Automation of the Multi-Option Fuze for Artillery (MOFA) Post-launch Battery

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Presentation Outline

Facility Highlights

Description

Equipment History

Process Control and DFSS/6-Sigma Lean

Material Identification and Handling

Video Clips of Equipment

Summary

Power Sources Center

Horsham, Pennsylvania

Power Sources Center has all of the physical assets and facilities required to: design, develop, manufacture, test, and analyze lithium batteries.

Features:

- Single story, 52,000 ft^2 facility.
- 40,000 ft^2 available for manufacturing.
- 6,000 ft^2 of humidity controlled dryrooms (RH maintained at < 5%)
- Computer modeling and analysis capability.
- Extensive laser welding capacity.
- In-house machining and tool room.
- Multiple production lines.
- Specialized battery manufacturing and processing equipment.
- Quality Assurance ISO 9001:2000 Certified
- Extensive battery testing equipment and expertise.

Description

- The MOFA Post-launch Battery is a state-of-the-art reserve lithium oxyhalide power supply.
  - It utilizes a moderate rate formulation of the lithium / thionyl chloride.
  - It can be stored in the dormant state for in excess of 20 years and then be activated by the conditions of ballistic launch.
- Supplies post-launch power to the MOFA Fuze -- Army's next-generation, NATO standard all-purpose artillery fuze for bursting munitions.
  - Power needed for electro-mechanical operation during four fuze modes: Proximity, Time, Point Detonate, and Delay
- Automation needed to assemble large quantities of this small, hermetic vessel (current orders and future domestic/foreign forecasts include over 1 million units)

Equipment's History

- ATK initiated design, development and procurement of automated equipment 1999.
- Installation of equipment at Horsham, PA facility was completed in November 2001.
- Average monthly production is 25K units, with surge capacity to 35K units
- To date, the line has produced nearly 400K batteries
- The four major pieces of automated equipment are:
  - Battery Assembly Machine (BAM)
  - Closure/Terminal Plate Welder (automatic laser)
  - Reservoir Welder (semi-automatic laser)
  - Electrolyte Fill and Seal Machine
- We have since installed another semi-automated work-cell in 2003 for inspection as part of our DFSS/Lean Six Sigma Initiatives

Process Control and DFSS/Lean 6 Sigma

- In-process/statistical process control (SPC) data collection capability:
  - The equipment automatically monitors 14 parameters and will shut itself down if parts become out-of-tolerance
  - The program team performs weekly data review of key characteristics to review data trends and proactively respond to conditions prior to defect creation
- All equipment yields are greater than 98% with over 90% availability
- DFSS/Lean 6-sigma philosophy and tools have become instrumental to the facility to develop a culture of Continuous Improvement
  - 100% percent of manufacturing/quality engineers trained as green-belts
  - 2 engineers are currently in training for black-belt certification
  - 7 projects completed and/or underway…significant improvements seen in quality, cost, and lower risk for battery

Example: Results from Poka-Yoke

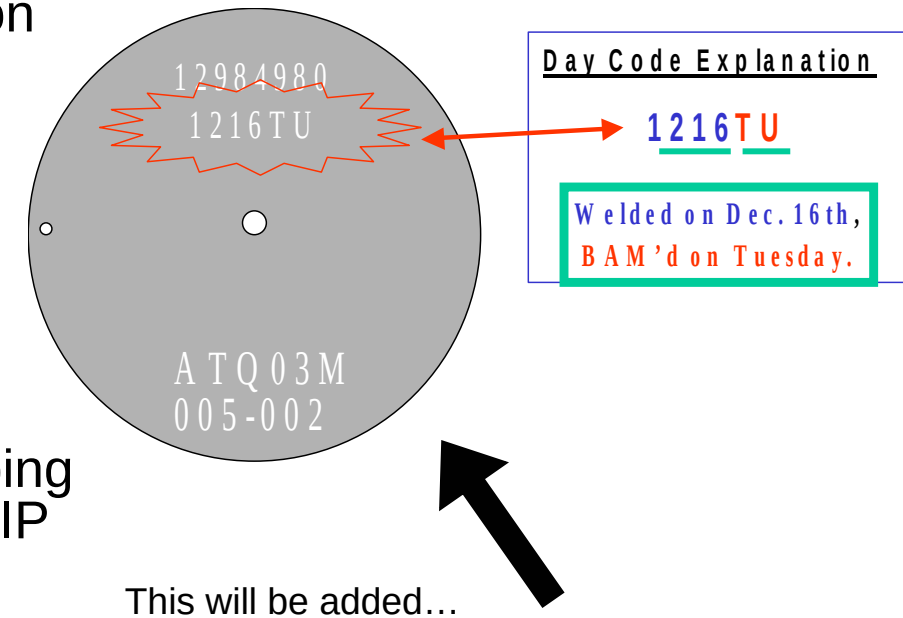
- Installed semi-automatic work-cell for final inspection
- Integrated ball-height and voltage & resistance inspection
- Eliminated risk of escapes
- Improved throughput by 20%
- Reduced labor costs by 35%

1999	2001	2003	2004
• Hand assembly	• Automated assembly	• DFSS/Lean Six Sigma initiated	• DFSS/Lean Six Sigma throughout the organization
• Limited rate	• Greatly Increased throughput 10x	• Increased throughput 1.5x	• Increased throughput capabilities
• Operator dependent	• Operator dependency reduced • Machine uptime focus	• Poka Yoke • Machine Uptime > 90% and increasing. • Reduced defects • Reduced cycle time from value stream mapping	• Machine uptime >95% • TPM incorporated on all equipment • Trend analysis prior to creating defects • Kanban
• Supplier variation in parts	• Supplier variation in parts	• Reduced part variance.	• Reduced part cost, number of parts, and variance

Material Identification and Handling

Now:

- Pin-stamping required for lot identification purposes
- Date-coding added to record material pedigree information
- Auto-laser has *Telesis PINSTAMP Dot Peen Marking System*
- Started implementation of Lean Manufacturing using value stream mapping and Kanban to reduce cycle time and WIP



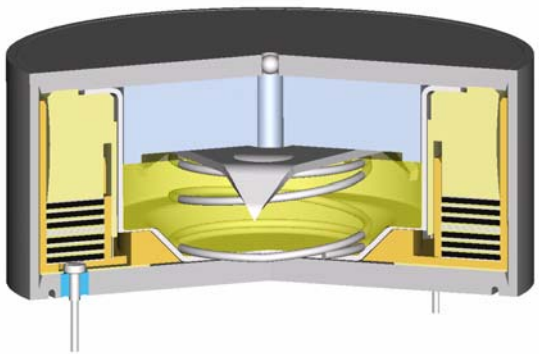
This will be added…

Next Step:

- 2-D code direct part marking (DPM) and reading capability. Improves quality and satisfies DoD's new UID initiatives
- Complete implementation of Kanban

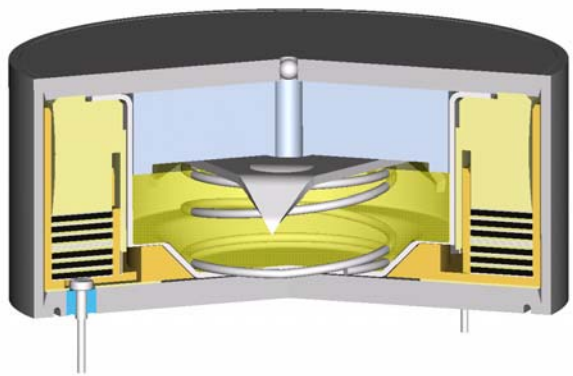
Battery Assembly Machine (BAM)

- **8 dies to punch anode, cathode, and separator.**
- **5 robots to assemble stacks.**
- **Rate = 800 batteries per shift.**
- **Automated SPC on 14 characteristics**



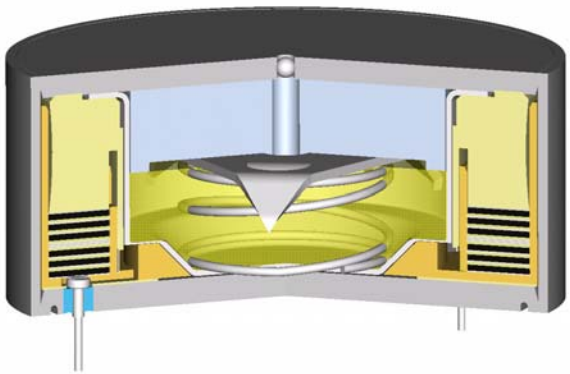
Auto-Welder

- 1 robot
- 4 position index table
- Terminal plate to case
  - 240/hour
- End plate to case
  - 240/hour
  - Lot marking
  - Date marking



Fill Machine

- **Fill and seal battery**
- **1 robot**
- **8 position index table**
- **800 per shift**
- **Automated SPC on fill weight.**



Summary

- LESSONS LEARNED: Automated equipment by itself did not achieve the results we wanted. It took a team focused on DFSS/Lean Six Sigma at the Enterprise level using automation as another tool for continuous improvement
- We have the proven capability to manufacture high volume battery programs through the use of automated equipment.
- Power Sources Center has embraced DFSS/Lean Six Sigma concepts throughout our facility to make improvements in quality, cost, and reduced risk.
- We are a leader in the design, production, test, and analysis of lithium batteries.
- We appreciate the sponsorship and technical contributions of the U.S. Army ARDEC and US. Army Research Laboratory