GKN Aerospace
Paraplast Wash Enclosure Project
MECH 4240 Concepts Review
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Abstract

The current paraplast wash enclosure area is run down, inefficient, and filled with ergonomic issues. The goal of this project is to create a new wash enclosure system that can efficiently and safely load parts, wash those parts, and dispose of the waste paraplast.

Part loading is one of the ergonomic issues the area currently faces. The parts contain a heavy paraplast material and can weigh up to 70 lbs. Carrying these parts from a work table to the wash enclosure is currently a safety hazard to the operator. The weight also makes the parts hard to maneuver, often resulting in part damage upon loading.

The second issue is the disposal of the waste paraplast from the weir system. The waste paraplast is currently shoveled out by hand. This process is not ergonomic and extremely labor intensive.

After evaluating several concepts, the design our group chose incorporated the use of a crane to both load the parts and dump the waste paraplast into the disposal drum. The new design will produce cost savings from reductions in part damage and the labor time needed to dispose of the waste paraplast. It will also eliminate safety hazards found in the loading and paraplast disposal processes.

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Introduction

GKN Aerospace is one of the world's largest suppliers to the global aviation industry. They employ 17,000 people in 62 locations on three different continents. GKN in Tallassee, AL came to Auburn University with a problem. GKN manufactures composite parts for the aviation industry. These parts are set in a mold and then cured in an autoclave. After the part is cured, it is full of the molding compound. The current mechanism for washing out this compound is unsafe and not ergonomic. The design problem at hand is to design a safer and more ergonomic wash station.

In any manufacturing environment, safety is the number one goal. The current system does the task at hand but leaves many safety problems unaddressed. The paraplast is washed out using high pressure near boiling water, currently there is no way to keep the water from heating up the outside of the wash station. There is no "in use" indicator so the operator has to risk the heat in order to know the status of the machine. Secondly, ergonomics is a huge issue. When loaded into the wash station, the parts plus the compound can exceed 50 pounds, the part has to be carried up to ten feet and then loaded into the wash station via a 3x3 opening. During this process not only can the operator suffer physical injury, but the product can be damaged when rested on the frame of the opening. Another ergonomic issue is waste removal. The paraplast builds up in a weir system over time and needs to be cleaned out on a regular basis. It is currently shoveled out by hand into a 55-gallon drum. This is an unergonomic and labor intensive process.

The goal of this project is to act on the issues described above by implementing a new design. This concepts review will go into detail on how the safety and ergonomic issues will be corrected. The team developed two solid concepts and chose the concept that met the design requirements most completely.

Mission Objective

The mission objective is to produce a fully functional, safer, and more efficient paraplast wash machine in comparison to the existing one. The alternative system will minimize manual lifting by workers via mechanical advantage. This will reduce the risk of damaged product and aid in the effective removal of paraplast washout. The machine will be capable of withstanding specified loading and ultimately be water-tight. It will also incorporate operating lights, timers, and sensors, all ensuring worker safety and efficient use of their time.

Architectural Design Development

Concept 1: Crane Assisted Loading with Removable Paraplast Catch Tray

An overhead crane system is installed and spans the entire wash enclosure work station. Parts are loaded onto a tray on the work bench and transported to the wash enclosure via the overhead crane. A pull out drawer is built into the wash enclosure for simple loading of the parts tray. After the parts tray is in place on the enclosure drawer, the drawer is pushed into the enclosure and the door can be closed. To clean out built up paraplast, the top section of the enclosure slides to the rear, allowing access to the paraplast catch tray. The catch tray sits underneath the washing grate and catches the majority of paraplast material before it enters the weir system. For cleaning, the overhead crane is used to lift the paraplast catch tray out of the enclosure. A valve is located at the bottom of the catch tray which is opened when the tray is above the waste drum, allowing for easy paraplast removal. Figure 1 shows a CAD rendering of the proposed concept.

Advantages:

- Minimize heavy lifting by worker.
- Several parts can be transported from work table to enclosure at one time.
- Minimize damage to parts by loading them onto parts tray at the work table.
- Less labor required for clean out procedure
- Faster Clean out procedure

Disadvantages:

- Cost
- Possible maintenance required for crane system
- Requires movement of heavy loads several feet above the ground
- Drainage valve could become clogged
- Possible splashing of water onto floor
- Requires use of crane system

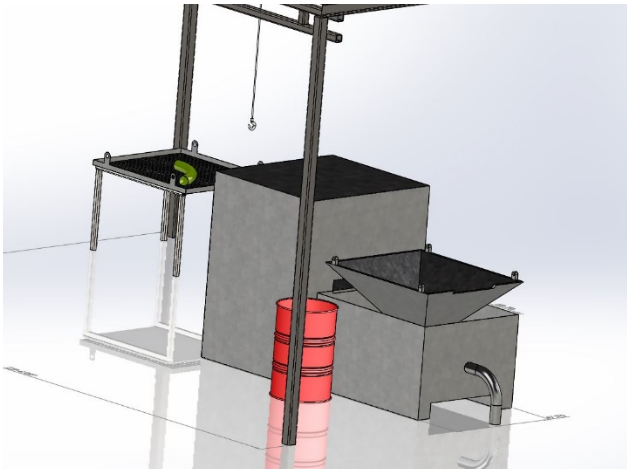

Figure 1: Removable Tray with Crane Assist

Concept 2: Cart Assisted Loading with Hydraulic Lift Clean Out System

A cart is utilized to transport a removable parts tray to and from the enclosure. The parts tray has a set of wheels on both sides which allows it to slide in and out on a pair of rails within the wash enclosure. A worker loads the parts tray at the work table then moves the tray to the enclosure via the cart. Once the wheels of the tray are aligned with the rails within the enclosure, the tray is slid into the enclosure. During use, the paraplast is caught in the lower portion of the wash enclosure. The lower section of the enclosure is attached to the ground with a hydraulic scissor jack system. When the built up paraplast needs to be removed, the jack system is used to raise the lower portion of the wash enclosure. Once the waste drum is in place underneath the enclosure, a valve is opened at the bottom of the enclosure, allowing paraplast to flow into the drum. Figures 4 and 5 in the appendix illustrate the proposed system.

Advantages:

- Does not require crane installation
- Minimize damage to parts
- Does not require moving of heavy loads through the air

Disadvantages:

- More components to manufacture
- Requires source to power hydraulics

Concept 3: Crane Assisted Loading with Hinged Weir System

The loading process utilizing the overhead crane is the same as in Concept 1. During use, the paraplast and water mixture immediately leaves enclosure and enters into a weir system to the rear of the enclosure. The weirs are individually attached to the weir enclosure wall via a hinge system as shown in Figure 2. For cleaning, the weirs can be tilted allowing the water in the weirs to drain off. Once the majority of the water is out of the weirs, they can be tilted completely over the edge of the weir enclosure allowing paraplast to be emptied into the disposal drum.

Advantages:

- Minimize heavy lifting by worker.
- Several parts can be transported from work table to enclosure at one time.
- Minimize damage to parts by loading them onto parts tray at the work table.
- Each weir can be emptied individually

Disadvantages:

- Care must be taken to prevent paraplast from going down drain
- Clean out must be done more often

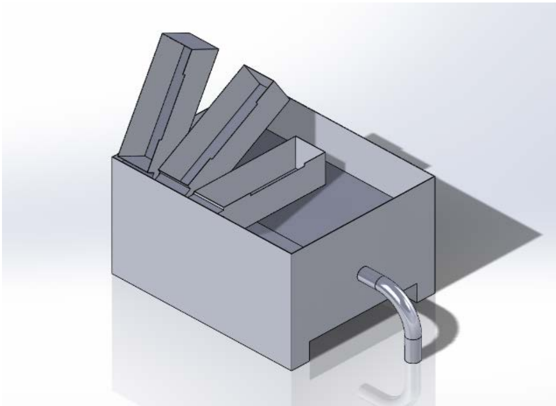

Figure 2: Hinged Weir System Concept

Decision Matrix

Table 1: Weighted Decision Matrix

Weight	4	2	1	1	1	9	
Percent	44%	22%	11%	11%	11%	100%	
Option	**Load Part**	**Waste Removal**	**Cleaning System**	**Electronics**	**Frame**	**Score**	
Removable Tray	95	80	85	85	85	88	
Rolling Cart	90	45	85	85	85	78	
Crane with hinged weir	95	95	85	85	85	92	

Design Recommendation

CAD Drawing of Proposed System

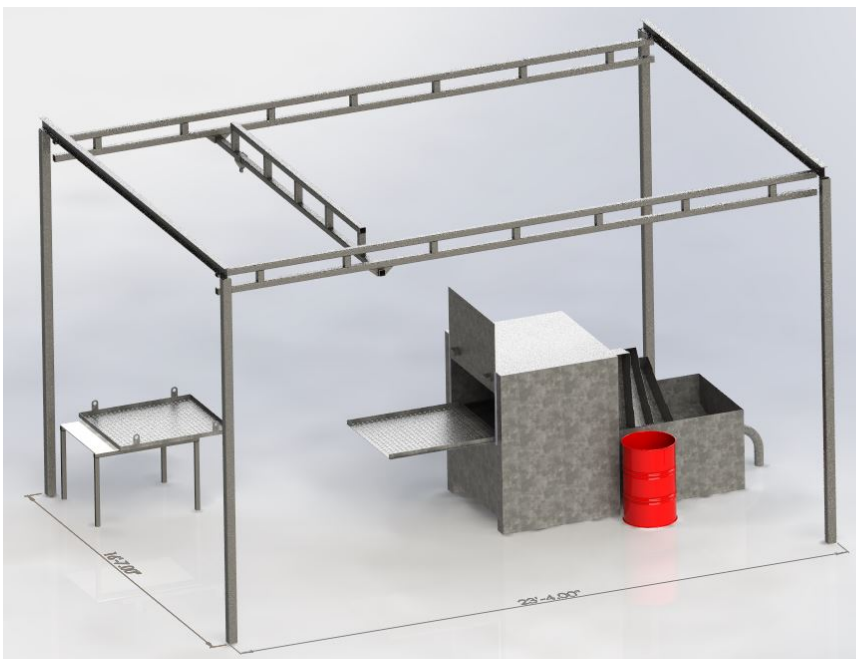

Figure 3: Proposed Paraplast Wash System

Product Hierarchy

<u>Loading</u>
- Crane
- Basket
- Pull-out tray

<u>Waste Disposal</u>
- Crane
- Tray holding paraplast
- Filtering (Weir system)

Cleaning the Molds

- Valves
- Pressure gauge
- Piping
- 6 nozzles

Electronics

- Temperature sensor
- Timer
- Indication Lights

Enclosure

- Insulated door

First-Cut Economics Analysis

Table 2: First - Cut Bill of Materials

Item Description	Part Number	Qty.	Cost/unit	Total Cost
Nozzle	5307K76	6	$10.39	$62.34
Piping				$1,074.90
Perforated Sheet Metal				$305.32
Sheet Metal				$3,646.98
Overhead crane - 1000 lb. cap. - 10'x23' - 12' overhead	(Gorbel model)-GLCS-FS-1000-10 (S or AL)-23-12	1	$5,000.00	$5,000.00
steel stud concrete anchor - 7/8" diam. - 6" length	98880A630	16	$10.04	$160.64
Electric wire rope hoist - 500 lb. cap.	9479T51	1	$859.53	$859.53
			Total	**$11,109.71**

Requirements:

- Safety
  - No leaks
  - On/off lights
  - Insulated door
- Easy travel of molds to wash system:
  - Gorbel crane
- Easy loading of molds into the wash machine: (reduce damage)
  - Pullout tray
- Ergonomic:
  - Easier door lifting
  - Waste removal
- Auxiliary Equipment
  - Light
  - Timer
  - Temperature Sensor
  - 6 Nozzles
    - Water hoses (currently use air hoses)

Concept of Operations

To begin the washing of casting compound from designated molds, loading trays should be ready on tables at the front of the work station. Prewashed molds are then placed on the trays. The electric hoist mounted to the overhead crane system is then attached to the loading tray with the appropriate connections. The operator then uses the handheld control switch to lift the loaded tray which is then easily maneuvered to the front of the wash machine where the loading drawer should be ready and fully extended. The raised tray is then lowered on top of the drawer and disconnected from the hoist which is then moved aside for later use. The loaded drawer is then pushed fully forward into the wash machine. Flexible nozzles can now be placed in desired positions for optimal washing of each particular mold. This completes the loading process and the door can now be closed and locked. Hot water is now turned on opening only the selected nozzles needed at the time. While water is flowing the in use light remains on and a timer setup displays the duration of the current wash. As the operator checks the progress of each wash cycle, the water is first turned off and the duration of that cycle is be noted. The onboard sensors are checked as well and enough time should be allowed for the door temperature to drop to a safe level. Once cooled, the door is unlocked and opened. The drawer is then extended and clean molds are removed. After several washes the settling weirs require emptying. At this point, using the designated attachment the hoist is clipped one by one to each weir. First for this process the weir is raised to a height just enough to drain excess water from the top of the sediment bed. The hinged weir is then lifted to its maximum height allowing the paraplast to empty into the waste barrel positioned beneath. Each subsequent weir is then treated accordingly until all are clean. The next load of molds may now be loaded and the process repeated thereon.

Mission Environment

The mission environment for this project is inside a factory with climate controlled atmosphere. Heat and humidity are a factory because of the nature of the system. High pressured hot water is used in the device causing wear on the flexible hoses used to connect the nozzles. These will be designed to be easily replaced to reduce down time due to unexpected failure. This design should greatly improve the operator's work environment and physical stress related to the job.

Risk Management

No system comes without potential risks and this crane and paraplast wash station system are no different. Implementation of an overhead crane and electric hoist is desirable but includes certain risks that must be addressed. The trays loaded with unwashed molds poses a risk of tilting. If this occurs, not only is the safety of workers jeopardized but also the damage to product is inevitable. Prototyping will be necessary to ensure the best possible design for the hoist connections to prevent instability while loaded trays are elevated. Furthermore, damage to product can occur if a segment of a mold overhangs from the tray. Again, prototyping of detailed loading trays is necessary to ensure all molds being loaded will have clearance from hitting any part of the machine frame. Another safety risk that must be considered is water spilling on the floor. Rubber seals around the door and openings will be used and must be checked regularly for damage. Also, a low speed setting is necessary on the hoist for lifting the weirs to prevent splashing water. Risks of mechanical failures must be considered as well. Further detailed design will allow for more precise material selection and ultimately finite element analysis for critically loaded joints and connections.

Configuration Management and Documentation

Google drive is currently being used to manage files for the concepts review. Team members are able to collaborate on common documents from anywhere. Making it a useful tool for working together even when the team cannot be in the same place.

Subsystems Design Engineering

The subsystems design engineering is an ongoing process. At this point for the concepts review the subsystems are very basic. As the project progresses towards the final design more details will come together. The most complex of the subsystems are the loading and waste disposal.

Project Management

Project management is essential for any team to be stay on track and organized while completing the design process. At the beginning of each meeting goals were discussed to give the meeting a clear goal to accomplish. Each team member produced a Contract of Deliverables that held each person accountable for his or her work. The contracts of deliverables are attached in the appendix as well as an example of meeting goals. The report outline was used to delegate tasks and a copy of the assigned tasks was uploaded to Google Drive. Once the sponsor gives the go ahead for the design, preparation for the CDR begins. Solid Works drawings will be dimensioned and details of each subsystem will be ironed out. The specific design work begins after the concepts review in preparations for a fully developed and detailed design for the CDR.

Conclusion

In conclusion, it was decided to pursue Concept C involving the crane and hinged weir system as a final design. This design fulfills the requirements, mainly safety and ergonomics. The process will be more user friendly and reduce damage to the product. The new system will have a visual on and off so that a person can know exactly what is happening at the machine without being at the station. The next stage will be to determine the exact crane that will be used. The weir system will also be analyzed to see where it can be improved. Between now and the critical design review the concept will be further developed into being exactly what is needed to fulfill the requirements. At the next review the design will be ready for implementation.

Appendix and References

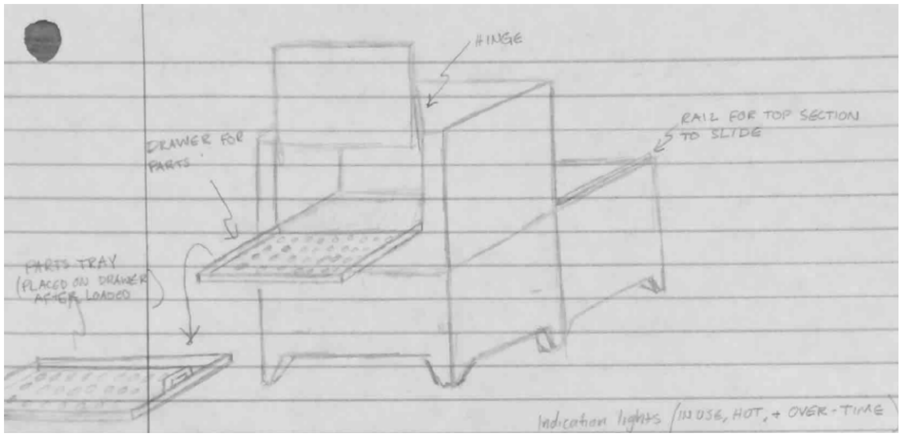

Figure 4: Pull Out Drawer Sketch

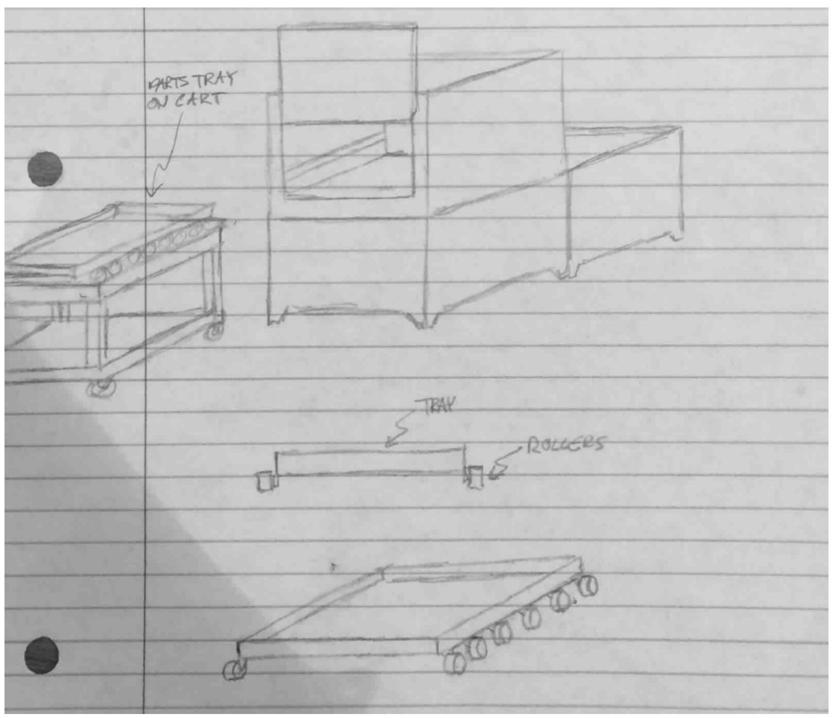

Figure 5: Rolling Cart Concept Sketch