Maritech-ASE
AGREEMENT NO: 2000932

Ultra-High Pressure Water Blasting Project

Final Project Results Summary

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Title

Ultra-High Pressure Water-Blasting: Optimization of the Surface Preparation Process through Process Reengineering, Ergonomics, and Environmental Improvements (TIA#2000-932)

Executive overview

The goal of this project was to reduce the total life cycle cost of the Ultra-High Pressure Water blasting process by 50% through industrial engineering analysis, ergonomic interventions, and the application of environmental solutions.

With the threat of increasing environmental regulations in the area of particle matter air emissions, shipyards will be pressured to replace their current conventional dry abrasive blasting with an environmentally friendly solution. The objective of this project was to produce results that will make it economically feasible for ship repair yards to transition to UHP water blasting. Since surface preparation and coating processes represent approximately 25% of ship repair work, it was presumed that cost reductions made in this area would have a significant impact on the competitiveness of the ship repair industry.

Many operational challenges associated with the UHP Water-blasting Process were addressed by this project, such as:

- Worker fatigue induced by activities involving prolonged and repetitive use of heavy tools and equipment.
- Discharge of contaminated process and storm water into adjacent waterways and onto adjacent property via storm drains and groundwater percolation.
- Increasing material and consumables costs associated with the surface preparation process.
- Equipment downtime and the associated waste of labor (delays).
- Lack of management control systems

Atlantic Dry Dock Corp was the lead shipyard on the Project Team. Surface Preparation and Coating is one of Atlantic's core ship repair processes. It is often in the critical path of the repair schedule, so that any improvements in the cycle time of "blast & paint" should result in the reduction of overall repair cycle time. Atlantic transitioned from dry abrasive blasting to ultra-high pressure water jetting in 1998, due to trends in environmental regulations, and the belief that UHPWB would prove to result in a lower total cost alternative for the surface preparation process. Few shipyards have converted to water blasting because of its associated impact on productivity. Conventional Dry Abrasive Blasting operations result in an approximate average of 100 sq ft of blasting per hour, while current manual water blasting operations achieve an approximate average of 40 sq ft of blasting per hour (includes both sweep blast and 100% blast.)

While the Final Report (Deliverable 9.1) provides details of each of the accomplishments, the following bullets highlight the improvements implemented:

- Tools and equipment were made available at point of use to eliminate delay time. For example, air and ultra-high pressure water lines were hard-piped along the wing wall of the dry-dock with quick disconnects.
- A daily planning system was developed that visually depicts where all equipment, pumps, man-lifts, and workers would be positioned.
- Daily manning communication boards were implemented.
- Ergonomic interventions were implemented to equip high-reach and scissor-lift baskets with an equipment support rack.
- Portable equipment conex boxes were organized so that all equipment and materials would be clean and ready for use when needed.
- A pre-treatment system was installed to treat the water with softening and filtration devices to achieve a clean, consistent water supply.
- Pump attenuators were installed to control the pressure spikes that were damaging hose sections during the baseline study.
- An electro-pulse treatment system was installed to treat the captured process water so that it meets drinking water standards.

We were able to measure total cost improvements ranging from 22% to 29%, on subsequent ship repair jobs . The measured statistics fell short of our 50% cost reduction target, as some of the key improvements were not installed in time for the shipyard trials, such as the water treatment system. While we were not able to prove a 50% reduction in total life cycle cost, we were able to institutionalize a continuous improvement process for the UHP Water Blasting Operation. Therefore, it is realistic to expect that our goals will be achieved in the near future.

Description of methodology

The project team applied Lean Manufacturing Principles to attack the wastes associated with the current UHP Water-blasting Process. The improvement approach that was employed during this project is highlighted as follows:

- The current process was defined and measured through industrial engineering time & motion studies.
- Cost drivers were identified from the waste assessment of the process.
- Root cause analysis was performed to identify the sources of each waste stream.
- Countermeasures were developed to eliminate the current wastes.
- Solutions were implemented, evaluated, and documented.
- The impact of the improved solutions were measured during shipyard trials.

Implementation and Technology Transfer

The UHPWB Project consisted of a series of implementations over an eighteen month period.. The earlier implementations did not follow a methodology designed to institutionalize the change, which resulted in approximately a 50% sustainability rate.

The 50% successes were associated with "hard changes" such as facility upgrades to the dry dock. We discovered in the earlier implementations that the roles required to initiate and implement solutions had not been clearly defined. In review of the initial process, the sponsor was in support of the changes, but was not able to dedicate much attention to the project due to other key events at the time. The Target group (blasters) was struggling to make team-based decisions in a totalitarian environment. The Agent, the surface prep and coating foreman, appeared to be overwhelmed with the current state of operations and therefore did not exhibit the ability to "change the tire while the car was moving". Many activities were reprioritized to adjust to the chaos of the daily production schedule.

During the last nine months of the project, we were able to implement many process improvements with higher probabilities of sustainment over time. We clearly defined the roles and filled the roles with willing and able persons.

Sponsorship of the project's implementation was assigned to ADDC's Lean Ship Repair Steering Committee that is led by the Production Manager. Results and performance were presented to this group every two weeks for guidance, accountability, and approval. Sponsorship was not limited to one person. Under our business model, the Lean Steering Committee had the authority to legitimize the change and proved effective in their team-based decision making ability.

The Surface Preparation and Coating Foreman was established as the Agent, the person responsible for implementing the change..

The UHP Water Blasting Operators and Mechanics remained the Change Targets as they represented the group that had to change.

In the initial implementations, the Advocate was chosen erroneously as the Industrial Engineering Group. The IE's were chosen as the group wanting to achieve a change, but did not possess legitimization power. After reviewing the results of our final study, we realized that the Advocate needed to be the Project Management Team in order to achieve the level of sustainability throughout all of our surface preparation work. While the implementation produced remarkable results, and the enthusiasm for the new processes was high, the new processes were not transferred to the next vessel. In order to institutionalize these new processes in a multi-project environment, we determined that the project management group would serve as a more appropriate advocating group. They would provide the universal coverage on each job, as well as the desire to ensure that the new processes are being used on all surface preparation jobs in the future. The Lean Steering Team is currently addressing the need to formalize a detail planning requirement through our ISO Program.

Do you feel that this can be implemented as delivered or will there be additional time required for customization?

Another shipyard could perform the assessment and implement the improvement process as delivered, regardless of the type of ultra-high pressure water blasting equipment they

are using. Their current process could be quantified in terms of value-added vs non-value added and a combination of ergonomics, environmental, industrial engineering improvements could be implemented as needed.

What could limit the implementation of this project? What are the necessary conditions to implement in your organization.

In order to perform this improvement process, the availability of ultra-high pressure water blasting equipment (either leased or owned) is required. Milestone 6 of this project details three levels of ultra-high pressure water blasting "tool-boxes" (for a small, medium, and large blasting operations).

How much time do you estimate would be needed for this to be set up and implemented in another shipyard? What type of shipyards could apply this project (large, small, new construction, repair, etc.)?

This project could be implemented in another shipyard within 6 months to a year, depending on the resources assigned to the project, as well as a steady volume of blasting work available in the shipyard to evaluate solutions. Any shipyard that performs surface preparation outside could apply this project to their operations.

Did the implementation of this project impact any existing systems or processes? Describe both positive and/or negative impacts to your systems and/or processes? How did you overcome any of the negative impacts?

The Daily Planning Boards have been an extremely useful communication tool between the crafts and management. Several other crafts have adopted these to aid in their daily planning.

We found that it is difficult to implement changes in the Blasting Operation without impacting the Coatings Operation. Because of this strong interdependence, we began including the painters in our Root Cause Analysis and Solution Generation Events.

How are you sharing this information with others in the industry? Did you complete the steps for technology transfer as agreed to in your technology transfer plan.

An end-of-project workshop for the industry was held in Jacksonville, Fl in November 2001, where the project team detailed each of the improvements, as well as demonstrated the improved ultra-high pressure water blasting operation at our facility. A final report was also released to the industry in April of 2002, detailing the project improvements and results. All activities were accomplished in accordance with the project's technology transfer plan.

Resources needed for Implementation

The following resources were needed to implement this project:

Sponsorship of the project's implementation was assigned to ADDC's Lean Ship Repair Steering Committee that was led by the Production Manager. Results and performance were presented to this group every two weeks for guidance, accountability, and approval. Sponsorship was not limited to one person. Under our business model, the Lean Steering Committee had the authority to legitimize the change and proved effective in their team-based decision making ability.

The Surface Preparation and Coating Foreman was established as the Agent, the person responsible for implementing the change.

The UHP Water Blasting Operators and Mechanics were the Change Targets as they represented the group that had to adopt and perform the change.

In the initial implementations, the Advocate was chosen erroneously as the Industrial Engineering Group. The IE's were chosen as the group that wants to achieve a change, but does not possess legitimization power. While the implementation produced remarkable results, and the enthusiasm for the new processes was high, the new processes were not transferred to the next vessel. In order to institutionalize these new processes in a multi-project environment, we determined that a better advocating group would be the project managers. This group would provide the universal coverage on each job, as well as the desire to ensure that the new processes are being used on all surface preparation jobs in the future.

Were there specific hardware or software requirements?
UHP Water Blasting Equipment

How many people would be needed to implement this project? Are there certain levels of expertise needed?
The number of people would depend on the size of the UHP Water-Blasting Operation.. Knowledge of the ultra-high pressure water blasting process is required, as well as understanding of the environmental impact of the ultra-high pressure water blasting process.

Is specific training needed to implement this project?
Education in Lean Manufacturing Principles is recommended to streamline the operational value stream of the ultra-high pressure water blasting operation.

What materials or equipment are needed? Did you develop materials or equipment that will or must be used in the implementation?
Ultra-high pressure water blasting equipment

Evaluation and analysis methods

The improvements were measured against a baseline that was calculated at the beginning of the project. Traditional Industrial Engineering time and motion studies, as well as job cost analysis were performed periodically throughout the duration of the project.

Because of the variability of work scope that is inherent in most ship repair jobs, improvement is often difficult to accurately measure from job to job. However, the project team was provided the opportunity to accurately measure the efforts of the project by comparing the statistics from similar water blasting jobs on two sister warships. Vessel X underwent interim dry-docking availability when the UHPWB project was just getting underway Vessel Y was in interim dry-docking availability, after many UHPWB process, material, environmental, and ergonomic improvements had been implemented.

Vessel X was used to establish our baseline measurements at the beginning of this project, prior to the implementation of any improvement initiatives. Vessel Y was chosen to document the impact of the improvement effort, as it was a sister ship to the Baseline with similar surface preparation requirements.

At the conclusion of the project, what evaluation and analysis was done to measure the success of the project? Do you have plans to re-evaluate the project in the future? In what time period?

Vessel Y was measured at the end of the project, which incorporated all of the improvement initiatives implemented under this project. Intermediate measurements were taken throughout the project, and Vessel Z was used to document the intermediate results. Vessel Z represented a smaller work scope, and a less complex ship structure.

To continue our evaluation of the Ultra-High Pressure Water Blasting Process, we are tracking $/sf of blasting on every vessel that is blasted. The metrics are categorized in terms of "sweep", "spot-blast", and "100% blast". There is evidence of wide variation due to the type of coatings, but at this time we have not differentiated the metric by this characteristic. We will be performing another series of industrial and engineering studies on future naval vessels to measure our rate of continuous improvement. These studies will be performed twice a year.

Cost Benefit analysis/ROI

Impact on Total Life Cycle Costs

In comparing the Final Shipyard Trial (Vessel Y) to our Baseline (Vessel X) we were able to achieve a 22% reduction in total life cycle costs. The analysis highlights an irregular material cost expense that was atypical. Eliminating this anomalous expense would have resulted in a 29% reduction in total life cycle costs. The major improvements that had been implemented prior to Vessel Y were as follows:

- UHP Water Blasting Hard Piping
- Dock Floor Leveling for access
- Ergonomic Improvements (Gun-Mount Rack & Crawler)

- Formal Daily Planning System Implemented
- UHP Methods/ New Sequencing of Work Implemented
- Environmental Solutions
- Organization Changes
- Point of Use Tools Implemented

Lessons Learned

Describe the lessons learned as a result of working on this project. What went well, and why? What could you have improved? Looking back, what advice would you give to a shipyard planning to implement this project?

- The initial project plan was not clearly communicated to the paint & blast work teams, therefore resulting in a slow start-up.
- Production schedules often impacted the ultra-high pressure project schedule as project activities were delayed due to heavy production workload.
- In the beginning of the project, the work teams found it difficult to identify and address process problems. Most of the solutions that were identified were equipment/technology related. We had to train the work teams on continuous improvement tools such as waste assessment, root cause analysis, pareto analysis, etc.
- After the first round of improvements were implemented and measured, we achieved an improved state although we had not met our initial targets. Management focused on the shortcomings instead of taking the time to celebrate the wins, so the team was temporarily discouraged.
- The project stretched over two years instead of the expected one year due to scheduling blast work in the yard. Naturally, an increase in cycle time increased the costs of the project.
- Because of our lack of available internal resources to dedicate to the project, we should have planned for outside consultants/contractors to perform more of the work.