MILITARY
$86B 8.7%

Communications
Fire Control
Missiles
Radar

AUTOMOTIVE
$48B 4.8%

Entertainment
Engine Control
Safety
Body Control
Navigation
Instrumentation

**COMPUTER &
BUSINESS EQUIPMENT**
$383B 38.6%

Desktop PC's
Low Cost PC's
Printers/ Scanners
Notebooks
Photocopiers
PDA's
Servers & Workstations
Point of Sale Terminals
Calculators/ Organizers

INDUSTRIAL & MEDICAL
$105B 10.6%

Instruments
Process Control
Oscilloscopes
Motor Control
Power Supplies
Hearing Aids
Transaction Terminals

CONSUMER
$112B 11.3%

Smart Cards   Game Systems
Clocks & Watches   Cameras
Portable Audio   Set Top Boxes
CD Players   Satellite TV
VCR's   Camcorders

COMMUNICATIONS
$259B 26.1%

Handsets   Modems
Wireless Phones Fax Machines
Line Cards   Switches & Routers
LAN Cards   Wireless Base Stations
Pagers   Switching & Transmission

Figure from "Fundamentals of Microelectronics Sys Packaging" Rao Tummala

Computers and Business Equipment Representative products

- ❖ Calculators
- ❖ Desktop PCs
- ❖ Printers
- ❖ Notebooks
- ❖ Photocopiers
- ❖ Personal digital assistants
- ❖ Workstations
- ❖ Servers
- ❖ High performance computers

Communication
Representative products

- ❖ Cellular/PCShandsets
- ❖ Linecards
- ❖ LANcards
- ❖ Pagers
- ❖ Modems

- ❖ Faxmachines
- ❖ LANswitches
- ❖ Routers
- ❖ Mainswitches
- ❖ Cellular and PCS base stations

Cellular phone is the mascot of this wireless revolution

Automotive Electronics

❖ All on-board electronic modules, systems, and sub-systems that have electronics content.

Automotive Electronic Systems:

❖ Engine control and management systems

❖ Transmission controllers

❖ Cruise controllers

❖ Braking controllers

❖ Traction controllers

❖ Suspension controllers

❖ Steering controllers

Automotive Electronic Systems…

- ❖ Lighting, wipers and air conditioning/ heating systems

- ❖ Electronic dashboard and mirrors

- ❖ Safety, convenience and entertainment systems

129° C Ignition Surface

150°C Alternator Surface

Engine Compartment Close to Engine 120° C

Engine Compartment Remote from Engine   105° C

Engine - 140°C

Exhaust System 587°C

Engine Oil 148°C

Exterior - Accessible to Splash, etc. 70° C

Transmission Oil 148 °C

Road Surface 66°C

Figure from "Fundamentals of Microelectronics Sys Packaging" Rao Tummala

Passivation / Conformal Coating

Solder Component Attach

Flip Chip IC Attach

Unpackaged Chip Wirebond

Wirebond Interconnect

Component Attach Packaged

Other Interconnect

Conductive Adhesive Component Attach

Solder Flux & Cleaning

Substrate Attach Adhesive & Package Construction Adhesive
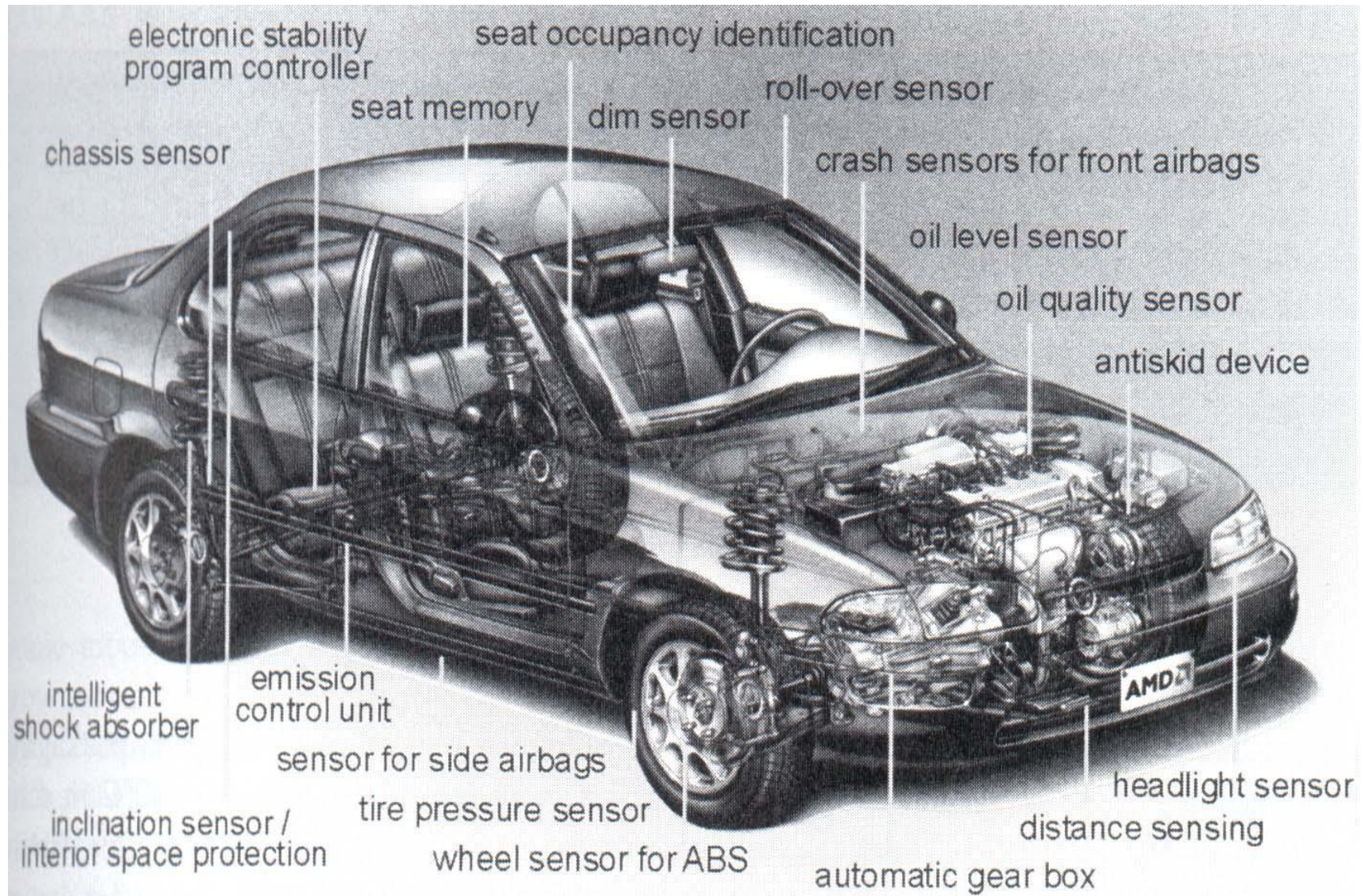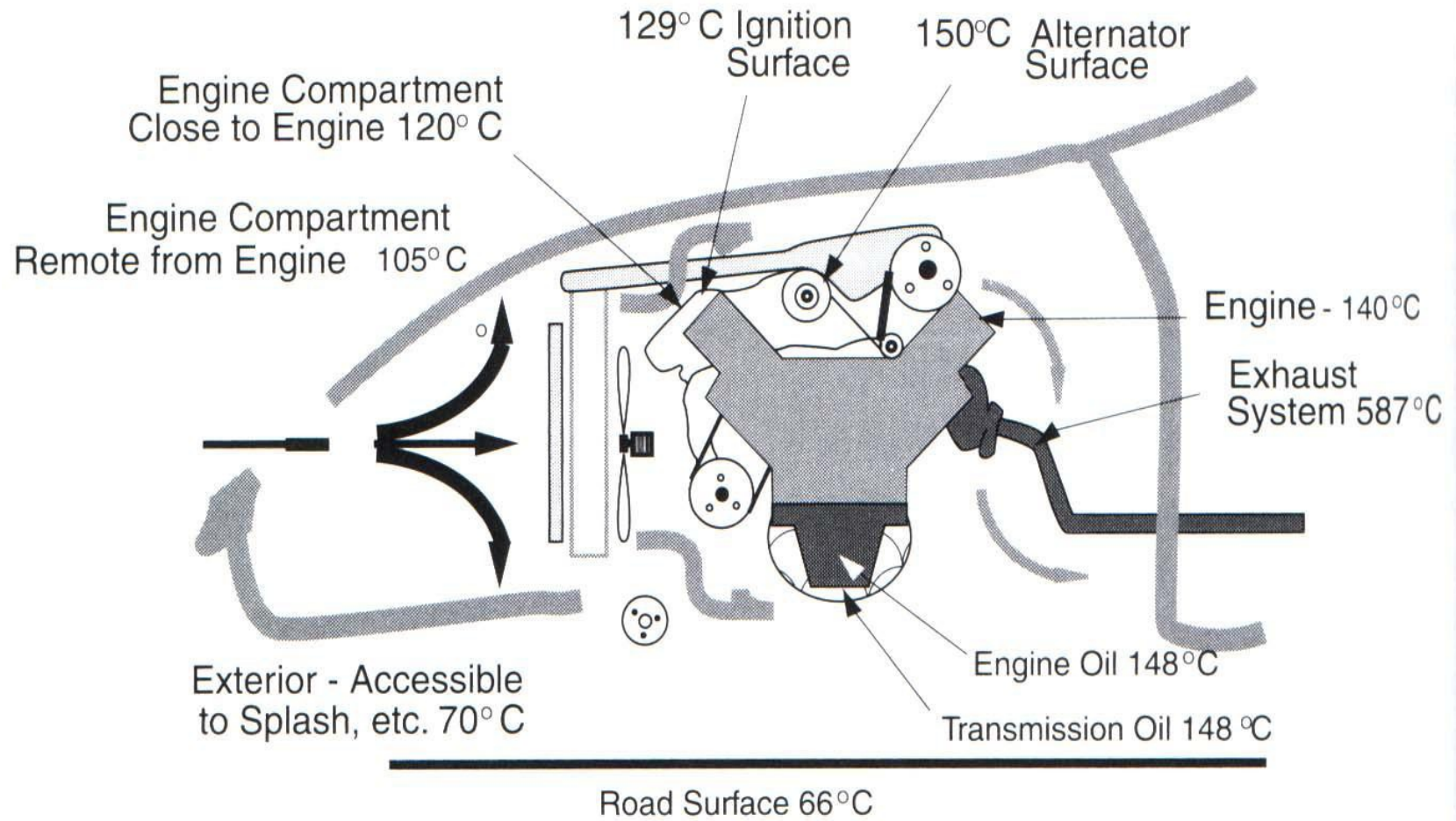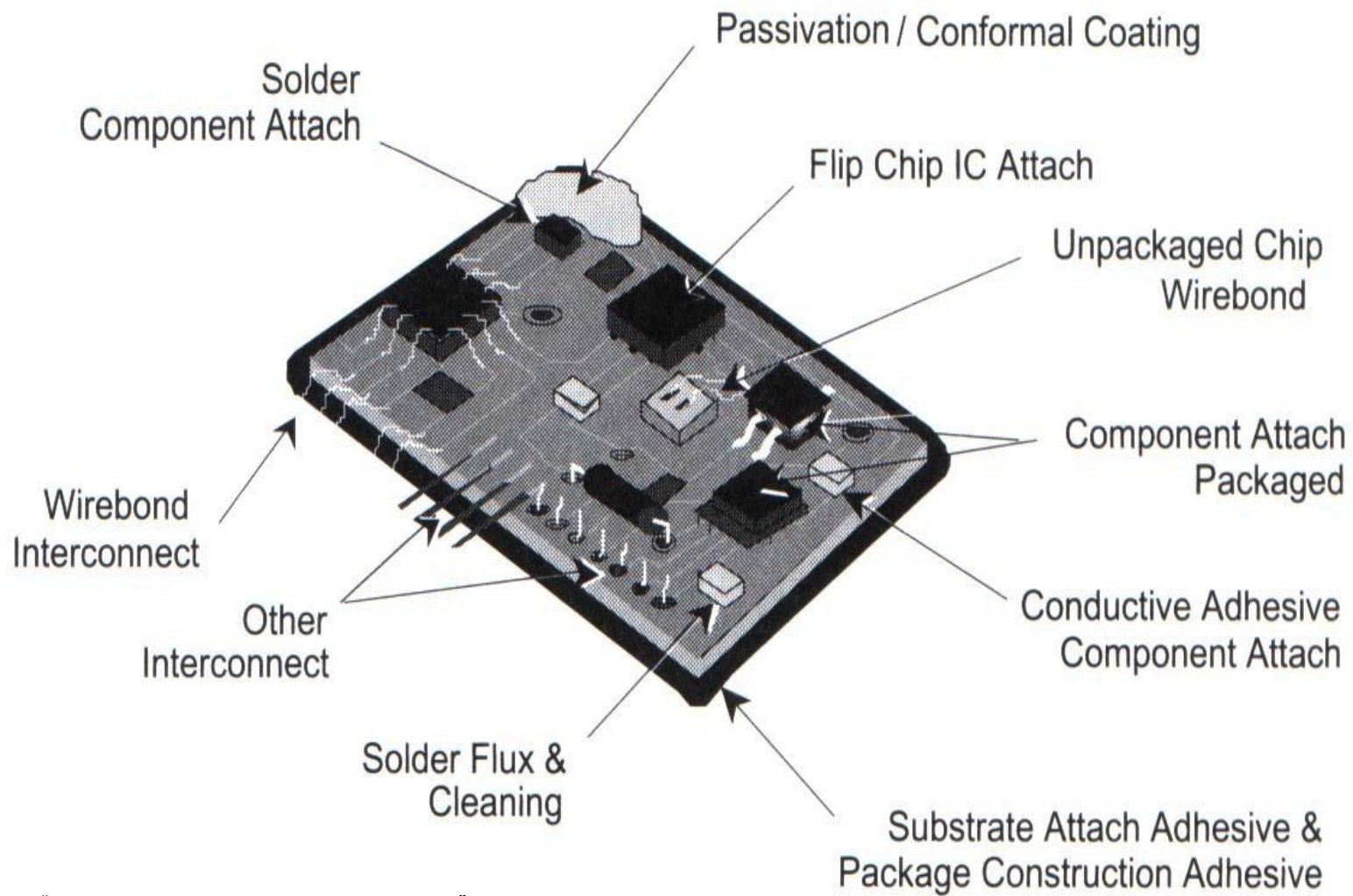
Figure from "Fundamentals of Microelectronics Sys Packaging" Rao Tummala

Consumer Electronics Representative products

❖ VCR

❖ Compact audio systems

❖ Music CD players

❖ Game systems

❖ Game cartridges

❖ Watches

❖ Portable audio players

❖ Camcorders

Consumer Electronics
Representative products…

- ❖ Smart cards
- ❖ Microwave ovens
- ❖ TV sets

Performance is typically not leading edge, and
reliability requirements are relaxed

Cost is usually the overriding criteria
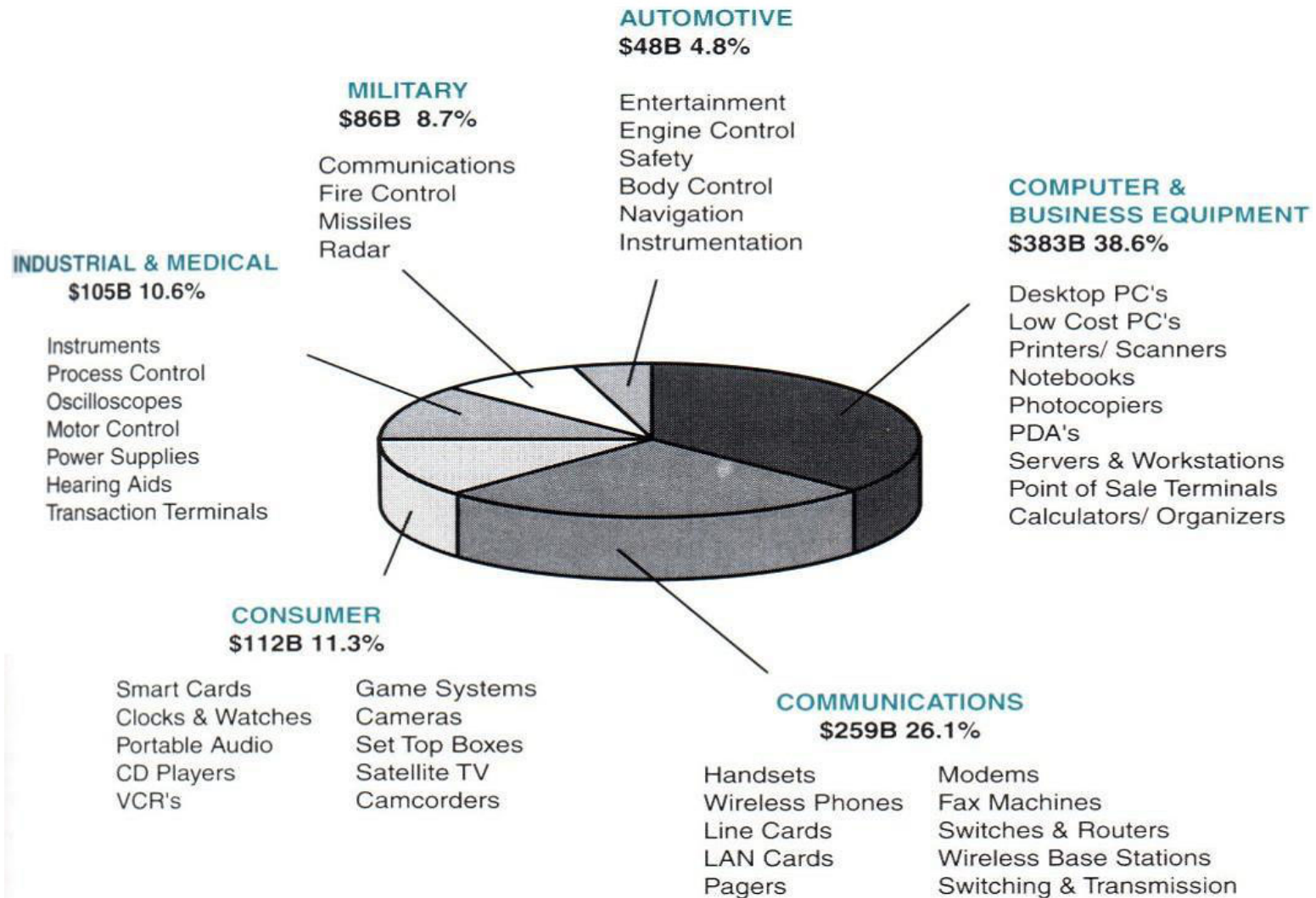
Produced in high volumes

Industrial and Medical systems

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$48B 4.8%

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Wireless Base Stations
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Figure from "Fundamentals of Microelectronics Sys Packaging" Rao Tummala

Industrial and Medical systems…

Representative products

- ❖ Test and measuring devices and instruments
- ❖ Calibrators
- ❖ Process control systems
- ❖ Motor controls
- ❖ Uninterruptible power systems
- ❖ NC controls

Representative products…

- ❖ Vision systems
- ❖ Robotics
- ❖ Hearing aids
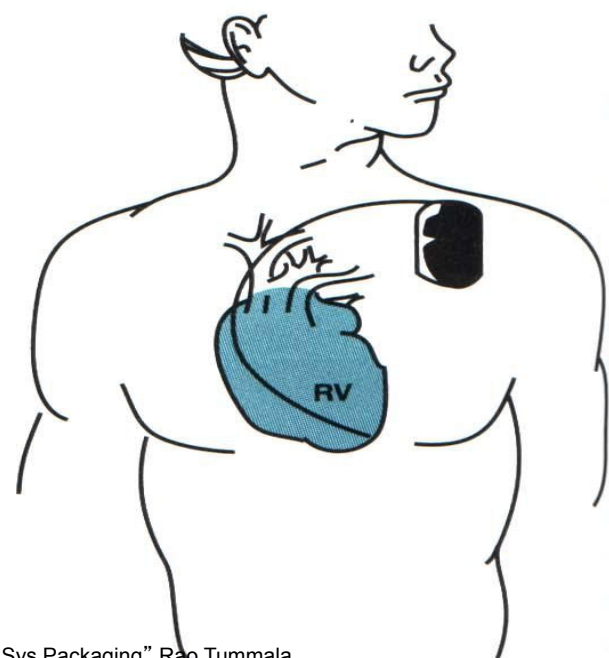- ❖ ECGs
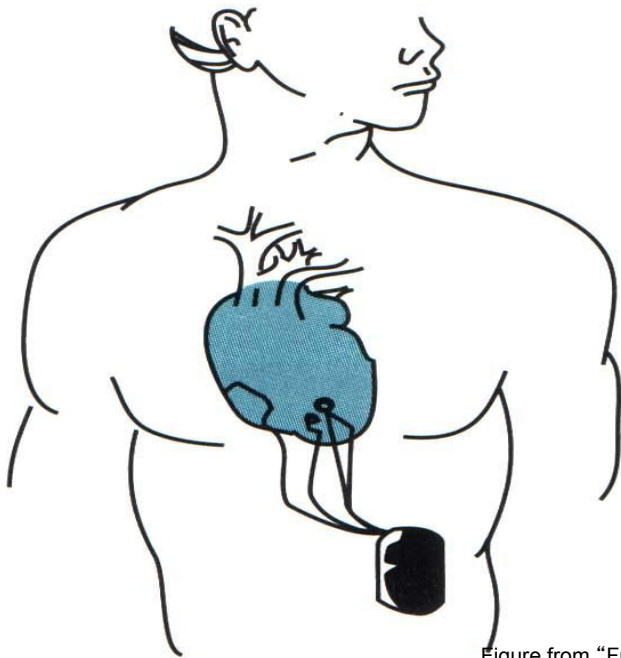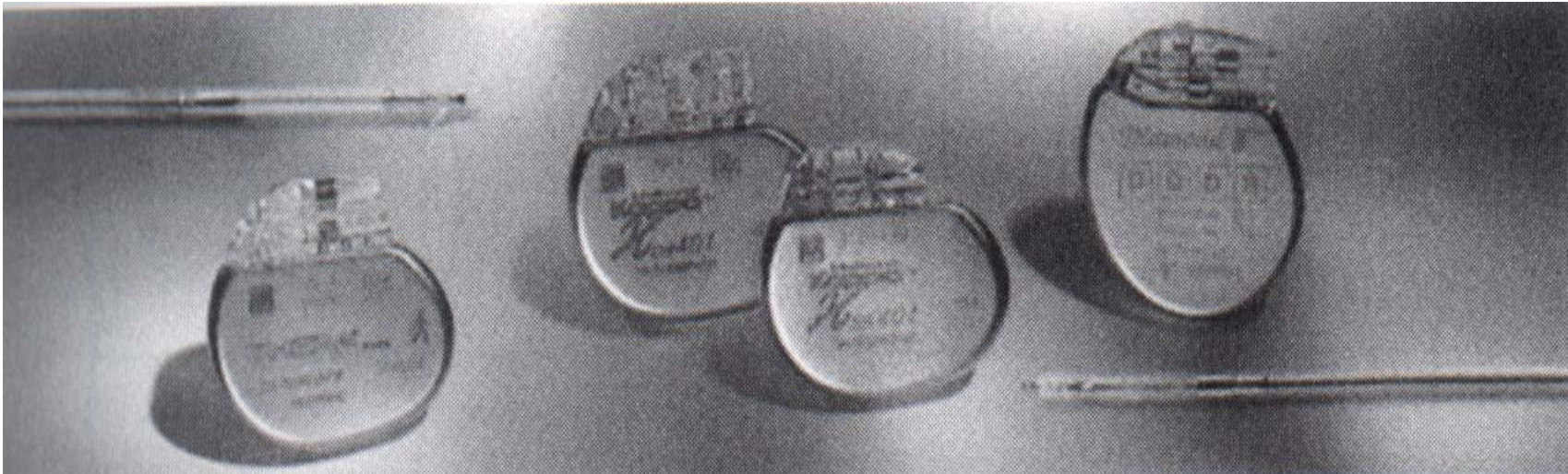- ❖ Implants
- ❖ Medical imaging systems

Figure from "Fundamentals of Microelectronics Sys Packaging" Rao Tummala

Military Electronics Systems

AUTOMOTIVE
$48B 4.8%

Entertainment
Engine Control
Safety
Body Control
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Figure from "Fundamentals of Microelectronics Sys Packaging" Rao Tummala

Military Electronics Systems

❖   Market depends on very complex relationships
Between global political scenarios, strategic interests
Of Western nations

Important products of this category

- ❖ Mobile communications
- ❖ Fire control systems
- ❖ Missiles
- ❖ Avionics radar
- ❖ Satellite links
- ❖ Land-based radar and communication systems

PRODUCTS

The users are the reason for products.

Users are not concerned

- ❖ with the internal details of the product
- ❖ how it is designed
- ❖ how it is manufactured etc.

Users

Want to use products effectively

Use them for a long time

(But this is the utmost concern for engineers and industry)

Main interests of a user in a product

❖   Function and features

❖   Simplicity in understanding its use

❖   Ease of use and taking care of the product

❖   reliability

❖   Its features in comparison to the competing products

❖   After sales service

❖   Happiness and pride in owning, and using the product

❖   cost

A simple view of an electronic product

System Functions

System Architecture

ICs and Components

System Level Packages

(Boards, rocks and enclosures)

User Interface

Software
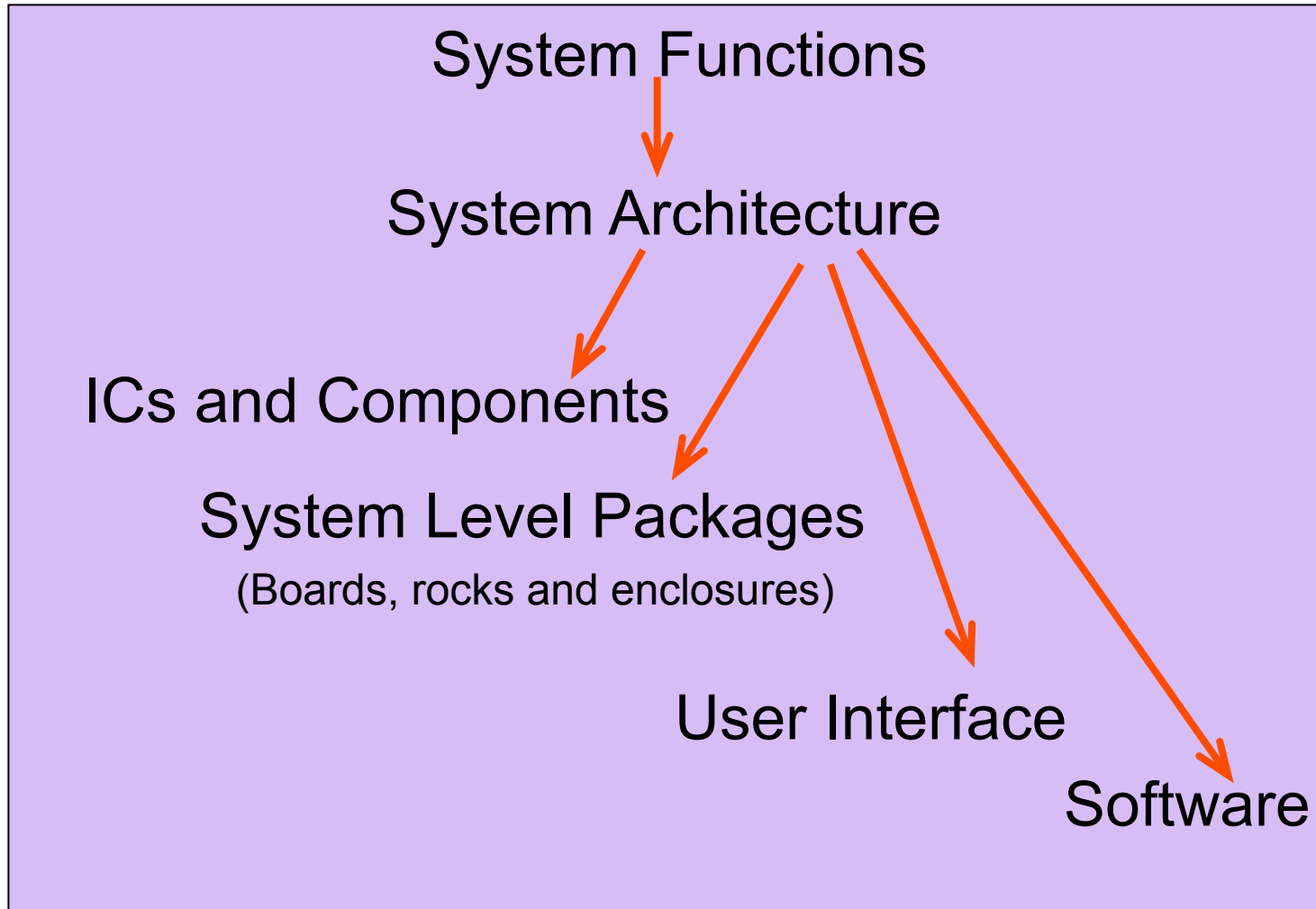
Examples of System Functions

- ❖   MIPs or FLOPS of a computer
- ❖   Power capacity, efficiency of power conversion, cleanliness of its output, and power density (footprint) of an SMPS
- ❖   Extended battery life of portable products
- ❖   A cell phone has to provide reliable communication
- ❖   Automobile engine controller: operating reliably under the adverse environmental conditions

Integrated Circuits (ICs)

- ❖ Main elements of an electronic product
- ❖ Enable us to build the required functionality into the product
- ❖ Available off the shelf or as ASICs

A product also requires

- ❖ Passive components (resistors, capacitors and inductors)
- ❖ Electrical/electromechanical components (switches, connectors, cables, jumpers etc.)

A product also requires…

- ❖ Cooling components (fans and heat sinks),
- ❖ Magnetic/optic storage components
- ❖ Optical interconnects
- ❖ Batteries
- ❖ Display components (LEDs, LCDs, CRTs and plasma displays)

What is Electronics Packaging?

"Science and art of providing a suitable environment to the electronic product as a whole to perform reliably over a period of time"

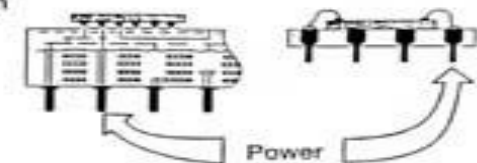## Major functions of Electronics Packaging

❖ Signal distribution
❖ Power distribution
❖ Heat dissipation (cooling)
❖ Protection (mechanical, chemical, electromagnetic)

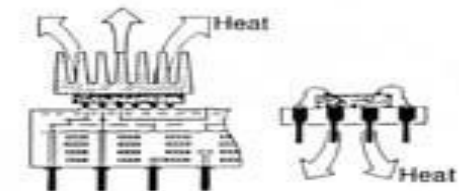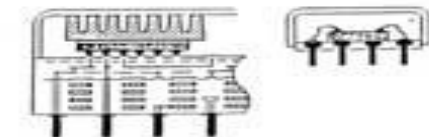The package must function at its specified performance level

Other definitions for 'electronics packaging'

❖ The process of assembling a group of discrete electronic circuit elements into an electronic assembled device.

❖ Specifically, the grouping or combining of components, integrated circuits or chips into a unit and through holes on a multilayer circuit board with subsequent soldering of the above items onto the printed wiring of the board. Electronic packaging generally involves taking a concept of circuit design and making a finished circuit.

Other definitions for 'electronics packaging' ...

(Synonyms: electronic component packaging, electronic systems packaging, electronics assembling, electronics assembly process, electronics packaging)

❖ The process of converting a circuit schematic design into a working (prototype) manufacturable assembly unit, which should be of high performance, cost-effective, highly reliable, easily testable and one that can sustain the external environment (temperature, moisture, dust, IR, vibration shock, fatigue failure etc) for a reasonable period of time. The process shall follow the principles of 'Design for Manufacturability', 'Design for Reliability', and 'Design for Testing'.

Levels of Packaging

Level 0: Interconnections on a monolithic silicon die

Level 1: Packaging silicon dies into single chip
        packages

Level 2: Multi chip modules based on chip-set
        technologies

Level 3: Printed wiring cards and boards

Level 4: Complete electronic systems consisting of
        several subassemblies (boards, racks and
        frames)

Wafer size?
Wafer fab cost?

Die size?
Technology?

Wafer

Level 1
Integrated Circuit

Level 2
Multichip Module

Level 4
System

Level 3
Motherboard

Level 3
Printed Circuit Board (PCB)

Through hole
Surface Mount
Bare die-direct
chip attach (DCA)