

until particular fundamental knowledge, for example, of the subject of microbiology, had been acquired.

It is an open question whether the agricultural industry would or could itself have established or maintained the vast amount of research which has been in progress since the nineteen-thirties on all aspects of agriculture. The author shows how the State intervened at a fairly early stage, at first almost by accident with "Whisky Money" and then more purposefully with Lloyd George's development fund. The author and evidently other directors of research were much relieved when eventually they no longer had to beg for all or for large proportions of the money they needed. Nor is there any suggestion that the use of State money has placed any restraint on the freedom of individual research workers.

If it is accepted that the justification for agricultural research, whether fundamental or applied, must be its benefit to this most basic of all industries, the book only hints at the relationship between research workers and farmers. Until the foundation of the agricultural societies from the end of the eighteenth century onwards, there seems to have been virtually no contact. Even then, husbandry was improved more by the efforts of a handful of well to do and educated landowners who had acquired an interest in new ideas than as the direct result of scientific research. The research workers of the early twentieth century were, generally speaking, men in touch with the soil, but it has taken two world wars to bring science directly to bear on the industry as a whole. Sir John Russell ends, however, with a warning against a new danger. Research is now devoted mainly to the more fundamental problems and is conducted by teams of highly trained scientists rather than agriculturalists. The State's advisory service is also a separate body. The problem is how to maintain the contact between scientist and farmer that was stimulated by the needs of war.

The book offers valuable background knowledge for administrators as well as for research workers. The last chapter, in which the author summarizes five stages of the development of agricultural research, may almost be regarded as an introduction to his main theme.

D. F. BARTON

TOOL HISTORY

Men, Machines and History

The Story of Tools and Machines in Relation to Social Progress. By S. Lilley. Pp. xiv+352+48 plates. (London: Lawrence and Wishart, 1965.) 45s. net.

THE first edition of this book was completed in 1946, though the imprint is 1948; this second edition is based on sources available up to the beginning of 1965; hence the revision and enlargement cover nearly twenty years. When it is recalled that the first nuclear power station, producing only 5,000 kW, started production near Moscow only in 1954, that the "modern" form of computer made its first fully automatic calculation in 1949, and that automated transfer lines became effective only in 1954, we do not have to consider the dubious relevance of space flight to human welfare to appreciate the great enlargement necessary to make the new edition up to date. The chapters on nuclear power, computers, automation and the conquest of space occupy nearly a hundred additional pages. There are two brief chapters on other recent developments, and a concluding chapter on the prospects for a new social structure in which the remarkable achievements of a relatively small part of the world may be extended to the whole human race. The great increase in the available evidence has compelled Dr. Lilley to omit the problem of measuring technological progress discussed in the original work.

Lilley takes the view that there have been two technological revolutions—one ending about 2500 B.C., the other

"beginning modestly in the Middle Ages and growing in speed and volume ever since". If we must have revolutions at all, this seems as good a division as any: it does at least emphasize continuity in growth and change rather than the miraculous births so beloved of less critical historians than Lilley. Lilley's temperament is also evident in the caution with which he treats documents, warning against the assumption that models and reconstructions necessarily represent accurately the original machines, which in some cases would never have worked; the same caution extends to the question of priorities and influences in respect of East and West. Though he makes no claim to completeness, the reader should get from the first part of the book a fair idea of progress from the Bronze Age to 1660, which Lilley takes as marking the beginning of the English capitalist industrial phase of history: one notable omission here is the gun-founding clock-making gold-work complex of the city of Nuremberg at the end of the fifteenth century and the beginning of the sixteenth. The review of the "Capitalist Era" up to 1945 is necessarily highly selective: I found especially interesting Lilley's conclusion (to which I had come some years ago) that the last decade of the nineteenth century saw the establishment, though not the wide diffusion, of the great majority of modern technological advances: it is only since the last war that a new momentum has been created at a level the consequences of which beggar the imagination—though not Lilley's, whose extrapolations seem rash to me.

It will be appreciated that Lilley is convinced that the historical process has reached a stage where socialistic planning alone can "give life and give it more abundantly" to the whole of mankind. Though one may not be convinced by his arguments, one must respect his fair-minded exposition: he neither shouts nor sentimentalizes. I read the book with great pleasure and no little instruction. There are forty-eight finely produced plates; but it is depressing to find that at forty-five shillings the publishers use a paper inferior to that of the edition produced in the stress of 1948.

W. P. D. WIGHTMAN

MATHEMATICS OF MECHANISM

Advanced Mechanism

By Joseph Stiles Beggs. (Macmillan Series in Mechanical Engineering.) Pp. xiv+270. (New York: The Macmillan Company; London: Collier-Macmillan, 1966.) 105s.

THE writing of a book on mechanisms presents special difficulties. At its simplest level the subject can be treated by elementary and direct methods of analysis, but a point is quickly reached beyond which it is not possible to go without heavy mathematical reinforcements. Moreover, the hierarchy of practical mechanisms is far from orderly: to set up a coherent framework thus becomes a major problem in its own right.

Confronted by these and other obstacles, Professor Beggs has added a valuable book of twelve chapters to the literature of the subject. It begins with chapters on the transformation of co-ordinates and components, displacements of rigid bodies, screw displacements, velocities and accelerations in plane and spatial motion, and contacting surfaces. This amounts to rather more than a third of the book. The treatment is highly analytic and generalized. Vectors are represented both as column matrices and also as square matrices associated with antisymmetrical tensors, although there is no explicit reference to tensors in the text. There are, however, references to dual numbers and quaternions but these seem more digressive than useful.

The next two chapters describe graphical and matrix methods of analysis and set the pattern for much of what