Plan B: The Hybrid

CVHS Motorized Drift Trike Project

Crescent Valley High School — Small Engines + Fabrication
Students: Colton Hankey & Atticus | Instructor: Mr. McAteer | Spring 2026

Buy axle + bearings + clutch separately. Use Colton's Amazon wheels. Machine your own hub adapters on the mill.

Estimated additional cost: $357–$437 | Best balance of cost, learning, and fabrication showcase | Real machining project built in

What this plan is about

Plan B sources the rear drivetrain as individual components rather than a pre-engineered kit. You buy the axle, bearings, hubs, sprocket, clutch, and chain separately, and use Colton's Amazon wheel find to save money. The centerpiece learning project is designing and machining your own hub adapter plates on the knee mill — genuine precision work where tolerance and concentricity matter. Your time and skill go into the engine build, frame fabrication, CNC plasma branding, hub adapter machining, and making this trike a showpiece that demonstrates CVHS's shop capabilities.

What You Already Have

Item	Status
Predator 212cc Non-Hemi engine (model 69730) with Stage 1 mods	In shop
ARC 6695 billet flywheel + ARC 6254 billet rod	Purchased
1.25" sq tube 0.095" wall — 50 linear ft (structural)	Ordered — Ram Steelco, Salem (will call)
1.25" sq tube 0.063" wall — 48 linear ft (secondary)	Ordered — Ram Steelco, Salem (will call)
Donor steel bicycle frame (26" wheel)	Located — students pick up
Full metals lab: CNC plasma, knee mills, lathes, MIG welders	Available

What You Need to Buy

#	Item	Source	Est. Cost
1	**1" x 40" keyed live steel axle**	Amazon / OMB	$30–40
2	**1" Pillow block bearings x2 (UCP205-16)**	Amazon	$25–30
3	**1" bore aluminum hubs x3**	GoPowerSports / Amazon	$30–45
4	**60T #35 sprocket**	GoPowerSports	$20
5	**Centrifugal clutch 3/4" bore, 12T, #35 chain**	Amazon	$20–35
6	**#35 chain (5 ft) + master link**	Amazon	$12–15
7	**1/4" x 12" keystock**	Hardware store	$5
8	**1" lock collars x4**	Amazon	$10–12
9	**ECILKUC 10x4.5-5 wheels (pair)** *Colton's Amazon find*	Amazon	$60–80
10	**PVC pipe 6" Schedule 40 (~4 ft)** for drift sleeves	Home Depot	$20
11	**Mechanical disc brake kit** for drift trike / go-kart (1" axle)	Amazon	$30–40
12	**7/8" twist throttle kit** with cable + kill switch	Amazon	$15–20
13	**Tether / deadman kill switch** (magnetic or clip type)	Amazon	$10–15
14	**Go-kart seat** — low-profile aluminum bucket	Amazon	$30–40
15	**Grade 5/8 bolt assortment** (various sizes)	Hardware store	$20
16	**1/4" flat plate for gussets, brackets, hub adapters** (~12"x24")	Ram Steelco	$20
17	**Spray primer + paint** (school colors)	Hardware store	$20
	PLAN B TOTAL (additional purchases)		**$357–437**

✓ **ADVANTAGES**

~$80–100 cheaper than Plan A
Hub adapter project = genuine machining skill
Students design axle assembly from scratch
More "we built this" factor
Best balance of learning + cost + risk

✗ **TRADEOFFS**

Hub adapters require precision machining
More parts to source = more shipping/waiting
If adapters don't fit well, rework takes time
More alignment work during assembly

Phase 1 — Engine Build

SMALL ENGINES CLASS Installing billet flywheel + billet rod, governor removal

> **Safety: Why Billet Matters Even for a Slow Trike** Once the governor is removed, nothing limits RPM except the throttle. The stock cast flywheel can shatter above ~5,500 RPM — that's an explosion of metal shrapnel. The ARC 6695 billet flywheel is machined from a solid forged aluminum block and rated to 10,000+ RPM. The ARC 6254 billet rod prevents connecting rod failure. These are *safety parts*, not performance parts. We're installing them even though we plan to cruise at 3,000–4,500 RPM.

What You're Installing

Part	Part Number	Purpose
Billet aluminum flywheel	ARC 6695 (Non-Hemi specific)	Replaces cast flywheel — safe to 10,000+ RPM
Billet connecting rod	ARC 6254	Replaces cast rod — aircraft-grade aluminum, ARP bolts
Side cover gasket	From kit	Required when opening the crankcase
Spark plug	Autolite 3910X	Proper heat range

What You're NOT Installing

The performance cam and heavy valve springs from the kit stay in the box. Stock cam and springs are fine for a slow drift trike. Less to go wrong.

Procedure Summary

1. Drain oil, remove external components (air filter, exhaust, shroud, recoil starter)
2. Remove ignition coil (note air gap), then remove stock flywheel with puller
3. Remove side cover — access the governor and connecting rod
4. **Remove governor** gear, shaft, and arm. Plug shaft hole. Clean ALL debris from crankcase.
5. **Install ARC 6254 billet rod** — oil bearing surfaces, torque rod bolts to kit spec. *Second person verifies torque.*
6. Reassemble side cover with new gasket (star pattern, 8–10 ft-lbs)
7. **Install ARC 6695 billet flywheel** — align key, torque nut to 60–65 ft-lbs. *Second person verifies torque.*
8. Set ignition coil air gap: 0.010"–0.014" (business card method or feeler gauge)
9. Reinstall everything, fill fresh 10W-30 oil, install new spark plug

10. Pull through by hand — verify no binding
    See the full step-by-step Engine Build Procedure document for the detailed version with torque specs and verification log.

WATCH BEFORE YOU START

YouTube: "Predator 212 Non-Hemi Governor Removal + Billet Flywheel" — Search for videos by **Red Beards Garage** and similar channels. Watch the full governor removal process before touching the engine.

Go Kart Nerds: Step-by-Step Governor Removal Guide — Written walkthrough with photos.

Go Kart Nerds: Complete Predator 212 Performance Mod Guide — Understand all the stages so you know where your build sits.

OMB Warehouse: Official Governor Removal Instructions — The kit manufacturer's own guide.

STUDENT DOCUMENTATION REQUIRED

Before engine work: Photograph the engine from 4 angles (baseline reference).
During: Photo of governor removed + clean crankcase, photo of billet rod installed, photo of billet flywheel installed.
After: Complete the two-person verification log with torque values and signatures.
Deliverable: Completed verification log sheet, signed by both students and Mr. McAteer.

Phase 2 — Frame Fabrication

METALS / FABRICATION CLASS Design, cut, weld, inspect

Key Dimensions

Parameter	Target	Why
Wheelbase	52–56"	Long enough for stability, short enough for responsive drifting
Rear track width	30–34"	Wide = stable, prevents tipping during slides
Seat height	10–14" from ground	Low center of gravity for drifting
Ground clearance	3–4" minimum	Clears paved surfaces without scraping
Front wheel	26" bicycle wheel	From donor frame — provides steering and grip
Rear wheels	10x4.5-5 go-kart wheels with PVC sleeves	ECILKUC Amazon wheels — PVC provides low-friction drift surface

Material Usage

Material	Color Code	Use For
0.095" wall (50 ft available)	**RED mark**	Main frame rails, rear axle cross-members, engine mount, bicycle junction, gussets
0.063" wall (48 ft available)	**BLUE mark**	Cross-braces, seat frame, foot pegs, chain guard frame, cosmetic panels

Color-code your tubes BEFORE cutting.

Mark the end of every 0.095" tube with a red paint marker and every 0.063" tube with blue. This prevents accidentally using thin-wall tube in a structural location. One wrong tube in the wrong spot could mean a frame failure.

Build Sequence

1. **Prepare donor bicycle:** Cut behind seat tube. Keep: head tube, fork, front wheel, handlebars, front brake. Remove everything else.
2. **Design and cut list:** Sketch the frame (3 views). Map ALL cuts onto stock lengths before cutting anything. Two people verify each measurement.
3. **Cut all tubes:** Band saw or chop saw. Deburr every cut. Label every piece.
4. **Weld rear frame on flat table:** Tack → check square (diagonals must match within 1/8") → full weld. Use 0.095" for main rails and cross-members.
5. **Join bicycle front to rear frame:** This is the highest-stress joint. Align front wheel centered and vertical. Tack → verify → weld → ADD GUSSETS (CNC plasma cut from 1/4" plate).
6. **Engine mount sub-frame:** Match Predator 212 bolt pattern. Crankshaft height must align with axle sprocket height.
7. **Axle bearing mount plates:** CNC plasma cut from 1/4" plate, face on mill. Slot holes for chain tension adjustment.
8. **Secondary structure:** Seat frame, foot pegs, chain guard frame (0.063" tube).
9. **Weld inspection:** Mr. McAteer inspects all structural welds before anything is mounted.
10. **Finish:** Grind, clean, prime, paint in school colors.

WATCH BEFORE YOU WELD

YouTube: "Drift Trike Frame Build Welding" — Watch several builds to see different approaches to the bicycle-to-frame junction.

YouTube: Cut Weld Build — Drift Trike Series — Time-lapse style build showing the full fabrication process.

Instructables: Complete Drift Trike Build Guide (16 steps with photos) — Detailed written + photo walkthrough of a similar bicycle-front-end drift trike build.

YouTube: "MIG Welding Thin Wall Square Tube" — Critical technique reference. Your 0.063" tube WILL burn through if your settings are too hot.

STUDENT DOCUMENTATION REQUIRED

Before cutting: Dimensioned 3-view sketch (top, side, rear). Cut list mapped onto stock lengths.
During: Photo of each major weld joint. Diagonal measurement log (to prove frame is square).
After: Completed measurement log with actual vs. design values. Photos of finished frame before paint.
Deliverable: Design sketch, cut list, measurement log, weld inspection sign-off from Mr. McAteer.

CNC Plasma Opportunities (Plan B Highlight)

Plan B gets BOTH the CNC branding work AND the hub adapter machining project — more CNC time, more skills demonstrated:

- **CVHS nameplate / logo** — CNC plasma cut from 1/8" or 3/16" steel plate, weld to rear frame
- **"Small Engines + Fabrication"** text plate for side panels
- **Gusset plates** with school logo or decorative perforation patterns
- **Engine mount plate** — CNC plasma cut to exact Predator 212 bolt pattern
- **Brake caliper mounting bracket** — precision-cut for exact alignment
- **Decorative side panels** — perforated patterns that let you see the tube frame underneath
- **Hub adapter plates** — CNC plasma rough-cut, then finish-machined on the knee mill (see Phase 3)

Phase 3 — Drivetrain Assembly

Plan B: Build from Components + Machine Hub Adapters Source, machine, assemble, align

Axle Assembly — Build from Individual Components

Unlike a kit build, Plan B has you designing and assembling the axle system from scratch. You'll learn how every component relates to every other component — and you'll machine the part that connects the wheels to the axle.

1. **Inspect the 1" x 40" keyed live axle:** Check for straightness by rolling on a flat surface. Verify keyway depth and width with calipers.
2. **Plan the axle layout:** Sketch the axle with all components positioned — lock collars, hubs, sprocket, bearing locations. Mark positions with a Sharpie on the actual axle.
3. **Mount pillow block bearings (UCP205-16) to frame:** Bolt (not weld) to the bearing mount plates. Slot holes allow chain tension adjustment.
4. **Slide components onto the axle in order:** lock collar → hub → lock collar → sprocket hub → lock collar → hub → lock collar. Align keyways. Snug but do not fully tighten yet.
5. **Thread axle through both pillow block bearings.**
6. **Check alignment:** Axle must be perpendicular to the frame centerline. Measure from each bearing to the frame center — both sides must be equal within 1/16".
7. **Spin axle by hand** — must rotate freely with zero binding. If it binds, check bearing alignment (shim if necessary).
8. **Install centrifugal clutch on engine crankshaft** (3/4" bore, keyway + set screw + bolt).
9. **Install #35 chain** between clutch sprocket (12T) and axle sprocket (60T).
10. **Set chain tension:** 1/2"–3/4" deflection at mid-span. Adjust by sliding bearing mount plates in slotted holes.
11. **Verify chain alignment:** Sight down from drive sprocket to driven — must be straight. Shim engine mount if necessary.
12. **Install chain guard** (fabricate from flat stock).
13. **Install PVC drift sleeves over rear tires** (deflate tire → slide PVC on → reinflate).

The Hub Adapter Project — Plan B's Centerpiece Learning Moment

REAL MACHINING PROJECT This is genuine engineering work where tolerance and concentricity matter

> **Why this matters:** The ECILKUC Amazon wheels have a bolt pattern. The axle hubs have a different bolt pattern. You need an adapter plate that connects the two — and it has to be concentric, flat, and precise. If the bolt holes are off by even 1/32", the wheel will wobble. This is *exactly* the kind of precision fabrication that makes a shop class portfolio stand out.

Step 1 — Measure the Amazon Wheel Bolt Pattern

- Remove the wheel from packaging. Clean the mounting face.
- Measure the **bolt circle diameter (BCD)** — the diameter of the circle that passes through the center of each bolt hole.
- Count the number of bolt holes and measure their diameter.
- Measure the center bore diameter.
- Record ALL measurements with calipers. Sketch the pattern with dimensions.

Step 2 — Measure the Axle Hub Bolt Pattern

- Measure the hub's bolt circle diameter, number of holes, and hole diameter.
- Measure the hub's center bore or pilot diameter.
- Sketch the hub pattern with dimensions.

Step 3 — Design the Adapter Plate

- The adapter must have **two bolt circles** — one matching the wheel, one matching the hub.
- Both bolt circles must be **concentric** (share the same center point).
- Material: 1/4" flat plate (mild steel). Strong enough, machinable on the knee mill.
- Outside diameter: large enough to clear both bolt circles + 1/4" margin.
- Draw a dimensioned sketch showing both bolt patterns overlaid on the same center.

Step 4 — Cut the Adapter Blanks

- **Option A:** CNC plasma cut circular blanks from 1/4" plate (fastest, uses the CNC plasma table).
- **Option B:** Band saw rough blanks, then face and true on the lathe.
- You need at least 2 adapters (one per rear wheel) — cut 3 blanks so you have a spare for practice or mistakes.

Step 5 — Machine Precision Bolt Holes on the Knee Mill

- Mount the blank on the knee mill using a vise or clamping kit.
- **Find center** using an edge finder or dial indicator.
- **Use the DRO (Digital Readout)** to position each bolt hole precisely on the bolt circle.

- For each hole: calculate X and Y coordinates from center using bolt circle geometry:
  X = (BCD/2) x cos(angle), Y = (BCD/2) x sin(angle)
- Center drill → pilot drill → final size drill for each hole.
- Repeat for the second bolt circle pattern.
- Deburr all holes on both sides.

Step 6 — Test Fit and Iterate

- Bolt the adapter to the hub. All bolts should slide in without forcing.
- Bolt the wheel to the adapter. All bolts should slide in without forcing.
- Mount on the axle. Spin by hand. Watch for wobble.
- **If it wobbles:** Identify which hole is off. Ream to next size up if minor, or re-make the adapter if the error is too large.
- **Success criteria:** Wheel spins true with no visible wobble at the rim edge.

> **This is the engineering moment.** Measuring bolt patterns, calculating hole positions, using the DRO to hit precise coordinates, and test-fitting to verify your work — this is what machinists and engineers do professionally. Document every measurement. When the wheel spins true with no wobble, you'll know you earned it.

WATCH BEFORE ASSEMBLY

YouTube: "Go Kart Live Axle Assembly from Components" — How to assemble a live axle from individual parts (not a kit).

YouTube: "Pillow Block Bearing Alignment" — Proper technique for aligning UCP-series bearings on a frame.

YouTube: "Go Kart Hub Adapter Machining" — See how other builders machine adapter plates to connect wheels to hubs.

YouTube: "Bolt Circle Layout Knee Mill DRO" — How to use a DRO to precisely locate holes on a bolt circle — this is exactly the skill you'll use for the hub adapters.

Instructables: Complete Drift Trike Build Guide (16 steps with photos) — Detailed written + photo walkthrough of a similar bicycle-front-end drift trike build.

SpiderCarts: Go-Kart Rear Axle Setup Guide — Excellent written guide on live axle fundamentals.

STUDENT DOCUMENTATION REQUIRED

Before machining: Dimensioned sketch of the hub adapter with both bolt patterns, showing calculated X/Y hole positions. Hub adapter design sketch with measured bolt patterns from both the wheel and the hub.
During assembly: Photograph the axle assembly before sliding into bearings. Measure and record chain tension. Photo of each hub adapter on the mill during drilling.
After: Verify axle spins freely (video clip is ideal). Verify chain alignment with a straight-edge. Verify wheels spin true with no wobble.
Tolerance analysis: What's the maximum acceptable hole position error? Calculate and document how much positional error causes visible wobble at the rim edge.
Deliverable: Hub adapter design sketch with bolt circle calculations, photos of completed drivetrain from both sides, chain tension measurement, tolerance analysis write-up.

Phase 4 — Brakes, Controls & Safety Systems

NON-NEGOTIABLE — ALL ITEMS REQUIRED

Controls Setup

Control	Location	Source
7/8" twist throttle	Right handgrip	Amazon kit (~$15–20)
Front brake lever	Left hand	From donor bicycle
Rear brake lever	Right hand or foot pedal	With brake kit or bicycle lever
Kill switch button	Left handlebar	With throttle kit or separate (~$5)
Tether / deadman switch	Clip to rider's wrist, mount on frame	Amazon (~$10–15)

Safety Checklist — Must Be Verified Before ANY Riding

- ☐ Kill switch (handlebar): start engine → press switch → engine dies instantly
- ☐ Tether (deadman): start engine → pull tether → engine dies instantly
- ☐ Throttle return: twist open → release → snaps closed on its own
- ☐ Front brake: squeeze lever → front wheel locked, cannot spin
- ☐ Rear brake: activate → rear wheels locked, cannot spin
- ☐ Chain guard: fully covers chain run, no exposed links
- ☐ All bolts checked with torque wrench (engine, axle, bearings, wheels, seat)
- ☐ Oil level checked on dipstick
- ☐ Fuel system: no leaks at tank, line, or carburetor
- ☐ No loose wires, cables, or clothing-snag hazards

> **The tether kill switch is the single most important safety feature.** If the rider falls off, the cord pulls out and grounds the ignition coil — engine dies instantly. Without it, a riderless trike keeps going. This is mandatory for a school environment. Budget $10–15 and install it before the first engine test.

WATCH

YouTube: "Go Kart Kill Switch + Tether Wiring" — How to wire both the handlebar kill switch and tether in parallel to ground the ignition coil.

YouTube: "Twist Throttle Install Predator 212" — Routing the cable, setting up the return spring, connecting to the carburetor.

Safety Gates — Hard Stops

The project does not advance past a gate until Mr. McAteer signs off. No exceptions.

Gate	Must Be Complete	Sign-Off
0 — Design Review	Dimensioned sketch (3 views), cut list mapped onto stock, parts ordered with confirmation numbers	☐ Mr. McAteer
1 — Engine Build	Governor removed, crankcase clean. Billet rod torqued + verified by 2 people. Billet flywheel torqued + verified by 2 people. Oil filled. Photo documentation complete.	☐ Mr. McAteer
2 — Engine Running	Engine starts and idles. No leaks after 5 min. Kill switch tested. Throttle return tested. Break-in complete (30 min). Oil changed post-break-in.	☐ Mr. McAteer
3 — Frame Complete	All welds inspected (no porosity, cracks, undercut). Frame flat + square (diagonals within 1/8"). Gussets at bicycle junction. Painted/primed.	☐ Mr. McAteer
4 — Drivetrain	Axle spins freely. Wheels secure. Hub adapters verified — no wobble. Clutch installed. Chain tension correct. Chain alignment verified. Chain guard installed. Engine mounted (all 4 bolts).	☐ Mr. McAteer
5 — Safety Systems	Front + rear brakes tested. Kill switch tested on complete trike. Tether tested. Throttle return tested. ALL bolts torque-checked. PPE ready. Fire extinguisher staged.	☐ Mr. McAteer

First Ride Protocol (After Gate 5)

1. Walking speed only — idle and roll, no throttle
2. Test brakes at walking speed
3. Test kill switch while rolling
4. Test tether while rolling (walk alongside, step away)
5. If everything works: slow laps, 5–10 MPH, no drifting
6. After 10 clean minutes: gentle drift attempts
7. **Never ride alone. Mr. McAteer present + fire extinguisher staged at all times.**

Timeline

Week	Phase	Key Activity	Gate
1–2	Design	Sketch, dimension, cut list, order parts, measure wheel bolt patterns	Gate 0 ✓
2–3	Engine	Billet install, governor removal, bench test, break-in	Gate 1 ✓ Gate 2 ✓
3–5	Frame	Cut, weld, inspect, CNC gussets + nameplate, paint	Gate 3 ✓
4–6	Hub Adapters	Design, CNC plasma rough-cut, knee mill bolt holes, test fit	—
5–7	Drivetrain	Axle assembly from components, chain, clutch, wheels + adapters	Gate 4 ✓
7–8	Integration	Brakes, throttle, kill switch, tether, final assembly	Gate 5 ✓
8–9	Testing	First ride protocol, tuning, refinement	—
9–10	Finish	CVHS branding, documentation, presentation	—

Documentation & Deliverables Summary

Deliverable	When	Format
3-view dimensioned design sketch	Gate 0	Hand-drawn or CAD
Cut list mapped onto stock	Gate 0	Written table
Engine verification log (torques, signatures)	Gate 1	Printed form, signed
Photo log of entire build	Ongoing	Phone photos, organized by phase
Frame measurement log (diagonals, spacing)	Gate 3	Printed form
Hub adapter design sketch with measured bolt patterns	Phase 3	Hand-drawn or CAD, dimensioned
Tolerance analysis: what's the maximum acceptable hole position error?	Phase 3	Written calculation, show work

Pre-ride safety checklist (signed)	Gate 5 + every ride	Printed form, signed
Gear ratio calculation	Phase 3	Written, show work
"Lessons Learned" write-up	Week 9–10	1 page, typed or written
Final presentation	Week 10	To class or school

Reference Links

VENDORS

GoPowerSports — Sprockets, Hubs, Engine Parts
OMB Warehouse — Axles, Bearings, Governor Removal Kits
Amazon — Axle, Bearings, Clutch, Brake Kit, Throttle Kit, Tether, Wheels

TUTORIALS & GUIDES

YouTube: Go Kart Live Axle Assembly from Components
YouTube: Pillow Block Bearing Alignment
YouTube: Go Kart Hub Adapter Machining
YouTube: Bolt Circle Layout — Knee Mill DRO
Go Kart Nerds: Complete Predator 212 Mod Guide
Go Kart Nerds: Governor Removal Step-by-Step
OMB Warehouse: Governor Removal Official Instructions
Instructables: Drift Trike Build — 16 Steps with Photos
SpiderCarts: Live Axle Setup Fundamentals
DIY Go Karts: Rear Drive System Plans

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