# [1. INDUSTRIAL MODULARIZATION: HOW TO OPTIMIZE, HOW TO MAXIMIZE (RS283-1)](https://www.construction-institute.org/industrial-modularization-how-to-optimize-how-to-maximize-e3e8d8f9b5f19c2790438959b1e075b3)

**Report Summary:** This study compared an idealized all-modular work process for industrial projects with current, largely stick-built work processes and identified key high-value practices that are in need of change. The findings led to the development of the Industrial Modularization: Five Solutions Elements tool ([IR283-2](https://www.construction-institute.org/industrial-modularization-five-solution-elements-version-1-1)), which consists of the following five distinct elements that industry leaders and project managers should consider carefully to achieve higher levels of modularization:

* A business case process
* Execution plan differences
* Critical success factors
* A standardization strategy
* Modularization maximization enablers

**Key Takeaways:**

## (1) Apply a modularization business case process at the earliest opportunity in the project.

## (Project Phase: Prefeasibility through Detailed Design and Procurement)

* Adopt the modularization business case process presented in [IR283-2](https://www.construction-institute.org/industrial-modularization-five-solution-elements-version-1-1) as standard procedure.

## (2) Identify planning and execution differences between modular and stick-built projects.

## (Project Phase: Prefeasibility through Detailed Design and Procurement)

* Review and address planning and execution differences between modular and stick-built projects according to project phase-oriented planning topics, including Selection, Basic Design, and Engineering, Procurement, and Construction (EPC). Refer to [IR283-2](https://www.construction-institute.org/industrial-modularization-five-solution-elements-version-1-1). Incorporate all relevant differences into the modular project execution plan.
* Review the execution plan to ensure that the Selection, EPC, and other relevant phases are taken into account for a modular project.
* Factor in early estimates of module envelope sizes and weights as inputs for fabrication and transportation planning.
* Address differences between modular and stick-built projects in four critical areas: planning and cost estimating, scoping, basic design standards, and detailed design deliverables.
* Apply these execution plan differences to ensure comprehensive modular project preparation.

## (3) Identify critical success factors (CSFs) and incorporate enablers into the planning and execution stages.

## (Project Phase: Prefeasibility through Construction)

* Review the 21 critical success factors found in [IR283-2](https://www.construction-institute.org/industrial-modularization-five-solution-elements-version-1-1), which also includes information regarding enablers, optimal timing for implementation, and different coordinators’ responsibilities.
* Special attention should be given to CSFs that are difficult to achieve, including the owner’s planning resources and processes, a timely design freeze, early completion, cost savings, contractor leadership, investment in studies into modularization opportunities, vendor involvement, owner delay avoidance, data for optimization, and transport delay avoidance.

## (4) Develop a strategy and follow eight steps that effectively integrate design standardization with modularization.

## (Project Phase: Prefeasibility through Detailed Design and Procurement)

1. Assess market needs, establish objectives, and create an implementation plan for design standardization and modularization integration.
2. Create standardized designs for targeted plant types and repeat this step as needed to achieve desired outcomes.
3. Create the modular standard design(s).
4. Repeat Steps 2 and 3, as needed.
5. Firm up agreements with vendors/packagers and involve them in refinements of the modular standard design(s).
6. Implement the execution of a modular standard plant for each client.
7. Assess and benchmark key performance indicators to assess the effectiveness of the modular standard plant effort.
8. Learn from modular standard plant projects and update/modify the standard design(s) only after thorough analysis and with confident justification.

## (5) Review the ten enablers that will help to buoy or elevate levels of modularization across the industry.

## (Project Phase: Prefeasibility through Construction)

Background ([RS283-1](https://www.construction-institute.org/industrial-modularization-how-to-optimize-how-to-maximize-e3e8d8f9b5f19c2790438959b1e075b3), p. 36): A modularization business case, well-prepared execution plans, attention to CSFs, and use of a standardization strategy should all facilitate a more effective modularization process. However, to truly maximize modularization, leaders must directly address a variety of industry-wide barriers that can have (and have had) the effect of creating a ceiling that restricts the levels that modularization can achieve. Higher levels of modularization will be fully achievable in the future only if industry and project conditions and actions are more compatible with, or supportive of, modular approaches. The ten enablers for modularization are as follows:

1. Expand comfort zones: Encourage owners, designers, and contractors to broaden their familiarity with modularization, adjust selection criteria for service providers, and adopt new risk management approaches.
2. Redefine project needs: Owners/operators should adopt new paradigms regarding their needs and ways to accomplish or deliver projects. They need sufficient in-house work practices, resources, and expertise to freeze the process design, conduct necessary studies in a timely manner, and effectively exploit modularization opportunities ([RS283-1](https://www.construction-institute.org/industrial-modularization-how-to-optimize-how-to-maximize-e3e8d8f9b5f19c2790438959b1e075b3), p. 47).
3. Prioritize early collaboration: Early and repetitive collaboration and coordination among project disciplines are keys to success. Implement proactive, multidisciplinary collaborations that involve planning, engineering, fabrication, construction, commissioning, operations, and project control to achieve optimal planning and design solutions.
4. Promote modular design education: Engineering schools should teach the modular design approach alongside traditional methods, and seek to make the integrated modular approach routine in the design of capital projects.
5. Leverage data for optimization: Owners and contractors must capture and exploit data to support modularization optimization studies that will address all aspects of modularization costs, schedule savings, and other benefits.
6. Increase module density and completeness: Design modules that are denser (in terms of fabrication work hours per cubic foot) and more complete (in terms of number of systems and functional components incorporated) while preserving safety, operational, and maintenance requirements, and consider related asset loss prevention tactics.
7. Modify equipment for modularization: Enhance equipment design with modularization-friendly configurations through collaborations among stakeholders, including manufacturers, owners, process engineers, designers, contractors, and economic analysts.
8. Standardize modular components: The industry should expand the inclusion of off-the-shelf modular components and assemblies with compatible interfaces. Package units should be compatible as submodules within a larger module. Component-to-component physical interface standard protocols should be expanded.
9. Improve transportation infrastructure: Upgrading ports, roads, and bridges to accommodate modular transport should be considered for capital investment projects. This effort will likely require collaboration among local parties and may involve some master planning by regional authorities.
10. Advance fabrication technology: The industry should develop advanced technologies that facilitate fabrication, transport, and installation/connection. For example, stronger, lighter materials, easier connections, and site connection methods that are fully compatible with fabrication tolerances are needed.

## [(6) Tool: Industrial Modularization: Five Solution Elements, Version 1.1 (IR283-2)](https://www.construction-institute.org/industrial-modularization-five-solution-elements-version-1-1)

## (Project Phase: Prefeasibility through Detailed Design and Procurement)

The five solution elements in the Industrial Modularization tool are:

1. Define the business case: Evaluate the project’s feasibility for modularization, focusing on cost, schedule, and risk to optimize project outcomes.
2. Adapt the execution planning phase: Adjust project planning to reflect the unique requirements of modularization versus traditional stick-built approaches.
3. Identify CSFs: Determine the essential factors, such as schedule adherence, site logistics, and design adaptability, for successful modularization.
4. Standardize the design strategy: Apply standardization across project phases to enhance modularization efficiency and integration.
5. Enable industry maximization: Overcome industry-wide barriers through the use of the ten strategic enablers (see ‘(5) Review the ten enablers. . .’ above), thereby promoting widespread modularization adoption and benefits.