Book Reviews

Title: Handbook of mathematical discourse, 2002
Author: Charles Wells,
http://www.cwru.edu/artsci/math/wells/home.html

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The Handbook "is a compilation of mathematical usage with a focus on usage that causes problems for students. It also contains words describing behaviors and attitudes that students and instructors might have." Many who (like this reviewer) have pondered such things in a superficial way for many years will turn to it in the hope of finding an analysis on a deeper level - for the theme should be of concern to all who teach mathematics.

However, as the quotation above already indicates, the current version combines a number of distinct aims which are not obviously compatible. In addition to the two aims mentioned in the opening sentence above, the author has sought to include - in dictionary format - definitions of numerous words and terms which cause students no problems at all, and whose inclusion often sheds little light on the question of how language is used in undergraduate mathematics. These examples contribute little to the question of identifying and resolving problems, and yet tend to overwhelm those instances which are genuinely problematic (and which warrant a more profound analysis). Moreover the whole collection is presented in a "semi-scholarly" format, which may have been intended to make the Handbook more respectable, but which seems likely to make it less useful.

The Handbook is structured like a dictionary - so cannot really be "read". Rather it should be perused - and then used to look up collections of related terms as and when one recognises the need to mull them over - related terms being cross-referenced in ways that make this relatively easy. However, the user should not expect too much! It is not easy to give examples which are entirely fair, so I would urge the interested reader to consult the given website for a more balanced impression.

The Handbook is a pioneering work, and is to be welcomed. For example, I can envisage it serving as a useful focus for a subject-focused seminar on "the use of language in undergraduate mathematics teaching". But it is a daunting collection, and many of the entries need further work (which is why its electronic format is to be welcomed).

My own view is that the present Handbook would be more useful if split into three separate parts: one part focusing on technical language which causes genuine problems, with an honest discussion of ways such problems can be confronted or avoided; a second (probably less useful, but clearly valued by the author) part dealing with student attitudes and features of the sociology of any body of knowledge; and a third part in the form of a lexicography of standard mathematical language.

I give two examples of each of the first two kinds of entry - each of which misses a valuable opportunity:

(1) **assume**: See "let".
suppose: Discussed under "let".

The discussion under "let" then focuses mainly on "let", and fails to do justice to the important psychological distinction between "assume" and "suppose", or to indicate the desirability of systematic usage to respect this distinction.

(2) **contain**: If A and B are sets, the "assertion" A contains B can mean one of two things: (a) B is a subset of A. (b) B is an element of A. [...] it appears to me that "contain" is used far more often to mean "include".

Again the opportunity is missed to stress that such (very common, but confusing) use of the expression "is contained in" makes it harder for students to distinguish between "is an element of" and "is a subset of".

(3) **algorithm addiction**: Many students have the attitude that a problem must be solved or a proof constructed by a "algorithm". They become quite uncomfortable when faced with problem solutions that involve "guessing" or "conceptual" proofs that involve little or no calculation. [...]

The phenomenon may be very real - but the label "algorithm addiction" would seem to get in the way of an appropriate analysis.

(4) **convention**: a convention in "mathematical discourse" is "notation" or terminology used with a special meaning in certain contexts or in certain fields. [...] Any given culture has some customs and taboos that almost noone inside the culture is aware of, others that only some who are particularly sensitive to such issues (or who have travelled a lot) are aware of, and still others that everyone is aware of because it is regarded as a mark of their subculture. [...]. One aspect of this Handbook is an attempt to uncover features of the way mathematicians talk that mathematicians are not generally aware of.

The current sociological/constructivist literature on the mathematical community reveals the dangers of a self-appointed group of "particularly sensitive" commentators! Nevertheless, the general aim here is laudable, and the willingness to attempt this daunting task is admirable.

And with luck, ongoing inputs from the mathematical community will ensure that the Handbook evolves into something significant. Fortunately, the hard work already put in by the author and the electronic format mean that this is a real possibility.

Title: *Calculus: Multivariable* (Second Edition)
Authors: R T Smith and R B Minton
McGraw-Hill 2002, ISBN 0-07-112270-2

Reviewed by: David Griffel
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The book starts with Chapter 10. This makes sense when you realise that the text is just a reprint of the last five chapters of the authors' book *Calculus*. This is one of many calculus texts from the USA, all with essentially the same syllabus; the multivariable part has chapters on vectors, curves, partial differentiation, multiple integrals, and vector fields. As usual there is a web site with a great deal of additional material.

The treatment of the subject is pretty well standard. The most problematic section is on vectors, a particularly subtle topic. Smith & Minton say that a vector is something with magnitude and direction. This is not quite correct because (a) some things with magnitude and direction don't add by the triangle law and therefore aren't vectors, and (b) the zero vector does not have a direction. Again, they define a "position vector" as a vector drawn with its tail at the origin. This seems to contradict the idea that a vector has no location. The usual definition says: given a point P and an origin O, the position vector of P with respect to O is the vector $\underline{OP}$. This seems clearer, and more useful in applying vectors to geometry.

However, these defects are easily corrected by a lecturer, and in most respects the text is sound. Each chapter is introduced by a page or so about a potential application. For example, the chapter on vector-valued functions is introduced by a photograph of US Navy fighter aircraft, with a description of the difficult tasks faced by a fighter pilot and the need to think about trajectories. But those who are not enamoured of military hardware need not worry: fighter planes do not appear at all in the rest of the chapter. Similarly for the applications at the beginning of other chapters.

There are many well-thought multicoloured diagrams. The layout in general is colourful, with different coloured shaded boxes for definitions, theorems, examples and so on. To my eyes it looks fussy, and it is sometimes hard to pick out the main thread of the mathematical argument between all the boxes; but others might describe the layout as lively and attractive.

The authors take a lot of trouble to explain things geometrically. They write in a conversational style, particularly in the many worked examples, and explain the ideas in very great detail. A student working through it carefully and patiently should get a good feeling for three-dimensional space and the functions that inhabit it, and should learn how to set about solving problems in this subject. It would be less suitable for students who want a clear and concise view of the subject and do not need so many worked examples or lengthy discussions.

At the time of writing, Smith & Minton's *Calculus* is listed on amazon.co.uk at £100.99. The publishers tell me that this is incorrect.

Title: Advanced Engineering Mathematics
Author: Robert J Lopez
Ed: Addison Wesley Longman Limited

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This book deals with engineering mathematics at a good second year undergraduate level and above. Its coverage is similar to [1] and [2], but may not be in the traditional order. It contains nine units: Ordinary Differential Equations - Part one, Infinite Series, Ordinary Differential Equations - Part two, Vector Calculus, Boundary Value Problems for PDE's, Matrix Algebra, Complex Variables, Numerical Methods and Calculus of Variations. The book is rather bulky nearly (1400 pages) but this is in line with the size of comparable texts.

The book originates from a longstanding effort in providing Maple worksheets to study the traditional contents. It comes with a CD containing 273 Maple worksheets which mirror the sections in the book. The text fields in these worksheets are essentially the same, but the interspersed Maple commands allow the students

to perform calculations or generate graphics. In some cases, ie the numerical methods sections, the Maple worksheet allows for a fuller discussion of the derivation of a method, which would have been a rather tedious exercise if reported in the traditional textbook way.

The use of CAS in the accompanying worksheets allows Lopez to discuss materials in a non-traditional order, e.g. a full discussion on Matrix Algebra follows well behind chapters on ODE's that use models of a vector-matrix structure. Students have to treat such calculations in a "black box" approach, but this should be compensated by the advantage of being able to treat related topics together.

The textbook can be used independently from the Maple worksheets. Methods are often introduced in an ad hoc way, while sketching the bigger picture, to be formalised later. There are plenty of motivation, examples and applications throughout the book.

In summary, this book offers the opportunity to use the accompanying Maple worksheets to get the student actively engaged in the mathematics presented and also provides a topical introduction into the use of Maple to do mathematics. I certainly would cherish a copy on my shelf, but the contents covered may put it outside the scope of materials offered to most second year UK engineering students (like [1] and [2]). It should be a must for any engineering student who's interested in more mathematical background than offered in the standard curriculum.

This review benefited from discussions with Dr Grant Keady, who also wrote a review which can be found as a .dvi file at [3]. More information and many of the accompanying materials can also be found at [4].

References:

[1] E Kreyszig, *Advanced Engineering Mathematics*, Wiley, 8th ed., 2001
[2] P V O'Neil, *Advanced Engineering Mathematics*, Brooks/Cole, 4th ed., 1995
[3] http://www.maths.uwa.edu.au/~keady/papers.html
[4] http://www.aw.com/lopez

Title: Elementary Linear Algebra: Applications Version **Reviewed by: Grant Keady**
Authors: H Anton and C Rorres **keady@maths.uwa.edu.au**
2000, Wiley: 8th edition, ISBN 0-471-17052-6 and its electronic accompaniments.

This is a well-known book - over 800 pages long. It is basically Anton's *Elementary Linear Algebra* with an additional chapter at the end on "Applications". The first edition of Anton's book appeared in 1973. It is clearly an indication in the book's favour that it continues in widespread use after 30 years. The question then arises as to what we get for the subsequent editions. One expects second editions to remove all the errors that might have been in the first, but what about editions later than this, and, in particular, what is the point of an 8th edition?

It was suggested that I might write this review because it was pointed out that the Preface said:

> *"This edition is a refinement of the earlier editions ... accommodate the needs of a new generation of students. ...*
> *Addition of Technology Exercises: A set of technology exercises has been placed at the ends of the chapters. ... The exercises are written in a generic, syntax-free form with the understanding that the student's own documentation will be the resource for specific commands and procedures. To relieve the students of the burden of data entry, data for the technology exercises are provided in Matlab, Maple and Mathematica formats. These data can be downloaded from www.wiley.com/college/anton ..."*

In the early 1990s, for my 2nd year engineering maths class - then using Maple, and then using Anton's book - I was faced with the problem of integrating the different strands of the teaching. I wrote an accompaniment to Anton's text illustrating the use of Maple. The examples in the accompaniment were, wherever possible, harmonised with those in the book. My accompaniment's distribution (1993-98) via the Maple Share library was approved by the publisher (as was its withdrawal in 1998). Of course, I remain interested in "technology" developments associated with this text (even though its use with my home university's first years has been superceded - for reasons of cost - by locally produced printed notes).

The Anton 8th-edition book has a publication date of 2000, so an inspection of the associated web site in April 2002 is not unfair. I am disappointed with how little there is at the Anton Web site. In particular, at present it is restricted, despite the claim in the preface, just to Matlab (or Octave which would work equally well). There are no large matrices there associated with "real applications", and it is hard to see that the students gain that much from saving the typing of the small matrices there, often 2 by 2. It is usually less effort to enter the matrices directly than to run the m script.

I am not impressed with the "Technology Exercises" for the first 10 Chapters. However in the final "Applications" Chapter they are a bit better. However, my belief is that the support can be much better by providing code that performs worthwhile, illustrative tasks. Students can learn, for example, by combinations of Maple's linear algebra and geometry packages - graphics - but need not code these things up themselves.

Wiley have produced better with accompaniments to other texts. For example, the books by Coombes et al on "Differential Equations with ..." various packages (Matlab, Maple, Mathematica) are acceptable accompaniments to Boyce and DiPrima's Differential Equations book published by Wiley. Extensive typing of code can be avoided by downloads. It would probably be better for such accompaniments - and similar materials which will eventually be distributed for Anton Linear Algebra - to be distributed electronically.

A quick look at www.mapleapps.com indicates that the production of materials supporting texts continues. However, there seem to be no recent Maple materials for Anton's Linear Algebra. At mapleapps one finds "a complete set of Maple lessons for an undergraduate course in Linear Algebra. These 30 lessons were developed by M May and R Blyth. Their worksheets follow the material in the text by R Penney, published by Wiley.

Part of the case for mass-market texts is the provision of support materials. It is also worth covering more than one package - Maple, Matlab and Mathematica - using separate well-written accompaniments. My judgement is that the 8th edition of Anton and Rorres does not yet live up to the promise in its Preface on this. Perhaps the items similar to those on the CD by Herman et al. are appropriate for some future accompaniment. I hope that the offerings at the Web site will improve in time. Publishers are likely to notice reviews - perhaps even this one.

References

[1] R Penney, *Linear Algebra, Ideas and Applications*, Wiley, 1997: ISBN 0-471-18179-X

[2] E A Herman, M D Pepe, R T Moore, J R King, *Linear Algebra: Modules for Interactive Learning Using Maple 6: Linear Algebra Modules Project (LAMP)*. w/CD-ROM, 496 pp, Addison Wesley, 2000: ISBN 0-201-44135-7

[3] K R Coombes, B R Hunt, R L Lipsman, J E Osborn, G J Stuck, *Differential Equations with MATLAB*, Wiley, 1998: ISBN 0-471-32602-X, and there are similar titles for Maple and for Mathematica

Monthly series on Computer-Aided Assessment in Mathematics http://ltsn.mathstore.ac.uk/articles/maths-caa-series

Computer-Aided Assessment (CAA) is likely to become an important form of testing in the next decade, and we have initiated a series of monthly articles on CAA in mathematics. Please read the articles as they appear and send your comments to the discussion list maths-caa@jiscmail.ac.uk. Below are summaries of some recent contributions. You are invited to suggest articles for this series by contacting the series editor Cliff Beevers, email c.e.beevers@hw.ac.uk

July 2002: Computer-Aided Assessment in Statistics at Heriot-Watt University

A version of this article was first published in the May issue of *MSOR Connections* and describes the practice of delivering tests over the web for a range of Service Statistics courses at Heriot-Watt University in Edinburgh. Mention is also made of the on-line learning materials for Statistics being created as part of the SCHOLAR Project. SCHOLAR is delivering on-line resources to over 90% of Scottish secondary schools next year.

June 2002: Evolution of a computer aided assessment strategy for statistics service teaching

This article describes the use of CAA in a statistics service course, and its gradual evolution over 4 years, from a basic but surprisingly encouraging start, to a more sophisticated system which now faces the imminent challenge of accessibility issues.

May 2002: Encouraging higher level mathematical learning by creative use of emerging CAA

This article defines "higher level mathematical skills" and details an important class: that of creating instances of mathematical objects satisfying certain properties. Comment is made on the frequency of higher level tasks in undergraduate work. We explain how such questions may be assessed in practice without the imposition on staff of an onerous marking load. Included are working examples which have been implemented on a free computer aided assessment system with some source code. Lastly we report an investigation of students' reactions to these questions and discuss their design and impact.