ENGINEERING MODELS

Scale models of industrial plants used to be nothing but expensive toys. Now they've been turned into valuable new engineering tools.

IN THIS PRESENT period of industrial expansion the economics of designing new plants assumes greater and greater importance. Technological changes and the shift to continuous processing have increased the complexity as well as the cost of new plants. And the shrinking dollar has seriously increased the plant investment per pound of production for normal plant expansion. Thus, one of the big problems of today's designer is to cut costs without impairing design quality.

This same period of industrial expansion, unfortunately, has not seen an increase in the number of experienced designers and engineers. The opposite is only too true, as is indicated by the unusual demand for trained engineers and even recent graduates.

Thus caught between demands for lower engineering cost; a good design for new, complex processes; and a shortage of talent, the practical engineer has been in search of a new tool. More and more he is turning to the engineering model.

Scale models of industrial plants used to be expensive toys, justified only for a few purposes. They were built from final drawings and attempted to duplicate every detail of the actual plant. This type of model was, and still is, useful for getting across engineering thinking to non-technical executives, clients and operating personnel. But the cost was high, the timing too late—and, besides, this type of model was not adaptable to the design office.

Only recently have engineers with design, construction and operating experience merged their knowledge with that of the craftsman and produced a valuable new engineering tool. The engineering model has now been developed to the point where it is a valuable aid for all engineering forces on a project—the design office, field construction and operating personnel.

The engineering model is used early in the planning for any new project. One form of it may be a custom-made "Engineer's Tinker Toy" or preliminary model to assist in the early stages of planning equipment arrangement and optimum steel structure. Once these decisions have been made, the basic engineering model is constructed quickly and delivered to the engineering office to coincide with the place in the design schedule where piping study would normally begin on paper. The model-maker then works with the leading pipe designer or the project engineer.

All pipe-line study and layout can be done on the model, working from the process flow sheet. The center-lines of all pipes are represented by 1/16-inch brass rod; the outside diameter clearance (including insulation) at any point along the pipe is indicated by a sliding fiber disc. This method creates a three-dimensional study value, as well as pointing out immediately any physical interferences in design.

Hand valves are soldered in place to indicate operability and accessibility, as well as to point out interferences. Automatic valves, orifices, rotameters, steam traps, relief valves, check valves and funnels are all shown on the design model. Conduit banks, instrument channels, windbracing, ventilation ducts and safety showers are also indicated and their space occupation defined.

This method of piping study, before making any final piping arrangement drawings, easily lends itself to revisions. Equipment is often relocated during this phase to accomplish better pipe routing.

Normal procedure in model design of chemical, process, oil, or power plants is to put 90 percent of the piping on the model before any final drawings are made. Then a design review is held with the plant operating and maintenance personnel.

This operating review serves two functions:

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(1) It allows the design group to present a complete picture of the project to the operating forces, showing all the variables affecting the location of any piece of equipment, pipe line, or piece of steel.

(2) It allows operating personnel, specialists in their own fields, to contribute to a better quality design before final drawings are started.

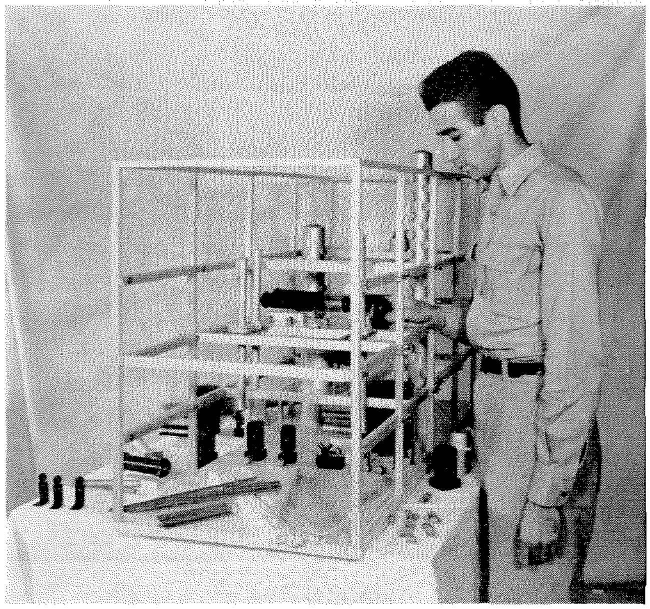
Revisions agreed upon during this review are quickly incorporated in the model, and *then* the final drawings are made. This procedure results in a reduction in the time required to design piping, a better quality of design, and appreciable savings in the cost of piping drawings.

Using a model in the design room offers a visual, three-dimensional tool for all design groups and quickly indicates any interferences between piping, conduit, structural steel, ductwork, and auxiliary equipment. For this reason it stimulates better coordination between design groups and reduces discussion and research time.

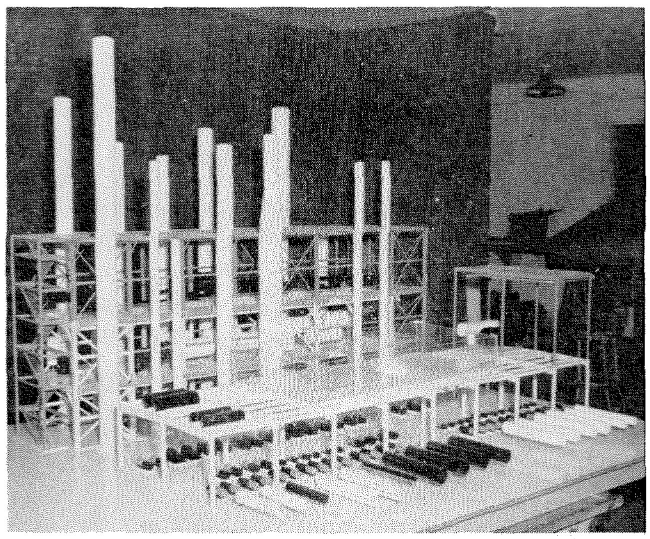
The same model used by the design group is turned over to the construction forces for their own use in scheduling, planning, material take-off and subcontracting bidding.

A construction engineer working on a project which has been modeled during the design stage is erecting a plant with good design insurance. The "hulls" or interferences often found in the field from checked drawings have already been eliminated during the design, and construction delays from this source are minimized. It does not take many wasted man-hours of a gang of pipefitters, riggers, or mill wrights to equal the cost of a model.

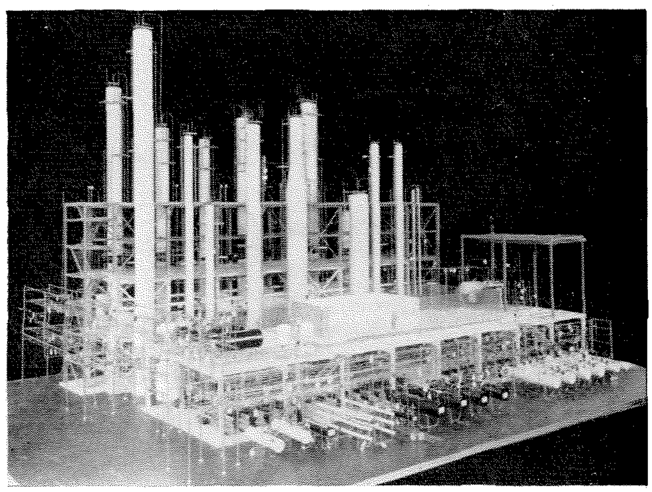
Day-to-day scheduling and planning of craftwork are also speeded by use of the model. Color coding on the model quickly points out the items of interest to each



Preliminary model is used by the designer to determine optimum arrangement and steel structure.



The engineering model looks like this when it arrives in the design office to serve as a layout tool.



The design model with all pipe lines and related equipment installed prior to final review.

craft, and indicates the location and scope of related work. Electricians recognize the defined path for conduit; insulators quickly spot the vessels and pipes needing their attention; instrument men detect the locations of their work, and each group can see what other crafts will be working in their area.

A recent example of construction use of a plant model was in the erection of new coal-chemical facilities at an old plant site. Because the space restriction was so confining it was necessary to erect the adjoining pump house, distillation structure and distillation towers together from the ground up. To complicate the problem, many of the adjoining towers were from separate vendors, which meant two or three rigs working at the same time. The model here was a natural tool for correlating all the various construction efforts within a small area and with a minimum of delay.

Saving sub-contracting dollars

Besides saving man-hours the model is also being used to save sub-contracting dollars. Constructors have discovered that a model at the plant site is worth many times its cost in obtaining more realistic bids on piping, painting, insulation, electrical work, sprinkler systems and lighting. It is difficult for any sub-contractor to wade through 800 drawings and give a firm bid on "piping in place." It is not the material cost he finds difficult to estimate, but the many man-hours necessary in scaffolding and erection. In at least one recent case, on competitive lump sum bidding on piping installations, local contractors who thoroughly studied a model were approximately 15 percent lower than their competitors who studied only the blueprints.

When piping represents 20 percent of the plant investment on a typical chemical installation, such a potential saving cannot be disregarded.

Anyone associated with the startup of a new plant, particularly a complex chemical plant, appreciates the many problems involved—economic, process, and personnel. It is a common sense fact that company money is invested in a new plant only if it will return so many dollars. For a ten million dollar plant in the changing chemical field this usually means earnings of $15,000 a day—before taxes. Any delay in putting the new plant "on-stream" only adds this amount to the plant investment.

The model as a training tool

Early and thorough training of operators will insure a successful and on-time plant startup when construction is complete. To accomplish this means using every training tool available. The model is one of the most important ones.

The modern plant is complex and, for that purpose, it is greatly instrumentized. Instead of reducing the responsibility of the operating group, however, this only increases it. Not only must the operator be trained to control the process through the instruments but he must be trained to operate "by hand" in case of instrument failure. This takes technically competent personnel.

A package deal

Location of many new plants is away from sources of technically trained personnel; or hiring agreements at old locations may preclude hiring men of this type. In these cases it is essential to present the entire plant concept in a package that the new operator can visualize. The model makes this possible, so that the new operating group can become familiar with the plant and equipment before the building is complete and without geting in the way of the construction people. All the main equipment can be identified and the principal lines traced out so that when the trainees enter a building for the first time they know exactly what to look for and where to find it. It is difficult to see how this could be done in any other way if a large proportion of the trainees cannot read blueprints.

The use of a model in design also insures better operating conditions, once the plant is in "on-stream." Operating and maintenance aids are built into the plant because plant personnel have detected their absence early in design and requested their inclusion before money was invested in costly final drawings. (At present drafting room rates the cost per drawing will vary between $300 for a simple layout and $1,000 for one complex piping drawing.)

Tight operating spots, inaccessible maintenance items, and unsafe operating arrangements are quickly detected on models by the operating group, even though they may not be able to visualize drawings of the same conditions. Correction of these spots before construction begins will result in easier and safer plant operation without delaying the construction schedule.

Continuously useful

Even after plant startup the model is used for maintenance planning of shutdowns or revisions, and by the training group for quickly orienting new trainees or visitors. The same model is also used for public relations and publicity—for there are very few persons not attracted and fascinated by all types of models.

The full use of scale models in the engineering of industrial plants is a recently accepted concept. Because it is new there are some individuals not acquainted with its many advantages, or with the potential savings to be gained from using models.

The benefits of using a scale model await all groups involved in the design, erection, and startup of any new plant. The larger a project the greater are the potential savings to be realized by using an engineering model—although the advantages of better design, fewer delays during construction, and less time spent in research and discussion during all engineering work exist, no matter how large the project.