NEXT CHAPTER:

* CAD (Computer Aided Design) FOR PRINTED WIRING BOARDS
* DESIGN FOR MANUFACTURABILITY

before we begin with the chapter....
TUTORIAL from “PACKAGES” CHAPTER
The cross-section of three packages is given below. Name the packages. (3 marks)

1. Answer: Stacked - BGA/CSP
2. Answer: P-QFP (WB)
3. Answer: QFJB
A core microprocessor for desktop computer is to be packaged efficiently. List the best options for the different package parameters (substrate, die attach, chip-package interconnection, package-PCB interconnection and encapsulation). Justify your choice, in brief.

<table>
<thead>
<tr>
<th>Substrate material</th>
<th>FR-4 (epoxy)</th>
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<tbody>
<tr>
<td>Die attach</td>
<td>Cavity-up</td>
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<tr>
<td>Die-package Interconnection</td>
<td>WB / FC (area array)</td>
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<tr>
<td>Package-PCB interconnection</td>
<td>BGA / PGA (large I/Os)</td>
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<tr>
<td>Encapsulation</td>
<td>Molding</td>
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*Name of the Package?*  
PGA / LGA

[Diagram showing HDI substrate with annotations: Via Blind, Through-Hole plated, BGA / CSP, Core Substrate, etc.]
Label the arrowed sections in the figure below which is a cross-section of a CU/WB/BGA.

1. Encapsulant - epoxy/mold
2. Silicon die
3. Die attach (glue/adhesive)
4. Wire bond - Au, Al
5. Interconnect Cu on a HDI substrate
6. Core HDI or substrate
7. Via interconnect structure
8. Ball grid array - solder ball
Packaging efficiency is defined as the ratio of die area to package area. Indicate in increasing order, the packaging efficiency for the following packages: BGA, DIP, PGA, WL-FC-CSP, QFP, SCSP. Give a brief reasoning for your choice.

\[
\frac{\text{die area}}{\text{package area}} \quad \text{DIP < QFP < PGA < BGA < SCSP < WL-FC-CSP}
\]

On the left is a conventional chip package. On the right is a wafer-level package. Substantiate WLP’s performance characteristics (electrical and thermal reliability) vis-a-vis a conventional package?

- Process parameters
- Size of package
- Electrical (inductance) ( parasitics)
- Thermal issues
- Cost
Identify the arrowed sections in the figure below which is a cross-section of a CU-BGA.

1. **Mold Plastic (epoxy) encapsulant**
2. **Au, Al, WB**
3. **HDI**
4. **Die attach**
5. **BGA's**

Email>>mahesh@cedt.iisc.ernet.in for clarifications
* CAD (Computer Aided Design) FOR PRINTED WIRING BOARDS
* DESIGN FOR MANUFACTURABILITY
<table>
<thead>
<tr>
<th>Benefits from CAD</th>
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<tbody>
<tr>
<td>❑ &gt;&gt; Computer aided engineering and analog/digital simulation of electronic circuits</td>
</tr>
<tr>
<td>❑ &gt;&gt; Computer aided design of printed circuit boards for EMC compliance, with any requirements of geometry, board density, and component/device types</td>
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<tr>
<td>❑ &gt;&gt; Computer aided manufacturing, generation and optimization of fabrication files</td>
</tr>
<tr>
<td>❑ &gt;&gt; Thermal and reliability management of electronic assemblies at “component” and “board” levels; SPICE simulation of cooling systems using heatsinks, fans and Peltier elements; contact-less temperature measurements</td>
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<tr>
<td>❑ &gt;&gt; Surface Mount Technology/Surface Mounted Devices</td>
</tr>
<tr>
<td>❑ &gt;&gt; Electronic passive components and circuits, printed passive components and circuits, characterization in frequency range, measurements of passive components and structures</td>
</tr>
<tr>
<td>❑ &gt;&gt; Electromagnetic compatibility (EMC) and signal integrity analysis (SIA) at board level, transmission lines characterization, controlled impedance topics on printed circuits boards design and manufacturing, crosstalk/reflections and reduction techniques</td>
</tr>
</tbody>
</table>
If you train yourself in CAD you:

Will be able to understand the:

Will be able to appreciate the:

Remember, CAD is an art; it is a practice; you have to spend hours to become an expert in CAD tools; you gain experience in electrical and electronics design gradually and working with different designs and challenges.

Three important terms used in CAD of PWBs is:

**Design for Manufacturing (DFM)**

**Design for Reliability (DFR) &**

**Design for Testability (DFT)**
Design for Manufacturing (DFM)
- handshake between designers and manufacturers
- bottlenecks in manufacturing
- impossible specs in manufacturing cannot be designed
- wastage of raw material can be minimised
- high yield at lower costs

Design for Reliability (DFR)
- failures to be predicted by simulation
- materials analysis is a must
- physical properties of materials used in PWBs and inner layers
- design for higher reliability- electrical and thermal
- MTTF and MTBF to be understood (complex though)
- current DFR mechanisms eliminate experimental verification

Design for Testability (DFT)
- ability to test the board efficiently after assembly
- layout of board components become crucial
- good understanding of components sizes, shapes, properties
- efficient usage of electromechanical components, if used
CAD - What Early decisions...?

There are THREE important early decisions

1. Type of Components Selected

THE DESIGNER SHOULD EXCERCISE GREAT CAUTION IN SELECTION OF THE COMPONENT.......

ELECTRICAL CONSIDERATIONS ALONE IS NOT ENOUGH

The moment a "mixture of components are selected", the design has already become complex.

Example: \[ \text{DIP IC + BGA + THROUGH HOLE} \]

as well as \( \text{SM PASSIVES} \)
2. The Board Size. Density of Interconnection

Size of the board decides the interconnection density.

General classification:

* Low Density, Medium Density or High Density Board

The Designer is faced with two typical situations:

First Situation is straightforward.

Second Situation is challenging.

The PWB fixes the dimensions of the Product, and hence complexity is designers choice.

The dimensions of the Product FIX the size and hence, the complexity of the PWB is decided by the product itself.
3. Type of Board

An important early decision is that the designer should be aware which type of board he is addressing...

* Wider choice exists: Single side or Double Side, or Double side with PTH, or Multilayer, or MCM, or Chip-on Board?

Rigid or Flexible or Flexi-rigid

- TYPE OF SUBSTRATE
- TYPE OF DIELECTRIC
- THICKNESS OF COPPER AND DIELECTRIC