May 22, 2010

ANNOUNCEMENT

The Margaret and Muir Frey Memorial Prize for Innovation and Creativity

Deadline: May 26, 2010

Robert R. McCormick School of Engineering and Applied Sciences
Northwestern University

The Prize:
The best innovative and/or creative Capstone projects required or acceptable for a McCormick School undergraduate degree will be recognized by receiving first, second, or third place prizes. The awards will be announced at the following Graduation Convocation and will be:

First Place $12,000 to the student(s) and $5,000 to the faculty adviser(s)
Second Place $ 8,000 to the student(s) and $3,000 to the faculty adviser(s)
Third Place $ 5,000 to the student(s) and $2,000 to the faculty adviser(s)
Honorable Mention recognition may be given to other highly meritorious entries.

Bases for the Recognition:
The work must be innovative and/or creative. It must be done to fulfill a capstone requirement of a McCormick undergraduate degree. The projects must be related to known problems or credible new products or processes. The integrative and multidisciplinary character of the work should be emphasized. Account will be taken for the number of participating students, in relation to the quality and magnitude of the work product. Applicants must make clear what portion (or the entirety) of the submitted work is the result of their own efforts.

Submitting an Entry:
Students in capstone course(s) will transmit their work directly to the Associate Dean for Undergraduate Engineering. At least one student on this project must have done the work to fulfill the capstone course requirement of their degree. **The form on the following pages serves as the template for each entry; variations from it (including length) will disqualify the entrant.** One hard copy and one electronic copy are required. The electronic version must be in a format that is searchable.

Judging:
The Department chairpersons, facilitated by the Associate Dean for Undergraduate Engineering, will act as a panel to screen all the submissions and thereby arrive at a set of finalists. These finalists will then be transmitted to a jury drawn from the McCormick Advisory Council, and this group will make the final decisions.

APPLICATION
for
THE MARGARET and MUIR FREY MEMORIAL PRIZE
for INNOVATION and CREATIVITY

For the best, innovative or creative-integrative 'Capstone' project required or acceptable for an undergraduate degree in the McCormick School of Engineering and Applied Science.

The Deadline is May 26, 2010; 5:00PM in Tech Rm L268

1. Capstone project title.

Automatic Meat Casing Remover (AMCaR)

2. Advising professor(s).

Wei Chen

3. Student(s) submitting the project.

Noah Pentelovitch, George Randolph, Sean Wood, Krystian Zimowski

4. State succinctly why this project should be honored with this prize. (It is suggested that this summary be written after the rest of the application is prepared.)

There are few aspects of the meat packing industry that have not yet been automated. Currently, there exists no reliable and simple method for automatically removing the cellulose casing from deli meat. Formax, our client, came to us to find a way to eliminate the need to do this process manually. Our design, the Automatic Meat Casing Remover (AMCaR) solves this problem in a simple five step process, making our design both innovative and energy efficient.

First, the layout of AMCaR represents the most compact geometry possible. The product enters and exits AMCaR transversely, allowing our design to be easily incorporated into various assembly line configurations. It also makes our design scalable to range of product sizes. Second, our design uses very few moving parts, substantially increasing reliability and efficiency. Fewer moving parts also reduce power consumption. AMCaR utilizes compressed air, which is among the most hygienic of power sources. In few other fields is maintaining sanitary conditions as important as in the meat packing industry. Third, AMCaR is fully automated. With regards to the second design feature, removing the human element from commercial meat slicing environments increases both hygiene and safety. Automating this process also increases throughput considerably. Finally, and most importantly, our design employs gravity to its advantage as a means of peeling the casing. Vacuum grippers engage the casing as the product rolls down the trough, unraveling itself. Because of this, no overly complicated mechanical actuators or pincers are needed to hold the casing. Instead, the product does a majority of the work itself.

These features reflect the engineering detail given to robustness and simplicity as well as sustainability and cost. By automating this process, the potential market value of our design is very high. AMCaR represents a new innovation in a centuries-old, global industry and a solution to one of the few problems left unsatisfactorily addressed in the meat packing process.

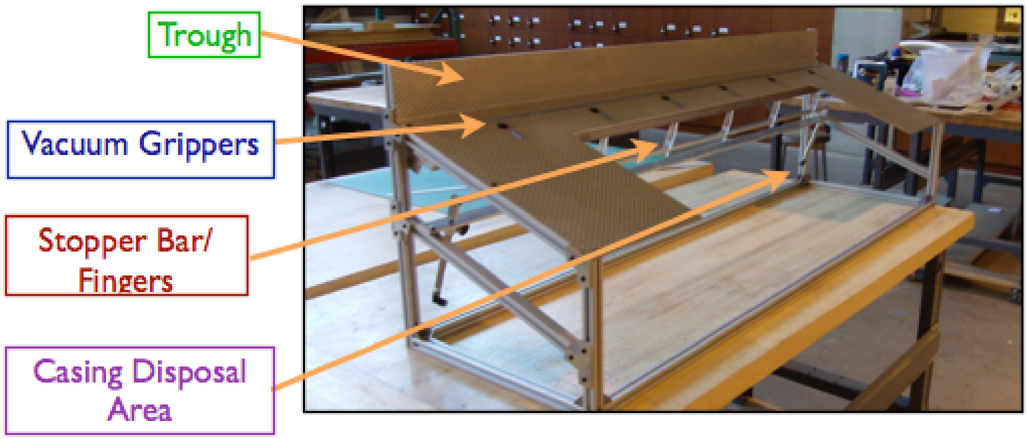
5. Proposed citation statement of the project's significance. (Not more than 25 words.)

Utilizing compressed air and gravity, the Automatic Meat Casing Remover effectively peels cellulose casings from deli meat, lowering manufacturer's operational costs while increasing throughput and hygiene.

6. Describe the new concept resulting in the development of a new product or process. Detail its innovative aspects, and how it has advanced the theory and practice of engineering beyond prior art.

Located in over 70 countries worldwide, Formax has set the industry standard for commercial meat forming and slicing systems. Constantly seeking ways to reduce their operational and manufacturing costs and improve working conditions, they have automated virtually every aspect of their meat packing process. The only major action still performed manually involves removing the cellulose casing from the product so it can be sliced and commercially wrapped. Our task was to design a device to automatically remove the product's casing.

Our design, the Automatic Meat Casing Remover, can be seen in the figure to the right. By eliminating unnecessary steps in the process, our design drastically improves product throughput. Consequently, increased throughput correlates to increased profit for Formax. Fewer steps also mean fewer parts. This aspect of our design has several benefits. A reduced number of parts make AMCaR inherently more reliable, minimizing the sources of potential problems that could arise with a mechanically bloated design. Also, our design is composed of mechanical parts which all utilize a single power source: filtered, compressed air.



Full View of AMCaR

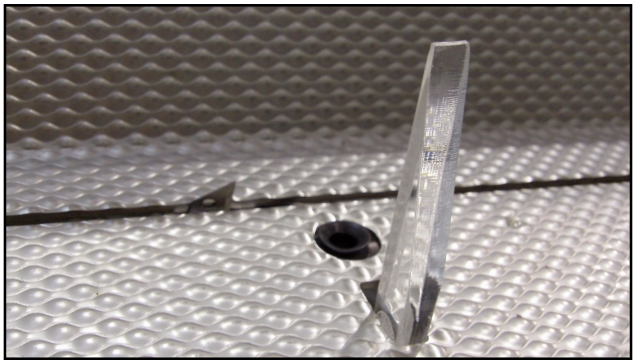
AMCaR uses compressed air to drive all moving components. The vacuum grippers extend approximately .25" above the trough's surface. Because they are flexible, they can conform to the curved surface of the product. The grippers only require about 75 psi, which helps preserve a safe working environment. In addition, the stopper bar assembly is powered by pneumatics. This method of power is incredibly energy efficient. By circulating sterilized air through the pneumatic circuit, it prevents fouling of the components, increasing the reliability of our design. Compressed air is also present in all meat processing plants, further simplifying the factory installation of our design. Finally, filtered compressed air is among the most hygienic power sources. In an environment where cleanliness cannot be compromised, preserving proper sanitation standards is critical. As such, the simplicity of AMCaR allows it to be easily incorporated into current wash down procedures.

The overall layout of our design exemplifies the most efficient geometry possible. The product enters and exits the trough transversely: this allows our design to be easily integrated into a variety of assembly line configurations with no need for reorganization. It also makes our design incredibly scalable to range of product sizes: the length of the trough needs only to be as long as the product. This space-saving feature of AMCaR is another innovation that makes our design so successful.

Finally, the actual method of casing removal represents the ingeniousness of our design: AMCaR uses gravity to its advantage. As the product rolls down the trough, the vacuum grippers hold the casing as it unravels. No finely calibrated actuators or pincers are needed. Instead, the product itself does all the work, resulting in a successful design that automates crucial component of the meat packing industry. As Formax would say, AMCaR truly is "Ingenuity made to order."

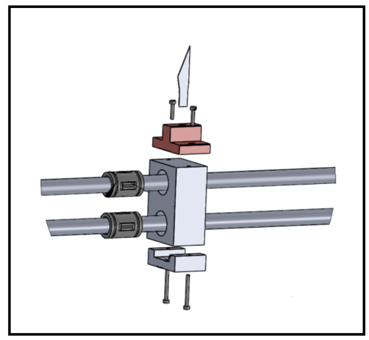
7. Provide any additional information that may not have been covered in the above points, but that the applicant believes will reinforce this application relative to the contribution to the advancement of the theory and practice of innovative or creative-integrative engineering.

AMCaR involves a simple five-step process that will further streamline Formax's assembly line layout. These steps are:



Close up of vacuum gripper, stopper finger, and blade tip

1) The product is transversely loaded into the trough, held in place by the raised stopper bar assembly
2) The knife truck assembly axially slices the casing
3) The pneumatic stopper bar assembly disengages and the vacuum grippers engage the casing
4) The product rolls downward while the casing maintains contact with the trough via the vacuum grippers
5) The stopper bar assembly is re-engaged



Knife Truck Assembly

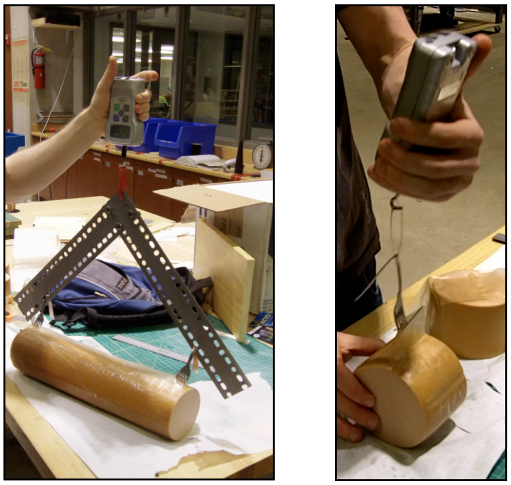
Another important feature of our design is an easily accessible, interchangeable blade fixture. This is important because different types of meat require different blade geometries. The trough is made of Rigitex, an inexpensive, durable material. Its pebbled surface prevents the casing from forming a seal around the edges of the disposal area. Thus the casing can be disposed of by only the force of gravity. The stopper bar fingers are made of an impact resistant acrylic. Their angled geometry assists in self-alignment of the entire stopper bar assembly.

Throughout the design process, we performed several tests, eventually resulting in the specific features previously discussed. The most important test was to determine whether or not vacuum suction was a viable solution for peeling off the cellulose casing. Twelve 1/8" diameter holes were drilled down one side of square tube to simulate the vacuum grippers. The end was sealed by hot-gluing a piece of aluminum across the cross section of the bar. The other end of the bar was attached to a 6.5 HP shop-vacuum via rubber tubing and the connection was sealed with duct tape. This provided a strong airtight seal between the tube and the hose.

Actual product was tested with the apparatus shown at the right. A 6" long sample was used in the experiments by slitting the casing axially. When the shop-vacuum was engaged, a vacuum sucking force was generated in the hollow metal tube. The bar was applied to the casing and when the casing was slowly unrolled, it remained in contact with the bar, thus verifying the viability of the concept.

Vacuum Test Apparatus

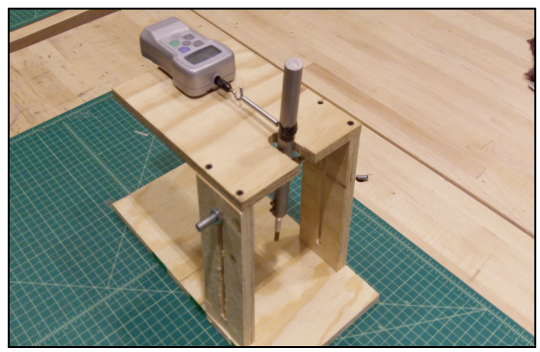
We also conducted tests to determine the amount of force needed to remove the casing. A Shimpo FGV-50XY Force Gauge was used to determine this information and was attached at the top of the bracket. A metal bracket was used to attach the meat log to the testing apparatus. This was done by bending a fork and puncturing either ends of the meat log. A picture of the testing apparatus can be seen to the left.



Force Testing Set Up

A slit was made down the length of the product. When the bracket was pulled upwards, the force required to peel the casing was transferred to the dynamometer. The results showed that the force required for 3" long product was in the vicinity of .15 Newtons. To check the consistency of these results, 18" long product was tested. The results were in the vicinity of 1 Newton, which was approximately 6 times that of the 3" long product.

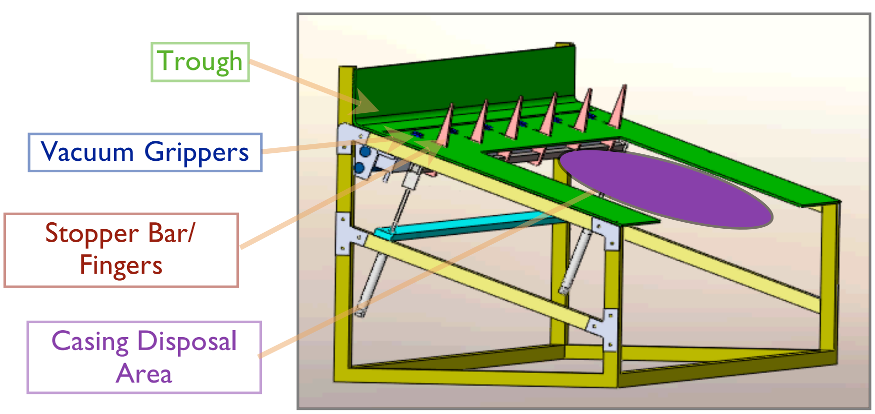
Blade geometries and cutting forces were determined through the next series of experiments. A fixture to measure the knife force was constructed. It was composed of a height adjustable rotating arm mounted in a wooden frame. One end was machined to hold an X-ACTO blade and the other end was attached to the same dynamometer used for the casing tests, the Shimpo FGV-50XY. The apparatus can be seen to the right.



Blade Testing Set Up

The product slid under the blade so that the cut was made approximately in the middle, per the same orientation used on an assembly line. The results would be much more meaningful the closer the simulation was to actual industrial performance. Two blade geometries were tested with this apparatus: straight and curved. Previous research suggested that these two geometries would be the most efficient at removing the casing. After several trials were completed with the various blade geometries, a definite pattern began to emerge. It became evident that the straight blade required significantly less force to puncture the casing as compared with curved blades. Thus our design incorporated straight blades.

A professionally machined, working prototype resulted from the hard work put into this intensive three-month project. AMCaR successfully removes the cellulose casing from the product in a simple five-step process and does so with a degree of simplicity and elegance not found anywhere else in its industry. By utilizing energy efficient power sources and its high amount of adjustability, the device can be easily installed in a variety of assembly line layouts. Indeed, AMCaR may be the next step in streamlining the entire meat packing industry.



CAD of AMCaR (fingers raised)