


MODULARISATION AND PRE-ASSEMBLY PAPER #5 DEVELOPMENT OF ECONOMIC MODEL COSTS

AUTHOR © ~ MARK STARKOFF, MANAGING DIRECTOR - SIGMA ENGINEERING PTY LTD
(www.sigmaengineering.com.au - info@sigmaengineering.com.au)
Paper for the Modular Construction and Pre-Fabrication Conference 11-12 May 2010 Brisbane (iQ Construction - Division of IQPC)

INTRODUCTION AND OVERVIEW

This paper is an extension of the discussion provided in the paper by the author Modularization And Pre-Assembly Paper #1 - Underpinning Parameters And Considerations.

The topics discussed in this paper provide the reader with an extended discussion on the principle cost evaluation components related to the evaluation of a modular or pre-assembly delivered project versus a traditional site erected or “stick built” project delivery. In addition to these key areas of interest, the reader will be provided with key information related to areas of concern long held by proponents of traditional project delivery models. In general, the discussion is applicable to projects from all industrial sectors and international locations This paper is augmented by another paper by the author; Modularization And Pre-Assembly Paper #6 - Offshore Fabrication and Assembly Cost Development.

The discussion of the approach to the development of the overall modular or pre-assembly economic cost position will be broached in the following sequence.

1. Modular and Pre-Assembly Economic Model Development Objectives;
2. Development of Shipping Cost;
3. Development of Land Transportation Cost;
4. Development of Site Installation Costs;
5. Development of Supporting Infrastructure Costs;
6. Concluding Comments.

The reader is referred to the paper by the author Modularization And Pre-Assembly Paper #6 - Offshore Fabrication and Assembly Cost Development for the specific detail related to this component of the overall cost development process.

The discussion presented in this paper will be held at a high level and specifically targeted to the early scoping and pre-feasibility development phases of a project. As a project develops execution momentum there is an additional refinement and development process related to the ongoing economic and cost modeling that is outside the scope of discussion for this paper.

MODULAR AND PRE-ASSEMBLY ECONOMIC MODEL DEVELOPMENT OBJECTIVES

As defined in the in the paper by the author, Modularization And Pre-Assembly Paper #1 - Underpinning Parameters And Considerations, the principle reason for the development of the economic model for a modular or pre-assembly project delivery is to validate the viability of the project delivery as more attractive to a project owner on the basis of the following key area;

1. Construction Safety
2. Project Delivery Schedule
3. Project Delivery Capital Cost
4. Project Quality
5. Site Environmental Impacts

While overall project cost prediction and forecast is not the only project owner focus, it holds strong favor as the primary evaluation tool for a project to establish project value and financial viability of core business decisions related to project development at a corporate level.

“While overall project cost prediction and forecast is not the only project owner focus, it holds strong favor as the primary evaluation tool for a project to establish project value and financial viability of core business decisions related to project development at a corporate level.”

As such, the economic model developed for the purpose of establishing the project delivery methodology must have the following key attributes.

1. Sensibly conservative and consistent basis of cost data development for robust eco nomic analysis;

2. Cost data for all components of the economic model must be representative of current market conditions applicable to future project development;

3. Cost data established and averaged such that there is a commercially independent platform for the development of the project economics in the early phases of project development;

4. Cost data must be established on the fundamental basis of unit of measure by commodity so that it is easily extrapolated to project quantities that may vary through project development;

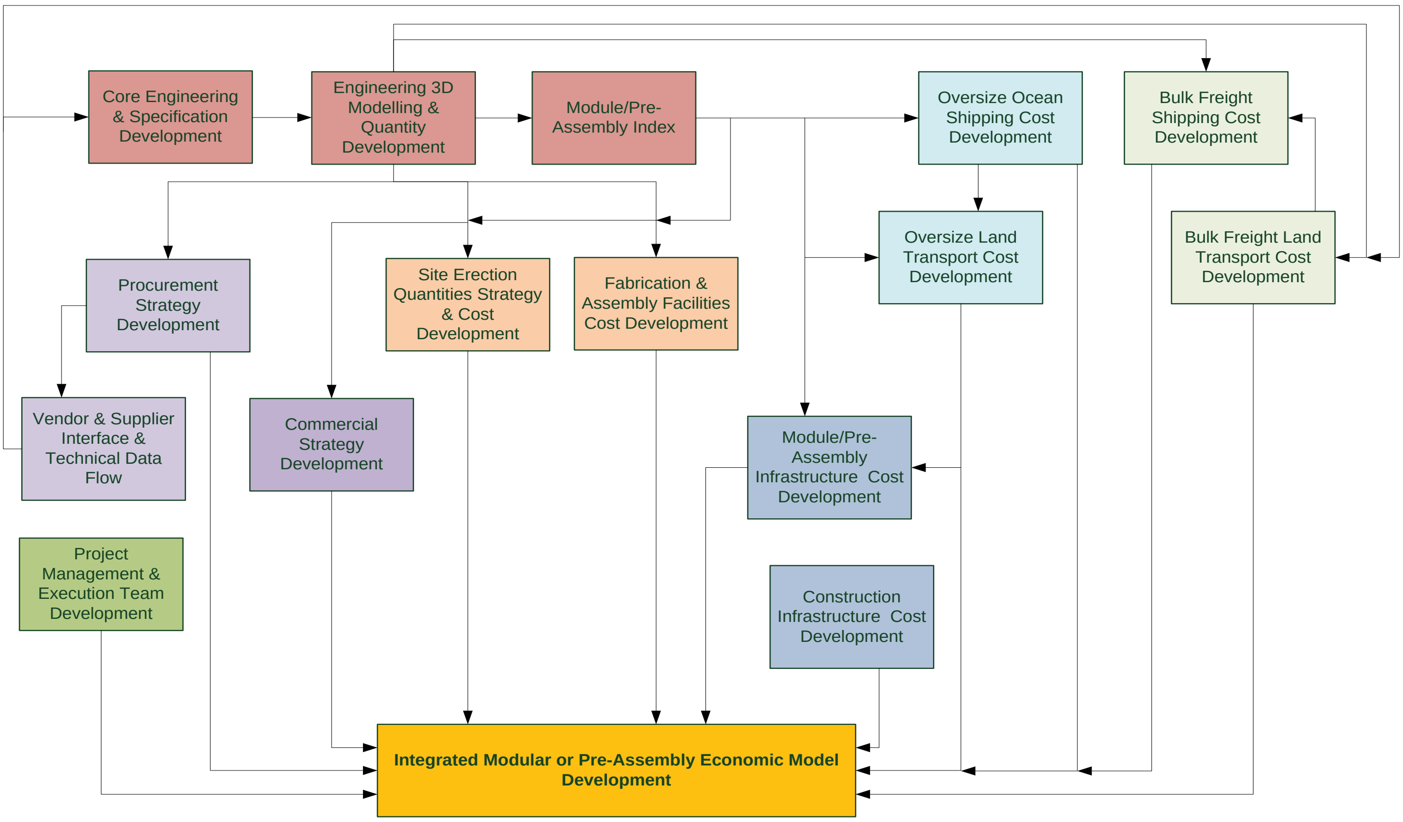
5. A basis of fundamental project scope quantities must be equally applied to a modular or pre-assembly delivery model and a site erected or stick build economic model.

With these key governing considerations addressed in the economic model development the resulting economic analysis will be build on a foundation of strength from which project owners can confidently endorse the selection of project delivery strategy. This is the primary objective of the module or pre-assembly economic model.

The key components of an economic model for a modular or pre-assembly delivered project are provided as follows; and the interface and integration relationships are identified in the diagram below.

- Engineering Development and Definition Of Modules and Pre-Assemblies;
- Engineering Quantities Development;
- Module or Pre-Assembly Index Development;
- Procurement & Commercial Strategy Development;
- Fabrication/Assembly Facility Costs;
- Oversize Shipping Cost;
- Bulk Shipping Cost;
- Oversize Land Transport Cost;
- Road Freight Cost;

INTERRELATIONSHIP FOR MODULAR AND PRE-ASSEMBLY ECONOMIC MODEL DEVELOPMENT



AUTHOR - MARK STARKOFF, MANAGING DIRECTOR SIGMA ENGINEERING PTY LTD (31-1-2010) (COPYRIGHT ©)
(www.sigmaengineering.com.au - info@sigmaengineering.com.au)

- Module and Pre-Assembly Supporting Infrastructure;
- On site Module or Pre-Assembly Installation Cost;
- Project Execution Team Development;
- Composite Economic Models of Module or Pre Assembly Delivery.

The key interdependent and interrelated areas identified above have varying influence on each phase of project development. As this paper focuses on the early phases of project development the procurement, commercial and organizational aspect of the overall economic model will be left as the focus of future papers by the author and the more fundamental aspects of shipping, transportation and site installation cost development will be discussed in more detail.

MODULE OR PRE-ASSEMBLY INDEX

One area of the economic modeling process that is extremely important is the development of the 3 Dimensional Engineering Models for the composite project scope and the individual modules, pre-assemblies and site erected material groups. It is essential in the early development of the economic model to progress the development of the associated module or pre-assembly lists and characteristic mass and dimensional parameters of the modules or pre-assemblies. It is a fundamental requirement that these lists or registers comprehensively identify all modules and pre-assemblies via unique and singularly applicable identifiers or tag or numbers. These lists have historically held many titles such as Module Index, PAM Master Log, Pre-Assembly Index etc; whatever the title, the underlying importance of this unique identity register and labeling process should be its early development and mirroring links to the project work breakdown structure. These list and registers will be utilized as a base information reference throughout an entire modular or pre-assembly delivery and will encompass many additional points of key information as the project develops.

The establishment of the individual component blocks contributing to the overall economic model, and most importantly the basis of the cost information for the individual elements comprising the aggregate of the component block is of fundamental importance. The fundamentally common base unit to all project delivery methodologies is the applicable project quantities and the commodities of construction that make up the project quantities. Invariably, this is the consistent and common basis of a project delivery, regardless of delivery method.

"The fundamentally common base unit to all project delivery methodologies is the applicable project quantities and the commodities of construction that make up the project quantities. Invariably, this is the consistent and common basis of a project delivery, regardless of delivery method."

DEVELOPMENT OF SHIPPING COSTS

A fundamental difficulty for many project teams in the early project development phases is the ability define the overall module or pre-assembly quantities and governing parameters. This fundamental limitation in project definition has often limited the ability of the project to gain fundamentally applicable shipping cost data that can be used for complex economic model development. Ship owners, freight fowarders and agents press a project for specific data on proposed manifests of future voyages. This common market position has been predominant in the oversize cargo market. Bulk freight cargo costs have been traditionally more easy to obtain and are generally linked to tonnage of the cargo for shipment which is more easily addressed by both the market and the project team.

In order for a project to establish meaningful cost data for oversize shipping, there must be a shift in approach enquiry to accommodate the unknown quantities and parameters of the as yet undefined oversize cargo. One simple solution is to develop a dedicated vessel charter approach and sample the market on this basis i.e. full charter voyage cost from location of fabrication and assembly to port of destination for modules or pre-assemblies.

An approach to cost development of this nature holds some strong advantages for a project in the early phases of development. Shipping cost data can be established on a charter basis while the development and refinement of the extent of the modular and pre-assembly scope is being further developed and refined. In order for the ship owners, agents or freight forwarders to be able to assist on a vessel charter basis they will need some information related to departure and destination locations such as berth configurations, navigation channels and associated bathymetry data.

AUTHOR - MARK STARKOFF, MANAGING DIRECTOR SIGMA ENGINEERING PTY LTD (31-1-2010) (COPYRIGHT ©)
(www.sigmaengineering.com.au - info@sigmaengineering.com.au)

This key information should be linked directly to the proposed locations of the offshore fabrication and assembly facility cost development studies. It should be noted that these studies can be undertaken concurrently.

TRANSPORTING AIR

Fundamentally, all commodities of construction must be transported to the construction site. Transportation will generally involve both ocean transportation and land transportation to the final location. The exception to this is when the final location of the freight is within reach of a ships lifting gear or it can be picked from the ship and directly placed from a land based crane.

These fundamental transport requirements must be linked to the cost development associated with the size, mass and complexity of the freight. The fundamental currency of modularization and pre-assembly is the construction hour cost on a commodities basis. It stands then, that the delta in cost between an off site, and an on site, construction hour considerably contribute to the financing of the transportation of oversized cargo such as a module or pre-assembly. Air is never shipped, construction hours are transferred and models and pre-assemblies are receipts for the transfer. The configuration of a module or pre-assembly alone is not an accurate indicator of its viability to fabricate, assemble off site and ship to its final site location. Economic viability must be proved or disproved through soundly based cost analysis and never visual configuration. A sparsely populated structure when accompanying a group of more construction hour rich modules or pre-assemblies, will have improved viability in the aggregate analysis of the total shipping plan and associated costs considered on a holistic basis.

To maximize the cost related benefits of modular or pre-assembly delivery, maximized utilization of off site fabrication, assembly and consolidated shipping and transport must be embraced. Module and pre-assembly value is destroyed by dismantling the aggregate opportunity into piece wise viability analysis.

Shipping cost can be provided by a number of different ship owners, agents or freight forwarders such that a pool of dedicated charter costs can be established for a pool of different vessels from a number of specified fabrication and assembly facilities. The vessel charter costs should include costs from the spectrum of shipping conceptually applicable for the project delivery, i.e. Towed Barges, Lift On - Lift Off (LOLO), Roll on - Roll Off (RORO) and Float On - Float Off (FOFO). The appropriate spread of shipping classes will allow the project to undertake value analysis with respect to total potential voyage tonnage versus cost. This level of analysis can be commenced as the modular or pre-assembly scale and overall extent is firmed during the pre-feasibility phase of project development.

The following brief table indicates the data collection structure.

VESSEL POOL - CHARTER VOYAGE COST DATA			
Vessel & Owner	**Location A To Site Port**	**Location B To Site Port**	**Location C to Site Port**
Owner 1			
Vessel 1	$	$	$
Vessel 2	$	$	$
Owner 2			
Vessel 1	$	$	$
Vessel 2	$	$	$

"Project oversize shipping cost are achieved by identifying the aggregate module or pre-assembly footprint area via the associated index or list and assigning a number of charter voyages on a vessel by vessel basis with an adequate cargo area utilization factor."

This cost data must be accompanied by specific information related to the particular vessel that each ship owner, agent of freight forwarder provides cost data for. This data consists of vessel flag, draught, allocatable cargo area, stowage configuration such as tween deck space, etc.

When this data has been collected by the project, specific vessel data can be matched and applied to the module or pre-assembly index and a shipping cost can be established. Project oversize shipping cost are developed by identifying the aggregate module or pre-assembly footprint area via the associated index or list and assigning a number of charter voyages on a vessel by vessel basis with an adequate cargo area utilization factor. The establishment of this key shipping cost data through this method allows the shipping cost component of the overall economic model to be flexibly established and adaptive to increases in modular or

pre-assembly numbers or refinements in dimensional characteristics without the requirement to continually reconfirm the cost basis in the market.

Another key aspect of the shipping costs is the general bulk freight costs that would be apparent in a traditionally delivered site erected project delivery. The associated cost must also be accounted for in a modular or pre-assembly delivered project. Fabricated items and many bulks can be shipped with the modules or pre-assemblies and are effectively filler freight on the oversize voyages and contribute to the positive cost benefits of a modular or pre-assembly delivered project by eliminating dedicated bulk freight ship-

ADDITIONAL STEEL FOR OCEAN ACCELERATION FORCE RESISTANCE, BRACING, GRILLAGE AND TRANSPORT BEAMS

There has always been some depth of anxiety in the market in relation to the quantity of additional steel required for a modular or pre-assembly delivered project. The following discussion should assist in the clarification and actual impact of the requirements on the overall project cost.

Additional Steel Requirements

1. Duplication of column and beam to facilitate modular or pre-assembly design;
2. Additional steel mass to resist ocean acceleration forces and compression forces due to rigging configurations;
3. Additional temporary structural bracing members;
4. Vessel deck grillage and transportation beams.

It should be noted that items 3. and 4. above can be reused through project execution and sold at the end of the project.

Offsetting Structural Characteristics

1. Seismic loading requirements of the final structural design;
2. Wind loading requirements of the final structural design;
3. Operational loading characteristics of the final operation design.

It should be noted that the strength requirements identified above are inherent to final operational conditions. These key requirements address design code factors of safety for the country of location. Some of the additional strength requirements associated with ocean acceleration forces may be offset by these requirements.

There is a general industry rule of thumb allowance of 5% to 12% of the heavy structural commodity quantity for ocean transport strengthening. There is also a requirement for column and beam duplication, deck grillage and transport beams. If the economic model holds a total of 25% additional allowance in the heavy and extra heavy structural steel commodity quantities, this will provide a robust, conservative cost platform for an economic model in the pre-feasibility level phases of project. Light and medium categories of structural steel commodities should not be adjusted.

An important point of conceptual note, the following table indicates a typical range of structural steel commodities. It can be noted that each category has a range of mass per linear meter which translates to a design strength.

TYPICAL STRUCTURAL STEEL COMMODITY GROUPINGS

DAC - Structural Steel Heavy	DAB - Structural Steel Medium	DAA - Structural Steel Light
81kg/m to 120kg/m	26kg/m to 80kg/m	Up to 25kg/m

It can be seen that the range of mass in each category will have an effect on the final procurement cost. However, careful understanding of how costs are compiled in estimates is required. Estimates for structural steel cost should always carry the higher end of the commodities range for mass (and by default strength). After close inspection of estimating methods, it may be found that the upper end of all commodity ranges for structural steel are always carried and the associated cost for additional strengthening steel is by default carried in module and pre-assembly project estimates.

ping requirements.

A key consideration with shipping cost is the validity period for the charter pricing, shippers are subject to variations in oil price that can have a marked effect on shipping cost. In a compounding manner, if shipping demand and oil prices surge, shipping cost can be considerably affected. It is good practice to validate shipping cost platforms on a quarterly or half yearly basis, and most definitely at the commencement of progressive project development phases.

In some instances and project location environments it is also required that vessels have a pilot to berth at either offshore facility locations or project destination ports and address associated port fee requirements. It is essential to specify the location of the offshore facility ports so ship owners, agents or freight forwarders can establish the requirements for these services and make account of the associated costs.

It is also important that the labor associated with the removal of modules or pre-assemblies from vessels at the port of arrival is captured in economic modeling. While it is not an extensive construction hour burden, there may be as many as 15 personnel over a continuous 72 hour period required to facilitate the removal of the modules and pre-assemblies from each vessel if they are substantially loaded the oversize deck cargo. This labor is not provided by the ship.

DEVELOPMENT OF LAND TRANSPORT COST

In a similar manner to shipping cost, land transportation cost for a modular or pre-assembly delivered project are central to the overall viability of the delivery strategy.

"In order for the transportation cost to be established, it is important that the modules and pre-assemblies are categorized into commodity groups for the purposes of costing both transportation and site placement and installation."

In order for the transportation cost to be established, it is important that the modules and pre-assemblies are categorized into commodity groups for the purposes of costing both transportation and site placement and installation.

The following table provides a typical example of the allocation of pre-assemblies into a commodity grouping for the purposes of assigning transport costs.

Pre-Assembly Commodity Categorisation for Land Transport	
Transport Cost Per Pre-Assembly Over 8m Wide Up To 500 Tonne	
<300 to 500 Tonne	$ per Transportation
<150 to 300 Tonne	$ per Transportation
40 to 150 Tonne	$ per Transportation
Transport Cost Per Pre-Assembly Over 6m Up To 8m Wide Up To 500 Tonne	
<300 to 500 Tonne	$ per Transportation
<150 to 300 Tonne	$ per Transportation
40 to 150 Tonne	$ per Transportation
Transport Cost Per Pre-Assembly Under 6m Wide Up To 500 Tonne	
<300 to 500 Tonne	$ per Transportation
<150 to 300 Tonne	$ per Transportation
40 to 150 Tonne	$ per Transportation

Each project will have a specific grouping that will be applicable to the extent of modular and pre-assembly scale and the commodity range can be customized to fit each project.

At the pre-feasibility phase of project development it is important to retain a robust and sensibly conservative approach to the establishment of costs for the economic model. As such, a costing basis built on a module or pre-assembly commodity basis covering the services and category on a commodity allocated foundation will provide a strong economic base. As the project progresses through the feasibility phase, additional definition will become available and the transportation equipment and service providers can develop a costs for equipment pools and personnel resources that are integrated into the project schedule to maximise cost effectiveness and equipment minimization. It is essential that in the pre-feasibility phases of project development the individual requirements for equipment and personnel are assigned on a per transportation basis for the module or pre-assembly commodity category. This approach allows flexibility for the designers and retains a platform for the economic model to be adjusted and changed as engineering definition is progressed.

(www.sigmaengineering.com.au - info@sigmaengineering.com.au)

As the project progresses through the feasibility phase, additional definition will become available and the transportation equipment and service providers can develop costs for equipment pools and personnel resources that are integrated into the project schedule to maximise cost effectiveness and equipment minimization. It is essential that in the pre-feasibility phases of project development that the individual requirements for equipment and personnel are assigned on a per transportation basis for the module or pre-assembly commodity category. This approach allows flexibility for the designers and retains a platform for the economic model to be adjusted and changed as engineering definition is progressed.

DEVELOPMENT OF SITE INSTALLATION COSTS

The development of on site installation costs for a modular or pre-assembly delivered project can be divided into two specific areas for the installation of fabricated and assembled quantities.

1. Placement and installation of modules and pre-assemblies;

2. Installation of site erected elements or “stick build” items.

For the installation costs associated with modules and pre-assemblies, there are two principle costs; placement and installation equipment, and associated site labor. The placement installation equipment is dependent on the placement technique i.e. trailer placement, crane lift, jacking or skating etc. The labor associated with the placement is limited to the module or pre-assembly placement activity. For a robust economic model, an allowance of 10 to 15 hours per tonne, selectively assigned on a module or pre-assembly commodity basis is an adequate allowance for a pre-feasibility study economic model. As feasibility phase engineering definition is refined, site installation and construction resources will be able to more accurately identify the module and pre-assembly installation costs on commodity and placement technique basis. To provide a general appreciation of the installation labor required for large models, the Alcan G3 project installed large modules with masses in excess of 1000 tonne, over a 24 hour period with crews of construction personnel and supervision ranging from 10 to 20 personnel dependent on the complexity of the interface and location of the specific module. From this benchmark, it can be seen that the allocation of 10 to 15 hours per tonne provides a conservative economic cost platform for the costing of large modules placement in early project development phases.

“The labor allocation for the site erected or “stick build” quantities for a modular or pre-assembly delivered project should be accounted for in exactly the same manner as the site installed quantities associated with a “stick build” project execution delivery.”

The labor allocation for the site erected or “stick build” quantities for a modular or pre-assembly delivered project should be accounted for in exactly the same manner as the site installed quantities associated with a “stick build” project execution delivery. The site installed quantities should be accounted for in the economic model on a unit of measure commodities basis with the prevailing on site labor rates applied to the productivity parameters of each commodity. For example, a Heavy Structural commodity group, (XXX - 81kg to 120kg per meter) may be assigned 15 hours per tonne for on site installation. The total tonnage for this commodity would be multiplied by 15 to determine the total site hours required by this commodity and the associated on site hourly labor cost associated with this commodity applied to derive the total direct cost for this quantity of the commodity. This is the process generally applied across the entire site erected quantities on a commodity basis. The resulting summation of all the costs will provide the direct cost for the site installed quantities.

It should be noted that the direct costs for a construction hour are the total costs of the construction hour on site. Indirect costs, contractor distributable costs, project managers costs (ECP, EPCM or PMC) and owner`s costs all contribute to the absolute cost of an on site construction hour.

DEVELOPMENT OF SUPPORTING INFRASTRUCTURE COST

This is an area in the development of the modular or pre-assembly economic model where close attention needs to be applied to the infrastructure requirements associated with the delivery strategy. The following list, while not comprehensively inclusive, gives the reader an understanding of the key areas of cost impact.

1. Berths and Wharfs at project or other locations;
2. Quarantine, customs and bonding area facilities including wash down;
3. Civil pavement development for module or pre-assembly access corridors;
4. Improvements to public highway or modifications to public infrastructure to facilitate transportation of modules or pre-assemblies;

These key areas require cost development and inclusion into the economic model. The resultant cost of these key requirements to support a modular or pre-assembly delivery strategy are fundamental to the viability of the strategy approach. As such they hold significant importance from an overall cost balance perspective. These costs associated with supporting infrastructure have an effect on the economic viability of a modular or pre-assembly delivery strategy. For instance, purpose built module transport corridors may be in the order of US$10,000.00 a linear meter to accommodate large module of the 1000 tonne plus category.

CONCLUDING COMMENTS

The essential objective of a modular or pre-assembly economic model is to develop a basis for the evaluation of project delivery methods and establish a defined strategy for project execution. The table on the next page identifies key elements of costing considerations for both a modular or pre-assembly and a "stick build" project delivery strategy.

The most essential elements in the evaluation of both methodologies is the consideration of direct and indirect costs and hours on site. This aspect of evaluation is discussed in detail in the paper by the author, Modularization And Pre-Assembly Paper #1 - Underpinning Parameters And Considerations. The reader is directed to the discussion in this paper related to direct and indirect cost, and how they impact on the overall positive economic position of a module or pre-assembly delivery strategy.

In final conclusion for this paper, the reader is asked to consider a very important question. What

"What course of action does a project owner take if the economics for a modular or pre-assembly delivery is in equal balance with a "stick build" project delivery?"

course of action does a project owner take if the economics for a modular or pre-assembly delivery is in equal balance with a "stick build" project delivery? This is an important question. It leads to a more important question. How does the project quantify the benefits of other key advantages of a modularized or pre-assembled project delivery strategy such as;

1. Construction Safety;
2. Project Delivery Schedule
3. Project Quality;
4. Site Environmental Impacts;

The areas listed above have intrinsic potential to positively improve project value via a modular or pre-assembly delivery strategy. The establishment of their individual value is complex and must be undertaken on a project by project basis. The implications and possibilities for each key area is uniquely defined by specific project parameters and execution environments. Without question, the ability to initiate and sustain multiple work fronts concurrently holds tremendous potential in respect to early project completion in comparison to traditional construction delivery methods. Any improvement in the speed to market for a project owner must improve the fundamental viability and value of a project at a base level. The impacts of a week, month or quarters improvement in project delivery can only be quantified on a project by project basis. The improvements to schedule completion can alternatively be viewed from a perspective of insurance against possible delays in construction often experienced in traditional delivery methods. Again, such a hedge provides a project with a strong measure of confidence that a traditional delivery schedule can be achieved, even if a project was not prepared to bank the projected improvement in project construction delivery associated with a modular or pre-assembly delivery strategy.

In final note, the standards of safety possible through a modular or pre-assembly delivered project eclipse the highest potential of a traditional site erected construction methodology. The basic reduction in resource density in a given construction volume is considerably improved and overall personnel number on site are substantially reduced. From a basic statistical perspective, and without consideration to immediate, safe access to elevated structures, modularisation and pre-assembly provides outstanding improvement to on site safety that overshadow cost benefits alone. The reader can define their own answer to the question posed. Σ

MODULAR / PRE-ASSEMBLY VERSUS STICK BUILD PROJECT DELIVERY COST DEVELOPMENT TABLE

Module / Pre-Assembly Construction Component	Cost	Stick Build Construction Component	Cost
Site Civil Construction	AU$	Site Civil Construction	AU$
Material & Equipment Supply	AU$	Material & Equipment Supply	AU$
*Off site Fabrication Quantities	AU$	Off site Fabrication Quantities	AU$
Off site Assembly Quantities	AU$	Off site Assembly Quantities	AU$
Module. Pre-Assembly Load Out	AU$	Module. Pre-Assembly Load Out	NA
Oversize Ocean Freight & Unloading	AU$	Oversize Ocean Freight & Unloading	AU$
Bulk Ocean Freight	AU$	Bulk Ocean Freight	AU$
Oversize Land Transport & Handling	AU$	Oversize Land Transport & Handling	AU$
Road Freight	AU$	Road Freight	AU$
Site Install Module or Pre-Assembly	AU$	Site Install Module or Pre-Assembly	NA
Site Erect Stick Build Quantities	AU$	Site Erect Stick Build Quantities	AU$
Wharf & Customs - Quarantine Facilities	AU$	Wharf & Customs - Quarantine Facilities	NA
Construction Infrastructure & Camp	AU$	Construction Infrastructure & Camp	AU$
Public Infrastructure Improvements	AU$	Public Infrastructure Improvements	AU$
TOTAL DIRECT COST	**AU$**	**TOTAL DIRECT COST**	**AU$**
TOTAL DIRECT ON SITE HOURS	**HRS**	**TOTAL DIRECT ON SITE HOURS**	**HRS**
Indirect Cost	AU$	Indirect Cost	AU$
Contractor Distributable Costs	AU$	Contractor Distributable Costs	AU$
Project Management (EPC,EPCM) Costs	AU$	Project Management (EPC, EPCM) Costs	AU$
Owners Cost	AU$	Owners Cost	AU$
TOTAL INDIRECT COST	**AU$**	**TOTAL INDIRECT COST**	**AU$**
TOTAL INDIRECT ON SITE HOURS	**HRS**	**TOTAL INDIRECT ON SITE HOURS**	**HRS**
TOTAL COST	**AU$**	**TOTAL COST**	**AU$**
TOTAL ON SITE HOURs	**HRS**	**TOTAL ON SITE HOURs**	**HRS**

Note 1: * Denotes requirement for additional steel for shipping grillage, transport stiffening and transport lashing above the quantities associated with a stick build delivery.

Note 2: Direct on site construction hours strongly influence camp size and subsequent capital required for camp infrastructure.

Note 3: Site Civil work specific for module/pre-assembly delivery is generally required. Public infrastructure improvements may be required by both module/pre-assembly and stick build delivery.

Note 4: Cautious review of each side of the component list to ensure items are not discounted as not applicable, stick build requires some oversize components and module/pre-assembly has stick build quantities.

Note 5: If indirect hours are considered equal for analysis purposes, the economic results will be conservative in favour of a module or pre-assembly delivery. Any construction hours moved from site have a strong impact on economics, given a typical 1.8 multiplier for direct cost to account for indirect costs, the assumptions for indirect hours must follow closely.

Note 6: Quarantine, customs and other related services and stipulated activities such as wash down should be accounted for in the Component Item “Oversize Land Transport & Handling”. Any specific export and import country taxes need to be accounted for in owners costs.