Preface

It is now three years since the first edition of this book was published in 2009. Moreover, I have recently given the lectures on which it is based twice more as part of the Continuing Education program of Oxford University in England. Experience of doing this gave me valuable feedback and suggested a little more material which could be added and so I was delighted when Springer asked me to prepare a second edition. Second editions are also an opportunity to remove blunders in the first edition (and hopefully not add too many more). Also, I am told that this new edition will be produced using print-on-demand technology and so can remain in print for evermore!

The first edition was based on lectures given several times at Reading University in England. One might wonder why I gave these lectures. I had been attending a few lectures on diverse subjects such as Music, Latin and Greek and my wife suggested that perhaps I should give some lectures myself. I was somewhat taken aback by this but then realised that I did have some useful material lying around that would make a starting point.

When I was a boy (some time ago) I much enjoyed reading books such as *Mathematical Snapshots* by Steinhaus and *Mathematical Recreations and Essays* by Rouse Ball. Moreover, I had made a few models such as the minimal set of squares that fit together to make a rectangle, some sets of Chinese Rings, and the MacMahon coloured cubes. This starting point was much enhanced by some models that my daughter Janet had made when at school. A junior class had been instructed to make some models for an open day but had made a mess instead. Janet (then in the sixth form) was asked to save the day. Thus I also had available models of many regular figures including the Poinsot-Kepler figures and the compound of five tetrahedra and that of five cubes.

Having written a few technical books on programming languages, it seemed a natural step to prepare colourful notes for the course in the form of what might be chapters of a book. It took longer than I thought to finally turn the notes into a book – partly because I was diverted into writing a number of other books on programming in the meantime. But at last the job was done. So that is the background to the first edition.

There are ten basic lectures. We start with the Golden Number which leads naturally to considering regular Shapes and Solids in two and three dimensions and then a foray into the Fourth Dimension. A little amusement with Projective Geometry follows (a necessity in my youth for those going to university) and then a dabble in Topology. A messy experience with soap Bubbles stimulated by Boys' little book is next. We then look at circles and spheres (the Harmony of the Spheres) and especially Steiner's porism and Soddy's hexlet, which provide opportunities for pretty diagrams. Next is a look at some aspects of Chaos and

Fractals. We then with some trepidation look at Relativity – special relativity can be appreciated relatively easily (groan – sorry about the pun) but general relativity is a bit tricky. The Finale then picks up a few loose ends.

Additional material on topics such as stereo images, further aspects of the fourth dimension, Schlegel diagrams and crystals has been gathered into a number of appendices. The main lectures contain some exercises (harder ones are marked with asterisks) but answers are not provided since I anticipate giving the course again.

The main changes in this second edition are that more material has been added on the golden number, shapes and solids, topology, chaos, and crystals. Also the colours of some diagrams, particularly those in stereo, have been changed to give a crisper effect. In particular, the appendix on crystals has been considerably extended to give a better treatment of (including better stereo images of) the structure of diamonds, graphite and a number of siliceous minerals such as quartz that exhibit intriguing geometrical properties.

An important question is to consider who might want to read this book. The mathematical background required is not hard (a bit of simple algebra, Pythagoras, a touch of trigonometry) and is the sort of stuff anyone who studied a science based subject to the age of 16 or so would have encountered. One obvious group therefore is young people with a zest for knowledge with beauty (I would have loved to have been given such a book when I was 16). Another group as evidenced by students on courses is those of maturer years who might like to know more about topics that they enjoyed when young.

I find that students on the courses are from varied backgrounds – of both sexes and all ages. Some have little technical background at all but revel in activities such as making models, cutting up Möbius strips and blowing bubbles; others have serious scientific experience and enjoy perhaps a nostalgic trip visiting some familiar topics and meeting fresh ones.

I have made no attempt to avoid using mathematical notation wherever it is appropriate. I have some objection to popular mathematical books that strive to avoid mathematics because some publisher once said that every time an equation is added, the sales divide by two. But I have aimed to provide lots of illustrations to enliven the text.

I must now thank all those who have helped me in this task. First, a big thank you to my wife, Bobby, who suggested giving the courses, helped with typesetting and took some of the photographs, and to my daughter Janet who provided much background material. Thanks also to David Shorter who took some other photographs; and to Frank Bott who translated parts of an ancient book in Italian; also to Brian Wichmann who gave good advice on generating some diagrams; and to Pascal Leroy who was a great help in finding a number of errors and suggesting many improvements.

I must especially pay tribute to the late John Dawes whom I knew when we were both undergraduates at Trinity in Cambridge – John worked with me in the software industry and provided the inspiration for some of the exercises. One episode is worth mentioning. We encountered the problem of proving that if one

puts squares on the sides of any quadrilateral then the lines joining the centres of opposite squares are always the same length and at right angles. I challenged the team working on a large compiler project to find a slick proof. John came up with the proof using complex numbers described in the Finale.

I am grateful to the authors of the many books that I have read and enjoyed and which have been a real stimulus to understanding. I cannot mention them all here but I must mention a few. The oldest is probably *Flatland* by Edwin Abbott, a marvellous tale written over a century ago about adventures into many dimensions. And then from the same era there is *Soap Bubbles* by Boys with its elegant diagrams – it seems that he entertained Victorian dinner parties with his demonstrations. The various books by Coxeter such as *Introduction to Geometry* and *Regular Polytopes* are fascinating. Three other books I must mention. One is *Excursions in Geometry* by C Stanley Ogilvy which introduced me to Soddy's amazing hexlet; another is *Stamping Through Mathematics* by Robin Wilson which explores the world of mathematics via illustrations on postage stamps; the third is the *Emporer's New Mind* by Roger Penrose with its material on curious topics such as aperiodic tilings and pentagonal crystals.

In a nostalgic mood, I must thank those who taught me about the wonders of mathematics at school and at Cambridge. At school (Latymer Upper in West London), we were privileged to learn from brilliant teachers such as Bob Whittaker. I recall sixth form lessons in the basement of a local milkbar where we could contemplate projective geometry. At Cambridge, I especially enjoyed lectures by Fred Hoyle on relativity and Paul Dirac on quantum mechanics. I was also privileged to enjoy wonderful supervisions from John Polkinghorne who also very kindly reviewed part of the first edition of this book.

For the second edition, I must especially thank Pascal Leroy for a suggestion regarding dipoles and Roger Penrose for help in developing a brief description of aperiodic pentagonal tilings and suggesting a number of improvements to the discussion on semi-regular figures.

Finally, I must continue to thank my friends Karen Mosman, Sally Mortimore, and Simone Taylor who encouraged me to persevere with progressing the original book to publication and, most important of all, Martin Peters, Ruth Allewelt and Angela Schulze-Thomin at Springer-Verlag and Sorina Moosdorf at le-tex who make it actually happen.

I hope that all those who read or browse through this book will find something to enjoy. I enjoyed writing it and learnt a lot in the process.

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