

NRAO ONLINE 40

Chapter 1954: Carnegie Corporation of New York Grant, GRT Progress in 1954, Pawsey visit to Tizard and Barnes Wallis in the UK

Bowen – Carnegie Corporation and Van Bush 1954

Bowen's trip to the US in early 1954 and especially the Washington Conference provided a golden opportunity to lobby the Carnegie Corporation and many of the influential scientists in the US in an effort to overturn the negative decision of the Carnegie Corporation of New York in late 1952, the CSIRO request for funding the GRT.¹

The Australians made no secret of one of the major reasons for Bowen's visit to the US. A few months later, White reported to Henry Tizard in April 1954:² "... you will be interested to hear that Bowen's recent visit to the States in January has had excellent and rather unexpected results for his radio astronomy group. He has just received a letter from Charles Dollard [President of the Carnegie Corporation of New York] saying that the Carnegie Corporation is prepared to recommend to its Trustees a donation of \$250,000 [for the GRT]..." Bowen clearly had discussed the proposed grant with Lee DuBridge, Merle Tuve and Vannevar Bush during the conference in Washington. The good will of Bush was to be decisive.³

On 14 April 1954, the news arrived from Dollard that the officers of the Carnegie Corporation were willing to recommend to their board on 20 May that the grant be awarded to CSIRO:⁴

The chief question we had to debate [whether to break with the decision to exclusively support the social sciences], therefore was whether the character and quality of your

¹ Background material concerning the 1952 Carnegie Corporation of New York's rejection of the initial request for funding in December 1952 and the consequences in 1953 is contained in NRAO ONLINE 38 and 40.

² NAA C3830. A1/3/11/3 Part 1. 28 April 1954.

³ See Chapter 27 and NRAO ONLINE 39 for a description of White's visit in July 1953 to the Carnegie Institute of Washington. Based on CSIRO archive Ke 20/2: Bowen gave Robert Casey (Minister in Charge of CSIRO) a report of the NSF Symposium on 6 February 1954. There were four "foreigners" at the conference in Washington, Graham Smith of the UK, van de Hulst of the Netherlands and the two Australians, Mills and Bowen. "We had an exceptionally good hearing and it is probably fair to say that the two Australian representatives provided more meat than any other country." He told Casey that the main rationale for the proposed Australian GRT was the University of Manchester 250 foot instrument. "Now.. there is a strong body of opinion in the USA that says it is wasteful to build another such antenna in the northern hemisphere [e.g. the proposed Caltech instrument of 1952]. The next one should be built in the [south] to study those parts of the sky not seen from the [north]." Bowen suggested that US foundations might contribute to the capital costs and that the telescope could be run on an annual basis from the present RPL budget.

⁴ NAA C 3830 A1/3/11/3 Part 1.

program would justify an exception to our general policy. Our final conclusion was that it would.

On 20 May 1954, the official news arrived from Dollard that the grant for \$250,000 was awarded (at the time this was assumed to be approximately ¼ of the external funds required). CSIRO was required to provide evidence that additional funds from sources in Australia, either private or government, would be found. Later on, CSIRO was told by the Carnegie Corporation that private funds from non-Australian sources would also be acceptable to the Corporation.

A month later, Dollard revealed to Bowen the major role played by Bush in modifying the negative decision of the Carnegie Corporation of N.Y. from late 1952.⁵

... Van Bush is an enthusiastic participant in this “conspiracy” to get things moving. He and I spent a good part of yesterday morning discussing this matter, and the copy [the announcement of the award in the Quarterly Report of the Carnegie Corporation of New York] which I now send you has been revised in terms of some good suggestions which he made.

The implication is that Bush (of the sister organisation, Carnegie Institution of Washington) had also been involved in the reversal of the 1952 decision of the Carnegie Corporation of New York. Bush (also a trustee of the Corporation) was quite enthusiastic about the new decision, indicating that his question “Why a big aerial?” had been answered. Bush reported to Bowen:⁶

Nothing... would bring our two countries closer together more efficiently than for Australia to lead the way in an important area of fundamental research. I am sure that this would have a salutary effect in Australia and throughout the world. We look to Australia for many things and admire a great deal we see from this distance. But if we could also see the Australians [as] the recognized leaders in an intellectual effort of a

⁵ *op. cit.* 30 June 1954. The article about the grant for the GRT appeared in the July Quarterly Report of the Carnegie Corporation of New York was sent to Bowen in draft form on 30 June 1954. Bowen asked that the title be changed from “Sound from Outer Space” to “Radio Waves from Outer Space.” Also he asked that “...some mention of Dr. Pawsey could be made. He has been a leading member of Radiophysics Laboratory since its inception and has played a vital part in the radio astronomy program”. Neither suggestion was followed as intended. The title was change from ***Sound from Outer Space*** to ***‘Sound’ from Outer Space*** and Pawsey’s name was added: “The dish has been designed by the Radiophysics Laboratory... under the direction of E.G. Bowen and his chief assistant, J.L. Pawsey.” This later designation was not Bowen’s intent. When the press release was shown to the CSIRO Advisory Council later in November 1954 the title of the press release was changed back to “Radio Waves from Outer Space” and the “chief assistant” description for Pawsey was removed.

⁶ *op. cit.* 17 May 1954

high order in the field of science, I am sure that the respect for Australia would grow in this country [USA] and this would be helpful indeed. Also I feel sure that this accomplishment on your part would lead the Australians to view this country increasingly as a place where good fellowship is found in the discussions of mutual interests.

The same enthusiasm was expressed in a Carnegie press release at the end of July 1954:

According to Dr. Bush, the new Carnegie grant also demonstrates American interest in promoting top-caliber scientific work in other countries... "America does not have and must not attempt to develop a monopoly on scientific advance. To do so would be as futile as it would be dangerous," Dr. Bush stated. "I think this grant represents a wise investment in international relations as well as in science. The Australian radio-astronomy scene exhibits all the elements for a vigorous and imaginative program-outstanding leadership from Dr. Bowen, an enthusiastic group of experienced young investigators and a clear indication that the new "dish" is the *sine qua non* for the next big advances in radio astronomy.⁷

Fred White's *Sydney Morning Herald* article about the GRT

On 26 July 1954, Fred White (CEO of CSIRO) prepared a 1700 word document ("Australia Leads in Radio-Astronomy"⁸) which was to be an article for the *Sydney Morning Herald*, the article appearing on 28 July 1954 (Wednesday) on page 2 of the major Sydney newspaper. The published title was "Tasks for £ 400,000 Telescope: Australia Can Maintain Lead in Radio-Astronomy". The text was essentially unchanged from the original draft submitted by White. The new article was based partly on the 14 March 1953 document of White (see Chapter 27 and NRAO ONLINE 39) "Radio Astronomy- An Australian Achievement". The new newspaper article provided a history of radio astronomy since World War II, with a strong Australian emphasis:

⁷ NAA C3830 A1/3/11/3 Part 2, 26 July 1954. The well-known *New York Times* science writer Waldemar Kaempffert wrote an article on 1 August 1954 "Largest Radio Telescope for Radio Work", describing the Carnegie Corporation grant.

⁸ KE 20/2. Probably, White had been assisted by Arthur Higgs, Secretary of the Division of Radiophysics, in the preparation of this article. Shorter versions of the report of the Carnegie Corporation grant had appeared in the *Sydney Morning Herald* on 26 and 27 July, the former on page 1 of the Monday edition. These were apparently based on the Carnegie and CSIRO versions of the press releases, respectively. In the CSIRO version article (27 July), there were quotes from Casey and the Prime Minister, Robert Menzies. Casey reported: We will discuss the possible government support "as soon as reasonably possible", funds for the giant "radio eye". Menzies was quoted simply: All such proposals were dealt with by the Commonwealth "when they are received"!

Radio astronomy is an entirely new branch of science that has been brought into existence, mainly over the past 10 years by the highly original researchers of the Division of Radiophysics of CSIRO and by a complementary group of scientists at the Universities of Manchester and Cambridge [not ignored as in the White text from the previous year] in England.... It is unusual for a group of Australian scientists to be really in the vanguard of a new science. With growing consistency Australian science has made conspicuous contributions in biology, chemistry and physics, and this country has a healthy reputation for original scientific research. It is probably an indication of our maturity in research that in the years since the war this new science has been created by one completely new discovery after another, either by the Australian group or the English group [sic].

White then described the Carnegie Corporation grant:

It is a recognition of the leadership of Australia.... and of the need for a giant-radio telescope [GRT] in the southern hemisphere.

White was keen to make a strong point concerning the **practical** uses of radio astronomy. He mentioned (so far futile) attempts to show that the 11 year sunspot cycle had a direct impact on the weather on earth.

Radio science has a special interest in the sun for since the widespread use of short-wave communication over giant distances we are all aware that the sun controls the conditions of our [radio] reception⁹.... Presumably the ejection [from the sun] is being observed and measures of great streams of particles which impinge on the earth's atmosphere, causing the aurorae and magnetic storms... This new science is already giving new knowledge of the sun which will have practical consequences in our understanding of radio communications and the general effects of the sun on the earth's atmosphere. The practical consequences of a study of the stars are more remote, but it must not be overlooked that the heavenly bodies are giant natural laboratories in which atoms and molecules are undergoing changes that are very difficult or impossibly expensive to reproduce in the laboratory.... Optical astronomy has taught us about the universe- radio astronomy will add greatly to this knowledge.¹⁰

⁹ The impacts of solar flares (and the associated Type II and Type III radio bursts discovered by RP radio astronomers in the late 1940s) on the ionosphere were the controlling factors.

¹⁰ White also pointed out a special advantage the radio astronomers had compared to the optical astronomers: "[I]t is not influenced by the weather- the observations can go on no matter how cloudy the sky."

White finished the article with the exhortation that “private benefactors” would help with financing of the project and help maintain “[t]his country’s lead in a field in which its scientists have won world renown.” As we will see, such generosity was not fulfilled.

Merle Tuve and the GRT Grant

In addition to Bush, Merle Tuve, the Director of the Department of Terrestrial Magnetism (DTM) of the Carnegie Institute of Washington, had remained a strong supporter of the GRT, who also had applied pressure on the Carnegie Corporation concerning the Australian grant.¹¹ Tuve stressed to Bowen that the requirement that the Australian government was to be responsible for a substantial portion of the expense of the GRT was his [Tuve’s] own idea. He did not want “your Australian associates to think that you [Bowen] laid any kind of trap for them during your visit here. If this is a trap for anybody I am glad to have been the one who set it.” Tuve wrote on 4 May 1954 that he was not claiming credit for the actions of the Carnegie Corporation. His actions were “solely to insure that no one among your officials [in Australia] could be angry with you for making arrangements in America which would necessitate further strenuous actions on their part. ... I was only one of many in the US who recognized the superlative quality of the achievements represented by the work of your group in the Radiophysics Division.... Dr. Bush, of course, was a the prime mover, but you would be surprised perhaps to learn of the [support] given by those among your scientific friends who perhaps most hoped that you might have been persuaded to move to the US... I am confident that if all goes well and the Australian plans work out with the [Carnegie] grant, you will find a universal agreement that some small measure of justice has been done in recognition of the first-class contribution by Australia in this example of a scientific venture for the benefit of the world community.”¹²

Pawsey in Europe and the US July to October 1954, Contacts with Tizard and Barnes Wallis

¹¹ NAA C3830 A1/3/11/3 Part 1, 19 April 1954. See Adelson (1996) and Needell (1991). From 1953 to 1965 DTM was a major centre of radio astronomy.

¹² NAA, C3830 A1/3/11/3 Part 1, 13 May 1954. A few weeks after this letter from Tuve to Bowen (13 May 1954), Bowen made a wry comment to White that “there are quite a number of people in the US who apparently want me over there, while there are others who would give a quarter of a million dollars to keep me away”.

Pawsey's long visit to the UK starting on 8 July 1954 had a major impact on promoting further progress of the GRT project¹³. Before his departure from Sydney, he wrote Cla Allen¹⁴, Secretary of the Royal Astronomical Society and former colleague at the Commonwealth Solar Observatory who had moved to the University of London Observatory¹⁵ in 1951. Pawsey asked that Allen request from the Royal Astronomical Society a statement of approval; after the completion of both the Jodrell Bank telescope and the GRT, the British Commonwealth would have full radio astronomical coverage of both the northern and southern hemispheres. By 19 July 1954¹⁶, Pawsey was in London reporting to Bowen and White about his contacts with the Royal Astronomical Society, the International Astronomical Union (IAU) and the Royal Society of London. The RAS support was well in hand and Sir David Brunt, Secretary of the Royal Society of London, was to contact Mark Oliphant of the Australian Academy of Science to seek coordination. The IAU presented a special problem: the President, Otto Struve of the US, did not want to involve the IAU Executive. "... It might be impolite to do it this way in view of the recent friction [between Australia and the USSR] over the Petrov affair".¹⁷ Instead Struve and the General Secretary P.T. Oosterhoff (Netherlands) would write a letter of support for the GRT from the officers of the IAU.

On 29 July 1954, Pawsey met Henry Tizard¹⁸, asking Tizard "... [for] advice [about] the identity of the best engineers in England from whom to ask advice. Tizard did not know ... but he proposes to consult a friend of his, B.M. Wallis, who is ... one of the best design engineers in Vickers [the aircraft manufacturer] ..." Wallis was the famous designer of the R100 Airship, the Wellington Bomber and the inventor of the "Dam buster" bombs (the bouncing bombs) used against Ruhr reservoirs in May 1943 by RAF aircraft over Germany. An important component of

¹³ In Chapter 27 we describe the decisive meeting of the radio astronomy group at RP in early July 1954 which contained Pawsey's vision of a change in strategy for this group. The independent small group model was evolving into an **observatory mode** of operation.

¹⁴ NAA C3830, Z3/3/A. Pawsey visited the Allen family during the period 4 to 6 September 1954; likely he had met Cla Allen soon after his arrival in London in July. In the period 9-12 September he visited Freeman Fox and Partners, likely the first direct contact between consulting engineers and RP. Pawsey also met Chris Christiansen in London on 30 September, just before his departure for New York on 1 October. Likely they also met earlier in Paris on 5 August before Pawsey went to Norway and Sweden.

¹⁵ *Op. cit.*, 15 June 1954.

¹⁶ *Op. cit.*, 19 July 1954.

¹⁷ Petrov Affair of April 1954. Vladimir Petrov of the Soviet Diplomatic Delegation in Australia defected to the Australian authorities. Petrov was a Colonel in the KGB. Diplomatic relations between Australia and the USSR remained troubled until 1959.

¹⁸ NAA, A1/3/11/3 Part 2, 3 August 1954, letter from Pawsey to White and Bowen from London

the aircraft designs was the geodetic construction of the airframes.^{19]} A month later Pawsey met him at the Vickers factory, introduced by Sir Henry Tizard²⁰:

I [Pawsey] found Wallis was very interested in the problem [the GRT design] and would himself very much like to be able to work on it. His opinions differ quite a lot from other people to whom we have spoken. He concludes ... that the structure should be built in light alloys [eg aluminium] not steel ... He suggested the possibility of our taking the next step, i.e. of getting a very rough design on which it would be possible to make an assessment of the size-cost relationship by using a small group of people working under his direction.

Pawsey warned his colleagues that getting Wallis's services from Vickers-Armstrong would lead to a tricky negotiation with the aircraft manufacturer.

Pawsey also was in contact with Lovell concerning the problems confronting the construction of the 250-foot telescope. Not only were there large cost overruns, but also a redesign effort brought about by the discovery of the 21 cm line in March 1951. Attempts to reduce the tolerances to ensure operation at 21 cm were proving costly. Pawsey was sceptical: "I do not think we will have the final answer until the whole thing is complete and tested." Pawsey met H. Charles Husband (the designer of the 250-foot Jodrell Bank telescope) at both Manchester and at his offices in London, at the time showing Pawsey the drawings of the new antenna. There was a discussion about bringing Husband into the design of the GRT. A week later Pawsey wrote Bowen in Sydney²¹: "... there is nowhere in the world such a fund of information on design, as he has". Lovell replied to Bowen a few days later. He was keen to help and was doubtful about the engineering expertise in Australia: "... I should think it unlikely that you would be able to find a consulting engineer of sufficiently wide experience in Australia to tackle the job ... [If I were in your position], I would seek ways and means of using Husband ... as a consultant for your telescope". Lovell appeared to be somewhat insistent: "... [M]y only vested interest in this matter is my desire for you to get your Australian telescope as quickly as possible and I am therefore quite unbiased in setting forth the above views."

¹⁹ See Morpurgo, J.E. (1972). "Barnes Wallis-- A Biography." Longman. London.

²⁰ NAA, A1/3/11/1 Part 2, letter to Bowen from Pawsey, 23 September 1954 from London. Thomas and Robinson (2005), Biographical Memoir of Harry Minnett Australian Academy of Science: "The story [of Minnett's involvement in the GRT] commences when Pawsey visited England and made contact with Barnes Walls at Vickers Armstrong Aircraft Company ... He now proposed the use of an altazimuth mount for the new telescope with pointing of its beam locked by a servo system to a small equatorial telescope, the 'Master Equatorial.'"

²¹ NAA, A1/3/11/3 Part 2, 10 August 1954

1954 Balance of Basic and Applied Research in Australia-. “Selling” the GRT to the Australian Government and Potential Donors

As 1954 drew to a close, White, Bowen and Pawsey were faced with a dilemma. The Carnegie Corporation’s donation of US \$250,00 represented only a fraction of the required funds. As an essential step in obtaining government approval for the GRT project, the Advisory Council of the CSIRO was asked for an opinion at a meeting on 9-11 November 1954.²²

The sensitivity of the CSIRO Executive to the balance between basic and applied research was evident in the summary presented to the Advisory Committee:

The Executive feels that we have here an example of really outstanding work by a CSIRO group which must be supported if Australia is not to suffer the indignity of being accused of failing to appreciate basic research and of giving support only to those lines of research which have some obvious practical application.

At the meeting in November 1954, Bowen and Pawsey provided a description of radio astronomy and the GRT to the committee.

To prepare for the meeting in November, White attempted to convince Vannevar Bush of the Carnegie Institution of Washington to visit Australia. White was keen that this internationally famous scientist-statesman would be capable of convincing the Australian Government to provide whole-hearted support for the GRT. Possibly White had even hoped that Bush would speak to the Advisory Council in person.

White illuminated the problem facing Australian policy makers as they grappled with the dilemma of funding a costly scientific instrument that was to be used exclusively for pure research. He was quite conscious of the vulnerability of the lack of a clear **applied research** rationale for the GRT as he wrote Bush a plaintive letter on 5 October 1954.

You will appreciate that although exceptionally outstanding work has been done by Australian science in one or two fields, including that of radio astronomy, this is still a small scientific community. The number of people here who appreciate fully the significance of what Radiophysics has done ... [in radio astronomy] is very limited. One consequence is that the responsibility of convincing others falls on one or two of us only who are outside the Division of Radiophysics itself. In such circumstances it is a very great help indeed if somebody from overseas such as yourself can talk to those in responsible positions in the Government about such a project as this. This work in [RP] is

²² The correspondence between Bush, White, Dollard, Bowen and the plans for the Advisory Council of the CSIRO meeting in November 1954, NAA, A1/3/11/3, Part 2.

a direct consequence to our radar work during the war. Since I left [RP, late 1944] and Bowen took charge [Briton was Chief until May 1946], I have done my best to encourage Bowen and his colleagues to get into one or two quite fundamental lines in physics in spite of the fact that CSIRO generally likes to foresee some fairly reasonable long term application of its work. It is difficult to point to any reasonably long term application of radio astronomy, but we have always argued that such fundamental work as this must, in the long run, be of practical significance in a country such as Australia.

White then pointed out that the CSIRO had to convince a number of bodies: the CSIRO Advisory Council, the Minister of the CSIRO and the Australian Treasury Department. White was optimistic that the Council would provide a favourable report influenced by the forceful opinion of Mark Oliphant, Director of the Research School of Physical Sciences and Engineering at the Australian National University in Canberra. The Minister, Casey, was favourable (but always looking for practical applications) while there was concern about possible negative opinions of Wilson of the Treasury Department [a prominent civil servant]. "Our present idea is to try to get at least another quarter or more of the money for the large radio telescope from private sources and then ask the Government to provide the remainder. It is here that I think you [Bush] could help us tremendously without much effort on your part."

Bush declined the invitation:

Your letter of October 5 is a very persuasive document. It increases my interest in what you are accomplishing in Australia and your plans. I wish that I could reply that you have convinced me that I ought to drop everything and come visit you, but I fear I cannot ... My program for [the coming months] seems to be ... crowded so that I will have to be here practically all of the time to cover the things under way, including one or two pieces of work I am doing for the United States Government ... I have no justification for interrupting some of the things I have to do in order to take on a very pleasant trip to your part of the world.

He provided his assessment of the balance of basic and applied research based on a lifetime of playing a major role in setting science policy in the US:

I realize ... what the general problem [of the balance of applied versus basic research] is in Australia, and I have met similar problems in industry [in the US] ... Some of us know that it is impossible to carry on applied research in a thoroughly effective manner without the presence of basic and fundamental research with it or alongside it. But I do not think that this is generally appreciated and it is not an easy thing to expound. When one has lived closely in scientific circles for many years it is quite apparent that one of the great motivating urges of scientific men is to increase the understanding of the race

and its grasp of nature, and we also know that in any group this philosophical approach should be present if it is to be a scientific group of the highest order. Moreover, the urge to add in a creative way to the general understanding is very strong among individuals, and if there is not an outlet for this urge those individuals who feel impelled most strongly thus to contribute to the grasp of their fellow men will go elsewhere. A scientific community, then, if it is to be really effective even in applying science for practical ends, needs to have in its midst those who are reaching far ahead in their thinking and who are building the foundation for the applied work of a later generation, or even building a foundation so that man may better grasp his position in the cosmos and reason more effectively about matters of the spirit. Now I know that in Australia there is just the same approach to this matter among scientific men generally as there is everywhere in the free world. The question is whether those who control the evolution of science in your country understand the nuances sufficiently well to be sure that there is an outlet and an opportunity for men of every type, so that in fact the scientific community will feel that it is fulfilling its full mission.

White was clearly impressed with this response and a long excerpt of the Bush letter was shown to the Advisory Council on 9 November 1954. White wrote to Bush on 25 October 1954:

I appreciate your very pertinent and kindly remarks about our situation here. There are fortunately a few senior men [eg Mark Oliphant] who see the need to support basic research quite clearly and I am assured of their assistance in promoting the activities of our Division of Radiophysics. Our Advisory Council meets in Canberra early in November and I am looking forward to gaining their wholehearted support for the [GRT].

At the meeting from 9 to 11 November 1954 three points were presented to the Advisory Council:

(1) The Division of Radiophysics is in the forefront in the field of radio astronomical research. The Executive believes that it is important to the national prestige of Australia in science that this work should be supported in the future and the Division given adequate opportunity of maintaining its position. These researches are making a conspicuous contribution to basic science and at the moment it is difficult to point to important applied objectives ... [Here a short discussion about possible spin-offs in understanding solar terrestrial relations and ionospheric problems as these impacted radio communications was included.] The merits of continuing this line of work must ...

be judged almost entirely in terms of maintaining a line of pure science in this country in which [RP] is outstanding.

(2) The endorsements of the International Astronomical Union and the Royal Astronomical Society (of the UK) were discussed.

(3) the Carnegie Corporation of New York grant was described with the expectation that this represented one-quarter of the total cost of the GRT. The expectation was that CSIRO would next attempt to raise an equivalent amount from private donors in Australia or overseas at which point an approach would be made to the government for a matching 50 per cent. [In 1955 this process of “matching pound for pound” was confirmed by the Australian government.]

After the meeting of the Advisory Committee in November, White discussed with Bowen:

Another facet is the development of the line on which we wish to “sell” this project. The Minister [Casey] has written me a letter urging us again to develop ideas of possible practical applications. I do not think there would be any harm in drawing parallels between the possible and unforeseen consequences of radio astronomy and the fact that many other lines of basic research have led to quite astonishing practical and unexpected results. This line, alone, of course, is insufficient ... There is, I feel, a great interest in basic astronomy, and it is true that patrons of the sciences are attracted by the adventurous outstanding approach when this is made obvious.

A few weeks later (13 December 1954), White wrote Charles Dollard of the Carnegie Corporation of New York with a summary of the positive reaction of the Advisory Committee:

You will be interested to know that our Advisory Council has given us wholehearted support for the building by the Division of Radiophysics of a large radio telescope ... The discussion of the proposal [for the GRT] was introduced by Professor Marcus Oliphant, who made an excellent short speech in favour of the project, pointing out the importance of CSIRO supporting the excellent work of Dr Bowen, Dr Pawsey and their colleagues. Several other members of the Council spoke in a similar way, and we reached the general conclusion that it is virtually important for us to support a group which has shown such initiative in a novel field of fundamental research. The Advisory Council is very appreciative indeed of the offer made by the Carnegie Corporation of a grant towards this project ...

1954- Setting the Specifications for the GRT, First Nine meetings of the Planning Committee – GRT

The second half of 1954 was a key period in setting the specifications of the GRT. Following the news of the Carnegie grant from 14 April 1954, the official Planning Committee-GRT began meeting twice a month in May and June. For the remainder of the year the meetings were held roughly on a monthly basis. (From May 1954 to mid- 1955 there were about 14 meetings of this committee.)²³

The first meetings were held on 10 and 31 May 1954 with detailed discussions of the “Specifications for Radio Telescope”, written by Bernie Mills and Frank Kerr. Three versions of the specifications with various levels of tolerance were proposed: (1) a reasonable ideal, (2) a minimum below which “we would not go” and (3) a good practical compromise. “The stated tolerances should cover the factors of constructional accuracy, windage, and temperature effects.” The committee realised that a compromise would have to be between size and accuracy. For example, the minutes of the first meeting reported, “Dr Pawsey favoured a large size, in preference to a higher accuracy, and therefore thought the reflector tolerance might be relaxed from [2.6 cm to 3.5 cm, based on an assumption of a limiting wavelength of 21 cm].” The size of the aerial was chosen to be 260 feet (4 per cent larger than the Manchester project!). The zenith angle limit was to be 60 degrees, including all the southern sky and the northern ecliptic. For the ideal specification, the “surface of the dish must be capable of being fitted to a paraboloid of the theoretical shape coincident with the dish at its centre with an error not exceeding 1.2 cm”, a statement of the desired homologous behaviour of the aerial. For this specification the pointing accuracy was to be 0.5 arc min while, for the compromise design, the pointing accuracy ranged from 0.8 to 3 arc min. Numerous details of the design were discussed such as the feed support structure (tripod or quadripod), the nature of the mesh surface and methods to monitor the shape of the aerial. Mills was especially concerned about the location of the new antenna: “In addition to the requirements of a low-noise site, Mills (10 May 1954) stressed the desirability of a large area of flat and open land ... to enable variable-spacing interferometry to be carried out.” He mentioned a number of possible sites within 50 km of Sydney. There was finally a detailed discussion (31 May 1954) about the necessity of optimising the various designs for 21 cm observations. The minutes from 31 May 1954:

Kerr drew attention to the statement: “For 21 cm work, it is considered more important to obtain the full resolving power of the whole aerial over a small part of the sky than the limited resolving power of a part of the aerial over the whole sky.” It was agreed that this should be interpreted as meaning that the mesh suitable for [HI work] should be carried to the edges, and the required structural accuracy specified only near the

²³ Planning Committee documents, Sullivan archive, NAA McGee archive – C4632/4.

zenith. The part of the dish within a diameter of about 100 feet could probably be used over the full angular range at 21cm.

The members present at these first meetings were Bowen, Pawsey, Mills, Bolton, McGee, Kerr and McCready. McCready was the chair of the group for several meetings in August and September 1954. After 2 November 1954, Pawsey was the chair, continuing in this role during 1955.

At meetings of the Planning Committee in June and July 1954, the problems of wind speeds in the Sydney area were discussed. It was thought that “it should be possible to operate for 80 per cent of the time or more, with low wind speeds”. Sites closer to the mountains were preferred to coastal sites since strong easterly winds were mitigated and sea breezes were absent. Arthur Higgs (27 July) suggested a novel antenna optical system, a Cassegrain mount, often used in optical telescopes. The feed “would be at the back of the dish, and a large convex mirror in front of the dish”. This form of optics is common in the modern era since it is most suitable for higher frequency observations, also allowing for rapid change of observing frequency. Ron Bracewell came to the meeting on 27 July 1954 and suggested a system of measuring the surface accuracy; this scheme was used later in the 1960s after the opening in late 1961:

... [This] is a modification of schemes based on reflecting light from a star to the focus of the dish. In this scheme, a dummy star would be placed at the focus, and mirrors fixed at numerous points on the dish, at suitable angles to reflect light back to a wide angle camera, also at the focus. A pattern of dots would be produced at the camera, the pattern changing if the dish distorted during the rotation ... After discussion it was agreed that this is the best proposal made so far, and Bracewell was asked to arrange a simple test ...²⁴

Thus as the year 1954 ended, there were many suggestions for building a successful GRT. Many challenges remained.

²⁴ NAA C3830 A1/3/11/1 Part 2. Bracewell also wrote a one page summary of the method. During the planning committee meeting of 2 November 1954, Jim Hindman reported that he had had promising discussions with Puttock and Macinante of CSIRO Metrology about determining the shape of the GRT. Maurice James Puttock (1921-1985) worked with Don Yabsley and Harry Minnett in the early years of the Parkes radio telescope in determining the shape of the Parkes antenna. See Puttock, M. J., & Minnett, H. C. (1966, November). Instrument for rapid measurement of surface deformations of a 210ft radio telescope. In *Proceedings of the Institution of Electrical Engineers* (Vol. 113, No. 11, pp. 1723-1730). IET Digital Library.

DuBridge, Bowen, Bolton and Pawsey – 1954. Bolton leaves RP for Caltech

Also important events had occurred in September 1954 about John Bolton's possible move to Caltech to begin an appointment to begin a radio astronomy group.

On 22 September 1954, Bowen wrote Pawsey in London²⁵. He had just returned from his second trip to the US in 1954, August and September; Pawsey was to return about a month later (21 October) from the UK, Europe and the US where he had been visiting since July. Bowen had just visited Tuve in Washington and DuBridge in Pasadena, continuing discussions about large aerials.

Lee DuBridge has failed to get a large sum for the erection and running of a big aerial, but has some modest sum immediately available which he will use to make a small start in Radio Astronomy if he can get the right person. By a "small start" he means a Mills Cross and a 60 foot steerable dish for Hydrogen Line work. His ultimate objective is a giant aerial and he hopes to have the finance for it in a few years' time.

Bowen was quite critical of Lloyd Berkner's (President of Associated Universities, Inc.- AUI- in New York) efforts to build "the largest parabolic aerial in the world [600 feet?]. There is some evidence that [AUI] are hypnotised by the gadget and have scarcely thought at all about the programme or who will run it." Bowen was impressed by the group of Merle Tuve at the Department of Terrestrial Magnetism of the Carnegie Institution of Washington: "As the prime mover in our quarter of a million dollars he deserves talking to. Furthermore, his own Radio Astronomy programme is on a much sounder footing than it was previously and he is also Chairman of a committee which is considering the AUI project mentioned above."²⁶

On the same day (22 September 1954), Bowen wrote DuBridge²⁷. He apologised for missing DuBridge as he had recently departed from Pasadena, "... but I was well looked after by Jesse Greenstein and Baade ... I have talked to Bolton about the possibility we discussed in Pasadena [first half of September 1954] and I will let you know his reaction ... I am personally very keen to assist in any plans to build up Radio Astronomy in the USA and we shall certainly do all we can to help from this end." The situation developed rapidly. On 28 September 1954, Bowen wrote again to DuBridge with the news that Bolton [then 32 years old] was interested in the Caltech offer. He summarised his astronomical achievements:

²⁵ NAA, C3830, Z3/3/A.

²⁶ Pawsey did not meet Tuve in Washington in 1954.

²⁷ NAA, C3830, Z1/3/1/V.

[H]e made the first identification of a radio star with a visible object, namely the Crab Nebula ... He is a man with an exceptionally clear physical insight into the problems he faces, is expert on the design of experiments and attacks his problems, be they of a practical or experimental nature, with an almost diabolical energy. In every way he is eminently suitable for taking charge of research programme and he gets on exceedingly well with those who work for and with him.

Bowen recommended a leave of absence from RP of 2-3 years. "For our part ... we are extremely happy at the thought of his being of some assistance to you, and look forward to closer and closer collaboration in the future." Barely a week later, on 8 October 1954, DuBridge wrote directly to Bolton with an offer. The salary was to be \$8,000 (approximately \$77,000 in 2019) for an initial period of two years. The expectation was that the appointment would be extended. DuBridge had an assurance from the Office of Naval Research [ONR] that funds would be available for a "fine program in radioastronomy. This support would be in accordance with a program to be submitted [to ONR] after your arrival and have an opportunity to explore various possibilities." DuBridge hoped to begin at "once with the construction of a dipole array [presumably a Mills Cross] and at a later time with other facilities. At the present time we do not see the funds in sight which will be required to construct a large aerial of the steerable searchlight type though a smaller dish for 21 cm [HI] might well be within our program." Preliminary funds from ONR would be received and then Bolton was "to draw up a more detailed program which you think feasible and reasonable for submission at a time after your arrival." The expectation was that Bolton and his family (wife and two sons) would arrive in January 1955; they did arrive in late January. Bolton was the first employee of the radio astronomy programme at Caltech (Cohen, Marshall H. "The Owens Valley Radio Observatory: Early Years." *Engineering and Science* 57, no. 3 (1994): 8-23.).