

# Moduloa Manufacturing — Vision, Thesis, Strategy and Execution Plan

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Moduloa Manufacturing sets out to turn manufacturing from fixed factory relationships into modular, certified, portable production capacity that behaves more like infrastructure — configurable, routable, and deployable across certified hubs. The central belief is that humanoid robotics and physical AI will erode the labor-cost advantage of low-wage regions, so production location comes to depend on product design, BOM structure, energy, logistics, tariffs, taxes, risk, and proximity to demand rather than wages. Moduloa is not a traditional contract manufacturer: the first factory is proof-of-work, and the scalable asset is the framework — factory OS, production tiers, certified hubs, tooling standards, training, data, and routing intelligence. This is a working strategic document for the pre-market period, written to be versioned and audited, not to be proven true today.

A 3D printer makes geometry portable. Moduloa Manufacturing should make production flows portable.

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# 1 Executive summary

This document compiles the Moduloa Manufacturing thesis developed through the discussion. It is written as a working strategic document, not a public pitch. Its purpose is to capture the vision, the assumptions, the business model, the technical architecture, the risks, and the plan before the market fully exists.

The central belief is that humanoid robotics and physical AI will change the economics of manufacturing. If humanoid robots become reliable enough for factory work, the historic advantage of low-cost human labor will weaken. Manufacturing location will depend less on wage arbitrage and more on product design, BOM structure, energy, logistics, tariffs, taxes, risk, automation readiness, production tier, and proximity to demand.

Moduloa Manufacturing is not intended to be a traditional contract manufacturer. It is intended to become a manufacturing framework and infrastructure company. The first factory is the proof-of-work. The scalable asset is the framework: factory OS, production tiers, modular cells, certified hubs, quality systems, tooling standards, training, data, and production routing intelligence.

The long-term model is a certified manufacturing capacity network. Products are industrialized into production tiers and production blueprints. Low tiers prioritize speed and low upfront engineering; high tiers prioritize repeatability, low unit cost, traceability, and portability between hubs.

Existing factories can eventually be converted into certified Moduloa hubs. This is the scalable part of the thesis. Moduloa does not need to own every factory — it needs to own or control the standard that makes factories interoperable.

| STATEMENT                                | MEANING                                                                                                          |
|------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| Manufacturing capacity as infrastructure | Customers access production capacity as a configurable resource, not only as a one-to-one supplier relationship. |
| Production flows become portable         | The process knowledge is encoded into validated production blueprints that can move between certified hubs.      |
| Humanoids are the execution layer        | Humanoid robots make physical reconfiguration possible with lower fixed-automation burden.                       |
| Factory OS is the control layer          | Software manages revisions, layout, stations, tools, quality, WIP, robot tasks, capacity, and traceability.      |
| Hub certification is the trust layer     | Factories become comparable and routable because their capability is measured and certified.                     |
| Moduloa Academy is the talent layer      | A new robot-era production technologist role is needed to operate this model.                                    |

## 2 The core thesis

The thesis is that humanoid robotics and physical AI will create a new manufacturing era.

As humanoid robots become reliable enough for practical factory work, the historical advantage of low-cost human labor will be reduced. Manufacturing will no longer be decided mainly by where people can assemble products cheapest. Instead, the decisive factors become product design, BOM structure, energy cost, logistics, automation readiness, production tier, factory capability, supply-chain risk, tariffs, taxes, and proximity to final demand.

This shift can make high-wage, engineering-heavy, energy-rich countries like Norway competitive in manufacturing again — but only if the manufacturing system is designed differently from today.

The goal is not to copy Asia's labor-heavy manufacturing model, and not to build a traditional lights-out factory. Traditional lights-out factories are very efficient, but often rigid, capital-heavy, and suited mainly to stable high-volume production. The goal is a humanoid-native, modular, reconfigurable factory system.

A customer should not be locked into one factory, one relationship, one country, or one strategic manufacturing partner. Instead, their product should be industrialized into a production tier and a portable production blueprint. If the product is engineered to a high enough tier, that production flow can be deployed in different certified hubs depending on demand, shipping cost, tariffs, taxes, political risk, war, natural disasters, energy cost, or proximity to the customer.

**One-paragraph thesis** Moduloa Manufacturing is based on the thesis that humanoid robotics and physical AI will reduce the labor-cost advantage of low-wage manufacturing regions and create a new opportunity for modular, reconfigurable, high-traceability production in countries like Norway. The goal is a manufacturing model where products are industrialized into production tiers and portable production blueprints, allowing production to be deployed across certified hubs based on demand, logistics, tariffs, taxes, energy, risk, and proximity to the final customer. Humanoid robots are the key enabling layer because they can make factory reconfiguration physically flexible. The long-term aim is to make manufacturing capacity configurable, portable, and globally deployable.

### 3 Why humanoids matter

Humanoids are not just another automation tool. In this thesis, they are the flexible physical execution layer that makes modular production practical.

Machine vision, cobots, AMRs, automated inspection, AI-generated work instructions, industrial data systems, and digital twins are all important. But on their own, these technologies often remain highly integrated, rigid, or dependent on human operators. Humanoids may be the missing physical layer that lets these puzzle pieces compound.

The reason is not that humanoids eliminate tooling, standards, or process engineering — they do not. The reason is that humanoids may reduce the need to engineer every physical action into fixed automation. Instead of building a dedicated automation line for every product, a factory can be designed around human-readable workstations, modular infrastructure, robot-compatible fixtures, and software-defined production flows.

The full factory should therefore not be built now and later retrofitted with humanoids. The first true Moduloa factory should be built when humanoids are ready enough to be foundational. The current phase is learning, doctrine-building, network-building, and system design.

| HUMANOIDS MAY PERFORM                         | WHY IT MATTERS                                                                       |
|-----------------------------------------------|--------------------------------------------------------------------------------------|
| Move carts, tools, fixtures, and WIP          | Allows the factory layout to physically reconfigure without a human logistics team.  |
| Load and unload test stations                 | Connects flexible assembly with repeatable automated test infrastructure.            |
| Scan, label, and verify workstations          | Creates a loop between the digital configuration and the physical factory.           |
| Perform simple assembly and material handling | Reduces dependence on human labor without requiring fixed automation for every step. |
| Inspect layout and self-correct deviations    | Reduces configuration drift and supports higher-trust reconfiguration.               |
| Use standardized tools and fixtures           | Makes modular tooling and robot task libraries commercially valuable.                |

## 4 The economic shift

The economics are not simply "robots make everything cheaper." The deeper shift is that the cost drivers change.

Today, many manufacturing decisions are driven by labor cost, established supplier ecosystems, private factory relationships, tooling access, and opaque supplier knowledge. In the Moduloa model, the decision moves toward total landed cost, BOM structure, hub capability, production tier, logistics, energy, risk, and demand proximity.

| TRADITIONAL MANUFACTURING ECONOMICS           | MODULOA MANUFACTURING ECONOMICS                                          |
|-----------------------------------------------|--------------------------------------------------------------------------|
| Labor rate is central                         | Robot/capacity cost, uptime, energy, and engineering become more central |
| Supplier relationships are private and sticky | Certified hubs become comparable and routable                            |
| Process knowledge sits inside one factory     | Process knowledge is encoded into a production blueprint                 |
| Price is negotiated case by case              | Pricing can be tier-based and capacity-based                             |
| Switching factories is difficult              | Switching becomes part of the productized model at higher tiers          |
| Production often follows cheap labor          | Production follows BOM, logistics, demand, tariffs, energy, and risk     |

The strongest economic statement is not that every country will have exactly the same unit price. That is too absolute. Energy, capital cost, taxes, logistics, currency, hub maturity, and local supplier depth will still matter. The better statement is this:

**Cost compression thesis** Moduloa does not make all locations equal. It compresses the labor-driven cost gap enough that logistics, demand location, resilience, tariffs, taxes, energy, and material proximity become more important in the production-location decision.

The BOM becomes a strategic routing document. It determines not only what a product costs, but where it should be produced, which components dominate shipping cost, which suppliers must be close, which parts should be localized, and which production tier is economically justified.

| COST DRIVER | TRADITIONAL QUOTE       | MODULO A QUOTE                                     |
|-------------|-------------------------|----------------------------------------------------|
| BOM         | Component cost input    | Component cost plus routing logic                  |
| Labor       | Major unit-cost driver  | Reduced relative importance if robots are reliable |
| NRE         | Setup and tooling cost  | Production blueprint maturity cost                 |
| Tooling     | Factory-specific assets | Portable or hub-compatible tooling package         |
| Capacity    | Implicit in lead time   | Reserved, priced, and routable                     |
| Risk        | Often hidden            | Explicit location and supplier risk allocation     |
| Logistics   | Freight add-on          | Core routing variable                              |
| Quality     | Inspection plan         | Trust layer for hub certification                  |

## 5 Software-defined manufacturing

Future factories can be software-defined. This does not mean the physical world becomes as easy as software. It means physical production can be represented, controlled, validated, and deployed with software-like discipline.

The best analogy discussed was a GitHub-style flow for manufacturing. A production engineer works on a proposed production flow in a controlled environment. The change is reviewed, validated, risk-assessed, and approved. Only then is it released to the factory. Humanoid robots and modular infrastructure then execute the physical reconfiguration.

| SOFTWARE ANALOGY | MANUFACTURING EQUIVALENT                                      |
|------------------|---------------------------------------------------------------|
| Repository       | Factory configuration database                                |
| Branch           | Proposed production flow or layout change                     |
| Pull request     | Engineering change proposal                                   |
| Code review      | Production engineering, quality, and safety review            |
| CI pipeline      | Simulation, cost, capacity, safety, and quality validation    |
| Merge to main    | Released production configuration                             |
| Deployment       | Robots and workers reconfigure the factory                    |
| Monitoring       | OEE, quality, WIP, deviations, and robot intervention metrics |
| Rollback         | Controlled physical rollback or WIP policy execution          |

The key point is change control. Things should not change because someone moved a cart or improvised a station. They change because an approved production flow changed. This makes the factory more auditable, more transferable, and more scalable.

Physical rollback is harder than software rollback. Some changes cannot be fully reversed without scrapping WIP, moving materials, or revalidating safety zones. The system therefore needs rollback classes and WIP policies.

## 6 Production tiers

The production tier model is central because customers do not all need the same level of engineering. Some need fast-start, flexible production. Others need highly validated, low-unit-cost, portable production. The tier model turns this into a commercial structure.

| TIER   | MEANING                                                                   | BEST FOR                                                            | TRADEOFF                                                       |
|--------|---------------------------------------------------------------------------|---------------------------------------------------------------------|----------------------------------------------------------------|
| Tier 1 | Fast-start flexible production with low upfront engineering               | 20 high-value specialized units per year, prototypes, urgent builds | Higher unit cost, less repeatability, low portability          |
| Tier 2 | Lightly standardized recurring production                                 | Pilot series and early recurring batches                            | Some process control, still limited portability                |
| Tier 3 | Modular production cell with controlled flow                              | Stable batches and recurring products                               | Medium NRE, better repeatability                               |
| Tier 4 | Validated reconfigurable line with strong quality and traceability        | Medium/high-volume mechatronic products                             | Higher upfront cost, stronger control                          |
| Tier 5 | Portable press-play production blueprint deployable across certified hubs | Long-life products, high-volume demand, global optionality          | Highest upfront engineering, lowest long-term flexibility risk |

The commercial logic: customers do not only buy production. They buy a production tier.

A Tier 1 customer may accept high unit cost because speed and low upfront cost matter more than optimization. A Tier 5 customer may pay large NRE because repeatability, portability, and long-term optionality matter more.

| COMMERCIAL QUESTION                       | TIER IMPLICATION                          |
|-------------------------------------------|-------------------------------------------|
| Is the product uncertain?                 | Prefer Tier 1 or Tier 2.                  |
| Is volume recurring but moderate?         | Prefer Tier 3.                            |
| Is quality and traceability critical?     | Prefer Tier 4 or Tier 5.                  |
| Does the customer need backup production? | Prefer Tier 4 or Tier 5.                  |
| Does the customer need global deployment? | Prefer Tier 5.                            |
| Is time-to-market the main driver?        | Prefer a lower tier first, upgrade later. |

## 7 The factory operating system

The factory OS is not simply an MES. It is the control layer for reconfigurable production. It should eventually manage product, process, layout, tooling, quality, traceability, robot tasks, hub certification, and capacity allocation.

| OBJECT           | WHAT THE FACTORY OS SHOULD KNOW                                                 |
|------------------|---------------------------------------------------------------------------------|
| Product          | Part number, revision, BOM, demand, customer requirements                       |
| Production flow  | Revision, station sequence, cycle time, quality gates, WIP policy               |
| Station          | Capabilities, location, utilities, safety zones, compatible tasks               |
| Tool             | ID, revision, calibration, storage, compatibility, maintenance                  |
| Fixture          | ID, revision, product compatibility, datum strategy, storage, validation status |
| Robot task       | Skill, tool required, success rate, safety limits, expected cycle time          |
| Hub              | Certification tier, capacity, equipment, supplier access, quality history       |
| Quality record   | Inspection results, test data, deviations, rework, traceability                 |
| Capacity slot    | Reserved time, available time, cost, customer allocation                        |
| Routing decision | Cost, risk, shipping, tariffs, energy, demand proximity                         |

A normal factory gains experience. Modulooa should convert experience into structured, reusable knowledge. This is where the manufacturing data loop becomes a moat.

## 8 Modular infrastructure and tooling

Modular infrastructure is mandatory for higher tiers. It may be optional or lighter for lower tiers. The important design principle is to standardize interfaces, not necessarily every product.

- Modular assembly workbenches with known footprint, power, network, and robot-access sides.
- Robot-readable tool racks with registered tool IDs and locations.
- Fixture storage with revision control and calibration status.
- WIP racks with clear product, status, and batch identification.
- Quarantine areas for deviations, nonconforming parts, and controlled holds.
- Robot docks and charging areas.
- Test stations with known interface, capacity, and data output.
- Material carts designed to be moved by humanoids or AMRs.
- Packing stations, label stations, and inspection stations as predefined blocks.

Toolmaking is one of the largest missing capabilities in Norway. The first local capability should not necessarily be complex molds and dies. It should be production aid engineering: fixtures, jigs, test rigs, grippers, nests, gauges, calibration aids, and modular workholding.

Humanoids do not remove the need for tooling. They increase the value of good tooling, because the interface between robot, product, and process becomes a strategic asset.

## 9 Production routing and global hubs

The long-term Moduloa network should answer a different question than a normal manufacturer. Not "how cheaply can this factory produce it?" but "which production tier and hub combination gives the best total cost, flexibility, risk, and portability for this product?"

This makes production routing a core capability. Production routing is not logistics routing. It is manufacturing routing — deciding where production should happen based on BOM, demand, hub capability, risk, and economics.

| ROUTING INPUT               | WHY IT MATTERS                                                                     |
|-----------------------------|------------------------------------------------------------------------------------|
| Demand location             | Production should move closer to where finished goods are needed.                  |
| BOM structure               | Heavy, low-value, or fragile components may determine the ideal production region. |
| Supplier geography          | Critical components may pull production toward their supply base.                  |
| Hub certification tier      | Only certain hubs can run certain production tiers.                                |
| Capacity availability       | The best hub is useless if capacity is unavailable.                                |
| Energy cost                 | Robot-heavy production links productivity to energy and uptime.                    |
| Tariffs and taxes           | Location choice can materially change landed cost.                                 |
| Political and war risk      | Customers may pay for optionality and backup production.                           |
| Shipping cost and lead time | Shorter supply chains reduce cost and risk.                                        |
| Quality history             | Hub selection must include actual performance data.                                |

In the short term, products may be produced near the highest shipping-cost or most critical material/component. In the long term, as certified hubs and supplier clusters mature, production should move closer to final demand.

The scalable model is to build one hub to learn, then convert many hubs to scale. Existing factories already have buildings, power, people, machines, local suppliers, and industrial culture. Moduloa adds the framework: factory OS, production tiers, quality system, training, modular standards, hub certification, and routing logic.

## 10 Business model

The business must not rely only on production margin. A factory-only business is capital-heavy and may not become venture-scale. The scalable value is in owning the framework that makes manufacturing capacity portable.

| REVENUE STREAM             | DESCRIPTION                                                                      |
|----------------------------|----------------------------------------------------------------------------------|
| Production services        | Direct manufacturing of customer products.                                       |
| NRE and engineering fees   | DfM, process design, work instructions, validation, and industrialization.       |
| Tier upgrade fees          | Moving a product from fast-start production to validated or portable production. |
| Tooling and fixtures       | Jigs, grippers, nests, test rigs, gauges, and modular workholding.               |
| Capacity reservation       | Customers pay to secure future production capacity.                              |
| Blueprint deployment fees  | Deploying a validated production flow into another hub.                          |
| Factory OS subscription    | Software layer for hubs and customers.                                           |
| Hub certification fees     | Assessing, certifying, and auditing partner factories.                           |
| Moduloa Academy            | Training and certification of robot-era production technologists.                |
| Transaction fees           | Fee on production routed through the network.                                    |
| Modular cell packages      | Standardized workcells, stations, carts, and tooling packages.                   |
| Manufacturing intelligence | Anonymized benchmarks, cost models, task libraries, and process learning.        |

The strongest investor framing: the scarce resource will not be the humanoid robots themselves. The scarce resource will be the manufacturing system that can use them productively.

## 11 Norway and Asia

### Norway

Norway has high labor cost, which is currently a structural disadvantage for manufacturing. But if humanoids reduce the labor-cost gap, Norway's advantages become more relevant: energy access, engineering competence, offshore and maritime experience, aquaculture, food-processing automation, trust, quality culture, and a strategic need for resilient local production.

Norway's weakness is practical manufacturing depth. The largest missing layer may be toolmakers and production industrialization competence. Moduloa should help rebuild this layer over time.

### Asia

Asia remains essential. It has manufacturing depth, tooling ecosystems, supplier density, NPI discipline, and production scale that Norway does not currently have. The near-term path is not to replace Asia, but to learn from Asia, use Asian tooling and production knowledge where needed, and gradually rebuild selected capabilities locally.

Asia is also important because the model may eventually reduce the strategic lock-in power of traditional manufacturers. Strong Asian manufacturers may become valuable certified hubs or suppliers. Relationship-dependent manufacturers may resist the model.

## 12 Learning roadmap before humanoids are ready

The objective before humanoids are ready is to learn the full stack around humanoid manufacturing. The target is not specialist mastery in every field. The target is system-level competence: the ability to turn a product into a validated, traceable, portable production flow.

| DOMAIN                     | WHAT TO LEARN                                                                                                       |
|----------------------------|---------------------------------------------------------------------------------------------------------------------|
| Manufacturing fundamentals | DfM, DFA, tolerance stack-up, cycle time, line balancing, ECOs, NCRs, RMA loops, and process validation.            |
| Production economics       | Unit cost, NRE, tooling amortization, capacity reservation, utilization, ROI, payback, and tier pricing.            |
| Tooling and fixtures       | Jigs, nests, grippers, gauges, test rigs, quick-change tooling, and fixture metadata.                               |
| Quality and traceability   | ISO 9001 thinking, inspection plans, control plans, CAPA, 8D, calibration, serial traceability, and audit trails.   |
| Modular factory design     | Layout, material flow, WIP zones, cells, utilities, ESD, safety zones, and modular blocks.                          |
| Industrial automation      | PLC, sensors, vision, cobots, AMRs, screwdriving, dispensing, labeling, OPC UA/MQTT, and safety circuits.           |
| Robotics and humanoids     | Manipulation, navigation, force control, end-effectors, reliability, fleet management, and intervention rates.      |
| Factory software           | MES, ERP, PLM, QMS, WMS, CMMS, APIs, databases, digital thread, and configuration management.                       |
| Supply chain               | Supplier qualification, MOQ, lead time, incoterms, tariffs, safety stock, dual sourcing, and geopolitical risk.     |
| Compliance and safety      | CE, machine safety, risk assessment, functional safety, ESD, product liability, and export controls.                |
| Commercial model           | Platform economics, SaaS, transaction fees, licensing, hub certification, capacity marketplace, and investor logic. |
| Leadership and culture     | Recruiting, advisors, partnerships, industrial sales, contracts, government relations, and training systems.        |

The first 90 days should produce artifacts, not only notes: a Moduloa Manufacturing Handbook skeleton, a production tier calculator, a hub readiness scorecard, a modular cell library, a robot task library, and a production flow template.

### 13 Hadrian benchmark

Hadrian is the closest public analogue found so far to parts of the Moduloa thesis. It is an advanced manufacturing company founded by Chris Power, originally from Australia, and positioned around software-defined, AI-powered manufacturing for aerospace, defense, maritime, and related high-value supply chains.

Based on the research, Hadrian is not a direct copy of Moduloa. It is better understood as a vertically integrated, software-driven manufacturing platform that owns and/or operates capacity itself. Its offer appears to include precision components, Manufacturing-as-a-Service, and Factories-as-a-Service. Its stack includes Opus as a factory autonomy platform, Atlas as a supply-chain/NPI orchestration layer, and acquisitions/partnerships such as Datum Source and Dirac.

Hadrian validates several parts of the Moduloa thesis: factory logic can be productized, capacity can be standardized, software can become a manufacturing moat, and production can move into more modular, software-defined forms. However, Hadrian is more closed, centralized, and US-centered than the Moduloa vision.

| DIMENSION         | HADRIAN                                                           | MODULOA                                                                                           |
|-------------------|-------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| Core model        | Vertically integrated owner-operator with proprietary software    | Certified hub network and portable production framework                                           |
| Geography         | Strong US defense reindustrialization focus                       | Global/allied and geography-agnostic over time                                                    |
| Factory ownership | Builds, owns, or operates capacity directly                       | Build one hub to learn, convert many hubs to scale                                                |
| Software          | Opus factory autonomy and Atlas supply-chain layer                | Factory OS for tiers, routing, hub certification, and robot task libraries                        |
| Customers         | Aerospace, defense, maritime, and national security supply chains | High-value mechatronics first, later broader certified manufacturing capacity                     |
| Humanoids         | No public evidence of a humanoid-native strategy found            | Humanoids are the central future execution layer                                                  |
| Network model     | Managed supplier network and customer-site cells                  | Certified, routable, licensable/franchise-capable hub network                                     |
| Differentiation   | Execution, capital, defense trust, and factory software           | Portability, certification, routing, existing-factory conversion, and humanoid-native flexibility |

**Hadrian lessons for Moduloa** (the document numbers these items 18–25 continuously):

18. Start with a sharp wedge, not the whole future. 19. Build real manufacturing capability, not only software. 20. Use one concrete production problem to prove the model. 21. Build proprietary software around actual factory work. 22. Show throughput, quality, cost, and capacity — not only vision. 23. Use high-value customers where speed and trust matter. 24. Avoid becoming only an owned-factory business if the goal is venture-scale. 25. Use Hadrian as a benchmark, competitor watch, and possible strategic dialogue target.

**Strategic conclusion:** Hadrian is evidence that the market is beginning to value software-defined manufacturing infrastructure, but Moduloa's intended differentiation is certification, portability, hub conversion, franchise/licensing, and humanoid-native reconfigurability.

## 14 Risk register

| RISK                         | WHY IT MATTERS                                                     | MITIGATION                                                                            |
|------------------------------|--------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Humanoid timing              | The core model may arrive later than expected.                     | Build transferable manufacturing, tooling, quality, and automation competence now.    |
| Humanoid reliability         | Factories need low intervention rates, not one-off demos.          | Track task success, MTBI, cycle time, maintenance, and safe failure modes.            |
| Capital intensity            | Owned factories and robotics can consume large capital.            | Use a pilot hub first, then convert existing factories into certified hubs.           |
| Customer trust               | Customers may resist portable production for critical products.    | Start with controlled tiers, strong traceability, and a backup-hub value proposition. |
| Quality escapes              | One hub failure can damage the whole network.                      | Strict certification, audits, stop authority, and traceability.                       |
| Configuration drift          | Physical layout can diverge from digital layout.                   | Daily robot/camera verification, fixture IDs, tool scans, and deviation rules.        |
| WIP complexity               | Reconfiguration can conflict with partially completed production.  | Define WIP policies: complete, quarantine, transfer, freeze, or scrap.                |
| Incumbent resistance         | Traditional manufacturers may see the model as commoditizing them. | Position Moduloa as demand, software, and an upgrade path for strong factories.       |
| Software scope creep         | The factory OS can become too large too early.                     | Start with a minimal production flow data model and expand from real needs.           |
| Regulatory/compliance burden | Defense, maritime, medical, and aerospace require strict controls. | Choose the first market wedge carefully; build quality discipline from day one.       |

## 15 Future audit log

Future claims are recorded here so they can later be reviewed honestly. The following are the key statements to audit in 5, 10, 20, and 30 years. (The document numbers these items 26–45 continuously.)

26. Humanoids become industrially useful within roughly 2–5 years. 27. Humanoid adoption ramps strongly within 5–10 years. 28. Humanoid cost drops significantly as production scales. 29. Humanoids reduce the labor-cost advantage of low-wage countries. 30. Manufacturing becomes more dependent on BOM, energy, logistics, automation readiness, and production tier. 31. High-wage countries like Norway become more competitive in selected manufacturing categories. 32. Toolmaking and fixture competence become a critical missing capability in Norway. 33. Traditional manufacturers lose some strategic power because process knowledge becomes portable. 34. Customers pay for manufacturing optionality and backup production capacity. 35. Production blueprints become portable across certified hubs. 36. Existing factories can be converted into certified network hubs. 37. A tiered production model becomes commercially useful. 38. Factory OS becomes central to flexible, robot-native manufacturing. 39. Manufacturing capacity becomes more like infrastructure or cloud capacity. 40. The model combines Airbnb-style distributed capacity, Uber-style routing, and McDonald's-style operating standards. 41. The moat becomes the framework, data, certification, tooling, training, and production-flow system — not the robots themselves. 42. Robot tooling and robot-compatible equipment become a high-margin market. 43. Norway develops or needs a new robot-era production technologist role. 44. A Moduloa hub model proves more valuable than traditional contract manufacturing for high-mix mechatronic products. 45. If the thesis fails, the biggest wrong assumption is likely timing, humanoid reliability, capital intensity, or customer willingness to trust portable production.

## 16 Stage 0 execution plan

Stage 0 is the pre-factory period. The goal is not immediate fundraising. The goal is thesis testing, network building, manufacturing learning, artifact creation, and credibility development.

| PERIOD       | FOCUS                                                | OUTPUTS                                                                                       |
|--------------|------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| 0–3 months   | Create doctrine and basic artifacts                  | Thesis v0.2, production tier model, cost calculator, hub scorecard, contact map               |
| 3–6 months   | Interview and validate                               | 10–20 expert calls, revised thesis, first partner/customer hypotheses                         |
| 6–12 months  | Build practical proof artifacts                      | Factory OS data model sketch, modular cell library, tooling standard v0.1, sample quote model |
| 12–24 months | System design and pilot preparation                  | Pilot product category, candidate hub criteria, advisor group, funding logic                  |
| 24–36 months | Humanoid readiness monitoring and first pilot design | Humanoid readiness scorecard, robot task library, pilot hub plan, investor thesis v0.5        |

### Priority people and institutions to learn from

The contact strategy should include manufacturing experts, robotics experts, factory software companies, supply-chain thinkers, industrial investors, Asian manufacturing ecosystems, and Norwegian industrial competence environments. The goal is not to pitch everyone. The goal is to learn what would make the thesis wrong or stronger.

- **Manufacturing and operations:** Toyota Production System thinkers, Torbjørn Netland, SINTEF Manufacturing, Raufoss industrial environments.
- **Supply chain and production routing:** David Simchi-Levi, Yossi Sheffi, Hau Lee, global EMS and contract manufacturing experts.
- **Robotics and humanoids:** Toyota Research Institute, Boston Dynamics AI Institute, UC Berkeley robot learning, 1X, Unitree, and the China robotics ecosystem.
- **Factory software:** Tulip, Siemens Digital Industries, Nvidia Omniverse/Isaac/physical AI, PTC, Dassault Systemes, Rockwell.
- **Asia manufacturing:** Foxconn, Pegatron, Quanta, Wistron, the TSMC ecosystem, BYD, DJI, the Shenzhen tooling ecosystem, Japanese automation companies.
- **Norway/Nordics:** SINTEF, Raufoss Catapult, Intek, Mechatronics Innovation Lab, NTNU, Innovation Norway, Siva, RunwayFBU, Nysno.

### Stage 0 outreach framing

Do not open by saying the goal is to make traditional manufacturers less valuable. Analytically, the model may reduce their lock-in. Commercially, the message should be adapted by audience.

| AUDIENCE   | POSITIONING                                                                               |
|------------|-------------------------------------------------------------------------------------------|
| Customers  | Reduce supplier lock-in and increase production optionality.                              |
| Factories  | Increase utilization and upgrade into the robotic manufacturing era.                      |
| Investors  | Build the platform layer that standardizes and routes global manufacturing capacity.      |
| Government | Create resilient local production capability without building every factory from scratch. |
| Experts    | Stress-test a thesis about robot-native, portable manufacturing capacity.                 |

## 17 Reference sources and evidence notes

This document is primarily based on the conversation and working thesis. The Hadrian section also draws on public research gathered during the Hadrian analysis. Because Hadrian is private, some financial and operational details rely on public press releases, public filings, partner releases, government announcements, and media reporting, not audited public financial statements.

Hadrian-related public sources used in the analysis:

- Hadrian official website — <https://www.hadrian.co/>
- Hadrian About — <https://www.hadrian.co/about>
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*This document should be treated as a living thesis, and it should be versioned. The purpose is not to prove the thesis true today. The purpose is to build a disciplined learning path toward the point where humanoid-native manufacturing becomes practical enough to test in the physical world.*

*Small steps · Smart systems · Lasting work.*