NAC Executive Insights

Economic & Schedule Trade-Offs in Modular vs Stick-Built Execution

Key Points

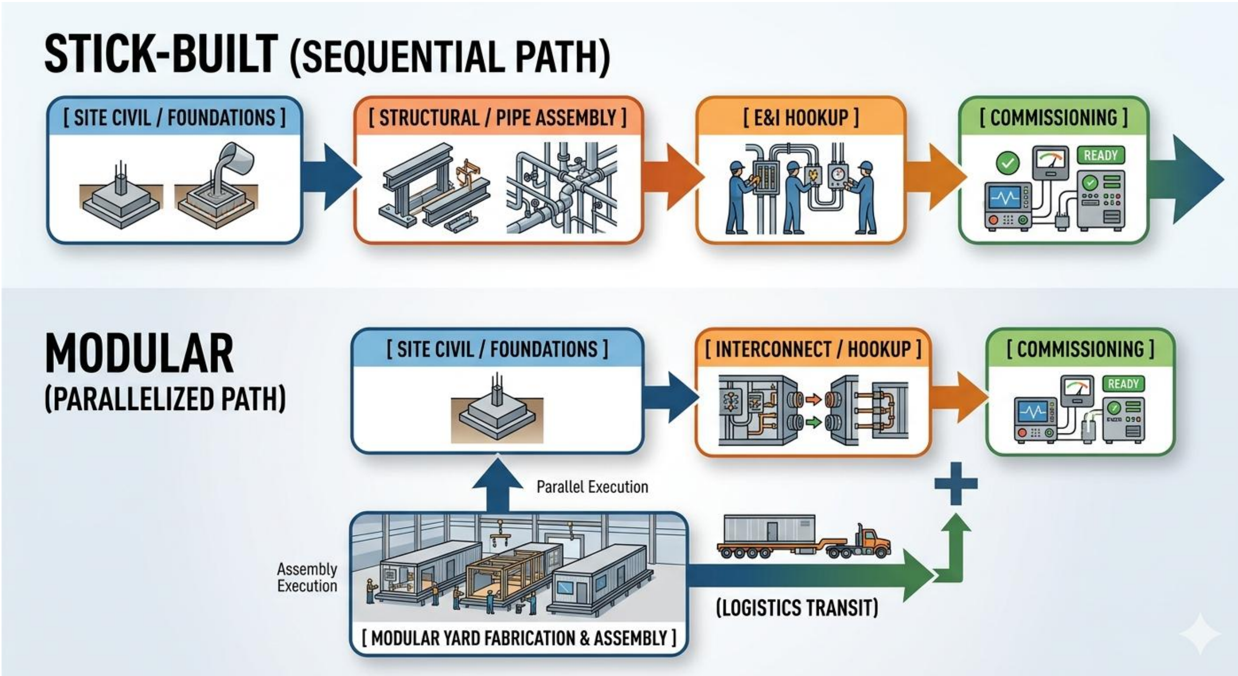
- **Industrialized Parallel Execution:** How modularization shifts projects from sequential stick-built pathways to dynamic, simultaneous parallel workflows.
- **Granular Yard Cost Dissection:** Identifying the six distinct components that build a true modular yard price, moving beyond simple material and labor base rates.
- **The TIC Advantage Formula:** A rigorous three-step methodology to quantify Total Installed Cost and Time-Value to determine absolute capital efficiency.
- **Field Labor Volatility Insulation:** Strategies to displace unstable, high-risk field craft hours into controlled, stable fabrication environments for improved predictability.
- **Multisector Comparative Data:** Executive summaries demonstrating massive financial advantages—ranging from $91M to $650M—across four examples covering infrastructure, LNG, mining, and AI data center sectors.

The Industrialized Construction Paradigm

As capital projects grow in scale and complexity, project governance boards are increasingly forced to move away from traditional, sequential field construction. Historically, stick-built execution—where raw materials are delivered directly to the project site and assembled linearly—was the default delivery method.

However, this approach exposes owner-organizations to severe local market volatility, including unpredictable craft labor availability, fluctuating regional productivity factors, unpredictable weather disruptions, and compounding site indirect costs.

Modular execution represents an organizational shift toward industrialized construction. By moving substantial portions of high-density structural, piping, electrical, and mechanical assembly into a controlled factory or fabrication yard environment, a project can parallelize its execution schedule. While site preparation, civil foundations, and underground utilities are progressed on-site, the core process or structural systems are simultaneously fabricated, assembled, and pre-commissioned off-site.



From an executive governance standpoint, evaluating modularization vs. stick-built construction requires moving past baseline fabrication costs (F). True economic evaluation must center on Total Installed Cost (TIC) and Time-Value (TV) maximization. Modularization frequently carries a premium in upfront engineering, structural steel reinforcement (to survive transport dynamics), and heavy logistics overhead. However, it achieves capital efficiency by displacing highly volatile field hours into stabilized fabrication yards and compressing the overall asset delivery timeline. This Executive Insight provides an executive cost-and-schedule comparison across the four infrastructure, industrial, and commercial scenarios established in our readiness strategy framework.

Granular Anatomy of Modular Yard Pricing

A frequent point of failure in capital project governance is the miscalculation of the Modular Yard Price (P_y) delivered to the project. Executive teams often mistake raw factory labor and material base rates for the final invoiced price. To establish a rigorous baseline for our comparisons, the comprehensive modular yard price is mathematically built upon six distinct cost components:

$$P_y = M_b + L_y + O_y + S_r + E_t + Profit_y$$

Cost Breakdown Elements:

- **Raw Materials & Equipment Base (M_b):** The procurement cost of bulk structural steel, piping spools, valves, cables, and equipment packages bought directly by or issued to the yard for incorporation into the modules.
- **Yard Production Labor (L_y):** The direct craft hours (welders, pipefitters, electrical technicians, painters) required for module assembly, calculated using the yard's internal productivity factors and localized base labor rates.

- **Yard Overhead & Facilities Amortization (O_y):** The allocation of the yard's fixed and variable operating costs. This includes crane operations, load-out quay maintenance, supervisory management, safety teams, insurance, utilities, and capital amortization of the asset yard itself.
- **Structural Transport Reinforcement (S_r):** The additional material cost (typically 10-25% more structural steel weight) required solely to resist dynamic acceleration, twisting, and bending forces experienced during marine transit, heavy-haul road shipping, or crane lifting.
- **Testing & Pre-Commissioning (E_t):** Factory acceptance testing (FAT), non-destructive testing (NDT) on welds, hydrotesting of pipe spools, electrical continuity checks, and loop testing performed within the yard to minimize field commissioning defects.
- **Yard Profit Margin ($Profit_y$):** The commercial fee and risk premium applied by the modular fabricator, reflecting their baseline execution risk and capacity utilization.

Total Installed Cost (TIC) Advantage Calculation Methodology

To objectively evaluate the economic variance between strategies, the project board utilizes the Total Installed Cost Advantage (Delta TIC) metric. A positive value indicates that modularization yields a lower absolute capital expenditure than stick-built execution, whereas a negative value indicates that stick-built is financially superior. The calculation is conducted using the following sequential methodology:

Step 1: Calculate Stick-Built Total Installed Cost (TIC_S)

$$TIC_S = M + L_s + I_s + C_S$$

Where:

- **M:** Bulk materials and equipment delivered loose to the project site.
- **L_s:** Unmanaged, variable field craft labor hours unadjusted for field productivity loss.
- **I_s:** Extended site indirect costs, including massive temporary facilities, scaffolding, scaffolding labor, local workforce transport, per diems, and weather-mitigation setups.
- **C_S:** Elevated stick-built contingency buffer (10-20%) to absorb weather delays, labor disputes, etc.

Step 2: Calculate Modular Total Installed Cost (TIC_M)

$$TIC_M = P_y + L_f + T + I + C_M - TV$$

Where:

- **P_y:** The fully burdened Modular Yard Price defined previously.
- **L_f:** Greatly reduced on-site installation labor hours required to secure modules.
- **T:** Heavylift logistics, marine barge leases, ocean freight, heavy-haul trucking permits, and SPMT mobilization.
- **I:** Site integration, structural hook-ups, stitching piping runs, and inter-module wiring.

- **C_M:** Tight, controlled modular contingency buffer (5-10%) reflective of factory predictability.
- **TV:** The captured Time-Value of construction, which directly represents the financial benefit of compressing the schedule. It is calculated as:

$$TV = (I_d + O_d + R) * \Delta t$$

Where I_d is daily field indirect savings, O_d is owner overhead savings, R is daily net operational revenue generated by early facility startup, and Delta t is the net calendar days saved by parallelizing construction.

Step 3: Determine the Final Advantage (Delta TIC)

$$\Delta TIC = TIC_S - TIC_M$$

A positive delta proves that the combined field labor reduction, site indirect mitigation, and compressed time-value outweigh the added logistics and yard overhead costs.

Cross-Industry Comparative Scenarios

Four different modular construction contexts are examined in the following examples. Values are for illustration only.

Example A: Heavy Infrastructure — US Cable-Stayed Bridge (Hudson River)

Context: Marine execution over an active shipping channel with high union labor costs, strict environmental windows, and zero land staging space.

Cost & Schedule Element	Stick-Built Strategy	Modular Strategy	Variance / Capital Impact
Procurement & Fabrication (M / P_y)	$180M (Loose steel/rebar)	$215M (Pre-cast/assembled)	-$35M (Modular yard premium)
Field Construction Labor (L_s / L_f)	$140M (High marine union hours)	$45M (Rapid block setting)	+$95M (Field labor displaced)
Logistics & Marine Heavy Lift (T)	$15M (Standard delivery barges)	$48M (Shear-leg cranes/tugs)	-$33M (Heavy logistics penalty)
Site Indirects & Integration (I_s / I)	$65M (Continuous staging)	$20M (Direct hook-up)	+$45M (Reduced marine footprint)

Contingency (C_S / C_M)	$40M (20% river delay buffer)	$16M (7% controlled yard buffer)	+$24M (Risk insulation)
Time-Value (TV)	$0 (Baseline path)	$36M (90 days compressed)	+$36M (Average test traffic/indirects)
Project Schedule Duration	32 Months (Sequential)	29 Months (Parallel)	3 Months Saved (Delta t = 90 days)

Delta TIC Evaluation & Narrative

> **Delta TIC = TIC_S - TIC_M**

Calculation: TIC_S = 180 + 140 + 65 + 40 = $425M

Calculation: TIC_M = 215 + 45 + 48 + 20 + 16 - 36 = $308M

Calculation: Delta TIC = 425 - 308 = +$117M

Financial & Schedule Narrative: Stick-built execution forces long, hazardous work over water, exposed to Northeast winter weather and high-cost union labor. In contrast, the modular strategy utilizes deep-water marine pathways to barge massive pre-assembled deck segments directly to the site. While the modular yard price carries a $35M premium due to fabrication overhead and structural transport reinforcement, it drives a massive $95M reduction in dangerous field hours over water. The schedule is compressed by 3 months, capturing $36M in Time-Value by minimizing extended marine indirect costs (I_d) and owner oversight expenses (O_d). This yields a net capital advantage of $117M.

Example B: Industrial — LNG Plant (US Gulf Coast)

Context: Multi-train greenfield megaproject facing severe local craft labor shortages and low regional productivity, but offering excellent deep-water access.

Cost & Schedule Element	Stick-Built Strategy	Modular Strategy	Variance / Capital Impact
Procurement & Fabrication (M / P_y)	$620M (Raw bulks/loose eq)	$740M (APAC Super-modules)	-$120M (Yard & transit premium)
Field Construction Labor (L_s / L_f)	$580M (Severe labor inflation)	$110M (Stitching/setting)	+$470M (Labor displacement)
Logistics & Heavylift (T)	$30M (Standard freight)	$115M (Ocean carriers/SPMTs)	-$85M (Logistics infrastructure)

Site Indirects & Integration (I_s / I)	$210M (Man-camps/scaffold)	$65M (Interconnect tie-in focus)	+$145M (Reduced site footprint)
Contingency (C_S / C_M)	$140M (15% labor/weather buffer)	$50M (6% yard buffer)	+$90M (Volatility insulation)
Time-Value (TV)	$0 (Baseline path)	$180M (180 days compressed)	+$180M (Early spot-market revenue)
Project Schedule Duration	48 Months (Sequential)	42 Months (Parallel)	6 Months Saved (Delta t = 180 days)

Delta TIC Evaluation & Narrative

Delta TIC = TIC_S - TIC_M

Calculation: TIC_S = 620 + 580 + 210 + 140 = $1,550M

Calculation: TIC_M = 740 + 110 + 115 + 65 + 50 - 180 = $900M

Calculation: Delta TIC = 1,550 - 900 = +$650M

Financial & Schedule Narrative: Attempting to stick-build a massive LNG facility on the US Gulf Coast exposes the owner to severe craft labor shortages and compounding regional productivity losses. By offloading more than 70% of structural and process piping weight to prequalified Asian mega-yards, the project replaces volatile field labor with highly efficient, lower-cost factory assembly. The logistics cost is substantial, requiring $115M for ocean module carriers, canal dredging, and complex SPMT roll-off logistics. However, parallelizing yard fabrication with site civil works shaves 6 months off the critical path. In a high-demand market, accelerating production by 180 days generates an immense $180M in Time-Value (TV), primarily driven by early spot-market LNG revenue (R). This delivers a total economic advantage of $650M.

Example C: Heavy Industrial — Iron Ore Complex (Western Australia)

Context: Greenfield mine site in the remote Pilbara region with extreme fly-in fly-out (FIFO) logistics, extreme desert heat, and strict road boundaries.

Cost & Schedule Element	Stick-Built Strategy	Modular Strategy	Variance / Capital Impact
Procurement & Fabrication (M / P_y)	$340M (Loose structural steel)	$395M (Bifurcated mod yards)	-$55M (Yard overhead premium)

Field Construction Labor (L_s / L_f)	$310M (Extreme FIFO rates)	$85M (Minimal hookup crews)	+$225M (Outback labor avoidance)
Logistics & Heavylift (T)	$25M (Outback road trains)	$65M (Permit/escort fees)	-$40M (Inland route constraints)
Site Indirects & Integration (I_s / I)	$115M (Extended camp operations)	$40M (Rapid structural tie-ins)	+$75M (Camp exposure reduction)
Contingency (C_S / C_M)	$75M (16% severe climate buffer)	$25M (6% yard control buffer)	+$50M (Climate protection)
Time-Value (TV)	$0 (Baseline path)	$90M (120 days compressed)	+$90M (JV revenue delivery)
Project Schedule Duration	36 Months (Sequential)	32 Months (Parallel)	4 Months Saved (Delta t = 120 days)

Delta TIC Evaluation & Narrative

Delta TIC = TIC_S - TIC_M

Calculation: TIC_S = 340 + 310 + 115 + 75 = $840M

Calculation: TIC_M = 395 + 85 + 65 + 40 + 25 - 90 = $620M

Calculation: Delta TIC = 840 - 620 = +$220M

Financial & Schedule Narrative: In the remote Pilbara desert, stick-built execution suffers from extreme heat constraints and costly Fly-In Fly-Out (FIFO) labor infrastructure. The modular strategy uses a bifurcated approach: large super-modules are deployed at the coast, while smaller, highway-compliant 150-ton linear skids are sent inland to bypass narrow road clearances. The specialized transportation permits and multi-stage transport network add a $40M logistics penalty compared to simple flatbed shipping. However, shifting high-density piping and mechanical assembly to coastal yards reduces remote field hours by more than 70%. This avoids $225M in field labor costs and cuts 4 months off the project schedule. This compression yields $90M in Time-Value, resulting in a net capital savings of $220M.

Example D: Commercial — AI Hyper Data Center (Austin, Texas)

Context: Fast-track suburban build balancing rapid speed-to-market with dense power infrastructure and fluid, late-stage chip architecture adjustments.

Cost & Schedule Element	Stick-Built Strategy	Modular Strategy	Variance / Capital Impact
Procurement & Fabrication (M / P_y)	$190M (Loose electrical/chillers)	$215M (Prefab E-Houses/Skids)	-$25M (Factory premium)
Field Construction Labor (L_s / L_f)	$95M (Congested site hours)	$35M (Plug-and-play hookups)	+$60M (Trade congestion relief)
Logistics & Heavylift (T)	$8M (Standard shipping)	$18M (Wide-load highway escorts)	-$10M (Permit & escort overhead)
Site Indirects & Integration (I_s / I)	$35M (Laydown/scaffolding)	$15M (Crane-to-pad setting)	+$20M (Laydown footprint savings)
Contingency (C_S / C_M)	$25M (10% trade buffer)	$16M (7% engineering buffer)	+$9M (Predictable execution)
Time-Value (TV)	$0 (Baseline path)	$45M (90 days compressed)	+$45M (Immediate cluster revenue)
Project Schedule Duration	18 Months (Sequential)	15 Months (Parallel)	3 Months Saved (Delta t = 90 days)

Delta TIC Evaluation & Narrative

Delta TIC = TIC_S - TIC_M

Calculation: TIC_S = 190 + 95 + 35 + 25 = $345M

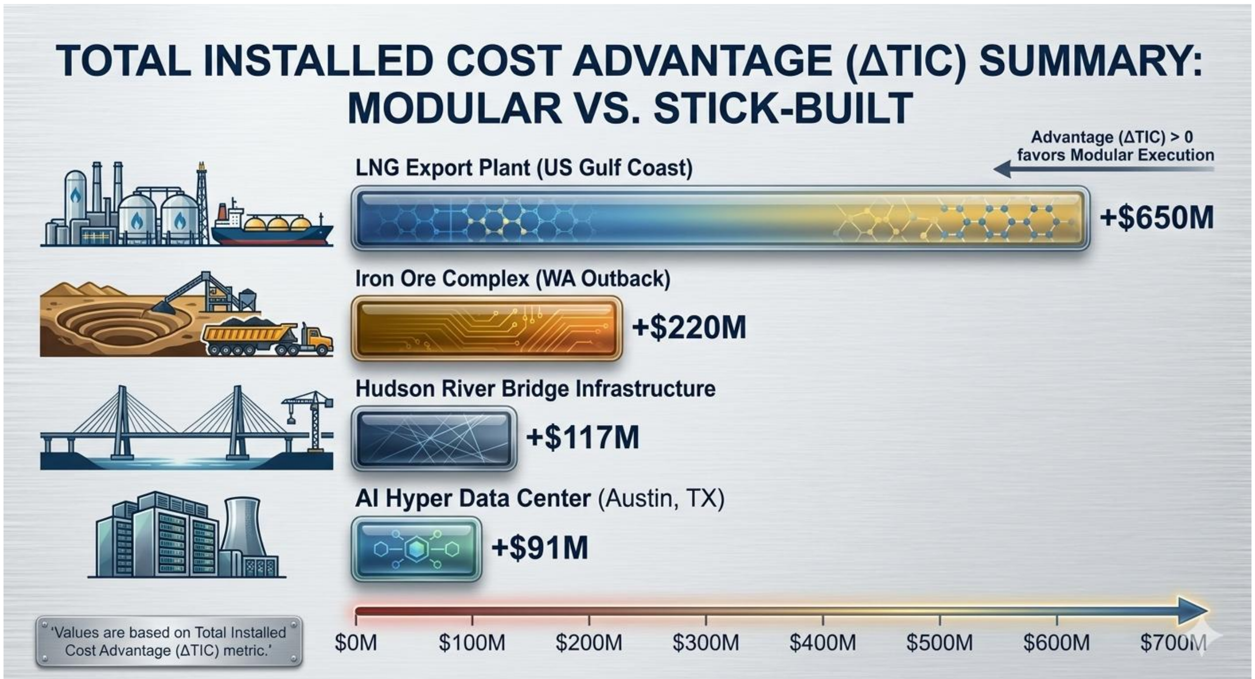
Calculation: TIC_M = 215 + 35 + 18 + 15 + 16 - 45 = $254M

Calculation: Delta TIC = 345 - 254 = +$91M

Financial & Schedule Narrative: Building high-density data centers using traditional stick-built methods creates significant trade interference on site, slowing down complex electrical and cooling hookups. The modular strategy uses pre-cast panels for the building shell, while concurrently building and pre-commissioning power distribution blocks and cooling skids at domestic integration yards. This off-site manufacturing premium adds $25M to initial procurement costs and increases the risk of design changes if computing technology shifts late in the project lifecycle. However, this risk is mitigated by strict change-control gates. Moving technical trade integration to a factory environment cuts 3 months off the critical path. In the competitive AI computing market, a 90-day acceleration yields $45M in Time-Value via immediate lease revenues (R), resulting in a net capital advantage of $91M.

Executive Capital Summary Dashboard

The cross-industry data shows that while modularization increases baseline material, fabrication, and heavy logistics costs, it consistently reduces overall project risk and total capital requirements when deployed under the right conditions.



Strategic Conclusions for Project Governance

- **Field Labor Displacement is the Primary Cost Driver:** The economic viability of modularization relies on shifting volatile field hours into stable, highly productive off-site manufacturing yards.
- **Logistics Costs Must Be Managed Closely:** Increased logistics and transportation costs are a structural certainty with modular execution. Project teams must treat logistics as an ongoing operational constraint, rather than a single transactional cost.
- **Time-Value Generates the Strongest Returns:** When early asset completion drives high daily operational revenue (R), schedule compression becomes the single largest factor in selecting a modular strategy, overriding baseline factory price premiums.

For Further Reading – Other Executive Insights

- Craft Training for Modular Construction
- Digital Passports Training for Modular Construction
- Golden Thread
- Modular Construction Contract Consideration
- Spare Parts in Modular Construction
- Modular Construction Transportation Risks
- Modularization vs. Stick-Built Readiness Strategy

About the Author

Bob Prieto was elected to the National Academy of Construction in 2011. He is a senior executive who is effective in shaping and executing business strategy and a recognized leader within the infrastructure, engineering, and construction industries. Bob received the 2024 ASCE OPAL Award (Outstanding Projects and Leaders) for his Outstanding Lifetime Achievement in Management.