Sir Alan Cottrell, ScD, FRS, FREng, LLD (Hon)

17 July 1919 – 15 February 2012

Generations of students have been weaned on Cottrell's *Introduction to Metallurgy*. Present-day students of materials science are likely to meet Cottrell atmospheres. These are but a glimpse of the contributions of Sir Alan Cottrell, the most influential physical metallurgist of the last century, one of the fathers of the subject of Materials Science, and a public servant and administrator of great distinction.

Cottrell attended Moseley Grammar School and then went to his local university, Birmingham, to read Metallurgy (BSc 1939, PhD 1942). His research was on cracking of armour plate at welds, and led to a continuing interest in plasticity and fracture. In 1943 he was appointed Lecturer and then in 1949 Professor of Physical Metallurgy, largely in recognition of his work on dislocation theory. Of this time at Birmingham, then at the forefront of developing the science of metals, he wrote†:

"In 1945, Professor Hanson set out, with Geoffrey Raynor and myself, towards an ambitious goal. … What we wanted to do was to explain the metallurgical properties, such as yield and fracture strength, alloy phases, heat treatment behaviour and corrosion effects, in terms of atomic structure and properties. In popular language we wanted to design alloys on the slide rule, from Schrödinger's equation. However, the task was simply too difficult in those days. The electron theory was having a hard struggle to explain even the simplest features of alloy structure, dislocations were no more than a dubious speculation; and the theory of mechanical properties had to content itself with simple billiard ball models of atomic structure. It is very different today." That it is so different today is in no small part due to Cottrell himself.

In 1955 he was invited to become Deputy Head of the Metallurgy Division at the Atomic Energy Research Establishment's Harwell Laboratory. Following the Windscale fire of October 1957, a nuclear emergency of national importance, Cottrell and his team set up a new laboratory, analysed the causes, and were soon able to make recommendations to ensure that the new Magnox reactors would not suffer from this problem caused by release of the Wigner energy in irradiated graphite.

Election to the Goldsmiths' Professorship at Cambridge followed in 1958. He transformed the Department of Metallurgy by new appointments (Nicholson, Kelly, Charles, Davies), and initiated research on superconducting alloys (Dew-Hughes, Campbell, Evetts) and on field-ion microscopy (Brandon, Bowden, Southon, Wald). In this period his own research flourished: on the brittle fracture of structural steel and elastic-plastic deformation at crack tips (with Knott, Griffiths, Tyson) and on the emerging physics of fibre composites (with Kelly).

This very fruitful period, to which the present Department still owes so much, was cut short in 1964 by Cottrell's appointment as Deputy Chief Scientific Adviser to the Ministry of Defence. He became Chief Scientific Adviser to the MOD in 1967, Deputy Chief Scientific Adviser to HM Government in 1968 and Chief Scientific Adviser in the Cabinet Office in 1971, when he was also knighted. His move to Whitehall was motivated at least in part by a desire to promote the UK's manufacturing industry through stimulation of science and technology. His work was varied indeed, on defence (TSR-2, East

of Suez policy), and on major projects (the Advanced Passenger Train, CERN, Concorde). His advice on policy covered aerospace, the environment and pollution, the funding arrangements and priority areas for research and development, the brain drain, international scientific relations, and the entry of the UK into the European Common Market. Above all, he is noted for his promotion of the UK's civil nuclear programme. In 1974, in evidence to the Select Committee on Science and Technology, Cottrell made clear his concerns about the structural integrity of the steel pressure vessel central to the pressurised water reactor. This ultimately led to the Marshall Report and to major advances in the procedure and regulations for ensuring the integrity of the pressure vessels and other larger structures. He was convinced that nuclear power generation could be safe, and did more than most to ensure that it would be so.

In 1974, he was elected Master of Jesus College, Cambridge. His Mastership was very successful, including a comprehensive revision of the college statutes and the admission of women. Following the practice at the time, Cottrell's mastership included a period, 1977 to 1979, as Vice-Chancellor of the University.

He retired in 1986, and returned to the Department, now of Materials Science & Metallurgy, where he was a regular fixture at morning coffee and in the library. He embarked on new work (modern electron theory applied to metallurgical problems such as embrittlement) that also built on the ambition of his time at Birmingham. He maintained his devotion to scholarly writing. Looking back on his contributions, perhaps above all we should celebrate his wonderful gift of a lively, clear style — somehow making the most complex matters intelligible. He displayed this most influentially in his books, and we have been fortunate that he was so prolific: *Theoretical Structural Metallurgy* (1948), *Dislocations and Plastic Flow in Crystals* (1953), *The Mechanical Properties of Matter* (1964), *Theory of Crystal Dislocations* (1964), *Superconductivity* (1964), *An Introduction to Metallurgy* (1967), *Portrait of Nature: the world as seen by modern science* (1975), *Environmental Economics* (1978), *The Undermining of British Industry* (1979), *With Energy, All Material Things are Possible* (1981), *How Safe is Nuclear Energy?* (1982), *The Physical World and Human Experience* (1984), *Introduction to the Modern Theory of Metals* (1988), *Chemical Bonding in Transition Metal Carbides* (1995), *Concepts in the Electron Theory of Alloys* (1998). With some aimed at a scientific readership, some at the general public, and covering transformative science as well as wider areas such as nuclear power, the environment and industrial policy, we can only be struck by the timeliness and ongoing relevance of these works.

Cottrell's distinguished contributions attracted many honours, some 16 honorary degrees and 20 medals and awards, too many to detail here. An innately modest person, Cottrell seemed unaware of his immense distinction. With his characteristic and endearing humour, he once remarked that he was now suffering from "medal fatigue".

In 1944, Cottrell married Jean Harber (d. 1999) and together they made a great team. His quiet, gentle manner was nicely complemented by her vivacious style, for example as hostess when he was serving as Master of Jesus, and as Vice-Chancellor of Cambridge. He is survived by a son Geoffrey and by Ioana, adopted when her parents, close friends of the Cottrells, died.

HRH Prince Edward, a student at Jesus College during Sir Alan's mastership, is Patron of the Cottrell Appeal, currently nearing the end of its mission to establish a Cambridge Professorship in his

honour. A memorial service will be held at 11 am on Saturday 9 June 2012 in Great St Mary's, the University Church, in Cambridge.

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†from A. H. Cottrell, 'The metallurgical applications of modern electron theory of alloys', *Mater. Sci. Technol.* **6** (1990) 974.