Early users, such as the author, considered hundred elements as a boon. A decade later, third generation computers enabled analysts to routinely use thousands of elements. By the seventies, the capacity and speed had increased ten times further. Nothing seemed to be beyond the reach of finite element analysis. In his paper (Ref. 1.16) written in 1983, the author has mentioned his work on a nuclear reactor (Fig. 1.1 a,b,c) and a tooth (Fig. 1.1d, Ref. 1.27)!

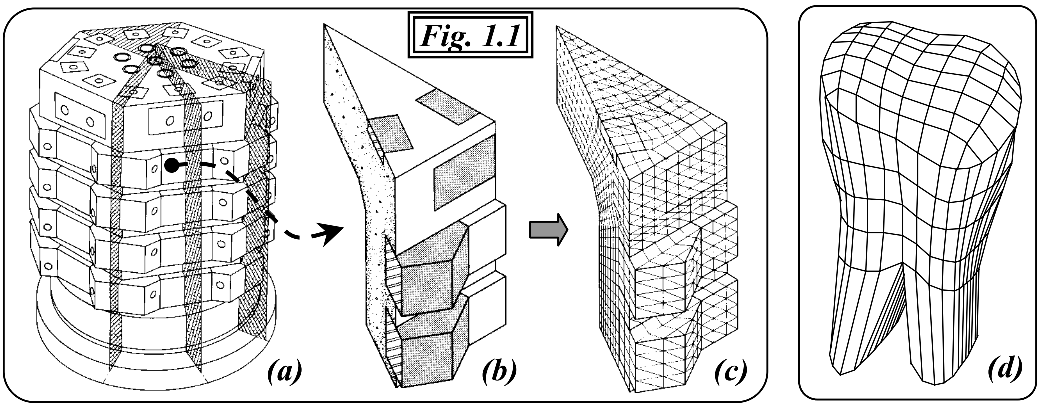

Fig. 1.1

Now, the computer packages which once demanded a mainframe have come to the desk top, and are loaded with graphics user interfaces, and interactive, on-line modelling and solution.

It was just a small imaginative step to extend the applications beyond linear structural analysis, to non-linear and plastic behaviour, to fluids and gases, to dynamics and stability, to thermal and other field problems, because all of them involved the same kind of differential equations, differing only in the parameters and properties, while the overall formulation, assembly, and solution techniques remained the same.

The references of historical importance, given at the end of the chapter, are merely representative, and often only the earliest in a series of many publications on a topic by the same or other authors. More detailed coverage of the history and further references may be found in the works by Cook, Desai, Gallagher, Huebner, Oden, Przemieniecki, and Zienkiewicz. The reader is referred to these latter references for additional information on any of the topics discussed by the author in further chapters.

Today, there is almost no field of engineering, no subject where any aspect of mechanics is involved, in which the finite element method has not made and is not continuing to make significant contributions to knowledge, leading to unprecedented advances in the state of the art and its ultimate usefulness to mankind.

1.2 DEFINITIONS AND TERMINOLOGY

The basic procedure for matrix analysis depended on the determination of relationships between the "Actions", namely forces, moments, torques, etc. acting on the body, and the corresponding "Displacements", namely deflections, rotations, twists, etc. of the body. A "structure" is conventionally taken to consist of an assembly of straight "members" (as in trusses, frames, etc.) or curved lines whose shape can be mathematically evaluated, which are connected, supported, and loaded at their ends, called "joints". Figure 1.2(a) shows a two-storey structure consisting of frames in the vertical plane, grids in the horizontal plane, and trusses for the entrance canopy.