Design Mode Fault Error Analysis (DMFEA)-[Project Name]

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# File name: DMFEA-Project Name, Location: Phase 3 Box Folder

# Description:

**Design for Failure Mode and Effect Analysis (DFMEA):** As part of this phase in the design process, you will need to conduct a DFMEA on your design. This is a technique to explore the possible ways your project might fail in order to address them prior to delivering the project. It is also a method for documenting that your team has explored the possible ways the project will fail and considered them. This is especially important in industry, where if a project fails in a way that injures someone, documentation may mean the difference between your company losing millions of dollars in a lawsuit or not.

A DFMEA is a process by which a detailed and quantitative analysis of the different ways a design can fail can be generated. Through the DFMEA process, each aspect of a design will be analyzed for possible ways it can fail, and then each of these failures will be rated based on some criteria.

Using the DFMEA can help designers to anticipate problems that will come up when building and testing designs. By determining what problems may occur before the design is complete and incorporating those elements into the design, a more sound design will be created and the time required to test and debug the design will be greatly diminished. Not only that, but there will also then be a document listing the possible ways that the design could fail, and giving the ways that these problems were addressed. This will help others to understand some of the design decisions that were made, as well as helping to keep you, or your company, from being sued for a failure in a device.

The four criteria that will be used are:

* **Failure Mode:** What went wrong with the design?
* **Effect of Failure:** What will happen if this failure occurs?
* **Cause of Failure:** What caused this failure to occur?
* **Current Process Control for Effect:** What measures are in place to prevent this failure and its effects?

With a rating for the severity of each failure, severe flaws in the design can be identified and steps can be taken to protect against these types of failures.

# Instructions

Use the DMFEA table below and the blue reference tables to complete the DMFEA for your deliverable.

1. List all of the process functions/components of the deliverable
2. List all possible ways in which the design might fail (failure modes) for each process function or component
   1. List failure modes for each sub component and design as a whole
3. List the effects of the failure
4. List the causes of the failure
5. List the control process for effect
6. Assign the numerical values for severity, occurrence, and detection
7. Write abstract for DMFEA (first section)

With a rating for the severity of each failure, severe flaws in the design can be identified and steps can be taken to protect against these types of failures.

# Abstract:

# DMFEA:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **#** | **Process Function (Component)** | **Potential Failure Modes (process defects)** | **Potential Failure Effects (Y's)** | **SEV** | **Potential Causes of Failures (X's)** | **OCC** | **Current Process Controls for Effect** | **DET** | **RPN** |
| 1 |  |  |  |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |  |  |  |
| 4 |  |  |  |  |  |  |  |  |  |
| 5 |  |  |  |  |  |  |  |  |  |
| 6 |  |  |  |  |  |  |  |  |  |
| 7 |  |  |  |  |  |  |  |  |  |

# References:

## Severity of Failure

The following table shows the rating system for the Severity of Failure category. A ranking of one indicates that the failure has very little to no effect on the operator or the overall functioning of the device. A ranking of ten would indicate that the failure is catastrophic to both the user and the actual device itself.

### Severity Rating Guidelines

|  |  |  |
| --- | --- | --- |
| **Severity** | **Criteria: Severity of Effect Defined** | **Ranking** |
| **Hazardous: Without Warning** | May endanger operator. Failure mode affects safe operation and/or involves non-compliance with government regulation. Failure will occur WITHOUT warning. | 10 |
| **Hazardous: With Warning** | May endanger operator. Failure mode affects safe operation and/or involves non-compliance with government regulation. Failure will occur WITH warning. | 9 |
| **Very High** | Major disruption to production line. 100% of product may have to be scrapped. Item inoperable, loss of primary function. Customers very dissatisfied. | 8 |
| **High** | Minor disruption to production line. Product may have to be sorted and a portion (less than 100%) scrapped. Item operable, but at a reduced level of performance. Customers dissatisfied. | 7 |
| **Moderate** | Minor disruption to production line. A portion (less than 100%) may have to be scrapped (no sorting). Item operable, but some comfort/convenience item(s) inoperable. Customers experience discomfort. | 6 |
| **Low** | Minor disruption to production line. 100% of product may have to be re-worked. Item operable, but some comfort/convenience item(s) inoperable at a reduced level of performance. Customers experience some dissatisfaction. | 5 |
| **Very Low** | Minor disruption to production line. The product may have to be sorted and a portion (less than 100%) be re-worked. Fit/finish/squeak/rattle items does not conform. Defect noticed by customers. | 4 |
| **Minor** | Minor disruption to production line. A portion (less than 100%) of the product may have to be re-worked on-line but out-of-station. Fit/finish/squeak/rattle items 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 re-worked on-line but in-station. Fit/finish/squeak/rattle items does not conform. Defect noticed by discriminating customers. | 2 |
| **None** | No effect | 1 |

## Cause of Failure

The following table shows the rankings for the Occurrence of Failure category. This category is ranked based on the likelihood of failure. A ranking of one would indicate that the failure is almost improbable, while a ranking of ten would suggest that the failure would occur once (or more) every ten times the operator uses the device.

### Occurrence Rating Guidelines

|  |  |  |
| --- | --- | --- |
| **Probability** | **Potential Failure Rate** | **Ranking** |
| **Exceedingly High**  Failure practically inevitable and very frequent | Failures happening more than once/day or a probability of more than three occurrences in ten events | 10 |
| **Very High**  Frequent | Failures happening every three to four days or a probability of three occurrences in tem events | 9 |
| **High**  Frequent Failures | Failures happening once/week or a probability of five occurrences in 100 events | 8 |
| **Relatively High** | Failures occurring once/month or once in 100 events | 7 |
| **Moderate** Infrequent Failures | Failures occurring once every three months or three occurrences in 1,000 events | 6 |
| **Relatively Low** | Failures occurring once every six months to one year or one occurrence in 10,000 events | 5 |
| **Low** | Failures happening once/year or six occurrences in 10,000 events | 4 |
| **Very Low**  Few failures | Failures happening once every one to three years or six occurrences in ten million events | 3 |
| **Relatively Remote** | Failures happening once every three to five years or two occurrences in one billion events | 2 |
| **Remote** | Failures occurring once in more than 5 years or less than two occurrences in one billion events | 1 |

## Process Controls

The following table shows the rankings for the Process Controls category. This category is based on the ability to detect the situation that will cause the failure before it is allowed to actually cause the failure. A ranking of one for this category says that the cause of the failure is easy to detect, and thus easy to prevent. A ranking of ten says that the cause is almost impossible to detect, and thus there is no way to predict and prevent it.

### Detection Rating Guidelines

|  |  |  |
| --- | --- | --- |
| **Detection** | **Criteria** | **Rating** |
| **Almost Impossible** | Absolute certainty of non-detection | 10 |
| **Very Remote** | Controls will probably not detect | 9 |
| **Remote** | Controls have a poor change of detection | 8 |
| **Very Low** | Controls have a poor change of detection | 7 |
| **Low** | Controls may detect | 6 |
| **Moderate** | Controls may detect | 5 |
| **Moderately High** | Controls have a good chance to detect | 4 |
| **High** | Controls have a good chance to detect | 3 |
| **Very High** | Controls almost certain to detect | 2 |
| **Very High** | Controls certain to detect | 1 |

## Summary

The figure below is a quick reference summary of each of the three categories and their rating system.

### Failure Mode Effects Analysis Rating Guidelines

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Rating** | **Severity of Effect** | **Likelihood of Occurrence** | | **Ability to Detect** |
| **10** | Hazardous: Without Warning | Very High | 1 in 2 | Cannot Detect |
| **9** | Hazardous: With Warning | 1 in 3 | Very Remote |
| **8** | Very High | High | 1 in 8 | Remote |
| **7** | High | 1 in 20 | Very Low |
| **6** | Moderate | Moderate | 1 in 80 | Low |
| **5** | Low | 1 in 400 | Moderate |
| **4** | Very Low | 1 in 2,000 | Moderately High |
| **3** | Minor | Low | 1 in 15,000 | High |
| **2** | Very Minor | 1 in 150, 000 | Very High |
| **1** | None | Unlikely | 1 in 1,500,000 | Almost Certain |

# Example:

# Abstract:

The team performed a DMFEA to uncover the modes that the kiosk project could fail. Failure modes were listed as well as causes, and process controls for identifying the failures. Based on the risk priority numbers, we have begun to identify the most pressing failures. This will enable the team to design a product that is reliable and also inform the user manual.

# DMFEA:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **#** | **Process Function (Component)** | **Potential Failure Modes (process defects)** | **Potential Failure Effects (Y's)** | **SEV** | **Potential Causes of Failures (X's)** | **OCC** | **Current Process Controls for Effect** | **DET** | **RPN** |
| 1 | Timer | Timer running too fast | Inaccurate time | 3 | Configuration Drift | 2 | Non | 7 | 42 |
| 2 | Timer | Timer Outputting Incorrect time | Time Corruption | 6 | Data Bus error | 3 | Daily Observation | 6 | 108 |
| 3 | Timer | Timer Outputting Incorrect time | Time Corruption | 6 | Chip Error | 1 | Daily Observation | 6 | 36 |
| 4 | Timer | Timer Outputting no time | No time display | 6 | Chip Error | 1 | Daily Observation | 6 | 36 |
| 5 | Timer | Timer failing to idle | No time display | 6 | Buss Error | 2 | Daily Observation | 6 | 72 |
| 6 | Timer | Timer failing to idle | Fatigue of laser | 7 | Incorrect/drifting setup | 3 | Daily Observation | 5 | 105 |
| 7 | Timer | Timer failing to idle | No Reset | 6 | Incorrect/drifting setup | 3 | Daily Observation | 6 | 108 |
| 8 | Timer | Timer failing to idle | Fatigue of sensor | 7 | Incorrect/drifting setup | 3 | Daily Observation | 5 | 105 |
| 9 | Timer | Timer idles to quickly | Maze deactivates | 7 | Incorrect/drifting setup | 2 | Daily Observation | 5 | 70 |
| 10 | Timer | Signal is overdriven | Destroy attached part | 9 | Part Fatigue | 3 | Zeener/Fuse | 4 | 108 |
| 11 | Timer | Signal is overdriven | Destroy attached part | 9 | Power Input Spike | 3 | Power Regulation | 2 | 54 |
| 12 | Timer | Run Time segment does not activate correctly | goal light does not illuminate | 3 | Part Fatigue | 1 | Other Observation | 6 | 18 |
| 13 | Timer | internal data corruption | Inaccurate time | 3 | Cosmic Rays | 1 | None | 8 | 24 |
| 14 | Timer | internal data corruption | Logic Lock-up | 7 | Cosmic Rays | 1 | Reset to default state if possible | 3 | 21 |
| 15 | Power | Fuse blows inside of power strip | laser maze will not have power | 8 | voltage spike from outlet | 2 | Undetectable | 10 | 160 |
| 16 | Power | open circuit to power strip | laser maze will not have power | 8 | power strip is off | 1 | regularly maintenance to verify wire integrity | 10 | 80 |
| 17 | Power | open circuit to power strip | laser maze will not have power | 8 | wear and tear | 2 | regularly maintenance to verify wire integrity | 3 | 48 |
| 18 | Power | open circuit to power strip | laser maze will not have power | 8 | someone unplugs power strip | 1 | Undetectable | 10 | 80 |
| 19 | Power | open circuit to power strip | laser maze will not have power | 8 | power outage | 1 | Undetectable | 10 | 80 |
| 20 | Sensor | photodetector not receiving power | photodetector not detecting laser | 6 | photodetector not plugged in | 1 | protected within housing | 2 | 12 |
| 21 | Sensor | photodetector not receiving power | photodetector not detecting laser | 6 | photodetector 12V battery to DC solder has come loose | 2 | diagnostic on maze startup | 7 | 84 |
| 22 | Sensor | dirty optics | photodetector not detecting laser | 6 | dust inside of display | 2 | routine maintenance | 3 | 36 |
| 23 | Sensor | broken photodetector | photodetector not detecting laser | 6 | wear and tear | 3 | diagnostic on maze startup | 5 | 90 |
| 24 | Sensor | broken photodetector | photodetector not detecting laser | 6 | manufacturer defect | 2 | diagnostic on maze startup | 5 | 60 |
| 25 | Sensor | weak laser | photodetector not detecting laser | 6 | laser may not provide equal output throughout lifetime | 2 | diagnostic on maze startup | 4 | 48 |
| 26 | Sensor | sensor is offset | photodetector not detecting laser | 6 | incorrectly mounted | 2 | occasional checks on laser output | 3 | 36 |
| 27 | Sensor | sensor is offset | photodetector not detecting laser | 6 | display has been jarred | 4 | test before release | 4 | 96 |
| 28 | Mirrors | separate from rod | Specific mirror not functional, must be reattached | 7 | improper attachment ,violent handling | 4 | mount with sturdy brackets | 4 | 112 |
| 29 | Mirrors | separate from rod | Mirror breaks | 7 | improper attachment ,violent handling | 2 | maintenance and checkup | 4 | 56 |
| 30 | Mirrors | poor reflection | laser beam loses visibility | 5 | component fatigue, scratch on surface | 3 | maintenance and checkup | 4 | 60 |
| 31 | Maze Components | broken | reduce functionality of display | 5 | wear and tear, tilting/mishandling of kiosk | 4 | maintenance and checkup | 4 | 80 |
| 32 | Rod/Knob | bent rod | Mirror cannot be manipulated, rod needs to be replaced | 6 | improper usage by patrons | 4 | maintenance and checkup | 4 | 96 |
| 33 | Rod/Knob | broken rod | safety hazard | 9 | improper usage by patrons | 4 | maintenance and checkup | 4 | 144 |
| 34 | Rod/Knob | injuring a child walking by | safety hazard | 9 | rod sticking too far out of display | 4 | maintenance and checkup | 1 | 36 |
| 35 | Rod/Knob | knob falls off | rod cannot be easily turned | 4 | improper usage by patrons, improper attachment | 5 | design so the rods do not stick out of kiosk very far | 4 | 80 |
| 36 | Rod/Knob | "stopper" breaks | the rod can be moved in and out of display | 4 | improper usage by patrons, improper attachment | 4 | maintenance and checkup | 4 | 64 |
| 37 | Rod/Knob | "stopper" breaks | components break, rendering project unfunctional | 8 | improper usage by patrons, improper attachment | 4 | maintenance and checkup | 4 | 128 |
| 38 | Rod/Knob | "stopper" breaks | safety hazard | 9 | improper usage by patrons, improper attachment | 4 | maintenance and checkup | 4 | 144 |
| 39 | Signage | colors fade | aesthetics, harder to read | 2 | fatigue, exposure to direct sunlight | 2 | keep covered under plastic | 2 | 8 |
| 40 | Signage | light bulb dies | interactive education is down | 3 | fatigue | 3 | change bulbs regularly | 3 | 27 |
| 41 | Signage | light bulb pops | interactive education is down | 3 | voltage spike, wear and tear | 2 | Power Regulation | 3 | 18 |
| 42 | Signage | light bulb pops | safety hazard | 10 | voltage spike, wear and tear | 2 | Power Regulation | 3 | 60 |
| 43 | Signage | Overload | footing breaks | 5 | kiosk weight underestimated, wear and tear | 5 | Strength testing | 3 | 75 |
| 44 | Footings | collapses | damage to components | 4 | footings fail, wear and tear, improper usage by patrons | 3 | Strength testing, maintenance | 3 | 36 |
| 45 | Kiosk | collapses | damage to kiosk | 6 | footings fail, wear and tear, improper usage by patrons | 3 | Strength testing, maintenance | 3 | 54 |
| 46 | Kiosk | collapses | safety hazard | 10 | footings fail, wear and tear, improper usage by patrons | 3 | Strength testing, maintenance | 4 | 120 |
| 47 | Laser | points where not intended | maze cannot be completed | 6 | jarring of display | 6 | secure laser to maze | 3 | 108 |
| 48 | Laser | points where not intended | points at user | 9 | jarring of display | 6 | secure laser to maze | 3 | 162 |
| 49 | Laser | laser disconnects from power | maze cannot be completed | 6 | jarring of display | 6 | circuit should be independent of display | 5 | 180 |
| 50 | Laser | laser does not have correct power | sensor is not tripped | 5 | short somewhere in circuit | 4 | Diagnostics Mode | 3 | 60 |
| 51 | Laser | laser quits internally | will not output beam | 7 | manufacturer defect | 3 | check before installation | 3 | 63 |
| 52 | Laser | laser does not have correct power | laser will not output beam | 7 | short somewhere in circuit | 4 | good circuit design | 3 | 84 |
| 53 | Laser | mirrors do not bounce parallel to ground | sensor will not be tripped | 5 | display jarred | 6 | Re-secure mirrors in display | 4 | 120 |
| 54 | Laser | mirrors do not bounce parallel to ground | sensor will not be tripped | 5 | improperly mounted mirrors | 3 | check mirror alignment before delivery | 4 | 60 |
| 55 | Laser | mirrors do not bounce parallel to ground | points at user | 9 | improperly mounted mirrors | 3 | check mirror alignment before delivery | 3 | 81 |
| 56 | Laser | mirrors do not bounce parallel to ground | points at user | 9 | display jarred | 6 | secure mirrors in display | 3 | 162 |
| 57 | Display | LED become disconnected from power | no display of goal | 4 | display jarred | 6 | circuit should be independent of display | 4 | 96 |
| 58 | Display | LCD become disconnected from power | no display of time | 5 | display jarred | 6 | circuit should be independent of display | 3 | 90 |
| 59 | Display | LED become disconnected from power | no highlight of goal | 4 | display jarred | 6 | circuit should be independent of display | 3 | 72 |
| 60 | Display | LED short internally | do display of time | 5 | Fatigue | 3 | Diagnostics Mode | 5 | 75 |
| 61 | Display | LED short internally | no display of goal | 4 | Fatigue | 3 | Diagnostics Mode | 5 | 60 |
| 62 | Display | LCD short internally | no display of time | 5 | circuit improperly wired | 3 | good circuit design | 3 | 45 |
| 63 | Display | LCD short internally | no display of time | 5 | Fatigue | 3 | Diagnostics Mode | 5 | 75 |
| 64 | Display | LCD short internally | Meltdown | 9 | Power Surge | 2 | Power Regulation | 2 | 36 |
| 65 | Display | LCD short internally | Meltdown | 9 | fatigue | 3 | Diagnostics Mode | 5 | 135 |
| 66 | Display | LCD short internally | Will not show time | 5 | short somewhere in circuit | 2 | Power Regulation | 3 | 30 |
| 67 | Display | LCD not powered correctly | Meltdown | 10 | short somewhere in circuit | 2 | Power Regulation | 3 | 60 |
| 68 | Display | LED not powered correctly | no display of goal | 4 | short somewhere in circuit | 2 | Power Regulation | 3 | 24 |