The cost of doing it wrong

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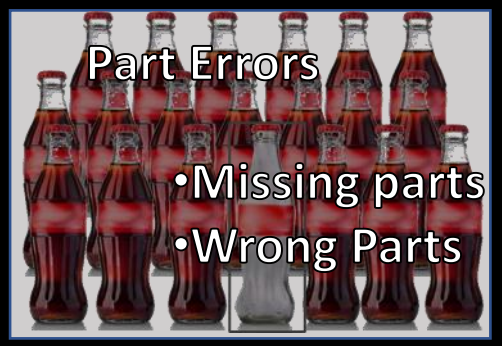
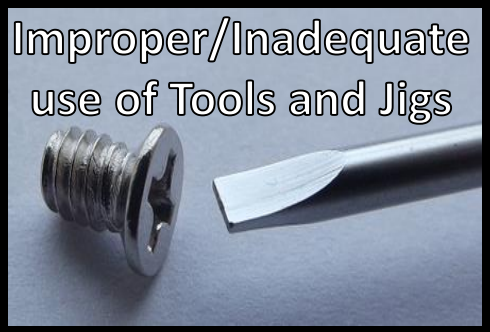
Potential Causes of Costly Production Issues





What to Do

- **While developing manufacturing processes:**
  - Form a diverse team to brainstorm potential process issues that may arise and how they can be prevented, or at least detected, and mitigated before significant product damage occurs.

- **If a processing problem becomes apparent due to the occurrence of failed product:**
  - Form an equally diverse team to determine the Root-Cause of the issue.
  - Once Root-Cause is determined, formulate Corrective Action to be taken to both corrective the problem as well as to prevent its reoccurrence.
  - Track the performance of the process after the corrective action has been implemented.

Several Examples of Costly Production Issues

(that could have been avoided)

An Accident at Work Causes Human Suffering & Monetary Loss

Selecting the Incorrect NDT Test for Qualifying a Part

Using the Wrong Solder for a Critical Electrical Connection

Parts Failed to Receive Paint in the Coating Booth Station

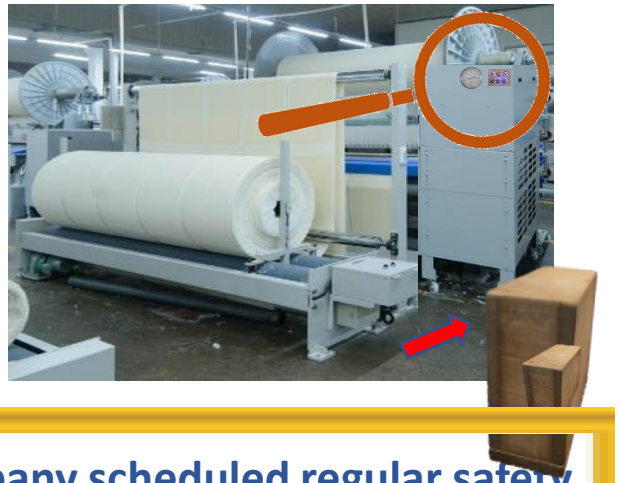
An Accident at Work Causes Human Suffering & Monetary Loss

An employee tripped over a wooden crate placed in an aisleway adjacent to a machine on the manufacturing floor. The employee sustained serious head injuries resulting in:

- *Workers' compensation payments (partial salary, medical costs)*
- *Disruption to the manufacturing work schedule*
- *Need to hire and train a temp to perform the injured employee's job*
- *Completing numerous forms and paperwork*
- *Employee sustaining trauma once returning to work*

A team was formed to investigate the occurrence and determined that a machine operator was responsible for placing the two crates in the aisle. The operator said that the gauge that needed to be read, and controller that needed to be adjusted were located high up on the equipment cabinet and therefore could not be read while standing on the floor.

***Root-Cause*: Access to the gauge and the controller was very difficult due to its location, forcing the operator to stand on the crates each time it was necessary to read the gauge and making the necessary machine adjustments.**



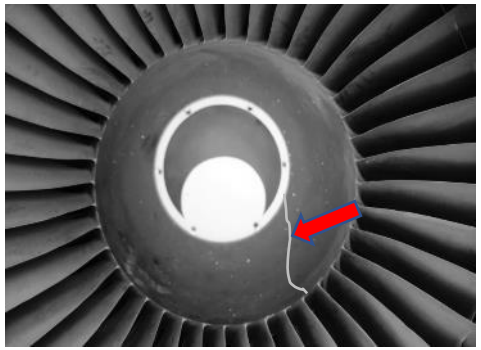
***Corrective Action*: Relocate the gauge and controller to an operator-accessible location on the equipment so that there is no longer any need for the operator to climb.**

The entire incident could have been avoided if the company scheduled regular safety audits to be proactive regarding addressing such issues. An estimated expenditure of over $14,000 and unnecessary employee trauma could have been avoided.

Selecting the Incorrect NDT Test for Qualifying a Part

A series of superalloy engine rotors were found to be failing during fatigue testing by a rotor customer.

- *The supplier (vendor) of the rotors was informed that rotors were fracturing during engine test at stress levels well below the maximum stress allowed while in service.*



The vendor sectioned several failed rotors and verified that for each case, a fatigue crack originated from an existing internal defect. Measurements of the defect size indicated that failure occurred due to the defect's size being above the specification's allowed maximum limit.

***Root-Cause**: The vendor examined their x-ray radiography inspection NDT records and found that none of the rotors shipped to the customer had any sign of defects. However, upon sectioning apparently "good" rotors, the vendor was shocked to find defects larger than those permitted by specification. The vendor assessed the sensitivity of their x-ray examination method and found that the wavelength being used was too large to detect the out-of-spec defects in the rotor.*

***Corrective Action**: The vendor performed numerous calculations and determined for this product and customer they needed to use a shorter wavelength gamma ray instead of x-rays to detect the defects.*

This costly (estimated to be over $40,000) incident could have been avoided if the vendor reviewed the sensitivity parameters of their radiography testing. If they did, they would have detected that their present x-ray instrumentation could not detect the defect size that they needed to screen for.

Using the Wrong Solder for a Critical Electrical Connection

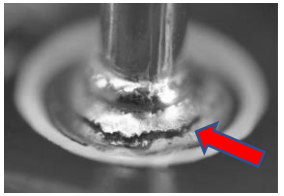
While an assembler was hand-soldering critical electrical connections using high melting-point (HMP) solder on a navigational device that the company produced, they noticed that the surface of the solidified solder was not as shiny as it is normally.

- Since the resulting surface appearance of the solidified solder was not specified, the assembler continued with the soldering process on over 20 units before a problem was detected in high-temperature test.

The quality engineer disassembled one of the failed the units and determined that several electrical solder joints had opened resulting in the test failure. The quality engineer spoke with the operator who indicated that recently the appearance of the solder joint had changed.

***Root-Cause**: The quality engineer sent material from the solder joint out for analysis and found that the it was not the HMP solder, but a lower melting-point solder used for electrical connections that were not exposed to elevated temperatures in service. Two issues were found:*

- *The HMP solder and the lower melting point solder were commingled in the Kanban location where the solder is stored.*
- *There was no statement in the Standard Work document instructing the operator to look for solder issues nor to report problems to their supervisor*



***Corrective Action**: The solders are now stored separately, and a barcode on the part traveler paperwork is required to be scanned before the solder can be accessed. The Standard Work was then modified to state that the operator should both inspect for solder joint issues and seek assistance if an issue is found.*

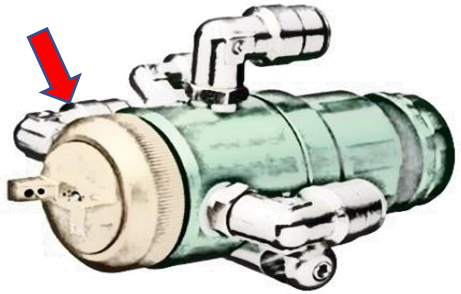
The cost of this incident was estimated to be over $25,000 mainly due to the rework and additional testing required. This could have been avoided if the solder materials were properly segregated, and the Standard Work had indicated that the operator should both inspect for solder joint issues and seek assistance, as necessary.

Part Failed to Receive Paint in the Coating Booth Station

Ceramic Endcaps produced in a continuous in-line process failed to receive the required paint coating during this processing step. This has been a chronic problem.

- Endcaps are visually inspected at the end of the production line to ensure that non-conforming product is not shipped to the customer.
- The Endcap processing continues until the machinery is manually stopped, or the ceramic feedstock is depleted.
- The coating equipment is left unattended during second shift due to cost concerns.
- When unpainted Endcaps are detected, they then must be coated via a manual process which is very costly.

A team was formed to investigate the occurrence and to recommend corrective action toreme dy the issue.



RC ***Root-Cause: Two conditions were identified that would cause the problem of mis-coating: a blocked paint nozzle or a depleted paint supply vat.***

CA ***Corrective Action: Two types of sensors were installed for the coating process. One sensor to detect if the paint reservoir is in the process of running out of paint, and a second sensor that examines the Endcap itself for the presence of paint. If activated, either sensor would shut down the machinery, and alert floor supervision to either refill the paint reservoir or take other action as required.***

This issue could have been avoided if potential process failure modes were considered during the Endcap process design stage. Since product inception, 2 % of Endcaps produced required rework due to lack of paint. If detected at the painting station, a significant loss of money could have been avoided since the unpainted Endcaps could have been reloaded in the equipment. If detected at the end of the production line, manual rework is required, resulting in an estimated additional annual cost of $27,000.