National Radio Astronomy Observatory
Charlottesville, Virginia

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25 Meter Millimeter Wave Telescope
Memo #119

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M E M O R A N D U M

To: M. S. Roberts, M. A. Gordon, H. Hvatum,
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From: J. W. Findlay

Subj: Surface Plates for the 25-meter

Please consider the attached note, which arose as a result of Leighton's visit to us. It is the joint effort of W-Y. Wong and me.

JWF/pj

cc: W-Y. Wong

SURFACE PLATES FOR THE 25-METER TELESCOPE

John W. Findlay and Woon-Yin Wong

1. Introduction

We have established some time ago that the numerically-controlled machining of cast aluminum plates will be adequate for the 25-meter surface. However, we know that this technique is probably being pushed to its limit in this application. We also suspect that it will cost about $2M to fabricate the surface. In the hopes of finding a better alternative, we have entered into a contract (for $100k) with the Harris Corporation to try a method using the honeycomb with carbon fiber surfaces. This, if it works, could give a good surface made by a replicating method. We shall have the first look at how this is going towards the end of this year.

2. The Leighton Surfaces

We took advantage of Bob's visit for the Visiting Committee to go through with him the present status of his telescope building, with main emphasis on the surfaces he has achieved. He left us copies of his report to the NSF (May, 1978). One can be borrowed from JWF if it is needed. It is unnecessary to summarize this report. Many of us have followed the Caltech work from a distance and understand it. But Bob is prepared to speak of a goal of building one telescope (10.4 meters in diameter) with a surface accuracy of 10 μm RMS. The numbers he gives of the performance of his machine and of all the techniques associated with it suggest that he can reach this goal.

After meeting with Bob, Woon-Yin and JWF separately reached a very similar conclusion, and this note is intended to set out this conclusion. We propose that we should start now on a series of steps to determine whether the Leighton technique could be applied to manufacture the surface plates for the 25-meter. We would so plan these steps so that, if the answers continued to be good, we could proceed to the point where a manufacturing machine and technique could be in existence and be used to make all the 25-meter surface plates. While admitting that we are brave enough to consider as the end-point of this work the manufacture of the entire surface, we would prefer at present to outline only the early phases of what we believe should be done.

3. The Feasibility Phase

(a) To clear the air of what might be thought a possibility, we should ask Bob whether Caltech would accept a contract to make our surface for us. This does not seem to us to be at all likely, since Bob clearly has planned work for himself in building and using his own telescopes. But perhaps we should ask.

(b) Our suggestion then is to see how the Leighton technique could be used, with the fewest changes, to make our individual surface plates. We do not propose to change any of our design plans, so that we are still talking of the 528 plates in 8 rings that are described in our design.

(c) Thus the first step in this phase would be to develop an outline plan of what the plate-making machine would look like. The following points suggest themselves as possible ways to start on this:

(i) We attempt to keep all aspects of Bob's techniques as unchanged as possible. However, we would look first at a machine which could make one-by-one all the identical plates in one ring. It must, however, be so planned that it can do this subsequently for any other ring.

(ii) We do not, of course, build and rotate the whole dish support structure. But we do have the needed amount of structure to rotate through a sufficient angle to carry the plate being cut. (We do not change from Bob's method of a cutter moving on a fixed radial track and the work rotating under it.)

(iii) The material, thicknesses, glue and methods would all start by being identical with Bob's choices. This, unless it proves that our larger plates need to be thicker or stiffer, would lead to a plate weight of 14.9 kgrm per sq. meter. (From page 21 of Bob's report, where he gives 1380 kg as the panel weight and I compute, with some difficulty, his curved surface area to be 92.8 sq. meters.) Such a nice low weight is clearly attractive. We do not meet our foot-load requirement, but this is not, to us, vital.

(iv) We believe we can suggest an outline machine design which allows just about all of Bob's methods of checking levels, concentricity, shape profiles and so on to be applied.

(v) We suggest that the machine itself be used as our first-line test of the accuracy of the plate profiles. But other methods are also possible for use in the shop. We may later alter our plans for final plate setting on the telescope, but at this stage we see no difficult problems arising here.

(d) To do this first phase we would need some intelligent manpower, but not money. JWF would be glad to work through this phase. (Woon-Yin will be in China for much of it.) Why not a small working group of JWF, Lee King, Al Steinemann and Omar Bower to put an idea down on paper? If it looks good, we could ask Bob's opinion.

4. The Building and Testing Phase

If the feasibility phase looks good, we think we should be prepared to build a machine and make plates. This obviously needs money but the first phase should tell us about this. It is worth pointing out the obvious, however. In the Caltech work the main machine components are not highly expensive. The accuracy comes from the inventive use of precision measuring methods. An H-P interferometer will be essential, but if ever we build the 25-meter we are going to need one anyway.

This phase would clearly need manpower as well. But if things looked good, we are sure that some help would come from our Engineering Division. JWF would be prepared to work as a substitute Bob Leighton. So we might need only about one technician once the machine was built. We cannot yet estimate the machine-building effort. We guess it might be built at Green Bank.

5. The Telescope

It does seem to be presumptuous to suggest that NRAO might in fact manufacture the 25-meter surface. But by that time Bob will have manufactured almost as much area of surface, to a quite remarkably accuracy. Thus it seems to us to be essential for NRAO to explore this route to the telescope surface. How far we go should depend on our assessment of the results of our work.

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