MODEL CONSTRUCTION

presented by

Mechanical Shops

In your inspection of the Laboratory you have seen, or will see, many different kinds of research models. Many other types are used which are equally important, but have not been integrated into the exhibits. At this stop we thought it might be interesting to you if we digressed a moment from the technical results of aerodynamic research and briefly examined some of the techniques involved in model construction. Afterwards, we will make a short tour of the shop.

The primary consideration in model wing construction is the selection of materials and techniques which properly balance cost and ease of construction against the requirements of strength and accuracy. The balance is influenced strongly by model size. An idea of the range of model sizes can be had by contrasting this small model (exhibit model of F-80) used in high-speed research with this large wing panel used in the 40- by 80-foot wind tunnel. This wing panel will be used to investigate problems associated with landing and take-off. In the construction of this wing panel, standard shop techniques are used. Wood, glued to a steel spar, is contoured to the desired shape using this router which is guided on a contour bar.

Another example where standard construction techniques have been adapted to model wing fabrication is in the casting of low-melting alloys. These alloys, which melt at low temperature, are cast over a rough steel spar. An advantage of this technique is that the contours of these wings can be built up or cut down as the test may demand, thus saving the cost of a completely new model. It is often necessary to install many pressure orifices in the models for aerodynamic measurements. A technique has been developed for casting models with pressure tubes in place. Where pressure measurements are desirable, this type of wing construction has a great advantage over a solid wing machined from a metal billet. In this first photograph (A-16060) you can see the steel spar with the numerous pressure tubes attached to it by means of clips and rivets. Pressure tubes are led along the spar and are taken out at the root section. A wooden mold is next made in two halves to enclose this spar while the molten metal is poured around it. In this next photograph (A-16065) is shown the actual pouring process. When the job is cooled sufficiently the mold is removed and the wing contoured to the desired shape. A finished model wing is shown here, and by close examination one can see the 245 pressure orifices that are flush with the surface. The copper tubes connected to these pressure orifices are imbedded in the alloy along the spar. They leave the model at the root section (point) and are finally connected to the manometer at the tunnel. The precision airfoil contouring machine which makes the final contour operation will be seen on the tour of the shop.

Another example where a commercial machine has been adapted to a special purpose is shown in this photograph. The device seen here on the 20-foot planer is a jig for machining all-metal, high-strength wings of trapezoidal or tapered plan form, that is, wings whose surfaces are composed of straight-line elements radiating from a common apex. On this jig, the apex is simulated by the center of the ball-and-socket joint. The whole jig rotates about this ball socket joint, and the base of the jig moves on these rollers and curved tracks. The angular movement of the jig in the horizontal plane, together with vertical movement imparted by the rise and fall of the rollers on the track surfaces, combine to govern the shape of the wing. Upon completion of machining, the wing is hand-finished, using the bottom of the tool marks as a finishing gage. This machine will be demonstrated in the tour of the shop.

I would like to introduce Mr. __________, who will describe some additional techniques used in model fabrication.

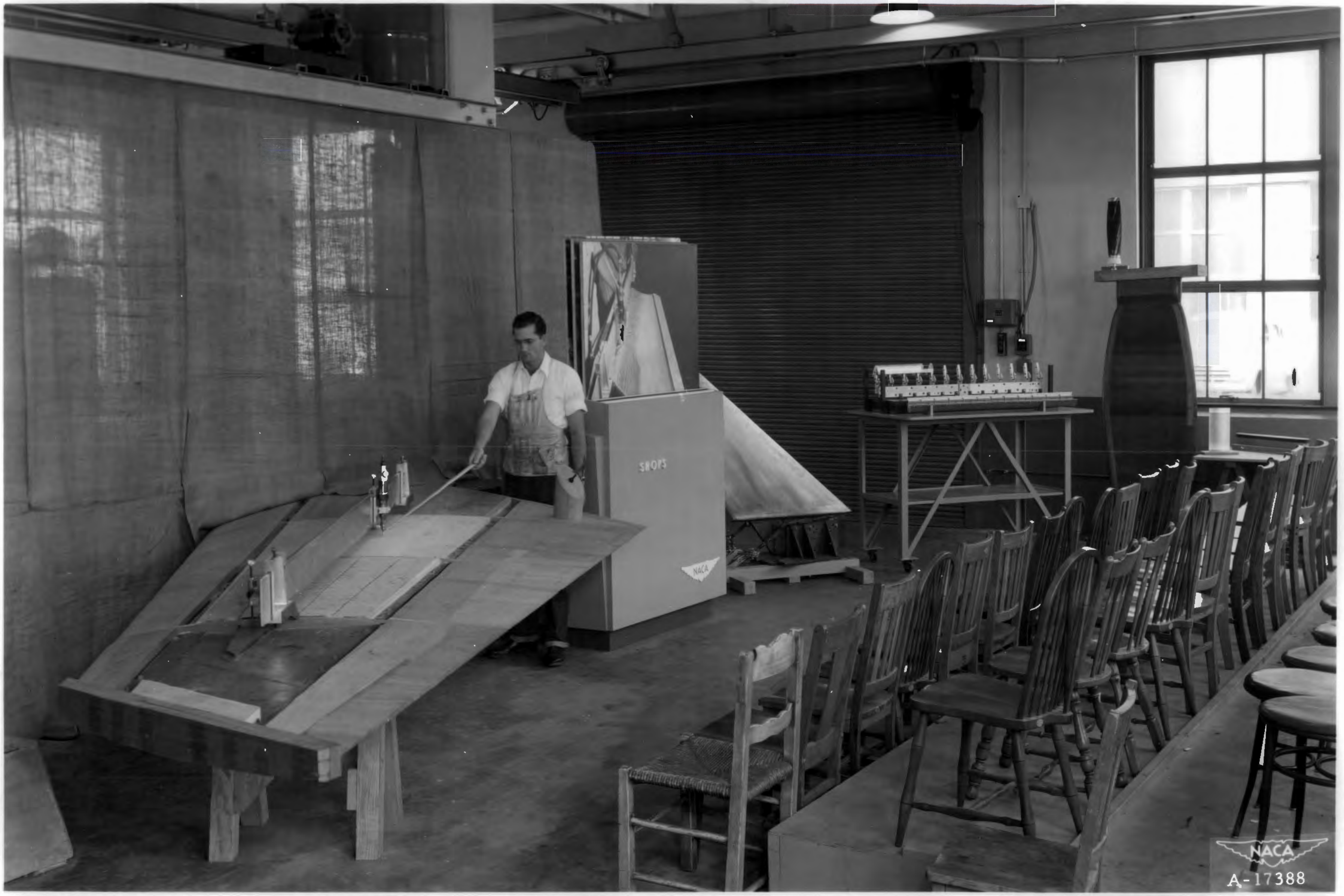
In general, the small size of and the high loads imposed on the wings tested in the smaller supersonic wind tunnels require that they be made of solid metal, usually steel, and to a high degree of accuracy. The models are sometimes further complicated by the incorporation of control surfaces, pressure measuring devices, strain gages, and various other devices which make for difficulty in manufacture.

In producing airfoils of this type, wide use is made of duplicating machines which, although different in appearance, operate on similar principles. In some cases we have had to devise new techniques and special machines for which no commercial equipment was available. An example of such a machine is the airfoil cutting machine shown in this photograph (A-12550). As we have indicated this airfoil machine is a duplicating machine in principle, and someone informed on this subject might well point out that duplicating machines are not new. In fact, gunstocks were made by duplicating machines many years ago. This machine's distinctiveness lies in the greatly increased accuracy of the cutting operation and in its ability to cut metal. There are two of these machines at the Ames Laboratory which can produce wings, propellers, compressor blades, and similar shaped objects. The smaller of the two will cut both aluminum and steel. The larger machine, shown in this photograph, at present will cut only aluminum, but is being modified to produce steel wings as well. A typical pattern mounted in the airfoil machine is shown here, and the finished airfoil is being cut on the far end of the machine. It is not visible in this photograph. The wood patterns used on our airfoil cutting machines are made oversize to the finished metal product on ratios of 4 to 1 or 6 to 1 on the chord and up to 12 to 1 on the span. Such a procedure has several distinct advantages: first, any inaccuracies in the pattern are reduced in the finished product; second, the pattern can be made stronger; third, the machine itself can be made stronger by using larger components in the follower mechanism, which in turn eliminates any inaccuracies due to vibration and chatter in the machine. A pattern and finished product is shown here.

Although the wings shown so far are mechanically simple, many of the wings that our shops fabricate have controls, pressure orifices, flaps or other special devices. One of these that I would like to describe to you is a porous leading-edge wing structure which we have fabricated for the boundary-layer control studies described in the demonstration on landing. A considerable number of porous substances and fabrication techniques were investigated before a satisfactory solution was found. Sintered metals, filter paper, rolled and hammered metal screens, and even cactus wood were among the many materials investigated for this research study. The material finally chosen for the surface of the leading edge was a very thin porous metal sheet. The primary problem in this case was to make a smooth, uniformly porous, leading edge and yet maintain adequate strength. To do the job, this special jig was designed. Ribs and longitudinal spars were attached to the jig, making a rigid frame over which the porous surface material could be stretched. The skin was not preformed to fit the ribs, but was clamped in place along one side and then stretched as it was being spot-welded to the ribs. A standard commercial spot-welding machine was adapted for this particular job. The jig itself acts as one electrode and the other electrode is manually controlled by the operator.

To obtain the right amount of air flow, a porous felt of variable thickness is secured to the inside surface of the wing leading edge as shown on this model. The desired variation in velocity through the porous surface in the chordwise direction is obtained by tapering the thickness of the felt. This felt is formed under pressure in a metal mold and subjected to steam to fix the desired contour. The resulting surface is shown on this model.

We would now like to take you on a short tour of the machine shop, which is in the building adjacent to this one. Machinists will be on hand to explain the machines in use and act as your guides. At the end of the tour a horn will sound three times as your signal to entrain for the next stop. Please follow the group leader. Thank you.



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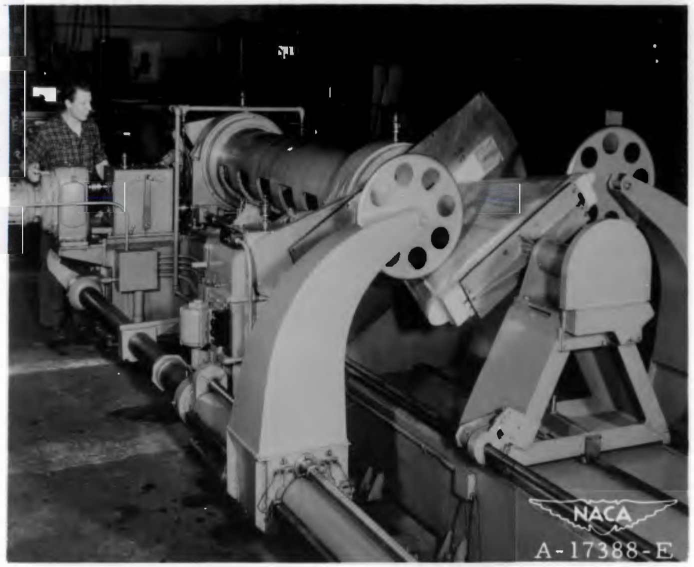
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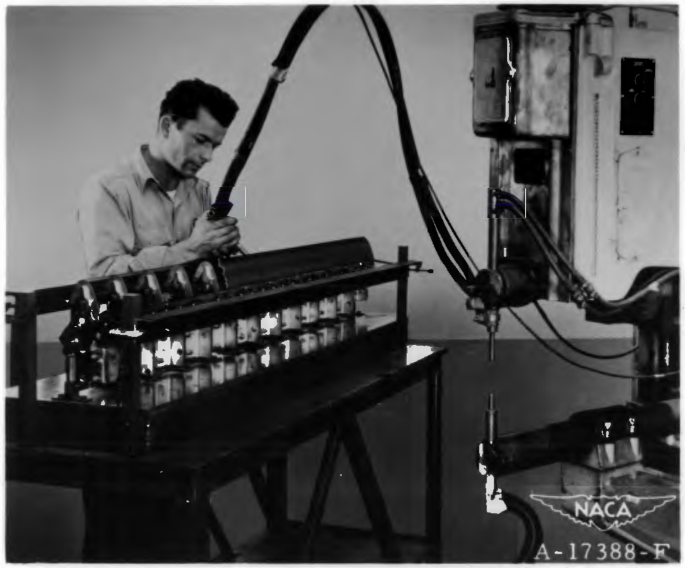
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