EXAMPLE AUTOMOTIVE PLAN OF PROCEDURE (POP)

Student Reference Document - Use This as Your Model

PROJECT INFORMATION

Project Name: Custom Battery Hold-Down Bracket
Student Name: Alex Johnson
Vehicle Application: 2018 Toyota Tacoma (aftermarket battery upgrade)
Date Started: October 28, 2025
Estimated Completion Date: November 22, 2025
Estimated Shop Time: 6-8 class periods

PROJECT DESCRIPTION

What am I building?
A custom battery hold-down bracket to secure an upgraded Group 31 AGM battery in my Tacoma. The OEM bracket doesn't fit the larger battery, so I'm fabricating a new bracket that uses the existing mounting holes but accommodates the larger dimensions.

Why this project?
I upgraded to a larger battery for my truck camper electrical system, but the stock hold-down won't work. This project combines **measuring**, **CAD design**, **metal cutting**, **bending**, **drilling**, and **powder coating**. It's a real problem I need to solve.

What makes this challenging?
The bracket must be strong enough to hold a 75-pound battery during off-road driving, fit within tight engine bay clearances, use existing mounting points, and look professional.

SKILLS REQUIRED

✓ **Precision measuring** with calipers and tape measure
✓ **CAD modeling** in SolidWorks for design verification
✓ **Material selection** - choosing appropriate steel thickness
✓ **Band saw operation** for straight cuts
✓ **Sheet metal bending** on brake press
✓ **Drilling and tapping** for threaded holes

✓ **Surface preparation** and powder coating
✓ **Test fitting** and adjustment techniques
✓ **Fastener selection** and torque specifications

MATERIALS NEEDED

Material	Quantity	Dimensions	Supplier	Cost
1/8" mild steel flat bar	1 piece	2" × 24"	Metal Supermarkets	$12.00
1/4" mild steel flat bar	1 piece	1" × 12"	Metal Supermarkets	$8.00
M8 × 1.25 bolts (Grade 8.8)	2	40mm length	McMaster-Carr	$3.00
M8 × 1.25 hex nuts	2	-	McMaster-Carr	$1.50
M8 flat washers	4	-	McMaster-Carr	$2.00
M6 × 1.0 threaded rod	1 piece	300mm	Local hardware	$4.00
M6 × 1.0 wing nuts	2	-	Local hardware	$2.00
Black powder coat	1	-	School supply	$0.00
TOTAL MATERIAL COST				**$32.50**

Material Justification:

- 1/8" steel for main bracket - strong but bendable
- 1/4" steel for mounting feet - extra strength at stress points
- Grade 8.8 fasteners for OEM mounting points
- Powder coat for corrosion resistance

TOOLS & EQUIPMENT REQUIRED

Measuring & Layout:

- Digital calipers (0.01mm resolution)
- Tape measure
- Combination square
- Scribe and center punch
- Sharpie markers

Cutting:

- Band saw with metal cutting blade
- Angle grinder with cutoff wheel (if needed)

- Bench vise

Forming:

- Sheet metal brake press
- Hammer and dolly (for minor adjustments)

Drilling & Threading:

- Drill press
- 7mm and 5mm drill bits
- M6 × 1.0 tap and tap handle
- Cutting fluid
- Countersink bit

Finishing:

- Belt sander or file
- Deburring tool
- Wire wheel
- Powder coating equipment
- Oven

CAD/Design:

- Computer with SolidWorks
- Printer for templates

SAFETY CONSIDERATIONS

Hazard	Risk Level	Mitigation
Band saw kickback	HIGH	Use push stick, secure material, never reach over blade
Sharp edges after cutting	HIGH	Deburr immediately, wear gloves when handling
Pinch points on brake press	MEDIUM	Keep fingers clear, use proper technique
Flying metal chips when drilling	MEDIUM	Always wear safety glasses, use cutting fluid
Powder coating fumes	MEDIUM	Use spray booth with ventilation, wear respirator
Hot metal after welding	LOW	Not welding this project, but be aware

Heavy battery during test fit	MEDIUM	Get help lifting 75-lb battery, proper lifting technique

Required PPE:

- Safety glasses (ANSI Z87.1) - **mandatory at all times**
- Leather work gloves when handling sharp metal
- Closed-toe shoes (no sandals/crocs)
- Respirator for powder coating
- Hearing protection for extended power tool use

STEP-BY-STEP PROCEDURE

PHASE 1: Measurement & Design *(Class Period 1-2)*

Step 1.1: Take Vehicle Measurements

- Measure battery dimensions: Length × Width × Height
- Measure distance between OEM mounting holes
- Measure available clearance above battery
- Photograph engine bay for reference
- Document OEM bolt size and thread pitch

Step 1.2: Create CAD Model

- Model battery as reference geometry in SolidWorks
- Design bracket with proper clearances (10mm minimum)
- Verify bend radii are achievable with shop brake press
- Design mounting feet to use existing holes
- Add adjustable top bar for different battery heights
- Run interference check with clearances

Step 1.3: Create Technical Drawings

- Generate dimensioned drawings with tolerances
- Create flat pattern for cutting template
- Print full-scale template on paper
- Get **instructor approval before proceeding to fabrication**

Quality Check: CAD model reviewed, template printed, measurements verified against vehicle

Estimated Time: 2 hours

PHASE 2: Material Preparation *(Class Period 3)*

Step 2.1: Cut Main Bracket

- Tape full-scale template to 1/8" flat bar
- Scribe cut lines with sharp scribe
- Mark bend lines clearly
- Cut to rough dimensions on band saw (leave 2mm extra for finishing)
- Label pieces with Sharpie

Step 2.2: Cut Mounting Feet

- Cut two pieces from 1/4" flat bar
- Cut to exact dimensions (these don't bend)
- Drill 8mm mounting holes in feet
- Countersink holes slightly for flush bolts

Step 2.3: Cut Threaded Rod

- Cut M6 threaded rod to required length
- Deburr cut ends with file
- Test thread both wing nuts

Quality Check: All pieces cut to size, labeled, deburred. Holes in mounting feet are correct size and location.

Estimated Time: 1.5 hours

PHASE 3: Forming & Shaping *(Class Period 4)*

Step 3.1: Mark Bend Lines

- Transfer bend lines from template to metal
- Use combination square for accuracy
- Double-check measurements before bending

Step 3.2: Make Bends

- Set brake press for 1/8" material
- Make first 90° bend for mounting foot attachment
- Make second bend for top bar angle
- Check angles with protractor or template
- Make minor adjustments with hammer if needed

Step 3.3: Test Fit Components

- Assemble bracket dry (no permanent attachment yet)
- Check fit with battery dimensions
- Verify mounting feet align with OEM holes
- Make any necessary adjustments

Quality Check: All bends are accurate angles. Dry assembly fits properly. No interference issues.

Estimated Time: 1.5 hours

PHASE 4: Drilling & Threading *(Class Period 5)*

Step 4.1: Drill Main Bracket

- Mark hole locations for threaded rod
- Center punch all holes
- Drill pilot holes (5mm)
- Step up to final size (6.5mm for M6 clearance)
- Deburr all holes

Step 4.2: Tap Holes for Adjustable Bar

- If using threaded attachment points, tap M6 × 1.0 threads
- Use cutting fluid generously
- Back out tap every 2-3 turns to clear chips
- Verify threads with threaded rod test fit

Step 4.3: Final Fitting Check

- Assemble complete bracket
- Test with battery (get help with weight)
- Verify all adjustments work
- Mark any interference points for grinding

Quality Check: All holes properly sized and located. Threads are clean. Bracket holds battery securely with adjustment range.

Estimated Time: 1.5 hours

PHASE 5: Finishing *(Class Period 6)*

Step 5.1: Surface Preparation

- Grind any sharp edges or burrs
- Sand all surfaces with 80-grit then 120-grit
- Remove all rust or mill scale
- Clean with solvent and wire brush
- Wipe down with acetone

Step 5.2: Powder Coating

- Mask any threads that need to remain bare
- Hang parts on wire for coating
- Apply powder coat in spray booth (follow instructor demo)
- Cure in oven per powder specifications (typically 400°F for 10-15 min)
- Allow to cool completely

Step 5.3: Final Assembly

- Remove masking from threads
- Assemble bracket with all hardware
- Apply anti-seize to threads
- Perform final quality inspection

Quality Check: Finish is even with no runs or bare spots. All threads work smoothly. Professional appearance.

Estimated Time: 2 hours

PHASE 6: Installation & Testing *(Class Period 7 - At Home)*

Step 6.1: Vehicle Preparation

- Disconnect negative battery terminal first
- Remove old battery and bracket
- Clean mounting area
- Inspect OEM mounting points for damage

Step 6.2: Install Bracket

- Bolt mounting feet to OEM holes
- Torque bolts to manufacturer specifications (typically 25-30 Nm)
- Place battery in position
- Adjust top bar for proper height
- Tighten wing nuts firmly

Step 6.3: Testing & Documentation

- Reconnect battery (positive first, then negative)
- Verify battery is secure - shake test
- Check electrical connections
- Take photos of installed bracket
- Update this POP with actual completion date

Quality Check: Battery does not move when pulled. All clearances maintained. Electrical system functioning. Professional installation.

Estimated Time: 1 hour (at home)

ANTICIPATED CHALLENGES & SOLUTIONS

Challenge 1: Achieving Accurate Bends

Problem: Sheet metal can spring back after bending, causing angle errors.
Solution: Over-bend by 2-3° to account for spring-back. Test on scrap first. Use brake press with proper tonnage for material thickness.

Challenge 2: Tight Engine Bay Clearances

Problem: Limited space makes test fitting difficult.
Solution: Create cardboard prototype first. Measure twice, cut once. Plan for adjustability in design.

Challenge 3: Threading Holes in Thin Material

Problem: 1/8" material might be too thin for strong threads.
Solution: Use through-hole with nuts rather than tapping thin material. Add backing washers for strength.

Challenge 4: Powder Coat Coverage in Corners

Problem: Inside corners may not get even coverage.
Solution: Apply multiple light coats from different angles. Use proper grounding for electrostatic application.

Challenge 5: Maintaining Adjustability

Problem: Wing nuts may loosen over time from vibration.
Solution: Use nylon-insert lock nuts or add Loctite to threads. Design allows for future adjustment if needed.

LEARNING GOALS

By completing this project, I will demonstrate mastery of:

Technical Skills:

- Precision measurement and tolerance application
- CAD modeling for real-world fabrication problems
- Material selection based on strength requirements
- Proper metal forming techniques with minimal distortion
- Professional finishing and corrosion protection

Problem-Solving:

- Engineering a solution to a real vehicle problem
- Working within existing constraints (mounting points, clearances)
- Iterative design improvement based on test fitting
- Troubleshooting fit issues and making adjustments

Documentation:

- Creating professional technical documentation
- Maintaining accurate records throughout fabrication
- Photographing processes and results
- Following systematic procedures

Shop Practices:

- Safe operation of all required equipment
- Efficient workflow planning
- Proper tool selection and use
- Quality control throughout process

PROJECT REFLECTION *(Complete After Installation)*

What worked well?
[To be completed after project]

What would I do differently?
[To be completed after project]

What did I learn?
[To be completed after project]

How can I apply these skills to future projects?
[To be completed after project]

INSTRUCTOR APPROVAL

Design Review Passed: _____ (Date)
Final Project Approved: _____ (Date)
Grade: _____ / 100 points

Instructor Comments:

This POP demonstrates the level of detail and professional documentation expected for all automotive fabrication projects. Your POP should be equally thorough.