Boeing Tool Condition

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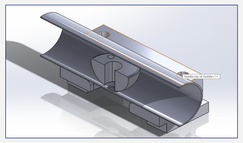
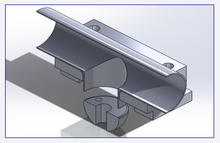
Background

Boeing performs approximately 45,000 pullout procedures each year. On average, each pullout goes through 45 minutes of rework. Each year, Boeing will spend up to 30,000 hours on rework alone for the worst case. This rework consists of strenuous hammer strikes to adjust the pullout size and shape so that the duct can be welded flush with its mating counterpart. Rework is not only time demanding but is also physically demanding for mechanics.





Problem

- Pullout punches wear out over time
- No system to track the usage of each tool
- No system to verify the dimensions of each tool
- Pullouts created are often out of tolerance
- Additional rework is required

Goal

The goal of this project is to develop a system to verify if pullout punches are within tolerance, and to determine when to replace the pullout punches.

Ranking Alternatives

(A) How accurate the alternative is? (B) How soon the alternative can be put to place?

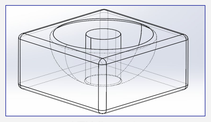
(C) How quick the alternative is to use? (D) How user-friendly the alternative is?

	Criterion A (45%)	Criterion B (10%)	Criterion C (20%)	Criterion D (25%)	Total Score
VTM	1	9	9	9	5.4
Engraved Visual Cue	1	1	9	9	4.6
Tool Usage	3	1	9	9	5.5
Digital Scanner	9	3	3	3	5.7
Tool Usage/Digital Scanner Hybrid	9	3	9	9	8.4

Engraved Visual Cue Concept

- Digital Scanner has the highest score (5.7)
- Criterion A (accuracy) most important
  - VTM and Engraved Visual Cue scored only 1
  - Both alternatives eliminated from consideration
- Digital Scanner has highest score for accuracy but lacking in other aspects
- Tool Usage System has high scores for quickness and ergonomics
- Both systems have acceptable scores for timeliness (3)

Decision: Combine both Digital Scanner and Tool Usage
  - Hybrid System: High accuracy and Usability



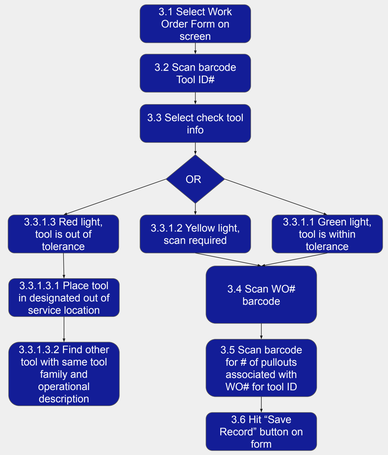
VTM Concept

Solution

Tool Utilization System

The Tool Utilization System is a predictive solution to the pullout punches' tolerance problems. It includes a Microsoft Access database where work orders, scan orders, tool information, and operation information are stored. The purpose of the database is to track the utilization of each tool as they are used to create parts and provide feedback signifying a tool's current status. This database will be available locally on the computers at the work stations, and will require the use of a barcode scanner for easier inputs.

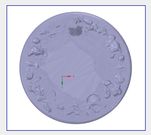
Functional Diagram



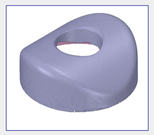
3D Scanning System

Once the Tool Utilization System requests a Scan the following steps must be taken to check the dimension of the pullout punch

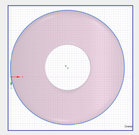
1. Take the punch to ATOS scanner and scan the top portion of the punch and export a STL file
2. Import the STL file into Ansys Spaceclaim or other scan to CAD program and project the object onto a plane perpendicular to the hole in the punch
3. Use the built in measuring tool to measure every arc along the projected outline. Calculate the diameter from the circumference.
4. Once the diameter is calculated it will be compared with the tolerances given for each punch. If the punch is within tolerance the measurements must be recorded and the punch recirculated. If it is out of tolerance, update the system and throw the punch away.



Initial 3D scan taken from iTero Scanner



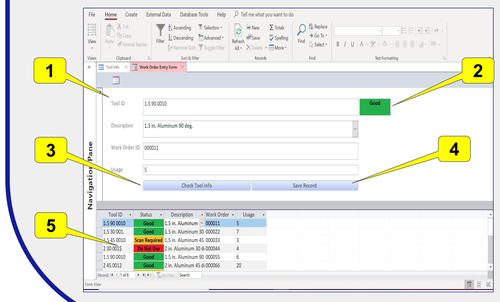
3D scan taken from ATOS Scanner



Projection of 3D scan onto a plane

ATOS 3D Scanner

Tool Database Work Order Form



Laser Engraved Barcode

Cost-Benefit Analysis

Current Performance:

	# of Pullouts	Percentage Of Total
Total Pullouts Performed	45417	N/A
All Pullout Or Pipe Defects	1177	2.59%
Pullouts Unacceptable	432	0.95%
Pullout Tool Connection Failures	20	0.04%

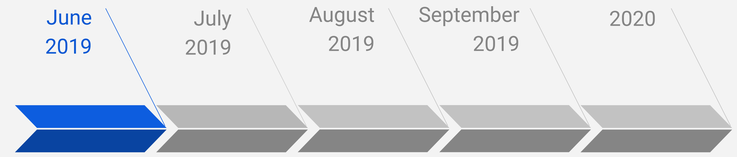
Potential: Achieve a "good" level of rework of 3,784 hours. Cost of rework greatly outweighs the cost of buying new tools. System can be leveraged to track pullout tool connection failures.

If labor costs $45/hr, this will reduce labor costs by upwards of **$560,000** annually

	Current	Future
Cost	- 16,400 hrs/yr on rework - Tools replaced at an unknown rate, age of tools unknown	- 3,784 hrs/yr on rework - Develop system for several months - Purchase tools more frequently
Benefits	- Maintain current performance - Strenuous hammering labor	- Reduce rework by 76% - Improve quality of pullouts - Boeing already owns a 3D scanner and laser engraver - System can be leveraged to other areas of facility for tool tracking and verification

Implementation and Future Work

The next phase of this project is for Boeing to begin the project plan we developed. The phases of that are below:



Handoff Period

- Full mockup and demonstration.
- Handover all related documents and project plan for future implementation.

Begin Project Development

- Boeing will design project using their data and personnel.
- Follow recommended project development plan.

Beta Testing

- Walk through processes and trial runs on production floor.
- Training will be necessary.

Implementation

- 3D scanning at scheduled rate. Important to know how much wear occurs per use.
- Some tools might need to be immediately replaced.

Post successful implementation

- Transition to 3D scans at certain utilization levels, once several tool life cycles have completed.
- Develop accurate upper limit of each tool's utilization.

Acknowledgements

This project could not have been completed without the support and guidance from James, Tim, Bryan, Angela, Patty and Boeing.

Barcode Demo

1 Input Parameters

Input data for work order by scanning barcodes for:

- **Tool ID**
- **Work Order Number**
- **# Cycles for Work Order**

2 Andon Signals

Andon signals appear after Tool ID has been entered. Allows mechanics to quickly identify status of a tool.

- **Green: Tool is in good condition**
- **Yellow: Scan is required before use**
- **Red: Tool is out of tolerance**

3 Check Tool Info

Runs a query to check additional info of requested tool. Shows:

- **Description**
- **Tool Status**
- **Total Usage (# Cycles)**
- **Upper Limit**
- **% Life Util**
- **% Life Scan**
- **Date Issued**
- **Date Last Used**

4 Save Record

Saves data inputted into the Work Order Entry Form. Error messages pop up if the tool's status is either "Scan Required" or "Do Not Use".

5 Previous Records

Shows a summary of all the previous work orders.