FSU-FAMU College of Engineering

# TECT POWER 68K Blade Process Handling

## Design for Manufacturing, Reliability, and Economics

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# A – PROTOTYPE DESIGN AND COMPONENTS TO BE MANUFACTURED

## A-1 MANUFACTURING PROCESSES

The final design uses only metal parts connected with nuts and bolts. Many parts were made from scrap – for instance, the cylinder about which the bearing rotates about was formed from a piece of pipe cut to size that was therein welded to a plate with a hole cut to the size of the internal diameter of the pipe. Thus, the design called for standard machining processes: cutting, welding, and drilling. The parts with formed shapes in their structures such as the cylindrical housing were formed by cold-rolling the parts.

## A-2 CRITERIA USED IN SELECTION

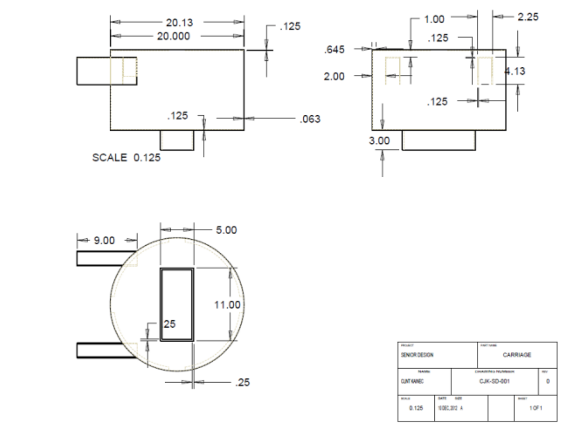
The parts had to be durable enough to withstand the machining environment that they would be subjected to at TECT Power. As such, the parts had to be constructed from hard, non-porous materials – metal was chosen. The collective mass of the central housing and the vertical housing for the pulleys has lend to preventing the system from tipping, and because the cart used is rated for a 2,000lb load, it was advantageous to design and economics to use cheap steel to construct the housing. However, the pulley housing arm, being extended away from the cart had to have a minimized mass, thus aluminum was desired. The aluminum housing was given a shape to improve its bending performance.

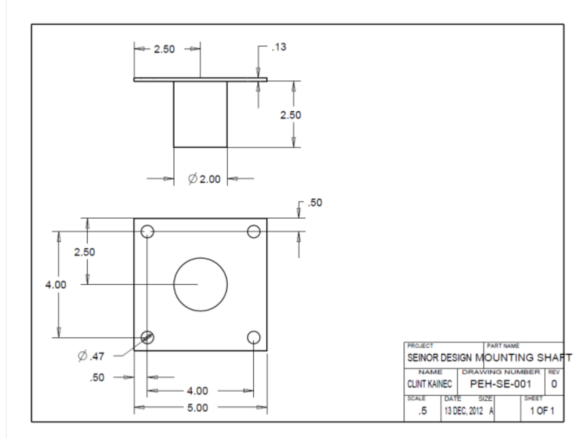
## A-3 DECISION ON WHERE TO MAKE PARTS

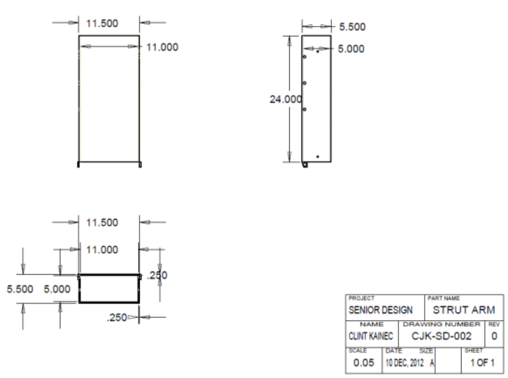
Westgate Sheetmetal, a machine shop in Riviera Beach, FL, offered to provide services at material cost without charging for labor. Their offered was graciously accepted as their facility was more than adequate for the design and their warehouse of scrap was abundant of usable materials for the design. The assembly of the design was chosen to be in a member's garage as the design is large and needed an indoor environment with adequate lighting to be assembled.

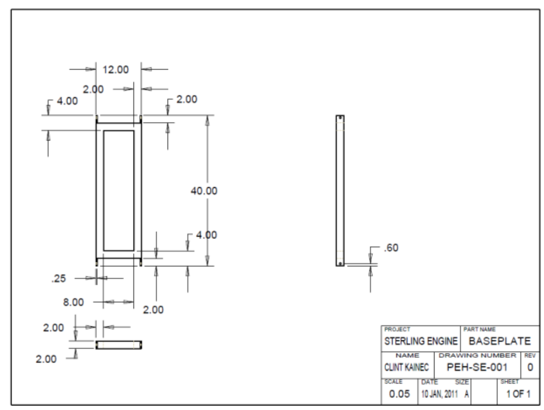
# A-4 DESIGN AND BILL OF MATERIALS

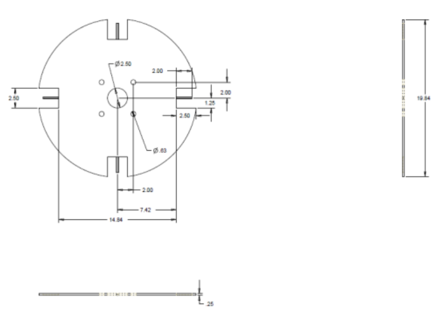
### *DESIGN*



These images display the initial designs before being altered for machining ease at Westgate Sheetmetal. They are representative of the parts that have been constructed. A new representative model in Pro/E was constructed, but is not accurate to the finished parts. Because of their durability, and the need for only one system, new engineering drawings are not necessary.

***BILL OF MATERIALS***

| **Component** | **Material/Type** | **Quantity** |
|---|---|---|
| Cart | Steel | 1 |
| Wheels | Stainless steel/plastic | 6 |
| Table plate | Steel | 1 |
| Pivot column | Steel | 1 |
| Bearing | Steel | 1 |
| Batteries | 12VDC Lead-Acid | 2 |
| Battery chargers | N/A | 2 |
| Winches | N/A | 2 |
| Housing | Steel | 1 |
| Shaft | Steel | 1 |
| Pulleys (vertical) | Stainless steel | 6 |
| Pulleys (horizontal) | Steel | 2 |
| Pulley track | Aluminum | 1 |
| Pulley track cover | Aluminum | 1 |
| Hinges | Steel | 2 |

## A-5 DESIGN ADJUSTMENTS

Minor adjustments as to the shape of the original design had to be altered to accommodate machining. Because of machining limitation and to ease the process, some parts were cut from existing scrap instead of being made from other parts – the rectangular tube atop the housing is an example of this compromise. Also, some parts were adjusted, such as the aluminum housing, to decrease material usage to both decrease cost and weight.

## A-6 CHALLENGES ENCOUNTERED

Minor challenges were encountered while attempteding to find parts adequate for the system. For instance, motors were intially researched for use in drawing the line to lift the blades. However, it was found that the motor-spindle-wire system could be simplified and reduced in cost by purchasing pre-made winches intended for use on ATVs.

Manufacturing challenges arose when drilling holes in thick components such as the rectangular tube. The thickness of the material would wear on the compoenents used, so after consulting with a machinist, higher quality bits and an adjustment to the drilling speed were used to complete the drilling.

# B – DESIGN FOR RELIABILITY

## B-1 RISK

The overall design is large and bulky. Because the cart was salvaged from the previous year's Senior Design group and is a costly expenditure, it was accepted as-is. It was later found that the breaking mechanism on the cart which places feet on the ground to prevent the cart from moving was removed by the previous group. However, because of the additional mass being added to the cart and the grated flooring in the machining area at TECT Power, the cart should not roll unless forcibly pushed with its handle.

More risk involved is associated with the mechanism inside the device. If it were to fail, the blade it is carrying could be damaged. To address this, the pulleys, wire, and winches all have tolerances well above the weight of the blade as well as additional weight, possibly from a worker slipping and pulling on the line. The wheels inside the design that allow the table top to pivot about its central axis is also designed for the weight of every component on top of it, the blade, and additional weight.

## B-2 POTENTIAL FAILURE

A large consideration when designing the system was the environment it is subjected to. The machines around the system will spray oil and shave shrapnel off the blades which could interfere with operation and possibly even be catastrophic. The housing systems that contain the pulleys and the electrical systems prevent particulate from entering the pulleys and the electronic components.

## B-3 LONG-TERM SURVIVIBILITY

The design is built to last. However, some of the electrical components may wear after time. The batteries of the system may eventually refuse to hold charge and the winches may eventually lose power. These components are removable can be replaced or maintenanced if needed.

### B-4 Repair

The entire assembly is assembled with single components mounted with nuts and bolts. If any individual component is broken, it can be removed from the system with relative ease. The wheels, pulleys, hardware, bearing, winches, batteries, and chargers can all be repurchased and therein replaced from their respective supplier. The metalwork on the system should not be damage to the point of system failure, but – assuming that something happens – the steel structures can be welded for repair, but the aluminum, being of a grade that is non-weldable, must be replaced. These parts were custom-made, so replacement is not an option unless they were to be re-machined.

## C – Design for Economics

### C-1 Material costs

| | |
|---|---|
| Machined parts | $675 |
| Small parts | $150 |
| Hardware | $90 |
| Electronics | $170 |
| Winches | $240 |
| Harness | $120 |
| **TOTAL** | **$1445** |

The design materials were given at a bulk cost for the metal used. The smaller parts and electrical components that were purchased, however, were acquired from various vendors. It should be noted that the cost does not require future optimization for the prototype being assembled is for a single use and not intended to be replicated.

### C-2 Assembly cost

Assembly had no costs associated with it. The design was assembled by the group and required assembly materials such as drills and miscellaneous tools like screw drivers were already acquired or borrowed for no cost. The sewing of the harness is also being done by a seamstress gratis.

## C-3 TESTING COST

Testing had no costs associated with it as well. The testing is merely validation of the ability of the winches with a mass attached to them; the reliability of the pulleys, line, and wheels; and the ability of the system to translate, rotate, and orient the blades.