Pop-Up Car Cover

A Baccalaureate thesis submitted to the
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Bachelor of Science

in Mechanical Engineering Technology

by

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Thesis Advisor: Professor Amir Salehpour
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I would like to thank Professor Salehpour for all his help and support throughout the senior design process.

I would also like to thank my father, Stephen Cassada, for his help with the fabrication of the Pop-Up Car Cover.
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ABSTRACT

The Pop-Up Car Cover is a cover that can quickly and easily cover a car to keep it clean, safe from weather, and prevent UV damage to the paint. There are many people who could use this product. With the sloped design, durable frame and weather resistant material, users will never again have to feel useless when it comes keeping their car safe.

This report begins with an introduction of the problem and research of existing products. Based on research and interviews, customer features and product objectives are set. The design is constructed in consideration of the product objectives. Once the design is selected from the alternatives, the fabrication and assembly of the working prototype begins. Upon completion of the prototype, multiple tests are conducted to prove that the design is functional and meets the product objectives. The conclusion follows everything to discuss the success of the design and suggest any changes for future designs.
INTRODUCTION AND RESEARCH

PROBLEM DEFINITION AND BACKGROUND

There are many people who do not have any way to cover their vehicle and keep it safe from inclement weather. Imagine not having to scrape ice off your car or worry about hail damage. There are not many options for people without a garage or carport and there is certainly nothing that can cover and uncover your vehicle quickly with a single user. A cover with a sloped design and durable frame that could cover the car easily, all while keeping the car safe from inclement weather, is the answer to this problem.

INTERVIEWS

Cheryl Fenner is the former Business Development Center Manager at Jack Maxton Chevrolet in Columbus Ohio. Cheryl was involved with almost every aspect of the company and explained that when inclement weather is on the way they move their high end vehicles indoors as best as they can. She noted that there is simply not enough space at most dealerships to get every vehicle out of harm’s way. She said they “just have to hope for the best when it comes to the weather.”(1) Hail damage is obviously their biggest concern. She said any cover they would consider would have to be durable, easy to store and use, and inexpensive. When I asked about special features they would like to see with a cover she said a clear see through cover would be cool because “these car guys hate to lose 10 seconds of time to sell something.”

Kyle King, a fellow student at the University of Cincinnati, lives in an apartment without a garage or carport. He has three vehicles including his precious Corvette. His main concern is damage to the paint as well as the frame and structure that can be caused by all kinds of weather. Kyle said he would definitely consider a cover that was easy to use and durable enough to handle inclement weather. He said that he has tried to use an existing cover but “they are a hassle to take on and off and really only protect the car from rain and UV rays.”(2) One such cover even scratched his paint when the wind blew it off. One feature Kyle would like to see is a cover that is 100% rain proof and breathable at the same time. Another feature he mentioned is that it would still be nice to have access to the driver’s side door even when the cover is on.
RESEARCH

Harbor Freight offers a variety of products to cover your vehicle. The "Portable Garage" shown in Figure 1 below claims to stay secure during heavy rains or wind. In order for this product to withstand inclement weather it is anchored to dirt or asphalt using 15" auger anchors. The cover is held down by heavy duty webbed straps with ratchet-action tensioning. This product would take multiple people and hours to assemble. With a total weight of 143 pounds it does not seem very "portable." Multiple customer reviews pointed out that this product does not even keep the rain out. The manual warns not to allow any snow accumulation on the structure. This product is about as "portable" as it gets in the current market and is reasonably priced at $299.99.

Figure 1 — Portable Garage
Menards sells a sturdy carport manufactured by Versa Tube. The carport can withstand winds up to 90 mph and holds up under snow. However as you can see in Figure 2 below, the vehicle is not completely protected from the elements. The structure is open on the ends and sides. They call it a “Do-It-Yourself project requiring simple tools." More than one person is required for installation and the structure still needs anchored to the ground to withstand the wind. This is not a portable or easy to use product by any means. Versions of this carport come in at $900 and up.

![Figure 2] Metal Roof Carport

The Speed-Way Easy Retractable Motorcycle Garage is the best product that I researched but it is only manufactured for motorcycles. It provides quick assembly, is easy to use, rain resistant and lightweight. At only 55 pounds the cover is certainly portable. The drawback on this product is that it still has to be anchored to the ground to withstand wind and it costs $425.

![Figure 3] Speed-Way Motorcycle Cover
CUSTOMER FEATURES

Based on the research of similar products the following features are the desired for a functional car cover.

1. Weather Resistant Material
2. UV Protection
3. Lightweight
4. Easy Assembly
5. Easy to use
6. Ability to anchor to ground
7. Strong durable frame
8. Ventilation
9. Easy storage
10. Inexpensive
PRODUCT OBJECTIVES

In Figure 4 below you can see the different product objectives and their percentage weights. The most important product objective according to this figure is Ease of Use at 25%. UV protection and Ventilation are both weighted at 5% which means they are not quite as important as the other features.

1. Weather Resistant Material (15%)
   a. Canvas material will be weather resistant
2. UV Protection (5%)
   a. Canvas will provide UV protection
3. Lightweight (15%)
   a. Aluminum or plastic framing
   b. Lightweight canvas material
4. Easy Assembly (10%)
   a. Simple instructions for the operator
   b. Minimal amount of components
5. Easy to use (25%)
   a. Collapsible
   b. Lever to pull cover over vehicle
6. Ability to anchor to ground (5%)
   a. Design will either be able to anchor to the ground or under the tires
7. Strong durable frame (10%)
   a. Sloped design will create durable form whether the material is aluminum or plastic or something else.
8. Ventilation (5%)
   a. There will be screen windows on either side of the vehicle
9. Easy storage (10%)
   a. Collapsible Design
   b. Lightweight Materials
DESIGN ALTERNATIVES AND SELECTION

**COLLAPSIBLE PLASTIC TUBING FRAME**

This was the very first concept that I came up with. The idea was simple, use plastic tubing as the frame for the cover and design it so that the tubing could slide into smaller sections which would collapse the cover. This design would be durable and cover the car all the way to the ground, including the wheels. The problems with this design is that it would be difficult to anchor to the car, and in order to collapse the sections together there would have to be multiple push buttons or other fasteners that the user would have to handle.

Push buttons would be required at multiple locations to collapse the cover.

Figure 5 – Collapsible Plastic Tubing Frame Concept
**POP-UP FRAME CONCEPT 1**

This was the first pop up concept to be considered. The cover would be able to pop up and then fold down flat so that it could be placed in the trunk. The frame is made up of thin metal that would be able to flex and bend. After further research into pop up designs it was determined that this design would not work. The frame would not be able to fold flat with this design. This pop-up frame design would lead to the final concept.
**POP-UP FRAME CONCEPT 2**

This is the final concept and the 2nd iteration of the Pop-Up Frame design. This cover will pop up and be able to collapse flat and be small enough to fit in the trunk of a car. The design concept was inspired by the design of smaller pop up tents. This concept will include a draw string around the bottom of the cover so that it can be pulled tight underneath the vehicle. The problem with this design is that it will not cover the wheels completely but the rest of the car will be covered. Magnets may be added to the side of the cover so that it could pull tight to the side of the car. What you can see in Figure 8 below is the frame design for the cover.

![Figure 7 - Pop-Up Frame Concept 2](image)
Each design concept was evaluated using the weighted rating 5 point method. The concept with the highest rating was the Pop-Up Concept 2, with a rating of 3.40. The first Pop-Up concept came in second followed by the Plastic Tubing concept. This outcome makes sense because the Plastic Tubing Frame concept would take forever to collapse so it received low scores in ease of use and ease of storage. The first Pop-Up concept scored low in ease of storage because it would not fold easily. The second Pop-Up concept scored the highest because it is the easiest to use and very easy to store.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Importance Weight (%)</th>
<th>Plastic Tubing Frame Rating</th>
<th>Pop Up Concept 1 Weighted Rating</th>
<th>Pop Up Concept 2 Weighted Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Durability</td>
<td>20%</td>
<td>3</td>
<td>0.60</td>
<td>3</td>
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<tr>
<td>Cost</td>
<td>10%</td>
<td>4</td>
<td>0.40</td>
<td>3</td>
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<tr>
<td>Ease of use</td>
<td>25%</td>
<td>2</td>
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<td>Ease of storage</td>
<td>15%</td>
<td>1</td>
<td>0.15</td>
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<tr>
<td>Lightweight</td>
<td>10%</td>
<td>2</td>
<td>0.20</td>
<td>3</td>
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<tr>
<td>Weather Resistant</td>
<td>20%</td>
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<td>0.60</td>
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<tr>
<td>Total:</td>
<td>100%</td>
<td>2.45</td>
<td>2.85</td>
<td>3.40</td>
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</table>

Weighted Rating 5 Point Method
Rating 0-4 with 4 being the highest

Figure 8 Concept Weighted Rating
**SOLID MODEL ASSEMBLY**

In Figure 9 below, you can see the full assembly model of the Pop-Up Car Cover. The cover’s frame will pop up and be able to fold down flat to store in the trunk of the vehicle. The bottom of the cover has a draw string so that it can be pulled tight underneath the car. The black lines are the slots where the frame will be held. In Figure 10 you can see how the vehicle fits within the cover.

![Figure 9 – Pop-Up Car Cover Model](image)

![Figure 10 – See-Through Assembly](image)
Figure 11: Lower Frame 3D Model

Figure 12: Upper Frame 3D Model
LOADING CONDITIONS

The main purpose of the pop up car cover is to protect the car from weather. The next purpose of the cover is to be able to cover and uncover the car easily. The following loading conditions must be considered when using the pop up car cover.

- Rain
- Frost
- Light snow and ice accumulation
- Dirt
- Light to moderate winds
- Bending forces
- Twisting forces
- Repeatability
COMPONENT AND MATERIAL SELECTION

Now that the frame concept has been chosen, it is time to choose the material for the cover. The materials in consideration are Polyester, Ripstop Nylon and Vinyl. All of these materials are commonly used for covers and canopies. The material that scored the highest was Ripstop Nylon, with a rating of 3.35. Polyester comes in at second with a rating of 3.10 and Vinyl was last at 2.75. All materials are a viable option for a cover but Ripstop Nylon had the most balanced criteria scores. Ripstop Nylon is weather resistant, easy to use, lightweight and durable. Ripstop is commonly used for tents, canopies, parachutes and more because of these attributes. Another positive about Ripstop is that if the cover were to tear it would not spread any further even if it is under tension; this is why it is commonly used in parachutes.

<table>
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<tr>
<th>Criteria</th>
<th>Importance (%)</th>
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<th>Weighted Rating</th>
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<tr>
<td>Weather Resistant</td>
<td>20%</td>
<td>3</td>
<td>0.60</td>
<td>3</td>
<td>0.60</td>
</tr>
<tr>
<td>Cost</td>
<td>10%</td>
<td>3</td>
<td>0.30</td>
<td>4</td>
<td>0.40</td>
</tr>
<tr>
<td>Ease of use</td>
<td>25%</td>
<td>3</td>
<td>0.75</td>
<td>3</td>
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<tr>
<td>UV protection</td>
<td>15%</td>
<td>3</td>
<td>0.45</td>
<td>2</td>
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<tr>
<td>Lightweight</td>
<td>10%</td>
<td>4</td>
<td>0.40</td>
<td>3</td>
<td>0.60</td>
</tr>
<tr>
<td>Durability</td>
<td>20%</td>
<td>3</td>
<td>0.60</td>
<td>2</td>
<td>0.70</td>
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<tr>
<td>Total:</td>
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Weighted Rating 5 Point Method
Rating 0-4 with 4 being the highest

Figure 13  Cover Material Weighted Rating
PROJECT MANAGEMENT

BUDGET

The budget in Table 1 shows the forecasted amount versus the actual amount. The frame material ended up being $12.23 USD cheaper than I originally thought. However the canopy materials ended up being $120.00 USD more than I originally forecasted. The total amount for materials came in at $255.77 USD with an additional $600.00 in labor. The cover took much longer to build than I thought it would which is why the labor cost is so high. The original goal was to be able to sell the cover for less than $500.00. The cost of labor could easily be reduced in mass production and the cover could sell for well under that mark. The budget can also be seen in Appendix D.

<table>
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<th>Materials, Components or Labor</th>
<th>Forecasted Amount</th>
<th>Actual Amount</th>
<th>Difference</th>
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<td>Frame</td>
<td>$100.00</td>
<td>$87.77</td>
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<td>Canopy + Thread</td>
<td>$25.00</td>
<td>$145.00</td>
<td>$(120.00)</td>
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<tr>
<td>Misc. Parts (Draw String)</td>
<td>$20.00</td>
<td>$7.00</td>
<td>$(13.00)</td>
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<td>Joining Materials</td>
<td>$30.00</td>
<td>$16.00</td>
<td>$(14.00)</td>
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<td>Total for Materials:</td>
<td>$175.00</td>
<td>$255.77</td>
<td>$(80.77)</td>
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<td>Labor ($15/hr)</td>
<td>$500.00</td>
<td>$600.00</td>
<td>$(100.00)</td>
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<td>Total:</td>
<td>$675.00</td>
<td>$855.77</td>
<td>$(180.77)</td>
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</tbody>
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Table 1: Budget
**SCHEDULE**

Table 2 shows the schedule which was constructed to provide an organized track to complete the senior design project. The yellow represents the forecasted timeline of each task and the green is the actual timeline for each task. The schedule can also be found in Appendix C.

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<td>Project Report to Advisor</td>
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</table>

Table 2 - Schedule
BILL OF MATERIALS

The following table shows the list of materials used to create the Pop-Up Car Cover. For each material you will find a description and cost.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Qty</th>
<th>Cost Per Unit</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.062&quot; X .375&quot; X 100' wear resistant 1095 spring steel</td>
<td>1</td>
<td>$87.17</td>
<td>$87.17</td>
</tr>
<tr>
<td>2</td>
<td>JB Weld</td>
<td>2</td>
<td>$6.99</td>
<td>$13.98</td>
</tr>
<tr>
<td>3</td>
<td>Ripstop Nylon (23 sq yards)</td>
<td>15</td>
<td>$7.99</td>
<td>$119.85</td>
</tr>
<tr>
<td>4</td>
<td>1/8&quot; x 50' Braided Nylon Rope</td>
<td>1</td>
<td>$4.97</td>
<td>$4.97</td>
</tr>
<tr>
<td>5</td>
<td>Heavy duty outdoor nylon thread</td>
<td>4</td>
<td>$5.29</td>
<td>$21.16</td>
</tr>
<tr>
<td></td>
<td><strong>Total:</strong></td>
<td></td>
<td></td>
<td><strong>$247.13</strong></td>
</tr>
</tbody>
</table>

Table 3 - Bill of Materials
FABRICATION AND ASSEMBLY

**Spring Steel Frame**

The frame of the cover consists of two long continuous loops of .062\(\times\) .375\(\times\) wear resistant 1095 spring steel. The spring steel is purchased in a 100 ft strip. The upper loop is 32 ft long and the lower loop is 43\(\times\)long. Using a Sawzall with a metal blade the frame was cut to these two lengths. The cut ends were sharp and needed to be ground down to create a smooth edge. The edges of the cuts were ground down using a Dremel grinding wheel. Figure 14 below shows the 100\(\times\)spring steel coil. The steel is ideal because it can be bent into any shape and it will spring back to form.

![Spring Steel Coil](image-url)

Figure 14 ņ Spring Steel Coil
RIPSTOP NYLON COVER

The ripstop nylon material is purchased in 59" x 10 yard sections. The total amount of material used for this cover was around 23 square yards. The tan, middle section is one continuous section. Two black sections were sewn along the long ends of the tan section. Using a sewing machine the sections are sewn together using a double stitched, zigzag pattern. The thread used is heavy duty outdoor nylon thread. The combination of the heavy duty thread and double stitching makes the seams very strong. In figures 15 and 16 below you can see the fabrication process for the ripstop nylon cover.

Figure 15 – Cover Material Fabrication

Figure 16 – Double Stitched, Zigzag Seam
**FRAME SLOTS AND DRAWSTRING**

For the spring steel frame to form a continuous loop slots were sewn in all the way around the cover. I used tape to mark where the slots would go. The slots are strips of ripstop that were cut into 10\(\times\)30 sections from the excess material. The lower middle section of the slot is left open so that the frame can be inserted and joined at the same spot. You can see the planning for the slots in Figures 17 and 18 below. A 1/8\(\times\)40 rope was sewn around the entire bottom of the cover. The rope exits on the back drivers side of the car cover and can be pulled tight. The draw string keeps any wind from getting under the cover and also provides the nice sloped shape in the frame.

![Figure 17 – Taping Slot Path](image1)

![Figure 18 – Checking Slot Paths](image2)
**FINAL ASSEMBLY**

First the lower spring steel frame is inserted into the lower slot and pushed through until both ends are showing. The frame is then put under tension by holding one end and pushing the other end as hard as you can. The ends of the steel frame are then clamped together with a 5\(^\circ\) overlap. JB Weld epoxy putty is then shaped and formed around that 5\(^\circ\) section to join the two ends of the frame. After an hour the weld is cured and can withstand up to 900 psi. The clamps are removed and the same process is repeated for the upper loop. To cover the joints and prevent any steel from being exposed in the cover, Velcro strips were placed around the exposed joints. Two Velcro straps were added to the back of the cover to pull the cover tight and provide more of a slope in the frame. Figure 19 below shows the cover assembly.
TESTING AND PROOF OF DESIGN

TESTING METHODS

The main purpose of the Pop Up Car Cover is to protect the car from weather. This includes rain, wind, UV rays, light snow and ice accumulations. The best way to test the cover for weather conditions is by using the cover in those weather conditions. The cover held up under heavy rain while keeping the car dry. The material also quickly dried so I did not have to wait long to pack it up. I also tested the cover in high winds. On Tuesday, April 21, 2015 Dayton, Ohio was placed under a wind advisory for sustained winds of 25 to 35 mph and gusts in excess of 45 mph. I put the cover on my car and left it on for at least 5 hours in those winds. The cover barely moved in the wind and everything stayed in place.

The next big test was how functional the cover is. The cover needs to pop up and quickly cover the car and it also has to be able to fold flat and small enough to fit in the trunk. All of this also must be performed by a single user. I tested the functionality by repeatedly using the cover. I have opened and closed it dozens of times now. The cover does not pop open to the shape that I would like it to. You have to pull the drawstring tight in order to get the desired sloping shape. I am able to fold the cover down and fit it into a custom 40" diameter bag. The folding process takes 4 steps and can be difficult because it wants to spring back open at two fold points. I will address necessary changes to make this easier in the conclusion.

Figure 20 – Cover Folded

Figure 21 – Cover Open
RESULTS

The cover performs exactly like I designed it to perform. It springs open and can be placed on the car and set within 90 seconds. Then you can remove the cover and fold it down flat and small enough to fit in the trunk in less than two minutes. The ripstop nylon material protects the car from rain, wind and even UV rays. Figures 22 through 26 below show the Pop-Up Car Cover in use and provide proof of the design.

![Figure 22 - Passenger Side](image)

![Figure 23 - Back](image)
Figure 24 – Front

Figure 25 – Driver’s Side
CONCLUSION

The Pop-Up Car cover could fill the need of many people like me who do not have a way to keep their car safe from weather, dirt, UV rays and more. The cover is easy to use, weather resistant, lightweight, durable and easy to store. At only 13 pounds a single person can handle the cover easily. The cover can fit into a 40" diameter bag when folded so it is easy to throw in the trunk and go anywhere you go. This design could be very marketable because of its unique look and functionality.

CHANGES

Improvements that could be made to the design of the Pop-Up Car Cover include:

- Thinner spring steel
  - This would allow for easier bending and folding
- Add buckles or straps at fold points
  - This would prevent the cover from springing back open when folding
- Use elastic string instead of draw string
  - This would eliminate the step of pulling the draw string
WORKS CITED
APPENDIX A – RESEARCH

Interview with former Business Development Center Manager Cheryl Fenner at Jack Maxton Chevrolet, 700 E. Dublin Granville Rd. Columbus, OH 43085 (9/15/14)
Cheryl was involved with almost every aspect of the company at one point or another.
She explained that when severe weather is on the way they try to move most of their high end vehicles indoors.
There is not enough space at most dealerships to get every vehicle out of harm’s way. Just have to hope for the best when it comes to the weather.
Hail damage is their biggest concern.
She said any cover they would consider would have to be durable, easy to store and use, and inexpensive.
She mentioned that something quick to install would be ideal.
When asked about special features they would like to see with a cover she said it would be cool if there was a clear see through cover. These car guys hate to lose 10 seconds of time to sell something."

Interview with Kyle King, who does not have a garage or carport to cover his vehicles. 3250 Jefferson Ave, Cincinnati, OH 45220 (9/15/14)
Kyle owns three vehicles and does not have any way to cover them at the time.
His main concern is damage to the paint as well as the frame and structure that can be caused by all kinds of weather.
He said he would definitely consider a cover that was easy to use and durable enough to handle inclement weather.
When asked why he would not just use an existing cover he said he tried and that they are a hassle to take on and off and really only protect the car from rain and UV rays.
One cover even scratched his paint on his corvette during some high winds.
One feature he would like to see is a cover that is 100% rain proof but breathable at the same time.
Another feature he mentioned would be a cover where he can get in and out of the car without having to take the cover off.
This portable garage protects your compact car or truck in all kinds of weather with a drum-tight cover and door panel. The best-in-class cover attachment keeps the portable garage cover secure during heavy rains or wind. Featuring a stabilized all-steel frame for maximum strength, 15" auger anchors for dirt or asphalt and heavy duty webbed straps with ratchet-action tensioning to keep the cover tight and secure, this portable garage brings unparalleled protection to your vehicle.

- All-steel 1.27" diameter tubular frame
- Weather-resistant enamel finish
- Water-resistant cover with zinc plated eyelets to resist rust
- UV treated to prevent fading
- Overweight Item subject to $89.95 additional Freight Charge
- An additional lift-gate charge may apply.
- 143 lb shipping weight

http://www.harborfreight.com/10-ft-x-17-ft-portable-garage-69039.html
9/7/14
Harbor Freight Tool
www.harborfreight.com
VERSATUBE METAL ROOF CARPORT

Protect your car, boat, SUV or other valuable equipment from the outdoor elements. Easy assembly with our patented "Slip Fit" connections makes this carport a true Do-It-Yourself project requiring simple tools. Galvanized 2" x 2" steel frame offers durability and superior rust protection. (12'W x 20'L x 7'H Model Shown)

- Frame engineered for 75# ground/52# roof snow load and 90 MPH wind load when anchored per instructions. Please consult your building department for local codes before purchasing.
- Actual length of frame is 18'. 20' length includes 1' overhang of metal sheathing on both ends.
- Galvanized 2" x 2" steel frame offers superior rust protection
- Side Wall Height 7', Peak Height 8' 3"
- 3:12 Roof Pitch
- Ground anchors included
- Attached assembly video represents just one size and is intended as a general outline of how to assemble versa tube frames

**Dimensions:** 10'W x 18'L x 7'H Frame Size

Can withstand winds up to 90 mph
Holds up under snow
Requires more than 1 person to install
Must be anchored to ground
Does not completely protect the car from the elements
Not portable

$900 USD and up

9/7/14
Menards
www.menards.com
**SPEED-WAY EASY RETRACTABLE**

![Motorcycle Garage](image)

**MOTORCYCLE GARAGE**

- Waterproof material. Durable Polyester Fabric
- Provides full coverage protection from sun, rain, snow, dust and debris
- Sturdy steel frame structure protects your bike from falling objects
- **Easy to use** Simple hand-lift retractable function
- Shelter allows you to park and cover your bike with hot pipes
- Fast assembly less than 30 minutes
- Fully taped interior seams for waterproofing
- Two side windows offering full ventilation & full closure window covers
- Includes a custom carry bag, LED light, and locking hardware for storage

700mm Polyurethane Coating and Fully Taped Seams for waterproofing, sewn-in Velcro bottom allows for a sealed enclosure, Side tie-down attachments sewn into each side of the fabric cover for added support in the event of high wind. Built-In Locking Hardware allows the Speed-Way motorcycle cover to be locked in the lowered position. Powder coated steel tube structure for rust protection, anchor Plates for Secure Mounting and use. 48 lamp LED Bright Light with 3 operating functions. Helpful for night parking or general night access. Diamond-tough mpact resistant flooring, size customized to fit both shelter models (accessory not included with cover).

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
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<tbody>
<tr>
<td>Easy to use</td>
<td>Simple hand-lift retractable function</td>
</tr>
<tr>
<td>Quick assembly</td>
<td>Less than 30 minutes</td>
</tr>
<tr>
<td>Only exists for</td>
<td>Motorcycles</td>
</tr>
<tr>
<td>Rain resistant</td>
<td>If anchored</td>
</tr>
<tr>
<td>Wind resistant</td>
<td></td>
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<tr>
<td>Easy to transport</td>
<td>Weighing only 55 lbs</td>
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<tr>
<td>$425 USD</td>
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</table>

This design is the closest to what I had in mind to cover a car quick and easy.

http://www.shelter-solution.com/motorcycle-garage.html
9/7/14
Shelter-Solutions
www.shelter-solution.com
APPENDIX B – PRODUCT OBJECTIVES

Product Objectives

1. Weather Resistant Material (15%)
   a. Canvas material will be weather resistant
2. UV Protection (5%)
   a. Canvas will provide UV protection
3. Lightweight (15%)
   a. Aluminum or plastic framing
   b. Lightweight canvas material
4. Easy Assembly (10%)
   a. Simple instructions for the operator
   b. Minimal amount of components
5. Easy to use (25%)
   a. Collapsible
   b. Lever to pull cover over vehicle
6. Ability to anchor to ground (5%)
   a. Design will either be able to anchor to the ground or under the tires
7. Strong durable frame (10%)
   a. Sloped design will create durable form whether the material is aluminum or
      plastic or something else.
8. Ventilation (5%)
   a. There will be screen windows on either side of the vehicle
9. Easy storage (10%)
   a. Collapsible Design
   b. Lightweight Materials
### APPENDIX C - SCHEDULE

<table>
<thead>
<tr>
<th>TASKS</th>
<th>Dates</th>
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<tr>
<td>Content review (Salehpour)</td>
<td>Sep 29-Oct 5</td>
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<tr>
<td>Proof of Design Agree (Salehpour)</td>
<td>Oct 6-12</td>
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<tr>
<td>Concepts/Selection (Salehpour)</td>
<td>Oct 13-19</td>
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<tr>
<td>3D Model - (Body Frame)</td>
<td>Oct 20-26</td>
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<tr>
<td>3D Model - (Canopy and misc. features)</td>
<td>Oct 27-Nov 2</td>
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<td>Design Calculations</td>
<td>Nov 3-9</td>
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<td>Design Freeze</td>
<td>Nov 10-16</td>
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<tr>
<td>Bill of Materials</td>
<td>Nov 17-23</td>
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<tr>
<td>TBD</td>
<td>Nov 24-30</td>
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<td>Design Presentation to Faculty</td>
<td>Dec 1-7</td>
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<td>Design Report to Advisor</td>
<td>Dec 8-14</td>
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<td>Tech Expo</td>
<td>Dec 15-21</td>
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<td>Project Presentation to Faculty</td>
<td>Dec 22-28</td>
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<td>Dec 29-Jan 4</td>
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<td>Library PDF</td>
<td>Jan 5-Jan 11</td>
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</tbody>
</table>

**Adam Cassada**  
**Super Easy Car Cover**
## APPENDIX D - BUDGET

<table>
<thead>
<tr>
<th>Materials, Components or Labor</th>
<th>Forecasted Amount</th>
<th>Actual Amount</th>
<th>Difference</th>
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<tr>
<td>Frame</td>
<td>$100.00</td>
<td>$65.25</td>
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<tr>
<td>Canopy + Thread</td>
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<td>$120.00</td>
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<td>Misc. Parts (Draw String)</td>
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<td>Joining Materials</td>
<td>$30.00</td>
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<td>Labor ($15/hr)</td>
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<td>$600.00</td>
<td>$(100.00)</td>
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<td>$675.00</td>
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**APPENDIX E – BILL OF MATERIALS**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Qty</th>
<th>Cost Per Unit</th>
<th>Total Cost</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>.062&quot; X .375&quot; X 100' wear resistant 1095 spring steel</td>
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<td>$7.99</td>
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<td>4</td>
<td>1/8&quot; x 50' Braided Nylon Rope</td>
<td>1</td>
<td>$4.97</td>
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</tr>
<tr>
<td>5</td>
<td>Heavy duty outdoor nylon thread</td>
<td>4</td>
<td>$5.29</td>
<td>$21.16</td>
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<td><strong>Total:</strong></td>
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APPENDIX F – 3D MODEL
Lower Frame

Upper Frame
# APPENDIX G – MATERIAL DATA

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<td>Thickness</td>
<td>0.062&quot;</td>
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<tr>
<td>Width</td>
<td>3/8&quot;</td>
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<td>Hardness</td>
<td>RC 48</td>
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<td>Material Condition</td>
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<td>Nominal Density</td>
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<td>Thermal Conductivity</td>
<td>26-27.5 Btu/sq.ft./ft./hr./°F @ 212°F</td>
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<td>Thermal Coefficient of Expansion per °F</td>
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<td>Elongation</td>
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<td>Cure Time</td>
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<td>Max Temperature</td>
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<table>
<thead>
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