

Preface

These notes constitute an introduction to both elementary geometry and elementary computer graphics. They introduce the graphics programming language PostScript as a tool for understanding geometry, and introduce (or reintroduce) geometry as a tool to produce interesting computer graphics.

They are aimed at several audiences. On the one hand, they make up the latest version of notes that have been distributed for several years to students in a third year university course on elementary geometry. Many of the students in this course were Computer Science majors, often simultaneously taking a professional course in computer graphics. For them this course was an opportunity to see the mathematics underlying much of what they passed over rather rapidly in other courses. Many of the remainder were majors in Mathematics whose long range intention was to teach in secondary school. For them the course was an opportunity to learn how the use of computers could explain mathematical principles in new ways, and also how the pleasures of doing even simple computer graphics could motivate much of the mathematics they had only learned in an abstract way before.

But these notes should also be suitable for introducing useful graphics tools to a large number of practicing scientists who can use them to enhance their professional work.

What they require as prerequisites are small amounts of linear algebra and calculus—so small, in fact, that a well motivated secondary school student might profitably read them.

Of course, it would be impossible to expect all parts of these notes to be equally interesting to all these groups. With that in mind, I have tried to make it possible to skim quickly over any part of the notes already known. The text itself includes fragments of PostScript one can perhaps use immediately in one's own tool box. More elaborate reusable procedures are available through the Internet.

The geometrical topics covered are mostly elaborations of secondary school geometry and trigonometry, although this does not mean that the mathematical problems encountered are trivial for all readers. We shall see, sooner or later, Pythagoras' theorem, vector dot-products, linear and affine transformations in two and three dimensions, Bezier curves, perspective, regular solids, and spherical geometry.

There are several reasons why I am using PostScript rather than some more capable language such as C or Java. The main one is that PostScript is designed from the start as a graphics language, and even someone who has never done any previous programming can usually produce interesting and rewarding pictures after a few sessions of work. The main point of mixing geometry and graphics programming on one course is that PostScript is a well designed programming language that forces one to think carefully about aspects of geometry that might otherwise seem pointless. In my experience, the reaction among students to this hybrid course is on the whole extremely favourable, although even now there are every year at least a few students who find the course and these notes extremely heavy going. At the other end of the spectrum are a larger group who tell me that this was by far the most interesting mathematics course they have ever taken.

I might mention to those instructors who are contemplating using it as I do, as the basis for a course with wide appeal, that such a course inevitably requires, at least at the beginning, an enormous amount of time and patience—with both machines and students! Anyone who uses computers for course work learns quickly that in spite of a vast amount of work, they are not always dependable, and their use often non-intuitive. It has always been a source of relief and amazement to me that most students are already familiar with this basic truth, and have acquired an almost inexhaustible patience in dealing with them.

The standard reference for PostScript is the *PostScript Language Tutorial and Cookbook* (usually called simply the *blue book* to distinguish it from the red and green ones) published by Addison-Wesley. It is an excellent book, and you may find it useful, but you shouldn't need it. As a basic technical reference to PostScript, I find the *red book*—the *PostScript Reference Manual*, in either of two editions—very useful. There is also a huge amount help with various aspects of PostScript available on the Internet. Sites I find especially valuable are these: