SHORTER COMMUNICATION

ENGINEERING FOR EVERYBODY: A REVIEW OF THE BOOKS OF PROFESSOR J.E. GORDON

by

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The Books:

"The New Science of Strong Materials: Or Why You Don't Fall Through the Floor", 1968.

"Structures: Or Why Things Don't Fall Down", 1978.

Both published by Penguin Books, Harmondsworth, England, in their Pelican Series.

The art of education lies in the ability to divert the interest and sympathy of the student onto the topics being presented. The art reaches its pinnacle when the subject matter is one for which the student instinctively feels that he has an "allergy". Whilst numeracy seems to present the greatest problem to the largest number of people, there are mental 'stumbling blocks' in all academic disciplines. It is the ability to simplify the intricacies and complexities of a subject, in order to help others over their difficulties, that distinguishes a great teacher. The subject of engineering has historically been sadly lacking in this respect, but two books by Professor J.E. Gordon go some way towards correcting this situation.

The art of simplifying a subject is to make it comprehensible to the intelligent layman, as well as to the committed student. As a result, the particularly successful 'teachers' often become household names, and hence they are able to popularise their subject. The growth of the publishing industry, and the consequent availability of relatively cheap books, has had a major influence on both education and entertainment. Most important, the popular press has been able to make academic works readily available to the general public as well as to the student. Occasionally, fashion and the timeliness of a particular work has carried it almost immediately into the public doman. Such books as "Small is Beautiful" or "The Naked Ape" for example, achieved considerable vogue, although they were not what would normally be considered subjects with popular appeal.

The advent of television has introduced a new medium for the transmission of ideas, and has produced its own 'superstars' in terms of popularists of academic subjects. For example, Jacob Bronowski made science and the 'Ascent of Man' into an intelligible and interesting adventure story. Sir Kenneth Clarke, in his uniquely civilised way, demonstrated that art reflects and is reflected by the civilisation that produces it. Patrick Moore infects millions with his unsuppressed enthusiasm for astronomy. Richard Attenborough with his calm detachment and self-effacing humour has recently made anthropology an interest of the people. Alistair Cooke makes the history of America interesting by his use of the anecdote, and John Kenneth Galbraith, by his prodigious knowledge, has convinced people of the value of economics. Each in his own way has demystified his own subject, and has taken it from the preserve of the academics and given it to the people. Each has infected his audience, in his own way, with his own fascination and enthusiasm for his subject.

Unfortunately, the whole subject of engineering has escaped the attention of the popularists. There is nothing inherently unattractive or uninteresting about the subject itself, or its products. Throughout history, people have marvelled at, and delighted in the creations of engineers, from the pyramids of ancient Egypt to the oil production platforms for the North Sea. Similarly, engineering has produced its fair share of personalities and characters, going back perhaps to Eupalinus of Megara, and the Roman, Vitruvius. Leonardo da Vinci of course was an engineer of considerable note, though he did have other interests. In more recent times it is easy to think of names like Brunel, Newcomen, Stephenson, Telford and Eiffel as engineers who were, and still are widely known throughout society. Each in his way was a brilliant practical man: an inspiration to his peers and to young prospective engineers.

Unfortunately, the interest that these men stimulated, tended to be dampened by the unimaginative approach of the educators. Engineering is almost invariably taught in the most unimaginative and crushingly boring way possible. Obviously one cannot have too much levity when lives are at stake, as they are with most engineering structures. However, the right balance between respect for the subject, the use of humour and wit in the selection of alternatives for comparison or as examples, and the occasional appropriate anecdote, can make all the difference between the student being alert or asleep.

Soil Mechanics and Structures have tended to be the two courses which loom like Scylla and Charybdis out of the mists of most engineering courses. In concentrating their efforts on dealing with one, the students often fall foul of the other. It will be of considerable relief to many to know that Professor J.E. Gordon has recently published a book that goes a long way towards de-mystifying structures. Soil Mechanics is still awaiting its popular interpreter.

Professor Gordon's approach is exemplified early in his first book, which was "The New Science of Strong Materials", and its sub-title "Why You Don't Fall Through the Floor" is indicative of what is to come. On the very first page he sets out a paragraph of 'simple' questions, the sort a child may ask, like "Why do things break?" As any experienced researcher knows, the simple question usually has the most complicated answer, because it addresses an awkward aspect of the problem. Like an infuriating child, Gordon delights in picking out the awkward question to ask, and in this book even advises others on how to find the awkward angle. However, unlike the pesky child, Gordon himself comes up with the answers. Furthermore, he joins the question to the answer with an anecdote or two, and usually with some historical background. In this way the answers do not just appear at the bottom of the page with QED after them, as they do in so many textbooks, but the reader is told why and when such a question was asked, by whom, in what circumstances, and how he went about finding his answer.

Like all the great popularisers, Gordon is a polymath. He has worked with and around almost every material there is', both practically and theoretically. His writing is full of his 'feel' for the materials. One gets the impression that while he respects iron and steel, he appreciates wood. His personal preferences seem to lie with natural materials. He cannot be accused of pantheism however, for he is prepared to admit that natural decay "... is a general objection to the use of biological materials by man, for nature's planned obsolescence may be in conflict with ours." While detailing and recording the strengths and advantages of specific materials for certain purposes, Gordon does not lose sight of their inherent deficiencies.

It is also good to see Professor Gordon emphasising the importance of good workmanship. It is rare to see this aspect of the use of materials discussed in a book on the strength of materials. Far too often, failures are blamed on deficiencies in materials, when the real cause has been poor design or shoddy workmanship. In Gordon's words, "There are always a few people for whom the most obvious sequences of technical cause and effect have no meaning. Gluing is not so much a skilled job as a responsible one and a large number of mistakes are available to a determined man, all of which have dangerous results." Whilst in this instance, it is the use of glue that is being specifically referred to, the same point could be made about most aspects of civil engineering. Where the task being performed is skilled, so the potential mistakes, and the consequences of mistakes, multiply in number and cost, and as a result the need for a responsible attitude is so much greater.

Professor Gordon ends this book by looking at new materials, and makes it clear that gains in one property are always made at the expense of another property, so that material design is a compromise between the various combinations of desirable characteristics. Clearly, if new materials or more normally new combinations of materials are to be effective, they must be designed with their function in mind. Having made this point, Gordon also criticises the poor selection of materials by engineers. Too often existing materials are used inappropriately in new functions, and too often the specification of materials for familiar functions owes more to tradition than to logic. His plea is that design should not only take account of the distinctive properties of the materials available, but also of the structural requirements of the edifice or artifact itself, bearing in mind the possible effects that time may have on the materials, and on the use that is put to the edifice or artifact. This book should be considered essential reading for any engineer, and it is an entertaining and well written book that should also appeal to the interested layman.

Exactly the same can be said for Professor Gordon's second book. Having ended his book on materials with a plea for attention to structural design, typically, he was not content to leave it there. In 1978, he published his book titled "Structures" as a companion volume to the first, and again with an indicative sub-title, "Why Things Don't Fall Down?"

Gordon immediately accepts in this book that the normal presentation of the subject is such that "... some of us are left with the conviction that the study of structures and the way in which they carry loads is incomprehensible, irrelevant and very boring indeed" - a sentiment that will strike a chord of sympathy

with many frustrated engineering students. However, the knowledge that J.E. Gordon has intervened should bring as much relief to the beleaguered student as did the arrival of the cavalry to the embattled wagon train in so many Western movies.

Throughout this book, Gordon again uses language and examples, that the layman can understand, and with which he can identify. Hence, when discussing stress concentrations caused by the subtraction or addition of material, he can compare putting a patch on an old garment with fixing a plate of armour on the side of a warship, and note that no good will come of either. In the words of Sir Robert Steppings, quoted by Gordon, "Partial strength produces general weakness."

The concept of the storage of strain energy takes on a particular vividness when it is discussed in terms of the selection of Spanish yew for longbows, and of the design of catapults. Creep becomes important when it is considered in terms of why old shoes are more comfortable than new ones, and why the ancients used to turn their chariots over at night. Gordon seems equally at home whether he is talking about sailing ships or steel mills, glass fibres or animal physiology, aeroplanes or arches, beams or bats. He boundshappily from nature to artefact and back again throughout his books. Most importantly perhaps, he shows that the engineer should try to understand how and why Nature achieves her effects, and how the engineer can learn from Nature's solutions to structural problems.

Professor Gordon again rounds off his book admirably, with three chapters on philosophy, failures, and the future, in which he presents some salutory warnings to the designer about attitudes and approaches. The book should be considered essential reading for a young engineer for these chapters alone. Not only does he provide an introduction to structural design in the early part of the book, but also he emphasises the need for care, responsibility and professionalism in the engineer in these concluding chapters. This ethical aspect of engineering is all too often overlooked in textbooks. In Professor Gordon's own words, "... very few accidents just "happen" in a morally neutral way. Nine out of ten accidents are caused, not by more or less abstract technical effects, but by old-fashioned human sin - often verging on plain wickedness... It is squalid sins like carelessness, idleness, won't-learn-and-don't-need-to-be-told, you-can't-tell-me-anything-about-my-job, pride, jealousy and greed that kill people... I very much doubt if the remedy lies in the imposition of yet more regulations. It seems to me that what is wanted is the creation

of more public awareness, and a climate of opinion which regards such "mistakes" as morally culpable." One can only wholeheartedly endorse Gordon on this. A careless attitude to responsibility is one of the most reprehensible aspects of modern engineering.

Engineers are currently much concerned about their declining status and social standing, and it is clear that much of this decline has been due to a lack of understanding of the engineer's function by the layman. The fact that there has never been a popularist of engineering capable of being interesting, knowledgeable and entertaining at the same time, has meant that engineering has not yet been 'discovered' by the media or the general public in the same way as the subjects mentioned earlier. Clearly the time for such a man is long overdue. Professor Gordon may yet turn out to be that man, but if not then he has at least shown the way by proving that materials and structures can be presented in a way that is both entertaining and educational.

Professor Gordon must also be congratulated on his selection and use of excellent diagrams and photographs in each of these books. They both illustrate and complement the text. Finally, it should be mentioned that Gordon also includes lists of further reading for those who find that their enthusiasm has been roused.