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Root Cause Analysis – Technical Report

Engineering Applications & Study Skills (ACMA 4039)

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2. Introduction

This report presents a structured Root Cause Analysis (RCA) into the malfunction of a rotary hydraulic press by investigating the practical application through an RCA. The objective is to emphasise the importance of structured risk management within manufacturing engineering through an evaluation of failure events, identifying its root causes and developing engineered controls to prevent the recurrence.

3. Literature Review

3.1 Critical role of risk management in manufacturing engineering

Risk management is identified as a mandatory measure within manufacturing engineering operations, where it is implemented to minimise operational failures, health and safety risks and

quality inconsistencies. Evidence indicates that risk management strategies lead to a reduction in workplace incidents, *Risk assessments are crucial to preventing accidents in the workplace: not only can risk assessments reduce the likelihood of accidents, they also help raise awareness of hazards and minimise risk.* British Safety Council (2024).

The use of risk management in the workplace extends beyond the positive impacts towards safety concerns. It also affects the economic condition of many organisations. Where companies experience a reduction in costs associated with production downtime, legal penalties and manufacturing iterations. For instance, *Effective Reduction of Production Costs ISO 31000's structured risk management approach allows companies to identify and eliminate high-risk areas in the production chain. This directly impacts production cost reduction, ultimately increasing the company's profit margins.* SGSCorp. (2018).

3.2 Tools for risk mitigation in manufacturing engineering

Manufacturing engineering has implemented a range of different methodologies that help reduce risks. A principal methodology is Root Cause Analysis (RCA), a structured tool for investigating underlying causes of failure. Then using a FMEA (Failure Mode and Effects Analysis) to investigate issues and their reoccurrence. It is a proven methodology that allows engineers to identify the root cause of an issue they are facing by addressing underlying system/protocol problems.

The use of RCA within manufacturing engineering allows for risk identification through scoring categories. This includes severity, occurrence and detection which creates a final Risk Priority Number (RPN) scoring. This scoring evaluates the above criteria, allowing the organisations to understand the highest-risk failures for incidents. The RCA process breaks down a primary failure event into multiple potential causes, where each cause is assessed through a scoring system. Additionally, the analysis evaluates the current controls and the recommended actions and how these actions directly reduce RPN scores through a reassessment of severity, occurrence and detection. The successful implementation of an RCA allows manufacturers to understand problems and their root causes. Eventually, enabling the organisation to focus their efforts on issues with the greatest risk reduction.

3.3 Professional standards, legislations and acts

Manufacturing engineering operates within mandatory professional standards and legislations. These are put in place for a variety of reasons ranging from health and safety to product quality and reliability. This is further emphasised in the Institution of Mechanical Engineers (IMechE) Code of Conduct which outlines that we should *Quantify and limit risk in all aspects of professional work, including with those who are working under our authority.* IMechE, (2023). This professional obligation highlights that risk management is not only a legal requirement but also an ethical responsibility

The Health and Safety at Work act (1974) securing the health, safety and welfare of persons at work. This act regulates employers to ensure the health and safety of its employees whilst at work. Therefore, in the manufacturing engineering industry tools like RCA and risk assessments are key. These acts encourage risk management to be a necessity through legal documentation rather than common and optional practise.

ISO 9001 establishes a criterion for quality management systems within manufacturing engineering that is driven by risk management. It's requirement for continuous process improvement-*The standard helps identify and eliminate inefficiencies, reduce waste, streamline operations, and*

promote informed decision-making, resulting in cost savings and better outcomes. ISO 9001 (2015). Is in line with the use of many risk management tools. For example, a Root Cause Analysis which helps identify the greatest risk reduction in a company's system, allowing for the elimination of inefficiencies that the standard promotes.

4. Methodology

4.1 Approach to risk management investigation

This approach into manufacturing risk management was conducted through a two-stage structure that included a Root Cause Analysis (RCA) and a Technical Report that explained all the investigation. This structure ensured the research remained organised and directly linked back to the question, supported by a relevant industrial case study.

4.2 Theoretical and contextual research

A wide range of research was conducted through a variety of academic and professional sources. This research established the foundation for essential context in the investigation. Academic sources such as Google Scholar were used to investigate recent and up to date written papers that would provide referencing for views and opinions. Additionally, professional standards and legislations were analysed: (IMechE, 2023) and ISO directly affected risk management within manufacturing engineering.

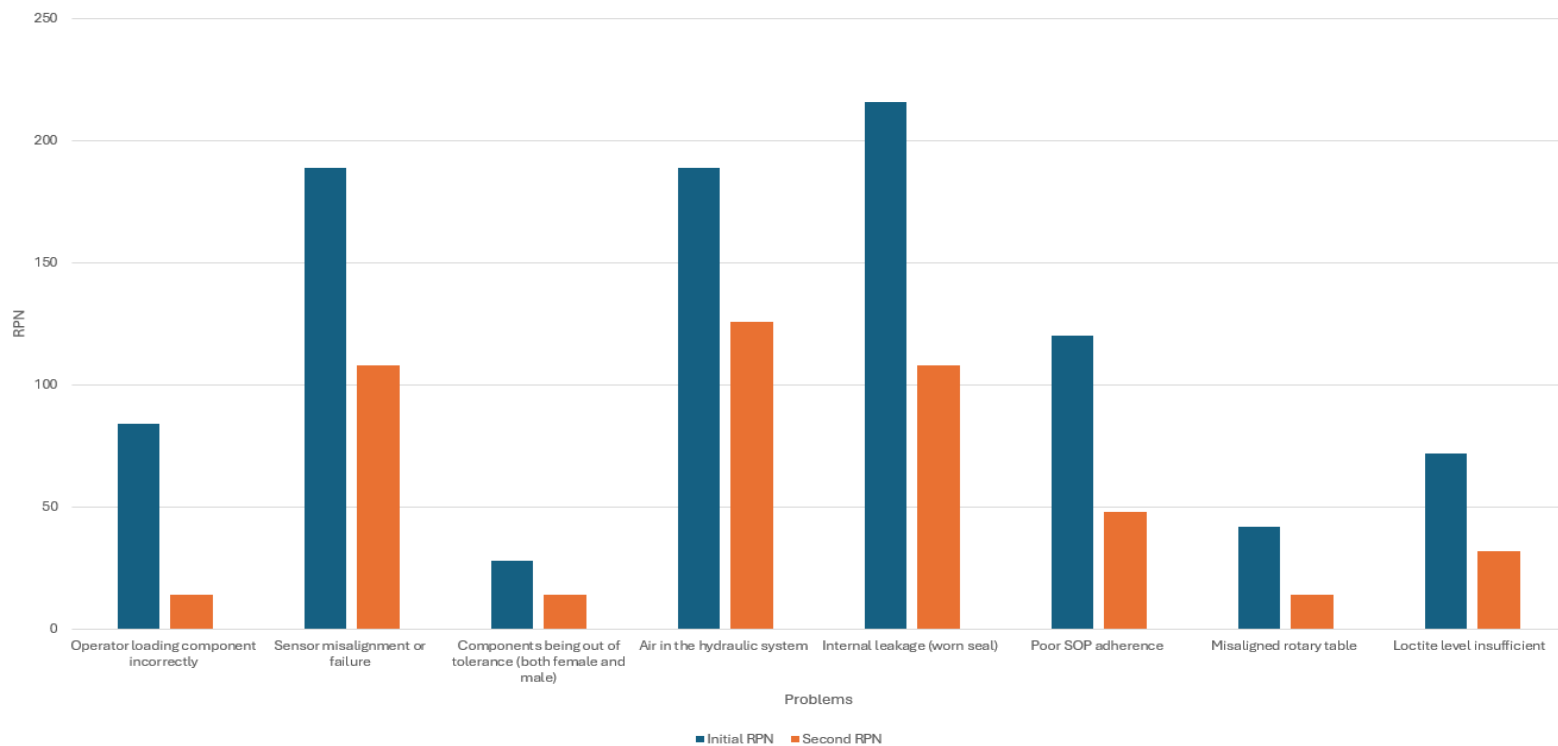
4.3 Risk analysis using RCA

The final phase emphasised the research made and referred it back to a relevant workplace incident: The failure of a rotary hydraulic press. The RCA involved identifying and definition of the core problem (press arm ejection). A further criterion evaluated the cause against: Severity (Impact on safety or functionality), Occurrence (Likelihood) and Detection. These parameters were then multiplied to create a Risk Priority Number (RPN) which allowed me to calculate the level of current risk and its risk after the new measures that have been put in place. This process provides an assessment for risk and planning.

5. Results & Analysis of RCA

5.1 RCA explanation

The RCA revolved around a consistent issue with the rotary hydraulic press machine where a range of problems caused the machine to malfunction. Eight clear failure contributions were identified. The issues were then described in the RCA table; and all issues were listed, the effects on the machine were identified whilst also analysing the effects if the issue occurs and how that can affect the machine and production. The next column along included the severity (SEV), occurrence (OCC) and detection (DET) ratings which were collected and the initial ratings in terms of these criteria would eventually create the initial RPN score. Once the initial RPN was created actions were recommended that would help lower the RPN and this was further recalculated by using the same criteria as the initial RPN.



5.2 RCA justification

Firstly, looking into the RCA table, the severity maintained a rating from 7-9. These ratings were assigned because the issues listed would cause failure to the machining components or would cause a halt in production time. Ratings of 8 or 9 were reserved for issues that would cause arm ejection. A rating of 7 was given if it caused significant downtime but not arm ejection, it was rated a 7 due to the prolonged time of the machine being in maintenance. All issues were classified as Critical Characteristic, as each issue would cause excessive production stoppage or machine failure. The occurrence ratings ranged from 2-5, the higher ratings (4-5) were concluded because they occurred more often and were primarily linked to human error. Whereas the lower ratings (2-3) were assigned with mechanical failures. Detection ratings varied most significantly (2-8), based on how easily a failure could be seen before causing an issue. A lower rating (2-3) was assigned if the issue was clearly visible, like an operator error. An error that required machinery to be taken apart to be seen has been rated 7-8. This is because it is an internal component of the machine like an internal leak which requires a maintenance team or someone doing regular inspections on the machine to understand that it is occurring. Whereas a mechanical error like a misaligned rotary table is clearly visible without the dismantlement of the machine.

5.3 Mitigating actions and revised RPNs

The implemented actions were directly targeted at reducing the RPN. The largest percentage reduction (83%) was for operator loading error, which was achieved by installing a depth gauge. This engineering control eliminated the chance of human error. The largest point reduction (108) addressed an internal mechanical issue regarding seal leakage. This was done by implementing a routine inspection of the machinery. The two results along with the 100% success rate in lowering each issue's RPN highlighted the importance of risk management principles within manufacturing engineering. Figure 1 highlights the implementation of the preventative measures that resulted in the significant reduction in RPN. Where every failure mode saw a decrease confirming the effectiveness of the actions taken.

6. Conclusion

6.1 Summary of key findings

This report has investigated the importance of structured risk management in manufacturing engineering by using FMEA methods and a practical application of a rotary hydraulic press and its failures. The conclusion of this report confirms that risk management is integral to manufacturing and is an essential framework for operational safety, cost control and product reliability.

6.2 Effectiveness of an RCA

The RCA conducted proved through figure 1 it was an effective resource for risk mitigation. As explained earlier, it analysed complex failures into specific causes that were scored on a particular criterion. The results highlighted significant risk reduction, with RPN scores decreasing by an average of over 60% after actions were implemented. This was confirmed notably through the most significant risk reduction of 83% and 108 RPN points after the application of gauges and routine inspections. These statistics strengthen the argument of an RCA's importance through data driven results.

6.3 Weaknesses of an RCA

However, the effectiveness of an RCA is not guaranteed, its effectiveness can be compromised by organisational culture; through cross-functional misalignment among stakeholders. The different views and perspectives cause underlying problems with blame and responsibility. Furthermore, the post failure initiation factor of an RCA can be seen as an issue because these factors should be considered during the design stage rather than after flaws occur.

6.4 Final assessment

In conclusion, while not the only tool for risk mitigation in the engineering industry it is an essential tool to provide quality and transparent results. It is an effective method to help minimise risks in the workplace, clearly demonstrated by our results. The process allows for a safer and more efficient approach to manufacturing operations. The implementation of the RCA conveys the importance of risk management in manufacturing engineering by highlighting how it can impact and identify the primary root cause of a significant problem

7. References

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Root Cause Analysis (RCA)																	
Item: Hydraulic Press (with rotary table)		Responsibility: Manufacturing Engineering Department		RCA number:													
Model: Need to find out		Prepared by: Aranbeer Moore		Page :													
Core Team: Production Engineer				FMEA Date (Orig):		Rev:											
Process / Function	Identified Issue	Potential Effect(s) of Failure	S e v	C i s s a	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	
Process / Function	Describe the issue	What can happen if the issue occurs	Rate the severity from 1-10	Ex: Operational Failure- so it would be SC or CC	List potential causes of the issue	Rate the occurrence likelihood from 1-10	List current controls in place to detect/prevent the issue	Rate the detection capability from 1-10	Multiply severity, occurrence, and detection	Actions recommended to mitigate the issue	Person responsible and target date for action completion	Results after implementing actions					0
Rotary Hydraulic Press Operation	Operator loading component incorrectly	Scrap/waste material, inconsistent product quality	7	CC	Poor operator training, Lack of concentration, Excessive workload	4	SOP adherence, Basic training	3	84	Depth guage-detects the depth of the whole piece to identify whether the male is misaligned	Operator	Depth guage-detects the depth of the whole piece to identify whether the male is misaligned	7	2	1	14	
*	Sensor misalignment or failure	Machine Downtime-Production Halt- Fall in production output-Not meeting contract requirements-Client dissatisfaction-Brand reputation impact Substantial repair costs Scrap/Waste material Contract penalties Inconsistent product quality Risk of injury from ejected component	9	-	Sensor not calibrated, obstructed sensor	3	Monthly calibration, Secure fittings	7	189	Routine cleaning/inspection, Fail-safe system stops operation if sensor signal is lost	*	Routine cleaning/inspection	9	2	6	108	
*	Components being out of tolerance (both female and male)	Scrap/waste material, inconsistent product quality, Machine downtime due debris clean up, Hydraulic press damage	7	-	Incorrect design specifications, miscalibration of machined components, delivery damage	2	Visual inspection, Quality control	2	28	Depth guage-detects the depth of the whole piece to identify whether the male is misaligned	*	Depth guage-detects the depth of the whole piece to identify whether the male is misaligned	7	2	1	14	
*	Air in the hydraulic system	Air is trapped in the hydraulic system which causes unexpected arm movements due to the pressure instability caused by sudden pressure releases	9	-	Air leaking into the system through: worn seal, puncture, Rushed repairs, Insufficient bleeding	3	Visual fluid inspections (not routine), High quality seals, System bleeding	7	189	Install automatic air bleed valves, Tested seals before installation	*	Install automatic air bleed valves, Tested seals before installation	9	2	7	126	
*	Internal leakage (worn seal)	Air into the hydraulic system, Increased energy consuption, Decreased efficiency	9	-	Degradation (chemical, thermal, physical) Environmental contaminants, Improper installation	3	Visual inspection (not routine),Temperature control	8	216	Routine inspection,Seal temperature testing (understanding maximum and minimum temperature that the seal can still function in)	*	Routine inspection,Seal temperature testing (understanding maximum and minimum temperature that the seal can still function in)	9	2	6	108	
*	Poor SOP adherence	Scrap/waste material, inconsistent product quality	8	-	Poor operator training, lack of concentration, Excessive workload	5	Basic training, SOP paperwork describing correct actions	3	120	Monthly assessments to assess SOP knowledge	*	Monthly assessments to assess SOP knowledge	8	3	2	48	
*	Misaligned rotary table	Scrap/waste material, inconsistent product quality, Damage to hydraulic press	7	-	Mechanical shock or impact, worn bearings, sensor misalignment or failure	3	Secure fittings, monthly routine inspection	2	42	Misalignment sensors to detect movement	*	Misalignment sensors to detect movement	7	2	1	14	
*	Loctite level insufficient	End product quality impacted, Scrap/waste material, Production delay	8	-	No refill of loctite	3	Visual inspection of loctite being dispensed into product (not mandatory)	3	72	Mandatory loctite inspection, Loctite drip test (tests amount of loctite being dispensed)	*	Mandatory loctite inspection, Loctite drip test (tests amount of loctite being dispensed)	8	2	2	32	

Personal Development Plan

Name – Aranbeer Moore

Degree – Mechanical Engineering

Previous Qualifications – A Levels (Mathematics, Product Design and Business)

Previous Experience – Real Estate, Customer Service, Software Engineering

Long Term Goals (5 to 10 years)

Achieve chartered Engineering status

Short Term Goals (0 to 5 years)

Improve Technical report writing skills to meet engineering standards and cater towards the appropriate audience

Learn to communicate technical figures and findings effectively to mixed audiences

Develop an understanding of Root Cause Analysis and the reasons to use it

Develop professional capability in risk management practises for the engineering industry

Goal	Objective	Resources Required	Measurement	Target Date
Improve Technical Report Writing Skills	Write 1700-word technical report following brief and structural requirements Apply Harvard referencing to support report findings Describe the process of conducting RCA and justification for the findings in report	Assignment Brief UWTSD Harvard Referencing guide RCA Excel Template Google Scholar-Research Following “Creating a Technical Report Template” Feedback from Lecturer	6+ references correctly formatted in Harvard style Adhering to the guidelines of “Creating a Technical Report Template” Word count is 1530-1870	25/11/2025
Develop RCA Skills	Research relevant workplace problems Complete RCA using provided template	RCA Excel template Google Scholar Workplace insight – briefing with health and safety team	All RCA template fields and requirements are completed Ensure justification and reasoning is noted	18/11/2025

Develop skills in creating a technical video presentation	Produce a 5-minute video presentation that communicates the RCA findings and technical report to the appropriate audience	PowerPoint Recording equipment/software (Teams) Created script for professionalism	Ensuring it is within the time requirement Professional presentation style-same font across all slides and same format Improved performance in future technical presentations	30/11/2025
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