Chapter 1

Introducing ACG

1.1 Introduction

This unit has the title "Advanced Computer Graphics".

There is programming involved: 25% of the unit marks go on an assignment, the rest on the written exam.

What is this unit about? At the simplest level, graphics is about drawing pictures and computer graphics is drawing pictures with the aid of a computer. It therefore includes simple pattern-generating programmes but it also includes sophisticated CAD packages, rendering scenes for movies, computer animation etc. In general we distinguish between modelling - creating a mathematical/programmed representation of an item, often in the form of a data structure; and rendering - converting the data struture into a picture. Here are some application areas.

Science and Engineering

- Computer Aided Design (CAD), e.g., architecture. Model it before you build it for real!
- User interfaces. You can tell a good interface by the fact that you don't notice it. A bad UI interferes with your work. It requires an understanding of human psychology to do this properly.
- Visualisation. Chemists like to see molecules. Medics like to see scans, perhaps in 3D; or to simulate surgery. Weather people like to see evolving weather patterns.
- Simulation. Military battlefields. Aviation training.

Graphics is a key technology for "serious" virtual reality, itself being driven by games.

Entertainment

- Games. The market is now huge, bigger than Hollywood. Games need models that look OK and are fast to display; scientific applications need things that are "physically correct".
- Films. Many big films use CG FX, both realistic (Titanic) and non-realistic (Toy Story). Graphics and image processing can also be used during post-production, to fix problems with the live action film.

The eye is a high bandwidth connection to the brain. Most graphics systems require huge amounts of data to be shifted about very quickly. There is a high performance requirement: (a) real time generation of images for applications such as games and visual simulators, in contrast to (b) non-real time (e.g., frames in a film).

Thus need to think about clever software to do this. Alternatively, and becoming a popular choice, is to use clever hardware (e.g., graphics cards and physics cards in PCs).

Also it turns out that a little knowledge of human perception helps a great deal in designing these things. Facts about how the eye and brain work (human physiology), optical illusions, colours, shades.

Much of the above requires large computer models, in particular virtual reality. There are several things we might need to model:

- Geometry of objects. For example, spheres, cubes, chairs, tables.
- Properties of objects. Colour, reflectivity, scattering (fog)
- Movement of objects. Newtonian physics. Internal motion, e.g., jelly, cloth.

In principle we can use the laws of physics to model the world: in practice we often have to approximate.

1.1.1 Book

There is no required text for this unit, the lecture notes are the source text.

If you wish to read further or seek clarification, the "Introduction to Computer Graphics," by Foley, van Dam, Feiner, Hughes, Phillips (Addison Wesley) is as good a general book as you are likely to find. This is a subset of a much bigger book with similar authors, reduced to the material most relevant to teaching the subject. I also like "Three-dimensional computer graphics" by Alan Watt (Addison Wesley).

There are many other books on graphics. Avoid the ones specialised to a particular package or to a specialised area such as web graphics.