OBITUARY

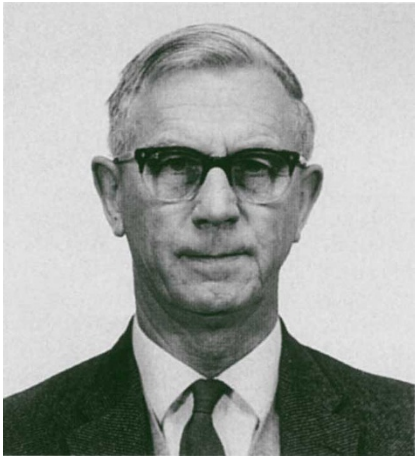
Charles Oatley (1904–96)

Professor Sir Charles Oatley died in Cambridge, England, on 11 March. His death marks the end of a long chapter in the history of the scanning electron microscope (SEM) — arguably the single most important scientific instrument to emerge since the Second World War. The first 17 years of the development of the SEM in its modern form took place in his laboratory at Cambridge, and led directly to its industrial production and wide application.

Following a higher education in physics, and a period in industry and at King's College London, Oatley spent the war years at the Radar Research and Development Establishment, Malvern. In 1945 he was elected a fellow of Trinity College and appointed to a lectureship in the engineering department at the University of Cambridge. His remit was to modernize the teaching of electronics, which was then called 'electric signalling', and to set up a research group. He wrote that one of his criteria in the choice of a research project was that "it should be adventurous and speculative"; electron optics was to be included but he did not want to trespass on the ground of V. E. Cosslett who was setting up a transmission electron microscopy (TEM) group in the Cavendish Laboratory.

Oatley thought that the SEM would be a suitable project, although attempts during the 1930s by Knoll and von Ardenne in Germany, and by Zworykin in the United States, to develop it for the direct imaging of surfaces, had been largely abortive. The experts he consulted were all opposed to the scanning concept, but he nonetheless decided to assign a research student to work on it: "in the worst case it would lead to a PhD and the failure to achieve the desired result would not be a disaster". I was lucky enough to be the student selected (in 1948), probably because I had had some years' experience in radar and the television industry.

The first rather rudimentary SEM worked in 1951 and from the start produced the striking three-dimensional images of surfaces that are now commonplace. One reason for this success was that the metal specimen was etched and placed at an angle to the scanning beam, and the contrast was topographic. The earlier workers had intended to use variations in the secondary emission ratio to produce contrast, a forlorn hope in the typical vacuum of an electron microscope (although Knoll was successful because he used baked and sealed-off vacuum tubes for his experiments). It is only comparatively recently that microscopists have become aware that an ultra-high vacuum microscope is essential for meaningful secondary electron imaging.



Oatley realized that with further development the SEM could be a most useful instrument. At that time, surface structures were imaged indirectly in the TEM by means of replica techniques which could achieve high resolution. The comparatively low resolution of the early SEMs was one of the reasons why electron microscopists were indifferent to the many advantages of direct imaging of surfaces; another was that Oatley's group was outside the mainstream of electron microscopy and "anyway they were only gifted amateurs".

Undeterred, Oatley continued work on the project with a succession of research students, in particular K. C. A. Smith, who greatly improved the first SEM and produced images comparable with those from modern instruments; even so, it was many years before the virtues of the SEM came to be generally recognized. Meanwhile Oatley's aim remained: to have the SEM marketed. Finally, after one fruitless attempt by a leading electron microscope manufacturer, in 1965 the Cambridge Instrument Co. Ltd announced the world's first production SEM, the Stereoscan.

The SEM has since been applied in virtually every scientific field, and instrumental developments continued: high-resolution (0.5 nm), low-voltage operation for non-conducting specimens, and the environmental SEM for wet specimens. Electron-beam microfabrication, which was first demonstrated in Oatley's group in 1964 by A. N. Broers, has had a major impact in the manufacture of microchips.

Oatley became professor of electrical engineering in 1960, and was knighted in 1974. He had retired three years previous to that, but continued with the development of the SEM, including carrying out single-handed a meticulous investigation on electron detectors; he read a paper on this topic at the symposium held in honour of his eightieth birthday. He then concentrated on tending his beautiful garden that had been a lifelong interest.

All of his students regarded him with great respect and affection, and many have had outstanding careers. To name but three, I. M. Ross became president of Bell Telephone Laboratories and T. E. Everhart of the California Institute of Technology, and A. N. Broers is professor of electrical engineering and vice-chancellor elect of Cambridge University.

Charles Oatley is survived by his wife, Enid, and his sons, John and Michael.

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baseline tasks that do not elicit spontaneous left medial temporal activity (J. F. Binder, L. Nyberg and J. V. Pardo, personal communications). All demonstrate increased left medial temporal activity as compared to tasks that divert attention from linguistic features of stimuli.

Additionally, more sensitive analyses of medial temporal activity can be designed that do not rely on the simple subtraction method. The study by Nyberg *et al.*[6] effectively uses two alternative approaches. Subtraction did not reveal significant modulation of medial temporal activity in their study. Instead, correlations between regional blood flow during a single task and behavioural performance were used to reveal the association of medial temporal activity with retrieval success. These authors also introduced a new multivariate method for image analysis, partial least squares, which was able to demonstrate changes in medial temporal activity between tasks that univariate contrasts between tasks did not demonstrate.

Amnesia provides the basis for one of the most solid links between brain and behaviour — the link between the medial temporal lobe and memory. Perhaps future imaging studies will help unravel the relative contributions of the different medial temporal lobe structures to the encoding, consolidation and retrieval of memories. □

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