

plane based on a common spheroid is a goal towards which we should be striving.

In some of the territories which it is desired to map, there may not be any existing ground control or any adequate ground control. Employment of ground geodetic control parties would be a difficult and lengthy task. The need has been seen for some time for a means to establish geodetic control from the air with the minimum of ground installations. Much work is now being done on a method of Shoran mapping. Shoran mapping is to be the main topic of the following papers.

THE HISTORY OF SHORAN

H. G. Sennert

Bombing Branch, Radiation Laboratory

THE term Shoran is a contraction of the phrase Short Range Aerial Navigation. Although its tactical employment was greatly delayed, Shoran was one of the first radar systems to be developed during World War II.

The initial conception of the Shoran idea occurred in 1938 when the Radio Corporation of America, while engaged in television research, noted that ghost images frequently appeared on the television screen. Investigation revealed that these ghost images were caused by signals that were reflected from buildings or other objects and reached the television receiver by paths other than the direct path.

It occurred to these television engineers that perhaps radio waves could be utilized to measure distances accurately and rapidly. During the years 1939 and 1940, the RCA engineers conducted certain experiments that enlarged and developed the "radio distance measuring" idea.

During the fall of 1940, the Aircraft Radiation Laboratory, Navigation Branch, was considering proposals for a new navigation system and the RCA was solicited for a proposal to develop such a system utilizing the radio distance measuring technique. In February 1941, the RCA was granted a development contract by the Aircraft Radiation Laboratory. The developmental system, officially designated SCR-297-T2, was delivered in February 1942. However, this country was then newly engaged in war and official interest was directed toward development and procurement of basic essentials with which to equip the rapidly expanding Air Forces. Hence, the priority assigned to a new system of unknown value was rather low. The result was that flight tests of the new system were not begun until six months later in August 1942.

The results achieved in the flight tests were surprisingly good. Although no bombing computer was available for use with the new system, a technique had been evolved for pre-computing release points, and bomb release was effected manually by the operator when the proper point in space, determined by Shoran distance measurements, was reached by the bombing airplane. Of the first twelve bombs dropped from 14,000' altitude, two were direct hits on a 30' square target, and the average error for the twelve bombs was 220'. These results compared favorably with visual bombing under similar conditions.

Under ordinary circumstances, following such favorable test results, the equipment would have been placed in quantity production for immediate application to tactical use. However, information was received at that time that the British were producing a similar system, and in the interest of utilizing combined productive capacity to the utmost, work on the project was temporarily discontinued. Shortly thereafter, in December 1942, a delegation of officers and

engineers was dispatched to England to investigate the British development. Investigation revealed that the systems were not a duplication and that a real need existed for the Shoran equipment. However, the project again met with misfortune. The delegation separated on the return trip, and the plane carrying the chief of the party was lost at sea.

Finally, in March 1943, a contract was initiated with RCA for the development of a new Shoran system suitable for tactical use. During the two years since the original system had been designed, great advances had been made in radar circuit techniques and experience with the system had indicated many modifications.

In January 1944, the redesigned system was delivered. Flight tests conducted at Boca Raton, Florida, proved that the system was capable of measuring distances with an absolute accuracy of $\pm 50'$.

In the meantime, production orders had been placed and production was under way. In September 1944, the first Shoran systems were shipped to Corsica for use in bombing vital pin-point targets in Northern Italy. Following a brief period of organization and training, the first tactical Shoran mission was flown 11 December 1944. From that time on success of the project was assured. In rapid succession, targets that had been near misses by visual bombing methods were destroyed by means of Shoran. Further losses of airplanes and crews due to enemy action were sharply reduced as missions could now be scheduled at night or in overcast conditions.

Following its introduction in the Mediterranean Theatre of Operation, the system was scheduled for extensive use by the 9th Air Force in France. However, by the time the equipment could be made available in sufficient quantity and 9th Air Force personnel were trained in the tactical employment of the equipment, the European war was nearly over and tactical targets were practically non-existent.

Extensive plans were also made for Shoran's employment in the war against Japan but there again the war ended before the plans could be put into effect.

So far I have mentioned only the application of Shoran to bombing. Allow me to retrogress slightly in the story. When the Shoran tests were conducted at Boca Raton, Florida, in the Spring and Summer of 1944, representatives of the U. S. Engineers participated in the tests. The ease and accuracy with which Shoran could measure long lines soon became known to Geodesists and Mapping and Charting people. It occurred to them that Shoran might be useful in establishing geodetic control and in the rapid preparation of maps and charts of suitable accuracy. Accordingly, a project was undertaken by the 311th Reconnaissance Wing to determine the suitability of the equipment for such purposes. As a result of over $1\frac{1}{2}$ years experimentation, operating procedures have been developed which, in conjunction with equipment modified to yield even greater accuracy, indicate that it will be possible, with Shoran, to obtain geodetic control of first order accuracy and to employ Shoran in conjunction with aerial cameras to obtain directly photographic maps and charts of second order accuracy.

In tomorrow's meeting you will be given the opportunity to see the Shoran equipment, observe it in operation, and ask any questions you may have concerning the system or its applications.