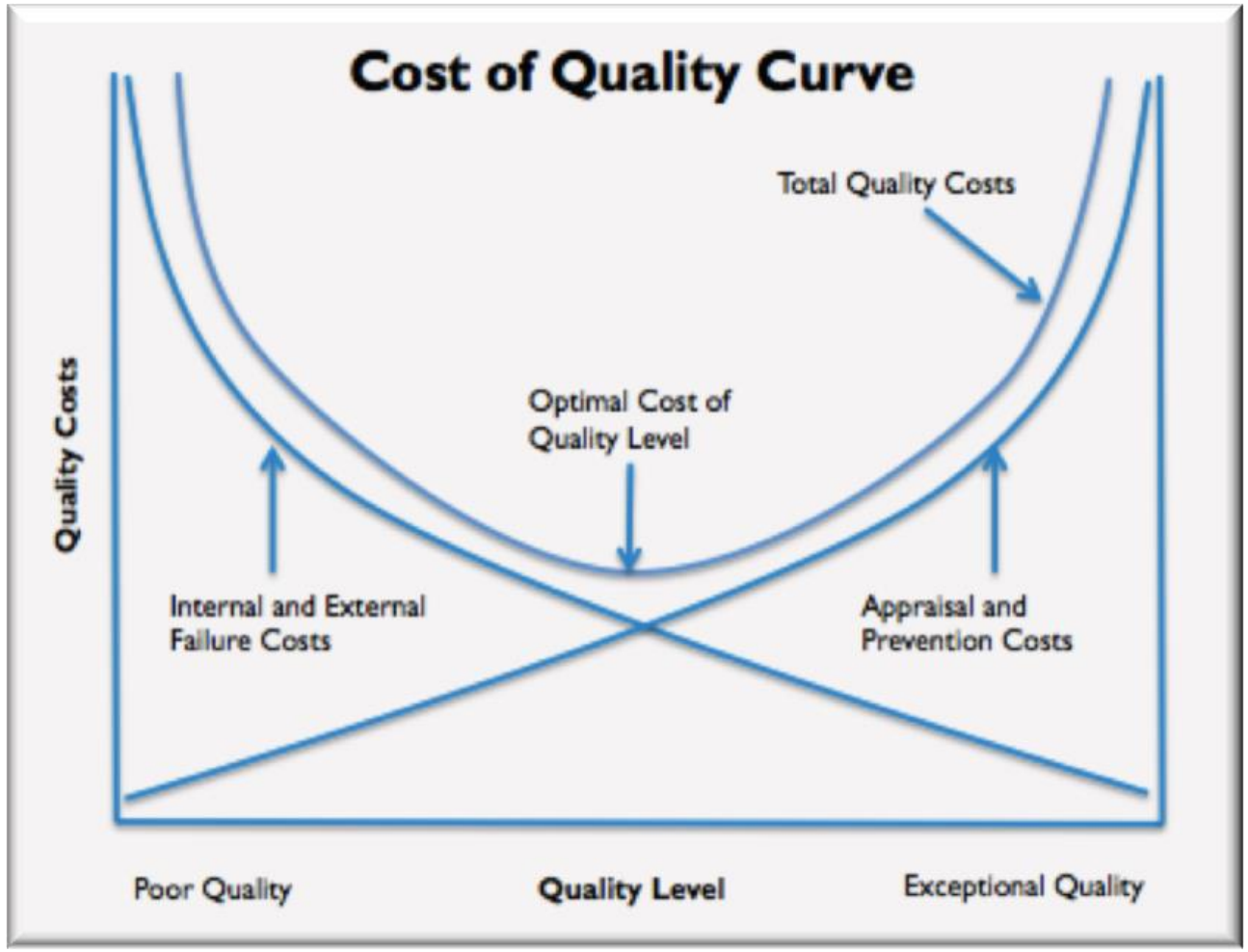
Learning Objectives

- In this session you will:
  - Be reminded of the connection between FMEA and the Cost of Poor Quality (COPQ)
  - Be introduced to the new Automotive Industry approach
  - Hear some best practices taken from that new approach that can be applied in any industry & for any FMEA format
  - Learn to love FMEA! (It's not just a nasty four-letter word)

Cost of Quality



Does FMEA Cost or Pay?

- Is the investment in FMEA an asset or liability?
- What is the cost of the inspections and tests to assure quality? (Appraisal) Is it worth it? Does it cost less to avoid more?
- “Occurrence” values speak to internal failure
- “Detection” values speak to external failure
- Use PFMEA to drive COPQ down and meet targets

Important Changes

1. New First Step to ‘set the stage’ for the FMEA activity, including renewed emphasis on Mgt. commitment
2. More focus on understanding Effects on customers, no more guessing
3. Potential Causes for PFMEA… 4M – Man, Machine, Material, EnvironMent. More expansive view of potential causes
4. Action Priority (AP) High/Medium/Low replaces RPN and Considers SOD independently
5. More deliberate assignment and follow up of ‘recommended actions’ tasks

New AIAG-VDA Approach to FMEA

- US - *Automotive Industry Action Group* (AIAG)
- Germany – *Verband der Automobilindustrie* (VDA)
- Collaboration between the two, 2019

- New approach, *very* new format



Seven Step Approach

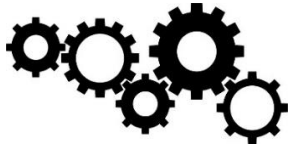
Step 1 – Planning & Preparation



Step 2 – Structure Analysis



Step 3 – Function Analysis



Step 4 – Failure Analysis



Step 5 – Risk Analysis



Step 6 – Optimization



Step 7 – Results Documentation

1 – Planning and Preparation

- Project identification, management commitment
- Baseline, Foundational FMEA
- Design or Process boundaries and scope
- Project Plan

- Foundational FMEA
  - Product Families
  - Manufacturing Processes

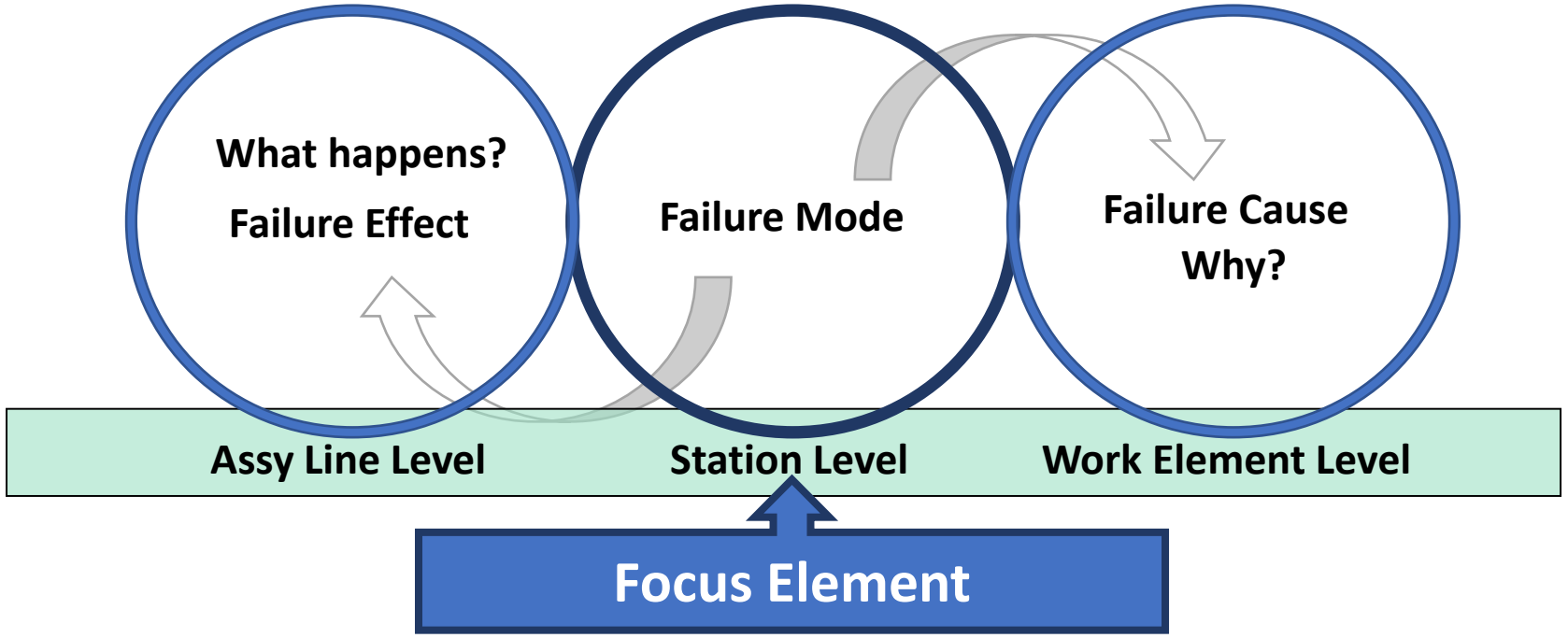
Foundation and Family FMEAs

- Create foundations or baselines for each process
- Ensure foundations always reflect the latest lessons-learned
- Keep them generic – requirements, but no specifications
- Start with the foundation for all new parts - efficiency
- Families for similar products – focus on differences



Failure Chain

- Failure Effect (FE)
- Failure Mode (FM)
- Failure Cause (FC)



2 – Failure Effects, Customer Focus

External customers

- End user of the product
- Your direct customer, Manufacturing/distribution centre etc.
- Supply Chain Manufacturing
  - Coating, Heat Treating, etc.
- Regulators

Internal customers

- The next operation or department

Note: If we don't know the effect of a failure on the customer or the final user, DON'T GUESS. Simply record 'unknown'

3a – Potential Failure Modes

How can the process fail to meet the requirements of the design/process?

- No Function – Operation not performed
- Partial Function – Incomplete Operation
- Degradation of process function
- Overachievement - Too much, too high
- Intermittent Function – inconsistent operation
- Unintended function – wrong operation
- Wrong part installed
- Delayed Function – operation performed too late

Potential Failure Modes

- Brainstorm all failure modes. They're potential failure modes
- Start with past experiences from similar product, field feedback, customer issues with similar products, etc.
- How can the part/process fail to meet requirements?
- Describe these modes in physical or technical terms, not symptoms
- Consider user misuse/abuse

3b – Failure Causes

- Why does the failure mode occur?
- Identify all potential causes of failure
- List and describe causes in ways that can be controlled

The facilitator can lead the team through a series of stimulating questions to uncover all potential failure causes

It can be an immense challenge to anticipate Failure Modes the group has never seen. Groups fall back into what they know. 4M helps us with this!

(Failure Causes –Design FMEA)

- Inadequate Design, wrong components selection, wrong material selection, geometry, tolerancing etc.
- System Interactions with our part(s)
- Changes over time, fatigue, wear
- Inadequate design for use cases, outside environment
- User errors, misuse, abuse
- Lack of robust design for manufacturability

Failure Causes – Process FMEA

Man – Line operator, set-up person, material handler, inspector, maintenance technician, etc.

Example assembly process questions:

- Within the assembly cell, can the wrong part be applied?
- Can a part(s) not be applied at all?
- Can the parts be loaded incorrectly?
- Can parts be damaged within the cell?
- Can wrong material(s) be used?

Failure Causes – Process FMEA

Machine – Stamping Press, Molding Machine, Robots, Parts Feeders, conveyor belt, inspection fixtures, vision cameras, etc.

Example assembly process questions:

- Can the automated process be interrupted?
- Can data input be performed incorrectly?
- Can machines be run in manual mode, by-passing controls?
- Is there a schedule to confirm prevention and detection controls? (such as periodic poke-yoke checks)

Failure Causes – Process FMEA

Material (Indirect) – Machining oil, installation grease, mold release, die/mold coolants, wash/rinse chemicals, etc.

Example assembly process questions:

- Can too much, too little, none be used?
- Can wrong materials be used?
- Can material be applied to the wrong location?
- Can the use of a cloth for wiping leave contamination behind?
- Can indirect materials introduce contamination?

Failure Causes – Process FMEA

EnvironMent – Ambient conditions such as heat, dust, contamination, lighting, noise, etc.

Example assembly process questions:

- Is lighting adequate for the task? (eg. Visual inspections)
- Can foreign material or contamination occur?
- Is ambient air dry/humid enough?
- Will vibration affect the parts or process equipment?

Failure Causes – Process FMEA

Method – Standard Work Instructions, order of operations, work aids, craftsmanship

Example assembly process questions:

- Is the method properly defined?
- Is there more than one way to interpret requirements?
- If instructions are followed, can a mistake happen?
- Is the level of common cause variation acceptable?
- Can operations be done by right and left-handed operators?
- Do methods allow for identification of failures and recovery?

Failure Causes – Process FMEA

Measurement – Inspection devices, automated controls, poke-yoke, visual inspections, etc.

Example assembly process questions:

- Are measurement methods sufficient? (GR/R etc.)
- Can inspections be done incorrectly or skipped?
- Can all defects be identified? (visual inspections, etc.)
- Can measurements be conducted in different ways?

Failure Analysis

1. Failure Effects (FE) to the Next Higher Level Element and/or End User	2. Failure Mode (FM) of the Focus Element	3. Failure Causes (FC) of the Work Element
Your Plant: Rework or Scrap in Next Operation Immediate Customer: Unable to assemble into their product End User: Noise, Rattle, Premature Wear	Drill a Hole the Wrong Size	**M**AN: Selected wrong program setting, wrong Drill Bit **M**ACHINE: Wrong Drill Bit, Tool Wear, Machine Vibrations INDIRECT **M**ATERIAL: Insufficient Coolant ENVIRON**M**ENT: Dirt, Oil build up on camera lens used for in-line automated optical inspctions

4 – Evaluations S.O.D.

Each failure mode, cause, and effect relationship is assessed for its independent risk

S.O.D ratings are subjective – it is not appropriate to compare the ratings of one team to another, since each team's environment is unique

One of the biggest criticisms of FMEA is the imperfect nature of RPN

Evaluations – Action Priority (AP)

Decide how to prioritize risk reduction efforts

AP tables emphasize S.O.D, in that order, to emphasize prevention controls

RPN is insufficient because it gives equal weighting to S.O.D

Risk matrices provide a visual representation of risk analysis

If the organization chooses to modify S.O.D tables and rankings for their own needs, carefully review these AP tables for suitability

RPN combines and 'washes out' individual SOD contributions

AP considers SOD independently

Evaluations – Action Priority (AP)

HIGH – *Must* identify an action to improve prevention and/or detection controls or justify and document why current controls are adequate

Medium – *Should* identify actions to improve prevention and/or detection controls or we may justify and document why current controls are adequate

Low – *Could* identify actions to improve controls

It is recommended that High and Medium be reviewed my Top Management, including any actions that were taken

This is not prioritization of risks, but rather actions to reduce risks

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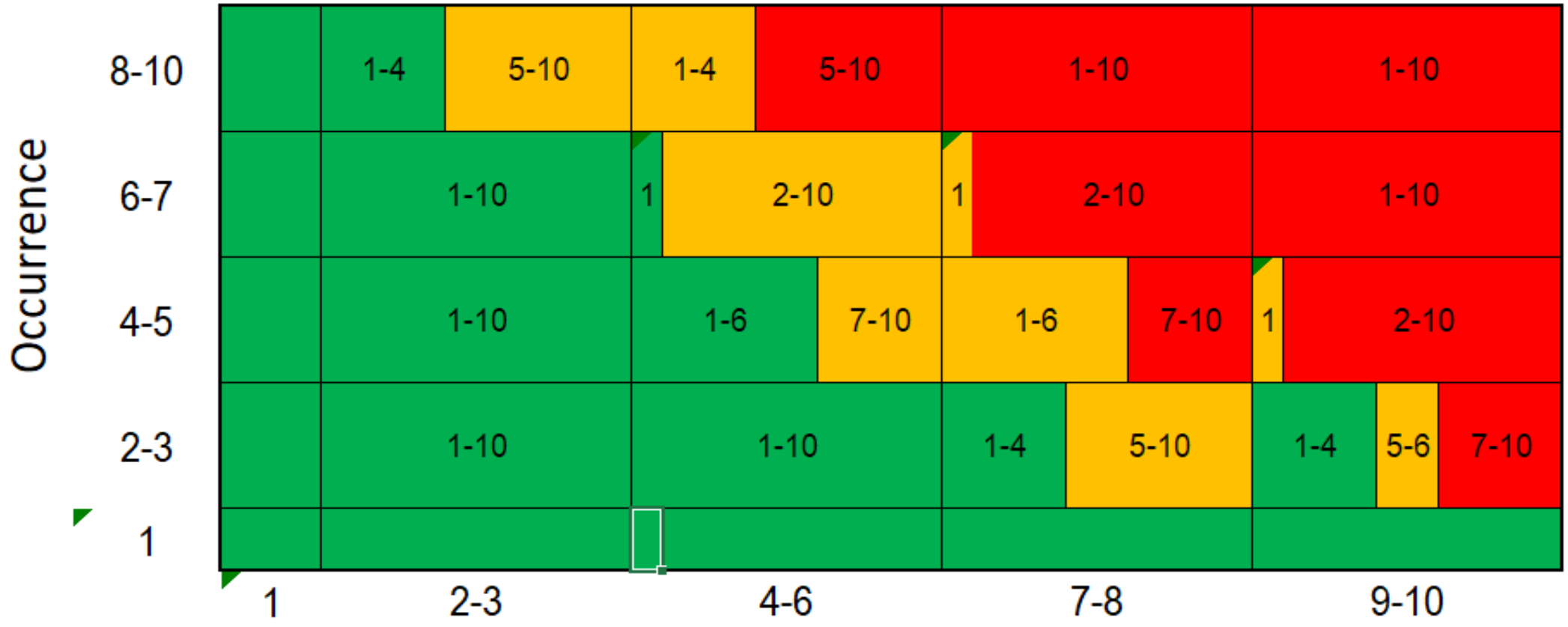
AIAG-VDA FMEA Action Priority (AP) Table



Action Priority

Low | Medium | High

Detection values are listed in each cell - eg. 1-4, 7-10

Devos Associates

Advisors to the Automotive Industry

5 – Responsibilities and Actions

Each action has a responsible individual and target date

Actual actions and actual dates are recorded

Status of Actions

Open – No actions defined

Decision Pending – Action is defined, but not decided on

Implementation Pending – Decided on, not implemented

Completed – Implemented and effectiveness evaluated

Not Implemented – Action is not taken. Risks related to practical and technical limitations may be beyond current capabilities

5 – Example of Improvement Actions

PFMEA RISK ANALYSIS (STEP 5)							PFMEA OPTIMIZATION (STEP 6)											
Current Prevention Control (PC) of FC	Occurrence(O) of FC	Current Detection Controls (DC) of FC or FM	Detection(D) of FC/FM	PFMEA AP	Special Characteristics	Filter Code (Optional)	Prevention Action	Detection Action	Responsible Person's Name	Target Completion Date	Status	Action Taken with Pointer to Evidence	Completion Date	Severity(S)	Occurrence(O)	Detection(D)	Special Characteristics	PFMEA AP	Remarks
Machine Settings and Tool Change Intervals	5	OD check every hour using SPC	2	M			Conduct tooling capability studies to optimize tool change interval	In-line automated inspection to check OD 100%	Process Engineer Dr. Brian May	Oct. 10 2022	open			8	3	2		L	

Take-Aways

1. ‘Set the stage’ for the FMEA activity, including renewed emphasis on Management commitment
2. Real understanding Effects on customers, no more guessing
3. Potential Causes for PFMEA… 4M – Man, Machine, Material, EnvironMent. More expansive view of potential causes
4. Action Priority (AP) High/Medium/Low replaces RPN
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Thank You!

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Questions?

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