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### **Paper No. 7: So You Want to Use Engineering Models**

U.S. DEPARTMENT OF THE NAVY  
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**VOLUME I**



**INSTITUTE FOR RESEARCH AND ENGINEERING FOR AUTOMATION AND PRODUCTIVITY IN SHIPBUILDING**

**I R E A P S**

**SO YOU WANT TO USE ENGINEERING MODELS**

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**ABSTRACT**

**Concerns and requirements for making use of models within your company are presented. Alternatives are weighed, suggested approaches are provided, and some of the people requirements, and other resources necessary to have a successful program are discussed.**

**A new model program must be planned into the design program-it must be sold to management and the various design personnel, and integrated into the present way of doing things. How effectively you do this can mean the success or failure of your model program**

## INTRODUCTION

I don't like to start by introducing a note of caution, but any tool, including engineering models, is only as good as the understanding and skill with which it is used. If it's properly used, you are going to get better engineering design, more effective communication and cooperation among engineers and shipbuilders, in addition to being a useful aid to management in reviewing design and monitoring and guiding design progress.

Now, I am going to try to give you some practical guidelines for deciding what kind of model program you need, how you sell management on a model program and how to plan and integrate it into your organization. Whether you are considering a model program for the first time or are simply dissatisfied with the results of your current one, the outline of initial considerations in developing a program and the steps in planning, staffing, implementing, and supervising the program should be helpful.

The first question many people ask is "how much does a model program cost?" This is difficult to answer in exact terms of dollars and cents. Programs vary. The important thing to remember is that costs must be weighed against sizable savings achieved through the elimination of up to 60 percent of drawings, shortened schedules, and reduction of construction rework and delays. The more appropriate question, in fact, is "How much does a model save?" The answer to that is that it can be up to fifteen percent of total project costs. So, it is quite safe to say, that in the end, an effective model program will cost you nothing.

You will note that I said effective model program. A model program must be carefully planned and supervised. There must be strict adherence to schedules and budgets and management must be knowledgeable about and supportive of the program.

## INITIAL CONSIDERATIONS

The first thing to do is to define your needs and objectives - that is, to ask yourself what it is you hope to achieve through the use of models.

Is cost savings the primary objective. Or is it improved communication among groups responsible for various aspects of the design, or perhaps, reduction

of project time. How extensive is your requirement for models for design and/or design check purposes?

Depending upon what objectives you have in mind and the resources available to you, you may choose one of the following alternative approaches:

(1) A "captive" or total in-house model program (2) A "subcontract" or in-house program with supplemental services of an outside model services company, or (3) A program utilizing models built entirely by an outside model company, usually in their own model shop.

A captive program has the advantage of being totally under your own control and more convenient to manage. Model technicians are your own employees who are responsible permanently and solely to you. On the other hand maintaining a full in-house program over the long term can be expensive especially for smaller design companies or design companies where the model workload is light or fluctuating. One way to overcome this problem is to use short-term contract modelers or "job shoppers". These temporary employees, who are hired to work for a specific period of time, usually three to nine months, are generally competent in the complete range of modeling activities, but most often assist with the design and installation of piping systems. These trained modelers are more costly, but in a pinch, they can help you get the job done quickly. They are available from a number of sources, but preferably they should be associated with a company whose primary business is engineering modeling.

One variation on the captive approach is to develop your own in-house program but have outside model consultants staff it as needed. This is useful for companies who have been unable to make use of models because of lack of people, facilities, know-how, or a sustained requirement. For companies already using models, it can afford an overhead free program, except for space and utilities.

If you use the "subcontract" approach, you can save on investing in a model machine shop by having the basic model built by a reputable model service company and do only the piping and other distributive systems design in house. This approach is gaining in popularity especially among companies just getting established in modeling and companies that do not have a continuous model required workload. There are several model service companies that can help you get your model program under way.

Finally, you may decide to have an outside model service company produce a model for you in their own shop. Such models are often called "check models", and are used by companies to evaluate their design decision and drafting systems. Many times a "check model" is a company's first introduction to modeling. Not many "check models" are built because it usually adds cost to design.

Another important consideration at the outset is how the model will tie in with other methods of developing, communication, and evaluating design concepts. As you are probably well aware, there are three such methods: conventional engineering drawings, models, and computer aided design.

Each has certain advantages and disadvantages. When they are used in combination, the results far exceed those for any of the techniques used alone. Models and computers, for instance, are not competitive, but complementary. Models are excellent inputting devices for computers. At the same time, computers can quickly check design information and perform calculations necessary for construction and for pipe fabrication and installation.

The future indicates an ever-increasing role for the computer in design and engineering, but it also establishes the three-dimensional model as an ideal medium for developing and coordinating input for the computer.

Once you have decided which type of model program is best for you and how the model will be used in relation to other design methods, you can begin shaping your model concepts for management approval.

#### SELLING MANAGEMENT

Assuming you need a model program in-house, the first job is to sell management all management - on the value of the program. To do that, you will need back up information. When you've captured management's interest with rapturous stories of interferences found, dollars saved, and schedules met, by the competition through use of models, you have to be ready with a battle plan to press your advantage, which initially means attacking the problem of planning a successful model program.

So, first you find out how the most successful have planned their model programs and develop your own plan on the basis of your needs and the good ideas you've obtained from everyone else. Seminars, publications, visits to companies using models will all help you see the various ways in which others have developed successful programs - or, just as important, show you what mistake to avoid.

The first thing management is going to want to know is "how much?" As we said earlier, the answer is "nothing", but the accounting department probably won't accept that answer readily. That means you're going to have to come up with the following: space costs, machine and tool costs, materials costs, and personnel costs. Depending upon the size of your shop the number and kinds of projects you anticipate undertaking during the first two years - the costs will vary considerably.

The next step is to put the dollars in your estimate against the actual cost of design procedures currently being used and the cost of schedule delays and cost overruns on recent projects that can be attributed to inadequate design review procedures or schedule problems.

This comparison should yield not only a favorable cost factor, but by implication, greater confidence in the design quality obtainable through use of models.

By now, you should have a list of objectives, and budget requirements, a specific location, and a cost analysis of setting up the model shop.

Now you're ready to present all these to management. If you have established the need and your cost analysis supports your argument, you should have little trouble making your case. Once management has approved your plan, you have to retain their support by keeping them informed of progress and making the models convenient for management to use.

You should view yourself as a General embarked upon directing a successful campaign, the goal of which is to prove the value of your recommendation and accomplish the objectives you have already defined. If the campaign is successful you should not be surprised when management takes the credit. After all, every General knows that if the Commander-in-Chief takes the credit, the campaign was a success. Management might never know the reasons for the increased quality, or improved cost effectiveness, or other benefits

that come out of the model program, but the successful implementation of a model program will speak for itself and in all likelihood justify continuation and expansion of the program

#### FITTING THE MODEL PROGRAM INTO YOUR EXISTING FRAMEWORK

Management's blessing is essential, but they are not the only ones who have to accommodate to a new system. The program must be properly integrated into current operating methods in order to work. Changes and adjustments have to be made. Remember the model is taking the place of other procedures.

Probably the most critical consideration is the placement of the model section in the organization. Its placement will define the way in which engineers will use the model and the frequency with which it will be used. Indirectly, these factors will affect the ultimate success of the model program

Placing the model section under a particular project is a frequent, but puzzling mistake made by many people. The model section must be regarded as a design resource for all projects rather than an anomaly associated with only one project. Generalists, and marketing managers know that, next to timing, position is everything - so position the section organizationally and physically for maximum use and visibility. It is a load bearing key activity in the structure and has to be centrally placed.

Another crucial task will be to educate management, engineers, and designers to use models. The initial introduction to the value of an in-house model program should probably be accomplished through a seminar conducted by a consultant from a model engineering firm. Everyone claims to suspect the briefcase-carrying consultant, but nevertheless we tend to listen more readily to the outside expert than to the in-house one. The formal seminar should be followed by guided tours of new section, an explanation of its capabilities and an introduction to the equipment and people who will be providing the modeling services to the engineers.

One major purpose of internal training sessions is to get designers and draftspersons to think "3-D". A surprising number of people still think the world is "flat", that is, that design concepts can be developed only

on conventional two-dimensional engineering drawings. Even though these people may not understand their drawings totally, they are like a crutch. Models eliminate a large proportion of drawings. It's mostly a matter of convincing people they can toss away the crutch and perform better without it.

Integrating the model program also involves developing communications channels among the various design disciplines, modelers, construction supervisors, and management. Models are communications tools as well as design tools, and in that respect, greatly enhance the design process. Unless communication is made easy and encouraged, it won't happen, and the value of the model will be diminished.

#### STAFFING

With the smoothest possible transition as your goal, the first step in actually implementing the model program is the selection of a model supervisor. He is the most important person in the model program. Get a pro. This is the man who is going to decide what equipment and materials you need, assess the number of man-hours needed for a job, establish communications with the engineers, and a hundred other things that all add up to proving you were right to push for your own model program.

The model supervisor, usually a permanent employee hired by the Manager of Engineering, should be a results-oriented professional with a background in engineering and several years' supervisory as well as modeling experience. He must be able to lead and make decisions.

This person who is going to provide administrative, technical and political direction for your model shop has to be able to develop standards and procedures your engineers can understand. He has to understand the importance of modeling for specifications rather than "detail-for-detail's" sake - a hazard, by the way of looking at hobbyists as prospective engineering model technicians. He has to know how to set up the necessary controls and procedures to assure that the model is kept up-to-date. He must be a good communicator, and his communication ability must be both verbal and written.

The model supervisor will provide a valuable service in helping the technicians. The model technician should be experienced model builders, or offer the qualifications of a model technician trainee. At least eight credit hours in addition to basic math, algebra, and geometry. Of course, previous experience in the engineering modeling or related fields is always desirable.

You might even consider women. They have a couple of advantages, smaller hands to fit in small places and usually superior fine motor skills. Regardless of whether you hire a male or female, hire someone who is qualified. Do not let the hobbyist learn engineering modeling on your time and money.

### PLANNING

With the model supervisor aboard, you can begin detailed planning of the program. There are several initial tasks you must begin working on:

- Design of space for shop
- Selection and ordering of equipment and supplies
- Establishing model construction procedures
- Establishing safety standards
- Establishing standard construction codes
- Establishing inventory procedures
- Developing model specification forms
- Developing a model project control system

This series of tasks, implemented at the beginning of the program, will ensure a quality model program that will serve well the goals of engineers and management.

Many of these details are outlined in "Model Handbook", available through the American Engineering Model Society.

The physical location of the model section is extremely important. It should never be very far from the center of design activity. If you have a machine shop, it should be located on the ground floor with street level access or in a separate building. Ground location of the machine shop

and paint spray booth is generally preferable from the standpoint of fire regulations compliance. Double doors make it easier to move models and material in and out of the machine shop.

Model construction procedures, governing designers and draftsmen as well as modeling technicians, should be written out in detail and include a section on safety, that covers housekeeping, machine usage, small hand tool usage, and first aid. These procedures should be signed off first by the model supervisor then his immediate supervisor, and finally the head of the department.

Model construction standards covering such things as color coding, detail, scale, tolerance, and tagging must be developed. These standards help to maintain consistency from one project to the next and effect economies in model parts inventory and painting, which is expensive and undesirable.

Fill-in-the-blank Model specification forms also must be developed. A specification form lists all of the possible items that may be modeled.

On a particular project, the model supervisor should issue this form as soon as he knows the intended use of a proposed model. Once the model specifications are established and approved, any changes or additions must be accompanied by signed approval from the model supervisor.

Finally, you need a simple model project control system, consisting of time records and model progress log books with records of design changes and resolutions. It may well be an extension of your existing system

The model must be an integral part of the scheduling for critical path milestones. If the model falls behind schedule or ceases to be effective, management, justifiably, will question its value as a design tool.

Ideally, the model section should be the place of formal and informal design reviews.

Now it is time to start building the model. The model program supervisor must direct his attention to directing the work of the model technicians and coordinating the flow of information. From this time on it is a continuous effort to build the model and encourage everyone involved to use the system properly.

After the model is complete a disposition must be made. The model will generally be shipped to the construction site. Here the model will be used primarily for planning the construction of the ship. If the model is required to be transported a long distance it is usually contracted to a model service company, or shipped in a dedicated moving van by a moving company.

Well, you can see that this whole process is very simple. I have in less than the space of half an hour told you how to plan, set up and integrate your model program into your existing organization. As in most other endeavors, the most important point is at the beginning: Know where you want to go, why you want to get there, and then draw up a battle plan. That is essentially what I have done. I have identified the objectives and then developed a simple management strategy for attaining them

Control and integration of a model into an organization are critical to the successful use of a model. When a model, intended as a design tool, ceases to function as one, you have lost the battle. With careful attention to the steps we have outlined, however, we think you can launch a successful campaign and prove that models are indeed effective tools with which to ensure quality design and reduce design time and cost. The range of possibilities you have for using models is limited only by your imagination.

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