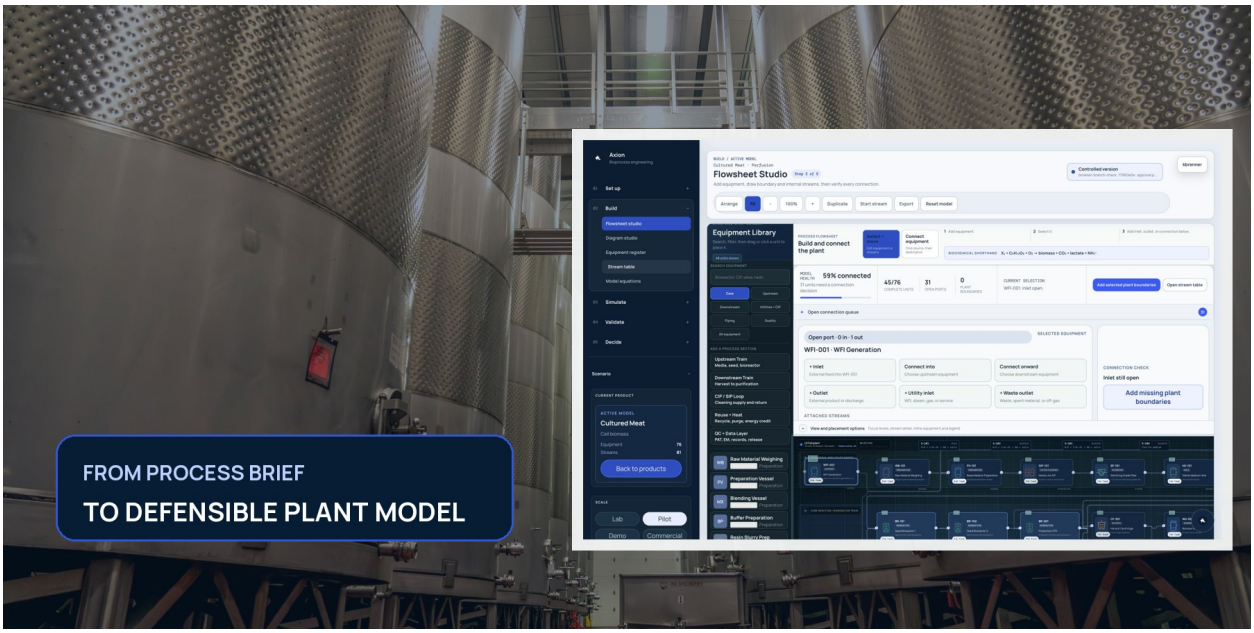
Axion

Axion User Manual

Step by step from process brief to a defensible plant model



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Axion · Bioprocess engineering software

Start here: What result do you need?

Do not choose a module first. Start with the decision you need to make. The guide below takes you to the correct workspace and states what must be true before the step is complete.

I need to …	Open	Continue when …
Build a new model	Set up → New model	Intended use, scope, owner and maturity are visible.
Change the process	Build → Flowsheet studio	Every affected unit and stream is connected.
Test a design	Simulate → Simulation	The pre-run check and balance closure are accepted.
Compare cost or environmental impact	Decide → Economics / LCA	Scenarios use the same quantity and time basis.
Hand over a result	Validate → Readiness → Downloads	Version, gaps, maturity and export are verified.

RESULT MATURITY

Screening answers a directional question. Calibrated uses project-adjusted data. Validated requires documented evidence and approval. Not decision-ready means: do not decide; close the visible gaps first.

The Axion interaction logic

Every task follows the same pattern. You can always see what you are doing, what changed and whether it is safe to continue.

Phase	Your action	Visible signal
1 · Orient	Check project, model, branch, maturity and workspace.	The workspace context is unambiguous.
2 · Change	Edit only the intended structure, input or assumption.	Changed elements and dependent areas are marked.
3 · Inspect	Read pre-run checks, connections, units, balances and warnings.	Errors are closed or assigned to an owner.
4 · Decide	Compare before/after, set maturity and save a version.	Decision, rationale and audit trail are traceable.

CORE RULE

A click is not completion. Continue only after the visible result and its acceptance check agree.

How to learn with this manual

This manual follows the engineering workflow. For a new model, work through the chapters in order. For a specific question, open the relevant chapter directly. Every chapter states the navigation path, actions, expected result and acceptance checks.

ENGINEERING STATUS

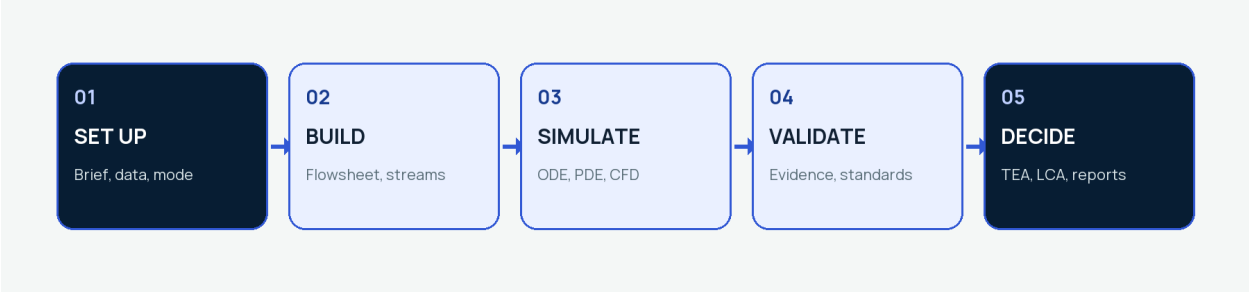
Axion supports engineering decisions. A result is decision-ready only when the data basis, model boundary, assumptions, maturity and expert approval are consistent.

Reading key

Element	Meaning
Path	The visible navigation in Axion, for example Build → Flowsheet studio.
Steps	Actions in the order in which they should be performed.
Result	What the application must display or calculate after the task.
Check	Technical criteria that must be satisfied before moving on.
Maturity	Screening, Calibrated or Validated; never infer maturity from a polished chart.

Who uses Axion

Role	Primary focus
Process Development	Operating mode, kinetics, yield, scale-up and critical parameters
Process Engineering / MSAT	Flowsheet, equipment, utilities, scheduling and plant capacity
TEA / LCA	Cost basis, scenarios, inventory, system boundary and sensitivity
Reviewer	Data provenance, balance closure, open gaps, version and approval
Administrator	Users, roles, integrations, data security and operations



The controlled Axion workflow.

If you get stuck

What you observe	Open	Next action
The starting point is unclear	Set up → New model	Define intended use and system boundary first.
Equipment has no material route	Build → Flowsheet studio	Open connection check and add inlet/outlet.
The simulation will not start	Simulate → Pre-run check	Resolve blocking errors from top to bottom.
The result is not defensible	Validate → Readiness	Review data gaps, uncertainty and maturity.
A handover is required	Decide → Downloads	Save a controlled version and open Complete package.

Learning map

Chapter	Workspace	Decision
1	Start · Login · Account	Who is working on what, with which permission?
2	Set up · New model	Which question must the model answer?
3	Build · Flowsheet studio	How do material, energy and information move through the plant?
4	Build · Equipment library	Which physical function does each unit perform?
5	Build · Operating mode	Which time-dependent operating logic represents the real process?
6	Build · Parameters · Data & sources	Which values are measured, assumed or calibrated?
7	Simulate · Simulation	Is the model numerically closed and physically plausible?
8	Simulate · Advanced modelling	How do states change in time and space?
9	Simulate · Bioreactor CFD	Where are mixing, oxygen, nutrient or shear risks?
10	Decide · Factory twin · Scheduling	Can the plant execute campaigns without resource conflicts?
11	Decide · Economics · LCA	Which cost and environmental drivers govern the decision?
12	Validate · Boundaries · Standards · Readiness	Which claim may be made from this model?
13	Projects · Versions · Collaborators	How do changes remain traceable and reversible?
14	System Composer	Which specific model change should Axion prepare?
15	Decide · Downloads · Projects	Can a third party reproduce the result and model state?
16	Account · System status · Support	Is the issue caused by data, model, browser or backend?

RECOMMENDED SEQUENCE

Set up → Build → Simulate → Validate → Decide. Save a version after every decision-relevant change.

1. Orientation and secure access

When you need this chapter	Path in Axion
At first login, after an invitation, or whenever project and account context are unclear.	Sign in → Account → Projects

Steps

- Sign in with your personal account; never share credentials.
- Open Account and verify name, organisation, role and subscription status.
- Open Projects and select the correct project and controlled branch/version.
- Check product, operating mode and maturity at the top of the workspace before changing values.

EXPECTED RESULT

The active user, project, version and edit state are unambiguous.

Check before continuing

- □ Correct project
- □ Role permits the intended action
- □ Controlled version identified

COMMON MISTAKE

Confusing a local browser model with an approved project version.

2. Define the project and modelling purpose

When you need this chapter	Path in Axion
Before placing equipment or importing data.	Set up → New model

Steps

- Name the product, organism/cell line, process family and intended scale.
- Write a specific intended-use question such as capacity, COGS or scale-up risk.
- Define system boundary, functional unit, time horizon and exclusions.
- Upload available data or explicitly mark missing inputs.
- Create the project and review the generated model brief.

EXPECTED RESULT

A versioned model brief with decision, scope, data status and responsible owner.

Check before continuing

- □ One clear decision question
- □ Documented system boundary
- □ Missing data visible

COMMON MISTAKE

Starting from a generic template without defining intended use and model boundary.

3. Read the flowsheet and understand hierarchy

When you need this chapter	Path in Axion
Before any structural edit and during technical review.	Build → Flowsheet studio

Steps

- Start at L0 Full plant and identify Main Process, Support, Utilities, CIP and Waste.
- Switch to L1–L6 to inspect Core Process, Upstream, Downstream, Utilities and Quality separately.
- Trace streams from boundary inlet through equipment to boundary outlet.
- Use Fit and Flow labels; zoom into individual units only afterwards.
- Select equipment or a stream and read its status, connections and equations.

EXPECTED RESULT

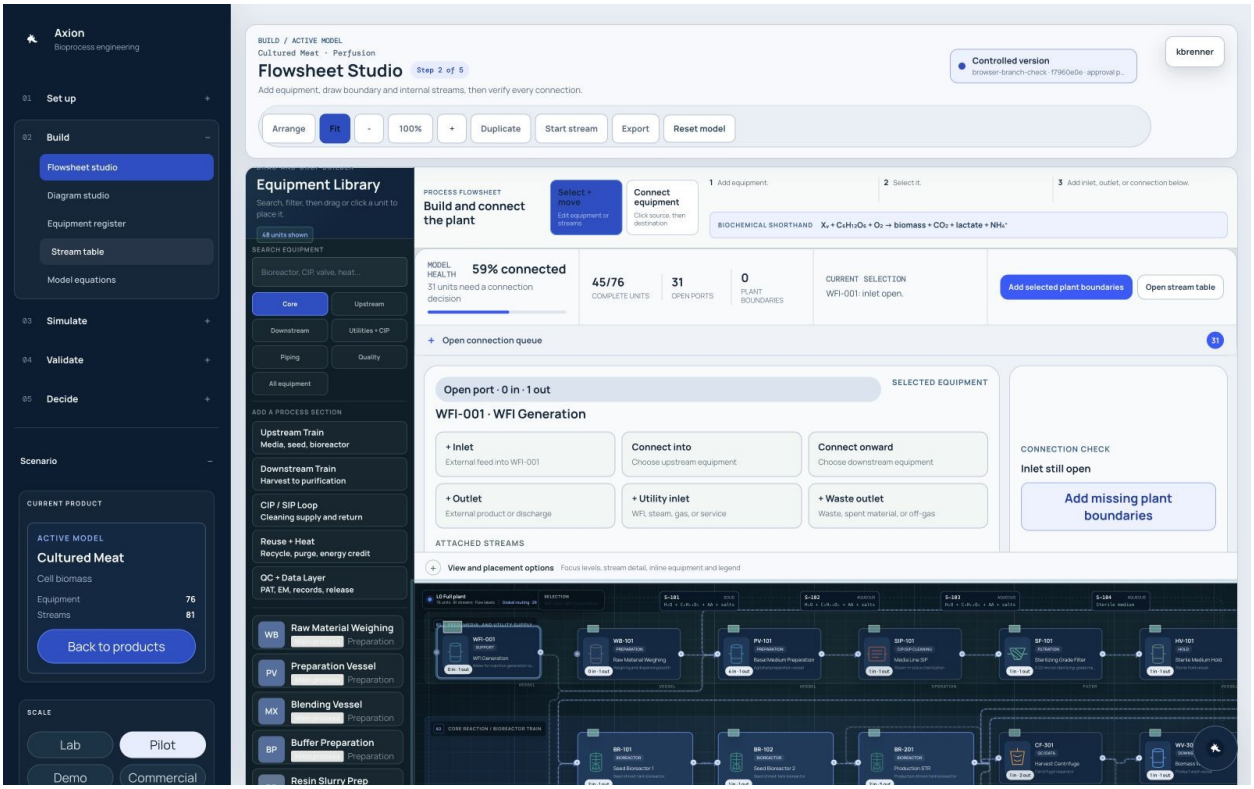
The complete production route and every supporting route can be followed.

Check before continuing

- □ Every main unit has a material route
- □ Utilities are distinct from product streams
- □ Waste and recycle terminate clearly

COMMON MISTAKE

Reviewing only the central reactor train while ignoring cleaning, supply and waste.



Axion workspace for Build · Flowsheet studio.

4. Add, move and connect equipment

When you need this chapter	Path in Axion
When adding, replacing or rearranging process steps.	Build → Flowsheet studio → Equipment library

Steps

- Search or filter equipment by Core, Upstream, Downstream, Utilities/CIP or Piping.
- Drag a unit onto the canvas or use Quick add near selection.
- Assign a unique tag, name, class and process role.
- Choose Start stream, then select source and destination; use Inlet or Outlet for boundaries.
- Verify direction, stream class, phase, components and flow rate.
- Use Arrange only after connecting the graph, then save a version.

EXPECTED RESULT

Equipment and streams form a directed, editable process graph.

Check before continuing

- □ No unintended islands
- □ Correct inlet/outlet direction
- □ Unique tags
- □ No critical connection gap

COMMON MISTAKE

Placing equipment as a decorative symbol without a material, energy or information relationship.

5. Configure batch, fed-batch and perfusion

When you need this chapter	Path in Axion
When a reactor or shared resource is modelled over time.	Set up → Operating mode · Build → Global parameters

Steps

- Use Batch for closed campaigns without continuous feed or bleed.
- For Fed-batch define feed start, profile, concentrations and endpoint.
- For Perfusion define exchange rate, cell retention, bleed and harvest.
- Set nominal and working volume separately and document headspace.
- Review which equipment and scheduling assumptions change with the mode.

EXPECTED RESULT

Operating mode, material streams, dynamics and schedule use one coherent process logic.

Check before continuing

- □ Plausible working volume
- □ Feeds/bleeds connected
- □ Endpoint defined
- □ Cleaning cycle included

COMMON MISTAKE

Changing only the mode label without updating feeds, harvest, dynamics and schedule parameters.

6. Manage parameters and company data

When you need this chapter	Path in Axion
Before every simulation and after every import.	Build → Global parameters · Validate → Data & sources

Steps

- Open Global Parameters and change value, unit and valid range together.
- Import CSV/XLSX data with column mapping, units, timestamps and source.
- Map each value to a parameter, stream, equipment item or time-series channel.
- Classify values as measured, literature, vendor, assumed or calibrated.
- Require review before imported values replace a controlled baseline.

EXPECTED RESULT

Every critical parameter has value, unit, provenance, time context, reviewer and status.

Check before continuing

- □ Compatible units
- □ Plausible range
- □ Linked source
- □ Uncertainty present
- □ No silent overwrite

COMMON MISTAKE

Treating database or literature values as project truth without expert review.

7. Run mass and energy balances

When you need this chapter	Path in Axion
After structural or parameter changes and before TEA, LCA or scheduling.	Simulate → Simulation → Run

Steps

- Resolve missing boundaries, parameters and units in the pre-run check.
- Start the simulation and wait for a completed run status.
- Read mass closure, energy balance, component losses and warnings.
- Open suspicious streams directly from the result view.
- Compare the case with the previous controlled version before approval.

EXPECTED RESULT

Reproducible stream tables, balance metrics, utilities and an auditable run.

Check before continuing

- □ Closure within project tolerance
- □ No negative mass
- □ Plausible energy signs
- □ Warnings explained

COMMON MISTAKE

Equating a numerically converged run with a physically validated model.

8. Interpret ODE/PDE dynamics

When you need this chapter	Path in Axion
For growth, substrate uptake, oxygen, heat, membranes or chromatography profiles.	Simulate → Advanced modelling

Steps

- Select the model package and inspect states, parameters, initial and boundary conditions.
- Set horizon, step size, tolerances and events.
- Run the solver and inspect status, residuals and conservation laws.
- Compare time series for biomass, substrate, product, O_2, pH and by-products.
- Run sensitivity or fitting only against a documented data basis.

EXPECTED RESULT

Time and, where relevant, spatial profiles with solver diagnostics and uncertainty context.

Check before continuing

- □ Consistent initial conditions
- □ Adequate step size
- □ No non-physical oscillation
- □ Fit and test data separated

COMMON MISTAKE

Accepting a smooth curve without checking residuals, units and identifiability.

9. Use bioreactor CFD correctly

When you need this chapter	Path in Axion
For scale-up screening and preparation of an externally validated 3D CFD run.	Simulate → Bioreactor CFD

Steps

- Select the real reactor and verify geometry, working volume, impellers, baffles and sparger.
- Define gas_inlet, feed_inlet, walls_baffles, top_headspace, impeller_zone and cell_uptake.
- Choose O_2, Nutrient, Velocity, Shear or Mixing time as the target field.
- Start the run; no moving field should be presented as a result before Start.
- Read hotspots, dead zones, kLa/OTR, mixing time and local violations.
- Label browser results as Screening and send validated 3D cases to the external worker.

EXPECTED RESULT

A traceable flow screening or a versioned external CFD job with inputs and result files.

Check before continuing

- □ Geometry matches equipment
- □ Complete boundaries
- □ Mesh/solver status present
- □ Maturity visible

COMMON MISTAKE

Confusing an illustrative 2D view with validated multiphase CFD.

10. Schedule the plant and shared resources

When you need this chapter	Path in Axion
For capacity, equipment reuse, CIP/SIP, rooms, staff and utilities.	Decide → Factory twin → Scheduling

Steps

- Generate a base schedule from unit procedures.
- Assign equipment, rooms, staff, utilities, holds and transfers.
- Insert cleaning, setup and release after each occupancy-relevant batch.
- Define campaigns, calendars, shifts, maintenance and parallel resources.
- Run conflict detection and optimisation; inspect Gantt, utilisation, queues and bottleneck.

EXPECTED RESULT

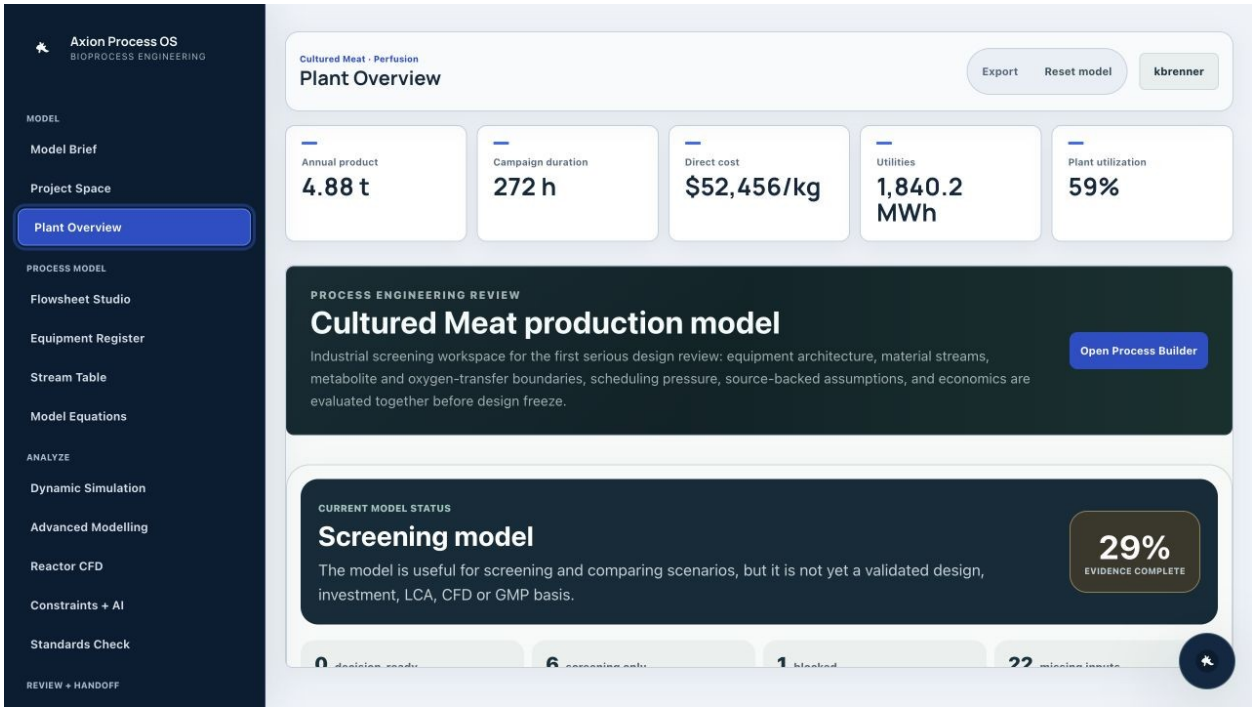
An executable schedule with resource conflicts, utilisation and a justified bottleneck.

Check before continuing

- □ No double booking
- □ Cleaning complete
- □ Utilisation not artificially high
- □ Plausible bottleneck

COMMON MISTAKE

Scheduling only process time while omitting cleaning, holds, transfers, labour or utilities.



Axion workspace for Decide · Factory twin · Scheduling.

11. Calculate TEA and LCA consistently

When you need this chapter	Path in Axion
After closing material, energy and scheduling models.	Decide → Economics · Decide → LCA

Steps

- Use one functional unit, reference year, region, currency and production basis.
- Review material prices, media, yield, labour, utilities, consumables and waste.
- Configure CAPEX, installation, depreciation, utilisation and uncertainty ranges.
- For LCA define goal and scope, system boundary, allocation, cut-offs and dataset quality.
- Run scenarios, sensitivity and Monte Carlo/range analysis.
- Compare cost and environmental hotspots on the same quantity basis.

EXPECTED RESULT

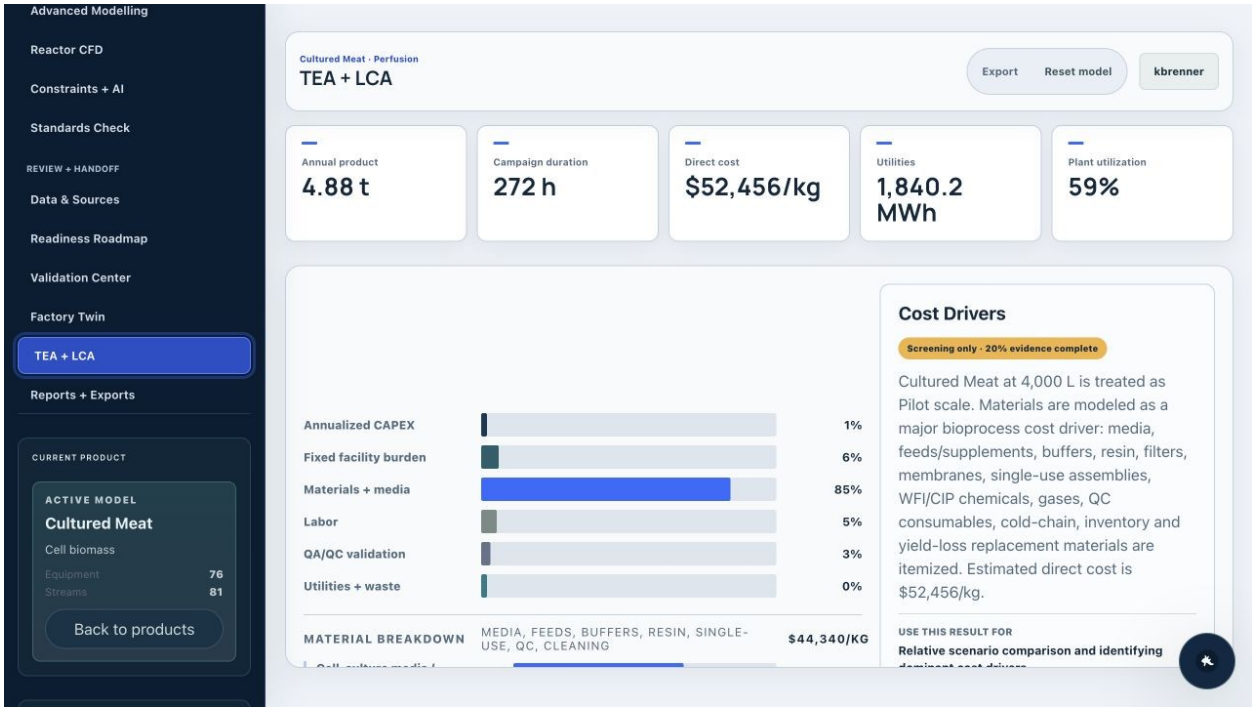
Cost stack, cash/capacity metrics, LCI, impact categories, intervals and sensitivity.

Check before continuing

- □ Same TEA/LCA basis
- □ Complete media cost
- □ Dated units/prices
- □ Allocation documented

COMMON MISTAKE

Exporting polished point estimates without ranges, data quality and dominant assumptions.



Axion workspace for Decide · Economics · LCA.

12. Review boundaries, standards and maturity

When you need this chapter	Path in Axion
Before technical review, approval or external presentation.	Validate → Boundaries + AI → Standards → Readiness roadmap

Steps

- Review physical, chemical, biological, equipment and safety boundaries.
- Evaluate limits such as working volume, ammonium, lactate, O_2, shear and temperature.
- Map relevant standards and project requirements.
- Close or accept findings with owner, rationale and due date.
- Set status to Screening, Calibrated, Validated or Not decision-ready.

EXPECTED RESULT

A visible readiness state with criteria, findings, owners and residual uncertainty.

Check before continuing

- □ Limits supported
- □ Standards in scope
- □ Open findings visible
- □ No inflated claims

COMMON MISTAKE

Raising maturity without evidence, comparison, review and approval.

13. Use versions, branches and collaboration

When you need this chapter	Path in Axion
For variants, teamwork, review or controlled baselines.	Projects → Branches / Versions / Collaborators

Steps

- Create a branch for a variant instead of overwriting the baseline.
- Save a version with a technical change note and decision context.
- Compare before/after for parameters, equipment, streams, results and costs.
- Invite collaborators with the minimum required role.
- Request review/approval and merge only reviewed changes.

EXPECTED RESULT

A traceable history with author, time, diff, review and restore point.

Check before continuing

- □ Baseline protected
- □ Change rationale present
- □ Independent review role
- □ Restore tested

COMMON MISTAKE

Keeping variants as unnamed copies or editing approved versions directly.

14. Apply System Composer safely

When you need this chapter	Path in Axion
For natural language, scenario creation and fast navigation.	Open System Composer → describe change → Review → Apply

Steps

- State the objective and constraint, for example reduce media cost without violating the VCD limit.
- Review the generated change plan and every affected model location.
- Compare before/after for structure, parameters and KPIs.
- Apply only safe operations; regulated or safety-critical decisions require review.
- Use Undo or restore the previous version if the outcome is unsuitable.

EXPECTED RESULT

A concrete, logged and reversible model change rather than text-only advice.

Check before continuing

- □ Affected locations visible
- □ No hidden assumption
- □ Plausible before/after
- □ Undo available

COMMON MISTAKE

Applying AI advice without a change plan, expert review and restore point.

15. Export, hand over and restore

When you need this chapter	Path in Axion
For review, TEA/LCA continuation, audit, client handover and archive.	Decide → Downloads → Complete package

Steps

- Select the complete engineering package or targeted XLSX/CSV/PDF/SVG/JSON exports.
- Check product, project, branch, version, date, units and maturity on the cover.
- Open XLSX and PDF after download and inspect tables, charts and links.
- Archive model snapshot, input data, assumptions, run IDs and review state together.
- Test restore in a separate project before calling a baseline protected.

EXPECTED RESULT

A readable, detailed and reproducible handover package for engineering, TEA and LCA.

Check before continuing

- □ Files open correctly
- □ Long tables complete
- □ Units/ranges included
- □ Model version unambiguous

COMMON MISTAKE

Sharing only a result screenshot without inputs, assumptions, version and data quality.

16. Troubleshoot and prepare support

When you need this chapter	Path in Axion
For login, import, run, connector, export or restore failures.	Account → System status · module diagnostics

Steps

- Record time, page, project, branch, version and correlation ID.
- Inspect status, network, file format, permissions and validation errors.
- Repeat the action once in a controlled test version.
- Capture expected versus actual behaviour and an anonymised screenshot/export.
- Never send passwords, API keys or confidential raw data to support.

EXPECTED RESULT

A reproducible report that isolates the likely failure layer.

Check before continuing

- □ No secrets
- □ Complete reproduction steps
- □ Version/run ID provided
- □ Impact described

COMMON MISTAKE

Reporting only 'does not work' without context, time, version or error message.

Model completion

MODEL COMPLETION

A complete model has a closed process graph, traceable inputs, numerically healthy results, consistent TEA/LCA bases, a controlled version and a verified export package. Open gaps remain visible.

- □ Intended use, product, operating mode and system boundary are explicit.
- □ Every main-process unit has a material route or an explained boundary.
- □ Critical parameters have unit, range, provenance, uncertainty and review state.
- □ Mass and energy balances are closed within the documented tolerance.
- □ ODE/PDE and CFD outputs include solver and maturity information.
- □ Schedule includes cleaning, shared resources, holds and maintenance.
- □ TEA and LCA use the same basis and report ranges and sensitivity.
- □ Open gaps, owner, version, branch and approval state are visible.
- □ The complete export package opens and can be restored.

Open Axion Book technical onboarding