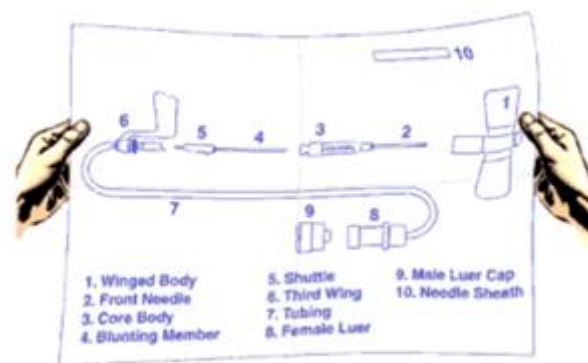


Laboratory 4

STEP 1 - Review the Design

In Step 1, the components and the respective intended function or functions of every component of the (product) design are identified. Use of a design blueprint or a detailed schematic is a good starting point for reviewing the product. There are several reasons for reviewing the product. First, the review helps assure that all team members are familiar with the product. This is especially important if you have team members who do not work with the product daily. The second reason for reviewing the product is to identify each of the main components of the product and determine the function or functions of each of those components. Finally, this review step will help assure that you are studying all components of the product with the DFMEA.



Using the blueprint or schematic, label each component with a sequential number starting with 1; the print here has been numbered from 1 to 10. Your team should not skip past the review step if a blueprint or a schematic does not exist. If one is not available, the team should have one developed if possible or develop it on their own. With the schematic or blueprint in hand, the Design-FMEA team members should familiarize themselves with the product by comparing the schematic or blueprint with a prototype of the product if one is available.

The schematic or blueprint must be comprehensive, showing components, sub-assemblies (if there are any), interfaces that connect the product to other components such as adhesive or wiring, and finishes such as paints, coatings, and lubricants.

For each component, list its function or functions on the flipchart as well. It may be helpful to use a different colour marker for the functions and again, leave some space in between each function for adding additional information.

STEP 2 - Brainstorm Potential Failure Modes

A potential failure mode represents any manner in which the component of the product could fail to perform its intended function or functions. There are several key words and phrases here. One is "potential." Do not leave out a potential failure mode because it rarely happens. The frequency will be considered later. A second is "any manner." Look at every manner a failure can occur, even if it involves a seldom-used process setting. And a third is "intended function". Reconsider the intended function of

each component of the product; most components have more than one function. Don't take shortcuts here; this is the time to be thorough.

The easiest way to document this step of the study is to keep using the flipchart used in Step 1. Add the failure modes identified for each function leaving room for Step 3, adding the effects of the failure modes. Continue colour coding by writing out the failure modes in a different colour. This will help keep everyone clear on what's what.



Example: As an example, let's look at the potential for failure of the flexible hose used to deliver hot water to a residential washing machine. The component is the hose. The function we will look at is "to deliver hot water."

That's right! It can be difficult to distinguish between failure modes, effects, and causes. A failure mode is how the product can fail, the effect is the impact of the failure, and the cause is the mechanism of failure. Here, leaking hose and blocked hose are the failure modes; the other selections are effects or causes of the failure.

STEP 3 - Identify Potential Effects of Failure

In Step 3, we will determine the effects, or the impact, associated with each failure mode. The effect is related directly to the ability of that specific component to perform its intended function.

An effect is the impact a failure could make should it occur. Some failures will have an effect on customers, others on the environment, the process the product will be made on, and even the product itself. When we discuss customers, remember, your product has several layers of customers. The customer may be your next internal process, your external customer and its process, or the eventual end user.

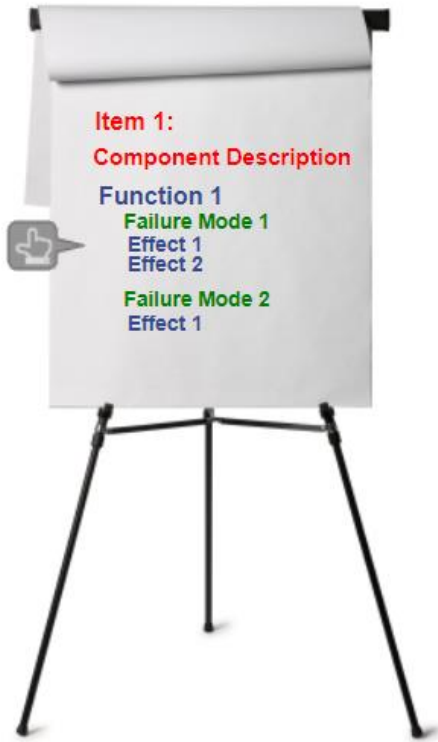
As with failure modes, use descriptive and detailed terms to define effects. The effect should be stated in terms meaningful to product performance. If the effects are defined in general terms, it will be difficult to identify (and reduce) true potential risks.

► Descriptive

- Not compliant with "XYZ" regulations
- Assembly leaks
- Objectionable odor
- Vibrates

► Too General

- Doesn't meet spec
- Won't work right
- Customer dissatisfaction
- Wrong



Both usability and safety should be considered when determining the effects of a failure. Either can result in serious issues for the company should a failure occur. Since you will be building on the information tabulated on the flipchart pages from Steps 1 and 2, continue to use the same flipchart sheets for Step 3. Simply add the effects to each failure mode as appropriate. Note that once we have the failure modes and their corresponding effects, we're ready to transfer the information to the DFMEA Analysis Worksheet.

Using the washing machine example from the last step, the effects of the two failure modes have been identified. In this case, the effects of the failure modes primarily impact end-user customers.

Failure Mode	Effect
Hose Blocked	No water flow
	Low water flow, long cycle
	Premature pump failure
Leaking Hose	Large water spill; ruin customer's floor; angry customer
	Small water leak; slippery condition; dissatisfied customer



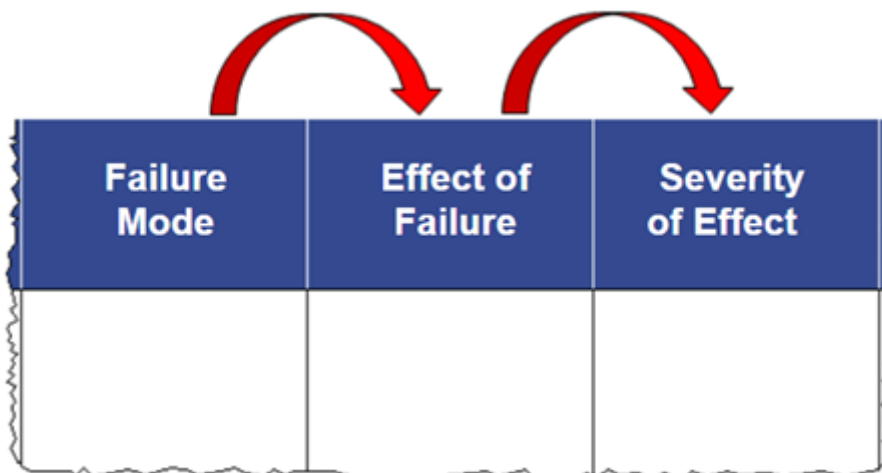
At this point, you have enough information for the DFMEA Worksheet that you can begin filling it out. Start filling out the DFMEA worksheet by listing the product or design component. Then, list the first function of that product component. Now, for each function, list the failure mode or failure modes for that function.

Finally, list the effect or effects for that failure mode. Even for our simple washing machine hose example, you see how one component can result in numerous failure modes and effects. Continue filling out the DFMEA Analysis Worksheet with the information listed on the flip chart pages until all the information has been transferred to the worksheet.

Component & Function	Mode	Effect
Component 17: Hot water hose. Function: Delivers hot water to washer	Hose blocked	No water flow
		Low water flow; long cycle
		Premature pump failure
	Leaking Hose	Large water spill; ruin customer's floor; angry customer

STEP4 - Assign Severity Rankings

The severity ranking is an estimate of how serious the effects would be assuming that a specific failure mode occurred. To determine the severity, consider the impact the effect would have on the customer or the customer's operation or the people working with the product.



The severity ranking is based on a relative scale ranging from 1 to 10. A ten means the effect has a dangerously high severity leading to a hazard without warning. Conversely, a severity ranking of one means the severity is extremely low.

While you will want to customize the ranking scales for your organization, for now, we will use a simplified scale ranging from the highest severity as "hazardous without warning" to the lowest severity ranking of "none."

- 10 = Hazardous without warning**
- 9 = Hazardous with warning**
- 8 = Very High**
- 7 = High**
- 6 = Moderate**
- 5 = Low**
- 4 = Very Low**
- 3 = Minor**
- 2 = Very Minor**
- 1 = None**

They may not be the same as you would rank them because you are working with less information than the team. In addition, each person is going to have a different opinion about how an item should be rated because you did not have specific example from which to compare rankings.

Failure Mode	Effect	Sev.
Hose blocked	No water flow	6
	Low water flow; long cycle	3
	Premature pump failure	7
Leaking hose	Large water spill; ruin customer's floor; angry customer	10
	Small water leak; slippery condition; dissatisfied customer	9

While AIAG (Automotive Industry Action Group) guidelines suggest customizing the scales, they do not require it. The reasons to customize the scales are to make it easier for those in your organization to understand and use them and ensure the scales relate directly to issues faced by both your process and your end-users. The product and its design can have a tremendous impact on the process if not designed for manufacturability.


This is a recap of the AIAG "Suggested DFMEA Severity Evaluation Criteria." We'll use this as the starting point for customizing severity scales.


Effect	Criteria: Severity of Effect on Product (Customer Effect)	Rank
Failure to Meet Safety and/or Regulatory Requirements	Potential failure mode affects safe vehicle operation and/or involves noncompliance with government regulations without warning.	10
	Potential failure mode affects safe vehicle operation and/or involves noncompliance with government regulations with warning.	9
Loss or Degradation of Primary Function	Loss of primary function (vehicle inoperable, does not affect safe vehicle operation).	8
	Degradation of primary function (vehicle operable, but at reduced level of performance).	7
Loss or Degradation of Secondary Function	Loss of primary function (vehicle operable, but comfort / convenience functions inoperable).	6
	Degradation of primary function (vehicle operable, but comfort / convenience functions at reduced level of performance).	5
Annoyance	Appearance or Audible Noise, vehicle operable, item does not conform and noticed by most customers (>75%).	4
	Appearance or Audible Noise, vehicle operable, item does not conform and noticed by many customers (50%).	3
	Appearance or Audible Noise, vehicle operable, item does not conform and noticed by discriminating customers (<25%).	2
No effect	No discernible effect.	1


As you add examples specific to your organization, consider adding several columns with each column focused on a topic. One topic could provide descriptions of severity levels for customer satisfaction failures and another for environmental, health, and safety issues. However, remember that each row should reflect the same relative impact, or severity, on the organization or customer.


Ranking	Severity: Customer Satisfaction Examples
10	In-service failure that threatens safety.
9	Extensive product recall.
8	Unscheduled engine removal.
7	Premature (unscheduled) component replacement.
6	Oil leak but system still operational.
5	Air-conditioning system not operating properly.
4	Interior panel rattles.
3	Variation in seat colors.
2	Door plugs missing.
1	Scratch on interior of housing.

Ranking	Severity: EH&S Examples
10	Catastrophic product failure causes loss of life or serious injury.
9	Product creates major hazardous environmental disposal problem.
8	Use of product under normal conditions leads to OSHA Recordable injury.
7	Use of product under normal conditions leads to exposure above PEL.
6	Product creates moderate hazardous environmental disposal problem.
5	Manufacture or use of product leads to temporary non-compliance with ISO 14001 audit.
4	Use of product under normal conditions leads to injury requiring first aid.
3	Use of product leads to spill of non-hazardous material.
2	Use of product leads to poor housekeeping.
1	Manufacture or use does not have a detectable impact on EH&S.

 See Customer Satisfaction Examples

 See EHS Examples

 See Customer Satisfaction Examples

 See EHS Examples