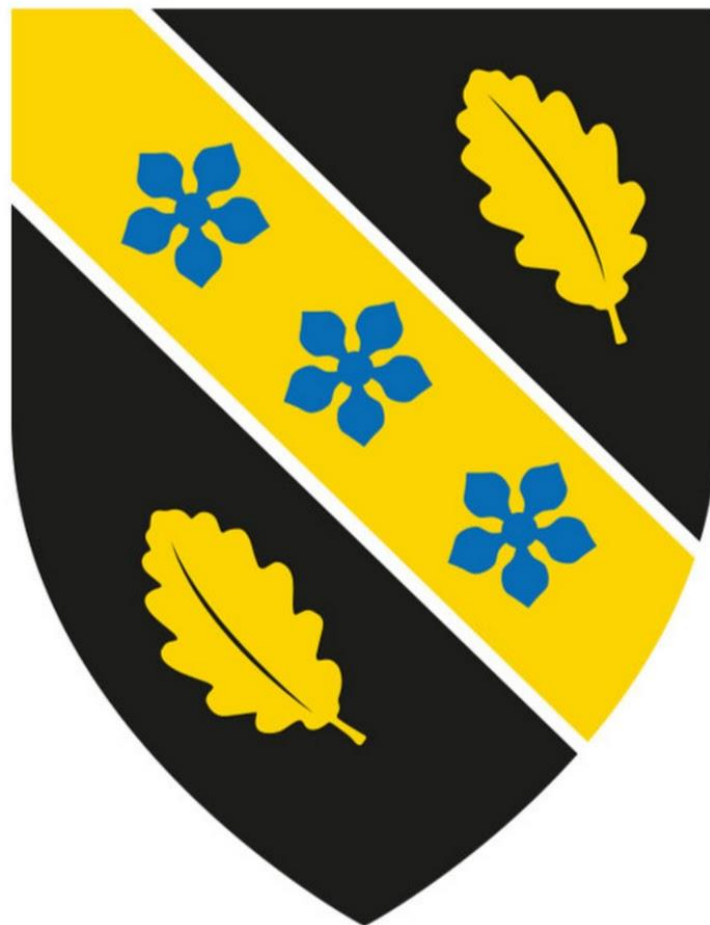


University of Wales Trinity Saint David
School of Engineering

The Relevancy of Risk Management in
Manufacturing
Engineering Applications and Study Skills
ACMA4007



Julian Edwards
2315607

Contents

1	Introduction.....	i
1.1	Aims	i
1.2	Objectives	i
2	Literature Review.....	ii
2.1	What is Risk Management?	ii
2.2	Engineering Code of Conduct.....	iii
2.3	Health and Safety.....	iii
3	Failure Modes and Effect Analysis.....	iv
3.1	What is a Failure Modes and Effect Analysis?.....	iv
3.2	Conducting an FMEA.....	v
3.3	Scoring an FMEA.....	vi
4	Conclusion	viii
5	References.....	ix
6	Appendix.....	x
6.1	Personal Development Plan	x
6.2	Technical Poster.....	xi

1 Introduction

Risk management is a tool that should be used by all engineers, especially within manufacturing, as almost everything can pose a risk to an organisation, an individual, or even a product. This is not only limited to the manufacturing sector, but every sector has its own unique set of risks and methods of managing these risks. These risks must be managed to be able to work in a full capacity with as few risks to people, products, or organisations as possible and claim the benefits.

1.1 Aims

The primary aim of this report is to gain an understanding of risk management and how this is beneficial to the manufacturing sector and engineers. This will be done by examining and reviewing literature and legislation surrounding risk management, manufacturing, and identifying how to mitigate risks. This will be done by literature review and conducting a Failure Modes and Effects Analysis.

1.2 Objectives

- To explore what is meant by risk management and how it affects organisations.
- To discuss the importance of risk management to the manufacturing sector.
- Identifying the benefits of managing risks for manufacturing organisations.
- To understand current legislation and codes of conduct surrounding risk management and manufacturing.
- To illustrate the purpose of a Failure Modes and Effects analysis and how it is conducted.

2 Literature Review

2.1 What is Risk Management?

Firstly, it is important to understand what can be identified as a risk and how risks can be assessed. (Jorge, S, & Capinha, 2020) states that a risk can be described as ‘one of the most dynamic scientific areas’ meaning they can exist in almost any environment and are constantly changing and can be created very easily, especially in a manufacturing environment where each change can introduce a new risk entirely or eliminate another. It is important to assess these risks to identify the scale, severity, likelihood of occurrence and, safeguards to mitigate these risks. There are many ways to identify risks in each sector such as a Failure Modes and Effects Analysis which is widely used within the manufacturing sector to identify risks at each point of possible failure (Failure mode) and assess which current controls are in place and what changes could be implemented.

It is also important to understand what is meant by “Risk management” and how it is applied within industries. ‘Risk management is a very important process in the context of global and organizational sustainability’ (Sarfraz & Ivascu, 2021), this applies to all organisation types and sectors including manufacturing, this remains true despite the disparity of types of risks which are specific to each sector. This would also mean that risk management is an essential tool in keeping organisational practices sustainable. ‘Managing risk is to minimise, control and share risk’ (Odimabo, Oduoza, & Subashini, 2018), this would make the impact of a risk to the business less of a burden and allow for resources to be allocated into other areas whilst also making risks easier to mitigate and possibly neutralise some risks and issues when they arise. This is of great benefit to manufacturing as they face risks that could potentially stop all processes, costing them, time, money, and human resources. Businesses in the manufacturing sector can prepare themselves for when a risk develops into an issue, or at the very least lessen the impact that it would have on the business. It is also important to note that not all risks can be completely removed and would only be able to reduce the severity and made less likely to happen this could be due to the risk’s nature or the scale of the risk.

2.2 Engineering Code of Conduct

The Institute of Mechanical Engineers (IMechE) is a ‘purpose-driven organisation, committed to improving the world through engineering.’ (IMechE, n.d.) and has a code of conduct for professional engineers that details the rules that its members must follow even if they are not yet chartered engineers. Many of these values and responsibilities can be linked to proper risk management such as where it states, ‘They shall quantify, balance and limit risks in all aspects of professional work’ (IMechE, 2021), which encourages risk management to meet their values and be supported by the IMechE. They also recognise that the environment is a large factor and that members should ‘take account of the needs of the diverse environment, while never knowingly or deliberately wasting or carelessly using natural resources.’ (IMechE, 2021). Environmental factors can also be considered by conducting risk assessment and management, typically around the disposal of materials and fluids, or when construction is taking place.

2.3 Health and Safety

(IMechE, 2021) Also states that members should be committed to following health and safety regulations. Health and safety can also be at risk and should be seriously considered when conducting risk assessments and risk management and should be put as the highest priority to protect organisations and their workers so that they can perform their roles with any issues and prevent any other tragedies. This coincides with the work that the Health and Safety Executive (HSE) does to attempt to ‘reduce work-related death, injury and ill health’ (HSE, n.d.) and the wide range of acts that they, and local authorities, enforce upon organisations and are officially recognised by the government. This shows that it is not only a moral and ethical obligation to manage risk concerning health but also a legal obligation for organisations to put the lives of both their workers and consumers first when mitigating risks. This can also be seen in the (Health and Safety at Work etc. Act 1974), Section 2 which clearly states that it is the employer’s duty to provide and maintain a working environment that is ‘safe’ and ‘without’ risks to health (Health and Safety at Work etc. Act 1974). To be able to mitigate these risks, the employer would need to conduct a full risk assessment and apply control measures to ensure safe working procedures and environment.

3 Failure Modes and Effect Analysis

3.1 What is a Failure Modes and Effect Analysis?

One of the most effective ways of assessing risks and further managing them would be to conduct a Failure Modes and Effects Analysis (FMEA), there are two styles of this kind of document which slightly differ in content. Firstly, there is a PFMEA (Process FMEA) which focuses on the Process or function of a piece of equipment or part of a manufacturing process to ensure that the process/function will be operational and identify issues that can be mitigated and then changes can be applied. There is then a DFMEA (Design FMEA) which focuses more on the quality of a given product, machine, or service and is more likely to be completed when the item/service is still in development but can also be conducted later when changes are going to be made.

3.2 Conducting an FMEA

When carrying out an FMEA, firstly one or many processes or functions are chosen, this is typically an item/process that is still in development or an item/process that is undergoing a change either due to the implementation of a new function, help mitigate an existing issue, or an unforeseen issue with the item/process has been identified.

After choosing an appropriate item/process, potential “Failure Modes” or issues will be identified for each of the items/processes. Once these have been established, potential causes can then be identified, these can be identified by using other methods such as an Ishikawa (Fishbone) Diagram or 5 Whys, there may only be one potential cause or there could be several depending on the complexity of the process or function.

Finally, the current controls are identified, these could have been implemented after a previous FMEA or are already a part of the existing item/process.

This data is then entered into a document as shown below:

FAILURE MODE AND EFFECTS ANALYSIS																
Item: <u>Zone 9 Trimmers</u>		Responsibility: _____				FMEA number: _____										
Model: _____		Prepared by: <u>Julian Edwards</u>				Page : _____										
Core Team: _____						FMEA Date (Orig): <u>08/02/2024</u> Rev: _____										
Process / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v	C l a s s	Potential Cause(s)/ Mechanism(s) of Failure	O c c	Current Controls	D e t	R P N	Recommended Action(s)	Responsibility and Target Completion Date	Action Results				
												Actions Taken	S e v	O c c	D e t	R P N
Coil Trimming	Trimmed Width incorrect / not trimmed at all	Customer complaint, or diverted to be re-trimmed			Trimmer degraded over time		Regular maintenance.		0						0	
					Coil has poor shape / poor weld		Visual inspection, rework / scrap coil.		0						0	
					Width measurement inaccurate		Measurement equipment checked and calibrated frequently by inspector an operator.		0						0	
					Steering failure		Regular maintenance, inspector to monitor width variation.		0						0	
					Incorrect width of incoming coil		Label is checked in TLR and check what the coil width should be.		0						0	
	Rough edges after trimming	Rejection by customer			Incorrect gap setting on trimmer blade		Exit worker to inspect coil edges, trimmer heads checked when offline.		0						0	
					Poor edge condition		Check trimmer heads when offline, edges are inspected by exit worker, visual checks for scrap on sides.		0						0	
	Strip break	Delays in schedule, down time for line			Faulty weld tracking / weld in wrong place		Observed by operator, maintainance to be carried out routinely.		0							0

Figure 1- Zone 9 Trimmers PFMEA

3.3 Scoring an FMEA

After all areas have been identified, each section is then “Scored” or “Rated” on a scale that will be defined uniquely with each FMEA or use an existing scoring system from a similar FMEA.

Severity, occurrence, and detectability are then ranked on an individually defined scale that will vary depending on the scenario it is used in as well as the item/process that is the subject.

Below is an example method that was used to score the previous document:

Effect	Criteria	Ranking	Probability of Failure	Criteria	Ranking	Likelihood of detection	Criteria	Ranking
Extreme - without warning	Will cause a line stop without warning that will mean there will be a commission that could take several days.	10	Very high - Consistent Failures	Every 1 or 2 coils	10	Almost impossible	Control will almost never be able to detect failure mode either due to the failure mode's nature or ineffective control.	10
Extreme - with warning	Will lead to the ultimate decision to stop the line with warning for repairs that could take several days.	9		More than Every ~5 coils	9	Very unlikely	Very unlikely chance that the control can detect the cause and by extension the failure mode.	9
Very high	Will cause a delay that will likely mean that the line will have to stop temporarily (1 day or less) for repairs or to remove scrap.	8	High - Likely chance of failure	> 1 Time every shift	8	Unlikely	Unlikely chance that the control can detect the cause and by extension the failure mode.	8
High	Will lead to a large customer complaint that could impact future business from that customer / product will have to be diverted for further work.	7		> 1 Time every 24 hours	7	Low	Low chance that the control can detect the cause and by extension the failure mode.	7
Moderate	Product would have to be diverted and reworked and may no longer fit within specification	6	Moderate - Failures will occur occasionally	> 1 Time per week	6	Moderately Low	Moderately low chance that the control can detect the cause and by extension the failure mode.	6
Low	Product would probably be diverted and reworked but still fit within specification	5		> 1 Time per month	5	Moderate	Moderate chance that the control can detect the cause and by extension the failure mode.	5
Very Low	More likely to affect customers but still within specification	4		> 1 Time every 2/3 months	4	Moderately High	Moderately high chance that the control can detect the cause and by extension the failure mode.	4
Minor	May affect some customers with very strict limits	3	Unlikely - Very few failures	> 1 Time every 5/6 months	3	High	High chance that the control can detect the cause and by extension the failure mode.	3
Very little	Will not affect the customers products but is still a quality concern.	2		> 1 Time every 9/10 months	2	Very high	Very high chance that the control can detect the cause and by extension the failure mode.	2
None	No real impact.	1	Extremely unlikely - Failure will very rarely happen if ever.	~1 failure per year	1	Almost every time	Very unlikely chance that the control can detect the cause and by extension the failure mode.	1

Figure 2 - PFMEA Scoring Tables

As shown in Figure 2, Severity (left) was ranked based on the impact on the business if an issue were to occur with ten being the most extreme causing an unexpected stop in production and 1 having no real impact on the business. Occurrence (Centre) was ranked based on the likelihood of this issue occurring from every 1-2 coils (products) to one failure per year which is almost to be expected. Thirdly, detection (right) was scored from being impossible to detect to being able to detect the issue every time.

Below is the fully scored version of the previous PFMEA:

FAILURE MODE AND EFFECTS ANALYSIS															
Item: <u>Zone 9 Trimmers</u>			Responsibility: _____			FMEA number: _____									
Model: _____			Prepared by: <u>Julian Edwards</u>			Page : _____									
Core Team: _____						FMEA Date (Orig): <u>08/02/2024</u> Rev: _____									
Process / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v	C l a s s	Potential Cause(s)/ Mechanism(s) of Failure	O c c	Current Controls	D e t	R P N	Recommended Action(s)	Responsibility and Target Completion Date	Action Results			
												Actions Taken	S e v	O c c	D e t
Coil Trimming	Trimmed Width incorrect / not trimmed at all	Customer complaint, or diverted to be re-trimmed	6		Trimmer degraded over time	4	Regular maintenance.	2	48	None / No Improvements					0
			7		Coil has poor shape / poor weld	5	Visual inspection, rework / scrap coil.	4	140	None / No Improvements					0
			7		Width measurement inaccurate	3	Measurement equipment checked and calibrated frequently by inspector an operator.	6	126	None / No Improvements					0
			6		Steering failure	3	Regular maintenance, inspector to monitor width variation.	3	54	None / No Improvements					0
			6		Incorrect width of incoming coil	2	Label is checked in TLR and check what the coil width should be.	3	36	None / No Improvements					0
	Rough edges after trimming	Rejection by customer	7		Incorrect gap setting on trimmer blade	3	Exit worker to inspect coil edges, trimmer heads checked when offline.	5	105	None / No Improvements					0
			7		Poor edge condition	4	Check trimmer heads when offline, edges are inspected by exit worker, visual checks for scrap on sides.	5	140	None / No Improvements					0
	Strip break	Delays in schedule, down time for line	7		Faulty weld tracking / weld in wrong place	4	Observed by operator, maintainance to be carried out routinely.	3	84	None / No Improvements					0

Figure 3 - Zone 9 Trimmers PFMEA Scored

4 Conclusion

To conclude this report, there are many reasons why risk management is relevant and important to the manufacturing sector, which consist of moral, ethical, and legal obligations to conduct risk assessments and manage risks. When managing these risks there are also several contributing factors such as health, safety, the environment, and the workplace, and managing these risks can produce many benefits such as cost benefits, performance benefits, and improved morale for all sectors and not just manufacturing. One of the best tools for conducting risk management is an FMEA, which is simple for anyone to be introduced to and works best for teams with members being in different areas of the workplace with different specialties to balance all considerations when in development or improvement. The findings of the PFMEA as shown in Figure 3, show that the current controls in place are effective at mitigating the risk of failure, and while no improvements were suggested, there are always improvements that can be made by other teams with more experience or with a new approach to the issues.

5 References

- Health and Safety at Work etc. Act 1974*, c. 37. Retrieved 02 12, 2024, from <https://www.legislation.gov.uk/ukpga/1974/37/section/2>
- HSE. (n.d.). *Legislation owned and enforced by HSE and Local Authorities*. Retrieved 02 12, 2024, from Health and Safety Executive: <https://www.hse.gov.uk/legislation/enforced.htm>
- IMechE. (2021). *Code of Conduct Regulations*. Retrieved 02 12, 2024, from Institute of Mechanical Engineers: https://www.imeche.org/docs/default-source/1-oscar/About-us/governance/code_of_conduct_02_03_02.pdf?sfvrsn=2
- IMechE. (n.d.). *About us*. Retrieved 02 12, 2024, from Institute of Mechanical Engineers: <https://www.imeche.org/about-us>
- Jorge, R., S, O., & Capinha, C. (2020). *Introductory Chapter: Risk Management. Risk Management and Assessment*. London: IntechOpen. Retrieved 02 12, 2024, from <http://dx.doi.org/10.5772/intechopen.93553>
- Odimabo, O. O., Oduoza, C. F., & Subashini, S. (2018). *An Insight into the Process, Tools and Techniques for Construction Risk Management. Risk Management Treatise for Engineering Practitioners*. (C. F. Oduoza, Ed.) London: IntechOpen. Retrieved 02 12, 2024, from <http://dx.doi.org/10.5772/62812>
- Sarfraz, M., & Ivascu, L. (2021). *Risk Managment*. London: IntechOpen. Retrieved 02 12, 2024, from <http://dx.doi.org/10.5772/intechopen.91067>

6 Appendix

6.1 Personal Development Plan

Personal Development Plan

Name – Julian Edwards (2315607)

Degree – BEng2-PT Materials Science

Previous Qualifications – A Level Computer Science, ICT, Mathematics

Previous Experience – 4/5 Months working as a Technical Apprentice in TATA Steel

Goal	Objective	Resources Required	Measurement	Deadline
Create/Conduct an FMEA analysis.	- Research previous examples of FMEA documents. - Research and learn about the Zodiac Line - Choose a simpler section of the line to conduct an FMEA. - Create an effective scoring system. - Conduct FMEA.	- TATA steel <u>Llanwern</u> past FMEA documents as examples for structure - University Library	Complete FMEA document accurately and to a professional degree.	12/02/2024
Write a technical report about the relevancy of risk management in manufacturing.	- Conduct research on risk management. - Attend study skills lectures. - Complete first version. - Review. - Rewrite and improve until deadline.	- University Library - Websites, Journals, Articles - Lectures	Complete a technical report that fits within a reasonable range of the word limit to a professional degree whilst including all relevant information that will help communicate the relevancy of risk manufacturing in manufacturing to a technical audience.	12/02/2024



Failure Modes and Effects Analysis – Zone 9 Trimmers

Julian Edwards

School of Engineering
BEng (Hons) Materials Science

Introduction

An FMEA was carried out by a single team member of the Zone 9 trimmers inside of the ZODIAC at TATA Steel Llanwern to gain a better understanding of how risks are managed and understand the benefits of an FMEA.

Why is Risk management important?

‘Managing risk is to minimise, control and share risk’ (Odimabo, Oduoza, & Subashini, 2018), this would mean that the organisation will be better prepared for any issues that may arise and have contingency plans ready. This would also allow them to mitigate these risks and focus on other areas. A general overview of this can be seen in Figure 4



Figure 1 – Risk Identification Process (Odimabo, Oduoza, & Subashini, 2018), this shows the general process of identifying risks.

What is an FMEA?

An FMEA is one of the best ways to assess and manage risks whilst coordinating with a team. It allows for the identification of possible “Failure Modes” and their causes and takes into account the control measures which may or may not be in place and improves them to reduce severity, and occurrence or increase the probability of detections. The PFMEA of the Zone 9 Trimmers can be seen in Figure 2, and the general overview of conducting an FMEA can be seen in Figure 3.

FAILURE MODE AND EFFECTS ANALYSIS												
Item: Zone 9 Trimmers			Responsibility: John Edwards			FMEA Number:			Page:			
Date Taken:			Prepared by:			FMEA Date (Orig):			Rev:			
Process / Function	Potential Failure Mode	Potential Effect of Failure	Potential Cause(s) of Failure	Current Controls	Recommended Actions	Responsibility	Completion Date	Actions Taken	1	2	3	4
Trimming	Trimmer damaged over time	Customer complaint on damaged trimmer at all	1. Trimmer degraded over time	1. Regular inspection	1. Regular inspection	John Edwards	18/02/2024					
			2. Cut too poor shape / poor width	2. Visual inspection, measure & replace cut	2. Visual inspection, measure & replace cut	John Edwards	18/02/2024					
			3. Width measurement inaccurate	3. Measurement equipment checked and calibrated	3. Measurement equipment checked and calibrated	John Edwards	18/02/2024					
			4. Steering failure	4. Measurement equipment checked and calibrated	4. Measurement equipment checked and calibrated	John Edwards	18/02/2024					
Cut Trimming	Incorrect width of cutting cut	Lateral is checked on 15 and check should be	5. Incorrect width of cutting cut	5. Lateral is checked on 15 and check should be	5. Lateral is checked on 15 and check should be	John Edwards	18/02/2024					
			6. Incorrect width of cutting cut	6. Lateral is checked on 15 and check should be	6. Lateral is checked on 15 and check should be	John Edwards	18/02/2024					
Rough edges after trimming	Rough edges after trimming	Rough edges after trimming	7. Incorrect gap setting on trimmer heads	7. Check trimmer heads when adjusted when adjusted	7. Check trimmer heads when adjusted when adjusted	John Edwards	18/02/2024					
			8. Poor edge condition	8. Check trimmer heads when adjusted when adjusted	8. Check trimmer heads when adjusted when adjusted	John Edwards	18/02/2024					
Strip break	Strip break	Strip break	9. Strip break	9. Strip break	9. Strip break	John Edwards	18/02/2024					
			10. Strip break	10. Strip break	10. Strip break	John Edwards	18/02/2024					

Figure 2 – Complete PFMEA of Zone 9 Trimmers that has been rated in all three areas.

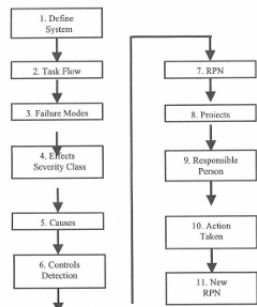


Figure 3 – (Terninko, 2003) Illustrates the general process for conducting a Failure Modes and Effects Analysis



Figure 4 – adapted from (ISO 31000, 2018),. This figure outlines the over process of managing risks

Conducting the FMEA

Firstly, the process or function is identified, this item was chosen due to easily identifiable failure modes. Secondly, the failure modes were identified, of which there were 3 that have been seen so far. Each failure mode was then carefully researched and monitored to find several potential causes and identify the current controls that are in place. The severity, occurrence and detectability were then rated based on the contributing factors such as the potential causes and current controls. To which the controls that are currently in place are more effective than other actions which could be recommended.

Summary of Key Findings

Risk management is important to all sectors but is most of all effective within manufacturing and has several benefits such as being able to prevent risks from developing into problems or being prepared for the eventuality that it will occur. Failure modes and Effects Analysis is one of the best methods for managing risk and was carried out by a single team member on the ZODIAC Zone 9 Trimmers which identified possible issues and their causes. The current controls were also more effective than any recommended action that could be identified by the current team.

References

Odimabo, O. O., Oduoza, C. F., & Subashini, S. (2018). An Insight into the Process, Tools and Techniques for Construction Risk Management. Risk Management Treatise for Engineering Practitioners. (C. F. Oduoza, Ed.) London: IntechOpen. Retrieved 02 12, 2024, from <http://dx.doi.org/10.5772/62812>

TERNINKO, J., 2003. Reliability/Mistake-proofing Using Failure Mode and Effect Analysis (FMEA). Quality Congress.ASQ's ...Annual Quality Congress Proceedings, 57, pp. 515-526. Available at: <https://www.proquest.com/docview/214392724/9988CEDAC89425DPQ/4?accountid=130472&source=Scholarly%20Journals>

ISO. ISO 31000: Risk management—Guidelines. Geneva, Switzerland: International Organization for Standardization (ISO); 2018. Available from: <https://www.iso.org/obp/ui/#iso:std:iso:31000:ed-2:v1:en>