

motors and keep the rocket on the flight path. All this is done in Astrionics.

Next is Propulsion and Vehicle Engineering. This is our chief mechanical engineering lab. It deals with propulsion, structures, materials, things that are so important in rockets.

We have a test laboratory here which deals with testing of large rockets on static test stands where the rocket is tied down to the test stand and fired at full throttle so we can fully measure the performance of the rocket prior to flight.

We have a manufacturing engineering lab. The function of this laboratory is not to produce, but to familiarize itself with modern manufacturing techniques used in industry, and at the same time remain astute with respect to adequacy of manufacturing methods. For example, if one of the companies, and this happens to the very best ones, uses an unacceptable welding method, our people move in and virtually show our industrial contractors how you can do a better job. Now, you can do that only if you keep your own fingers dirty, of course, and that is the secret of success in all these laboratories. There must be a certain amount of in-house work going on all the time, so that these men know what they are talking about. I think the fact that all our laboratory directors and their assistants enjoy a great deal of respect with our industrial contractors stems from the fact that time and time again they were able to go in and help them solve a problem.

One contractor said, for example, "Your specifications are too stiff. Nobody can build it so accurate."

We take a piece to them and say, "Here it is; build it just like this. You see, it can be done."

We consider this, our continued ability to keep a yardstick in the hands of the Government to assure that we are getting our money's worth, as one of the most important tools we must have. If you throw your yardstick away, you become the victim of your own contractors. So we consider this a very important capability.

Now, how did we get this capability? Well, that is more a question of history. Before we joined NASA, we were with the Army Ballistic Missile Agency. The Army, at that time, operated to a great extent on the arsenal concept. Thus, we did a lot of development in-house, and one of the reasons why NASA wanted this element from the Army was the realization that, if you want to build big rockets, you must have within the Government knowledgeable people who can judge the quality of what you are buying.

Let me come back to the other elements of our organization. We have a quality and reliability assurance lab which sees to it that the necessary quality control screens are provided between industry and the Government, and that even industry protects itself with adequate screens between contractors. For instance, as it happened to us a major aerospace contractor buys some titanium bottles from a vendor, who, in turn, buys welding rods from another vendor, and this latter vendor sends the wrong welding rod to the vendor that makes the titanium bottles, and as a result a bottle blows and with it a whole Saturn V stage, causing several million dollars' worth of damage, then you have a case where the quality assurance system in industry has not worked properly. Now, it is probably too much to ask that the Government