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Obituary

Kenneth J. Stout 1941–2006: A memorial

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ABSTRACT

Kenneth J. Stout was an important figure in the development of surface metrology, and in particular of roughness measurement and characterisation, during the last decades of the twentieth century. He made substantial contributions to the statistical characterisation of rough surfaces and the application of this work to tribological measurements. Later he was instrumental in developing and popularising practical techniques for three-dimensional description of surface roughness, including the well known "Birmingham 14" set of roughness parameters. Finally he was one of the first to promote the application of wavelet transforms to surface metrology.

This memorial discusses his personal contribution to the subject and attempts to set it in the context of historical developments in the field. It includes what is hoped to be a definitive bibliography of his journal publications and those of his co-workers.

1. Biographical details

Kenneth John Stout was born in London in 1941. He left school at 16 and served his time for 6 years as an apprentice at Standard Telephones & Cables, becoming a planning engineer there before moving to Ford at Dagenham in a similar role in 1965. Looking for better professional qualifications, in 1967 he enrolled for a 2-year Master's degree at Cranfield Institute of Technology. His academic career started in 1969, when he became a lecturer at Henley Technical College in Coventry, moving the following year to Lanchester Polytechnic (now the University of Coventry). In 1972 he moved to Leicester Polytechnic (now De Montfort University) as Senior Lecturer, then successively Principal Lecturer and Reader. He returned to Coventry in 1981 as Head of the Manufacturing Systems Department. In 1988 he was appointed to the Lucas Chair of Manufacturing Engineering at the University of Birmingham and also became Dean of the School of Engineering till 1995. From 1995 till his retirement in 2002 he was Dean of the School of Engineering at the University of Huddersfield.

His research interests began with externally pressurised bearings, the subject of his Master's dissertation at Cranfield and later his doctorate under the supervision of Prof. W.B. Rowe. Between 1972 and 1998 he published 25 papers on bearing design [1–3,6,7,9,13,15–20,22–26,29,32,34,36,41,42,44,48,71], many of the earlier ones in collaboration with Prof. Rowe. Based on this substantial body of work, he developed a postgraduate course on the design of aerostatic bearings which he presented over the years at a number of international venues. He also made contributions to the development of coordinate measuring machines [62,65–67]. The present memorial, however, is intended to address only his contribution to the theory and practice of surface roughness, which started during his time at Leicester.

2. Leicester 1972–1981

Let us begin by reminding ourselves of the state of the art of surface roughness measurement and characterisation in the early 1970s [80]. The only available instruments for making quantitative measurements of surface roughness were stylus instruments. Computers, the smallest of which was still the size of a large filing cabinet, were available only to the handful of researchers who could afford them. These researchers had to write their own code, as no proprietary software packages were available. The huge installed base of stylus instruments in engineering industry was limited to the analogue estimation and display of the average roughness R_a, which was the only roughness parameter at all widely understood. National and international standards were written exclusively in terms of this and one or two other amplitude parameters such as R_t and R_z. The possibility of three-dimensional (3D) surface measurement by raster scanning had been demonstrated in academic laboratories as a painfully slow and labour-intensive process, spectacular but of little practical use for anything beyond the production of PhDs [81]. On top of all this, Prof. Whitehouse had just plunged the metrology community into disarray by demonstrating that the measured values of all roughness parameters were not intrinsic properties of a surface but artefacts of the measurement process itself [82]. Tribology, however, had recently been launched as a serious discipline, and tribologists were quickly coming to realise that to get to grips with their new subject they needed to know much more about the topography of technical surfaces [83].

Against this background Stout began his roughness researches, first of all with a tribological emphasis. At Leicester he was lucky enough to have as neighbour Rank Taylor Hobson, as it then was, at that time probably the world's leading manufacturer of surface metrology equipment and the employer of the legendary

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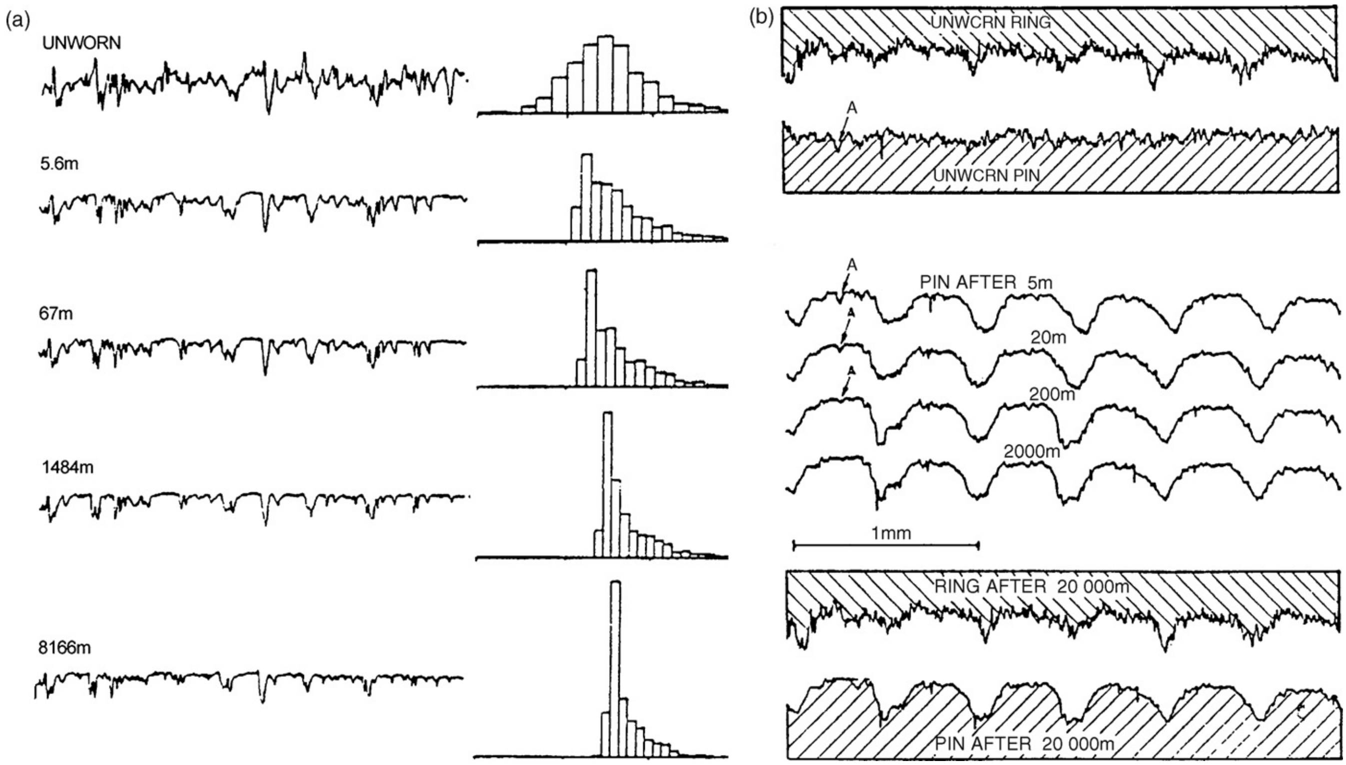

Fig. 1. Running-in experiments: (a) profiles and their height distributions from a phosphor bronze pin after lubricated sliding over various distances against a harder ring [8]. (b) Evolution of relocated profiles of pin and ring after sliding distances up to 20 km [10].

R.E. Reason and his successor David Whitehouse. In collaboration with Whitehouse and others he carried out a good deal of work on changes in surface topography during the running-in process (Fig. 1) [8,10,14,15].

His attention was particularly drawn by the current difficulties in characterising profiles of run-in surfaces, which did not seem to be represented well by the rather simple statistical descriptions then in use. He investigated the possibilities of using higher moments of the height distribution to classify worn surfaces, particularly Pearson distributions (Fig. 2).

3. Coventry 1981–1988

At the beginning of the 1980s cheap microcomputers began to be offered commercially. At first these were relatively crude and slow, with tiny memories. Users still had to write their own code, often on an individual basis, as machine-independent software packages did not yet exist. But these new microcomputers could be connected to a stylus instrument and programmed to produce statistical analysis of its output in real time. Stout soon began to explore the possibilities of the new technology, and also its limitations, continuing the work which he had begun at Leicester on the application of higher moments to the description of amplitude frequencies (Fig. 3) [30,39,40]. At the same time he was continuing to investigate tribological applications of this work, to cylinder bores [33,37,43,56] and rolling of steel sheet [45,46].

4. Birmingham 1988–1995

By the time of Stout's move to Birmingham the subject had moved on again. A number of researchers had realised the possibilities for 3D measurement offered by computer analysis of fringe patterns obtained by optical interferometry. The stringent inspection requirements of the new microcomputer component industry opened a market for such instruments and in 1986 the first commercial scanning interferometers began to become available [84]. As the newly installed Lucas Professor of Manufacturing Engineering, Stout was in an excellent position to attract substantial financial support to realise his ambition of a dedicated surface metrology laboratory. Soon the Centre for Metrology, with suites of environmentally controlled workrooms, was established and he began to furnish it with the latest measuring equipment and, more important, a dedicated team of talented young researchers, some brought with him from Coventry and some newly hired.

A serious current problem was the gap which had suddenly opened up between measurement and characterisation. Development of 3D instrumentation had far outstripped the progress of roughness characterisation. Existing roughness standards were written exclusively in terms of traditional 2D parameters derived from profiles measured by stylus instruments, and their updating was proceeding at its usual glacial pace. There was not even an academic consensus on how surfaces in three dimensions should be described; powerful methods had been developed [85] but they were controversial and in any case highly mathematical and unsuited to modifying for the shop floor. Against an industrial background where new scanning interferometers were being installed at a rate of one a week, the situation seemed likely to descend slowly into chaos.

With characteristic energy Stout threw himself into the struggle. With the help of a generous grant from the European Commission, he set his team to producing a fundamental evaluation of the 3D field which would result in a practical and workable set of parameters and a complementary set of protocols for their implementation. This included studies of parameters and their calculation and sources of uncertainty, [47,49,51,53,54,57,59,60,64], including *inter alia* an in-depth investigation of the novel problems