AUTOMATED AMMUNITION RELOADING PRESS KIT

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by

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ABSTRACT

As recreational shooters transition into competitions and more classes, their ammunition needs also change. Namely, an increased volume of rounds are used per year and often a desire for increased accuracy or reduced recoil. By reloading ammunition, shooters can gain all these benefits.

To gain insight into the consumer market for reloading, a survey was created and distributed to a variety of users. Responses indicated that consumers are looking for an automated ammunition reloading press kit that would be reliable, ensure process accuracy and repeatability, safe and easy to operate. With the customer needs in mind, design concepts were generated and analyzed using the engineering design process.

Parts were designed in order to provide consumers with a kit that would retrofit to an existing reloading press. Stress analysis was performed on the components to ensure that a long lifetime could be achieved. Throughout the design process, costs and size were minimized to ensure that the kit would be affordable and occupy minimal space. The kit is projected to have a service life of over five years, providing great value for the investment. Additionally, the installation of the kit takes less than 20 minutes.
INTRODUCTION

BACKGROUND

As shooting has evolved over the years, more shooters are turning to competitions. For these competitions, shooters have been hand loading their own ammunition customized to their firearm and their preferred accuracy and tactile feedback. For many competitive shooters, reloading ammunition is their only means of making enough without spending exorbitant sums of money. Reloading ammunition is not a complex process, but it is very time and labor intensive. It can sometimes take up to a minute to reload cartridge from start to finish. Many modern reloading presses are capable of running at nearly 1,000 rounds per minute, while still requiring lots of attention from the user, namely pulling the handle to cycle the press.

The intent of this design project is to create a kit that will allow the user of a reloading press to perform other necessary tasks. Reloading ammunition can be a dangerous process if published date is not obeyed, resulting in severe injury, even death. Non-commercial customers with large round counts will benefit from this kit, as it will make reloading ammunition easier. This kit will drive the reloading press and perform quality control checks on the cartridges being loaded.
EXISTING METHODS

In the shooting community, there are several options for those wanting to reload their own ammunition. As explained above, there are numerous benefits including a reduced cost per round. Typically, a manual reloading press has three different styles: single-stage, turret, and progressive. A progressive reloading press, as seen in Figure 1 (1), is the fastest reloading press typically employed by a recreational or competitive shooter. It has provisions for multiple dies on the tool head, with automatic indexing each time the handle is cycled. While a single stage reloading press performs one operation at a time, with the user needing to change dies to perform a different operation, while being the least expensive. A turret type press provides room for multiple dies on the tool head of the press, while allowing the operator to manually index the shell plate. Reloading ammunition at home will yield anywhere from 60 to 600 rounds per hour, depending upon press type and ammunition being loaded.

Currently, there is one off the shelf solution available to automate reloading presses. It is made for the reloading press most suitable to automation due to its design. The XL650, manufactured by Dillon Precision is considered by many to be one of the best reloading presses on the market. The Ponsness Warren automating kit only serves to cycle the press, and requires the use to keep their foot on the safety stop when operating. The basic setup of the Ponsness Warren Auto Drive can be seen below in Figure 2 (2). Ponsness Warren also makes shotgun shell reloading systems that are viewed as the standard for shotgun reloading.
Another segment of reloading ammunition is the commercial reloader. The role of the commercial ammunition reloader is to meet a price point between that of factory ammunition (produced by Remington UMC, Winchester, Federal, etc.) and the price of self-reloaded ammunition. Depending upon volume, these commercial reloaders will employ at least one; sometimes more fully automated reloading systems similar to that of the large factories. As seen in Figure 3(3) and Figure 4 (4) below, a commercial-grade reloading system has substantial differences from a consumer-grade system. An obvious visual difference is that the dies (stations) are arranged in a linear fashion, allowing room for more stations. In the following two examples, it can be seen that there are nine (ten in the case of the Camdex) stations. Approximately double that of a progressive reloading press. The increased number of stations allows for more quality control to be performed throughout the process. Both the Ammo Load and Camdex machines are capable of producing nearly 4,000 rounds per hour. However, the machines come with a very high cost that is not appealing to the recreational shooter, unless they were going to use it to make a side income with. At roughly $20,000 it is a large investment. The features present in these commercial systems will be part of the inspiration for the reloading press automation kit. Quality checks are some of the most time consuming processes of reloading.
Figure 3: Ammo Load Worldwide Mark X – Pistol Ammunition Loader
Several users were interviewed on an online discussion forum related to reloading. The results of their comments and the previous research were taken into account when designing the customer survey and ultimately the product objectives. User Sevens’ comments on quality checks (5) were particularly valuable when comparing the design vision to commercially available products. Overall customer feedback seemed to be fairly agreeable as far as what features were more or less valuable to end users.
CUSTOMER FEEDBACK, FEATURES AND OBJECTIVES

SURVEY ANALYSIS

Customer surveys were distributed to online forums that are specific to the hobby of reloading ammunition. This presented a large audience to survey, with varying levels of skill and experience. Twenty-two surveys were completed within the designated time period. The survey presented the reader with ten features, and asked the customer to rank the importance of the features on a scale from one to five, with five being the most importance (see Appendix B for complete survey and results). The results were sorted and are displayed in Table 1 below.

<table>
<thead>
<tr>
<th>Survey Question</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>18</td>
<td>4.85</td>
</tr>
<tr>
<td>Process repeatability</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>18</td>
<td>4.85</td>
</tr>
<tr>
<td>Safety</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>18</td>
<td>4.77</td>
</tr>
<tr>
<td>Durability</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>18</td>
<td>4.77</td>
</tr>
<tr>
<td>Quality checks</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>13</td>
<td>4.59</td>
</tr>
<tr>
<td>Ease of operation</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>12</td>
<td>6</td>
<td>4.05</td>
</tr>
<tr>
<td>Price</td>
<td>0</td>
<td>4</td>
<td>8</td>
<td>5</td>
<td>5</td>
<td>3.50</td>
</tr>
<tr>
<td>Ease of installation</td>
<td>0</td>
<td>6</td>
<td>10</td>
<td>4</td>
<td>2</td>
<td>3.09</td>
</tr>
<tr>
<td>Low noise</td>
<td>4</td>
<td>2</td>
<td>7</td>
<td>0</td>
<td>1</td>
<td>2.27</td>
</tr>
<tr>
<td>Compact size</td>
<td>7</td>
<td>10</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>2.00</td>
</tr>
</tbody>
</table>

Using the results of the survey, it can be determined that reliability, repeatability of the process, safety and durability are the most desired features. Low noise and compact size are not nearly as important. From these results, concepts will be designed to address these features.

PRODUCT FEATURES AND OBJECTIVES

The product objectives are determined from the result of the survey and are then ranked according to customer importance. By ranking in order of importance, certain aspects of the design can be focused upon, while others are less significant. The following list shows the features in order of importance (relative percentage) while showing how it will be gauged that the objective is met.

1. Reliability (13%)
   a. Reliability and life of purchased components shown by the following spec sheets
      i. Motor spec sheet
ii. PLC spec sheet
   b. All designed components will be suitable for a five year life (# of cycles)

2. Process repeatability (13%)
   a. The design of the reciprocating mechanism will allow a consistent cycle
      i. Quality checks are related to this objective

3. Safety (12%)
   a. Moving mechanisms guarded
   b. Guarding installed over pinch points
   c. An explosion guard to protect the operator
   d. Emergency stop button

4. Durability (12%)
   a. Design factor consistent with expected loading conditions
   b. Corrosion resistant material selection

5. Quality checks (12%)
   a. Rounds will be inspected
      i. For primer installation
      ii. For powder charge ±5%

6. Ease of operation (10%)
   a. Any reaching tasks to be performed within reach of the operator in accordance
      with human factors
   b. All exterior functions/switches labeled for clarity

7. Cost (9%)
   a. Retail cost will be less than $2,000

8. Ease of installation (8%)
   a. Standard size fasteners
   b. No modifications needed to existing product
   c. Basic tools to install/setup kit

9. Low Noise (6%)
   a. Noise level consistent with human factors for safe operation (60dB)

10. Compact Size (5%)
    a. Unit won’t take up more than 1ft² space

Each objective was correlated to an engineering characteristic, shown in Table 2 below. A three number system was used to denote the strength of correlation between the characteristics and the feature, as can be seen in Appendix C. Similar to the objectives, these ranked characteristics will drive how the design is implemented.
<table>
<thead>
<tr>
<th>Engineering Characteristic</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>27%</td>
</tr>
<tr>
<td>Speed</td>
<td>23%</td>
</tr>
<tr>
<td>Standard fasteners</td>
<td>15%</td>
</tr>
<tr>
<td>Weight</td>
<td>9%</td>
</tr>
<tr>
<td>Size</td>
<td>8%</td>
</tr>
<tr>
<td>Installation time</td>
<td>7%</td>
</tr>
<tr>
<td>Manufacturability</td>
<td>6%</td>
</tr>
<tr>
<td>Installation time</td>
<td>5%</td>
</tr>
</tbody>
</table>

Table 2: Engineering Characteristics
CONCEPT GENERATION AND SELECTION

In order to automate the reloading press, the most substantial aspect will be how to drive the ram up and down while keeping cost and space used to a minimum. As such, most of the design generation and selection was focused around the drive system.

To accomplish the goal of this design project, many different drive systems were considered. In stock form, the operator of the reloading press moves a lever through a vertical motion to transmit the motion into the ram. The drive system for the kit needed to have as small a footprint as was possible, to keep wasted bench space to a minimum. Noise was less of a concern for users than safety features. The considered options for the drive system can be seen below in Table 3, with their pros and cons.

<table>
<thead>
<tr>
<th>Drive system</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor</td>
<td>- Precise control</td>
<td>- Difficult to transmit linear motion</td>
</tr>
<tr>
<td></td>
<td>- Compact</td>
<td>- Requires a separate controller</td>
</tr>
<tr>
<td></td>
<td>- Inexpensive</td>
<td>- Requires speed reduction</td>
</tr>
<tr>
<td>Pneumatic Cylinder</td>
<td>- Compact</td>
<td>- Needs air supply</td>
</tr>
<tr>
<td></td>
<td>- Good control</td>
<td>- Leaks can affect system</td>
</tr>
<tr>
<td></td>
<td>- Inexpensive</td>
<td></td>
</tr>
<tr>
<td>Hydraulic Cylinder</td>
<td>- Good control</td>
<td>- Expensive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Needs oil</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Large system</td>
</tr>
<tr>
<td>Electric Cylinder</td>
<td>- Compact</td>
<td>- Very expensive</td>
</tr>
<tr>
<td></td>
<td>- Precise control</td>
<td>- Needs a separate</td>
</tr>
</tbody>
</table>

Table 3: Design Selection

Due to its low maintenance, small footprint, and ease of installation, a pneumatic cylinder was chosen to drive this kit. The cylinder will be easily controlled with a two-position valve connected to a programmable logic controller (PLC), which will also be connected to the sensors. A 3D model of the finalized design can be seen below in Figure 5, showing the cylinder to the right, driving a linkage arm, (partially behind a transparent machine support) and a knuckle which replaces the standard manual handle.
DESIGN ANALYSIS

LOADING CONDITIONS

To ensure that the kit would be safe for the end user, loading conditions and mechanical safety needed to be addressed. The parts that would see the most force were the linkage arm and the knuckle connecting the arm to the press, shown below in Figure 6. Complete detail drawings for the manufactured parts are presented in Appendix G.
As the cylinder is rated for a maximum force of 100 lbs, both the arm and the knuckle were analyzed according to the maximum possible force acting on the system. Force was applied in the direction shown below in Figure 7. 100 lbs force was applied to both the Arm and the Knuckle. Although the cylinder is capable of providing 100 lbs of force, actual force exerted by the cylinder was 32.5 lbs. During research, the amount of force to cycle the action was tested, with a result of 28-30 lbs of force needed to cycle the ram. Air pressure was regulated to 40 psi in order to generate a slightly higher force, as shown below:

\[ F = \frac{P}{A} \]

\[ \frac{40\text{psi}}{1.23\text{in}^2} = 32.5\text{lbs} \]

Shear force exerted on the pin connecting the arm and knuckle was calculated, while the pin supplied with the cylinder was specified to at least the maximum force exerted. The connecting pin has a diameter of 0.18 inches, resulting in a stress of 306 psi; a safety factor of nine compared to the rated shear stress of grade 5 #8 screws (2780 psi).

\[ \sigma = \frac{F}{d(2t_1 + t_2)}, t_1 = 0.17\text{in}, t_2 = 0.25\text{in} \]

\[ \sigma = \frac{32.5\text{lbs}}{0.18\text{in}(2(0.17\text{in}) + 0.25\text{in})} = 306\text{psi} \]
The results of the analysis on the linkage arm can be seen in Figure 8 below. Force was applied to the arm at the larger mounting hole, while the smaller hole was considered the fixed point for analysis. Von Mises stress analysis shows that the arm will be subjected to a maximum of 30.9ksi. For 1045 steel, the yield stress is 76.9 ksi, which would give a safety factor of 2.5. However, the actual force is 32.5 lbs, which increases the safety factor to 7.5, acceptable for dynamic loading according to supplied references (6).
Figure 8: Von Mises Stress on Arm

Also critical to the operation of the system is the knuckle. The knuckle will be the secondary pivot point and direct connection to the existing reloading press. Again, Von Mises stress analysis was performed on the knuckle. Fixed and applied force can be seen below in Figure 9. Maximum stress (at 100 lbs force) was found to be 25.5 ksi, providing a safety factor of 3 for the yield stress of 1045 steel. As before, the actual force applied increases the safety factor to 9, which is acceptable for dynamic loading of the part.
PLC PROGRAMMING

To control the actuation of the pneumatic valve a PLC was chosen as it would be easily configurable and allow the interconnection of the relays for the sensors. Several different attempts were made at programming the PLC. Rather than several different timers and contacts, a drum timer was chosen as it was the most configurable for the application. Timing changes were easily made while testing the system. The PLC provided more than the required number of inputs and outputs for this project.

The wiring schematic for the electronics can be found in Appendix G.
Figure 10: PLC Program

**PURCHASED COMPONENTS**

Electrical and pneumatic components were purchased from AutomationDirect in order to automate the reloading press. A list of components purchased can be seen below in Table 4.

<table>
<thead>
<tr>
<th>Line</th>
<th>Part #</th>
<th>Manufacturer</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A20040DN</td>
<td>Nitra</td>
<td>CYLINDER 1-1/4in BORE 4in STROKE DBL ACTING</td>
</tr>
<tr>
<td>2</td>
<td>AMB-7</td>
<td>Nitra</td>
<td>MOUNTING BRACKET, 1-1/4 CYLINDERS</td>
</tr>
<tr>
<td>3</td>
<td>ARC-716-20</td>
<td>Nitra</td>
<td>ROD CLEVIS 7/16-20</td>
</tr>
<tr>
<td>4</td>
<td>C0-00D1-D</td>
<td>Koyo</td>
<td>MICRO PLC, 8 DC IN / 6 SINK DC OUT</td>
</tr>
<tr>
<td>5</td>
<td>AR-323</td>
<td>Nitra</td>
<td>REGULATOR, 1/4 IN NPT, 130 PSI, GAUGE, BRACKET</td>
</tr>
<tr>
<td>6</td>
<td>AVS-5211-24D</td>
<td>Nitra</td>
<td>VALVE, 1/8 NPT, 24VDC, 5-PORT, 2-POS</td>
</tr>
</tbody>
</table>

Table 4: Purchased Components

All purchased components are validated with their specification sheets as per the product objectives and needs for the project. For example, the number of inputs and outputs of the PLC was checked against required number per the electrical diagram. The data sheets and all relevant purchased product information are provided in Appendix H.
FABRICATION AND ASSEMBLY

To manufacture parts for the Automated Reloading Press Kit, typical machine shop tools were used. This included:

- Mill
- Lathe
- Press brake
- Assorted hand tools
- Acetylene torch

In the following figures (Figure 11 – Figure 15), some steps of the manufacturing process are shown. Final assembly of the kit can be accomplished with simple hand tools.

Figure 11: Milling and Drilling Holes in Arm
Figure 12: Heating and Bending Knuckle
Figure 13: Final Fitting of Arm

Figure 14: Components Installed
Figure 15: Testing Wiring
**INSTALLATION PROCEDURE**

To install the Automated Reloading Press Kit, the following tools will be needed:
- Standard hex keys
- Adjustable wrench
- Screwdriver

1) To prepare the press for kit installation, remove the existing sensors using the hex keys. Screw locations are shown below in Figure 16.

![Figure 16: Screw Locations](image)

2) Next, locate the hole on the existing handle. Insert a screwdriver through the hole and just an adjustable wrench to remove the nut on the bottom. Then, install the new knuckle as shown below in Figure 17 using the same technique.
3) Once the new knuckle is in place, the right side support of the reloading press can be removed, and the support for the kit can be installed. There are two bolts, shown in Figure 18, that secure the support to the reloading press.
4) Finally, the arm and knuckle can be connected using the supplied screw as shown in Figure 19. Manually cycle the reloading press to ensure there is no binding. Assembly is now complete.
TESTING AND PROOF OF DESIGN

To ensure that the Automated Reloading Press Kit was able to cycle the press correctly, it was first run with no ammunition components loaded. This allowed the cycle times to be tweaked so that operation was smooth and consistent. After several hours, it was deemed ready to produce ammunition. The test plan called for a run of 500 rounds to be produced using the automated system, and then verified.

Of those 500 rounds, three rounds failed the powder level check during assembly, which is comparable to manually operating the press. Every tenth round was set aside for further inspection. The rounds were inspected for overall length, bullet seating, primer insertion and powder charge. An example of a deconstructed round can be seen in below.

![Deconstructed Round](image)

The testing performed with the automated ammunition reloading press kit shows that it is able to produce consistent ammunition. It is safe to use and control with the interconnected sensors monitoring the condition of the press. Also, it occupies less than an additional square foot of space, adding only 10 inches to depth and 4 inches across the rear of the machine. Pictures of the completed automated ammunition reloading press kit are shown below in Figure 21 – Figure 24. No permanent modifications to the Dillon 650XL are needed. The kit can be installed by simply removing the original handle.
Figure 21: Front View Showing Ram and Linkage in Down Position
Figure 22: Rear View Showing Electrical and Pneumatic Components
Figure 23: Right Side View of Completed Kit
Figure 24: Left Side View of Completed Kit
SCHEDULE AND BUDGET

The schedule for this project begins the week of October 14\textsuperscript{th} 2012, and ends the 3\textsuperscript{rd} week of April, 2013 with the final report and presentation. The outline of the schedule can be seen below in Table 5. The projected was completed for demonstration on April 4\textsuperscript{th} at the 2013 MET Tech Expo.

<table>
<thead>
<tr>
<th>Research</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Existing products, interviews, data gathering</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Concept sketches, 3D modeling, calculations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assembly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ordering, fabrication, testing, modifications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5: Project Schedule

The final budget of the automated ammunition reloading press kit is outlined below in Table 6. The final value of the budget does not include the air compressor or labor to manufacture and assemble the final product. The forecasted budget was in excess of $750 as can be found in Appendix F.

Materials, Components

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Cylinder + Mounting Acc.</td>
<td>$41.25</td>
</tr>
<tr>
<td>Valves, Tubes, Etc.</td>
<td>$11.82</td>
</tr>
<tr>
<td>PLC</td>
<td>$69.00</td>
</tr>
<tr>
<td>Wires, Relay, Electrical supplies</td>
<td>$15.33</td>
</tr>
<tr>
<td>Solenoid Valve</td>
<td>$20.00</td>
</tr>
<tr>
<td>Hardware</td>
<td>$2.51</td>
</tr>
<tr>
<td>Metal</td>
<td>$30.00</td>
</tr>
<tr>
<td>Compressor (if needed)</td>
<td>$50.00</td>
</tr>
<tr>
<td></td>
<td>$189.91</td>
</tr>
</tbody>
</table>

Table 6: Project Budget
CONCLUSION

As shooting once again gains popularity with the American public, so will the number of competitors and competitions. In a time where ammunition costs are also constantly rising due to political pressure and materials prices, more shooters will adopt the secondary hobby of reloading ammunition. With reloading comes reduced cost per round and increased customization of performance. However, reloading is a monotonous process and many people become tired during a several-hour long period. This Automated ammunition reloading press kit will allow those persons to focus their attention to secondary tasks with minimal additional monetary investment.
APPENDIX A – RESEARCH

Online discussion forum reply to questions posted by me on www.ohioccwforums.org. These replies are from user Sevens. Some great discussion was had that will help clarify features for the device.

When reloading, what are the typical quality control checks that you perform?
There's likely more than would be productive to list here, but I do:
--multiple and cross checks on the suitability of my powder choice and charge weight
--multiple checks on the state of my brass
--many redundant checks on the powder charge that I'm dropping
--COAL checks on 3% to 5% of my loaded rounds
--when loading anything to be fired in a semi-auto handgun, I do "push-tests" in to the edge of my bench top to ensure that I've got solid case-mouth tension and bullet pull

A big, maybe the biggest quality control check that I have in place is my log, which records everything I have EVER built at the bench. This keeps me from repeating poor loads or making the same mistake more than once.

Any issues you've had with some of the equipment that you've used?
Most of the tools I use work best when used in a very easy repeatable manner. Do it the same each time and you get very consistent results. I've upgraded many of my tools over time, but the items they replaced certainly weren't bad in a "glaring" manner. Because it might be relevant, I'll mention that I can't imagine running my bench without also using my ultra-cheap items that seem to work better than anything I could buy for the same purpose. Those items include 3"x3" post-it notes, stacks of cool-whip containers and 50-rd ammo trays from boxes of factory ammo.

What is your average load rate? (rough estimates are fine)
I load in two stages. I use a progressive press in a semi-progressive manner -- it sizes, deprimes, reprimes and flares my case mouths. I stockpile prepped brass and it waits in a container for whenever I feel like I wish to make ammo in that chambering. Including the time to fill the primer tray and collect the prepped brass, I do this at a rate that slightly exceeds 1,000 rounds per hour, and that's working at a typical and non-rushed pace. If I attempt to rush, that production rate drops.

Actually loading the rounds likely comes out somewhere around 250 rounds per hour, I would guess. That's metering in to each case with a Lyman 55, placing a bullet on top of each, and running each piece through my single stage press.

Have you used or observed an automated reloading system (commercial or otherwise)? Any comments on it?
If you have not used an automated system, do you have any opinions of them currently?
Automated, as in, step back and watch without actually taking part in the process? I have not seen these in person, only in video clips.
My comment would be all of these:
--would cost too much money and take too much tweaking to benefit a hobby handloader such as myself, even considering the somewhat heavy volume of ammo that I produce
--more to the point is that I need more than 25k rounds a year, but I do -NOT- need that in one chambering... I need that across 16. That obviously complicates any manner of an automated system and again, wouldn't be something of interest to me.
--I would cringe at the amount of money I'd spend on bullets, primers and powder to keep such a machine running. I can't even fathom the idea for any use less than commercial.
Appendix A

Online discussion forum reply to questions posted by me on www.ohioccwforums.org. These replies are from user EChryst. Some more input from another user, which was not quite as detailed as I had hoped. The discussion will remain open on the website, so there will hopefully be more information coming in.

Any issues you’ve had with some of the equipment that you’ve used?
When I reload the first for that session, I measure everything to make sure my "settings" haven’t changed. Then I randomly check powder weight and OAL throughout the session.

What is your average load rate? (rough estimates are fine)
Using a turret press, I average about 100 rounds an hour.

Have you used or observed an automated reloading system (commercial or otherwise)? Any comments on it?
I’ve only seen it on TV/Youtube.

If you have not used an automated system, do you have any opinions of them currently?
Sure would be nice!

Ponsness/Warren AUTO-DRIVE

The AUTO-DRIVE is easily operated by pressing down on the foot pedal. The full pivoting system allows the arm to work in one continuous motion. If you need to reverse the system, simply flip the toggle switch to reverse and press the foot pedal.

- Relatively compact system
- Heavy!
- Price is perhaps on the high side for what it offers - $850
- Basic controls
- No monitoring features

Most similar to my vision

http://www.reloaders.com/index.php?main_page=product_info&cPath=1&products_id=71&zenid=f6298a3965029e0c3b9ce8480a3e85f9
Ammo Load Worldwide Mark X – Pistol ammunition loader

The Ammo Load is designed with the operator in mind. Particular attention to safety, convenience, and efficiency is reflected throughout.

The Ammo Load machine has 9 stations: Case Check, Size & Deprime, Primer and Primer Disk Check, Belling, Powder Feed, Powder Check, Bullet Seating, Bullet Crimp, Final Sizing. There are checks of shut-off switches for case feed, primer feed, bullet feed and powder load check. The Mark X comes complete with shell case feeder, primer feed tube, powder flask and bullet feed tube.

http://ammoload.com/mark_x_pistol.htm

- True commercial machine
- High cost (~$20,000+)
- Linear, instead of rotary loading stations
- Has checks and safeties
- Turn-key system (not my target market)
- Good features to keep in mind
Camdex 2100 Series Pistol Loading Machine

2100 Series Standard Features

Our state of the art control system monitors 10 functions simultaneously to ensure that the finished ammunition will be of the highest quality. An automatic 14 inch case feeder and a 14 inch variable speed bullet feeder are standard equipment. The automatic primer feed system is assisted and monitored by an Air/Vacuum system.

Monitoring Features

- CASE LEVEL - Low case level in feed tube automatically shuts off machine.
- CASE PROBE - Checks for case feeding, foreign particles and live rounds.
- PRIMER POCKET PROBE - Mechanically checks the primer pocket for ringers.
- PRIMER SLIDE - Shuts off the machine should a primer jam occur due to dirt or high anvils.
- PRIMER FEED - Shuts off machine should it run out of primers.
- PRIMER LEVEL – Fiber Optics automatically maintain approximately 60 primers in feed system
- POWDER PROBE - Checks for both high and low powder charges.
- BULLET FAULT - If the machine fails to feed or runs out of bullets, the machine shuts off.
- VACUUM SYSTEM - Checks vacuum pressure to assure primer feeding.
- CURRENT SENSOR - Any increase in preset amperage shuts off the machine.


- Another true commercial machine
- MANY monitoring features (necessary for quality)
- Again, high cost
- Linear stages

Appendix A4
Dillon xl650 full automatic by Maurizio Boccia

This video posted on Youtube.com is one of many that demonstrate how people have done an automation conversion to their machine. It has been difficult to find a website or blog with a detailed process that has been followed.

http://www.youtube.com/watch?v=mYpyUM5bqH0

- Hard to tell exactly how the process has been implemented
- What functions are monitored is unclear
- Attempts to contact have so far gone unanswered in this case
APPENDIX B – CUSTOMER SURVEY RESULTS

AUTOMATED RELOADING PRESS KIT
CUSTOMER SURVEY

The goal of this project is to design a kit that will automate a reloading press, while including features that are desirable to the target market. This kit will allow the user to take a more supervisory role in the process of reloading ammunition.

How important is each feature to you for the design of an automated reloading press?

Please circle the appropriate answer.  
1 = low importance  
5 = high importance  

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<th>Feature</th>
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<th>3</th>
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How much would you be willing to pay for a prototype of this kit?

$250-$500 (6)  $500-$750 (11)  $750-$1000 (2)  $1000-$1250 (2)  $1250-$1500 (1)

Thank you for your time.
## APPENDIX C – QUALITY FUNCTION DEPLOYMENT

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<th>Automated Reloading Press Kit</th>
<th>Material</th>
<th>Standard fasteners</th>
<th>Size</th>
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<th>Installation time</th>
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<td>0.05</td>
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APPENDIX D – PRODUCT OBJECTIVES

The following is a list of product objectives and how they will be measured to ensure that the goal of the project will be met. Objectives are ranked according to importance from the customer survey results.

11. Reliability       (13%)
   a. Reliability and life of purchased components shown by the following spec sheets
      i. Pneumatic cylinder and accessories spec sheets
      ii. PLC spec sheet
   b. All designed components will be suitable for a five year life (# of cycles)

12. Process repeatability  (13%)
   a. The design of the reciprocating mechanism will allow a consistent cycle
      i. Quality checks are related to this objective

13. Safety           (12%)
   a. Moving mechanisms guarded
   b. Guarding installed over pinch points
   c. An explosion guard to protect the operator
   d. Emergency stop button

14. Durability        (12%)
   a. Design factor consistent with expected loading conditions
   b. Corrosion resistant material selection

15. Quality checks    (12%)
   a. Rounds will be inspected
      i. For primer installation
      ii. For powder charge ±5%

16. Ease of operation (10%)
   a. Any reaching tasks to be performed within reach of the operator in accordance with human factors
   b. All exterior functions/switches labeled for clarity

17. Cost             (9%)
   a. Retail cost will be less than $2,000

18. Ease of installation (8%)
   a. Standard size fasteners
   b. No modifications needed to existing product
   c. Basic tools to install/setup kit

19. Low Noise        (6%)
   a. Noise level consistent with human factors for safe operation (60dB)

20. Compact Size      (5%)
   a. Unit won’t take up more than $1ft^2$ space
Yellow denotes planned dates.
Blue indicates completion.
APPENDIX F – BUDGET

Forecasted budget:

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<tr>
<th>Materials, Components</th>
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<td>Motor</td>
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<tr>
<td>PLC</td>
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<tr>
<td>Sensors</td>
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<tr>
<td>LCD Display</td>
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<tr>
<td>Manufactured Parts (material)</td>
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<tr>
<td>Hardware</td>
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<td>Miscellaneous</td>
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Actual budget:

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<td>Valves, Tubes, Etc.</td>
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<td>PLC</td>
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<tr>
<td>Wires, Relay, Electrical supplies</td>
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<td>Hardware</td>
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APPENDIX G – DRAWINGS

Mechanical drawings for manufactured components.
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<td>5</td>
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</table>
Wiring diagram for electronics.
APPENDIX H – PURCHASED COMPONENTS

Basic CPU Module Specifications

C0-00DD1-D

8 DC Input/6 Sinking DC Output Micro PLC

Equivalent Input Circuit

Internal Module Circuitry

Equivalent Output Circuit

Internal Module Circuitry

C0-00DD1-D Built-in I/O Specifications - Inputs

Inputs per Module: 8
Operating Voltage Range: 24 VDC
Input Voltage Range: 24 VDC
Input Current:
- X1: 0.6 mA @ 24 VDC
- X2: 0.5 mA @ 24 VDC
- X3: 0.5 mA @ 24 VDC
- X4: 0.5 mA @ 24 VDC
- X5: 0.5 mA @ 24 VDC
- X6: 0.5 mA @ 24 VDC
- X7: 0.5 mA @ 24 VDC
- X8: 0.5 mA @ 24 VDC

Maximum Input Current:
- X1: 47 mA
- X2: 47 mA
- X3: 47 mA
- X4: 47 mA
- X5: 47 mA
- X6: 47 mA
- X7: 47 mA
- X8: 47 mA

ON Voltage Level:
- X1: 15 mA
- X2: 15 mA
- X3: 15 mA
- X4: 15 mA
- X5: 15 mA
- X6: 15 mA
- X7: 15 mA
- X8: 15 mA

OFF Voltage Level:
- X1: 0.5 mA
- X2: 0.5 mA
- X3: 0.5 mA
- X4: 0.5 mA
- X5: 0.5 mA
- X6: 0.5 mA
- X7: 0.5 mA
- X8: 0.5 mA

Minimum ON Current:
- X1: 0.5 mA
- X2: 0.5 mA
- X3: 0.5 mA
- X4: 0.5 mA
- X5: 0.5 mA
- X6: 0.5 mA
- X7: 0.5 mA
- X8: 0.5 mA

Status Indicators:
- Logic ON: 0.01 A (with green LED)
- Common: 2 A (power common)

C0-00DD1-DBuilt-in I/O Specifications - Outputs

Outputs per Module: 8
Operating Voltage Range: 24 VDC
Input Voltage Range: 24 VDC
Maximum Output Current:
- X1: 0.4 A (per output, 0.4 A common)
- X2: 0.4 A (per output, 0.4 A common)
- X3: 0.4 A (per output, 0.4 A common)
- X4: 0.4 A (per output, 0.4 A common)
- X5: 0.4 A (per output, 0.4 A common)

Minimum Output Current:
- X1: 0.2 mA
- X2: 0.2 mA
- X3: 0.2 mA
- X4: 0.2 mA
- X5: 0.2 mA

Maximum Leakage Current:
- X1: 0.1 A
- X2: 0.1 A
- X3: 0.1 A
- X4: 0.1 A
- X5: 0.1 A

External DC Power Required:
- 24 VDC Maximum 8.5 W

ZipLink Pre-Wired PLC Connection Cables and Modules

ZL-RT28 20-pin feed-through connector module
ZL-C3-4BL20 (5.0 m length)
ZL-C3-5BL20-1 (1.0 m length)
ZL-C3-6BL20-2 (2.0 m length)

General Specifications

Current Consumption at 24 VDC: 110 mA
Terminal Block Replacement Part No.: CB-108
Weight: 5.0 oz (140 g)
**Pneumatic Directional Control Solenoid Valves — AVS-5 Series**

NITRA™ pneumatic AVS-5 series directional control solenoid valves are body ported 5-port (4-way) spool valves. Available port sizes are 1/8", 1/4" or 3/8" NPT with flow coefficients [Cv] from 0.67 to 0.89. Models are available with single solenoid, spring return or double solenoid 2-position operation. In addition, double solenoid models are available with 3-position, center closed or center exhaust operation. Solenoid coils are available in either 24 VDC or 120 VAC control voltages. The AVS-5 series can be used in individual valve applications or multiple valves can be field assembled on AV-5 series manifold assemblies simplifying piping connections. AVS-5 series manifolds are available in 2, 4, 6 or 8 stations. The DIN style wiring connector includes LED indication of the solenoid coil status.

**Features**

- Body ported, 5-port (4-way) spool valves
- 1/8", 1/4" or 3/8" NPT ports
- 2-position, single solenoid, normally closed, spring return, 3-position, double solenoid, energized open/energize closed, 3-position, double solenoid, center closed or center exhaust
- AM/FMAC or DC/AC solenoid coils
- DIN style wiring connector with LED indication
- Single valve or multiple manifold mounted valve applications
- In-line manifolds
- 2-year warranty

### AVS-5 (5-port, 2-position) Series Specifications

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<th>AVS-5211-5A1</th>
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</table>

**Diagram “A”**

Diagram “B”

2-Pass, Spring Return

2-Pass, Double Solenoid

- **AVS-5211-5A0**
- **AVS-5211-5A1**
- **AVS-5221-5A0**
- **AVS-5221-5A1**
- **AVS-5221-5A2**

### AVS-5 (5-port, 2-position) Series Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>AVS-5211-5A0</th>
<th>AVS-5211-5A1</th>
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<td>Weight (lbs)</td>
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<tr>
<td>Valve Size</td>
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**Diagram “A”**

Diagram “B”

2-Pass, Spring Return

2-Pass, Double Solenoid

- **AVS-5211-5A0**
- **AVS-5211-5A1**
- **AVS-5221-5A0**
- **AVS-5221-5A1**
- **AVS-5221-5A2**

### AVS-5 (5-port, 2-position) Series Specifications

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<thead>
<tr>
<th>Model</th>
<th>AVS-5211-5A0</th>
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<th>AVS-5221-5A0</th>
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### A-Series Pneumatic Cylinders

1-1/4 inch Bore

1-1/4 in. Bore, Double-acting, Front Nose Mount

NITRA pneumatic stainless steel round body, interchangeable, non-repairable cylinder, 1-1/4 inch bore, 1/8 NPT port, double acting, front nose mount.

#### Cylinder, 1-1/4 in. bore, double acting, front nose mount

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<th>Part Number</th>
<th>Stroke Length (in.)</th>
<th>&quot;A&quot; (in)</th>
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</tbody>
</table>

#### Specifications

- 30.53 cylinder body
- 1.2 oz. in. jet bore
- High strength aluminum end caps: Pre-lubricated for maintenance-free life
- High strength 303 stainless rod: Pressure rating 300 psi
- Low friction bushing: Torque to engage 300°F to 200°F (30 to 90°C)
- Extended force 100 psi = 120 lb; retract load 100 psi = 100 lb.

<table>
<thead>
<tr>
<th>Mount Style</th>
<th>Bracket</th>
<th>Nut</th>
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<tr>
<td>Front Nose Mount</td>
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<td>ANS4-17&quot;</td>
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*Note: Not included with cylinder

Cylinder acts as N8C-F14-20

See end of 1-1/4" section for accessories

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### Diagram

Dimensions shown in inches

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Appendix H3