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AUGMENTING PRODUCTIVITY BY MINIMIZING SCRAP RATE USING INDUSTRIAL ENGINEERING TOOLS AND AUTOMATION

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Abstract – *This article describes the use of industrial Engineering techniques which improves productivity by minimizing scrap percentage. Implementing IE techniques (Automation, work-study, time study, layout design, operation study) to eliminate human intervention in order to reduce the scrap percentage. This leads to process improvement which resulted in a reduction of waiting time and lead time thereby increase in productivity.*

Key Words: Value stream mapping, Cause and effect diagram,3D-Scanner, Macro program, process chart,2^3 experiment.

1. INTRODUCTION

Productivity is a measure of economic performance that compares the number of goods and services produced by outputs with the number of inputs used to produce those goods and services. Scrap rate evaluates the number of goods companies produce that become waste because of defects or errors during manufacturing. The average productivity of the company was around 1.3 to 1.4lakhs and the average scrap rate is 29%. Powder metallurgy is one of the developing manufacturing techniques in which we can manufacture from small-size inserts to big-size dies and also it is an easy method to produce complex shapes in which some of the products do not need any secondary machining process to attain their shape and for some products secondary machining is required. The time consumption in the inspection was more, the Scrap rate was high (both in Green Carbide Inspection and Grinding).

1.1 Problem Identification

1. High scrap rate at the Sintering process due to manual calculation in the Green Carbide Inspection area and more time consumption for production.
2. Inappropriate Measuring Instruments lead to inaccurate measurements due to component sensitivity and brittle nature.
3. Inadequate monitoring and control in the grinding process (surface grinding) leading to poor quality of the finished workpieces

1.2 Literature Review

1. According to the needs of the purchase department of the ABC Company, the plan and formulae were kept to be the same but the manual operations from the report were totally removed. As in apropos of VBA, literature was reviewed in the context of automation in MS Excel.
2. Yakubu Yisa, in a 2^3 factorial experiment is designed to examine the influence of such factors as teaching method, gender, and level of study on students' academic performance.
3. Mario COCCIA, the fishbone diagram can be a comprehensive theoretical framework to represent and analyze the sources of innovation.
4. Using an intrinsic function of our institution's EMR, vital signs and lab results from 20 individual hospitalizations were exported to a spreadsheet.

2. Aims and Objectives

Aim:

To improve productivity by minimizing scrap rate using Industrial Engineering tools such as (Time study, process chart, simulation, fishbone diagram, Design of Experiments, and standard operating procedure).

Objectives:

- Avoid errors by eliminating manual calculations and entries on route cards.
- To reduce the waiting time for machine operators at green carbide inspection.
- To obtain accurate measurements using a 3D scanner by providing the standard operation procedure.
- To ensure the integrity of the component and to prevent damage.

- To determine the relevant process variables that have the potential to impact the quality of the system
- To Develop a structured and well-designed experimental plan that outlines the specific experiments to be conducted.

3. Methodology

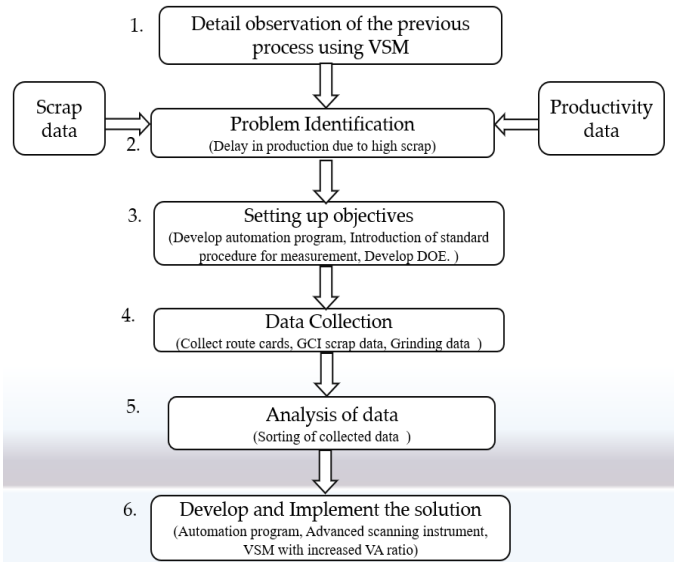


Figure -1: Methodology

4. Data Collection and Analysis

Some of the data collected are:

1. Route card
2. Tolerance charts
3. GCI scrap data
4. Grinding Scrap data

Month	Total scrap (nos)	Scrap due to manual calculation (nos)	Scrap due to inefficient measurement system (nos)
February	335	168	58
March	341	170	60
April	220	110	40

Table -1: Scrap rate

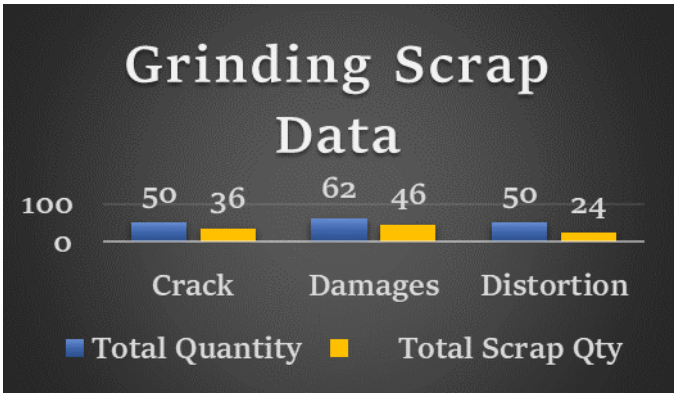


Figure -2: Scrap rate at grinding

Analyzing these data using graphs, simulation, process charts, and fishbone diagrams.

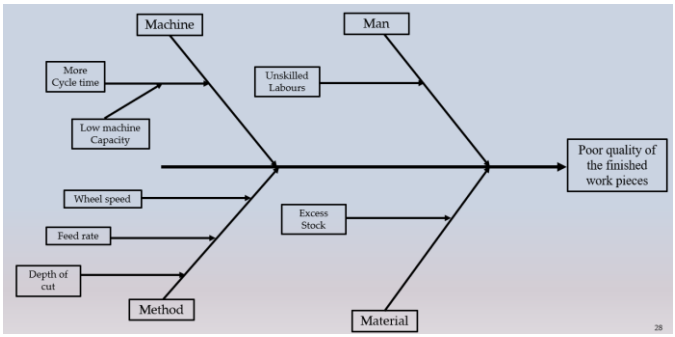


Figure -3: Fishbone diagram for analysis

5. Implementation of IE techniques

5.1 Implementation of excel based macro program to eliminate manual entries. The macro program reduces the error due to manual entries.

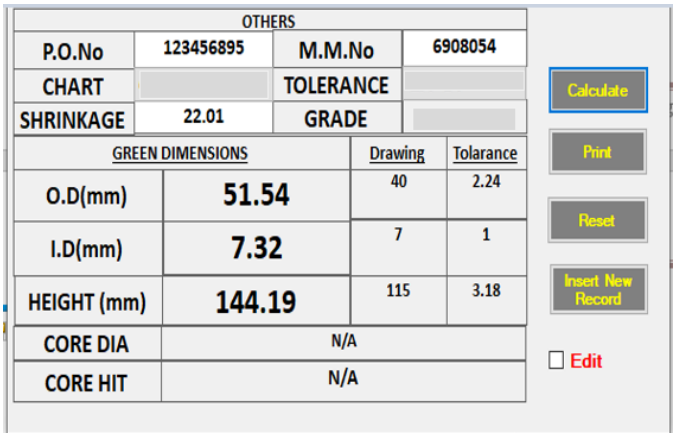
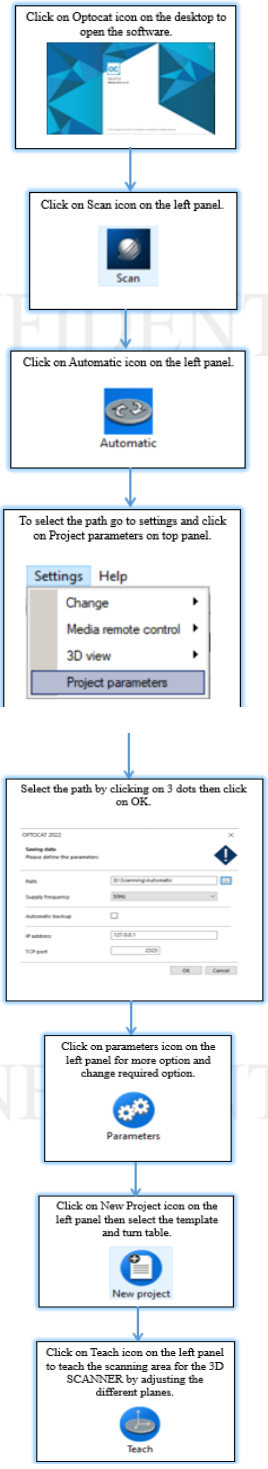


Figure -3: printed output

5.2 Creating a Standard operating procedure for 3D-Scanner which is to be implemented in the process where the brittle components are measured correctly and safely. It scans the components and measures the component's measurement without human intervention.

Flow Chart of the Process:



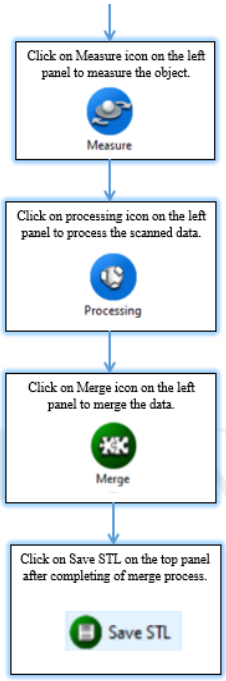


Figure -3: SOP for 3D scanner

5.3 Implementing the DOE (2^3 factorial design) for the factors wheel speed, depth of cut, and feed rate. By designing an experiment, it will give which combination of factors will provide the yield. Here the factors of wheel speed increased the yield and depth of cut increased. The feed rate is kept constant.

Treatment Combination	Response Total	1	2	3	Effect	Estimate of Effect	Sum of Squares
(1)	187	344	665	1539	I	-	-
a	157	321	874	49	A	4.08	100.04
b	172	472	53	93	B	7.75	360.37
ab	149	402	-4	-5	AB	-0.4166	1.041
c	232	30	23	-209	C	-17.416	1820.041
ac	240	23	70	57	AC	4.75	135.37
bc	203	-8	7	-47	BC	-3.916	92.041
abc	199	4	-12	19	ABC	1.583	15.041

Figure -4(A): Yates Algorithm

Source of variance	Sum of squares	DOF	Mean sum of squares	F(0)
A	100.04	1	100.04	1.054
B	360.07	1	360.07	3.798
C	1820.041	1	1820.041	19.185
AB	1.041	1	1.041	0.0109
AC	135.37	1	135.37	1.426
BC	92.041	1	92.041	0.970
ABC	15.041	1	15.041	0.158
ERROR	1612.681	17	94.8635	-
TOTAL	4136.625	23	-	-

Figure -4(B): Yates Algorithm

- **From F-distribution table $F_{(0.05,1,23)}$ =4.28**

Therefore, from the above table Feed rate (C) is significant

6. Results and discussion

6.1 Decreased scrap rate after implementation of macro program

Figure -5: Scrap rate due to manual calculation

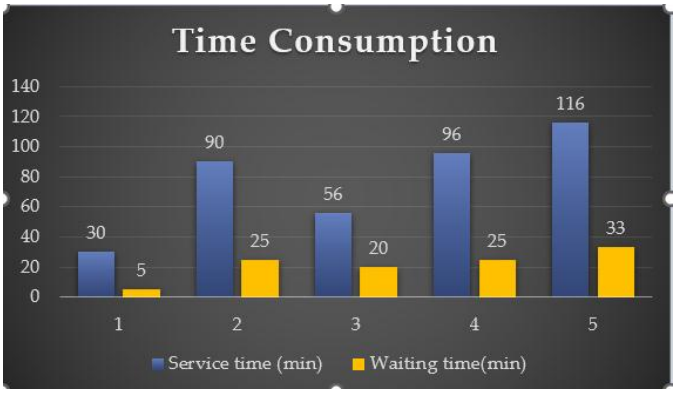


Figure -6: Time consumption

- Out of Total Green Scrap obtained 50% of scrap is due to manual Calculation.
- After implementing the macro program, the scrap due to the manual calculation is reduced by 35%
- After the implementation of the macro program, the waiting time in the system decreased, and service time also decreased.

6.2 Decreased scrap due to inefficient measurement system after the implementation of 3D-scanner into the process

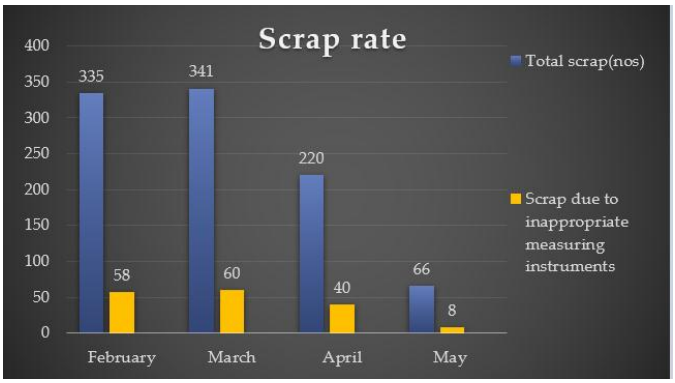


Figure -7: Scrap rate due to inappropriate measuring instruments

- Out of Total Green Scrap obtained 30% of scrap is due to inefficient measurement systems.
- After implementing the 3D-Scanner in the process the scrap due to inefficient measurement system is reduced by 15%

6.3 Decreased hard scrap (grinding scrap) after changing the combination of method parameters.

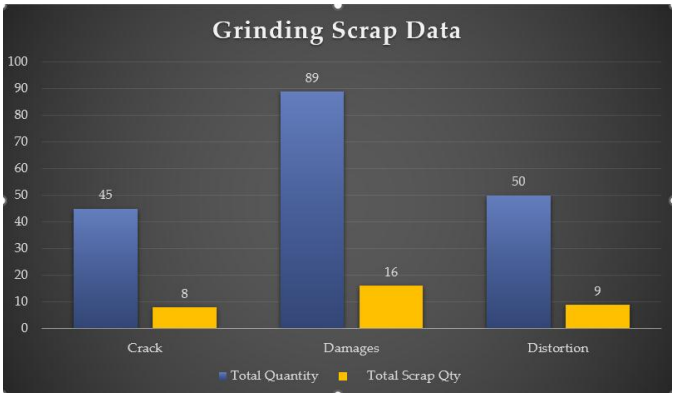


Figure -8: Scrap rate due to grinding

- From the graph it is observed, the scrap is reduced by 57%i i.e., initially, it was 75% and present scrap% is 18%

7. Conclusions

- The project work was completed successfully and the changes made were implemented with the aid of IE tools such as Standard Operating procedure, Cause and effect diagram, process chart, simulation, and Design of Experiments they were able to minimize the scrap rate thereby increasing productivity.
- The results were shown for the production of the month of May 2023 and the results are tabulated.
- Implementation of an Excel-based Macro program resulted in the elimination of manual calculations and reduced scrap rate from 50% to 15%.
- Implementation of 3D-scanning in the processes of Green Carbide inspection has reduced the scrap rate from 30% to 15%.
- Implementation of DOE results, the scrap rate at grinding is decreased from 25% to 15%
- The productivity has been increased by 50000pcs per month by decreasing the scrap by 19%

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