**Mechanical Design Considerations**

In order to come up with our design extensive research was done to see how parts are moved, counted, stored, contained and controlled in real world settings. After exploring some examples we started to consider our own design additions to make or add to designs that would in theory mimic the results of massive modern parts counting machines. We took away key pieces that each machine seemed to achieve to make it successful.

In order to choose a design, a chart was created for each feature that would have to take place in the machine. The events were ordered to follow the path of a single small part through each step in the machine’s processes. Where each step would need to physically be controlled and have the capability for an electrical system to view and provide feedback to the machines main electrical controls.

In order to hold the parts the machine needed a larger bin or space that could feed parts to the rest of the machine. The model of the bowl design in the case feeder could hold large amounts of small parts and would be providing continuous feeding to the machine. Other hopper designs where considered however, it was deemed not necessary due to the expected part volume being too small to add another major part storage device.

The machine has to be able to physically move the small parts from the hopper to the rest of the machine, and it must do so efficiently and orderly. In order to move the parts, many examples that were observed used vibration methods, conveyor belts, rail systems and good old gravity. It was decided for this machine to attempt to use a gravity feed method that performed by agitating the parts into one orientation in its bowl. It then allowed only one part per slot, acquired each part one by one and separated them from the main parts population in an orientation that could be used for counting.

From the systems major flow of parts the amount of parts exiting the upstream portion of the machine was limiting the flow by means of spaces and gaps that would allow parts of one orientation to move through without falling back into the main population at the bottom of the bowl. These limitations allowed for a single oriented and controlled line of parts to be fed to the rest of the machine. For this project the machine will use multiple disks to limit the size of fastener allowed in a slot. Each disk is made with only one fastener in mind and takes into account thicknesses, length and width. In order to change fasteners the operator will stop the machine, empty the remaining content, take off one plate and reinstall a new plate dedicated to the new part being put into the machine.

Once oriented and position to a single feed made slower accurate counting easier. It has been noted that some machines can count multiple small parts moving out to the machine at once, however the accuracy of the count and the speed of the machine have been deemed a risk to our application. It is recognized that this machine has been made to feed slowly to ensure accuracy and control of both the parts and the count. It is decided to use multiple sensors so that we can read multiple counts and compare counts to determine the correct count in the machine. We are confident in our counting abilities that we will collect the screw in one presentation bin.

The last method that each machine provided was to deliver the parts to their final holding area or destination. The project destination is a waiting hand; however the maximum number of parts to be presented is limited. Due to this we developed the idea based off of a soap dispenser, soda fountain, and ice water dispenser from a refrigerator, where the user puts a cup or a hand under the count holder and pushes a bumper that will allow for the parts to be dispensed vertically. We have put this bin on a rail system in combination with the slide. This allows the slide to be supported by the bin. Between the bin and the slide we will install two tension springs that will be about 58mm at rest and be able to stretch 128mm without yielding. The spring constant will be tested and set such that the springs will reposition the slide when the operator lets off but not be so high that the operator strains to release the parts.

In order to contain the machine and support components we thought of building a cage where the machine components would be inside. Cage would act as a frame and would be built out of columns and beams to provide support to the components within the machine. It was noted that a machine in the senior design room was using a support system mainly out of 8020 beams and connectors that could be ordered in smaller sizes and be tailored to fit this machine. These pieces will hold up the case feeder bowl, the dispensing bin, the funnel and the electronic interface at the front of the machine. The frame will be fitted Plexiglas to allow for observation but with a protective barrier between users a machine. It also serves to prevent foreign material from entering the machine. The frame supports the main assembly above the surface of the table and allows for a 160mm gap for the operator to put his/her hand into interacting with the presentation bin and slider.

In order to move parts in the machine we use disks that are attached to a slow moving servo motor in order to mix the parts and feed them to the funnel for counting. The geometry of each plate is such that only one part can fit into a slot on the plate. The rest will be dropped back down to the rest of the population. One disk will be made for each part. By using similar key features, we will be able to change the disks quickly to allow different parts to be held, oriented, and moved by the disk. It has been noted that one fastener has a pointed tip which could cause damage to the machine. In order to prevent this we will put a tapper into the edge in order to catch the fastener and not allow for wear in the machine. We plan to use ABS for both the bowl and the disks so that the friction constant between the two remains low.

The funnel in the design allows us to attach sensors for parts coming through the machine to count. It also orients the parts as they are falling into the presentation bin. By using 2 counters we can confirm the count and of each part and stop the motor at the correct count.

**Electrical and Controls Design Considerations**

Some of the key electrical design considerations include:

* Power Supply
* Motor selection and control
* Sensor selection and design requirements
* Microcontroller selection

**Power Supply:**

The power supply necessary for this design is one that can provide a 12V and 5V bus from a standard 110VAC single-phase line. The power supply would employ the use of an isolation transformer and a full-wave bridge rectifier. Each rectifying diode in the bridge rectifier shall have a peak inverse voltage (PIV) capacity of 30 V. At the output of the rectifier would be a 100uF electrolytic capacitor as is standard in power supply design to smooth out the ripples left in the rectification process. Then the smoothed power signal would be passed through two voltage regulators in parallel, a 12V and a 5V voltage regulator. After the voltage regulators would await another set of 100uF electrolytic capacitors to provide further noise immunity for the control and motor circuits.

**Motor Selection and Control:**

After careful examination of the system’s static and dynamic characteristics it was determined that a motor with a minimum torque output of 20oz.-in. would be sufficient. Given that the there is considerable torque loss in the shaft of any given motor (~10%) and the need to both observe and control the speed of the motor it was determined that the 131:1 gear motor offered by Pololu was a desirable material solution for the motoring needs of the system. This motor offers 250 in-oz. of torque at 80 rpm, giving a safety factor of 12.5 and an encoder resolution of 64 counts per revolution, creating enough sample for an adequate velocity measurement. Control can be performed by implementing a PID controller in software on the microcontroller to control velocity output for desired velocity state or an integrated motor controller can be purchased that controls the motor with only a simple command from the microcontroller controlling the rest of the system. Given allocated memory and system response time it might be desired to control the motor using a motor controller.

**Sensor selection and design requirements:**

It was decided to use theusing IR led to make IR emit and receive system.The Components: A 5mm IR led, IR receiver: TSOP34338, Arduino 2560 R3, Cylinder crust, resister and wires It is not necessary to add a lens in emit system, because IR led has already had similar structure. The IR-333A LED offers high-reliability and low forward voltage. The TSOP34338 IR receiver offers a detector and preamplifier in one convenient package, while also being immune to ambient light. In order to detect item accurately, we have to consider using which way to send and to receive signal. The light from IR cannot gather into one point in our system. So, we need to consider the reflection of IR light and disturbing between each IR sensors. Therefore, taking example by IR remoter, we may choose to use IRRemote function library to add compiling signal on carrier wave if the result is unsatisfactory when use receiver to detect IR pulse signal.

**Microcontroller Selection:**

The microcontroller selected, the Arduino Mega 2560 R3, was selected due to its intuitive and easy to program interface and native language; Wirish. Also, this particular board offers the right combination of needed PWM and UART ports to support the operation of the sensors, LCD HMI, and motor control. The board offers 15 PWM ports and 3 UART serial communication lines. The board also is clocked at 16MHz which allows the generation of the 26us pulse needed to achieve the 38kHz carrier signal for the IR sensors and also allows a single instruction to be executed in 62.5 ns. Furthermore, the RISC architecture that is inherent in the Atmel core design allows the micro to execute instructions more efficiently, optimizing computation throughput for a given clock frequency.