# Advancement in Through Hole Absence in Drilling Operation

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*Abstract*— This paper presents a review of vendor facing problem of drill breakage while doing 2nd hole in component named as U.J. Cross. In this report firstly, we founded problem to drive absence of through hole missing of lubrication hole operation which cause high PPM of company supplier X. Our focus was on to Find and eliminate problem for drill break (through hole absent) during lubrication drilling operation in X cause 66% to total rejections contributor. We had checked the part visually and thought about it where and why the problem came. We converge on Scrap Characterization, Reintroduce not good Part to Process, Operation Search. After in this case study we had done a test, by adding a speed sensor to SPM drilling machine. Action implemented on one machine shows the visibly difference in rejection % in action implemented & other 3 machines. We understood Speed sensor reduces speed while chip is in between part & drill cause more energy to drill & results in drill breakage. The problem magnitude of chip direction cause drill breakage. Then we had applied Speed sensor installed to all SPM machines & solution Run Chart proved that problem magnitude was controlled. This paper provides a snapshot of the Problem solved on through hole Absence in drilling operation.

***Key words:*** Breakage, PPM, Rejections, Defect Pareto, Definition Tree, Solution Tree, through Hole

## I. INTRODUCTION

Universal joint cross (u j crosses) are one forged piece, especially prepared for heavy duty applications. These universal joint cross and automobile universal joint cross are made from case carburized alloy steel in precision dimensions. Finest quality needles are applied to ensure extra-long life. Apart from this, proper oil sealing is done to avoid lubricant losses and penetration of impurities into the bearings. The UJ crosses can work under proper load with safe operation and smooth running without vibrations.

This paper shows that the one supplier X having problem for doing through hole in component named U.J Cross which is fit in universal joint in drive shaft. X company were using three SPM drilling machines, and this drill breakage problem is on all three m/c. Firstly they had tried to change motor of m/c & brought different special dills for cutting then also the problem continues. We had firstly seen the last four months record of three SPM drilling machines, the problem was arisen from jan-17, we had noticed how PPM and rejections are increasing month to month.

This U.J Cross is very critical part because it is fit in the universal joint & its four holes needs to be very precise. U.J Cross is a component used for connecting rigid rods whose axes are inclined to each other, and is commonly used in shafts that transmit rotary motion. U.J Cross consist of a pair of hinges located close together, oriented at 90 degrees to each other, connected by a cross shaft. The universal joint is not a constant velocity joint. Then we check the defect wise Pareto till June & found that maximum defect is because of through hole absence.

Then we gone through the problem & rationale it. We have taken some tips of Shainin for solving the problems. We have listed the problems step by step by Shainin method as shown further in this paper. We conclude that this problem of drill breakage and defect has been arise only because of through hole absence. We listed all the manufacturing process of U.J Cross and we found the main thing that during drilling of second hole the drill got break (every 2nd hole of U.J Cross).

After that we had plotted the project definition tree & used the defect strategy. We found that the defect is coming only in all crosses and These defects are not specific related to specific machine. It is observed on all 4 SPMs. Then we have plotted defect strategy diagram i.e. point to point, region to region, within unit to within unit, unit to unit. Plotted the concentration diagram as shown further in this paper review. Finally plotted the solution tree and taken trial on 1 SPM, when it got success we applied it on all SPMs.

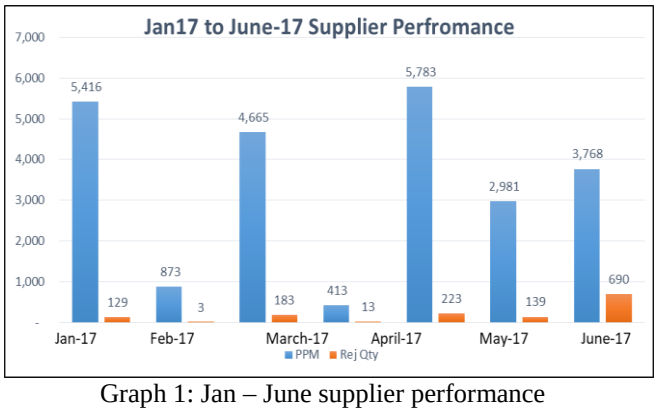
## II. PROJECT TRACKING SUMMARY

| Project Tracking Information | |
|---|---|
| Review Date | April-17 |
| Start Date | May-17 |
| Days Open or Date Closed | Sep-17 |
| Plant / Site | X |
| Project Savings / Benefits | PPM reduction |

Table 1: Project tracking summary

## III. PROBLEM BACKGROUND

Drill breakage issue were present in U.J Cross component, while drilling. At every second hole of U.J Cross the drill gets break. So, we have taken the details about problem background. Taken the data of PPM and rejections of last 5 months.




Graph 1: Jan – June supplier performance

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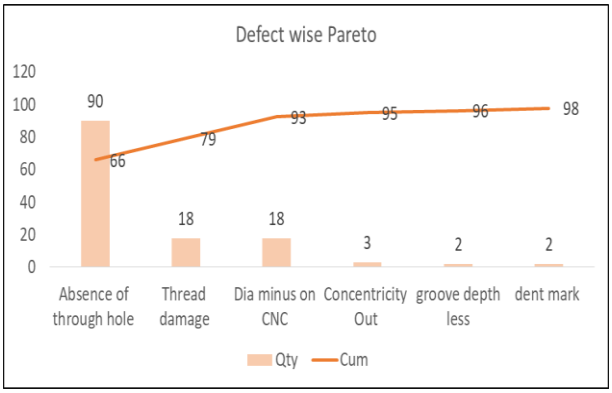
## IV. DEFECT WISE PARETO GRAPH

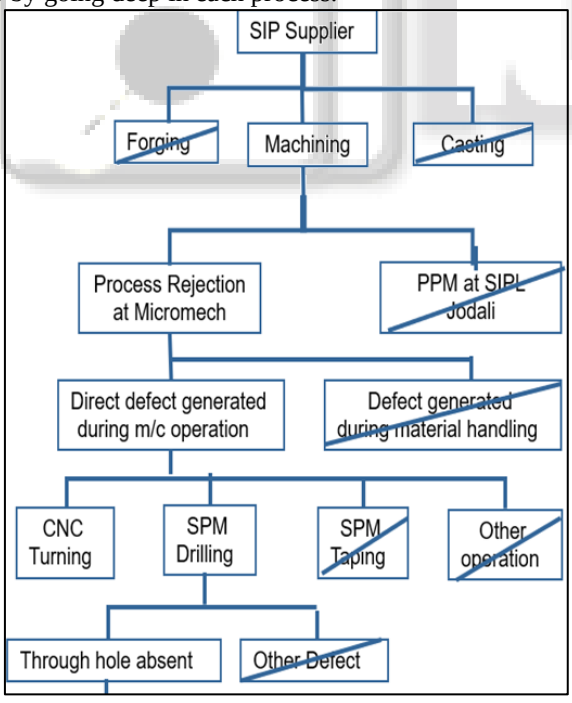
In the problem background we have also take the data of defect wise pareto for finding by which defect more rejections are found in U.J crosses. Defect wise pareto chart is a type of chart that contains both bars and a line graph, where individual values are represented in descending order by bars, and the cumulative total is represented by the line. The left vertical axis is the frequency of occurrence, but it can alternatively represent cost or another important unit of measure. The right vertical axis is the cumulative percentage of the total number of occurrences, total cost, or total of the unit of measure.




Graph2: Defect wise pareto

## V. FINDING THE PROBLEM DISCOVERY POINT

We have found the problem discovery point step by step by going deep in each process.




### *A. Rationale*

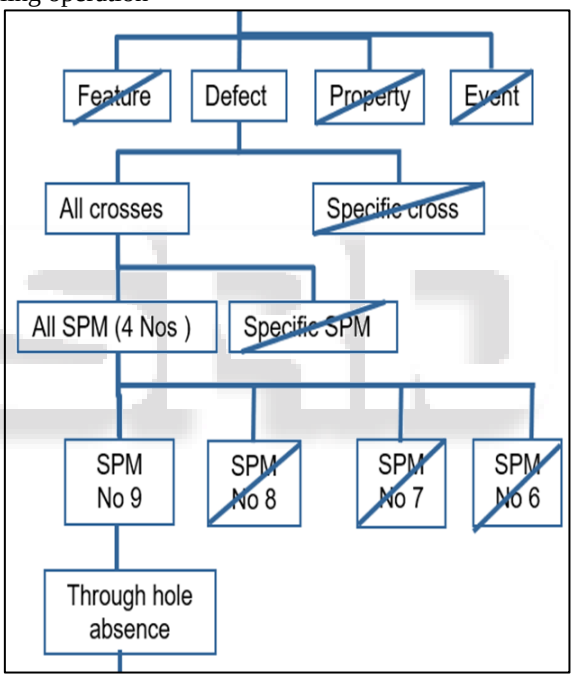
- X (Supplier Improvement Process) with high PPM supplier. X supplier is one of high PPM supplier assign to individual responsible.
- Vendor PPM is 3.7 K
- Vendor PPM at X is 1K
- Vendor in house process rejection PPM 3K
- In process machining defect is 90% & material handling defect like dent is 10 %
- Defect wise Pareto shows major defect generator on SPM drilling machine almost 66% out of all defect CNC operation defect 13%, SPM Tapping cause defect 13% & other defects 8%
- Through hole absence in cross defect cause 66 % rejection as per pareto.

## VI. PROJECT DEFINITION TREE

The problem tree, together with the objective tree and analysis of strategies, is a methodology of three steps for identifying main problems, along with their causes and effects, helping project planners to formulate clear and manageable objectives and the strategies of how to achieve them. Now using defect strategy, as shown below.

### *A. Project Statement*

Find and eliminate the driving drill breakage in cross during drilling operation




(Not Good) (Good)

### *B. Rationale*

- Use a Defect Strategy. The problem affects due to defect of the part.
- Defect is not specific to a cross (part family) it is for all crosses.
- These defects are not specific related to specific machine. It is observed on all 4 SPMs.

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- All machines having problems. Select one SPM no 6 for improvement & remaining for horizontal implementation.
- Drill breakage is only one defect cause almost 95 %.

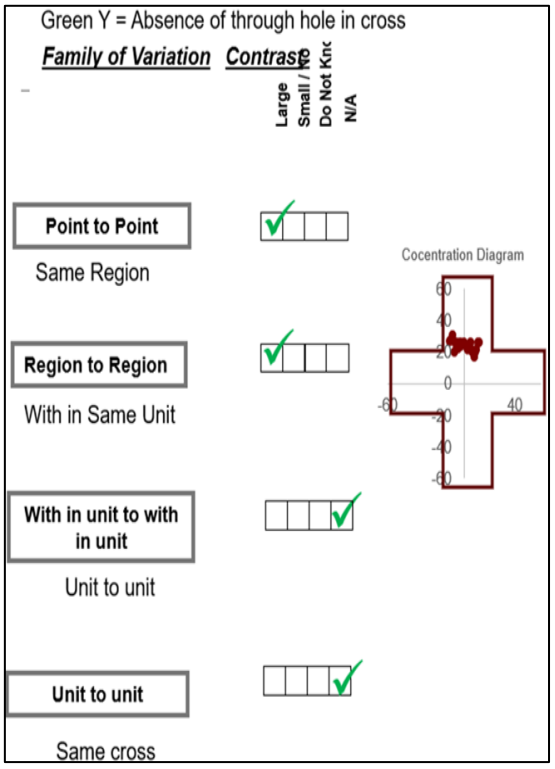
## VII. DEFECT OBSERVATIONS:

Visited to the X supplier and seen visually the defect and click some pictures of broken drill & U J cross. There are four drills in U J cross after doing 1st drill while doing second drill, when the drill is at 90 degrees and it came to middle of the U J cross it gets break because the chips doesn't get space to come outward.


Fig.1: Fig1: Broken Drill. Fig. 2: Sharpened Drill
Fig 3: New Drill

Fig. 4: Not Good

Fig. 5: Good




### *A. Meaning of Each Contrast*

- Hole depth absence due to drill breakage inside. Depth reading shows variation of 10 to 15 mm shows that there is
- Point to point co-relation. Concentration diagram attached.
- Absence of through hole during stage second. Concentration diagram attached
- There is no specific trunnion as per forging. It is observed during concentration diagram data collection. It is depended on fixture & operation (Through hole first operation only)
- Data shows only 0.4 % rejection is not specific to parts, it is randomly.

## VIII. SOLUTION TREE

A problem tree provides an overview of all the known causes and effect to an identified problem. This is important in planning a community engagement or behavior change project as it establishes the context in which a project is to occur.

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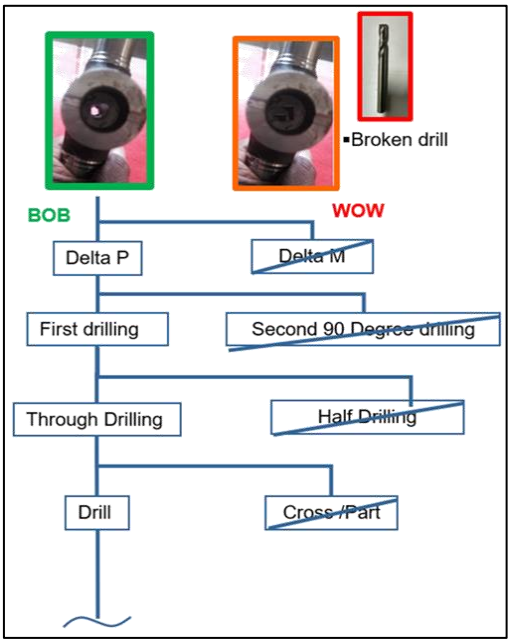


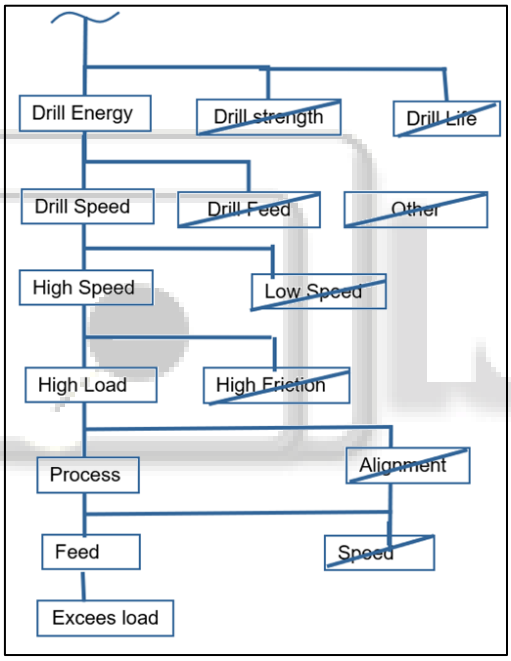


- Presence or absence of hole can easily be visually identified through examination of the part.so no Delta M & Isoplot.
- Concentration Diagram shows problem with first drilling & Through drilling
- Material Part material compared hardness & micro of BOB & WOW parts (BOB & WOW are of same heat code having same material property Drill material changed from HSS to carbide from in the month of Aug. No improvement in Rej.
- Drill life & changing frequency data collected on each machine in the month of June shows minimum drill broken at 10 & maximum 200 Nos. Drill life changed from 125 parts (500 holes) to 70 parts (280 Holes).
- Conduct trail for 20 Part with low speed feed & high-speed feed.
- Results are Low speed feed = 10 Nos OK High Speed feed = 08 Nos OK & 2 Nos Rej.
- Drill are with special blue coated to check the
- difference in consultant with drill manufacturing.
- Friction is going reduce drill life already validated above
- Alignment verified it is 0.02 micron & setup mandrel is available for to align SPM spindle & Fixture V.
- Compared BOB part drill & WOW part Broken drill under microscope with help of drill expert consultant given the direction of chipping as shown in next PPT Sketch.

| Sr No/Speed | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.5K PRM | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |
| 1.5K PRM | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |
| Sr No/Speed Feed | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 50 mm / min | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |
| 130 mm / min | OK | OK | OK | OK | NO-OK | OK | OK | NO-OK | OK | OK |

Table 2: Record of SPM after slowing speed of drill

- Problem = Chipping direction random due to high speed cause load on drill & drill break
- Drill 10 sample each with special color applied on drill. For low speed & High Speed. Two parts are cause defect of absence of through drill.
- Compared BOB & WOW broken drill under microscope shows pattern as per sketch in next PPT
- Understand = Physics was in variation of chipping direction randomly
- Corrective Action =As the Green Y is at the start of phase second entry point. We reduce speed at the time of entry & then it in going to be normal speed with the help of adding Super creep flow control switch & speed sensor. This work for both reduce entry speed as well as change speed when there is load on drill & prevent drill breakage.

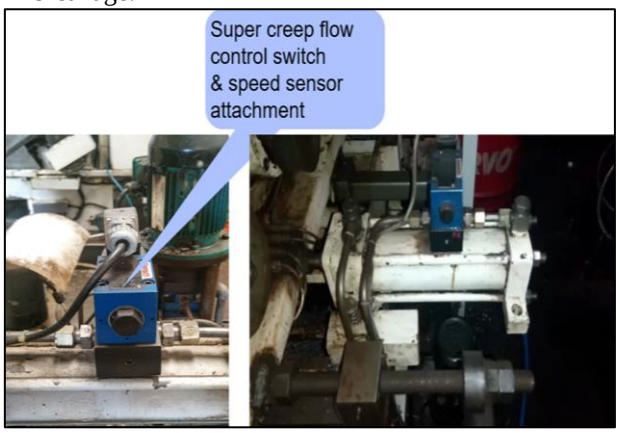


Fig. 6: SPM M/C with speed sensor attachment

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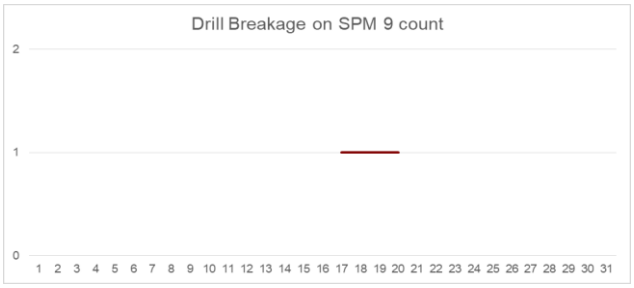


Graph 3: when Speed senor is removed for 5 days

– Confirmation test performed of SPM. Switched off the super creep sensor switch from date 15 to 20. Cause 5 drill broken again. Confirmation test gives results.

## IX. CONCLUSION

Hence there was problem of drill breakage in U.J crosses of vendors, we have solved the problem of slowing the speed of the drill at last stage for second hole by the help of super creep flow control switch and speed sensor attachment.

After fitting super creep flow control switch on one machine we record the data for one month and we get success, not a single drill was got break.

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