

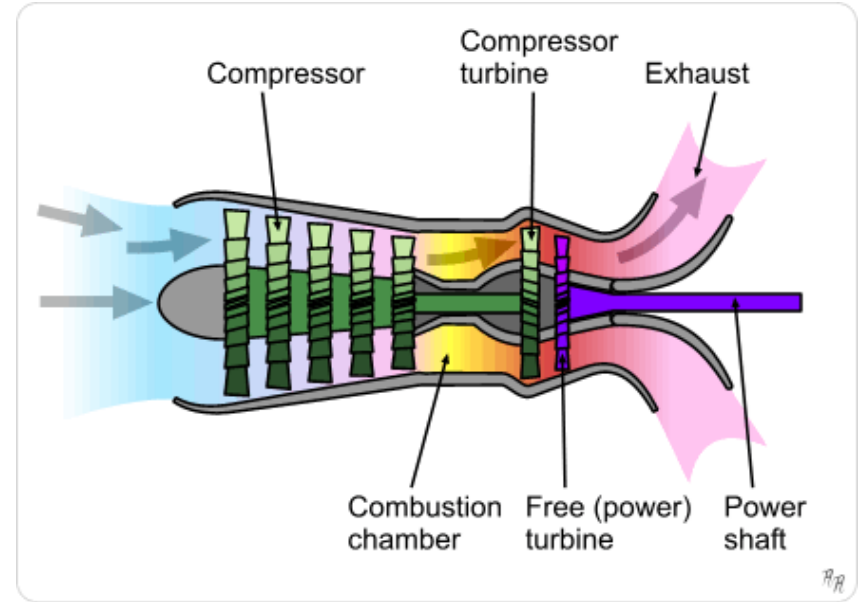
# Comparison of Helicopter Engines

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John Schenderlein, Tyler Clayton

# Turboshafts...What are they?

- Needed for high power in a small envelope
- Very similar to turboprops
  - many turboshafts derived from turboprop engines
- However,
  - exhaust is not used to propel
  - propeller load is applied to the airframe
- Began ~1950s



# Main Uses

- Helicopters
- APUs
- Marine Vehicles
- Tanks
- Motorcycles
- industrial power generation



M1 Abrams



CH-53 Super Stallion



MTT Superbike

# Major Players in the Market



# Turbomeca

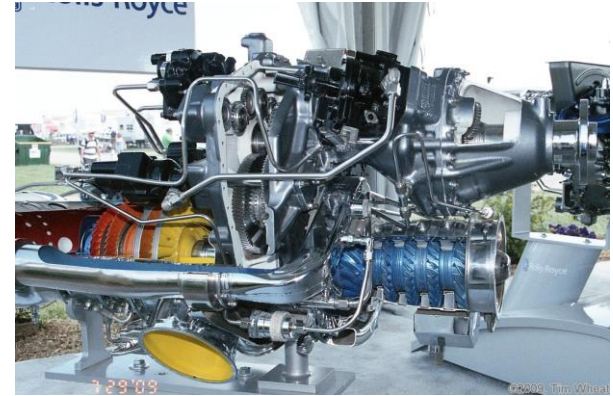
- French Manufacturer for small/medium turboshafts (500-3000 shp)
- 18000+ in operation
- Most popular engine: Arriel (600-1000 shp)
  - 30 variants
  - 245 lbs
  - SFC = 0.57
  - 1 axial/1 Centrifugal compressor (PR ~9)
  - 2 HPT/1 FPT turbine

# Turbomeca

- Newest Engine: Arrano (2018)
  - 10-15% increase SFC
  - new thermodynamic core & use of variable pitch inlet guide blades
  - Uses additive manufacturing for injectors

# Rolls-Royce

- Most popular engine: M250 Series
  - inherited from Allison Engine Company (1990s)
  - 31000+ produced (50%+ in operation)
  - 450-715 shp
  - 160-275 lbs
  - 4-6 axial/1 centrifugal compressor (PR 6-9)
  - 2 HPT/2 FPT
  - Also used on the MTT Superbike



RQ-8A Fire Scout

# Allison Engines (Rolls Royce)

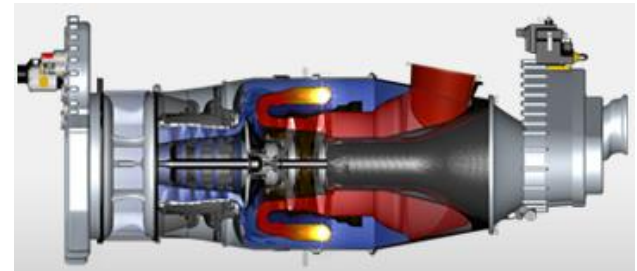
- Most notable engine: T406
  - Build specifically for the V-22 Osprey
  - 6150 shp
  - 971 lbs (6.33 p/w)
  - 14 axial compressor stages!





# Pratt and Whitney Canada

- Canadian based subsidiary of PW
  - focuses on smaller aircraft engines
- Majority of their engines based on the PT6 turboprop
  - PT6B/C series and the PT6T Twin-Pac (1000-2000 shp)
  - 3-4 axial/1 centrifugal
  - SFC 0.59
  - 2 HPT/2 FPT
- PT6T uses two PT6A engines combining gearbox
  - Popular among Bell 412/212 helicopters



# GE Aviation

- Entered aviation industry w/ production of super/turbochargers
- First turboshaft: T58
  - 1250-1870 shp
  - SFC = .39
  - 10 axial (PR 8.3) & 2 HPT/1 FPT
  - Used on Marine One
- Major seller today: T700/CT7
  - 1900-2600 shp
  - 5 axial/1 centrifugal (PR18)
  - AH-64 Apache engine



# GE Aviation Con't

- Newest Engine: GE38 (upgrade to the T64)
  - Designed for heavy lifting
  - 7500 shp (57% increase)
  - SFC:  $\sim$ .39 (18% increase)
  - 63% fewer parts
  - sand tolerant/corrosion resistant compressor (TiN coating)
    - improved inlet particle separators w/ CFD
  - CMC's used in turbine
- Fills a gap in the market not many engines 6000+ to 10000 shp range



[http://tx.technion.ac.il/~jetlab/9aijes/2%20-%20Helicopter%20Engine%20Technology%20Pitch\\_v6.pdf](http://tx.technion.ac.il/~jetlab/9aijes/2%20-%20Helicopter%20Engine%20Technology%20Pitch_v6.pdf)

# Textron Lycoming

- Put the first turbine engine into a helicopter: UH-1
- Now makes the powerful T55 for the US Chinook twin rotor helicopter



Soviet

# Turboshafts of a Different Era

- Soloviev Design Bureau
  - Responsible for one of the most powerful turboshaft engines ever (D-136)
- Klimov Experimental Design Bureau
  - Produced the TV3-117 engine
  - Powered 95% of Russian Helicopters - used throughout the developing world



# Conclusions & Comparisons

- Almost all use a 2 spool design with usually 2 HPT and 2 FPT
  - exceptions:
    - smaller use 1 HPT/1 FPT
    - large use 2 HPT/3 FPT
- Most use a combo of Axial/Centrifugal compressors
- SFC
  - New engines: 0.39-0.42 kg/kW/hr
  - Older engine: 0.5-0.6 kg/kW/hr