Case Study Title: Design Freeze and IFC: Protecting Offsite Delivery Through Lean Design Governance

Company Overview ARDMAC | ardmac.com

Ardmac is an international specialist in turnkey delivery of controlled environments, serving the Life Sciences, Data Centres, Microelectronics, EV Battery Facilities, Aerospace, Defence, Nuclear sectors. With almost 50 years of experience, we've evolved into a leading European provider of cleanrooms, data centre systems, modular off site facilities, fit outs, refurbishments, and manufacturing facility construction.

We deploy the latest digital construction technologies to deliver high-value workspaces and precision-built environments tailored to client needs. Our reputation is founded on deep sector expertise, uncompromising safety, and highly effective collaboration.

Ardmac stands as the contractor of choice for complex, mission-critical projects, delivering excellence as standard.

Author



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Overview & Background to the Lean Initiative

The case concerns a highly serviced, regulated life-sciences project delivered through a multi-party offsite strategy. It involved architectural systems, complex building services, specialist equipment and high levels of pre-manufactured value (PMV). The delivery model created the opportunity to shift labour and quality control into a factory environment, but it also compressed the window for design decisions.

The initiative focused on a recurring constraint: information continued to mature after procurement and, in some instances, after detailed module development had begun. Requirements relating to equipment, services, security, openings and specialist interfaces evolved across several stakeholders. This increased the potential for rework, resequencing and programme pressure.

The Lean problem statement

Problem: How can Ardmac protect the speed and quality benefits of offsite delivery when design information, interfaces and client decisions are still developing?

What worked

- Early engagement established the modular strategy and identified PMV opportunities.
- Collaborative reviews exposed interface risks before installation.
- Controlled manufacture enabled repeatable assemblies and factory testing.
- Cross-party workshops revealed the consequences of late information.

Principal constraints identified

Constraint	Observed effect	Lean response
Design maturity	Early assumptions	Stage gates
Model governance	Revision risk	Model ownership
MEP / OPE interfaces	Late changes	Clash review
Decision latency	Sequence impact	Pull planning
Post-freeze change	Factory impact	Formal change control

Figure 1: Principal Constraints Identified

Lean Initiative Undertaken – Lean Thinking, Tools, Techniques

Ardmac converted the project learning into a Lean design-to-manufacture control system. The approach translates the Voice of the Customer into measurable Critical-to-Quality requirements, develops coordinated information through structured design gates and prevents physical work from being released until the required evidence is approved. This creates a visible line from client need to design decision, procurement, manufacture, installation and final verification. It also gives the team a common basis for challenging assumptions, escalating constraints and protecting the value created by offsite delivery.



Figure 2: Proposed maturity and release path. Each gate requires defined evidence, ownership and sign-off.

Ardmac Lean toolkit applied to the issues

Voice of the Customer (VOC) and Critical to Quality (CTQs): Convert user, process, compliance and operational needs into measurable design requirements, acceptance criteria and named approvals. This ensures that value is defined by what the completed facility must achieve, rather than by assumptions made within individual work packages.

Early Contractor Involvement (ECI): Bring manufacturing, logistics, commissioning and installation knowledge into the design while options remain open. Early input tests buildability, access, transport and sequencing before decisions become expensive to reverse, improving certainty for both the factory and the site team.

Stage-gate reviews: Use 30%, 60%, 90% and Issued For Construction (IFC) reviews to test scope, layout, interfaces, clashes and readiness against defined evidence. A percentage complete is not treated as approval; each gate must demonstrate that responsibilities, decisions and critical interfaces are sufficiently mature for the next commitment.

Federated BIM governance: Establish one controlled source of truth, named model ownership, revision discipline and issue reporting. Weekly status reviews identify what has changed, who must respond and when resolution is required, reducing the risk of teams coordinating against different information.

DfMA/D and PMV planning: Standardise components, simplify interfaces and maximise safe, repeatable work in controlled conditions. The team evaluates each activity for factory completion while protecting transport, lifting, connection, access and maintenance requirements so PMV increases without transferring unresolved risk to site.

Pull planning and constraint management: Plan backwards from manufacture and installation milestones, expose missing information and decisions, and assign clear owners and due dates. Constraints are reviewed before they interrupt workflow, allowing corrective action while recovery options remain available.

Formal change control: Treat post-freeze changes as visible commercial, programme and manufacturing decisions. Every proposed change is assessed for cross-discipline consequences before approval, ensuring that local requests do not create hidden rework, abortive procurement or disruption elsewhere.

DMAIC and lessons capture: Define the issue, measure constraints, analyse root causes, improve controls and standardise learning. Evidence from design queries, changes, clashes, rework and interruptions is retained so future teams start with a stronger baseline rather than rediscovering the same risks.



Figure 3: Qualitative project mapping: 'Primary' identifies the principal countermeasure; 'Support' shows reinforcing controls.

The initiative was organised around six connected stages. Each stage linked a project issue to a Lean countermeasure, an accountable owner and a future standard. Together, the stages create an end-to-end control loop in which customer value is defined early, information is progressively validated and manufacture is authorised only when critical constraints are closed.

1 | Tender and early engagement

Challenge: Incomplete design maturity and developing user requirements created risk after package procurement, when changes could affect multiple disciplines and long-lead commitments.

Lean countermeasure: Use ECI, VOC/CTQ workshops and a controlled requirements register. Define the PMV strategy, decision schedule, key interfaces and known constraints before commercial release, with named owners for every open assumption.

Standard created: No manufacture-relevant assumption remains ownerless, invisible or without an agreed closure date.

2 | BIM and design development

Challenge: Multiple reviewers and changing information created inconsistent interpretations of the model, weakening confidence in which revision governed manufacture.

Lean countermeasure: Nominate the federated-model owner, issue a weekly model-status report, use controlled revisions and require formal discipline sign-off. Decisions and unresolved issues are recorded in one visible register linked to programme need dates.

Standard created: The approved model becomes the single controlled source of truth for coordination, procurement and work-pack release.

3 | Clash detection and coordination

Challenge: Ceiling congestion, penetrations, equipment clearances and plant interfaces matured later than required, increasing the potential for rework in completed assemblies.

Lean countermeasure: Hold multidisciplinary 60%, 90% and IFC reviews, maintain a red-flag issue log and block release wherever a safety, access, compliance or installation-critical clash remains unresolved.

Standard created: Every clash resolved digitally protects flow and avoids a slower, more expensive physical intervention in the factory or on site.

4 | Owner Process Equipment (OPE) coordination

Challenge: Equipment positions and connections affected electrical drops, controls, containment, pipework, service routes and safe maintenance access across several coordinated packages.

Lean countermeasure: Create a client owned OPE register, hold dedicated interface workshops, verify loads and connection points, set a freeze date and route every later change through formal impact assessment.

Standard created: Equipment locations, loads, connections and service interfaces are approved before detailed module completion and protected through change control.

5 | Design freeze and manufacture release

Challenge: Late decisions threatened procurement,

engineering, factory sequencing and manufactured assemblies already progressing against coordinated information.

Lean countermeasure: Make design freeze a commercial, programme and manufacturing gate. Release only approved IFC work packs, verify procurement readiness and process every post-freeze change as a visible variation with time and cost consequences.

Standard created: Manufacture begins only against stable, coordinated and authorised information supported by a complete release record.

6 | Programme and stakeholder management

Challenge: A multi-party environment increased decision latency, fragmented accountability and the risk that unresolved constraints would reach the factory sequence.

Lean countermeasure: Use pull planning, weekly risk and constraint reviews, a visible action register, firm escalation dates and one integrated programme owner. Measure commitments against planned completion and intervene early where flow is at risk.

Standard created: Constraints and decisions are cleared at the last responsible moment before they can affect procurement, manufacture or installation flow.

Lean Initiative Improvements & Impact

Project-specific proof story: the OPE interface ripple

One recurring project issue made the cost of moving information especially visible. Owner Process Equipment (OPE) positions and interface requirements continued to develop while the modules and building services were being coordinated. A movement that appeared local to one item of equipment had consequences across several disciplines and manufactured assemblies.

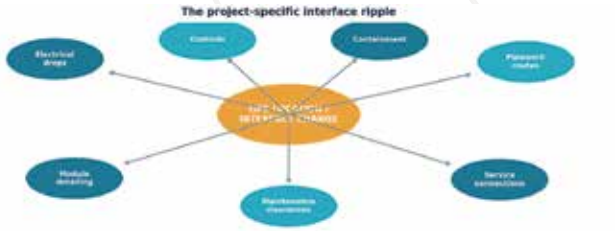

Figure 4. Project-specific qualitative map of the interfaces affected when OPE information moved during coordinated design.

What happened on this project

- Equipment positions and connection requirements evolved during design development.
- Electrical drops, controls, containment, pipework, service connections and maintenance clearances required renewed coordination.
- Layouts and service routes had to be revalidated against the developing equipment information.
- The information dependency affected engineering effort and placed pressure on the manufacturing sequence.

How the Lean response tackles the cause

From project lesson to Ardmac standard

The improvement is the conversion of lived project experience into a repeatable control system. The issue is not presented as an isolated design problem: it becomes organisational learning that can be deployed on the next high-PMV project from day one.



Figure 5: The capability-building loop used to turn project experience into a repeatable Ardmac delivery standard.

What Ardmac will do differently

See Chart on next page.

Standout capability: Ardmac can now explain not only what Lean tools it uses, but why each control exists, which project risk it addresses and what evidence is required before manufacture.

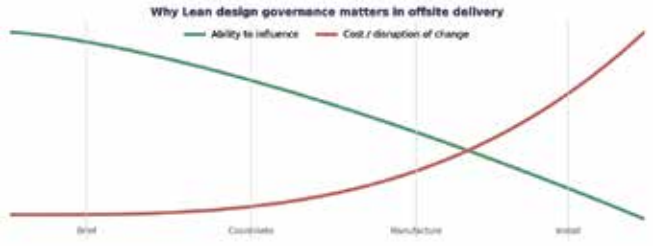

Figure 6: Conceptual Lean principle - not a project measurement. Influence reduces as physical commitment grows, while the disruption caused by change rises.

Observed condition	Lean control	Future release evidence
OPE information developing	Client-owned OPE register	Approved location, load and connections
Cross-discipline interface ripple	Dedicated OPE / services workshop	Signed interface matrix
Model interpretations differed	Model ownership	Single approved model revision
Late change after coordination	Design freeze and change control	Authorised impact assessment
Manufacture exposed to uncertainty	Constraint-led release review	Approved IFC work pack

Figure 7: Lean Response Impact Table

Why this matters: The project showed that a module can be physically ready to manufacture while its information is not. Ardmac's strengthened gate tests information readiness, not simply drawing completion.

Control point	Project-informed standard
Mobilisation	Agree the modular strategy, initial PMV ambition, design-responsibility matrix and client decision schedule.
Requirements	Create a controlled URS, CTQ schedule and OPE register with named owners and approval dates.
Coordination	Run 30%, 60%, 90% and IFC reviews against explicit acceptance criteria, not percentage labels alone.
Information	Nominate the federated-model owner and publish a weekly status covering revisions, clashes and constraints.
Design freeze	Record the approved baseline and route every subsequent change through cost, programme and manufacturing assessment.
Manufacture release	Release only when the IFC model, work pack, procurement status and affected interfaces are approved.
Learning	Capture late changes, interruptions and interface failures so the standard continues to improve.

Figure 8: Control point and project informed standard

Capability strengthened	Project evidence / value
Customer value	A controlled URS, OPE register and CTQs make requirements explicit.
Design quality	Model ownership, clash reviews and sign-off strengthen information reliability.
Manufacturing certainty	Design freeze and release gates protect procurement and factory flow.
Programme control	Pull planning links decisions and constraints to factory need dates.
Safety and quality	Controlled manufacture improves testing while reducing site interfaces.
Scalability	Lessons become repeatable standards for future high-PMV projects.

Figure 9: Capability strengthening/project evidence/value

The principal impact was a clearer operating model for converting complex design information into manufacturable work. The project demonstrated the value of offsite delivery and identified the controls required to protect it.

Future projects will baseline design queries, late changes, clash closure, rework, manufacturing interruptions and planned-percent-complete, enabling consistent, evidence-based measurement.

Summary and Lessons Learned

This project demonstrates Ardmac's capability to learn from complexity and convert that learning into a stronger Lean delivery system. High-PMV modular construction can reduce site labour, improve repeatability and accelerate installation, but its success is determined upstream - through the quality and timing of design decisions.

Five lessons to standardise

1. **Start with the customer:** complete the URS, OPE register and CTQs before detailed design and procurement commitments.
2. **Own the information:** one federated BIM model, one revision process and clear discipline accountability.
3. **Coordinate before committing:** Use 30%, 60%, 90% and IFC reviews with defined acceptance criteria.
4. **Freeze design deliberately:** design freeze is a commercial, programme and manufacturing protection gate.
5. **Control flow:** use pull planning, visible constraints and escalation dates to protect manufacture and installation.

Final message: Modular construction magnifies both good decisions and bad decisions. When information is frozen, coordinated and owned, Ardmac can unlock the full value of Lean, DfMA and offsite manufacturing.

Gate	Minimum evidence
Before tender commitment	Agreed modular strategy, initial PMV target, interface map and client decision schedule.
Before detailed design	Approved URS, OPE register, model ownership plan and design responsibility matrix.
Before design freeze	Closed critical clashes, coordinated services, verified site conditions and signed interfaces.
Before manufacture	Approved IFC information, controlled work packs, procurement status and post-freeze change route.
Before installation	Factory acceptance evidence, logistics plan, site readiness and integrated completion sequence.

Figure 10: Capability standard for future projects

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