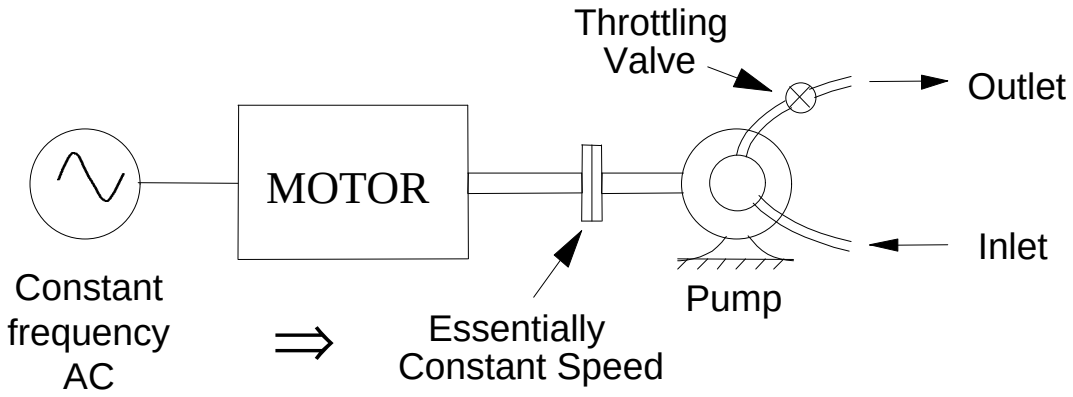
Chapter 1

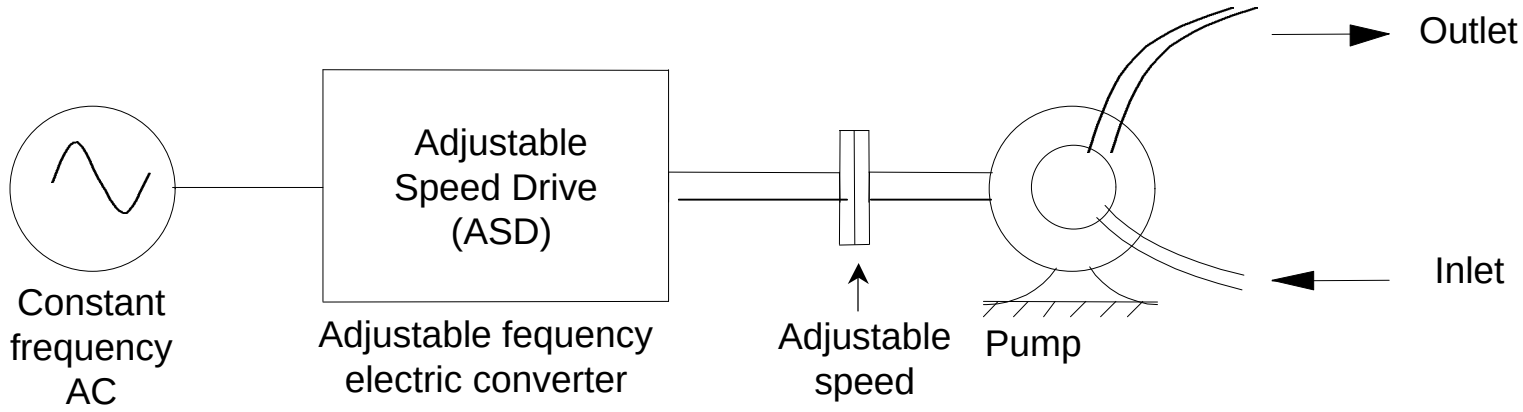
Introduction to Electric Drive Systems

History

- Constant frequency AC - essentially constant pump speed
- Inefficient - Heat generated in pump and throttling valve
- Not amenable to automation

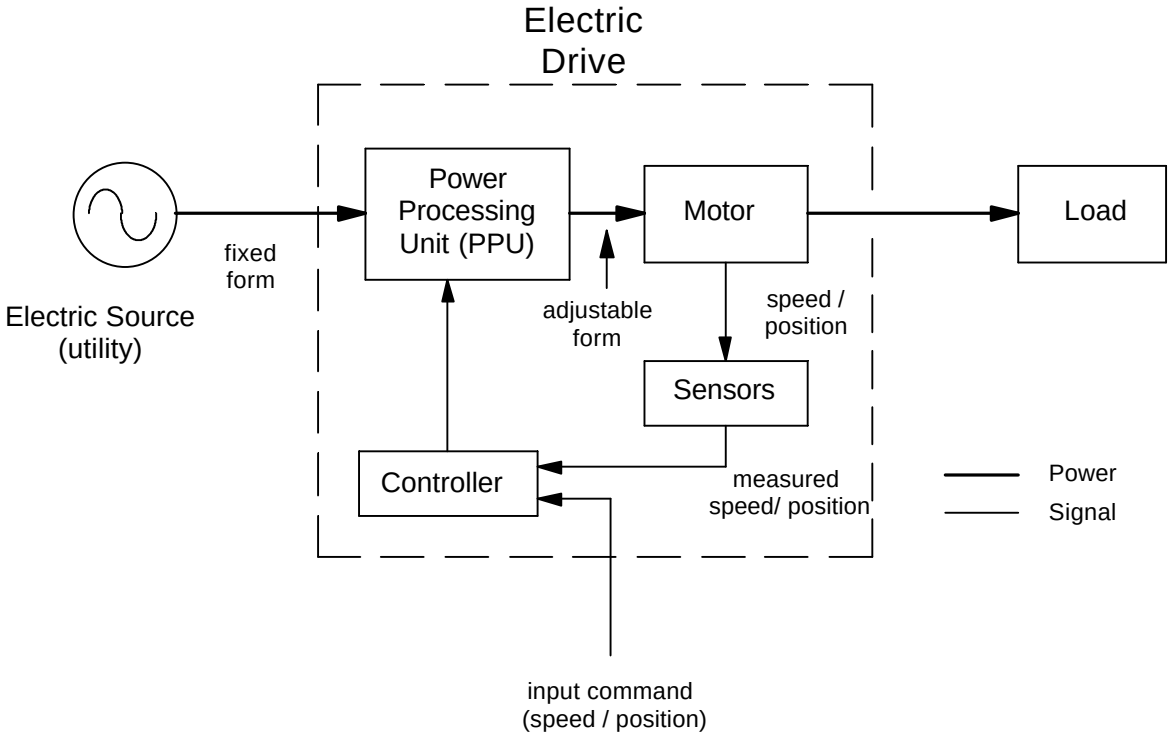


Trend : Adjustable Speed Drives (ASDs)



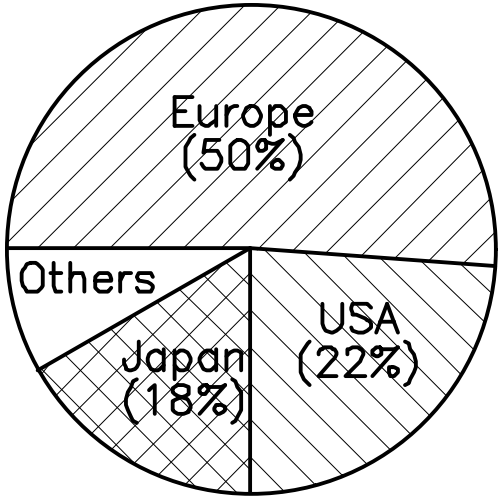
- Driven at appropriate speed
  - High Efficiency

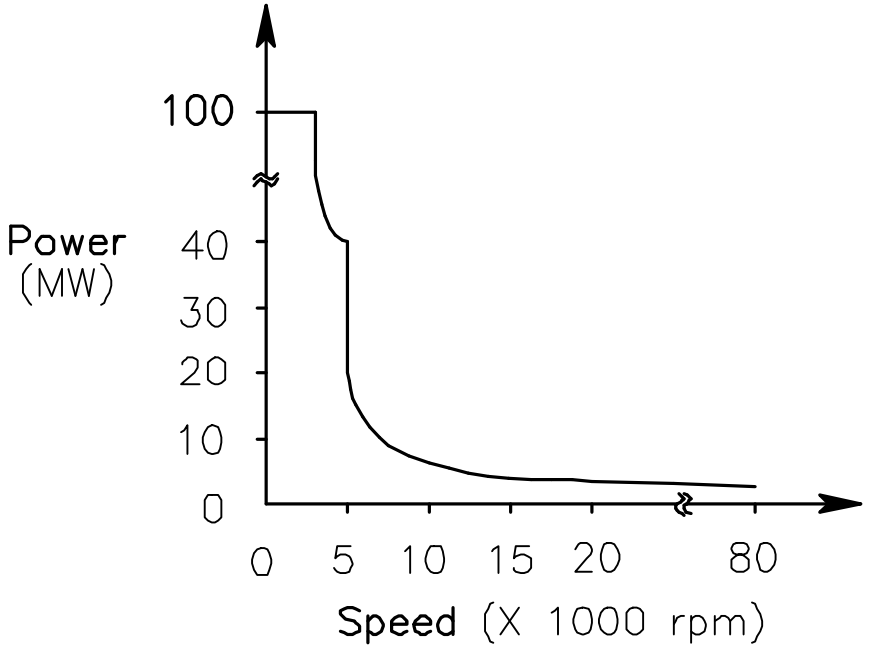
What is an Electric-Motor Drive?



- Role of Electric Drive: Efficient conversion of power from electrical to mechanical
- Role of PPU: Delivers appropriate form of frequency to motor (as required by the load)

World Market and Scope





- healthy growth rate
  ~ 25% per year

- A very wide range of speed and power

Factors for Growth

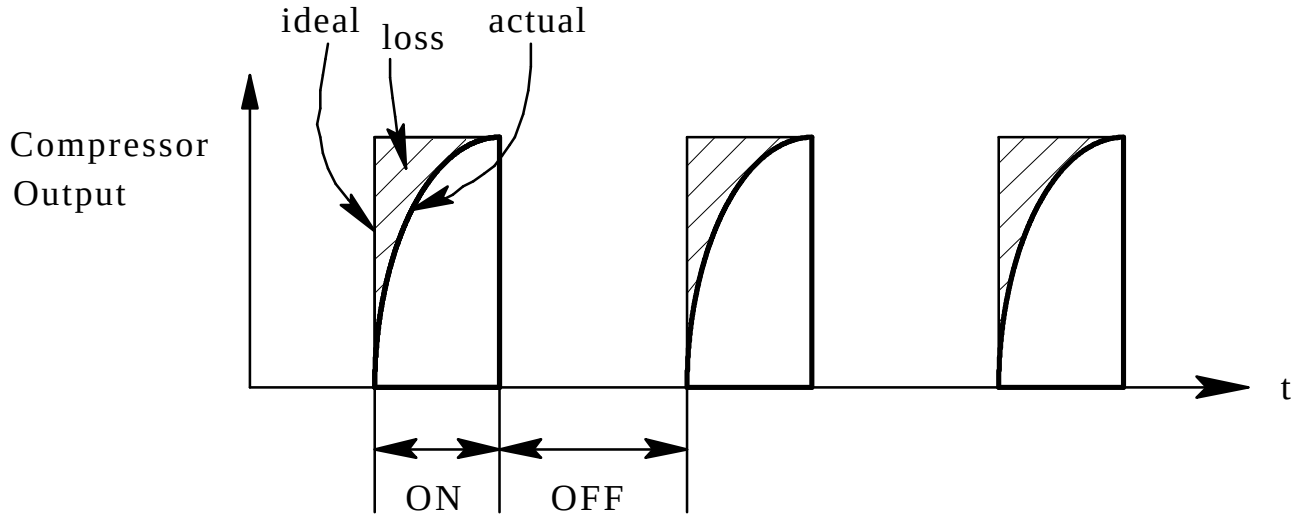
- Technical Advances in
  - Linear ICs and Digital Signal Processors
  - Power devices
- Market Needs
  - $20 Billion market in 1997
  - 25% Growth rate

Typical Applications

- Process Industry - agitators, pumps, fans, compressors
- Machining - planers, winches, calendars, chippers, drill presses, sanders, extruders, grinders, mills, presses
- Heating and Air Conditioning - blowers, compressors
- Paper and Steel Industry - hoists, rollers
- Transportation - elevators, trains, automobiles
- Textile - looms
- Packaging - shears
- Food - conveyors, fans
- Oil, Gas , Mining - compressors, pumps, cranes, shovels
- Residential - heat pumps, freezers, washing machines

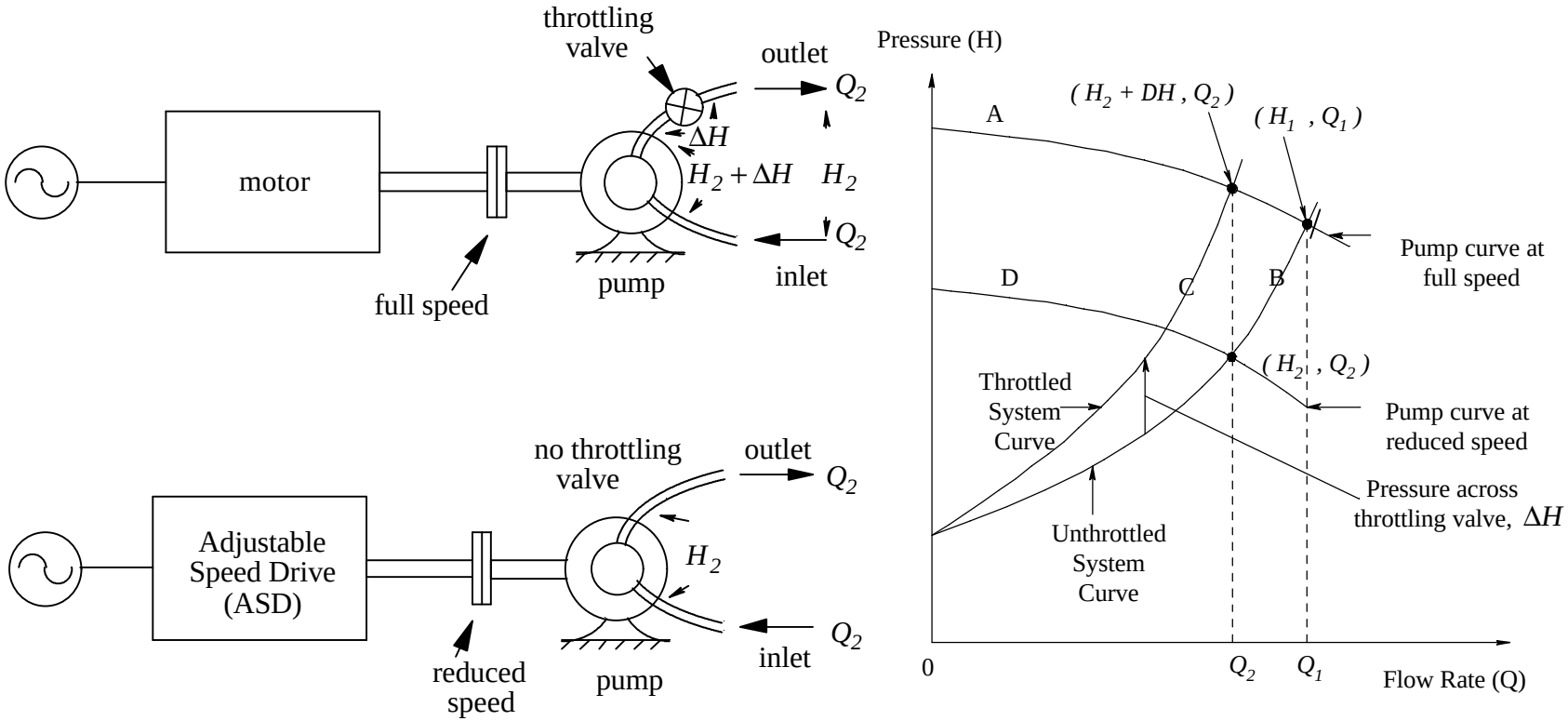
Application for Energy Conservation

- Heat Pumps and air-conditioners - cycled operation



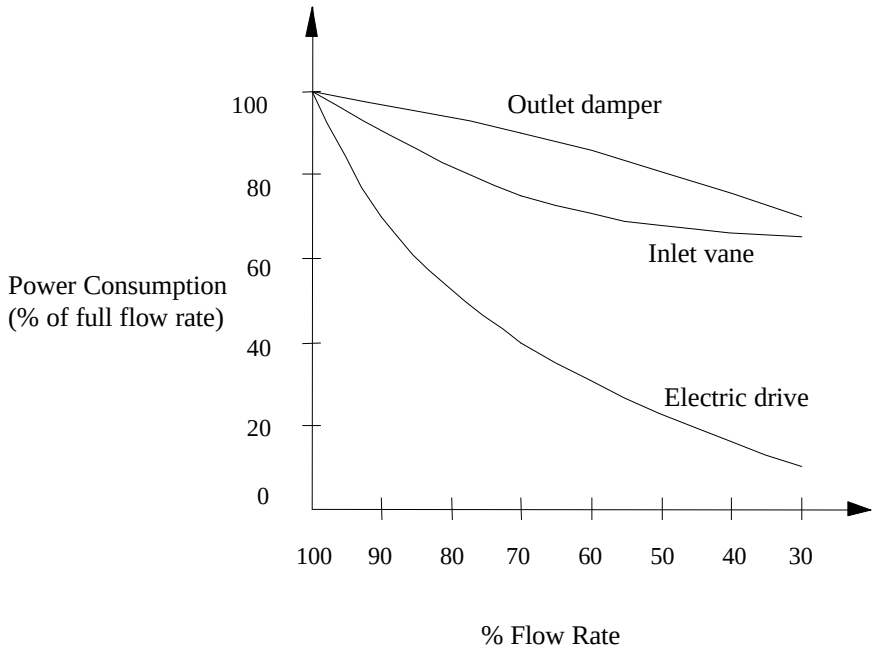
- 30% improvement in efficiency by running compressor at appropriately reduced speed using an ASD

Energy Conservation in Pumps



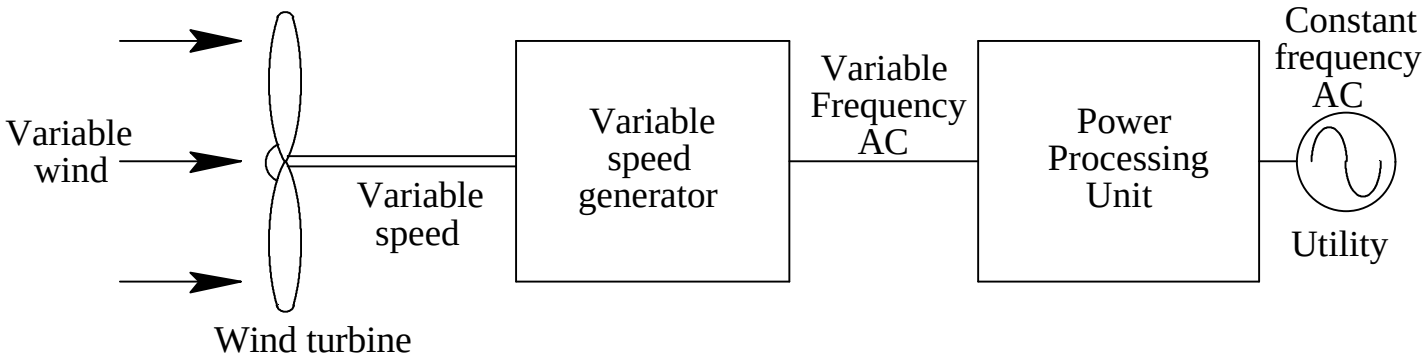
- Throttling introduces extra pressure drop, ΔH
- ASD reduces pump speed to match load requirement

Energy Conservation in Blower Systems

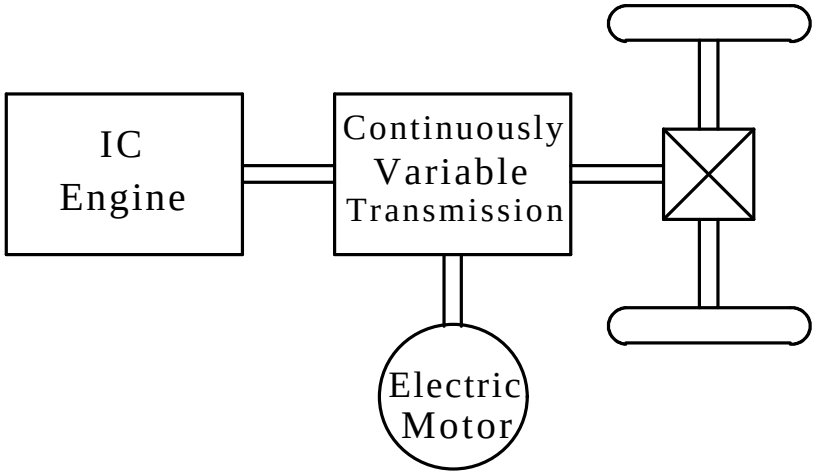


- Relative power consumption using three methods to reduce blower flow rate

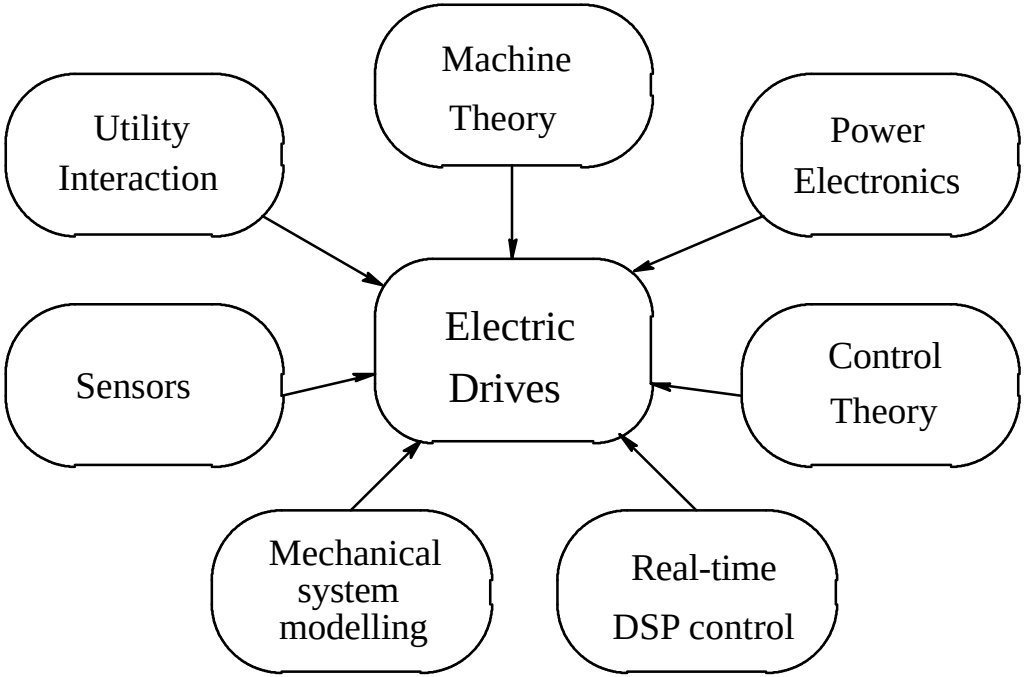
Harnessing Wind Energy



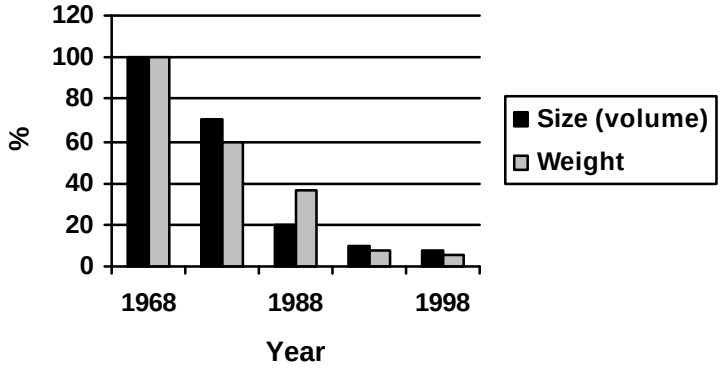
Hybrid Electric Vehicles

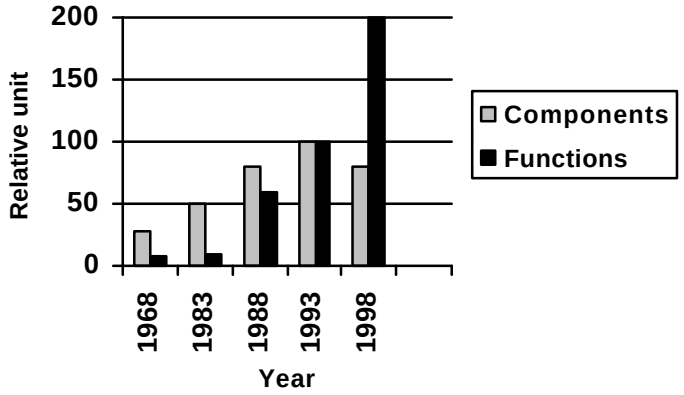


Multi-disciplinary Nature of Electric Drives



Evolution of Power Processing Unit





4kW Danfoss VLTR power processing unit

Summary

- What is an electric drive? Draw the block diagram and explain the roles of its various components.
- What has been the traditional approach to controlling flow rate in the process industry?
  What are the major disadvantages which can be overcome by using adjustable speed drives?
- What are the factors responsible for the growth of the adjustable-speed drive market?
- How does an air conditioner work?
  (Consult a handbook such as [10].)
- How does a heat pump work?
- How do ASDs save energy in air conditioning and heat pump systems?

Summary

- What is the role of ASDs in industrial systems?
- There are proposals to store energy in flywheels for load leveling in utility systems. During the off-peak period for energy demand at night, these flywheels are charged to high speeds. At peak periods during the day, this energy is supplied back to the utility. How would ASDs play a role in this scheme?
- What is the role of electric drives in electric transportation systems of various types?
- List a few specific examples from the applications mentioned in section 1-4 that you are personally familiar with.
- What are the different disciplines that make up the study and design of electric-drive systems?