

BUILDING AND MAINTAINING AN AIRPLANE

An Aluminum Experimental, Its Powerplant, Its Regulator, and the Owner-Maintainer

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CONTENTS

1	PREFACE	1
2	WHAT IS “BUILDING AND MAINTAINING AN AIRPLANE”?	2
3	THE REFERENCE LIBRARY	4
4	THE CONTESTED CHOICES AND THE “BEST BUILD” DECISIONS	6
5	SKILLS, WORKMANSHIP, AND THE DELIBERATE-PRACTICE FRAME	9
6	POWERPLANT — THE ENGINE AND THE PHILOSOPHY	11
7	THE A&P PATHWAY, THE REPAIRMAN CERTIFICATE, AND THE STRUCTURAL ANSWER	14
8	TOOLS, VENDORS, AND THE SHOP	16
9	COMMUNITIES, THE TECH COUNSELOR PROGRAM, AND THE HOUSE-BOUND CONSTRAINT	17
10	REGULATORY AND PHASE I	19
11	THE COMPETENCE-STACK MAPPING	20
12	THE PRACTICAL IMPLICATIONS	21
13	CLOSING — THE WORKING PICTURE	22

P R E F A C E

This is the lab's first subject investigation of a primarily practitioner-knowledge domain. Linear algebra has RUME, has Strang, has textbooks that have been pedagogically refined over decades inside a literature that argues with itself in peer-reviewed pages. Building and maintaining an airplane has Tony Bingelis's three EAA volumes from the 1980s and 1990s, Mike Busch's modern reliability-centered-maintenance corpus, Bob Nuckolls's continuously-revised *AeroElectric Connection*, the FAA's twenty-two-year-old AC 43.13-1B, and a fifty-thousand-member online community at vansairforce.net whose collective output dwarfs the printed canon. The evidence base looks different. The investigation has to look different.

What follows is the coherent picture that emerges from twelve phases of inquiry: what the domain *is* and where its borders are, what the working reference library looks like in 2026, where the contested choices live and where the evidence does and does not support an opinionated answer, what the skills hierarchy looks like at each layer of the lab's competence stack, what the powerplant landscape and the A&P pathway look like to a 49-year-old returning builder, and what the practical implications are for the lab's curriculum project. The companion artifacts — `taxonomy.md`, `library-matrix.md`, `best-build.md`, `cheat-sheet.md`, `tools-survey.md`, `skills-and-practice.md`, `learner-report.md`, `gaps.md`, `dispatch-recommendations.md`, `practical-implications.md`, and the four `research-streams/` source documents — contain the deep work. This review is the picture they jointly compose.

The audience is anyone who could plausibly need to understand what amateur experimental aviation is doing in 2026: a future builder, an owner-maintainer, a parent considering helping a child build, an A&P-curious career-changer, the lab itself looking for the durable map of a practitioner domain. The PI is also an audience, and where the conclusions are PI-specific they are flagged; the learner-report covers him directly.

WHAT IS “BUILDING AND MAINTAINING AN AIRPLANE”?

The phrase sounds like one craft. It is in fact a federation of six largely separate sub-disciplines that share a final assembly and a federal regulatory wrapper. The taxonomy document expands these in detail; for the purposes of this synthesis, the six are:

1. **Airframe construction.** Turning a kit of pre-formed aluminum parts into the load-carrying structure. For an RV-class kit, overwhelmingly sheet-metal work — layout, hole preparation, deburring, dimpling, riveting, edge work, structural assembly. Sub-disciplines within: primary structure, fuel-tank sealing, plexiglas and canopy work, composites for the cowl-and-tip work that no aluminum airplane escapes, control rigging, and final assembly with weight-and-balance.

2. **Powerplant.** The piston aero-engine — almost universally a Lycoming or Continental in this segment, opposed-cylinder, air-cooled, direct-drive, magneto-ignited, slow-revving. A 1930s-era machine refined but not redesigned. Sub-disciplines: engine selection and acquisition, installation (Firewall Forward), propeller selection and installation, break-in and Phase I flight testing, reliability-centered maintenance and condition monitoring, top vs. major overhaul decisions.

3. **Systems.** Everything between airframe and engine. Electrical (the spine; the Nuckolls book is the canonical reference). Avionics (the EFIS, EMS, autopilot, navigation, communication, transponder, audio panel — the modern Garmin G3X Touch ecosystem, the Dynon SkyView ecosystem, the Advanced Flight Systems ecosystem). Pitot-static. Fuel-line plumbing. Brakes. Lights and antennas. Environmental.

4. **Paint and finishing.** The cosmetic skin. Often contracted out; frequently done by the builder. Surface prep, primer, base coat, clear coat or single-stage urethane. The discipline most independent of the others.

5. **Regulatory and documentation.** The paperwork that turns parts into a legal airplane. Pre-build registration, the 51% / Major Portion compliance, Phase I flight test, the Condition Inspection regime, the Experimental Amateur-Built Repairman Certificate. The part of the craft that has changed most since the Van’s manual was written in 2011, because the FAA has issued updated guidance on amateur-built certification, on the post-2008 Major Portion framework, on the Repairman Certificate, and on the task-based Phase I program.

6. **Community and credentialing.** The meta-discipline. The EAA chapter, the type-club forum, the Tech Counselor visit, the Flight Advisor session, the SportAir workshop, the OSH AirVenture pilgrimage. Builders learn from each other; the social infrastructure is part of the technical infrastructure. Without this layer the rest does not work in practice.

The taxonomy resolves into three tiers organized by relevance to the modal aluminum RV-class builder. **Tier 1 (Core)** is everything a metal-RV builder must own — the sheet-metal disciplines, the engine installation, the systems, the basic regulatory items. **Tier 2 (Standard adjacent)** is what a serious builder may take on directly or contract out — paint and finishing, reliability-centered maintenance, top overhaul, interior fabrication. **Tier 3 (Peripheral)** is what an RV-class builder does not enter but should know exists — certified maintenance under Part 43, Inspection Authorization work, composite primary structures, welded steel-tube construction, turbine powerplants.

A builder is a Tier 1 specialist who reaches into Tier 2 selectively and orients to Tier 3 without entering. The A&P certificate, treated separately in §VI, is a Tier 3 credentialing question — pursuing it means entering the certified-airplane regulatory regime, not learning a different *craft*.

This tiering does substantial work. It says: focus the deep learning on Tier 1; treat Tier 2 as a planned expansion; treat Tier 3 as orientation only. For the PI’s question about A&P school it says: the Experimental Amateur-Built Repairman Certificate is Tier 1 and covers everything he actually needs; the A&P certificate is Tier 3 and is a separate professional question whose answer turns on whether he intends to work on other people’s airplanes.

Three features of the domain shape the rest of the picture and are worth surfacing early.

Practitioner-literature dominance. The body of knowledge is overwhelmingly practitioner-authored — vendor manuals, builder books, magazine columns, forum posts, vendor documentation, FAA Advisory Circulars. The academic literature is a thin sliver: human-factors and maintenance-error studies, scattered work on amateur-built accident comparison (Nelson and Goldman 2003 in HFES; a handful of follow-up papers), corrosion-and-fatigue studies on the relevant aluminum alloys, scattered work on aviation maintenance technician training pedagogy. Treating practitioner sources as legitimate evidence — with their own confidence tier — is structural to honest evaluation in this domain.

Safety-critical irreversibility. Bad decisions kill people, and the airplane is a long-lived artefact: a rivet driven badly today fatigues for thirty years and fails on a friend’s hands. The workmanship standard is higher than in most amateur crafts; the *recognition* skill — the ability to tell good work from bad — is more central than in domains where work is easier to inspect or to redo. This drives a deliberate-practice discipline that the lab’s existing work on motor-skill acquisition applies cleanly to (§IV).

Multi-disciplinarity. A serious builder/owner is, by the project’s end, a working sheet-metal technician, a fiberglass technician, a wiring-loom builder, an avionics installer, a paint sprayer, an FAA paperwork analyst, an engine mechanic, and a flight test engineer. No single curriculum on Earth teaches all of these together. The builder community has effectively invented its own multi-disciplinary curriculum out of necessity, which is part of why the project is a remarkable educational artefact in its own right (§VIII).

THE REFERENCE LIBRARY

The Van's RV-8 Construction Manual, on page 3 of Section 1, gives the builder a list of eleven recommended books — *Aircraft Sheet Metal Construction and Repair*, *Sheet Metal Vol. #1*, *The Sportplane Builder*, *Firewall Forward*, *Sportplane Construction Techniques*, CAM 18, *The AeroElectric Connection*, *Building the Metal Airplane*, *Light Airplane Construction*, *Standard Aircraft Handbook*, and FAA AC 43.13 (printed in the original as "41.13", a typographical error). The page also lists four sources: Van's Aircraft itself, the AeroElectric Connection address, Avery Enterprises in Fort Worth, Builder's Bookstore in Tabernash Colorado, and the EAA.

That list is the lab's *baseline*, not its boundary. Surveying it in 2026 produces three findings.

First, the list itself has aged unevenly. Bingelis's three EAA volumes — *Sportplane Builder*, *Firewall Forward*, *Sportplane Construction Techniques* — remain in print, EAA continues to sell them unchanged from their 1986–2000 printings, and the books remain useful for fundamentals while being silent on every chemistry, electronic, and avionics development since the early 1990s. Nuckolls's *AeroElectric Connection* has continued to evolve through twelve revisions and is more current than any Van's-list reference. The *Standard Aircraft Handbook* has reached an eighth edition (2021) under Sterkenburg and Wang. CAM 18 has been superseded by AC 43.13-1B (1998 with Change 1 in 2004 and a May 2024 editorial update; no -1C yet despite FAA ATEC solicitation in 2023-2024). Three of the eleven titles — *Aircraft Sheet Metal Construction and Repair*, *Sheet Metal Vol. #1*, *Building the Metal Airplane*, *Light Airplane Construction* — do not have unambiguous matches in the current product catalogues; they were placeholders for *the kind of book* the builder needed, which in 2026 means the AMT Handbook Airframe Vol. 1 and Sterkenburg's *Standard Aircraft Handbook* between them.

Second, Avery Enterprises, named on the Van's page as a primary tool source, closed in 2018. The Builder's Bookstore in Tabernash, Colorado, remains in operation. The major active vendors for an RV-class builder in 2026 are Cleveland Aircraft Tool (the modern dominant kit vendor), Brown Aviation Tool (rivet guns, sets, squeezers — much of the former Avery line moved here), Aircraft Spruce (the universal supplier — fasteners, raw stock, books, tools, FWF parts), Wicks Aircraft (comparable to Spruce), Plane Tools (smaller, competitive on specific items), Yard Store (specialty and surplus), and B&C Specialty Products (electrical components, Nuckolls book, alternator alternatives). McMaster-Carr serves for non-aviation hardware.

Third, the modern library cannot be reduced to a "new Van's list." The library extension agent surveyed the 2012-2026 builder book market and the answer is structural: *no new monolithic RV-specific build book has emerged in that window*. The replacement is a constellation: Van's plans and construction manual; Bingelis for fundamentals; the four-book Mike Busch corpus (*Manifesto* 2014, *On Engines* 2018, *Airplane Ownership Vol. 1* 2019, *Vol. 2* 2020) for engine and ownership philosophy; Nuckolls for electrical; AC 43.13-1B and the FAA's AMT Handbooks (FAA-H-8083-30B/-31B/-32B, all 2023, all free PDF) for "is this acceptable"; the type-club archive (Vansairforce.net) and individual builder websites for "how did someone else solve this exact thing." The library extension document characterizes each item in detail with current edition, ISBN, source, target audience, what it covers and omits, and confidence rating; the library matrix shows which item to pull for which topic.

The constellation insight is itself the load-bearing finding of Phase 2. The modern builder is not buying a single shelf of books; he is composing a working library out of a dozen sources, half of

which are continuously evolving (Vansairforce updates daily, the FAA handbooks every few years, Mike Busch every few years, the vendor installation manuals as products evolve) and half of which are stable references (the AC, the Bingelis books, the Lycoming Operator's Manual). The library matrix is the navigation aid the PI should print and pin to the shop wall.

The single most important additions to the canonical library since the Van's manual was written are: the Mike Busch corpus (which did not exist in 2011), the Nuckolls 12th edition (more current than the 2011 reference), Stewart Systems' technical data sheets for the modern non-chromated primer chemistry (which displaced the post-2010 chromate regulatory casualty), the AMT Handbooks B-revisions (which support the post-2022 Part 147 ACS), and the Savvy Aviation webinar and SavvyAnalysis platform (which did not exist as a public service in 2011).

The most important *absence* from the modern library is a current monolithic RV-specific build book. The Van's Construction Manual is the build manual; the community has filled the gap with the VAF archive and individual build logs. The PI's investigation should treat this absence as load-bearing: there is no single "next book to read for RV-8 specifically," only the constellation.

Every craft has its religious wars. RV building has more than most, because the kit affords legitimately different approaches at almost every step, the community is large and opinionated, and the practitioner literature does not adjudicate consistently. The contested-choices research stream worked through thirteen of these in detail; the `best-build.md` decision document organizes them by build sequence. This section summarizes the structure of the disagreements and the load-bearing recommendations.

The primer wars. The single most-debated choice in RV building. Options run from no primer through alodine-only, NAPA 7220 self-etching, Sherwin-Williams P60G2, AKZO Nobel chromated epoxy, Stewart Systems EkoPoxy and EkoPrime, rattlecan SEM and Marhyde products, the Cortec VpCI corrosion-inhibitor mist, and the newer chromate-free PPG and Sherwin alternatives. The picture has shifted meaningfully since 2018 under EPA and OSHA pressure on hexavalent chromium; the supplied-air respirator requirement for spraying chromated chemistry has effectively eliminated the chromated products as a residential-garage option. For a Muncie hangar climate (moderate humidity, indoor storage) and a PI with cartridge-respirator PPE, the load-bearing recommendation is Stewart Systems EkoPoxy as the primary primer with EkoPrime where the spec calls for prime-on-bare-aluminum. The decision rests on EPA pressure (which has made chromated chemistry hard to source and unsafe to spray without supplied air), on the community consensus that has converged on Stewart in 2024-2026 VAF threads, on Stewart Systems’ own technical data sheets, and on Aviation Consumer and Mike Busch’s primer coverage from 2018 onward. The decision is **community-consensus** rather than evidence-based, because no comparative corrosion test exists across these products in the relevant aluminum-on-hangar-shelf environment.

Dimpling rig. The PI owns a DRDT-2 and the question is whether it is still the right tool. The answer is yes, with supplementation — a pneumatic squeezer with #30 and #40 dimple dies in 3" and longeron yokes for tight reaches, a tank-die set for fuel-tank skin closeouts, and a pop-rivet dimple-die set for retroactive dimples. The DRDT-2 has been the consensus tool for flat-stock dimpling since its introduction and the 2026 market has not displaced it.

Rivet method standardization. Pneumatic squeezer as default wherever the yoke fits; back-rivet plate for flat-skin panels with full backside access; gun + bucking bar for everywhere else, with 2X gun for AD3/AD4 and 3X for AD5 spar work. AN426 flush where plans specify; never substitute universal for flush; pulled rivets (Avex preferred for visual consistency; Cherrymax for primary structure where blind is unavoidable) only where plans specify. Shop-head verification per AC 43.13-1B Chapter 4 — the $1.5D \times 0.5D$ rule, gauge every rivet. This is well-trodden territory; the recommendation is the consensus modern workflow.

Edge prep. Scotch-Brite wheel (3M 7A medium) as the primary edge-finishing tool, set up at a dedicated bench. Vixen file for heavy burr removal first-pass. Cleaveland 6" deburring wheel for production speed. Swivel-blade Noga deburring tool for hole edges. Treat every cut edge, not just stressed edges. The “only stressed edges” school is wrong; the cost of treating every edge is small and the workmanship and fatigue benefit are real.

Match-drill philosophy. Follow Van’s plans verbatim. Match-drill in pairs to final size, disassemble, deburr every hole on both sides, dimple where called out, reassemble, rivet. Use the pilot-first workflow (#40 pilot, deburr, enlarge to #30) on structural parts. The “drill once and

never touch” shortcut produces visible burr-trapped joints; the cleco-everything-first shortcut produces interlocked debris.

Quickbuild vs. slowbuild. The PI is committed to slowbuild for empennage and wings. The real question is whether to order a QuickBuild fuselage. The answer is yes — the 2019 pause already cost ~7 years of build calendar; the regulatory 51% threshold is met by the wing and empennage and FWF and avionics and canopy and finishing work collectively; the QB fuselage gives clean reference work for the right-side wing-attach integration; the cost delta (~\$11-14K post-Chapter-11 vs. ~\$7-9K pre) is small relative to total project cost. Inspect the QB fuselage on arrival for any laser-cut content; require punched parts.

Engine model. Lycoming IO-360-M1B parallel-valve 180 hp, factory new from Lycoming. The 180-hp IO-360 RV-8 is the well-trod path; performance hits Van’s published numbers; weight balance is right; the community knowledge base is deepest. Factory new beats mid-time core for a returning builder who cannot afford engine-history uncertainty. The 200-hp angle-valve is now common enough that Van’s historical caveat is essentially gone, but the parallel-valve remains the deepest fleet support and the simplest baffling.

Ignition. One factory Slick magneto (impulse-coupled, start side) + one SureFly SIM4P electronic. The SureFly has matured post-2022 production; the 2023 FAA STC for certified applications is a credible third-party reliability signal; the variable timing enables LOP. The Lightspeed Plasma III remains strong but the SureFly drop-in form factor and the 2026 community preference shift have moved the consensus.

Fuel system. Bendix RSA-5AD1 mechanical fuel injection with balanced GAMI injectors. IFR plan-of-record needs LOP capability for fuel economy and cross-country reach; LOP requires balanced injectors; GAMIjector matched-spread is the canonical solution. Mechanical FI over electronic for a one-airplane single-electrical-system IFR build — the engine-driven pump is fully self-powered.

Propeller. Hartzell BA-series scimitar two-blade metal constant-speed, HC-C2YR-1BF/F7666A. IFR plan-of-record favors constant-speed; Hartzell BA is the well-trod RV-8 choice; the scimitar profile is the modern Hartzell BA variant with reduced tip noise. Fixed-pitch is the right call for VFR-only RV-8s; this is not one.

Avionics architecture. Garmin G3X Touch (committed) + Garmin GSA-28 servos (committed) + Garmin GTN 650Xi (WAAS GPS/Nav/Comm) + Garmin GTX 345 (transponder with ADS-B In/Out) + Garmin GMA 245 (audio panel with Bluetooth) + Garmin G5 (backup attitude/altitude/heading). Single-vendor stack on the Nuckolls Z-13/8 architecture (60-amp main alternator, 8-amp SD-8 auxiliary alternator, single Concorde RG-25XC primary battery). Skip LiFePO₄ for v1; upgrade at first battery replacement when BMS integration questions settle.

Interior, paint, finishing. Paint after Phase I. Single-stage urethane (PPG Concept DCC) or Stewart EkoPoly waterborne. Classic Aero Designs interior kit. The cost-and-quality math for a one-airplane builder converges on “do the prep yourself, contract or DIY the spray, ordered finishing kit after the airplane proves it flies.”

The structure of these decisions matters as much as the content. Every recommendation is calibrated to the PI’s specific situation; a builder in Florida humidity, a VFR-only RV-8, or a builder with different avionics commitments would warrant different answers on several rows. The decision document explicitly tags each evidence level — FAA-Acceptable, Vendor-Acceptable, Community-Consensus, Contested — so a reader can tell where the recommendation rests on community consensus and where it rests on harder evidence. This is the *transparent on consensus, opinionated on evidence* discipline that distinguishes a useful decision document from a vendor catalogue with editorial.

A meta-point worth surfacing: most of the contested choices have *acceptable* answers across multiple options. The primer wars are a religious war partly because every option produces an airplane that does not corrode catastrophically in the median use case. The ignition debate is heated because every option produces an airplane that gets spark to the cylinders. The fuel system debate matters more than the primer debate but less than the engine model debate. The skill of reading the contested-choices document is *distinguishing the decisions whose downstream cost is large from the decisions whose downstream cost is small*. The engine model decision affects total project cost by ~\$10-20K and resale by similar; the primer decision affects future repaint cost by perhaps \$500 and corrosion outcome only marginally; the avionics decision affects panel cost by \$10-20K but is reversible at the cost of avionics-shop labor.

The PI should not spend equal cognitive energy on every decision. The engine model, the avionics stack, and the QB vs. slowbuild decision are the high-stakes ones; the rest are calibration questions where any well-supported choice produces an acceptable airplane.

The hand skills the RV builder needs are motor skills with a perceptual layer on top. Setting a flush rivet is a few hundred milliseconds of bucking-bar feel, a stop condition recognized by ear and touch, and an inspection step where the visual pattern of the shop head tells you whether you got it right. The skills protocol document expands this into seven primitives — solid flush riveting, bucking, dimpling, edge preparation, drilling, AN-fitting flare and torquing, and safety wire — each with acceptance standard, session protocol, feedback loop, and named failure mode. This section frames the pedagogy.

The lab's existing work on deliberate practice — the Ericsson body, the Hambrick critique synthesis from Wave 2, the motor-skill literature — applies cleanly. The argument is that exposure does not build skill; structured practice with immediate feedback against a clear acceptance standard does. The protocol the document specifies is a direct application: practice on scrap, log pass-rate by failure mode, validate with external recalibration (Tech Counselor), space sessions across days rather than mass them, vary conditions (flat scrap, then curved, then constrained-access). The deliberate-practice machinery the lab has documented is what makes the protocol work.

The piece that the deliberate-practice literature most usefully extends, in this domain, is the *recognition-vs-production* asymmetry. Most amateur curricula teach production extensively and recognition only implicitly — builders practice setting rivets, they rarely practice judging set rivets. But the safety-critical layer is recognition; the builder who can produce 95%-acceptable work but cannot reliably detect the 5% bad ones will fly an airplane with bad rivets in it. The Mike Busch borescope curriculum is the canonical recognition-first instructional design in this domain: Busch teaches the engine owner to *see* a degrading exhaust valve before he teaches what to do about it. The training of the eye is half the work. The skills protocol embeds recognition exercises (rivet gauging, photographic comparison to AC 43.13-1B Figure 4-65, dimple-die go/no-go gauging) at parity with production exercises.

The piece that the deliberate-practice literature applies in a more specialized form is *Layer 4 metacognition decay* in a returning-amateur-project context. A new builder's first rivet is bad and he knows it. A returning builder's first rivet is bad and he might not know it, because the calibration that tells him "that head is tipped, drill it out" has decayed faster than the motor pattern itself. The Layer 4 deficit shows up first; the Layer 2 deficit is downstream. The deliberate-practice protocol for the returning case has to lead with the *recognition* skill — re-establish what good looks like — before the *production* skill is asked to perform. This generalizes past aviation to any returning-amateur-project pattern, and is the load-bearing pedagogical observation of the investigation (developed further in §VIII).

A related observation: the "first rivet of the session is the worst" effect. The first 5-10 rivets of any session should be on scrap, not on the airplane, because the motor program has decayed during the off-period and re-establishes only after a few cycles. The motor-learning literature converges on diminishing returns past 90-120 minutes for novel skill acquisition, with the optimum lower for high-precision motor work; the RV community has independently arrived at the same conclusion (most builders report best work in 2-3 hour sessions with breaks). The folk wisdom is calibrated. The discipline is *stopping before quality degrades, not after*.

The skills protocol concludes with a re-onboarding schedule for the PI — three weeks of scrap practice, Tech Counselor visit at the end of week three, ailerons-and-flaps as the first new airframe work, left wing close-up over months 2-3, with a second Tech Counselor visit at the close of left-wing assembly. This is the practical application of the deliberate-practice frame to the specific returning-builder case.

The piston aero engine on an RV-8 is, mechanically, a strikingly old-fashioned machine. A Lycoming IO-360 in 2026 would not surprise a 1955 mechanic in its architecture. Air-cooled, opposed-cylinder, magneto-ignited, fixed-timing, leaded-fuel, slow-revving, direct-drive. The conservatism is deliberate — certification cost, parts inventory inertia, and a brutal safety calculus push against innovation in the certified piston-engine world. Understanding the engine well requires understanding why each choice is what it is, and how each differs from the modern automotive engine the typical builder's intuitions are anchored to.

The powerplant research stream covers the theory in detail; this section synthesizes the major themes.

The Otto cycle as it runs on a Lycoming. Four canonical strokes, but with timing fixed by the magneto and cam rather than advanced or retarded by a computer. No knock sensor, no closed-loop fuel trim, no variable valve timing, no electronic spark advance. Each cylinder fires once per two crankshaft revolutions; redline is 2700 RPM; cruise is typically 2200-2500. The simplicity is operational reliability — there is very little to go wrong because there is very little electronics-mediated. The cost is that everything the modern automotive ECU does for the driver, the pilot has to do himself: mixture management, leaning, RPM/MP coordination, CHT awareness, EGT monitoring.

Detonation and preignition. Detonation is uncontrolled combustion after normal flame-front ignition has begun, producing the characteristic acoustic ringing and rapid CHT rise. Preignition is ignition before the spark plug fires, typically from a hot spot in the combustion chamber. Both destroy engines. Both are detected by CHT and EGT pattern recognition on the engine monitor; both are prevented by correct fuel grade (100LL or future unleaded equivalent), correct mixture management, and correct cooling. The Lycoming Service Instructions (SI 1094 on fuel mixture, SI 1108B on cylinder head temperature) govern; Mike Busch's *On Engines* Part I covers the cylinder thermal architecture and the acoustic-vs.-pressure signatures of the two failure modes, including the Cirrus SR20 case study where a CHT spike past 500°F led to piston-crown melt and the manufacturer denied the warranty claim because the underlying cause was operational (advanced ignition timing was the culprit). The Advanced Pilot Seminars course is the operational training companion.

ROP vs. LOP — the mixture management debate. Rich-of-peak vs. lean-of-peak operation. The classical Lycoming and Continental position was ROP-only at high power, with leaning permitted only at reduced power. The GAMI / John Deakin / Walter Atkinson / Advanced Pilot Seminars body of work, refined through the 1990s and 2000s with engine-test-cell evidence, established that LOP operation at full throttle is safe and economical if the cylinder mixture distribution is balanced (which requires balanced injectors — the GAMIjector matched-spread is the canonical solution) and the engine is not detonation-prone at the relevant power setting. Lycoming has substantially aligned with this position; SI 1094D acknowledges LOP operation. Mike Busch's synthesis: when LOP works, it works (cooler CHTs, cleaner combustion, better fuel economy); when it does not work, the engine tells you (rough running, elevated CHTs, the absence of a clean mixture pull). The contested-choices stream recommends the Bendix RSA-5 with GAMI injectors for the PI specifically to enable LOP on an IFR plan-of-record airplane.

The unleaded transition. As of June 2026 the field is unsettled. G100UL has the FAA AML-STC and is retailing at limited California, Oklahoma, and Mississippi airports; Swift 100R has the ASTM spec and is targeting 300 airports by 2027; UL100E is on the PAFI track for 2027 fleet authorization. The FAA opened a data-collection inquiry on G100UL leak reports in April 2025. The answer-at-the-pump-in-2030 is not determined. The RV-8 fuel system should be built to 100LL spec; the PI should expect to retrofit when the field settles. This is the largest single piece of unresolved uncertainty in the engine picture.

Engine selection for the RV-8. Van's certifies the airframe up to 200 hp Lycoming and equivalent. The community runs predominantly Lycoming O-360 and IO-360 (180 hp parallel-valve), with IO-360 angle-valve (200 hp) increasingly common. ECi Titan and Superior XP-360 are credible alternatives with their own parts ecosystems; Lycoming Thunderbolt is the Lycoming-built version with builder-customizable options. The 180-hp parallel-valve IO-360 remains the well-trod default and the deepest fleet support. The 2020 Lycoming approval of the IO-390 in the RV airframes opened a 210-hp option but the airframe-mod implications make this an enthusiast choice rather than a default.

Engine installation (FWF). The Van's FWF kit includes the engine mount, exhaust (typically Vetterman crossover or a successor four-into-one), oil cooler, baffling templates, cowl, prop spinner, throttle/mixture/prop control cables, and the firewall penetrations. The builder sources the engine, propeller, and avionics-side engine-monitor integration separately. The mechanical fundamentals — mounting, baffling, oil cooler placement, induction routing, exhaust selection — are unchanged from the Bingelis *Firewall Forward* era. The modern additions are electronic ignition (where chosen), modern engine monitors (the JPI EDM 900/930 family, the Electronics International CGR-30P, or — for the integrated G3X-EMS path — the Garmin EIS sensors with G3X display), and the modern reliability-centered-maintenance instrumentation (borescope, oil analysis kit).

Break-in and Phase I. The first 25-50 hours of an engine's life have an outsized effect on long-term behavior. Lycoming's break-in protocol — mineral oil for the first ~25 hours, high-power operation, no LOP, frequent oil changes — is specific and unforgiving. The break-in document is Lycoming SSP-700-A. The Phase I flight test program — currently the EAA task-based program of seventeen tasks under the FAA's revised Operating Limitations — is the FAA-required proving ground for the airplane and the builder-pilot. AC 90-89B is the procedural reference; the EAA Flight Test Manual is the practical reference.

Reliability-centered maintenance and condition monitoring — the Mike Busch revolution. The Busch *Manifesto* (2014) argues against scheduled overhaul on calendar TBO (the Lycoming SI 1009 recommended TBO) and for condition monitoring. Its historical case is the *Waddington Effect* — C.H. Waddington's RAF Coastal Command analysis in 1942-44 that the 50-hour scheduled-check interval was *creating* breakdowns rather than preventing them; extending the interval raised effective flying hours 60%. The intellectual lineage runs through Nowlan and Heap's 1960s United Airlines work establishing that only one of six failure-pattern shapes (pattern B) actually responds to scheduled overhaul, and through Dr. Nathan Ulrich's 2001-2005 NTSB analysis showing that catastrophic piston-engine failures cluster in the *first* ~200 hours after build/rebuild/overhaul (infant mortality) rather than near or past TBO, and that ~80% of post-TBO failures with identifiable cause are *maintenance-induced failures (MIFs)* — the maintenance creating the very failures it intends to prevent. The instruments of the on-condition discipline: borescope inspection of cylinder bores and exhaust valves (the Vividia Ablescope VA-400 ~\$200 is the Busch reference, with the symmetrical *bullseye* of a healthy Lycoming O-360 exhaust valve as the recognition target; *On Engines* Part VI walks the comparison images); oil analysis trend monitoring (Blackstone Labs, with Busch flagging *iron, aluminum, chrome, copper, nickel, and tin* as the diagnostic spectrum); differential compression testing per Continental SB 03-3 and Lycoming SI 1191A (with

the Busch caveat that *Continental's own dynamometer testing showed an IO-550 holding full power at 40/80 compression* — the test is unreliable as a go/no-go gate); engine monitor data analysis (the SavvyAnalysis service, including the FEVA exhaust-valve algorithm that flags rhythmic EGT oscillations 100-200 hours before failure). The case the *Manifesto* makes: for owner-maintained Part 91 operation, the on-condition philosophy produces better outcomes than the calendar-TBO philosophy because the calendar approach replaces still-healthy parts at intervals that produce more failures than they prevent. The argument is mainstream among Part 91 owner-pilots in 2026 and is what the PI should adopt. **The companion owner-in-command framing** (*Manifesto* and *Airplane Ownership Vol. 1*) places the airworthiness responsibility on the owner under § 91.403; the three-phase annual-inspection discipline (mechanic inspects → owner reviews and approves → mechanic performs *only* approved work) is the operational expression. **The legal distinction between manufacturer recommendations** (Hartzell 6-year, Continental 4-year mag, Lycoming SI 1009 TBO) and FAA-mandated **requirements** (ALS items, ADs) is covered in *Ownership Vol. 1* “Recommended or Required?” and *Vol. 2* “By the Book?” — for Part 91 operators including experimentals, the *when-to* manufacturer guidance is largely discretionary; the *how-to* in § 43.13 remains mandatory.

Troubleshooting. The patterns: a rough mag drop on run-up means ignition fault (timing, plug, lead, coil); a smooth large mag drop means likely fouled plug to be cleared by aggressive leaning; no mag drop at all means the P-lead is grounded and the magneto isn't actually being switched off (the propeller is live). A single high CHT on the engine monitor at cruise means a baffle leak or injector clog; a single high EGT means an injector or plug issue on that cylinder; a stuck-rich pattern across all cylinders means a mixture-control failure. Oil consumption trends: a sudden increase signals ring or guide wear; a sudden decrease is rare and worth investigating. Hot-start of the IO-360 is the canonical nuisance — the vapor in the lines after a hot shutdown will not start without purging (throttle wide open, mixture idle cutoff, fuel pump on 30-60 seconds, then crank with throttle cracked). All of this is in Mike Busch's *On Engines* at chapter length; the cheat sheet condenses it to operational triggers.

Top vs. major overhaul vs. exchange. For an owner-maintained experimental, the on-condition philosophy says: cylinders fail individually and are replaced individually (top overhaul); the bottom end goes deeper than calendar TBO if metals in oil analysis trend correctly; major overhaul (full teardown, bearings, crank, accessories) is appropriate when the bottom-end evidence warrants it, not when the calendar says so; factory exchange is the right call when the in-shop labor would exceed exchange cost for the specific airplane. The decision is economic and condition-based, not calendar-based.

The synthesis: a competent owner-maintainer in 2026 runs a piston single on the Busch philosophy, with continuous engine-monitor data feeding SavvyAnalysis, oil analysis every change, borescope inspections at condition inspections, and an A&P or Repairman-Certificate-holder's hands doing the work. The IO-360 will run past its nominal SI 1009 TBO under this regime; many do. The cost of the philosophy is the discipline of running the instruments; the benefit is an engine that does not surprise.

THE A&P PATHWAY, THE REPAIRMAN CERTIFICATE, AND THE STRUCTURAL ANSWER

The PI asked whether to pursue A&P school as a possible second career. The A&P pathway research stream worked the question in detail; the answer is structural and worth surfacing in the review.

There are two routes to the FAA Aviation Maintenance Technician certificate under 14 CFR Part 65. The first is graduating from an FAA-approved Part 147 Aviation Maintenance Technician School (AMTS). The second is the practical-experience pathway under 14 CFR 65.77 — 30 months of airframe experience, 30 months of powerplant, or 18 months of combined experience for a single rating (the FAA Reauthorization Act of 2024 left this pathway unchanged from the post-2008 rule).

The consequential regulatory event for the PI's question is not the 2024 Reauthorization Act but the **2023 Part 147 final rule rewrite**, which moved AMTS regulation from prescriptive curriculum-hours to performance-based Airman Certification Standards. The new rule preserves the in-residence laboratory requirements (the part of the curriculum that cannot be done remotely — the actual sheet-metal, engine, and avionics labs); it relaxes the lecture-and-theory portion to allow more distance-learning. The net effect is that hybrid programs can reduce in-residence time by perhaps 25-40%, not 80-100%. There is no fully-online Part 147 program in 2026 and likely won't be within the PI's planning horizon.

For the PI in Muncie, the realistic Part 147 options are: - **Vincennes Aviation Technology Center at Indianapolis** (\$13,750 / 24 months / five-day-a-week commute). The closest cost-effective program. - **Sinclair Community College Dayton** (similar cost, 2-hour drive). - **AIM (Aviation Institute of Maintenance) and Spartan College of Aeronautics** (hybrid programs that still require substantial residential labs).

All three options require a 24-month commitment that the PI's house-bound constraint makes structurally infeasible. The recommendation is *plan against the Part 147 route*.

The practical-experience pathway under 65.77 has a separate problem: **building an Experimental Amateur-Built airplane does not count toward the 30-month experience requirement**. This is the settled FAA position; only post-airworthiness *maintenance* on an FAA-registered aircraft counts, and even then at FSDO discretion. EAA has been lobbying for a rule change that would credit E-AB construction time; as of mid-2026 no rule has been published. The PI should plan against current rules. The 65.77 route is unavailable to him.

The 8610-2 FSDO interview is the operational chokepoint for the practical-experience route in any case — the inspector evaluates the applicant's documented experience against the ACS standards. The chokepoint is real even for candidates whose experience would qualify on paper.

A&P salaries in 2026: BLS median \$78,680, mean \$79,870 (May 2024 OEWS data, updated annually). The credential pays. But the credential matters only if the holder intends to work on other people's airplanes for compensation; for an owner-maintainer working on his own E-AB, the credential is not the operational requirement.

The **Experimental Amateur-Built Repairman Certificate (FAR 65.104)** is the load-bearing credential for the PI's situation. It is earned at Phase I sign-off by the holder of the airworthiness certificate (the builder who performed the major portion of the construction). It costs nothing beyond the FSDO interview. It confers permanent authority for the Condition Inspection on the

specific aircraft and authorizes routine maintenance the holder is competent to perform. For the PI, it covers what he actually needs.

The **Light Sport Repairman with Maintenance rating** (Rainbow Aviation, ~\$4,000 / 15 days / Kingsville MO) is educationally valuable but does not directly authorize work on the RV-8 (which is not LSA). The course is a structured-curriculum experience covering the same fundamentals an A&P student learns. The recommendation is *consider it after the airplane is flying and the house-bound constraint has relaxed enough to afford 15 days at a residential course*. Not a near-term action.

The structural conclusion the investigation reaches: **the PI's situation makes the A&P certificate unavailable, but does not make the A&P knowledge unavailable**. The free AMT Handbooks (FAA-H-8083-30B/-31B/-32B), the Mike Busch four-book corpus, the Advanced Pilot Seminars online course, the Savvy webinar archive, and the SavvyAnalysis subscription collectively produce the curriculum an A&P student reads; the missing piece is the credential. The credential matters only if the holder intends to work on other people's airplanes for compensation, which is not the PI's plan. The Repairman Certificate covers what he actually needs.

This is opinionated. A different agent could reach a different conclusion (the Vincennes route is *technically* feasible; a house-bound constraint can relax; an economic future where the PI works as a part-time A&P is imaginable). The recommendation rests on the PI's stated constraints and preferences and is transparent about that dependence. If those constraints change, the recommendation changes.

TOOLS, VENDORS, AND THE SHOP

The tools survey document covers the inventory in operation-first detail. The synthesis at this level is shorter.

The modern RV-class builder's shop in 2026 is centered on: - a 30+ gallon two-stage air compressor with desiccant air dryer - a pneumatic squeezer (Main Squeeze, Cleaveland, or Tatco) with a yoke set including flat, 3" longeron, and 4-6" deep - a 2X rivet gun and a 3X rivet gun, with rivet sets in the AD3, AD4, and AD5 sizes - a DRDT-2 dimpler (or equivalent C-frame) with #30 and #40 dimple-die sets - bucking bars in 3-lb and 4-lb steel and tungsten variants - a Cleaveland 6" deburring wheel and Scotch-Brite 7A wheel on a bench grinder - vixen file, swivel-blade Noga deburring tool, drill bits in #40, #30, #21, #11 (stub and jobber lengths) - a complete cleco inventory — at minimum 100 each of #40 and #30 wedge clecos, with side-grip clecos for edge clamping - safety-wire pliers (twist-style) and 0.032" stainless wire - the consumable inventory: ProSeal for tanks, EZ Turn fuel-fitting thread sealant, Loctite 222 / 242 / 271, anti-seize for plugs, Cortec corrosion inhibitor, Stewart Systems EkoPoxy and EkoPrime - the avionics tooling: Daniels AFM8 D-sub crimper (~\$300, mandatory for Garmin work), wire stripper, soldering iron, heat gun, label printer, Fluke DMM, 22-AWG through 12-AWG M22759/16 Tefzel wire stock from B&C Specialty - the engine inspection tooling: USB borescope (Vividia Ablescope or DeWalt), differential compression tester (ATS or equivalent), spark plug socket and gapper - the larger one-time items: engine hoist, plans-built wing stand, canopy cutting jig

The tools-survey document tabulates this operation-first (for each operation a builder performs, the idiomatic tool, the alternatives, the rough 2026 price tier, and the PI ownership audit). The principle that runs through it: *a tool you fight is a quality risk*. Better one excellent example of each operation's idiomatic tool than three mediocre alternatives.

Vendor consolidation since the Van's manual: Avery closed in 2018. Cleaveland Aircraft Tool is the dominant RV builder tool vendor; Brown Aviation Tool covers rivet guns and sets and much of the former Avery line; Aircraft Spruce and Wicks remain the universal hardware suppliers. B&C Specialty Products is the electrical / Nuckolls component vendor. McMaster-Carr for non-aviation hardware. Harbor Freight for non-aviation, non-quality-critical items. Cleaveland's complete builder kit is the closest thing to a one-stop modern equivalent of the historical Avery offering.

COMMUNITIES, THE TECH COUNSELOR PROGRAM, AND THE HOUSE-BOUND CONSTRAINT

The community is part of the technical infrastructure. The Tech Counselor visit is, for the PI specifically, the single highest-value out-of-house event in the entire restart sequence — and it is not strictly an out-of-house event because the counselor comes to him. The communities research stream identified:

- **EAA Chapter 226** at Anderson / Muncie (KAID, ~25 minutes from Muncie) as the home chapter — the historical Muncie-area chapter, full program slate (Young Eagles, IMC/VMC Club, Tech Counselors, Flight Advisors). This is where the PI should join first and where Tech Counselor and Flight Advisor contacts should originate.
- **EAA Chapter 67** at Noblesville (I80, first Monday meeting, ~1 hour from Muncie) as the secondary — more aviation-active in current programming.
- **EAA Chapter 1311** at Plainfield and **Chapter 1121** at Indianapolis Regional (KMQJ) as event-driven occasional options.

The Technical Counselor program is the structurally important resource. An EAA-credentialed volunteer (experienced builder, restorer, or A&P) comes to the builder's shop to inspect work in progress, ask questions, and flag problems. Visits are free. The EAA recommends a minimum of three visits over the life of a build; for the PI, the first visit doubles as an audit of the 2018-2019 work before any new work is layered on. This is the highest-value single intervention in the re-onboarding plan.

The Flight Advisor program is the flight-side cousin — pilot evaluation, transition planning, ground-based co-pilot on first flight. Activates 12-18 months from build resumption, scheduled through the same chapter route.

Vansairforce.net is the central nervous system of the community. Founded by Doug Reeves in 2004, marked its twentieth anniversary in late 2024. Donation-funded (\$25/year unlocks classifieds and a subscriber badge — no paywalled technical content). The model-specific sub-forums (RV-8/8A, RV-7/7A, RV-9/9A, RV-10, RV-12, RV-14) and topic sub-forums (engines, electrical, avionics, paint, formation flying) are where the practitioner conversation lives. The most-cited recurring contributors include Dan Horton (cooling and baffles — the consensus authority), Carl Froehlich (RV-8 panel design and IFR architecture), Vlad (travel and operations), Bob Axsom (speed mods), Pierre Smith (paint and finish). A separate `appendix-vaf.md` is positioned for future work once the PI's separate VAF crawl makes the corpus systematically available.

The framing the communities research stream applied — *value-per-out-of-house-trip* — is the load-bearing principle for the PI's house-bound constraint. For each in-person event, the question is what it offers that cannot be obtained from books, video, VAF, and phone. The answers reorder the conventional ranking. The Tech Counselor visit ranks highest because it only happens in person, at the builder's site, with the work itself in front of the counselor. The Flight Advisor session ranks similarly high but later in the build. The EAA SportAir Sheet Metal Basics workshop is the third-tier in-person investment — the hands-on calibration of feel under a competent instructor is what video does not replicate, but the SportAir content is partially available via Hints for Homebuilders. AirVenture Oshkosh is excellent but skippable for educational purposes; the educational content is largely available via the Hints for Homebuilders archive and the Mike Busch webinars.

The AOPA Fly-In at KMQJ (Indianapolis Regional) is the highest-value local event — May 31, 2026 was the most recent; the annual fly-in is a day trip from Muncie, full builder programming,

no overnight cost. This is the kind of event the value-per-out-of-house-trip framing identifies as the right out-of-house investment.

The EAA Homebuilders Week (January 26-30, 2026 was the most recent edition) is the at-home substitute for the in-person builder-conference experience. Free online programming streamed live with archive.

A surprise gap: there is no organized RV builder cooperative in Indiana, Ohio, or Illinois that the investigation could identify. Van's recognized builder-group list has zero entries for the region. The closest organized group is in the Twin Cities. The implication: for the PI specifically, the Tech-Counselor-comes-to-you channel is *structurally more important* than it would be for a builder in a region with a stronger cooperative network. The investment in the chapter relationship pays off precisely because there is no cooperative-shop fallback.

REGULATORY AND PHASE I

The regulatory craft is what turns parts into a legal airplane. The picture in 2026 has changed in specific ways since 2011.

The 51% / Major Portion compliance. FAA Order 8130.2 (current revision H or successor; the FAA periodically updates) governs the inspection process. The DAR — Designated Airworthiness Representative — performs the certification inspection. AC 20-27G is the canonical guidance. The compliance test is “the major portion of fabrication and assembly tasks were performed by the builder,” documented by the FAA Form 8000-38 Eligibility Statement and the builder’s photo log. For the PI: the wing and empennage work alone, even before any fuselage work, comfortably exceeds the Major Portion threshold; the QB fuselage decision does not change the compliance picture.

The Phase I flight test. The post-2018 EAA task-based program (seventeen defined tasks, exit on completion rather than calendar hours) is the canonical structure. AC 90-89B is the procedural reference. For a Lycoming-powered RV-8 with a Garmin G3X panel: 25 hours minimum if the engine is FAA-certified, 40 hours otherwise; the task-based program substitutes a competence demonstration for the hours-based metric. The Flight Advisor (§VIII) is the structured-coaching resource. The Aircraft Operating Handbook required at Phase I sign-off becomes the operating reference for the rest of the airplane’s life.

The Condition Inspection. FAR 43 Appendix D adapted for the experimental — the annual inspection performed by the holder of the Experimental Amateur-Built Repairman Certificate (the builder) or by an A&P. The cheat sheet (§I-7) lists the high-yield items: differential compression, borescope per cylinder, oil analysis trend review, spark plug inspection, magneto timing, hose condition, baffle seal condition, propeller and gear inspection, control hinge wear, ELT and ADS-B and transponder bench checks. The Mike Busch *Airplane Ownership* volumes are the practical reference; the FAR 43 Appendix D text is the authoritative item list.

The Experimental Amateur-Built Repairman Certificate (14 CFR 65.104). Applied for at Phase I sign-off. The FSDO interview validates that the applicant performed the major portion of the construction and is qualified to perform the Condition Inspection on the specific aircraft. Confers permanent authority for the Condition Inspection and routine maintenance the holder is competent to perform. For the PI: do not skip. This is the high-yield near-term credential.

ADS-B Out compliance. The 2020 mandate is now operational reality. The G3X stack the PI is building includes ADS-B Out via the GTX 345; no special action required beyond standard installation.

Operating Limitations. The DAR issues the airplane’s Operating Limitations at the airworthiness certificate moment. Standard Phase I area is typically a 50-mile radius from the home airport; the PI at KMIE has plenty of central-Indiana airspace within this. Expansion (instrument-flight authorization, night authorization, formation flight authorization) happens after Phase I completion.

THE COMPETENCE - STACK MAPPING

The lab's five-layer competence stack (COMPETENCE-TARGET.md) applies to this domain cleanly. The taxonomy document mapped the layers; this section is the integrated picture.

Layer 1 — Domain knowledge. What an AN3-5A bolt is, what shear strength of 2024-T3 is at the relevant thickness, what detonation is, what the dirty-air-pump model of differential compression says, what the Lycoming SI 1009 recommended TBO is, what the Bendix RSA-5 fuel injection servo does. The layer most directly addressed by the reference library — what books teach. Sufficient for understanding; insufficient for doing.

Layer 2 — Skill. Setting a flush rivet to the $1.5D \times 0.5D$ spec. Dimpling a 0.025" skin without enlarging the hole. Torquing an AN flare nut to the correct value. Performing a differential compression check. Performing a borescope inspection. Reading an EGT/CHT pattern on the G3X. The operations practitioner literature teaches and deliberate practice with feedback builds. The skills protocol document expands the seven primitives.

Layer 3 — Judgment. Recognizing when a hole has been over-drilled and choosing oversize repair vs. part replacement. Recognizing when a rivet is smoking and drilling it out. Recognizing when an oil-analysis trend is signaling a real change. Recognizing when an EGT trend means a baffle leak vs. an injector clog vs. a sensor failure. The layer that distinguishes the merely-credentialed from the actually-competent. The layer where the Mike Busch corpus shines — Busch teaches pattern recognition, not just procedure. The layer where the Tech Counselor visit pays off — a counselor sees patterns the builder cannot.

Layer 4 — Metacognition. Knowing when you are tired enough that you should stop for the day. Knowing when your priming theology has overtaken the evidence. Knowing when you have decided the rivet is “good enough” because you are tired, and recognizing that the “good enough tired” tolerance is not the “good enough rested” tolerance. The layer the homebuilt-airplane community talks about as “knowing your limits” or “the discipline.” The layer that decays *fastest* in a returning-builder context and most *self-conceals*. The central pedagogical observation of the investigation: re-onboarding has to lead with Layer 4 recalibration before Layers 2 and 3 production work resumes.

Layer 5 — Character and disposition. The willingness to drill out a bad rivet, scrap a part, redo work, and accept the cost. The willingness to ask a Tech Counselor and believe the answer. The willingness to say “I don't know” when an unfamiliar pattern appears on the engine monitor and to seek out someone who does. The homebuilder community is genuinely good at this — the cultural pressure within EAA chapters and on Vansairforce is toward “if in doubt, replace it” rather than “if in doubt, hope” — but this is also the layer fatigue and time pressure and sunk-cost reasoning degrade. The single most expensive habit a returning builder can develop is to skip the Tech Counselor visit because the work “is probably fine.”

The inversion of the stack gives the design targets. The Tech Counselor program is, in lab framing, a structurally elegant intervention: it is *paid* (by EAA membership), *cheap* (the counselor's time, free), *external* (someone else does the judgment), and *recurring* (multiple visits over the build). The professional homebuilder community has independently invented exactly the kind of external-recalibration infrastructure the lab's pedagogy points toward.

THE PRACTICAL IMPLICATIONS

The practical-implications document expands these; the headline points worth surfacing in the synthesis are four.

Mechanism literacy as part of the MVA Technology domain. The recognition skill — what does *good* look like in a built artefact, what does *failing* look like — is universal in adult life and the MVA's Technology domain should treat it as such. The SUBJ-007 investigation is concrete evidence for the abstract claim that adult competence includes the ability to work with physical mechanism.

Layer 4 metacognition decay as a generalizable framework. The returning-builder case is one instance of a broader pattern — the graduate student returning to a thesis, the musician returning to an instrument, the athlete returning post-injury, the pilot returning to flying, the carpenter returning to a paused project. The framework says that Layers 1 and 2 decay slowly, Layer 4 decays faster and conceals itself, and the appropriate re-entry intervention is external recalibration. The SUBJ-007 investigation contributes the model.

Recognition-first instructional design. Production exercises (set a rivet, play the scale, draft the paragraph) dominate amateur curricula. Recognition exercises (judge this rivet, judge this recording, judge this paragraph) are rarer but more diagnostic and harder to game. The Mike Busch borescope curriculum is the canonical recognition-first design in this domain; the lab should treat it as a template for instructional design across domains.

Amateur-craft pursuits as adult capability-development infrastructure. The PI's airplane is a learning project that happens to produce an airplane. The competence built along the way — recognition, calibration, troubleshooting, the discipline of admitting uncertainty — is what transfers. In an AI-transition framing where Layer 1 and Layer 2 white-collar work is being displaced fastest, the upper-layer (Layer 3, 4, 5) competences are more valuable, not less. Amateur-craft pursuits are natural delivery mechanisms for upper-layer development. The lab's MVA framing should treat them as first-class capability-development tracks, not as recreation.

The picture the twelve phases compose is, in summary:

Building and maintaining an aluminum experimental amateur-built airplane in 2026 is a federation of six sub-disciplines under a federal regulatory wrapper. The reference library is a constellation rather than a single shelf — Bingelis for fundamentals, the Mike Busch corpus for engine and ownership philosophy, Nuckolls for electrical, AC 43.13-1B and the AMT Handbooks for “is this acceptable,” the type-club archive and Hints for Homebuilders for the things the books don’t say. The contested choices are real but most of them have multiple acceptable answers; the high-stakes ones are engine model, avionics architecture, and QB-vs-slowbuild, and the rest are calibration questions. The skills are motor skills with a perceptual layer on top; deliberate practice with logged feedback and external recalibration builds them; the returning-builder case requires explicit Layer 4 recalibration before production work resumes. The engine is a 1950s machine that runs on 2020s instrumentation — Lycoming on the firewall, Mike Busch on the operational philosophy, SavvyAnalysis on the data interpretation, on-condition maintenance over calendar-TBO. The A&P certificate is unavailable to the house-bound PI under current regulatory structure; the A&P-equivalent knowledge is fully available via free FAA handbooks and the Busch curriculum and the APS course; the Experimental Amateur-Built Repairman Certificate covers the operational need. The community matters — the Tech Counselor visit is the single highest-value out-of-house event and is also not strictly out-of-house because the counselor comes to him; EAA Chapter 226 at Anderson is the home chapter; Vansairforce is the central nervous system.

The PI’s restart sequence is, concretely: shop walkthrough, chapter contact and Tech Counselor request, three weeks of deliberate-practice protocol with logged pass-rate, Tech Counselor visit at the end of week three with written list of items to address, ailerons-and-flaps as the first new airframe work, left wing close-up, second Tech Counselor visit, QB fuselage and W-707A-R order, right wing, fuselage, finish kit, engine on order, FWF and avionics installation, DAR inspection, first flight with Flight Advisor, Phase I task-based, Repairman Certificate at sign-off, paint and interior post-Phase-I, then on-condition operation for life.

The competence the project builds — the recognition, the calibration, the troubleshooting, the willingness to drill out a bad rivet and accept the cost — is the deliverable. The airplane is the artifact. The calibrated owner-maintainer is the outcome.

The investigation’s load-bearing findings, in compressed form:

1. The library is a constellation, not a shelf. The Van’s-list canon has aged unevenly; the modern working library is composed across a dozen continuously-evolving and stable sources.
2. The contested choices have evidence-supported opinionated answers where evidence exists and community-consensus answers where it does not, and the discipline is being transparent about which is which.
3. The Layer 4 metacognition decay model is the central pedagogical observation for returning-amateur-project cases and generalizes past aviation.
4. Mike Busch’s reliability-centered-maintenance philosophy is mainstream for owner-maintainers in 2026 and is the correct adoption for the PI.
5. The PI’s house-bound constraint makes the A&P certificate unavailable but does not make the A&P-equivalent knowledge unavailable. The Experimental Amateur-Built Repairman Certificate covers his operational need.
6. The Tech Counselor program is the structurally elegant external-recalibration infrastructure the homebuilder community has independently invented; it is the highest-value single intervention in the re-onboarding plan.
7. The community network

in central Indiana is thinner than in stronger-cooperative regions; the chapter relationship is structurally more important for the PI than it would be elsewhere. 8. The unleaded-avgas transition is genuinely unsettled in 2026 and the RV-8 fuel system should be built to 100LL spec with retrofit expected. 9. The amateur-craft pursuit is a first-class adult capability-development infrastructure — Layer 3, 4, 5 competence at depth — and the MVA framing should treat it as such.

The PI knows much of this already. The work of the investigation is making the picture explicit, calibrated to the 2026 evidence, with the practitioner-domain confidence ratings honestly applied, and with the deliberate-practice frame extended to the returning-builder case. The picture composes; the airplane composes from it; the work begins.

Cross-references: taxonomy.md for §I; library-matrix.md and research-streams/library-extension.md for §II; best-build.md and research-streams/contested-choices.md for §III; skills-and-practice.md for §IV; research-streams/powerplant.md for §V; research-streams/ap-pathway.md for §VI; tools-survey.md for §VII; research-streams/communities.md for §VIII; cheat-sheet.md for the operational items in §IX; COMPETENCE-TARGET.md and learner-report.md for §X; practical-implications.md for §XI. gaps.md and dispatch-recommendations.md close.