Wartime emergencies – the Radio-Physics course and related training

University business did not carry on as usual during the second World war. Would-be students were called up, professors seconded to the Services, courses changed. I think there is little doubt that among the disciplines, Natural Philosophy was the most affected by the war. In hindsight it is a reminder if one were needed, and there have been times when it has been needed, that Physics is not ‘just another subject’ but has a particular strategic importance in science, industry, defence and discovery. In Natural Philosophy, staff numbers were doubled, the Professor spent much of the war in the Admiralty, new courses and what was effectively a new degree in Radio-Physics were set up, Honours degrees in Natural Philosophy in 1942 and 1943 were awarded to just one man and three women and in 1944 and 1945 ‘Students withdrawn for National Service before reaching Honours Standard’, as the exam results book records.

This account emphasis the Radio-Physics initiative. It owes a significant amount of content to serendipity. One of the instructors in Radio-Physics, James S. Whyte, and I were long-standing members of the Aberdeen Mechanical Society. I didn’t know of his past, as often happens in societies, but he offered reminiscences both of his life and in particular of his experiences with Radio-Physics. I have supplemented his words with information from a trawl of Court Minutes and other contemporary documents. Illustrations of apparatus are from the Natural Philosophy Collection of historical instruments in the University.

The second World War started in September 1939. By then Britain had radar and, although operators could be trained in a relatively short time, there was a dearth of officers in the Services who had technical knowledge of the circuits involved in radar sets to enable them to detect faults and supervise the necessary repairs.

In 1940 the Hankey1 Committee was set up to find means of rectifying the situation. It determined that courses should be established to educate the best of our 17/18 year olds, ‘boys and girls’ with a scientific background, in the intricacies of the circuits involved both theoretically and practically. The courses in Scotland were to be set up in Aberdeen, Edinburgh and Glasgow, the Aberdeen one to be created by Prof John A. Carroll. Although this course was housed in the Natural Philosophy (aka Physics) Department at Marischal College, it was separate from the normal Physics courses, and so extra staff were required. The Court Minutes of 10th Dec 1940 record that the Government requested ‘two courses in Radio Electricity - one for students taking a degree in Physics and another for Science students who have not selected Physics as a subject for their degree’. They recommended a temporary additional assistant be appointed in the Department of Natural Philosophy. It didn’t quite work out like that and would take significantly more than one Assistant to deliver the courses.

James Whyte’s description is that the full course consisted of 9 terms, the first three being devoted to the normal first year Physics and Mathematics and the remaining six terms to Radio Physics and associated Mathematics. At the end of the 9 terms, the students graduated M.A. or B.Sc. and were allocated as potential Officers in Radar to the branch of the Forces of their choice.

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The Court Minute of 11th November 1941 recorded that ‘In order to meet the Ministry of Labour requirements with regard to students taking subjects in the scarcity category, recommending as a war measure that the requirements in each of the following first year subjects in Science be reduced by approximately 15% in time and syllabus, viz Mathematics, Natural Philosophy, Chemistry, Zoology, Botany, Geology, provided that where a Head of Department so wishes he may retain the full course in his own subject for students who are not taking the Radio-Physics course or Chemistry with additional work in that subject.’ The Court may have approved but the Radio-Physics course was no easy ride. As time was a vital factor, a four-term year was instituted, consisting of a continuous series of terms of 10 weeks, separated by breaks of 2 weeks, with attendance from 9 am to 6 pm on six days of the week; staff from 8 am to 8 pm and on Sundays when necessary. In 1941 (at least) the Government provided an additional £400 towards summer school expenses. It would seem that general BSc students could also take Radio-Physics as a subject that could ‘as a war concession’ be counted towards their degree passes. James Whyte said that most of the Radio-Physics graduates returned after the War to complete their Honours courses.

The students for the first course were selected from the best of those who were studying Physics and Mathematics during the academic year 1939-40 and they completed the course in 1942. The students for the following courses were recruited from secondary schools across the North of Scotland, “only the very best being selected, about 30 plus in number”. In what seems excessive paranoia, “for security reasons, the students received instruction in the various radar circuits as separate units and never saw a complete set until they were in the Forces.”

The Government took notice of the Aberdeen initiative. Carroll’s daughter has written that Lord Hankey sent Carroll a very appreciative letter thanking him for his outstanding contribution to the Radio Training scheme in Aberdeen. There had been a convention in Northampton in 1942 at which Aberdeen university had provided a display of experimental equipment. Carroll had taken a very active part in discussions throughout the convention and Hankey expressed his gratitude and appreciation for the “magnificent assistance” which he had provided for the convention and also for "the great work you are doing in the training of radio students at your university."

**Teaching staff**
When the scheme was begun there were 4 permanent staff in Natural Philosophy: Professor Carroll, Drs Geddes, Griffith and Baxter. Dr Carl Westcott was appointed Assistant in 1938, though he appears as Carnegie Teaching Fellow in the Court Minutes with his salary of £350 split evenly between the Carnegie Trust and the University. Carnegie Fellows received slightly more than the standard assistant’s salary. Emil Rowland was also appointed Assistant in 1938 and kept his post until 1946 with duties considered as National Service. Westcott was granted leave of absence in 1942 to take up an appointment under the Ministry of Aircraft production, with Flora Black being appointed as a temporary Assistant in his stead. In 1938 these six provided teaching in the Faculties of Medicine, Arts and Science, the Science commitment covering Ordinary BSc teaching, Honours BSc and courses for Engineers, Foresters and Agricultural students. They may have had help from one or two Demonstrators not recorded in the Calendar but assistants undoubtedly got the brunt of marking regular exercises and supervising laboratory classes. The introduction of an intensive course in Radio-Physics required both changes and additional staff.

James Whyte (MA 1st class, 1933) had his RAF call-up papers cancelled and his own testimony says he started in January 1941. From 1943 to 1945 he was in charge of the laboratory work. Wilfred Abson BSc (£300 pa) and Helen Campbell (MA 1st class 1940) were recruited as Assistants for the duration of the war, others as ‘Temporary Assistants’. These included Scott Simpson (BA), Flora Black (BSc 1st class, 1940) who resigned after a year, Margaret Rode and Annabella Forbes (£250 pa) both 1st class Hons MA graduates of 1942 with Annabella Forbes taking the Rennet Gold Medal. Later appointees were William
Thomson (MA 1st class, 1936), George Burnett (BSc Lond), Alexander Mathieson (an ex-Radio-Physics student recorded in the Court Minutes paid £25 as a demonstrator for the summer course of 1942 and about twice that for two months in the summer of 1943). At least in respect of local graduates, it would seem that little less than a first-class Hons in Maths-Nat. Phil. would get you a job.

The situation was complicated by the secondment to the Admiralty of Professor Carroll, in 1942. A E M Geddes acted as Head of Department in Carroll’s absence. Carroll’s role was replaced by bought-in expertise. James Whyte takes up the story.

“In December 1941, Professor Carroll was appointed to take charge of Research Work in the Admiralty, for which he later received a knighthood, Dr A.E.M. Geddes taking charge of the Department and a Mr Stoodley from Southampton Polytechnic sent to take charge of the Radio Physics courses. Mr Stoodley was a brilliant physicist who had specialised in Radio-Physics, and he had the great ability to impart his knowledge and experience in his lectures and in the laboratories. He had a great belief in teamwork and the staff responded to his leadership, thus creating a very happy atmosphere in which the standard of work produced was very high. The staff voluntarily attended his lectures on transmission lines which involved very complicated mathematics and which he delivered without consulting any notes. Early in 1944 Mr Stoodley was called up to supervise the creation of manuals of instruction in the operation and maintenance of the most modern Radar Sets for all the three services.

His successor was Mr Bernard Meltyer from Edinburgh who, unfortunately, did not have the experience that Mr Stoodley had. However, the courses were so well established and the staff so competent, the good work carried on until May 1945. In March 1945 the Radio Physics

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2 The results given later suggest it was May 1944
section received a letter from the War Office praising the Standard of instruction given to the students and stating that those entering the Forces from the Aberdeen courses were superior to those entering from other courses in the country.”

Results

In spite of James Whyte’s detail of the Radio-Physics training, it’s not easy to untangle the mix of regular university courses and special courses laid on for the Radio-Physics students. The first relevant results I can find are for the ‘Final Exam (Advanced Radio)’ in June 1941. They contain 14 names, including Anabella Forbes as the top student, Alexander M Mathieson and Margaret Rode all of whom have been mentioned as contributing to teaching the course later. Further Advanced Radio results are recorded in September 1941, after the summer course, for 28 students. In traditional academic style these results are flagged with α, β and in two cases γ ratings but no clear Pass or Fail.

The Advanced Radio results of June 1942 contained results for 20 men and 6 women. By then the first year Radio-Physics course had results for 39 enrolled students of whom 11 were women. September results for 40 students flag 11 students as Edinburgh based. 7 students were women and the cohort included initially John C S Richards ‘called up for the Navy after 5 weeks’. Richards would later become Lecturer, Senior Lecture and Reader in Natural Philosophy at Aberdeen and head of the electronics workshop. By now the September results implied two written exams and a practical assessment. The radio results are distinctive in showing no pass or fail. It’s not clear how these were merged with regular courses to enable students to graduate with Ordinary or Honours degrees.

First year results in June 1943 contain 45 names (13 women). Four students failed to sit the exams and just 2 failed. The Radio summer school results for 1943 include 32 names with 8 from Edinburgh. Among the 24 Aberdeen names, 6 are women. In the graduation picture shown earlier there are 7 named instructors and 32 un-named, likely to be the students in this cohort that included 8 women. Descendants can scan the names in the footnote3 for any they may recognise.

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Radio-Physics in 1944 records an April pass for Margaret Swanson, one of the few failed first-year students in '43, and 16 passes in June of which 9 were women and one a re-attendance of a student who had been unable to sit the previous year. Curiously, the results for Radio-Physics then stop. Students names from this first-year class can be found in the standard second year MA and BSc courses for next academic year.

*Radar developments*

Radar changed significantly over the six years of the war. In the UK the ‘father of radar’ is acknowledged to be Sir Robert Watson-Watt, a man born and educated in Brechin. The adjacent picture shows his commemorative statue in the centre of Brechin. He is holding a model of a Chain Home tower in his left hand and an aeroplane in his outstretched right. Of course radar was not the development of one man alone. Thanks to Watson-Watt though, by September 1939 Britain had a series of operational radar stations along the South and SE coasts known as *Chain Home*. They operated at frequencies a bit above normal short-wave radio traffic, in the region of 35 MHz, with a wavelength between 10 and 5 m. The electronics needed was a refinement of short-wave radio technology. It was effective for detecting enemy bombing raids in the air over France and providing early warnings of size, direction and speed but the ‘kit’ needed was far too large to be incorporated into an aircraft. The aerial masts were over 100 m tall. Pulse lengths were necessarily around 10 μs, which sounds short but radio signals travel about 3 km in that time so resolution was not good. There were various other issues too, so there was a clear need operate at substantially higher frequencies with shorter pulses.

What was needed was technology that could operate at 10 or 100 times the frequency (VHF and microwave), that could emit short duration pulses of large power. The answer was invented quite early on in the war at the University of Birmingham by Randall and Boot – the cavity magnetron. It was small, could generate kilowatts of peak power in very short pulses of microwave radiation. It would be the cavity magnetron that would allow radar sets to be installed in planes and ships in due course. ‘Due course’ it turned out would be several years. For whatever reason, the development of magnetron radar sets was largely an American endeavour, triggered when an example of Randall and Boot’s device was taken to America as part of a
technology exchange agreement. Much of the development work was done at MIT\textsuperscript{4}.

The magnetron wasn’t the only device capable of generating much higher frequencies. The klystron was an American invention of 1937 that was favoured by the Germans when they developed their radar. This is not intended to be a physics lesson, just an illustration that training radar and radio technicians during the war had a strong element of keeping up with the times. The technology changed significantly over the six years.

\begin{figure}[h]
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\includegraphics[width=0.5\textwidth]{klystron.jpg}
\caption{WWII reflex klystron type CV36 Ref ABDNP:201512a}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{microwave.jpg}
\caption{Microwave apparatus likely used for demonstration on the Radio-Physics course. The metal is tarnished silver plate. Left: generator; Centre: parabolic reflector; Right: horn. Ref TE2113}
\end{figure}

**Other training courses involving Natural Philosophy**

The University was asked by the War Office to set up two intensive six month courses in Physics and Mathematics, one for a group of Royal Artillery Officer cadets and the other for a group of RAF Officer cadets. The RA cadets took exams in Maths, Mechanics, Physics (systematics) and Physics (practical). Unlike the Radio-Physics, there were only men on the courses. The table below shows the number of candidates and the number of passes (bracketed) at the end of each course. These results were supplemented by those for classes of RAF cadets who in addition had a course in meteorology. By then the Air Ministry had taken over Dyce airport, laid hard runways and based squadrons there. The Senatus Minutes of April 1942 reveal that the Air Ministry wished to confine the RAF short courses to “Universities that have a clearly marked residential character”. This explains the demise of the RAF training in Aberdeen.

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<tr>
<th>Cadets</th>
<th>March 1941</th>
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<td>RA</td>
<td>35 (30)</td>
<td>36 (30)</td>
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<td>37 (26)</td>
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<td>68 (33)</td>
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<tr>
<td>RAF</td>
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\footnote{Not the whole story but significant parts of it can be found in the fascinating account of the rich and influential American banker Alfred Lee Loomis: Jennet Conant "Tuxedo Park: A Wall Street Tycoon and the Secret Palace of Science That Changed the Course of World War II" [Simon & Schuster; first edition (2002)].}
These were quite large class numbers for the time. It was a once-only opportunity for the cadets, since there were no ‘resits’ and no sign of failed students enrolling again in the succeeding intake.

The war effort was not confined to Natural Philosophy. A Court Minute of June 1943 details financial commitments that were ‘on the same principle as last year’ showing ‘honoraria to staff for part-time war work in connection with the Royal Artillery and Radio-Physics Courses’. Mentioned are payments to 10 staff in Natural Philosophy, 6 in Mathematics, 1 in Engineering, 3 in STC, 1 in Fuels and 12 in the Administrative Office. Since Departments had but one Professor, his absence due to war-time secondment meant non-professorial staff taking over as Head. The Minutes of 1942 record 7 staff being paid honoraria for acting as Head of Department. By mid-May, John Carroll (on a salary of £1600 pa) had obtained extended leave of absence to join the Admiralty as Assistant Director D.S.R.E (Department of Scientific Research & Experiment). He would relinquish his professorial post at the end of the war and rise to become Chief Scientific Adviser to the Admiralty. Professors were seconded largely for their potential in providing innovation and high-level organisation. Radio-Physics training was largely aimed at keeping the machinery working.

It is a slight digression from University involvement to mention that throughout the whole of the war Aberdeen also had the ‘Aberdeen Wireless College’ specialising in training radio operators. Government had realised that radio and radar were technologies that needed a substantial cohort of technically able people over and above operators. To make an analogy, car mechanics are needed as well as chauffeurs to maintain a fleet of vehicles. Specialists from industry couldn’t be seconded to the services en masse for that would leave the industries without the means to innovate and produce. Technicians tend to be out of sight and perhaps out of mind but without them major operations will grind to a halt. Natural Philosophy at Aberdeen made a very significant contribution during the war to ensure that didn’t happen.

JSR

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The College was initially at 108 Crown Street. It seems to have opened for enrolment in late 1937, with early adverts offering training for wireless operators and engineers ending in City & Guilds qualifications. Later adverts concentrated on training wireless operators. Sending and receiving Morse code was an essential part of it. An advert in August 1941 began “So great is the demand for women wireless operators in the Services that the W.A.A.F. offer to refund college expenses up to £25 to qualified girls who volunteer.” By 1942 the College had moved to 7 Albyn Terrace and was offering day and evening classes. After the war it moved to 20 Golden Square and specialised in offering radio operator training for the merchant navy. Later it moved back to 7 Albyn Terrace but wound up in the mid 1960s.