DAGHER
TECHNICAL SOLUTIONS

The Production-Readiness Playbook

How to move hardware from a working prototype to qualified, repeatable production.

For
Aerospace · space · hardware

Readers
Founders, VPs, and engineers

From
Complexity to clarity

WHY THIS EXISTS

The prototype trap

A prototype proves an idea can work once. Production proves it works every time, on schedule, at cost, and to spec. The distance between those two sentences is where most hardware companies lose months — and sometimes their runway.

Capital has never flowed into hardware faster. Private space investment alone reached roughly **$12.4 billion in 2025**, up 48% year over year, and the median space-startup Series A has grown to about $15M. That money buys talent, tooling, and ambition. What it cannot buy off the shelf is the hard-won discipline of qualification and manufacturing readiness — the unglamorous engineering that turns a hand-built unit into a product.

This playbook lays out the path we use at Dagher Technical Solutions to close that gap. It is deliberately practical: a sequence, a set of checks, and the failure modes we see most often. An executive can read the structure in five minutes; an engineer can use the checklists on Monday.

HOW TO USE THIS DOCUMENT

Read it front-to-back once to internalize the arc. Then treat Sections 2–6 as standalone references — each maps to a stage of our methodology and ends with a checklist you can run against your own program.

What's inside

SECTION 1

The readiness gap

Teams rarely fail because the physics didn't work. They stall because the organization treated "it worked in the lab" as the finish line rather than the starting gun. Five gaps separate a prototype from a product. Naming them is the first step to closing them.

Gap	Prototype reality	Production requirement
Repeatability	Built once, by the person who designed it, with hand-fitting.	Built by anyone, the same way, to a documented process.
Design maturity	Geometry and materials that "work for now."	Tolerances, margins, and materials proven against the full environment.
Verification	A demo that showed the happy path.	A test campaign that proves requirements and exposes failure modes.
Manufacturability	Whatever the shop could make this week.	Designed for the chosen process, supply chain, and rate.
Traceability	Knowledge in one engineer's head.	Documented, version-controlled, and auditable.

THE PATTERN WE SEE MOST

Hardware that passes its demo and fails its first article.
A unit that performed beautifully in a controlled demo enters production and the first manufactured article fails — not because the design is wrong, but because nobody defined what "right" meant under real tolerances, real operators, and real environments. The fix is almost never heroic. It is a disciplined walk back through the five gaps before they compound.

The rest of this playbook is that walk, organized as the five stages we run with clients: **Discovery, Assessment, Roadmap, Implementation, and Optimization**. You can enter at any stage, but the sequence is deliberate — skipping Discovery is the single most common reason programs thrash later.

SECTION 2 · DISCOVERY

Define ”done” before you build

Most production problems are requirements problems wearing a costume. If the team cannot state precisely what production-ready means for this product, every downstream decision is a guess.

Establish the real requirements

Separate what the product must do from what the prototype happened to do. Capture the full operating envelope — not the lab bench. For aerospace and space hardware that means the environment the unit will actually see: thermal range, vibration, shock, vacuum or pressure, radiation, duty cycle, and service life.

- **Functional requirements:** what it does, measured in numbers with tolerances, not adjectives.
- **Environmental requirements:** the qualification environment, derived from the mission with margin.
- **Interface requirements:** mechanical, electrical, thermal, and data boundaries with neighboring systems.
- **Rate and cost targets:** how many units, how fast, at what unit cost — this shapes every design choice.

Write the definition of production-ready

This is the contract the whole program runs against. A useful definition is specific enough to be testable and honest enough to be uncomfortable:

A WORKABLE DEFINITION

"The design is production-ready when a unit built from released drawings, by trained personnel following released procedures, passes the full acceptance test against requirements — with documented margin, a closed failure history, and a supply chain that can sustain the target rate."

Surface the constraints early

Constraints are not obstacles to ignore; they are design inputs. The ones teams discover too late are usually organizational: a single-source supplier, a long-lead material, a certification that takes nine months, or a test facility with a six-week queue. Find them now, while they are cheap to plan around.

DISCOVERY CHECKLIST

- [ ] Requirements are quantified with tolerances and traceable to the mission.
- [ ] The qualification environment is defined with margin, not assumed.
- [ ] A written, testable definition of "production-ready" exists and is agreed.
- [ ] Rate, cost, and service-life targets are explicit.
- [ ] Long-lead items, single sources, and certification timelines are identified.

SECTION 3 · ASSESSMENT

Find the risk while it's cheap

Assessment is an honest audit of where you actually are against where production-ready requires you to be. Scored without flinching, it turns a vague sense of "we're close" into a specific list of what stands between you and a qualified product.

Score design maturity

Walk the design against its requirements and ask, for each critical feature: is the margin known, or assumed? A mature design has analysis or test behind its margins — structural, thermal, fatigue, tolerance stack-up. An immature one has confidence. Confidence is not margin.

Score test posture

List every requirement and ask how it will be verified — by inspection, analysis, demonstration, or test. Requirements with no verification method are requirements you have not actually committed to. Pay special attention to the environments: a unit that has never seen its thermal or vibration environment has not been tested, no matter how well it demos.

Score manufacturing readiness

Borrowed and simplified from the manufacturing-readiness-level framework used across aerospace and defense, the question at each step is the same: *can this be built repeatably, by the intended process, at the intended rate?*

Dimension	What "ready" looks like
Process	The manufacturing process is selected, proven on representative hardware, and documented.
Tooling & equipment	Required tooling exists or is scoped; no mystery fixtures invented at build time.
Supply chain	Sources qualified for critical materials and parts; lead times understood; risks have a plan.
Quality system	Inspection points, acceptance criteria, and nonconformance handling are defined (ISO 9001 / AS9100 aligned).
Workforce	Procedures are written so a trained operator — not the designer — can build the unit.

THE HONEST-SCORE RULE

Score against evidence, not intention. "We could do that" is a zero until there is hardware, data, or a released document behind it. The value of an assessment is entirely in its honesty; a flattering audit is worse than none.

SECTION 3 · ASSESSMENT (CONTINUED)

Map failure before it finds you

A structured look at how the product can fail is the highest-leverage hour in the program. A lightweight failure-modes review — formal FMEA if the program warrants it — asks three questions of every critical function:

1. **How can this fail?** Name the failure modes, not just the catastrophic ones.
2. **What happens when it does?** Trace the effect to the system and the mission.
3. **How would we catch it?** Detection in design, in test, or in acceptance — before the customer does.

Rank by a simple product of severity, likelihood, and detectability. The top handful of items become design changes, dedicated tests, or inspection points. Everything else is documented and watched. The goal is not a perfect register; it is a short, ranked list of the things most worth your attention.

ASSESSMENT CHECKLIST

- [ ] Every critical margin is backed by analysis or test, not assumption.
- [ ] Every requirement has a named verification method.
- [ ] Manufacturing readiness is scored across process, tooling, supply, quality, and workforce.
- [ ] A ranked failure-modes list exists, and the top items have owners.
- [ ] The assessment was scored against evidence, not intention.

Turn the audit into a risk picture

The output of Assessment is not a grade; it is a map. By the end you should be able to point at the two or three things most likely to keep you out of production — the immature margin, the untested environment, the single-source long-lead part — and say what you will do about each. That map is the input to the roadmap.

WHERE OUTSIDE HELP PAYS FOR ITSELF

Internal teams are often too close to score themselves honestly, and too busy shipping to run the audit at all. A focused external assessment — days, not months — frequently surfaces the one risk that would have cost a quarter. That is the entire premise of a diagnostic engagement.

SECTION 4 · ROADMAP

Sequence the work, gate the risk

A roadmap is not a list of tasks. It is a sequence of decisions, ordered so that the riskiest, most expensive-to-reverse choices are validated first — and structured around gates that the program must earn its way through.

Retire the biggest risks first

Order the work by risk, not by comfort. The temptation is to do the familiar tasks early because they feel like progress. Discipline means attacking the immature margin or the untested environment first, because those are the items that can invalidate everything built on top of them.

Use real gates

Borrow the gate structure that aerospace programs use, scaled to your size. Each gate is a go/no-go with defined entry and exit criteria — not a calendar date, but an evidence threshold.

PDR **Preliminary Design Review**

The design approach is sound and the requirements are met on paper, with analysis behind the critical margins.

CDR **Critical Design Review**

The design is detailed, manufacturable, and ready to build; drawings and the test plan are essentially complete.

TRR **Test Readiness Review**

Hardware, procedures, and facilities are ready; the qualification campaign can begin.

PRR **Production Readiness Review**

Qualification is complete, the process is proven, and the supply chain can sustain the rate.

RIGHT-SIZE THE RIGOR

A two-person team building a bracket does not need the same review apparatus as a propulsion program. The principle scales down cleanly: keep the *gates* and their evidence thresholds, lighten the ceremony. The point is earned confidence, not paperwork.

Every roadmap item gets an owner and a measurable exit. "Improve thermal margin" is not a task; "demonstrate ≥ 20% thermal margin by test at the qualification limit, owned by [engineer], by [gate]" is.

SECTION 5 · IMPLEMENTATION

Qualify it — and prove you can build it

Implementation is where the plan meets hardware. Two things have to happen in parallel: the design has to be qualified against its environment, and the manufacturing process has to be proven against the rate. Neglect either and "production-ready" is a claim, not a fact.

Build a test strategy, not a test list

A strategy decides what each test is for. Group your campaign into the three jobs tests do:

- **Development tests** buy information — they tell you whether a design choice works before you commit to it.
- **Qualification tests** prove the design survives the environment with margin, typically beyond the acceptance levels.
- **Acceptance tests** screen every flight or delivery unit for workmanship — run on production hardware, forever.

The most common mistake is conflating them: demonstrating a function once and calling it qualified, or qualifying a design and never defining the acceptance test that production will live by.

Specify the test stand deliberately

For most hardware programs the test stand is a product in its own right, and an underspecified one becomes the bottleneck. Decide early whether you need a temporary rig or a permanent, calibrated, documented stand — and treat its design, safety, and data system with the same rigor as the article under test.

A FAILURE INVESTIGATION IS A GIFT

When something fails on the stand, resist the urge to "fix and move on." A disciplined root-cause investigation — what failed, why, why it wasn't caught, and what else shares the mechanism — is how a single failure prevents a fleet of them. The teams that qualify fastest are the ones that learn the most from each anomaly.

The manufacturing handoff

A design is not production-ready because it can be built; it is production-ready when it can be built by someone other than its designer, repeatably, with the failures designed out rather than inspected out. The handoff from engineering to manufacturing is where that is won or lost.

Design for the process you'll actually use

Design-for-manufacturing-and-assembly (DFMA) is not a late cleanup step; it is a design input from the start. Match features to the chosen process, reduce part count, design assemblies that can only go together correctly, and eliminate the hand-fitting that a prototype tolerates and a production line cannot.

Release a real data package

The unit travels with its documentation. A production-ready package is complete enough that the program survives the departure of any single engineer:

Artifact	Why it matters
Released, version-controlled drawings	The single source of truth for what "correct" is.
Work instructions & travelers	Let a trained operator build the unit the same way every time.
Inspection & acceptance criteria	Define pass/fail objectively, before parts are made.
Bill of materials & approved sources	Protect against substitution and supply surprises.
Nonconformance process	A defined path for what happens when something is out of spec.

IMPLEMENTATION CHECKLIST

- [ ] Development, qualification, and acceptance tests are distinct and defined.
- [ ] The qualification campaign proves margin against the real environment.
- [ ] An acceptance test exists that every production unit will pass through.
- [ ] Failures get root-cause investigations, not patches.
- [ ] A complete, released data package travels with the hardware.

SECTION 6 · OPTIMIZATION

Make it repeatable, then make it efficient

Reaching first production is the milestone teams celebrate. Staying in production — at yield, at rate, without heroics — is the one that determines whether the company scales. Optimization is the discipline of removing the firefighting.

Watch yield and first-pass acceptance

The clearest signal of true production readiness is first-pass yield: the fraction of units that pass acceptance the first time, with no rework. A low or erratic yield says the process is not actually under control, regardless of what the qualification report claims. Track it, chart it, and treat every excursion as a root-cause opportunity.

Close the loop from the floor to the design

The manufacturing floor is the richest source of design feedback in the company. Nonconformances, rework notes, and operator workarounds are data. A team that feeds that data back into design and documentation gets compounding returns; a team that ignores it relearns the same lesson every build.

Build the system, not just the unit

The end state is an organization where production does not depend on any one person being in the room. That means living documentation, a functioning quality system, defined roles, and the kind of tribal knowledge captured in procedures rather than carried in heads. This is also where focused, secure AI tools earn their place — a well-built knowledge base that lets a technician query assembly steps or a reviewer find precedent fast, without putting IP or ITAR posture at risk.

OPTIMIZATION CHECKLIST

- [ ] First-pass yield is tracked and trending the right way.
- [ ] Floor feedback flows back into design and documentation.
- [ ] Production survives the absence of any single engineer.
- [ ] Knowledge lives in systems and procedures, not just people.

SECTION 7

The readiness scorecard

Run your program against these ten statements. Score each: **2** if it's true with evidence, **1** if it's partly true, **0** if it's aspirational. Total honestly.

#	Statement	Score
1	Requirements are quantified, toleranced, and traced to the mission.	
2	A written, testable definition of "production-ready" is agreed across the team.	
3	Every critical margin is backed by analysis or test.	
4	Every requirement has a named verification method.	
5	The design has been tested against its real qualification environment, with margin.	
6	A ranked failure-modes list exists and its top items have owners.	
7	Manufacturing readiness is scored across process, tooling, supply, quality, and workforce.	
8	An acceptance test exists that every production unit passes through.	
9	A complete, released, version-controlled data package travels with the hardware.	
10	First-pass yield is tracked, and production doesn't depend on one person.	

15–20 · PRODUCTION-READY

You have the discipline in place. Focus on yield, documentation, and removing single points of failure.

8–14 · CLOSING THE GAP

The path is clear but real risks remain. Prioritize the lowest-scoring items before scaling the build.

0–7 · STILL A PROTOTYPE

Producing now will be expensive and slow. A focused Discovery and Assessment pass will save far more than it costs — this is exactly the moment outside help has the highest leverage.

WORK WITH US

From complexity to clarity.

Dagher Technical Solutions helps aerospace, space, and advanced-hardware teams close the readiness gap — combining hands-on engineering with the management discipline to scale it. If this playbook surfaced a risk worth a conversation, that's exactly where we start.

A simple path to begin

01 Intro call

A 30-minute conversation about your goals and where you're stuck. No charge.

02 Diagnostic assessment

A focused audit — days, not months — that turns ambiguity into a prioritized plan.

03 Engagement

Project, retainer, or fractional leadership — matched to what will move your program.

EMAIL	EMAIL_HERE
SCHEDULE	Book a 30-minute intro call · CALENDLY_LINK_HERE
PHONE	PHONE_HERE
LINKEDIN	LINKEDIN_URL_HERE