

# The Design/Build Approach and Modular Construction

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*This approx. 60 million L/yr continuous biodiesel production plant was executed by Zeton using our design/build modular approach.*

The development timescale for the design, fabrication, and commissioning of a new pilot plant is characteristically much shorter than that for the commercial facility, and the commercial pressure to meet these tight schedules can be enormous. However, the technical and financial risk of carrying out an inadequate pilot program or skipping the pilot step entirely is also quite clear.

One of the issues that is unique to the pilot-plant scale is that although the individual pieces of equipment are smaller than those of the commercial plant by orders of magnitude, the overall level of complexity of a pilot project as measured by the number of pieces of equipment that must be designed, procured, installed, plumbed and wired, and tested is not reduced to the same extent. Further, custom-engineered equipment is often needed. Accelerated project schedules and the project execution strategies needed to meet these schedules are therefore critical to the overall project success.

We have found that an integrated design/build approach offers significant advantages over the conventional strategy of detailed design followed by fabrication by a contractor. Because the engineers who carry out the design directly supervise the fabrication, large numbers of detailed drawings and specifications are rendered unnecessary. The approach is also more flexible to change, permitting the design of long-lead items to be frozen earlier in the schedule with less fear of schedule impact. Perhaps most important of all, direct supervision provides feedback to the design engineers, who refine their skills and improve their design decisions on every project they execute.

The design/build approach tends to reduce the project schedule and minimize engineering costs, but it can only be implemented with confidence in operations where direct supervision is feasible.

Figure 1 compares a typical high-level conventional engineering, procurement, and construction management (EPCM) project schedule and a fast-track design/build project schedule. Both examples assume preliminary design is complete.

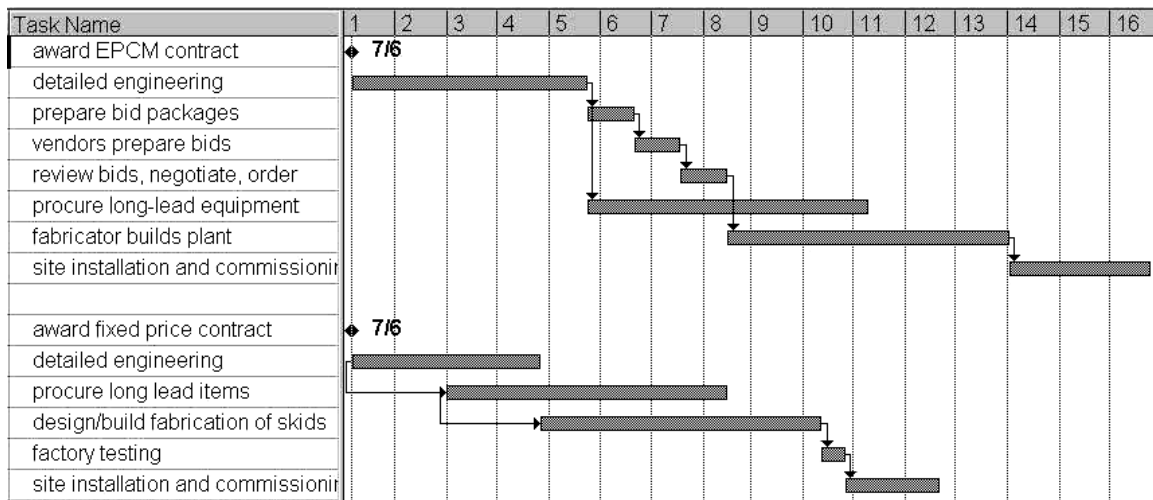


Figure 1. Comparison of EPCM/fabrication (top) and design/build (bottom) project duration in months

## Skid-Mounted Modular Construction

Our approach to the design of pilot plants is predicated on the use of individual horizontally- or vertically-oriented modular steel frameworks or “skids” that are sized to both fit the facility and to maximize the efficient use of common, rapid modes of shipment to destination.

Skid-based modular factory construction reduces cost and schedule in several key ways:

- It permits fabrication in an efficient factory environment rather than on a construction jobsite, and productivity and accuracy of fabrication are thus increased.
- Schedule savings are realized through simultaneous execution. For instance, the plant fabrication can occur at the same time as the construction or modification of the facility to house the plant without interruption or delay.

- Factory testing reduces commissioning time considerably, as problems can be diagnosed and rectified more quickly in the factory than on the plant site.

Skid-based modular factory construction is familiar to the mining industry, which frequently uses this method for equipment that must be shipped to remote mine sites. Modular construction is particularly well suited to pilot plants due to the scale and size of the individual pieces of equipment. Frequently, entire pilot facilities can be fit onto a single module. Modules can also be sized to permit physical reconfiguration of a flexible pilot-plant space, permitting the testing of multiple flowsheets without the need to remove and re-install individual pieces of equipment.

For larger, semi-works and demonstration-scale plants, the selection of module sizes is an optimization exercise between keeping the number of skids as small as possible to minimize reassembly labour on site, and the cost and complexity of shipment. This modularization exercise must take place before the sizes of all equipment are frozen and possibly even before a throughput capacity is determined.

Seemingly minor differences in the size of individual pieces of equipment can make successful modularization possible without affecting the function of the plant in a detrimental way. As an example, a recent Zeton basic design study for a multi-skid demonstration project allowed us to reduce the cost of shipment from over 7.5% for the client's original module concept to under 2.5% of module capital cost. We did so by optimizing the layout around module sizes that could be transported using readily available road transport equipment under normal road permits. To do this, we altered the dimensions of certain pieces of equipment to fit the necessary module dimensions without affecting their process function. More important than these cost savings, a schedule savings of over two months (from 14 to 12 months from start to delivery on site) was realized solely as a result of an optimized layout.

Whenever clients permit it, Zeton designs and builds modules which are fully integrated, with electrical and controls hardware on every skid containing more than a handful of I/O. Modern networked controls combined with switchgear cabinets on every skid make it possible to carry out a full I/O checkout prior to shipment, reducing reconnection labour on site considerably. The client ideally has to only supply one or two supply voltages to each skid, and to connect two Ethernet cables between each skid and the central controller (on another skid), and between the central controller and the control room. Another benefit of electrical modularization is a considerable reduction in the length and cost of cables needed to connect field devices to their controllers and switchgear.