Figure 13. A completed hand truck project with axle and wheels installed ready for final evaluation and many years of use by its owner.

PROJECT IMPACTS

During the mini-grant project time period, eight students were enrolled in the AGTM 100 spring course. For the final project, each student constructed a hand truck using schedule 40 steel pipe, hot rolled flat steel plate, round stock, and flat bar. We did not use any aerosol spray primer on any projects. Powder coating application errors experienced by the first two students included not completely removing all scale and rust from the surface of the pipe frame or not spraying closely enough to the surface of the project which resulted in incomplete application of powder to the frame or visible streaks of rust on the surface of the pipe. Prior to the third student applying powder coating, the remaining projects were thoroughly prepped using a combination of wire wheels, abrasive cloth, and paint thinner. Air pressure on the powder coating applicator was adjusted down. Other issues included “rubbing” the powder coated project against a solid surface before it is cured. This action removes the powder. One student placed the curing lamp too close to the hand truck project. This resulted in a “burn” of the powder coating finish. This can be corrected by following the procedure of properly suspending the project the correct distance from the support piece and allowing the hand truck to rotate freely in the curing box.

PROJECT OUTCOMES

It is as important to note what improvements can be made in our process to successfully implement a large-project powder coating curing project. In the following section, we have listed challenges we
observed and a description of what we intend to implement prior to the beginning of the fall 2013 semester and the next AGTM 100 class.

FUTURE PROJECT IMPROVEMENTS

- Expand the size of the powder coating booth. The existing dimensions (30 inches wide x 30 inches deep x 60 inches tall) does not allow enough room for the student to raise the hand truck to coat the underneath surface of the truck plate without physically holding a portion of the frame outside of the booth. Also, any wind in the lab causes the plastic sheeting to move and make contact with the frame causing powder to rub off. Our goal will be to increase the width and depth to 45 inches, and the height another 17 inches. This will give the students the ability to move the frame back by lifting and moving the support hanger towards the back of the booth while lifting the frame up to access the bottom surface areas.

- Build a better powder capture method. Using a large open-topped plastic container (such as storage container, or half- of a plastic trash barrel) and placed in the powder coating booth and under the project will help to contain some of the powder paint that is lost in the creases and folds of the plastic sheeting.

- Premeasuring the wire used to hang and suspend the hand truck from the swivel hook. The purpose will be to prevent hand truck frames from making contact with the curing box while the hand truck is being loaded, which results in rubbing and loss of powder. Some students arbitrarily cut their wire and attached it to their frames. This resulted in incomplete coating and curing (see photo of example below)

- Add a layer of insulation material to the outside bottom surface of the curing box. While there is minimal heat loss recorded from the bottom surface, capturing and retaining as much heat as possible will decrease the amount of time it takes for the interior temperature to reach the optimum 400 degree temperature, and the curing time.

- Curing increasing the area in the curing box. We can acquire another couple of inches of vertical space by carefully removing part of the angle iron frame from the top interior of the curing box using a manual plasma arc cutting unit.

- Early in our design process, we envisioned the use of a slow-turning motor installed on the top of the curing box for the purpose of rotating the projects while suspended in the box to attempt to equally apply the heat to the majority of the surface area of the project. Unfortunately, we did not have the time or the ability to acquire and mount a motor at this time. We will continue in our efforts to secure a motor and complete this process for future curing activities.
POWDERCOATING: ELIMINATING AEROSOL SPRAY PAINTS IN AGTM LABORATORY

KEY PROJECT PERSONNEL

Project Director
Edward A. Franklin, Associate Professor
Department of Agriculture Education
520-940-3718/eafrank@ag.arizona.edu
Role: Project management, secure project funding; order materials, supplies, equipment; communicate with project members, implement powder coating demonstrations to AGTM 100 students; write and submit final report.

Project Co-Director
Charles Defer
Agriculture & Biosystems Engineering
defer@cals.arizona.edu
Role: Design the booth for curing the powder coated hand truck projects.

Business Manager
Ms. Michelle Hintz
Department of Agricultural Education
520-621-1523/mhintz@ag.arizona.edu
Role: Business manager, track and handle account payables and provide statements.

PROJECT DESCRIPTION (300 WORDS)

UA students enrolled in AGTM 100 and AED 460/560 complete projects fabricated from metal using automated plasma arc cutting and gas metal arc welding processes. Fabricated metal projects include Wilbur wildcat cutouts and cold-metal battery cable pullers projects. The capstone project for AGTM 100 is a welded hand truck featuring a Wilbur Wildcat. Traditional method of finishing the project is application of aerosol spray paint using both primer and enamel paints. Current cost of finish is $7.00 per student project for both spray primer and enamel (for the hand truck project). For a class of 24 students, the total cost for paint is $168.00 per semester. In 2010 we introduced powder coating as a method to reduce the use and expense of aerosol paints. An electric oven (typical of type found in a kitchen) was obtained and has been used to successfully cure small-sized projects, such as the battery cable pullers and Wildcat cutouts less than 15 inches in diameter.

Currently, the Department operates two powder coating application systems. A 16-ounce bottle of powder coating averages $5.00 (Harbor Freight) and is capable of coating up to 24 battery cable projects in a single application. Traditional spray paint involves multiple cans of primer and enamel spray paint and drop cloth material to prevent overspray.

Our limiting factor is our ability to powder coat and cure our larger projects. We propose to acquire an 8,000 watt curing lamp and fabricate portable spray booths framed by one and one-half inch schedule 40 PVC pipe, couplings, and plastic sheeting. This will permit our students to “capture” and recycle the
overspray powder. A curing booth will be constructed using a sheet of aluminum provided by the ABE Department. The reflective ability of aluminum sheeting will serve to concentrate the heat from the curing lamp.

**BENEFITS**

- Project will provide UA AGTM and AED undergraduate and graduate students with an opportunity to develop experience with powder coating applications on larger projects.
- Project will help reduce the use of aerosol paint cans to apply primer and enamel paint to metal projects constructed in the AGTM Teaching Laboratory.
- Project will help reduce waste by eliminating use of aerosol paint cans for finishing our student-constructed metal projects.
- Project will save money by eliminating the need to purchase up to 48 cans of primer and paint each semester for our AGTM 100 and AED 460/560 courses.
- The success of the project will be demonstrated to Arizona high school agricultural education instructors who teach metal project fabrication and utilize aerosol paints to complete student projects.

**PROJECT TIMELINE  PROJECT STARTING AND COMPLETION DATES (COMPLETE WITHIN 6 MONTHS)**

<table>
<thead>
<tr>
<th>PROJECT TASKS</th>
<th>MONTHS</th>
<th>RESPONSIBLE PARTY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete and submit Mini Grant Proposal.</td>
<td>•</td>
<td>Franklin</td>
</tr>
<tr>
<td>Proposal reviewed by UA Green Fund Committee.</td>
<td></td>
<td>Franklin</td>
</tr>
<tr>
<td>Acquire steel, castors, PVC pipe, fittings, plastic sheeting.</td>
<td>•</td>
<td>Franklin</td>
</tr>
<tr>
<td>Construct two (2) portable PVC powder coating booths with AGTM students in AGTM 100 spring course.</td>
<td>•</td>
<td>AGTM Students</td>
</tr>
<tr>
<td>Construct steel frame hangers for suspending frames.</td>
<td>•</td>
<td>Students</td>
</tr>
<tr>
<td>Order and acquire curing lamp and stand from Eastwood.</td>
<td>•</td>
<td>Franklin</td>
</tr>
<tr>
<td>Construct and test curing booth, record curing temps.</td>
<td>•</td>
<td>Defer</td>
</tr>
<tr>
<td>Powder coat and cure AGTM 100 hand cart projects.</td>
<td>• •</td>
<td>Students</td>
</tr>
<tr>
<td>Prepare and submit report of results of project.</td>
<td>•</td>
<td>Franklin</td>
</tr>
</tbody>
</table>

**METRICS**

Through this project we anticipate:

- **Reducing** the amount of cans of aerosol spray primer and enamel paints needed to apply a painted finish to our large Wilbur hand truck projects by **85-90%**. In fall 2012, 25 AGTM 100 students used approximately 25 aerosol spray cans of grey primer and 25 aerosol spray cans of red enamel to finish their hand truck projects at an approximate cost of $3.00 per can (an approximate cost of $6.00 per hand truck project).
- **Exposing 100% of our AGTM 100 spring students to principles and practices** of powder coating applications in agriculture.
• Engaging 100% of our AGTM 100 spring 2013 students in the use of powder coating applications to finish their three metal projects fabricated over the course of the semester.

• Recycling approximately 80% of the overspray paint powder captured in the plastic spray booths during application.

• The ability to powder coat approximately three hand truck frames with one 16-ounce bottle of powder coat paint ($5.00) will reduce the finishing cost to $1.67 per project (28% of the cost of traditional spray paint finish).

Figure 1. A Wilbur cutout is prepped for powder coating then cured.

Figure 2. AGTM 100 student applies grey primer coat to hand truck frame.

Figure 3. A completed Wilbur hand truck finished with traditional aerosol spray primer and enamel paint; the capstone project of the AGTM 100 course.
<table>
<thead>
<tr>
<th>Expense Category</th>
<th>Amount Requested</th>
<th>Account #</th>
<th>Department</th>
<th>Project Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mini Grant Amount Requested</td>
<td></td>
<td>2465300</td>
<td>Agriculture Education</td>
<td>GMG5</td>
</tr>
<tr>
<td>Mini Grant Proposal</td>
<td></td>
<td></td>
<td>Green Fund Project Financials</td>
<td></td>
</tr>
<tr>
<td>Final Report</td>
<td></td>
<td></td>
<td>THE UNIVERSITY OF ARIZONA</td>
<td></td>
</tr>
</tbody>
</table>