

**Fishbone diagram  
aka  
Ishikawa diagram  
Cause and Effect Diagram**

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# Fishbone diagram

- This technique allow a team to focus graphically on a solution.
- Causes are separated into 4 or 6 different categories.
  - 4 categories are Machinery/Equipment, People, methods, Materials
  - Depending on the the issue 2 additional that can be included are Environment and measurements

# Data Collection

- Three initial techniques are generally used to gather data for future placement on the chart.
  - Process tour/documentation
  - Brainstorming Pre-meeting (email collection)
  - From process data
- This is followed by a brainstorming session placing items on the specific branches.

# Data Collection

- The brainstorming indicates the branch that the data pertains to (materials, people ...) and sub-ideas are as branches off of the main branch.
  - Brainstorming
    - Round Robin
    - Vocal Call Out
- This continues until no new ideas or ideas become trivial.

# Data Collection

- Minitab has a very good program for presenting the data and can be performed live in front of the group allowing for the document to be communicated/distributed immediately.
- More difficult is using Excel and requires a template ahead of time, with difficult sub-idea display. Shaded examples are from Minitab while unshaded are Excel.

# Data Collection

- Voting/multivoting techniques are used to select the likely problem causes.
- In excel/minitab a merging/prioritization using the RPN type analysis from FMEA/FMECA can be applied.
- Those calculations usually indicate  
Probability **x** Severity **x** detection = RPN and some also include probability of success resolving the issue.

Results of this is seen in the numbers preceding the item on the Minitab version.

# Probability of Failure

Probability of Failure	Possible Failure Rates	Ranking
Very High: Failure is almost inevitable	$\geq 1$ in 2	10
	1 in 3	9
High: Repeated failures	1 in 8	8
	1 in 20	7
Moderate: Occasional failures	1 in 80	6
	1 in 400	5
	1 in 2,000	4
Low: Relatively few failures	1 in 15,000	3
	1 in 150,000	2
Remote: Failure is unlikely.	$\leq 1$ in 1,500,000	1

<http://www.fmea-fmeca.com/images/saej1739-occurrence.jpg>

# Severity of Failure

Effect	Criteria: Severity of the Effect	Ranking
Hazardous - without warning	Very high severity ranking when a potential failure mode affects safe vehicle operation and/or involves noncompliance with government regulation without warning.	10
Hazardous - with warning	Very high severity ranking when a potential failure mode affects safe vehicle operation and/or involves noncompliance with government regulation with warning.	9
Very High	Vehicle / item inoperable, with loss of primary function.	8
High	Vehicle / item operable, but at reduced level of performance. Customer dissatisfied.	7
Moderate	Vehicle / item operable, but Comfort/Convenience item(s) inoperable. Customer experiences discomfort.	6
Low	Vehicle / item operable, but Comfort/Convenience item(s) operable at reduced level of performance. Customer experiences some dissatisfaction.	5
Very Low	Fit & Finish/Squeak & Rattle item does not conform. Defect noticed by most customers.	4
Minor	Fit & Finish/Squeak & Rattle item does not conform. Defect noticed by average customer.	3
Very Minor	Fit & Finish/Squeak & Rattle item does not conform. Defect noticed by discriminating customer.	2
None	No Effect.	1

<http://www.fmea-fmeca.com/images/saej1739-severities.jpg>

# Detection of Failure

<b>Detection</b>	<b>Criteria: Likelihood of Detection by Design Control</b>	<b>Ranking</b>
Absolute Uncertainty	Design Control will not and/or can not detect a potential cause/mechanism and subsequent failure mode; or there is no Design Control.	10
Very Remote	Very remote chance the Design Control will detect a potential cause/mechanism and subsequent failure mode.	9
Remote	Remote chance the Design Control will detect a potential cause/mechanism and subsequent failure mode.	8
Very Low	Very low chance the Design Control will detect a potential cause/mechanism and subsequent failure mode.	7
Low	Low chance the Design Control will detect a potential cause/mechanism and subsequent failure mode.	6
Moderate	Moderate chance the Design Control will detect a potential cause/mechanism and subsequent failure mode.	5
Moderately High	Moderately high chance the Design Control will detect a potential cause/mechanism and subsequent failure mode.	4
High	High chance the Design Control will detect a potential cause/mechanism and subsequent failure mode.	3
Very High	Very high chance the Design Control will detect a potential cause/mechanism and subsequent failure mode.	2
Almost Certain	Design Control will almost certainly detect a potential cause/mechanism and subsequent failure mode.	1

<http://www.fmea-fmeca.com/images/saej1739-detection.jpg>

# Probability of Resolving Issue

Absolute Uncertainty	1
Very Remote	2
Remote	3
Very Low	4
Low	5
Moderate	6
Moderately High	7
High	8
Very High	9
Almost Certain	10

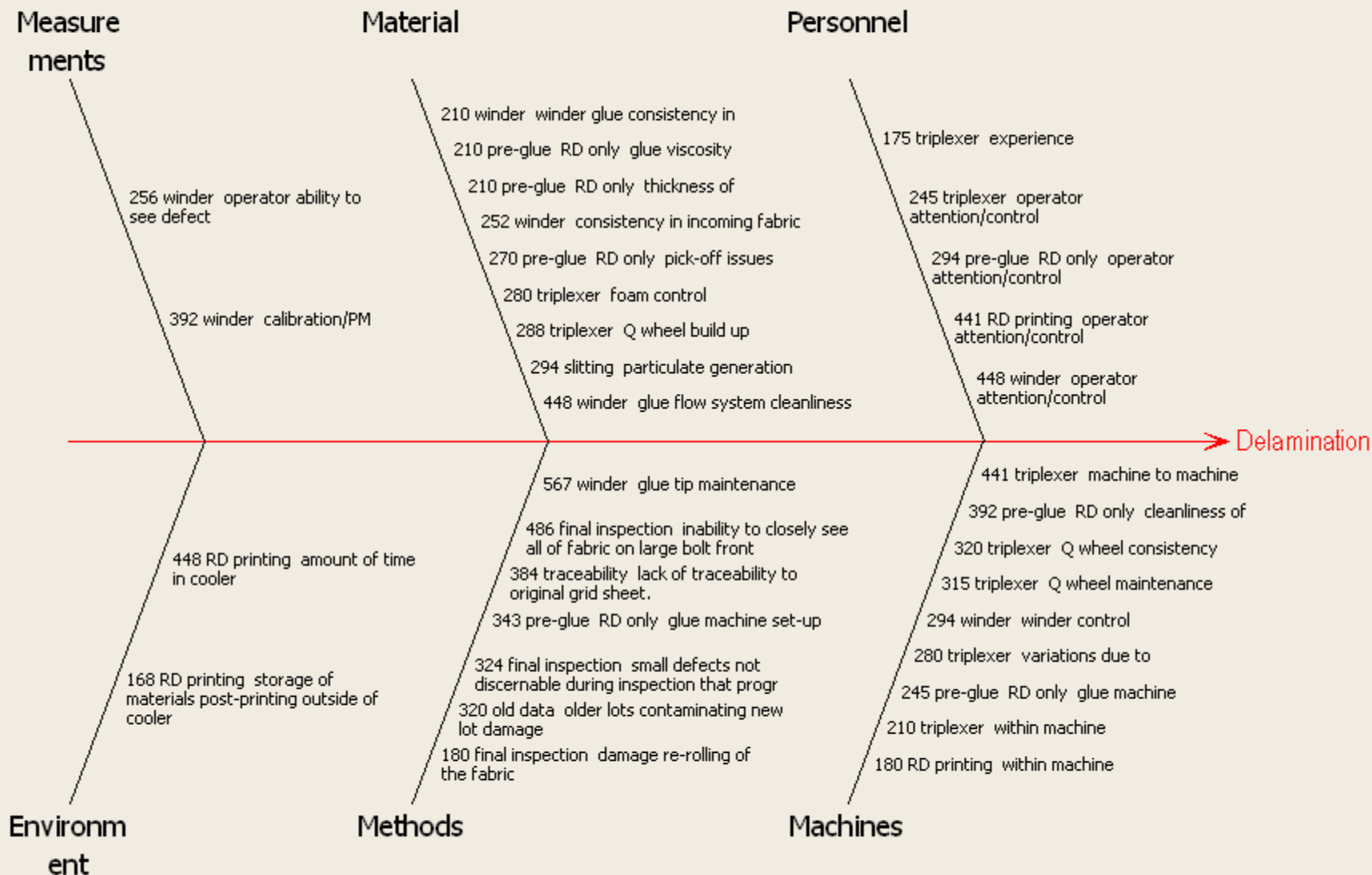
# FMEA/FMECA resource standards

- SAE J1739,
- AIAG FMEA-3
- and MIL-STD-1629A



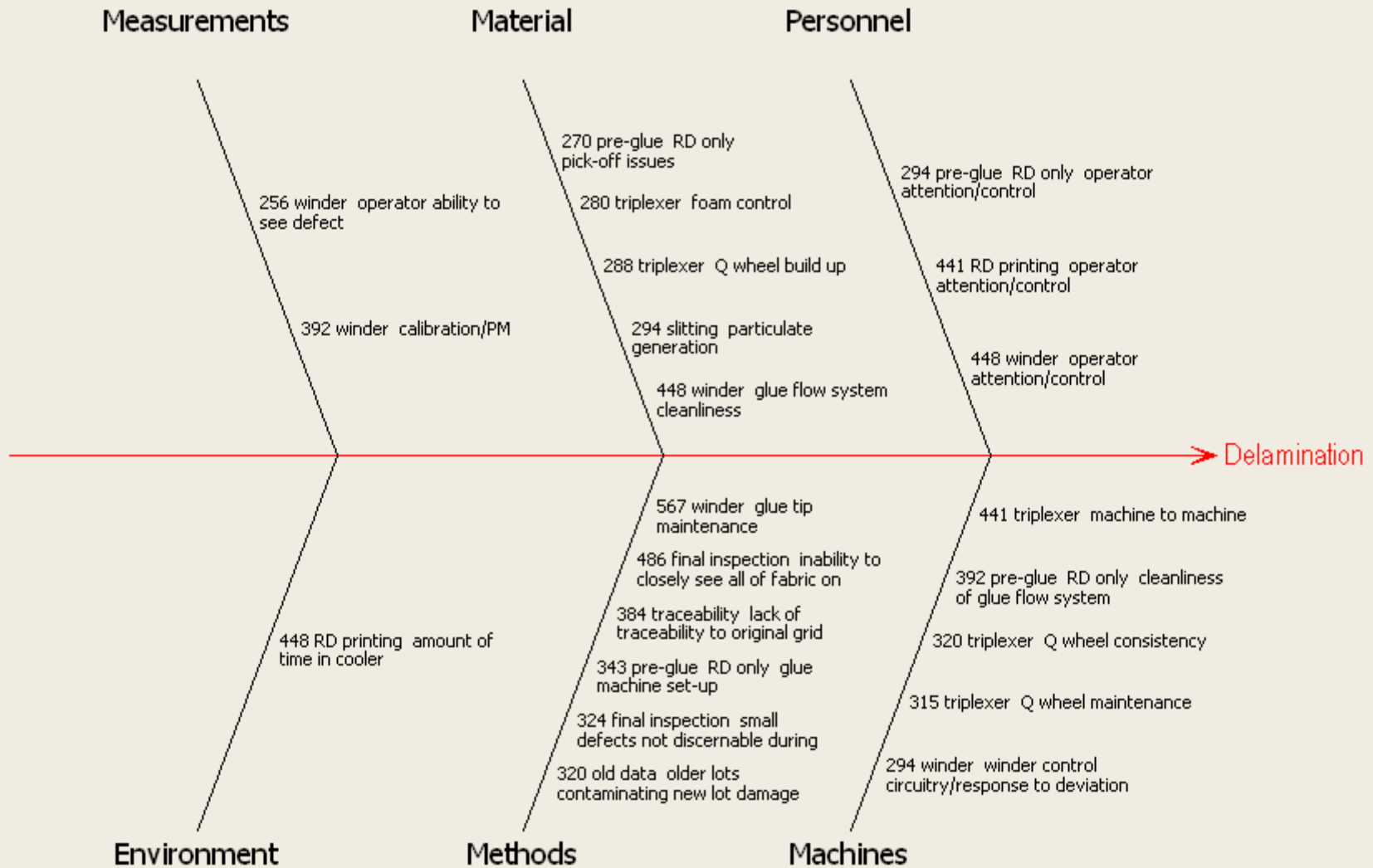
# Initial 34 Issues

## Sheer Horizontal Process analysis



# Reduced to 22 potential causes (eliminate causes Factor < 253)

## Sheer Horizontal Process analysis



# Thanks

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