MANUALLY OPERATED PUNCH PRESS

EXECUTIVE SUMMARY REV 1

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ABSTRACT

Team LeGo MaNiAcS chose to work with Tri State Industries, a company that exclusively employs physically and mentally disabled persons. Workers are assigned to a variety of jobs, including the process that we selected to improve, the cutting of aluminum screen circles. The circles are used in a plastic cap to filter an industrial sealant. The design intent is to increase production five-fold, reduce customer fatigue, eliminate dexterity issues and incorporate workers with more severe functionality problems.

This report is a summarization of the work completed by Team LeGo MaNiAcS of Ohio University in creating an aluminum screen punching device for Tri State Industries. The prototype punch device cuts 10 2.5 inch circles per cycle while reducing material handling. The device tackles a variety of technical challenges to improve the quality and production rate of the screen circles.

BACKGROUND

Tri State Industries is a Work Activity Center, N.E.C, which was established in 1981 to provide employment and job placement for adults who are mentally and physically disabled. Their mission is: to assist their employees “in the development and implementation of employment opportunities and related services as well as provide quality work services and products for our business customers.”

PROBLEM STATEMENT

Tri State Industries needed a device that would enable people with moderate to severe mental disabilities to overcome the workplace obstacles involved in their screen and cap cutting process. The customer specified that a roll of aluminum screen must be “cut” into 2.5” circular disks accurately, efficiently, and with limited waste. The stock material being cut is a 100 foot roll that is 36 inches wide.

The employees currently performing the task are middle to high functioning mentally and physically disabled persons, capable of moderately complex tasks. The primary goal is to develop a device that will allow the low level functioning employees an opportunity to work on screen cutting. Based on observations made while visiting Tri State Industries the team identified the following obstacles that the employees encountered which will be addressed by the design:

• Difficulty determining appropriate layout and spacing of stencils
• Difficulty cutting “Circular” discs, resulting in poor quality discs.
• Extremely low productivity

Our goal was to develop a “user-friendly” device that would produce consistent circular cuts using a pre-determined layout allowing for an increased production rate.

DESIGN

The functionality of employees at Tri State Industries varies greatly between individuals; typically only the higher functioning workers worked on cutting the screen due to the dexterity and
comprehension needed to complete the process. The previous requirement for high-functioning workers was a handicap because the supervisors had to pull them from other jobs to cut screen. It also excluded other lower functioning employees from working more hours. Our team recognized the need to make the screen cutting process available to lower functioning workers and developed our design accordingly.

After recognizing and choosing the need to improve the screen cutting process our team conducted research to determine what solutions are currently available. Our search concluded that the very limited solution, a paper craft punch, was inadequate as a stand-alone solution to the problem. Instead, the punch was modified and incorporated into our design as the cutting mechanism.

Key aspects of our punching mechanism include:

- Simple operation by lever
- Screen circles cut cleanly at 2.5"
- Improved safety due to shielded cutting mechanism

The pull down lever operation applies a force which is magnified through a linkage for enhanced punching force. The back of the machine has a guide for cutting strips of screen. Screen circles are uniform due to the use of the same ten cutters throughout. Improved safety is the result of less handling of the cut material, and covers over pinch points. Safety was addressed by strapping the device to a table and incorporating a plastic guard. The guard protects from nip points or potential debris.

Function:

When designing our punching machine we determined it needed to be large and robust to handle the forces generated in normal operations. It also needed to accommodate a three foot roll of screen and fit on a three foot wide table. Our project was highly specialized and was designed to address the need in its entirety, therefore we were not concerned with portability or reproduction costs. Operating ten cutters per punching motion vastly improves the production rate of a single worker, as well as the ergonomics and the safety.

Material:

Steel was utilized for a majority of the parts in our punch device due to its high strength and low cost. It is also durable, easily machined and readily welded. Polycarbonate was used for the
cover and top guide plates due to lower friction properties and lower material cost. The material also has excellent impact resistance.

**Safety:**

The device has been designed to accept a guard so that users cannot pinch their fingers between moving parts. All edges have been finished to reduce the risk of cuts and abrasions from
sharp edges. The device will be strapped to the work table to prevent it from potentially sliding off
the table and injuring the user.

**DESIGN DEVELOPMENT**

The development of our design started with evaluating the current process Tri State used for
cutting the screens. Apparent problems included poorly cut circles, sharp edges and the use of
scissors without protection. Some of the cut circles failed the only quality check, which is the
insertion of the screen circle into a cap to ensure a snug fit. Another issue with the screen cutting
process was that it required many higher-functioning workers to be pulled from other jobs to
complete an order of five thousand parts.

The device we created was designed with several goals in mind: safety and quality
improvement, the inclusion of low functionality workers and an increase of productivity.

**EVALUATION**

Inspection and testing of the device was performed by the engineering team. Initial tests and
inspections were used to check device safety, production rate, and output circle quality. Additional
testing will be done by customers at the Tri-State facility in May of 2009, including an endurance
test to evaluate alignment issues, a force test to ensure force requirements match the expected and
an evaluation by Tri-State employees in an on-site inspection. The main focus of the on-site test is
to determine the production rate of the workers with our design, to check the ergonomics of the
device and the short and long term fatigue of the workers.

The following specifications have been verified through testing:

- **Quality**
  - Pass “Cap fit” Check
  - Clean Edges

  Each test circle was placed in the plastic cap and if it fit without falling out, it passed the cap
  fit test. Each test circle was found to pass the cap fit test as long as the initial strip of material was
  fully inserted into the punch. This verifies the quality of the 2.5 inch screen circles.

- **Durability**

  The cutter alignment and durability were tested by punching hundreds of screen circles. The
cutter head was inspected for wear or functionality changes. No wear has been observed with this
current sample size. If wear is observed after heavy use, it can be rectified by punching through
aluminum foil.

- **Production Rate**

  - > 240 screen circles per hour

  Based on multiple tests by the engineering team, a production rate of over 240 screen circles
  per hour was estimated. Assuming 5 hours per day, this yields 1200 screen circles per day or over
  5000 per week, meeting the customer requirement. In the future an input force test will be done to
ensure all customers have the strength to repeatedly perform the punch operation. Maximum input force must not exceed 40 pounds.

**DISCUSSION AND CONCLUSIONS**

This team has strived to meet the customers’ screen punching needs. We have successfully created a multi-punch device that will allow people of low functionality to setup, operate, and efficiently meet the production requirements. The prototype can be operated by one worker but with two the device can be used more efficiently and effectively. One worker will work in the back cutting 6 × 36 inch strips while another worker at the front will place those strips in the cutters and punch the holes.

The individual punches produce 2.5 inch screen circles which fit in plastic caps 100% of the time. The functionality and cutting performance was maintained for 500 cuts for a single punch. The prototype device has 10 cutters. Therefore it will punch 5000 circles while showing minimal losses in functionality. The final design limits waste material, increases the production rate by 500%, and provides Tri-State’s business partner with a high quality product. The production rate of 240 screens per hour was verified allowing for the order of 5000 screens to be met in a one week time span.

The device will require minimal maintenance due to the design. It is comprised of steel, polycarbonate, and purchased cutters made of plastic and zinc. The design allows for individual cutters to be taken out and replaced. This consists of taking four screws out of the cover and simply lifting the old cutter off two pegs and replacing it with a new one. We will provide Tri-State with information where to buy individual cutter if one needs replaced. A manual will also aide customers in the replacement process.

**ACKNOWLEDGEMENTS**

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**REFERENCES**