MCL Bootcamp

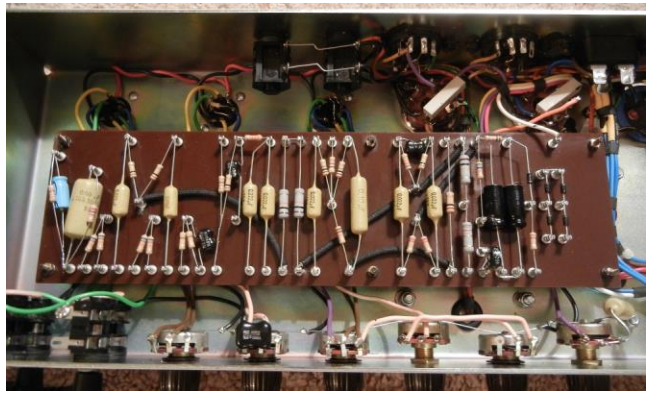
Evolution of PCBs

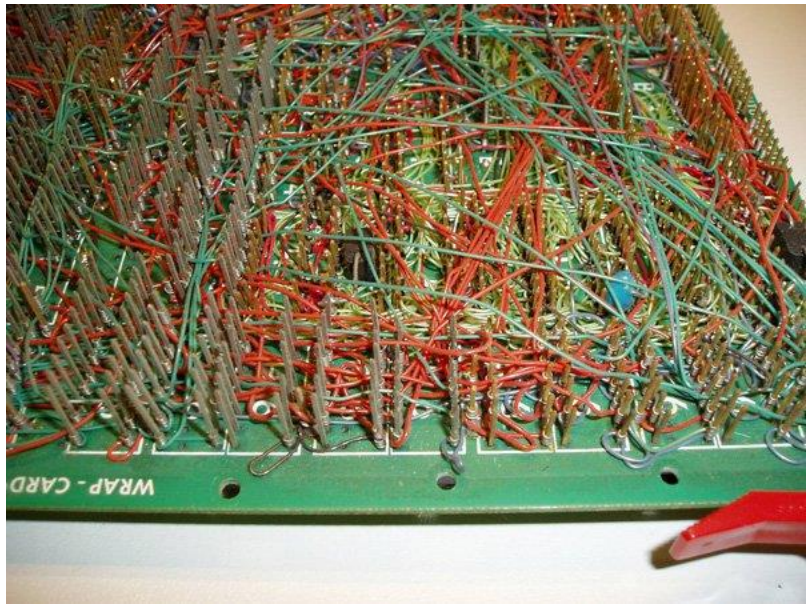
Evolution of PCBs

- Printed circuit boards are used in all but the simplest electronic products
- The history of their development is not very old, the last 115 years
- Alternatives to PCBs are wire wrap and point-to-point construction
- PCBs require an additional design effort to lay out the circuit, but manufacturing and assembly can be automated.
  - Manufacturing is cheaper and faster

History of PCBs – What did we use before the PCB?

- Alternatives are extremely bulky and unreliable designs that required large sockets and regular replacement; confusing wiring designs





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- 1903: Albert Hanson – flat foil conductors laminated to an insulating board in multiple layers
- 1904: Thomas Edison – experimented with chemical methods of plating conductors onto linen paper

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- 1913: Both Max Shoop and Arthur Berry patented a print and etch method to flame spray metal into a board through a patterned mask

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- 1920's: early PCB material could be anything from Bakelite to Masonite to plain, old, thin pieces of wood or cardboard
  - Holes were drilled into the material and flat brass wires would be riveted onto it
  - Used in tube-style radios and gramophones
- 1927: Charles Ducas – patented a method of electroplating circuit patterns
  - Created an electrical path directly on an insulated surface

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- 1936: Paul Eisler – invented the printed circuit as part of a radio set
  - The first real operational circuit boards
  - Eisler is called the Father of Printed Circuit Board Technology
  - His method of a resist in the shape of the circuit pattern is printed onto the surface of the copper cladding with the uncovered metal being removed by etching

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- He also proposed the generation of conductors on both sides of the copper clad base material with connection between conductors on both sides being made through eyelets
- Allowed for a method of mass production and an assembly scheme
- Offered economy in weight and space

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- 1941: multi-layer printed circuit was used in German magnetic influence naval mines
- 1943: USA started to use the technology on a large scale to make proximity fuses for WWII
  - 1948: USA released the invention for commercial use
- 1947: first double-sided PCB with through-holes produced, copper replaces brass as metal of choice due to ability to carry electrical current, low cost, and ease of manufacturing

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- 1949: the US Army Signal Corps invented “auto-sembly” process in which leads are inserted into a copper foil interconnection pattern and dip soldered
- 1950’s: printed circuits start to become commonplace in consumer electronics – TVs and radios, fueled by military applications

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- 1950’s – 1960’s: types of material used for board shifting to different resins and other materials but could still only be printed on a single side
  - The wiring would be printed on one side and the electronical components would be on the other
  - Still much more efficient than bulky wiring – wider adoption

- 1957: The Institute of Printed Circuits (IPC) formed

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- 1960: multi-layer PCBs begin production
- 1964: Photo Circuits, USA developed the fully additive process – the base material does not have copper on it and the copper is plated selectively on the required places for interconnections
- 1960's – 1970's: hand taping components and tracks
  - Introduction of the automation of fabrication and in testing of bare boards/populated boards

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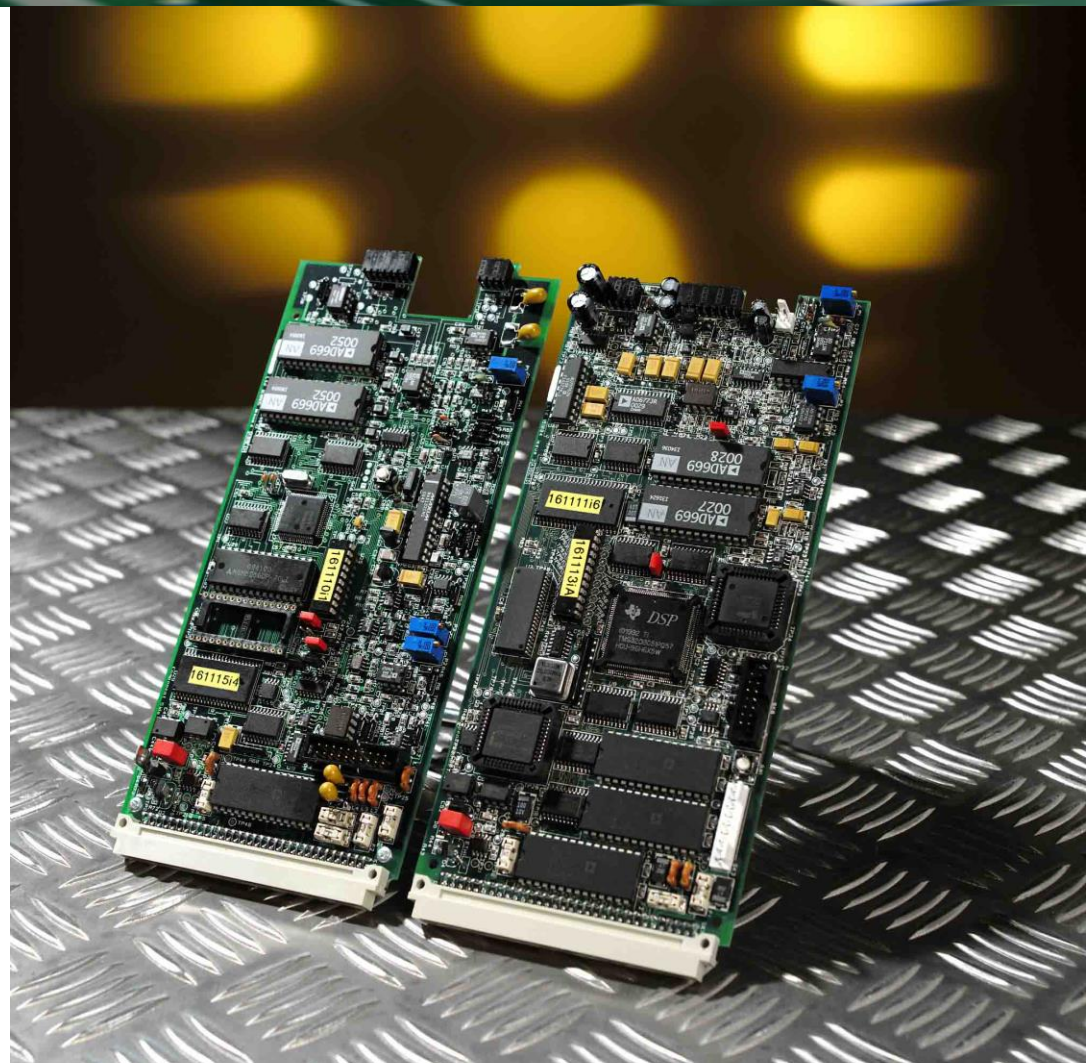
- 1970's – fully entrenched in consumer electronics, scientific equipment, medical equipment, air and space, defense, and personal computer industry
  - New processes: photo film lamination, dry film and wet film resist, solder masking, legend printing, and CNC drilling
  - The circuitry and overall size of the board started to get a lot smaller and hot air soldering methods began to be used

Evolution of PCBs

- 1980’s: surface mount parts become the preferred option over through-hole components; CAD software becoming more and more commonplace
  - Led to further size reductions while maintaining the same level of functionality

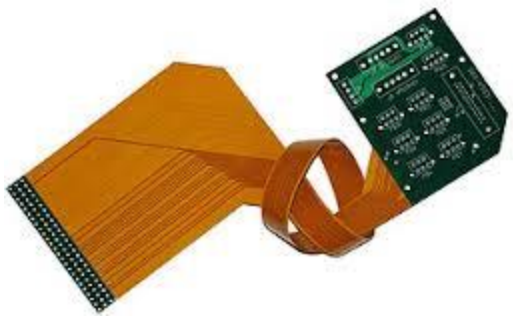


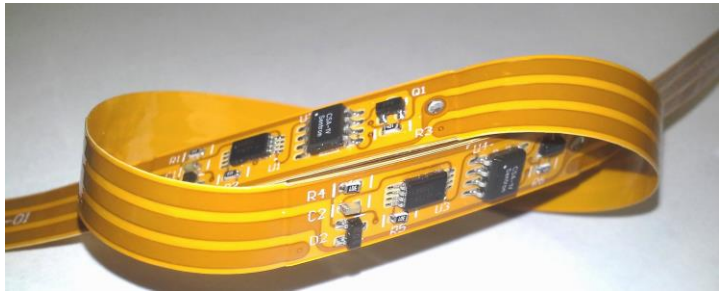
Evolution of PCBs

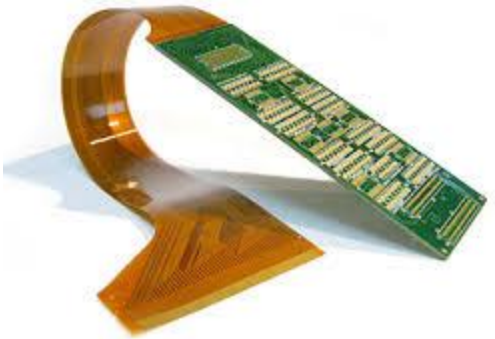
- 1990's: the complexity of modern circuit boards increases while size and costs of materials decreases
  - Incorporate combinations of rigid and flexible boards
- 1995: High Density Interconnect boards start production due to micro-via technology
- 1998: high speed/sign integrity beings to hit mainstream PCB

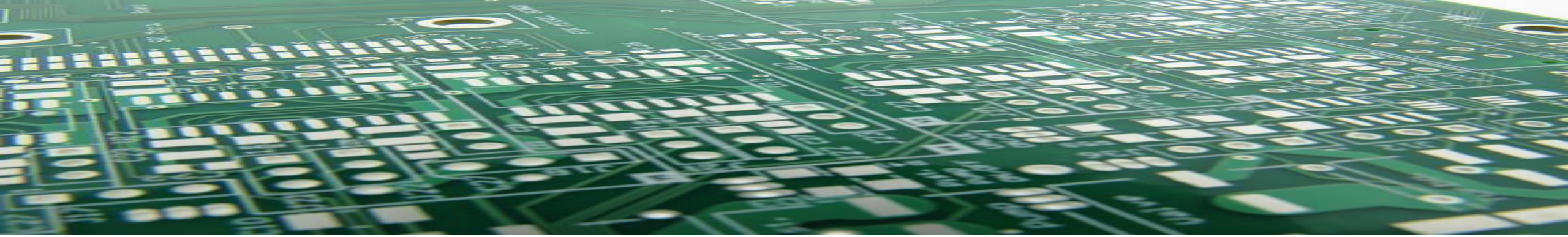
Evolution of PCBs

- 2000’s: PCB real estate becomes even tighter with 5-6mil trace and space becoming commonplace
  - Hi-tech shops fabricating boards with 3.5-4mil trace and space in production quantities
  - Flex and Rigid-flex boards become an affordable option and widely used
- 2010’s: Every layer interconnect (ELIC) production begins









Questions?
Thoughts?
Ideas?