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SUPPLYING PRODUCTION MACHINERY AND EQUIPMENT TO THE EVER GROWING COOPERAGE INDUSTRY

pāco manufacturing® was awarded projects from a ***new customer*** involving a ***new industry*** to us, namely **The Cooperage Industry**. This is usually somewhat of a scary adventure because of all the apprehension of getting familiar with the industry standards, requirements, and expectations, along with just understanding the industry language. Every industry has a language of technical acronyms for their components, processes, etc. which is well understood within that industry but not out in the general population. Within all industries in which we provide equipment and services we must understand the language, *talk the talk,* developing a full technical comprehension of their terminology. However there was not the normal apprehension with the introduction into this industry. Instead, excitement arose with all of our personnel as we became involved in these projects. Throughout our American Midwest we are seeing tremendous growth in the whiskey and wine industries. The Kentucky Bourbon Industry itself is gaining world recognition and increased demand. All of these industries rely on the supply of cooperage barrels. The current processes of making cooperage barrels which have been developed from proven old world techniques are now being implemented into modern machinery processes with the inclusion of PLCs (programmable logic controllers) and touch screen interface operator controls. ***It is thrilling to expand our company experiences and competencies within this fascinating industry.***

THE SCOPE OF THE PROJECT

Our customer contacted us on a request to design and build equipment very similar in operation to their existing production equipment for their ***new cooperage plant***. This equipment would be for the manufacturing of their cooperage barrels and would function similarly to the processes of the current equipment. Beginning with the proven history of the existing machine operations, our new designs would incorporate many improvements for additional precise handling of the product, improved operator ergonomics and safety, added structural integrity and replaceable tooling for decades of production, along with operator and maintenance friendly improvements. Included would be Human Machine Interface [HMI] touch panels programmed with operation sequences and fault conditions. These machines would be triggered with pneumatic and hydraulic cylinders controlled by solenoid valves, along with drive motors actuating the conveyors. The electrical controls would include PLC [Programmable Logic Controller] and HMI operator controls to completely maintain the automatic or semi-automatic sequence of machine operations.

THE EQUIPMENT

The **Bilge Hoop Puller Machine** is a fully automatic machine which removes the temporary bilge hoops from the barrel and elevates the hoops to a return track, and returns the hoops to the original installation process. The barrels are automatically conveyed, centered in position and fed into the machine lying down horizontally. A cradle lifts the barrel to the hoop removal station, where the barrel is properly positioned, and then two sets of pull arms are hydraulically actuated to retract - pulling the bilge hoops off each end of the barrel. The hoops are then released to vertical chain elevators and escaped to roll into the return tracks. The barrel is then discharged from the machine, being conveyed to the installation of the final hoops.

The **Bung Drill Machine** is a semi-automatic machine to drill the bung hole into the proper position in the barrel. The barrels are automatically conveyed one at a time into a receiving cradle so that the operator may rotate the barrel to a proper position, aligning a selected stave to a laser alignment line. The operator will then initiate THNTD (Two-Hand-No-Tie-Down) palm sensors to start and maintain the barrel clamping and drilling sequence. At completion of cycle the barrel is automatically discharged out of the cradle onto a conveyor.

THE EQUIPMENT (cont.)

The **Air-Water Test Machine** is a semi-automatic machine operated to pressure decay test the barrels with a combination of water and air. Water helps expand and seal the oak staves along with giving an easy indication to the operators if there is a major leak in the barrel. The barrels are automatically conveyed one at a time into a receiving cradle so that the operator may rotate the barrel to an appropriate position to install the rubber temporary bung and supply hose. The proper portioning of water to air mixture is preset by the valves and flow controls for a consistent test to all barrels. And the automatic pressure fill sequence is preset by the electrical controls, again for consistency to all barrels. Pilot lights indicate to the operator the sequence of operation and that the cycle is complete so that the hose may be removed from the barrel before the barrel is discharged from the cradle. If a gross leak is detected the barrel will be removed from the line and sent to the cooper for rework. Once the barrel is discharged the next barrel is fed into the cradle ready for testing.

The **Air Test Machine** is a semi-automatic machine used to pressure decay test the barrels with air only. These machines are for a final leak testing at the very end of the manufacturing process and before the barrels are accepted for shipment. This is a stand-alone pressure test station that is located to one side of the barrel cradle station at the end of the final conveyors. The automatic pressure fill sequence is preset by the electrical controls, for consistency to all barrels. Pilot lights indicate to the operator the sequence of operation and that the cycle is complete with acceptance or rejection, so that the hose may be removed from the barrel.

THE EQUIPMENT (cont.)

The **Barrel Cradle Station** is a structural base frame with a roller wheel barrel cradle and stainless steel catch basin with a floor drain, located at the very end of the barrel conveyor line. Through this area of final manufacturing the barrels are conveyed in a vertical position. This cradle was ergonomically designed so that an operator can easily lay the barrel down from the end of the conveyor and place it horizontally into the roller cradle. The bung is then manually removed from the barrel, and the barrel is rotated to point the bung hole down, allowing the water to quickly drain from the barrel into the catch basin. A plug is then installed into the bung hole and the operator manually slides the barrel out the end of the cradle onto the lower end platform, standing the barrel up vertically. The barrel can then easily be slid off the platform onto a shipping skid.

THE DESIGN & MANUFACTURING PROCESS

Engineering Evaluation

These projects began with our engineering team evaluating the existing equipment in operation during cooperage production, and then evaluating the equipment without production so that we could physically get into the machines and thoroughly study and take measurements. Our initial meetings with the customer helped to define their specifications and requirements, and brainstorm our initial thoughts of design improvements to better suit their production needs. From there, we preceded to 3D model a conceptual design for each of the machines and review these designs with the customer. Upon approval we completed the full 3D mechanical designs, safety and guarding designs, pneumatic designs, hydraulic designs, electrical controls design, and the PLC & HMI programming.

3D Modeling to Customer Approval

Presenting our 3D designs to the customer using a high resolution projector, we showcased the machines in every viable way, featuring product positioning. Animating some of the modeling enabled everyone to review and scrutinize the machine motions and product handling. [*Throughout the finalizing of the designs additional suggestions for improvements are introduced to the customer for their approval before implementing into the design. Sometimes one good idea leads to another!*]

THE DESIGN & MANUFACTURING PROCESS (cont.)

Safety Considerations

It should also be noted that these machines had to meet OSHA safety requirements for this type of equipment, along with meeting our customers' specifications of being category 3 intrinsically safe. The safety related function is identified as a result of the risk assessment process of each identified hazard. This of course is demanding of the electrical design and on the implementation of every specific component.

Processing from 3D CAD to Manufacturing Design Packages

At the completion of the engineering design, a full review meeting assured the customer that all project requirements and specification have been more than satisfied; and with their approval of design we prepared the design packages for our manufacturing. Our engineering package contained printed draft files of full machine assembly drawing with itemized bill of materials and all purchase components, sub-assembly drawing, part fabrication detail drawings with machining tolerances to suit, pneumatic diagrams, hydraulic diagrams, electrical schematics, and electrical enclosure layouts. Concurrently, our ERP system is updated with all the necessary information to be utilized for active production: purchasing, shop scheduling and job costing.

Fabrication

All of these machines are primarily fabricated with carbon steel and aluminum materials. Steel structural tubing with a heavy wall cross-section was utilized to assure structural integrity in the primary base frames. [*Where necessary, we quickly analyze bending moments and yield strengths to the structural design to suit the required stresses of the critical operations, and then add a margin of comfort to the material size selected. Our decades of engineering experience greatly help us in not only the structural material selection but also the proper design of a structure to best accommodate the applied stresses. No tinker toying on our designs.*]

The frame structures are completely fabricated in our weld shop utilizing MIG and TIG type welding. Machining requirements of the frame members are completed first, if required, before the structure is welded together. The weldment is dimensionally checked and rechecked throughout the welding process to assure it meets the design tolerances. [*These machines did not require stress-relieving, but when required, we will have the finished structure normalized to relieve those stresses induced by the welding process.*] The frames are then deburred and cleaned off before applying a primer and enamel paint to meet the customer's color specifications.

Machining Components

Most the machined components are manufactured in our 5-Axis CNC milling and CNC lathe machining centers, except for those few parts selected to be machined manually due to a specific need. [*Our 3D design files of the individual parts are translated from our engineering CAD software to our CAD CAM software for matching to the final CNC programming and cutting tool selections.]* Upon completion of the machined parts they are quality inspected and then applied with the specified finish: i.e. paint, black oxide, plating, anodizing, heat treat hardening and quenching, etc.

THE DESIGN & MANUFACTURING PROCESS (cont.)

Assembly

All fabricated and machined components along with purchased components and hardware are collected and checked-in to our assembly department. [*Our assembly technicians complete an introduction briefing with the project engineers to understand the full project scope before starting the machine assembly, from determining adequate floor space to final orientation of the machines for debugging and acceptance testing.*] After positioning the frame structures, we separately assembled all of the sub-assemblies (individual stations or mechanical operations within a machine) before installing them to the frame. We then completely assembled all mechanical parts and components per the designs, while checking fits, clearances, proper movement of the actuated items, and functionality of the tooling. Motors and actuators, along with the pneumatic and hydraulic valves, were installed to the tooling. Once the valves and actuators were plumbed up and connected to our plant utilities we were able to manually operate the valves so that we could check individual operations while setting actuator speeds with the flow controls and setting stop positions of the tooling. [*This way we can safely pre-debug the machine operations in a one-at-a-time way with each moving operation. After being satisfied with these initial adjustments we check the operations again one at a time with the product (i.e. cooperage barrel) in each position*.] After being satisfied with the initial pre-debug the customers' project engineers are invited to visit our plant to see the build progress and discuss project schedules.

Simultaneously, the electrical controls components are assembled and wired on the enclosure panels for preparation to install the completed panels to their enclosure. The NEMA 12 enclosures are machined with the required cut-outs, knock-outs, mounting holes, and painted in preparation for the enclosure assembly. The enclosures are then mounted to the machine structures along with their panels and fully assembled with all of the operator controls and wiring to the input and output hardware, i.e. push buttons, pilot lights, photo-eyes, proximity sensors, solenoid valves, etc. [*Note: the electrical controls for these machines were designed and built to the customers specifications of being category 3 intrinsically safe, along with all I/O being 24 VDC*.]

Testing: Dry Cycle & Complete Run Cycle

Upon completion of the machine wiring our plant utilities are connected and power is supplied to the machines [*it's almost as if each machine is taking its first breath*.] We then go through the process of checking that all I/O is properly wired and functioning, and then install the PLC and HMI programs [*we now have given the machine a heartbeat – we are now alive*]. All operator control functions are checked and machine actuations are manually forced so that adjustments can be made and input sensors can be confirmed. We then dry cycled the machine, i.e. without product, so that the sequence of operations can be checked. After gaining confidence that all machine operations and sequences are functioning properly we introduced the product, a cooperage barrel, to the machine, and ran a complete cycle. While cycling the machine with the barrels we fine-tuned all the mechanics and controls to optimize the sequence and the production cycle rate.

THE INSTALLATION AT THE NEW PLANT

After completing the final installation of guarding and safety components, the machine is made ready for the final FAT (factory acceptance testing) with the customer. During FAT each machine was put through a rigorous review with running barrels continuously for hours; along with purposely cycle stopping and restarting the cycle and emergency stopping the machine. Every possible scenario is checked for proper operation and fault recovery to assure our customer that the equipment meets and exceeds all their project requirements. Concurrently with the FAT we also trained the customer operators and maintenance personnel. [*At completion of the FAT we were complimented with the customer acceptance of the machines and we then coordinated the schedule for shipments to their new plant. The stork delivered these babies to their new home.*]

A few weeks after all the machines were delivered to the new plant the customer contacted us to confirm that all machines had been installed and utilities connected, and asked that we coordinate engineering supervision for the equipment start-up. We scheduled our technicians to arrive at the plant a day before the production start-up, so that each machine could be powered up and dry cycled, by our technicians, to check all sequence of operations. This allowed us to be preemptive to any issues that may be discovered after shipment and installation of the equipment. Fortunately only a few minor issues were found such as sensors that required realignment. We also had to confirm that the integration of the infeeding conveyor, which was supplied by others, was properly connected to the Bilge Hoop Puller Machine controls and that it was physically operating correctly. We found that the infeed conveyor operated slightly different in its sequencing than what was originally specified, so we had to improvise and make some programming modifications to suit the required sequence. Once we modified the infeed conveyor sequencing and its integration with the hoop puller sequence the fully automatic cycle operated very well. [*We try to make sure any needed provisions function properly with our babies*.]

On the following day we ran all of the equipment through a production start-up with the entire production line initially running in a dry cycle; and then later ran non-stop for several hours of production with the barrels. By the end of the day, all operations and all of our machines were accepted with very high compliments from the customers' engineers and plant management to our technicians.

For the following next several months the new cooperage plant has slowly ramped up production as additional equipment and operations are brought on line with the barrel manufacturing, along with selectively hiring the new employees for operators and equipment/plant maintenance. The cooperage is proposing to be at full production within the next 12 months.

THE REWARDS

Our customer advised us that they would be supplying us with a *testimonial of their satisfaction* for all the equipment we supplied on these projects, along with continued inquiries for additional machines.

Now that we have gone through the learning curve of this new industry to our company, all of our employees have an even greater excitement to further our understanding and experience with **The Cooperage Industry**. We look forward to continue providing cooperage equipment that exceeds the customer and industry standards. We also look forward to entering other industries, implementing the same processes to manufacture equipment which can assist companies in bringing their production methods into the Twenty First Century emphasizing automation, speed and safety. [*We are proud of this project and look forward to our next*.]

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