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Final Testing Results

NAU SAE TOOLBOX

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November 25th, 2025

Engineering 218

Design Requirements

Table 1: Customer and Engineering Requirement Overview

Category	Client Requirements	Engineering Requirements	Solution
Mobility	Terrain capable tires	Rubber casters > 8" OD preferred, 6" Minimum	13" x 5.5” Casters
	Steering system	Integrated human operated steering system	Tie-rod + handle steering system
	Brake system	Human operated brake lever system	Exterior foot latch system
	Trailer footprint	Fits and can maneuver in the travel trailer	60 x 32 x 33.5" Frame
Storage	General tool storage	Secure drawers and bins with latch systems	3D Printed add-on latches
	Ancillary equipment	Space to store required equipment per team	5 cabinet doors
	Driver gear storage	3'x2'x1' Internal cabinet volume minimum	21.6 ft^3 cabinet storage
	Fire extinguisher	External quick-acces mount	Exterior un-latch mount
	Tire carrier	Storage for 4 Baja or Formula SAE Tires	30x25" Top mounted carrier
Power & Electrical	Integrated power system	Stand alone inverter generator that can handle loads	2500W Inverter generator
	Charging capabilities	Extension cord with power bank	25 ft extension cord
	Powered tools	Capacity for power tools to charge	13 outlet 120V power bank
Work Features	Mounted vice	Top mounted vice big enough for work	6” Table-mount vice
	Tabletop work area	Top panel doubles as the workspace	60 x 32” Top panel
Durability	Strong materials	2x1" and 1x1" steel frame construction	A36 welded steel
	Construction	Sufficient welds and mechanical fastening's	MIG welded material connections
Identity	Visual Branding	NAU, Lumberjack Motorsports, Sponsor logos	Sponsored vinyl wrap

Requirements List View

Client Requirements

- CR1: The cart must serve as a large, organized toolbox for use in SAE pits.
- CR2: The cart must hold all driver equipment, including helmets, suits, spare wheels and rims.
- CR3: The cart must provide mounted locations for tools such as an arbor press, vice, and grinding wheel.
- CR4: The cart must include integrated braking and steering for safe and easy single person operation.
- CR5: The cart must be affordable and cost effective to build while staying lightweight
- CR6: The cart must include safe/secure storage for essential equipment such as a fire extinguisher, brake-bleed kit, and safety wire puller and other tooling

Engineering Requirements

- ER1: Caster diameter
- ER2: Steering system
- ER3: Wheel Locking
- ER4: Volumetric footprint
- ER5: Drawer security
- ER6: Driver gear storage volume
- ER7: Fire extinguisher holder
- ER8: Integrated power output
- ER9: Powered tool storage volume
- ER10: Sound system
- ER11: Accessory mount points
- ER12: Shade/canopy coverage
- ER13: Frame material
- ER14: Emergency storage volume

Top-Level Testing Summary

Table 2: Sub-System Testing Breakdown

Experiment/Test	Relevant DR's	Testing Equipment Needed	Testing location/Other
1. Brake application	CR4 -Fast brake response ER3 – Wheel locking	Completed cart, installed brakes, wrenches	Inclined parking lot 98C
2. Power Supply	CR6 – Essential Equipment ER8 – Integrated Power Output ER9 – Powered tool storage volume	Inverter generator, gas, 10W-30 oil, tools	NAU Machine shop 98C
3. Turning Radius	CR4 – Single person steering ER2 – Steering system	Completed cart, SAE enclosed trailer	NAU Machine shop 98C
4. Weight capacity	CR1 – Large organized toolbox cart CR2 – Driver equipment CR3 – Ancillary equipment CR6 – Essential equipment storage ER4 – Volumetric footprint ER13 – Frame materials	Various heavy objects, all tooling, 4 scales	NAU Machine shop 98C
5. Equipment fitment	CR2 – Driver equipment CR3 – Ancillary equipment CR6 – Correct tooling ER7 – Fire extinguisher holder ER9 – Powered tool storage volume ER14 – Emergency storage volume	Completed cart, driver equipment, tools, tires	NAU Machine shop 98C
6. Correct tools	CR6 – Essential equipment ER6 – Driver gear storage volume	Tools and toolbox, SAE tech sheet, Baja car	NAU Machine shop 98C
7. Drawers/door latches	CR2 – Equipment holding ER5 – Drawer security	Drawer latches and magnets, blocks for incline	NAU Machine shop 98C

Final Testing List

✓ Increase the braking angle from 7 degrees to 10+

✓ Test the drawer latches (50 cycles each) to confirm no fatigue

~~Repeat the tool usage test for Formula SAE tech~~

✓ Retrieve more equipment from Baja and Formula teams for fitment testing

~~Use a small welder from the inverter power~~

✓ Operate doors on a slant to confirm no interference/solid latching

~~Load the cart into the SAE travel trailer to ensure maneuverability/fitment~~

Detailed Testing Plans

Tests 1-7

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1. Brake Application Testing

Table 3: Detailed Brake Testing Plan

Test Experiment/ Summary	o **Question to be answered:** Will the integrated foot brake and wheel locking system reliably stop and secure the fully loaded cart, allowing for safe, single person operation and stable parking on inclined surfaces? o **DRs being tested:** CR4 (integrated braking for safe and easy single person operation) and ER3 (foot brake and locking wheel system to ensure the cart remains stationary when parked). o **Equipment needed:** Full load of tools and driver gear (to simulate maximum operating weight, estimated at 500 lbs), an inclinometer (or a digital level with angle function). o **Variables to be calculated:** The required brake engagement force (force applied to the foot handle/lever) to secure the cart and the required coefficient of friction (μ) between the wheels and the surface to prevent rolling on the measured incline.
Procedure	1. Fully load the cart to its maximum projected operational weight (500 lbs). 2. Identify an inclined ramp or surface. Using the inclinometer or phone, measure and mark the angle of the incline . 3. Push the cart onto the inclined surface, engage the brakes, and release the cart. Observe and record if the cart begins to roll down the incline. 4. Repeat step 3, incrementally increasing the incline angle (θ) until the cart just begins to slip. Record this maximum statiangle .θ_{max}).
Results	o **Kind of results looked for:** The cart must not move on the incline when the brake is engaged. o **Expected result:** The cart will remain stationary when brakes are engaged.

1. Brake Application Testing


Figure 1: Rolling Clearance Check

Figure 2: 13 Degree Slant PASS

Figure 3: 17 Degree Slant FAIL

2. Power Supply Testing

SAME RESULTS

Table 4: Detailed Power Testing Plan

Test Experiment /Summary	○ **Question to be answered:** Does the integrated power system deliver its rated continuous output and operate the powered-tool outlets reliably, to support charging in the powered tool storage? ○ **DRs being tested**: ER8, ER9 ○ **Equipment needed:** Resistive load bank (or combination loads such as tool chargers, phone chargers), true-RMS power meter (measuring V_{rms}, I_{rms}, P), multimeter, thermometer/thermocouple for inverter heat sink, stopwatch, extension cord to the powered tool storage outlet, representative battery charger/power tool. ○ **Variables isolated for measurement:** Output voltage, current, real power, outlet functionality inside storage, inverter surface temperature, breaker/fuse trip or alarms (Y/N). ○ **Variables to be calculated:** Output power: $P_{out} = V_{rms} I_{rms}$ (resistive loads), Voltage regulation: $\Delta V\% = \frac{V_{load} - V_{no-load}}{V_{nom}} \times 100\%$, Efficiency (if input is measurable): $\eta = \frac{P_{out}}{P_{in}}$, Energy delivered during a hold: $E = P_{out} t$.
Procedure	1. Safety & setup: Verify wiring/polarity, breaker rating, ventilation, and meter calibration. Connect the power meter at the inverter output; route a cord to the powered-tool storage outlet. 2. No-load baseline: Measure V_{no-lo} and ambient/inverter temperatures. 3. Step loading: Apply loads at 25%, 50%, 75%, and 100% of the nameplate rating. Hold 10 min at each step; log V, I, P every minute; note any alarms or sag. 4. Transient check: Switch from 0% → 100% → 50% → 100% (1–2 s transitions). Record minimum voltage dip and recovery time. 5. Full-power endurance: Operate at 100% for 30 min. Record steady P_{out}, voltage regulation and inverter temperature rise. 6. Powered-tool storage outlet (ER9): Plug a representative charger/power tool into the storage-area outlet. Confirm continuous charging/operation for 10 min while the main load is at 50% and then at 100%. 7. Documentation: Photos/video of meters and setup; complete the results table.
Results	**Kind of results looked for:** ○ At 100% load, the inverter provides stable output power with voltage within acceptable limits (no nuisance trips, alarms, or thermal shutdown). ○ Powered-tool outlet in the storage compartment operates the charger/tool without interruption at 50% and 100% system load. ○ Transient dips are modest and recover quickly; breaker/fuse status remains normal. ○ Endurance run shows temperature rise within manufacturer guidance.

3. Turning Radius Testing

SAME RESULTS

Table 5: Detailed Turning Testing Plan

Test Experiment/ Summary	○ **Question to be answered:** Will the manual steering system provide smooth, controllable motion in tight spaces and remain usable when the brake mechanism is present (no mechanical interference), enabling safe, single-person operation? ○ **DRs being tested:** CR4 (integrated braking and steering for safe and easy single-person operation) and ER2 (integrated manual steering system for controlled movement in tight spaces). (Packaging/clearance cross-check with ER4.) ○ **Equipment needed:** Fully loaded cart (projected operational weight), digital force gauge or spring scale (attach to push/steer handle), torque adapter for handle (optional), digital angle gauge or protractor, measuring tape, floor cones/tape to create a narrow corridor (tight-space course), chalk/marker for path tracing, camera/phone, wheel chocks. ○ **Variables isolated for measurement:** 　○ Steering input at the handle: force F_{hand}. 　○ Maximum steering angle achieved at the wheels/handle(θ_{max}). 　○ Minimum turning radius of the cart R_{meas} and ability to follow an S-curve inside a marked corridor (tight-space controllability). 　○ Interference/binding with the brake hardware or cables (Yes/No) in both brake-released and brake-applied states. ○ **Variables to be calculated:** 　○ Turning radius from path geometry. Trace a constant-radius arc; measure chord s and mid-ordinate (sagitta) d. 　○ Minimum aisle width for a 180° turn (no backing): 　○ Estimated steady pushing/steering force on smooth concrete using rolling-resistance:
Procedure	1. Load & safety: Fully load the cart to its maximum projected operating weight. Install wheel chocks when stationary. 2. Static steering sweep (brake released): From the center position, sweep the steering/handle to left and right extremes three times. Record $\theta_{\max}$, note any binding or interference. 3. Brake-applied clearance check: Apply the brake/lock. Repeat the sweep. Confirm there is no mechanical interference with brake linkages/cables and that the steering mechanism still moves freely (cart remains stationary). 4. Tight-space course setup: Mark a straight corridor with floor tape (width chosen by the team to represent a pit/shop aisle). Place cones to form an S-curve and a 180° turn pad; chalk the cart path. 5. Slow-speed steering test (brake released): A single operator pushes at walking speed and completes: 　○ One S-curve pass without touching the boundary lines. 　○ One 180° turn within the marked pad. 6. Turning-radius data capture: On the 180° turn, mark three points along the inner wheel path and measure diameter to compute R. 7. Repeatability: Repeat Step 5–6 two additional times; record video/photos and all measurements. 8. Post-inspection: Check all steering fasteners, linkages, and casters for loosening or rubbing; document findings.
Results	**Kind of results looked for:** 　○ Smooth, continuous steering range with no binding or brake-hardware interference. 　○ Single-operator completion of the S-curve and 180° turn inside the marked corridor (tight-space controllability). 　○ Recorded handle input F_{hand}, measured , computed R_{meas} and W_{min} .

3. Turning Radius Testing

Figure 4: S-Maneuver Demonstration

RESULTS

- Completed S-turns/laps around the machine shop/offroad to test steering capabilities
- Maneuvered over uneven terrain, uphill's, downhills
- Logistic issues with the enclosed trailer to test fitment
- Greased all steering and wheel bearing components
- One person-operable
- 101.25” Turning Radius
- 202.50” Circular Turn Diameter

4. Weight Capacity Testing

SAME RESULTS

Table 6: Detailed Weight Testing Plan

Test Experiment /Summary	○ **Question to be answered:** Can the cart withstand the full intended payload (tools, wheels, driver gear) without permanent deformation or loose joints, and are the casters and frame members adequately rated? (Supports CR3; checks attachment quality per ER13 welded frame with bolted accessories.)
	○ **DRs being tested:** CR3, ER13.
	○ **Equipment needed:** Full set of heavy objects/actual tooling (to reach maximum intended payload), floor scale (or scale + mass list) to obtain total weight W, dial indicators (or ruler/feeler) for deflection, tape measure, torque wrench, paint pen for bolt marks, camera/phone.
	○ **Variables isolated for measurement:**
	  ○ Total loaded weight W.
	  ○ Static deflection at critical points (deck/frame mid-spans) δ_{meas}.
	  ○ Joint integrity (bolt loosening, weld cracks) Y/N; caster condition Y/N.
	○ **Variables to be calculated:**
	  ○ Per-caster load (four casters assumed; use actual distribution if different)
	  ○ Caster safety factor

Procedure	1. Baseline: Empty cart; set dial indicators at selected mid-span points (deck center; long side rail mid-span). Zero readings; inspect and mark bolts. 2. Load-up: Place heavy objects/tools to reach the design maximum payload; record total W. If possible, weigh wheels/boxes as added to confirm tally. 3. Static check: With the cart stationery on level floor, record deflection δ_{meas} at all points. 4. Settle & roll: Slowly roll 10–15 m on level floor and traverse a 1 in threshold once to settle the load; re-check deflection and bolt marks. 5. Unload check: Remove the payload; read indicators to obtain residual set δ_{perm}. 6. Documentation: Photos/video and a results table (locations, readings, pass/fail).

Results	**Kind of results looked for:**
	  ○ No permanent deformation: $\delta_{\mathrm{perm}} \approx 0$.
	  ○ Deflection within limit: $\delta_{meas} \leq \delta_{allow}$ at all points.
	  ○ Joints/casters sound: no bolt loosening (paint marks aligned), no weld cracking; casters roll smoothly and show no overload marks.

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5. Equipment Fitment-Test

Table 7: Detailed Storage Testing Plan

Test Experiment /Summary	○ **Question to be answered:** Do the designated compartments and mounts fit all required items; tools, spare wheels/tires, and driver equipment (suits/helmets), so they can be stored securely and accessibly without interference? This validates organization (CR1), capacity (CR2), safe storage (CR6), driver-gear bay volume (ER6), powered-tool storage volume (ER9), and emergency/safety storage volume (ER14).
	○ **DRs being tested:** CR1, CR2, CR6; ER6, ER9, ER14.
	○ **Equipment needed:** Completed cart; the full kit of required tools; 3-4 spare wheels/tires, driver suits/helmets, fire extinguisher, brake-bleed kit, safety wire puller, tape measure & calipers, clip-board checklist, camera/phone, labels/marker.
	○ **Variables isolated for measurement:**
	  ○ Net bay dimensions *L, W, H* and volume *V* (ft^3).
	  ○ Item fit in the assigned location (Y/N) with clearance margin *m* (in).
	  ○ Closure & security: door/drawer closes and latches; straps/holders engaged (Y/N).
	  ○ Accessibility: retrieval without re-packing; optional pick time t_{pick} (s).
	○ **Variables to be calculated:**
	  ○ Driver-gear bay volume: $V_{driver} = LWH \geq 6\ ft^3$(ER6).
	  ○ Powered-tool storage volume: $V_{power} \approx 2\ ft^3$ target (ER9).
	  ○ Emergency/safety storage total:$\sum V_{emerg} \geq 2\ ft^3$ (ER14).
	  ○ Coverage ratio: $C = \frac{N_{present}}{N_{required}}$ for each category (tools/tires/driver gear).
	  ○ Tire rack capacity: count N_{tires} and side/front clearance margin m_{tire}.

Procedure	1. Checklist & mapping: Create a table listing every required item and its intended location (drawer/compartment/rack). 2. Measure volumes: Empty each relevant bay; measure net L, W, H (clear of hardware) and compute V. Record photos of the interior and dimensions. 3. Place items: Load tools, tires, and driver gear into their assigned locations. Confirm doors/drawers shut and latch; verify straps/holders are engaged for tires, extinguisher, and other safety items. 4. Accessibility check: Remove and replace a representative subset (e.g., helmet, torque wrench, charger) to ensure no repacking is required; optionally time t_{pick}. 5. Documentation: Photograph each bay before/after loading; complete the fitment checklist and volume table.

Results	**Kind of results looked for:**
	  ○ All required items are present and fit in their assigned locations; doors/drawers close and latch; straps/holders secure.
	  ○ Driver-gear bay $V_{\text{driver}} \geq 6\ \text{ft}^3$; powered-tool storage $V_{power} \approx 2\ ft^3$; emergency/safety storage total ≥ 2 ft^3.
	  ○ Tire rack holds the planned number of wheels with measurable side/front clearance; straps reach and tension correctly.
	  ○ Coverage ratio C=1.00 (100%) for tools, tires, and driver gear.

5. Equipment Fitment-Test

Figure 5: Additional Spare Tooling/Hardware Boxes

Figure 6: Extension cords, Power bank, Bungees, Rivets, Brake Bleed Kit

6. Tool Usage Testing

SAME RESULTS

Table 8: Detailed Tech-Inspection Testing Plan

Test Experiment /Summary	○ **Question to be answered:** With only the tools on the cart, can the team complete SAE tech inspection and routine pit work without borrowing tools, and can a single operator locate & return critical tool quickly?
	○ **DRs tested:** CR1 (organized toolbox), CR6 (safe storage).
	○ **Equipment needed:** Official/team tech-inspection tool checklist; toolbox, labels/foam cutouts, stopwatch, camera, calibration references (for torque wrench, calipers).
	○ **Variables isolated for measurement:**
	  ○ Presence & condition of each required tool (Y/N).
	  ○ Labeling/organization (slot/foam present) (Y/N).
	  ○ Retrieval time t_{pick} for critical tools (s).
	  ○ Calibration/accuracy status (Y/N).
	  ○ Consumables stock vs minimum list (Y/N).
	○ **Variables to be calculated from results:**
	  ○ Overall coverage: $C_{total} = \frac{N_{present}}{N_{required}}$.
	  ○ Critical-set coverage: $C_{crit} = \frac{N_{crit,present}}{N_{crit,req}}$.
	  ○ Spare ratio: $Rspare = \frac{Q_{on-hand}}{Q_{min}}$.
	  ○ Time metrics: median retrieval time t_{med} and 95th-percentile t95 .

Procedure	1. Prepare the inspection checklist and map each tool to a labeled slot/foam. 2. Inventory drawers: verify presence, condition, and labels; photograph. 3. Retrieval drill: One operator retrieves and returns 5 critical tools (e.g., torque wrench, 10–19 mm sockets, calipers, multimeter, safety-wire pliers) three times each; record t_{pick}. 4. Verify calibration/accuracy (certificate date or quick check). 5. Count consumables vs minimum list.
Results	**Kind of results looked for:** All required and critical tools present, labeled, functional drawers close/lock, retrieval is fast, consumables meet minimums.

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7. Drawers/Door Latching Tests

Table 9: Detailed Latch Testing Plan

Test Experiment /Summary	○ **Question to be answered:** Will each drawer remain securely latched (i.e., no self-opening and no excessive shift) under transport bumps and on inclines, thereby ensuring safe storage of critical equipment? ○ DRs being tested: CR6 (safe storage for essential equipment such as a fire extinguisher, brake bleed kit, and safety wire puller); ER5 (locking drawers / drawer security). ○ **Equipment needed:** Rated drawer payload (tools + weights); rough-track/speed-bump course or vibration/impact setup (≈ 1.0–1.5 g along drawer axis; optional short-pulse 2–3 g shock); steel ruler/feeler gauge or dial indicator; force gauge (opening/closing forces and latch holding force); labels/marker; camera; data sheet. ○ **Variables isolated for measurement:** • Drawer displacement Δx (mm) after test • Opening and closing forces F_{open}, F_{close} (N) • Latch holding force F_{hold} (N) • Qualitative: self-opening, binding, looseness (Y/N) ○ **Variables to be calculated from results:** • Inertial pull during bumps: $F_{inertia} = m_d a_{peak}$ • Slope pull (static): $F_{slope} = m_d g\sin\theta - \mu m_d g\cos\theta$
Procedure	1. Load & Baseline**:** Load the drawer to its rated payload (record mass m_d). Close and latch. Mark reference lines on the drawer face and cabinet; record initial position x_0 and gap with a ruler/indicator. 2. Continuous bump test**:** Drive the cart over a rough-track/speed-bump course (or use a shaker) targeting axial $a_{peak,cont} = 1.0 - 1.5\ g$ for 5–10 min. If using a logger, verify peak-g. 3. Shock test (short pulse): Perform 3–5 controlled impacts/drop equivalents to achieve $a_{peak,shock} = 2 - 3\ g$ for 20–50 ms (half-sine or equivalent). 4. Incline hold (static): Park the cart on a 10° ramp for 5 min with the engaged latch. 5. Post-test measurements: Record final position x and compute displacement $\Delta x = x - x_0$. Note any self-opening, binding, or looseness (Y/N). 6. Force measurements: Using a force gauge, measure opening and closing forces F_{open}, F_{close} (5 trials each). Then pull along the drawer axis to measure latch holding force F_{hold} just before release (use guarding). 7. Repeatability: Repeat Steps 1–6 on a second drawer of the same type.
Results	**Kind of results looked for:** ○ Displacement: Δx ≤ 5 mm; no self-opening and no binding. ○ Ergonomics: F_{open}, F_{close}= 10–40 N. ○ Strength:$F_{hold} \geq F_{hold,req}$ with safety margin SM ≥ 1.3.

7. Drawers/Door Latching Tests

Figure 7: Tilted Toolbox

Figure 8: 13 Degree Tip

Figure 9: Tilted Door Latch Test

Figure 10: Latch Cycling

Specification Sheet Preparation

Table 10: CR Summary Table

Customer Requirement	CR Met (Y/N)	Client Acceptable (Y/N)
CR1: The cart must serve as a large, organized toolbox for use in SAE pits.	Y	Y
CR2: The cart must hold all driver equipment, including helmets, suits, spare wheels and rims.	Y	Y
CR3: The cart must provide mounted locations for tools such as an arbor press, vice, and grinding wheel.	Y	Y
CR4: The cart must include integrated braking and steering for safe and easy single person operation.	Y	Y
CR5: The cart must be affordable and cost effective to build.	Y	Y
CR6: The cart must include safe storage for essential equipment such as a fire extinguisher, brake-bleed kit, and safety wire puller.	Y	Y

Final Testing Results

Table 11: ER Summary Table

Engineering Requirement	Target	Tolerance	Measured/Calculated Value	ER Met (Y/N)	Client Acceptable (Y/N)
ER1: Caster diameter	> 6 in	+ 8 in max	13” x 5.5”	Y	Y
ER2: Steering system	Manual steering, one person	+ 5 degrees	~ 50lb pull force, 101.25 inch turning radius	Y	Y
ER3: Wheel Locking	Stops > 10 degree incline	-2 degrees	~ 4 seconds to initiate. Withstands full weight force	Y	Y
ER4: Volumetric footprint	< 20 ft^3	Max 50 ft^3	37.22 ft^3	Y	Y
ER5: Drawer security	Locking drawers on incline	N/A	Locked at a 40+ degree tip	Y	Y
ER6: Driver gear storage volume	>3 x 2 x 1 ft^3	> +- 5 ft^3	21.6 ft^3	Y	Y
ER7: Fire extinguisher holder	Meets NFPA 10 access	N/A	Meets NFPA mounting/accessibility	Y	Y
ER8: Integrated power output	2500 W, 4 tools charging	+- 100 Watts	2500W	Y	Y
ER9: Powered tool storage volume	>2 ft^3	> + 1 ft^3	6.6 ft^3	Y	Y
ER10: Sound system	Optional	N/A	N/A	N	Y
ER11: Accessory mount points	> 1 location	+ 1	1	Y	Y
ER12: Shade/canopy coverage	Optional	N/A	N/A	N	Y
ER13: Frame material	Securely welded A36 Steel	+- 0.01” thick	Allowable moment 578 ft-lb	Y	Y
ER14: Emergency storage volume	> 2 ft^3	> + 1 ft^3	10.2 ft^3	Y	Y

QFD

Table 12: House of Quality

	Rubber Casters 6" to 10"	Integrated manual steering	Hand Braking/ Locking Wheels	Acceptable Volumetric Footprint in Trailer	Locking Drawers	3'x2'x1' Volume for Driver bag	Fire Extinguisher Mount	Integrated Power System for Tools	Charging Capability	Powered Tools Storage	Sound System (optional)	Mounting locations for vice, arbor press, etc	Shade	Welded Aluminum frame with bolted accessories
Rubber Casters 6" to 10"														
Integrated manual steering	9													
Hand Braking/ Locking Wheels	9	9												
Acceptable Volumetric Footprint in Trailer														
Locking Drawers				6										
3'x2'x1' Volume for Driver bag				6										
Fire Extinguisher Mount														
Integrated Power System for Tools														
Charging Capability								9						
Powered Tools Storage				6	3			9						
Sound System (optional)														
Mounting locations for vice, arbor press, etc				6										
Shade				6										
Welded Aluminum frame with bolted accessories				3	3					3				
Storage for saftey equipment, brake bleed kit, saftey wire puller				6	9									

Legend	
A	Redline 75" Pit Cart
B	Winter Pit Products
C	DK Hardware

Customer Needs	Customer Weights	Rubber Casters 6" to 10"	Integrated manual steering	Hand Braking/ Locking Wheels	Acceptable Volumetric Footprint in Trailer	Locking Drawers	3'x2'x1' Volume for Driver bag	Fire Extinguisher Mount	Integrated Power System for Tools	Charging Capability	Powered Tools Storage	Sound System (optional)	Mounting locations for vice, arbor press, etc	Shade	Welded steel frame with bolted accessories	Storage for saftey equipment, brake bleed kit, saftey wire puller.	Customer Opinion Survey: 1 *Poor*	2	3 *Acceptable*	4	5 *Excellent*
Large Toolbox	4	6	3	6	9	9					6		3		6	3			B		AC
Hold all of driver equipment/ spare wheels + rims	4	6			9		9												AC		B
Mounted items (arbor press, vice, grinding wheel,etc)	4	3			9				3	6	9		9					AC	B		
Price	5	3	3							3		6		6		3	ABC				
Brakes/ steering/ 6-10 inch casters	4	9	9	9															B		AC
Technical Requirement Units		inch	N/A	lbf/ N	ft^3	N/A	ft^3	N/A	Watts	Watts	ft^3	N/A	N/A	ft^3	ft^3	ft^3					
Technical Requirement Targets		10 in	Y	2+	72 ft^3	Y	6 ft^3	Y			2ft^3	Y	3 locations	72 ft^3	Y	2 ft^3					
Absolute Technical Importance		50	50	50	50	30	50	50	30	30	50	10	50	30	50	30	Total Score				
Relative Technical Importance		8%	8%	8%	8%	5%	8%	8%	5%	5%	8%	2%	8%	5%	8%	5%	610				

Thank You

Questions?

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