

Pencil Problem

Perform the following steps as part of a hypothetical Design FMEA on an inexpensive wooden pencil:

1. Assuming “pencil system” is the highest level of the system hierarchy, identify and write down two additional items from the wooden pencil system hierarchy.
2. For the item “Pencil system”, identify and write down two functions of a wooden pencil.
3. Identify and write down two potential failure modes of the first function.
4. Identify and write down the potential effect of the first failure mode.
5. Rank the severity of the effect, using the AIAG 4th edition severity scale (shown below). Note, in this scale “vehicle” can be replaced by “item.”

Suggested DFMEA Severity Evaluation Criteria

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 regulation without warning.	10
	Potential failure mode affects safe vehicle operation and/or involves noncompliance with government regulation 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 secondary function (vehicle operable, but comfort / convenience functions inoperable).	6
	Degradation of secondary 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

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6. Identify and write down two potential causes of the first failure mode.
7. Identify and write down one prevention-type design control for the first cause.
8. Identify and write down one detection-type design control for the first cause.
9. Assuming either the severity or the RPN is high enough to require action, identify and write down two potential recommended actions to address the risk from the first failure mode/cause.

Pencil Solution

Perform the following steps as part of a hypothetical Design FMEA on an inexpensive wooden pencil:

1. Assuming “pencil system” is the highest level of the system hierarchy, identify and write down two additional items from the wooden pencil system hierarchy.

Possible answers for pencil system hierarchy:

- Wooden shaft
- Lead shaft
- Eraser
- Ferrule

Compare answers to the above and see if similar. Reference the definition of “item”: the *focus* of the FMEA project. For a System FMEA this is the system itself. For a Design FMEA, this is the subsystem or component under analysis. Students can also review the definitions and examples from *Effective FMEAs* chapter 3, as needed.

2. For the item “Pencil system”, identify and write down two functions of a wooden pencil.

Possible answers for pencil system functions:

- To provide a safe and easy-to-use tool to write on paper, according to usages defined in technical requirements
- To provide an easy way to completely erase mistakes
- The pencil wood and lead must be easily sharpened using a normal pencil sharpener bringing the pencil back to full operation

Compare student answers to the training answers and see if similar. Ensure function descriptions include a standard of performance. Reference the definition of “function”: what the item or process is intended to do, usually to a given standard of performance or requirement. For Design FMEAs, this is the primary purpose or design intent of the item. Students can also review the definitions and examples from *Effective FMEAs* chapter 3, as needed.

3. Identify and write down two potential failure modes of the first function.

Possible answers for two potential failure modes of the first function:

Refer to the “Failure Mode” column in the Pencil Design FMEA “Example of partial Design FMEA on pencil”. Find in the spreadsheet the example failure modes for the identified function.

Compare student answers to the training answers and see if similar. Reference the definition of “failure mode”: the manner in which the item potentially fails to meet or deliver the intended function and associated requirements. Depending on the definition of failure established by the analysis team, failure modes may include failure to perform a function within defined limits, inadequate or poor performance of the function, intermittent performance of a function, and/or performing an unintended or undesired function. Students can also review the definitions and examples from *Effective FMEAs* chapter 3, as needed.

4. Identify and write down the potential effect of the first failure mode.

Possible answers for the potential effect of the first failure mode:

Refer to the “Effect” column in the Pencil Design FMEA “Example of partial Design FMEA on pencil”. Find in the spreadsheet the example effect for the identified failure mode.

Compare student answers to the training answers and see if similar. Reference the definition of “effect”: the consequence of the failure on the system or end user. Depending on the ground rules for the analysis, the team may define a single description of the effect on the top-level system and/or end user, or three levels of effects: Local effect: The consequence of the failure on the item or adjacent items; Next-higher level effect: The consequence of the failure on the next-higher level assembly; End effect: The consequence of the failure on the top-level system and/or end user. Students can also review the definitions and examples from *Effective FMEAs* chapter 3, as needed.

- Rank the severity of the effect, using the AIAG 4th edition severity scale (shown below). Note, in this scale “vehicle” can be replaced by “item.”

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Possible answers for the severity of the effect:

Refer to the “Severity” column in the Pencil Design FMEA “Example of partial Design FMEA on pencil”. Find in the spreadsheet the example effect for the identified failure mode.

Compare student answers to the training answers and see if similar. Reference the definition of “severity”: a ranking number associated with the most serious effect for a given failure mode, based on the criteria

from a severity scale. Students can also review the definitions and examples from *Effective FMEAs* chapter 3, as needed.

6. Identify and write down two potential causes of the first failure mode.

Possible answers for potential causes of the first failure mode:

Refer to the “Cause” column in the Pencil Design FMEA “Example of partial Design FMEA on pencil”. Find in the spreadsheet the example cause for the identified failure mode.

Compare student answers to the training answers and see if similar. Reference the definition of “cause”: the specific reason for the failure, preferably found by asking “why” until the root cause is determined. For Design FMEAs, the cause is the design deficiency that results in the failure mode. Students can also review the definitions and examples from *Effective FMEAs* chapter 3, as needed.

7. Identify and write down one prevention-type design control for the first cause.

Possible answers for prevention-type design control for the first cause:

Refer to the “Design Controls (Prevention)” column in the Pencil Design FMEA “Example of partial Design FMEA on pencil”. Find in the spreadsheet the example prevention-type design controls for the identified cause.

Compare student answers to the training answers and see if similar. Reference the definition of “prevention-type design controls”: how a cause, failure mode, or effect in the product design is *prevented* based on current or planned actions; they are intended to reduce the likelihood that the problem will occur, and are used as input to the occurrence ranking. Students can also review the definitions and examples from *Effective FMEAs* chapter 3, as needed.

8. Identify and write down one detection-type design control for the first cause.

Possible answers for detection-type design control for the first cause:

Refer to the “Design Controls (Detection)” column in the Pencil Design FMEA “Example of partial Design FMEA on pencil”. Find in the spreadsheet the example detection-type design controls for the identified cause.

Compare student answers to the training answers and see if similar. Reference the definition of “detection-type design controls”: how a failure mode or cause in the product design is *detected*, based on current or planned actions, before the product design is released to production, and are used as input to the detection ranking. Students can also review the definitions and examples from *Effective FMEAs* chapter 3, as needed.

9. Assuming either the severity or the RPN is high enough to require action, identify and write down two potential recommended actions to address the risk from the first failure mode/cause.

Possible answers for two potential recommended actions to address the risk from the first failure mode/cause:

Refer to the “Recommended Action” column in the Pencil Design FMEA “Example of partial Design FMEA on pencil”. Find in the spreadsheet the example recommended actions for the identified failure mode/cause.

Compare student answers to the training answers and see if similar. Reference the definition of “recommended actions”: the tasks recommended by the FMEA team to reduce or eliminate the risk associated with potential causes of failure. Students can also review the definitions and examples from *Effective FMEAs* chapter 3, as needed.