CHAPTER 1

INTRODUCTION

1.1 ELECTRONIC PRODUCTS, TECHNOLOGIES AND PACKAGING

The demands on electronic products vary enormously, depending on their use and their market. Some examples can be given:

- Satellite electronics: One unit, required mean time to failure 10 - 20 years, extreme demands on performance, reliability, low weight, small volume and low power consumption. Repair impossible, very high development- and production cost is acceptable.
- Military electronics: Must tolerate very harsh environments and rough handling. High reliability.
- Computer and telecommunication electronics: Wide range of demands, depending on the products. Maximum performance, short market window, i.e. the marketing and production must start at the right time, delays are very costly.
- Low end consumer electronics, like pocket calculators and watches: Very large market volume, extreme price pressure, low weight and power consumption. Lifetime: A few years. Replace, not repair.

These differences will be reflected in the technology used for the products, how they are designed and produced.

The main technologies used for electronic systems will be described in this course. Each has preferred types of applications, where it is the optimal choice.

Previously the properties of an electronic product were determined by its components, and the interconnection of the components was simple. Today the technology and materials chosen for interconnecting the integrated circuits and passive components may be the critical factor for the performance in a system, as well as for the price, reliability, etc.

"Electronic packaging" is a term describing the physical realisation of the electronic system. It implies the choice of technology and production method. The "packaging technology" starts where circuit design ends, with the circuit diagram. The designers responsible for the packaging will convert the circuit diagram into a physical product that works, can be produced at an acceptable cost, is testable - and repairable if desired - satisfies reliability requirements, etc.

Packaging requires knowledge of many disciplines: electronics, mechanical properties such as strength and thermal behaviour, material properties and - compatibility, chemistry, metallurgy (soldering, corrosion, etc.) production technology, reliability, etc. An understanding of the interplay between the disciplines and properties is most important.

1.2 PHASES IN THE DEVELOPMENT OF A PRODUCT

When a product is being developed the work is divided into different phases. This is to get a systematic process where results can be described and decisions can be made at defined points in time. An example, for large systems, is given in Figure 1.1.

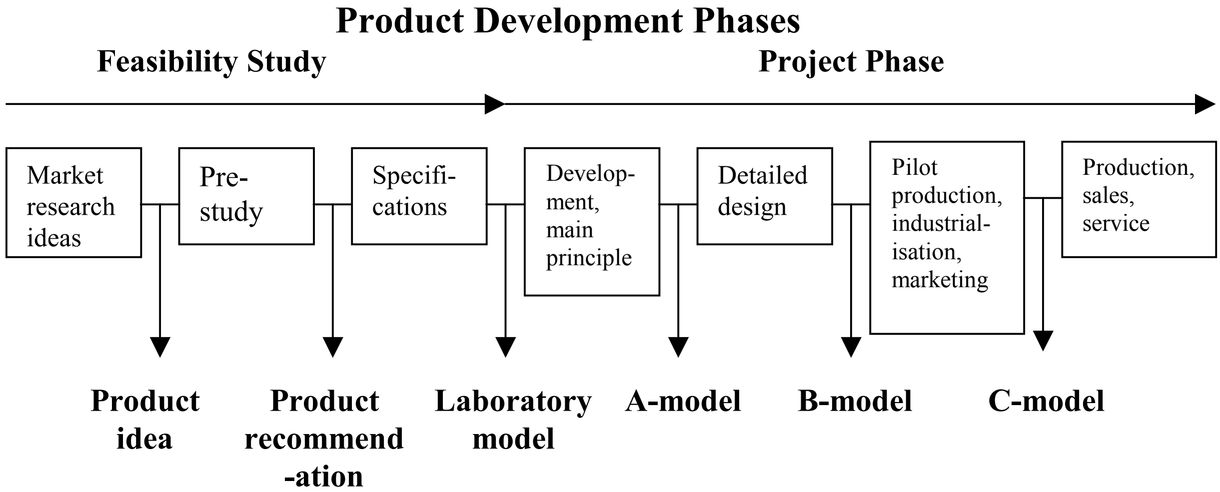

Fig. 1.1: Phases in the development of electronic systems.

The development starts with market investigations, and a description of what properties and specifications the market needs. This is coupled to our own ideas for the new product. The ideas are refined and made concrete during several rounds of studies and evaluation. Then the implementation starts. The main specifications and the main functional blocks are defined, and simulations are performed. Critical parts and details are made in hardware. Several generations of lab models and prototypes are made, evaluated and modified. At each stage the model is made more like the production version. At each stage a new decision is made: Do we still believe there is a market for the product, with the performance and cost we can obtain? It is easy to discontinue development at an early stage, and little money is lost, but it is very costly to discover that the market is not there after full production has started. It may also be concluded that the development is too slow and more resources should be allocated to speed things up.

In the first period expenses for development and industrialisation accumulate. The profit comes later, during the full scale production and sale. After some time the product is outdated in the market, either because new products have better properties, or because new technology makes it possible to produce a similar product significantly cheaper, smaller, etc. The time span that the product can be sold at a profit depends on when we get it on the market. This also determines the total profit we can obtain. In order to make the accumulated profit as large as possible, it is essential to get the product on the market as early as possible. If we can shorten the development time it may justify a much higher development cost. The market life time, "market window" for profitable production of many electronic products is only a few years.

The pressure to reduce the development time has led to the method of "concurrent engineering", in which the various phases of development are partly done simultaneously in an intimate co-operation between various groups of personnel. The main advantage is that this will give an earlier market introduction, giving extended lifetime of the product in the market with larger sales volumes and better prices. The main disadvantage is that this generally needs more resources to coordinate the different concurrent activities and the need for more adjustments of the work pursued.

In practice, most product development projects are partly serial, partly concurrent, based upon an assesment of where concurrent engineering is predicted to be more profitable than serial development.

1.3 LEVELS OF INTERCONNECTION

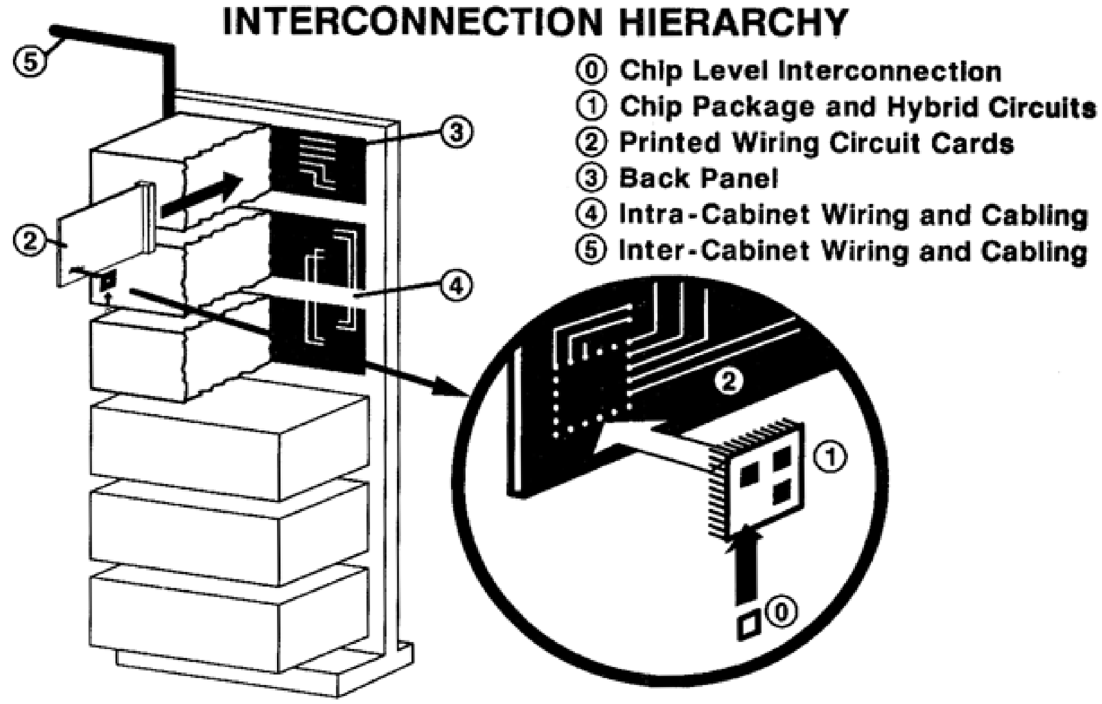

Fig. 1.2: Levels of interconnection in large electronic systems.

In electronic systems we talk about different "levels of interconnection", please refer to Figure 1.2. The lowest, level 0 is the interconnection of integrated, single transistors on a silicon (or gallium arsenide) integrated circuit (IC) chip. The chips communicate by interconnection on level 1, which is a hybrid circuit or a module. Alternatively it can be the wiring inside an IC package, between the chip and the external solder joints of the package. Level 2 is the wiring on a printed circuit board (PCB) where ICs and discrete components are mounted.

The circuit boards in a larger system are mounted on to a back plane, interconnection level 3. Several back planes may make up a cabinet, with internal cabling, level 4. Very large systems have several cabinets with cabling between them, interconnection level 5.

This is the traditional hierarchy of interconnection levels. In some of the multitude of technologies available today, there may be extra levels, or some levels may be missing.

In this course we shall emphasise levels 1 and 2. Level 0 is thoroughly described in many books [1.1] and courses and is outside our scope. The higher levels of interconnection are very product dependent and often represent a minor part of the product value. However, most companies attempt to standardise even here [1.2, 1.3].

REFERENCES

[1.1] See e.g.: S. M. Sze: "VLSI Technology". (McGraw Hill, 2nd. Ed. 1988.)

[1.2] See e.g.: W. L. Harrod and W. E. Hamilton: "The Fastech Integrated Packaging System" (AT&T). Solid State Technology, June 1986, p. 107, and AT&T Technical Journal July/Aug. 1987.

[1.3] Numerous examples of the technology and interconnection hierarchy of electronic products are described in: R. Tummala and E. J. Rymaszewski: "Microelectronics Packaging Handbook". (Van Nostrand, 1989.)