Book Reviews

Title: *Fundamentals of teaching mathematics at university level* by B.Baumslag **Reviewed by Bob Burn**
Publisher: Imperial College Press, ISBN: 1-86094-214-8, Price £35 **email: R.P.Burn@exeter.ac.uk**

With the assessment of teaching acquiring a more important role in British universities, a book with such a title should be valuable. It is however, a bit of a curate's egg.

There are valuable parts: a list of AMS, MAA and LMS videos in appendix B, and in other appendices interesting quotations and teaching maxims. There is a fine acknowledgement in chapter 6 of how reading a maths book must be done quite differently from reading most other kinds of books, and in the same chapter a recommendation that every formal definition should be accompanied by an intuitive description. Chapter 11 contains a good section on diagrams and generic examples and another on special cases and generality, with the same idea reiterated in chapter 12.

The author gives thumb-nail sketches of education in USA, England and Sweden. The information is accurate but inconsequential. He insists on the importance of organisation in chapter 8, but does not indicate the advantages or disadvantages of the organisations he describes.

There are also disappointments here. The author makes a short list of learning theories in chapter 7 and then disregards all of them. Since no one can write coherently about education without having at least a rudimentary theory about what is going on, I scrutinised the central part of the book for signs of such a theory. The result was that Baumslag seems to see the student as an apprentice. The apprentice watches the professional in action in a lecture and observes the professional product in a book, and by reflection and trial, becomes able to perform like the professional. Since this model is not articulated, its appropriateness is not considered.

Lectures are Baumslag's favoured means of teaching though he mentions a variety of other possibilities. He deplores mixed-ability classes and gives no advice on how to work with them, though this would have been easy to do using his own multi-dimensional measures of attainment (section 2.5) and a variety of problems.

There are serious shortcomings. Not just banalities such as "there is nothing more wonderful than education" (section 8.7) or "lift up your head, look at your class, speak out boldly, teach them what they need to know, watch them continually to see how they are taking it, and the rest will be added unto you" (section 11.1). But Baumslag fails to distinguish between the learning that may result from solving a problem and the learning that results from reading a solution (page 122). Baumslag "feels that there are no radical new methods of teaching as yet which will result in worthwhile improvement with a reasonable investment of time and effort" (page 49), betraying an ignorance of the Calculus Reform movement in the USA with its use of computers, and the comparable well-nigh universal revolution in the setting of computer-based statistics projects. Baumslag urges encouragement for weaker students, but does not suggest the most compelling reason for keeping in touch with them: the misconceptions that remain with students who have faithfully attended our lectures and studied our recommended texts are misconceptions that expose the weakness of our teaching, and that is why lecturers who want to teach better must maintain good contact.

The level of Baumslag's discussion is not that of a maths education treatise, but more of a "tips for teachers" handbook. If I were to make a suggestion on the level of and in the style of Baumslag it would be that departments should not make appointments without letting their students hear the applicants give a lecture. The relationship between research and teaching seems to be so haphazard that there is no other way of sensing teaching sympathies when an appointment is to be made.

I have sympathy with Baumslag's seeming devaluation of educational literature in section 7.4. Ten minutes may be enough to solve a mathematical problem or to see an illustration of an unfamiliar theorem. Ten minutes is not enough to change your teaching in a significant way. Learning more mathematics may improve your teaching but it may also lead you further from the classroom. The research which clarifies the habitual misunderstandings of students deserves our attention quite as much as does new mathematics.

Baumslag mentions Polya with respect and in a wistful epilogue. But he does not mention, even in his bibliography, the publications of Polya, which to my mind, are the most pertinent to the kind of courses Baumslag is discussing; these are Polya's two books on *Mathematics and Plausible Reasoning*. These books spell out again and again, with hundreds of examples, a theory of learning by and for university mathematicians. This theory of learning is a realistic foundation for the teaching of mathematics at university level; namely that generality and abstraction emerge from the particular and the concrete by conjecture.

Engineering Statistics 2nd Ed by D.C Montgomery, G.C Runger and N.F. Hubele
2001 John Wiley, New York. Hard-Bound, 494 p plus app ISBN 0 471 38879 3

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This is the second edition of a reduced version of a longer text (Applied Statistics and Probability for Engineers 1999) by the same authors and publishers. This cut down version is intended to avoid much of the harder statistical theory that underpins the basic concepts and thus to provide an introductory applied course devoid of most of the difficult and, from an engineering point of view, unnecessary mathematics. Examples come from a variety of engineering disciplines, although manufacturing predominates.

The book starts well with useful introductory scene setting chapters outlining firstly; the difference between statistical and 'engineering' thinking and linking this to the empirical model, and secondly; basic data presentation methods. Key points are highlighted throughout the book in special coloured boxes and these provide a focus and quick reference point for each section.

This is a saving grace for chapters 3 through 5 (half the book) because these follow basic probability theory and distributions, inference and hypothesis testing. This material can be pretty off-putting to many of the engineers that this reviewer has come across and the authors admit that this part of the book could well be applied to any subject matter were it not for the nature of the examples. These chapters are far too long for the stated purpose of the book and I am not sure, as a consequence, that the authors entirely succeed in what is a laudable attempt to make the material more engineer-friendly. This does remain, however, one of the better attempts on the market in that respect. I think the introduction to ANOVA at the end of chapter 5 could well have been left as a section in chapter 7, on the design of engineering experiments, that is itself one of the more useful and interesting chapters.

The Regression modelling in chapter 6 could also have been combined in some way with parts of chapter 7. Those students who do battle on to chapter 7 will find the introduction quite useful and stimulating and the material more to the liking of practical engineers. Chapter 8 outlines basic statistical process control and capability. The material here is mostly standard throughout but sometimes out of date. For example, when discussing the Western Electric rules for control charts there is no mention of the fact that one of these rules indicates an improving process (reduced variance) rather than one that is out of control.

Generally I think that even more use of graphics could encourage many engineers' liking for the text; there is no Half-Normal plot shown for example. As an introductory book specifically meant for engineers, the covering of Reliability in only two sparse pages in chapter 3 is a serious flaw. There is also little attempt within the book to emphasis the problems of the practical implementation of methods, an approach that a longer discussion of the six-sigma methodology (warts and all) might provide, which is a pity, because this type of discussion can help bring the subject to life. I also noticed that the index is rather incomplete and contains some errors.

Overall I think that the book, given it's target audience, would be better with a complete re-write, with reduced emphasis on standard hypothesis testing and more detail in the later chapters. Nevertheless, this is by no means the worst book of it's kind, far from it, and a useful bibliography at the end adds brief descriptions to the few texts that have been referenced during the book. It also has useful tips for the use of some statistical packages, in particular Minitab, and further information is available via a web site. For those engineers with no basic introductory statistics text, this one will provide a reasonable example, until someone writes a better one.

***Design and Analysis of Experiments 5th Ed* by Douglas C Montgomery**
2001, John Wiley, New York. Hard-Bound, 684 pp ISBN 0 471 31649 0

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This is the fifth edition of what is perhaps the most popular textbook now available on the design of experiments in the industrial setting. The writer, an engineer by background, makes the subject accessible to statisticians and non-statisticians alike with an uncomplicated style that is both accurate and easy to read. The book, as in earlier editions, relies heavily on diagrams and plots to get the major points over and appears to have improved on what were already some of the best graphics around. It also includes many worked examples from a variety of commercial and manufacturing settings. Compared to earlier editions there are more frequent and direct references to computer output, particularly from Minitab and the newer Design Expert (DE), and the book is supported by further material available on a web-site. There is also a CD/ROM version of this extra material for teachers and

a student version of DE is given with the book. Any specific failings in particular software packages are highlighted when known about.

The material has an applied leaning and concentrates on the factorial and fractional factorial approach (almost two thirds of the book covers factorials, response surfaces and their offshoots). The author relies early upon the concept of the empirical model in order to help those training as scientists to grasp the connection between statistics and it's application, an approach that this reviewer commends heartily.

ANOVA is introduced early, following a good introductory overview with practical guidelines for planning and conducting experiments and a review of the basic statistical concepts. Residual plotting and diagnostics, sometimes ignored completely in other texts, are covered early, as are non-parametric's and means comparisons. A short hop through randomised blocks and Latin squares then brings up the meat of the book.

Compared to earlier editions, the author has expanded the sections on random factors and nested and split-plot designs. This is probably the clearest text on the application of these erstwhile daunting but vital topics now available. Some more advanced areas, such as Generalised Linear Models are also covered briefly in the last chapter. In addition, we find updated text on topics such as the centre-faced central composite design, a design that was criticised in earlier editions, guidelines for the practical use of the centre point in factorials and the use of the minimum number of extra runs to untangle confounded effects. Some of this is quite bold and shows that the author has embellished the text with the benefit of his practical experience gained over time. Neither is he afraid to criticise when appropriate, such as in the use of Optimal Design or of 'Taguchi' methods.

All through the book comparisons of different techniques are shown, often with discussion, and several very recent discoveries are given, such as Soren Bisgaard's 'conditional inference chart' used for establishing the potential significance of factors in sparse designs. The text refers to many of the latest research papers in later chapters and the reference section provides not only a who's who of the industrial experiments' world but an up to date review of sources in many of the more state-of-the-art topics.

It is suggested that the text would be suitable for use as an introductory course in designed experiments for pretty well any group of engineering or science undergraduates. While correct I think this is underselling and the material would provide the basis for most industrial design of experiment courses, not just introductory ones, and should grace the workshops and libraries of any would-be World-Class manufacturer. No applied statistics degree should be taught without at least a reference to it, and an experimental design course, of any level, without it would be like viewing an emperor without his clothes on.

MATLAB Guide by Desmond J Higham & Nicholas J Higham

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This well-written and well-presented text allows the reader to appreciate the power and versatility of MATLAB. The authors' knowledge of, and affection for the package ensure that the text has a flowing and extremely readable style. The book covers a plethora of topics which are presented in a logical order (starting with a tutorial which a novice is encouraged to work through). This all enables the book to be used as a course text, but it can equally be used as a reference book for an experienced MATLAB user. The level of Mathematics used within the Chapters probably precludes its use for first year courses in Mathematics and Engineering; although it provides an excellent introduction to these topics within the context of MATLAB. The availability of the examples files on the SIAM website are a tremendous help (http://www.siam.org/ot75).

The overall structure of the text is: an initial tutorial, followed by a few chapters which allow a novice to come to grips with the way in which MATLAB 'works' namely its use of arithmetic, matrices and flow control. This phase of the text concludes with a discussion on the construction of user-defined functions and graphics. The text then moves on to discuss a variety of topics interspersed with further details of how MATLAB works, the first of these topics is naturally Linear Algebra followed by others on Numerical Methods. Other facets of MATLAB are discussed for instance the use of the symbolic toolbox.

In summary this is not a text which will fester on a bookshelf after its recommendation as an undergraduate text, but one which will remain within reach for repeated referencing.