GROUND CONTROLLED

APPROACH RADAR

IN

WORLD WAR II

Story as told by John P. (Jack) Whitehead
in collaboration with Richard G. (Dick) Batch.

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PREFACE

During WW2, due to the frequent inclement weather in the UK, returning aircraft from raids over enemy territory were often faced with terrible landing conditions at their home airfields and even emergency airfields. The problem was frequently compounded by aircraft being damaged and on-board aircrew being wounded so that a direct approach would be required. Homing beacons and VHF triangulation stations could normally bring the aircraft to their home stations, but there were no blind landing devices.

One attempted solution was FIDO (Fog, Intensive, Dispersal Of). The runway was lined on both sides with open troughs of fuel and when returning aircraft started their final approach, FIDO was ignited with the theory that the terrific heat generated would disperse the fog and the landing aircraft would be provided with a flare path. I gather that tests were only marginally successful and, of course, the fuel drain on fuel-starved Britain would have been enormous.

In the meantime, Professor Luis Alvarez and an engineering team at the Massachusetts Institute of Technology (MIT), Cambridge, Mass. developed and built a Ground Controlled Approach Radar System designated the GCA Prototype or GCA MK1. It was demonstrated in the USA during 1942 and the RAF observers immediately saw a possible solution to their bad weather landing problem and promptly took Dr. Alvarez, his crew and the GCA MK.1 over to the UK. Trials were carried out in 1942/43 at RAF locations at Elsham, Davistowe Moor and St.Eval, Cornwall. Even though the Prototype MK1 GCA was only an engineering model, the system showed enough promise that the RAF urged that production models be developed and built. With renewed interest being shown by both the United States Navy (USN) and the United States Army Air Force (USAAF), the United States Government agreed to proceed with the development of GCA MK2.

At this point in time, the authors became part of the GCA Project.

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Ground Controlled Approach Mk. 2 (designated AN/MPN-1).

RCAF Members on GCA Training

On 10 July, 1943, after completing a course on a newly-developed 10cm airborne radar equipment designed for Coastal Patrol anti-submarine surveillance at the US Technical Training Center in Corpus Christi, Texas, the RCAF course members eagerly awaited their overseas draft to operational airfields. Then three airmen were called out of the large group, **Batch, McKinnon and Whitehead,** and were told to report to RAF Delegation, Washington, DC., for assignment, together with RAF **Sergeant Ron Gillam**, who was also at Corpus Christi. With no other information than our travel documents, we duly reported and were met by a RAF **Squadron Leader Cockerham** and were informed we would form a new detachment that would take the first GCA Mk 2 production model to the UK for the RAF. We were to learn everything about the equipment as we would have to set it up, operate and maintain it and teach it to others....quite a large order when one considered that we three Canadians, while having a large amount of technical training, had yet to be on an operational unit and had no practical experience.

Our first stop was at MIT Boston where we met Dr. Alvarez and his designers who briefed us on the Mk1 and the proposed Mk 2. Gilfillan Bros. of Los Angeles, who made domestic radios pre-war, had been selected to build the first ten production models. No.1 was to be the test/development unit, three were to go to the RAF, three to the USN and three to the USAAF.

Next stop was Los Angeles and Gilfillan Bros. where we were surprised that parts of the Mk 2 were still in the design stages. We found accommodation close to the factory and commenced to find out as much about this new equipment as possible. In the ensuing several months we worked with the designers, installers, testers, writers and got our hands on the equipment and system at every opportunity until the first RAF unit was ready for shipment.

The system at this time was still highly classified so that it was deemed necessary to have the Royal Navy transport the RAF Unit No.1 to the UK. It was loaded aboard a new Escort Aircraft Carrier, HMS SMITER, at Los Angeles. The five-man detachment returned to Washington for de-briefing and joined HMS SMITER in Norfolk,Virginia, after her transit of the Panama Canal. Our slow convoy to UK took approximately three weeks as we meandered all over the North Atlantic avoiding U-Boat Packs. While in transit "D Day," 6 June 1944, occurred which had much to do with our transit route and we kept our ears tuned to the BBC Radio broadcast over the ship's Tannoy System. The carrier was ferrying Corsair Fighters and Avenger Torpedo Bombers and there is no place like a Royal Navy Ship for rumours. We were deluged with several a day, including dropping our aircraft off at the landing sites. We did, however, eventually dock in Liverpool and our precious GCA was duly off-loaded with the Corsairs and Avengers.

A couple of anecdotes on the crossing. We Canadians opted for camp cots in lieu of hammocks.

We placed them under the wings of the Avengers on the hangar deck. Every morning, the naval crew carried out an emergency drill called Dawn Action Stations as this was a dangerous time when the ship could be silhouetted against the rising sun. We three airmen had no such roles. One morning the Executive Officer was doing his action station rounds and found me fast asleep in my cot. Yelling at the top of his voice, his face purple with rage, he wanted to know where my action station was. As I stood at attention in my undershorts, I explained that I was a Canadian airman with no action stations. This seemed to make him more irate as he stomped off tearing a strip off of his CPO. I really don't think that he knew we were aboard. The more pleasant anecdote was that the Marine Sergeant-at Arms, who was in charge of measuring out the daily rum ration to the sailors, agreed that we airmen were also entitled to our daily tot, which was welcome---and no action stations.

First GCA in England

We were assigned to RAF Station Hinton-in-the-Hedges, near Banbury, where the Signals Development Unit of 26 Group was located. Our five-man detachment suddenly grew very rapidly as many of the Mk1 crew, including RCAF **Corporal Ken Rich**, joined us as well as other Radio Mechs (Radar Technicians),WAAF operators and RAF Officers who were to become GCA Controllers. Most of the officers were tour-expired aircrew or those who were medically grounded but with flying experience.

Our first task was to get our first GCA Unit as operational as quickly as possible as familiarization of all personnel with the equipment was mandatory before training would commence. Hinton was not a good airfield for this as facilities were widely dispersed. We soon moved to a much better facility, RAF Honiley, Warwickshire. The GCA work area was adjacent to the perimeter taxi- way with good fixed workshops, class rooms and a large storage area for incoming GCA Units. The flow of units soon increased as Gilfillan Bros. had been awarded a further contract and the USN had gone to contract with Bendix Corporation and in the wartime environment, factories worked 24 hours a day, 7 days a week. We designed and built workshop test and repair facilities that would allow major components from the mobile GCAs to be repaired and returned to service quickly.

As the stream of GCA units increased, training had to be stepped up also involving operators, mechanics, controllers, aircrew and aircraft. (A technical and operating description of the GCA System is contained in Appendix A). A satellite airfield at RAF Atherstone, renamed RAF Stratford, was added to provide training facilities for operator and controller training with operational aircraft and to form teams to be sent to operational airfields as soon as the GCAs were installed. At this time Cockerham, Gillam and Whitehead returned to the USA to assess an operator training facility which would substantially reduce the hours required for training with live aircraft. It had been developed by the USN and was approved from demonstrations witnessed in Gainsville, Georgia. The crossing was made in a French troopship, the Louis Pasteur, from an RAF Embarkation Unit. Whitehead almost didn't make it as on paper he had the necessary qualifications for a draft going to India and so was included to be shipped out. His story about being sent back to the USA in wartime didn't impress the Embarkation Officer and only some frantic phone calls saved

the day. Return to UK was made from New York on the Queen Elizabeth which made a solo dash across the Atlantic with a full US Army Infantry Division aboard. The trainer arrived shortly in Honiley and it was installed at RAF Stratford.

In conjunction with the training, three mobile installation crews were formed to survey sites, transport, install, test and hand over operating GCAs that had been checked out and certified at RAF Honiley. Both Sergeants Whitehead and Batch were Crew Chiefs and installations were made at Prestwick, Scotland, Lyneham, Wiltshire, Manston, Kent and other Transport and Bomber Command Stations .

GCA on the Continent

In the spring of 1945, Sergeants Batch and Whitehead accompanied their OC Squadron Leader Cockerham and Deputy **Flight Lieutenant McWiggan** to Evere, Belgium, to install the first GCA on the Continent. We flew by Wellington Bomber while the GCA went by Landing Craft (LCT) across the Channel and then by road to Melsbroek, Brussels where it was successfully installed. The airfield had a wing of Mosquito bombers which was to be served by our latest GCA unit. At Evere, the two Canadians were assigned truly unique accommodation. We were billeted in a nearby convent which had been taken over by the military. This one of a kind building had been built for a "Cloistered Order" of nuns--that is the nuns had no contact with the outside world. The rooms, called cells, had their windows installed at sharp angles looking heavenward so we had great sky-views but could not see the ground or surrounding country. We soon found some farm dwelling close to Melsbroek that suited us much better. Before returning to our home field of Honiley, the two Canucks took a side trip to Vimy Ridge where we saw our famous WW1 War Memorial and climbed among the WWI trenches. It was a moving experience. Also in Brussels, we watched a parade of the Belgian Underground and sat at a sidewalk cafe and drank with some of them. They had lots of interesting tales to tell but there were more GCAs to install so back we flew to England by Stirling bomber this time.

Return to Canada

The war in Europe came to its end on 8 May, 1945. The RAF, as with all forces, turned their attention to the Japanese conflict. They wanted to install GCAs throughout the Middle and Far East, but we Canadians were due for repatriation back home. We could have stayed on for a further year but we had both decided to take our Department of Veteran Affairs (DVA) credits and attend university. Staying with the RAF longer would have put us behind the main stream. So we continued working at RAF Honiley on the new GCA arrivals and then locking them away until the RAF decided what to do with them. The Japanese conflict came to an end on 15 August, 1945, and suddenly all forces were faced with the dilemma of what its peacetime forces would consist of. All the latest GCAs were put in storage and I suppose many of them were sold as War Surplus. Repatriation home was based upon time spent overseas, so we had to wait for our number to come up. We finally were sent to an RCAF Holding Unit at Aldermaston in November, followed by a December move to our Embarkation Unit at Bournemouth. We sailed on the Mauritania on 27 December and arrived in Halifax at the beginning of the New Year, 1946. We were "demobbed" in February at Calgary.

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"On the Lighter Side"

Of course, mixed up with the serious side of war, were episodes humorous to us. For example, one of our RAF NCOs decided to move a GCA Unit, prime mover and trailer, through the station at Honiley, but forgot that the long HF whip antennae were still up. He proceeded to drive under the main power line feeding the station and caused a major power failure on the station and surrounding area as the antennae shorted out the power lines, completely demolishing the whips. No one saw the fireworks and our white-faced NCO got the rig back to our workshops. The Station Commander, tearing around in his jeep, never did find out what caused the power outage. On another occasion, a VIP visit was announced on very short notice. Squadron Leader Cockerham, to speed things up, jumped into our demonstration GCA and took a short cut across a soft muddy area toward our hard stand. It never made it. It got completely bogged down and was in danger of tipping over. All hands went to the rescue and with power winches holding the trailer upright and an extra GCA Prime Mover acting as a tow vehicle, the unit was extricated just in time. We never did find out how our muddy, red- faced boss explained away the dreadful muddy condition of the GCA. We can only imagine that his broad Yorkshire accent suddenly got much broader, making it more difficult for the VIPs to understand.

One last post script.....One of the RAF Technical Officers who joined us from the Mk1 group was **Flying Officer A.C. Clarke**. We all thought that he was a bit far out as in 1944 he was the Secretary of the British Inter-Planetary Space Society and would amuse himself by working on 3D inter-planetary navigation problems. We were not to know that our Radar Technical Officer in World War II would become **Sir Arthur C. Clarke**, the highly regarded space consultant, TV personality, scientific writer and author of many science-fiction books. Remember the Movie 2001---that was an Arthur C. Clarke story.

An earlier book written by Arthur Clarke was titled "Glide Path."* Although written as a novel, it concerns the actual work of brilliant scientists, courageous flyers and specially trained servicemen working together in England during World War II to perfect a radar talk-down system for aircraft. Yes, **Sergeants Jack Whitehead** and **Dick Batch** were two of the RCAF specially trained radar technicians who formed part of that group.

*_Glide Path_ by Arthur C. Clarke. First published in Great Britain, 1969, by Sidgwick and Jackson Limited.
5BN 283 98066.4

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Appendix "A"

Technical/Operating Description of GCA AN/MPN-1.

GCA Radar:
The GCA Mk2 had two radar systems. The 10cm Search System had a maximum range of 30 miles, a 360 degree rotation and two PPI (Planned Position Indicator) Operator CRT Displays. The antenna consisted of an end-fed 10cm waveguide with a series of dipoles mounted along its length. This array faced into a vertical parabolic reflector providing a trapezoidal antenna pattern to 10,000 feet.

The 3cm Precision System had two antennae providing a vertical and horizontal sector scan covering only the runway approach area. Both antennae were end-fed, variable width extruded aluminum waveguides. A series of dipoles were mounted along the length of the waveguides...one being mounted vertically and the other horizontally both feeding into parabolic reflectors. A drive mechanism expanded and contracted the antenna waveguide widths thus changing the phase of the 3cm RF energy being fed to the dipoles and thus the angle that the radiated energy was transmitted. Thus these narrow beams swept a vertical and horizontal sector giving precision aircraft location data to a Horizontal CRT Operator as to its horizontal position on the glide path approach and to a Vertical CRT Operator as to its vertical position with respect to the glide path. The sweep displays on these two CRT displays were synchronized with the two antennae so that the aircraft radar returns were accurately portrayed on the Precision CRTs. All equipment and operators were situated in the GCA trailer.

Communications: Both HF and VHF transmitter/receiver equipment were located in the GCA trailer. HF Whip Antennae were mounted on the roof of the trailer as well as VHF Stub Antennae.

Spares and Test Equipment: Basic component spares and test equipment were kept in the trailer. Major spare items and major test and repair was carried out in the GCA Station Workshops.

Trailer: The trailer was a 5-ton, four dual-wheel trailer with a heavy duty towing tongue. The chassis weighed 6000 lbs., the body 5600 lbs., the radar and associated equipment 7000 lbs. for a total operational weight of over 9 tons. The trailer also had four hydraulic levelling jacks, one in each corner, that were used to level the trailer and to tilt it at the correct angle for the precision vertical scan sector. The trailer was 18 ft. 10 in. long, 7 ft. 10 in. wide, and 7 ft. 5 in. high.

Prime Mover: The prime mover was a 4-ton 6X6 Diamond T 968-A truck weighing 18,000 lbs. and rated to carry 8000 lbs. or draw 11,000 lbs. Our 6370 lbs. of installed equipment consisted of two 117v a-c motor generator power units PE127-A., an air conditioning unit connected to the operating trailer by two 10 in. ducts (remember the radar/communication equipment used a large number of heat-producing vacuum tubes and the GCA was designed to operate in temperate, desert and tropical environments), tools and spares for the power units. The truck was engined with a 51 HP (SAE) Hercules Motor. The combined weight of our loaded GCA prime mover and trailer was close to 22

tons. The trailer power connections were by cables plugging into a Junction Box mounted on the back of the truck. There was an intercom outlet for the driver that was used to help position the trailer accurately.

Placement on the Airfield: The trailer was placed approximately 100 ft. to the right of the runway in use and near the windward end. The azimuth antenna scanned from one degree to 21 degrees left to the normal of the array. Therefore the trailer was set at an angle of 84 degrees to the runway to give a horizontal scan of five degrees starboard to 15 degrees port along the runway. The elevation antenna scanned from one degree to eight degrees above the normal of the array. Therefore, the trailer was tilted two degrees below the level using the hydraulic jacks to give a vertical sector scan from one degree below to six degrees above the horizon. Calibration was done with radar reflectors placed a fixed distance along the runway and from the centre line of the runway.

Operation Of The System: The standard crew was made up of four operators, one Controller, one Radio (Radar) Mechanic and one motor mechanic/driver for the prime mover and power units. I recall that, if available, a second controller would take over a PPI operating position. The operators normally manned the two PPI positions, the Horizontal Precision CRT and the Vertical Precision CRT. The returning aircraft were first picked up by the Search PPI Operator at a range of up to 30 miles. The status of the aircraft was established as to fuel remaining, damage and casualties. Aircraft were stacked if necessary and the selected aircraft was handed over to the second PPI Operator to vector into the landing pattern. At a range of up to 10 miles the two Precision Operators would pick up the approaching aircraft. By using cursors to bisect the radar blips, height and azimuth information was made available to the Controller who normally stood between and behind the two precision operators so that he could monitor the height and azimuth information with relationship to the pre- planned glide/approach path. The Controller who was in VHF contact with the pilot would talk the pilot down giving him azimuth and altitude corrections and distance from touchdown. At two miles from touchdown, the precision operators would switch to a two-mile range on their CRT which would enable them to get more accurate positional information. After the successful landing, the Controller would switch his attention to the next aircraft in the landing funnel.

Post Script: The RCAF procured a number of GCAs in the postwar era but as I was out of the service I lost touch as to where they were used. Gilfillan Bros. continued to develop and modify the system until antennae were fixed off the sides of the runway and and the CRT Displays were in the Control Tower. But the GCA concept was soon to be overtaken by newer technology as ILS (Instrument Landing System), which enabled the pilot to make his own landing decisions, was improved and perfected. This in turn is being followed by automatic landing systems. Time and technology wait for no man.

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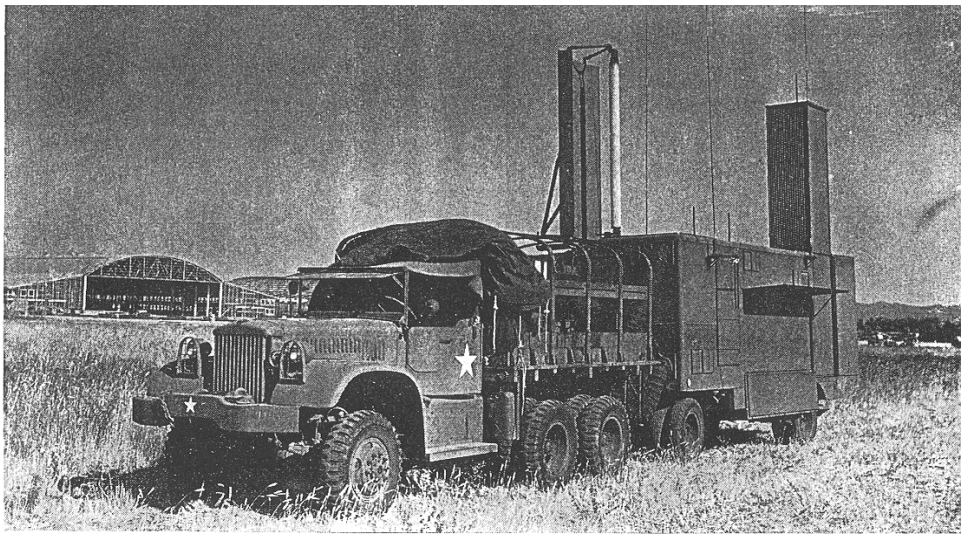
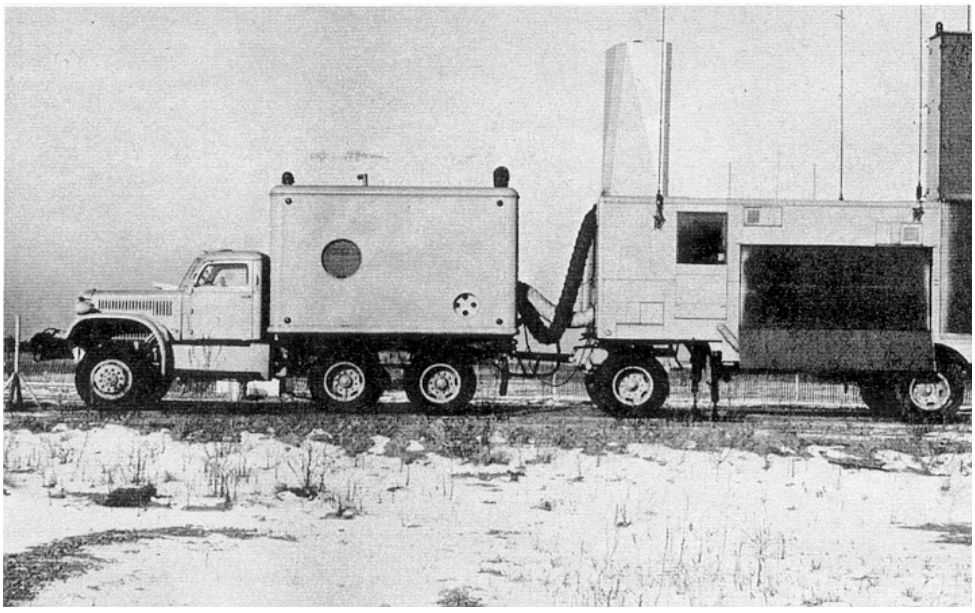


WWII U.S. Produced Ground Controlled Approach Radar System.
(Photo courtesy of R. Batch)



Ground Controlled Approach Radar Equipment - AN/MPN1(C)
(Photo from an article by Flight Lieutenant D.C. Clair in the October, 1956 issue of "The Roundel.")

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