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UNIVERSITY OF TECHNOLOGY

PROPULSION INSTALLATION MODELLING FOR GEARED ULTRA-HIGH BYPASS RATIO ENGINE CYCLE DESIGN

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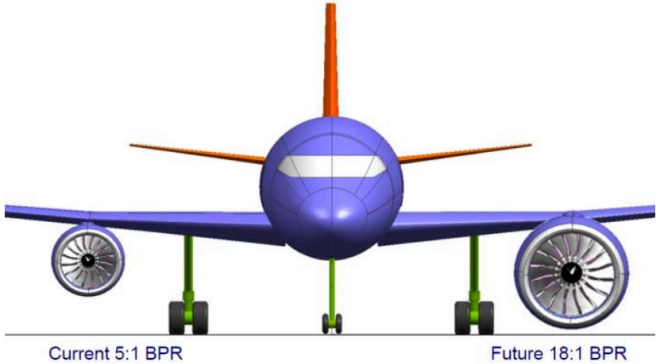
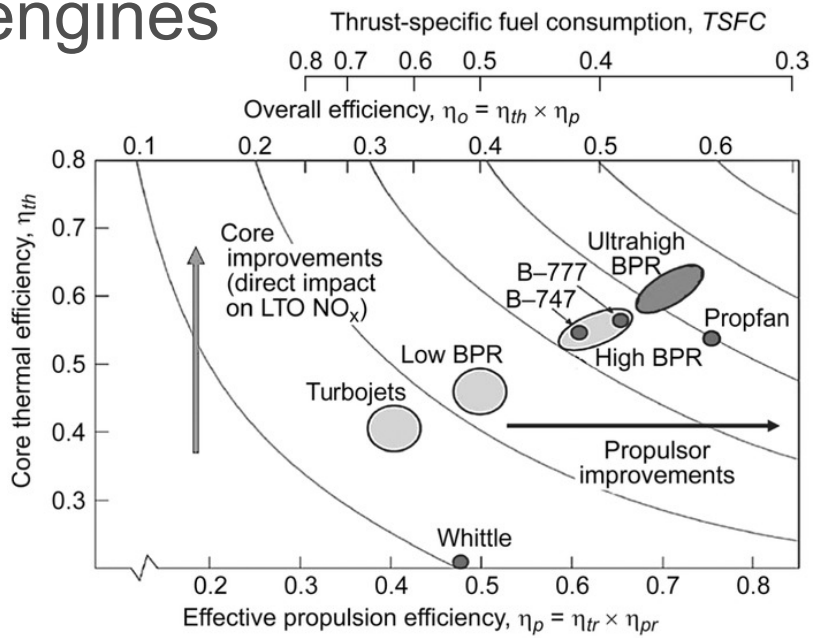
INTRODUCTION

- Turbojet engines -> turbofan engines
- IVANHOE
- Engine cycle selection



From: A. L. Mohd Tobi and A. E. Ismail 2016 *IOP Conf. Ser.: Mater. Sci. Eng.* **131** 012019

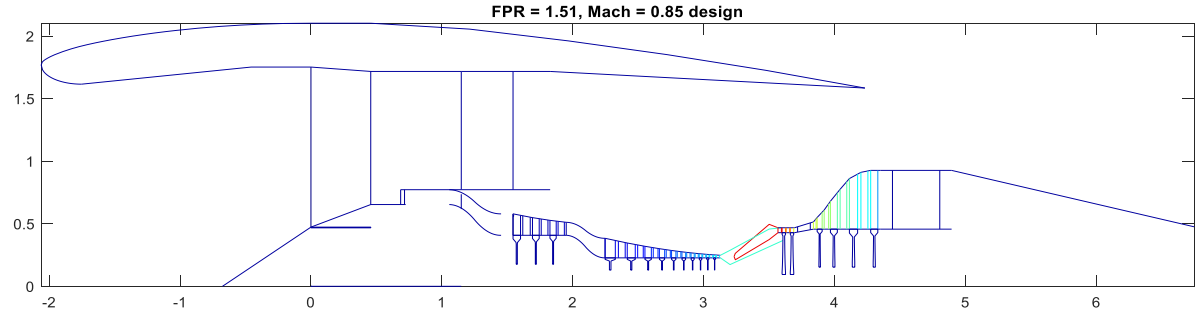


From: Suder K L and Heidmann J D, **"Improvement of aeropropulsion fuel efficiency through engine design"**, September 2017
https://www.routledgehandbooks.com/doi/10.1201/b20287-3

METHOD

- Inhouse code, GESTPAN
- WEICO
- Engine Architecture: 1-3-10-2-4
- Installed SFC
- Key design parameters

Altitude	35000 ft
Mach	0.80 and 0.85
ISA	+10 K
Net thrust	17535.97 lbf
Mass flow	513 kg/s
$\eta_{poly,FAN}$	0.925
$\eta_{poly,IPC}$	0.920
$\eta_{poly,HPC}$	0.925
$\eta_{poly,HPT}$	0.905
$\eta_{poly,LPT}$	0.940



$$SFC_{installed} = \frac{b}{F_{Net} - D_{engine\ mass} - D_{nacelle}}$$

RESULTS AND DISCUSSION

- Minimum installed SFC
  - OPR constant, varying FPR and BPR
- Suboptimal solutions
  - FPR constant
  - Variation of 0.13% for a fan diameter variation of 6.2%.

Installed SFC [mg/Ns] (blue) and Fan size [inch] (magenta) for different FPR and BPR

TOC	FPR	1.46	1.51	1.55
	BPR	15.56	13.92	13.46
	OPR	71.70	66.12	61.40
CRUISE	FPR	1.36	1.40	1.43
	BPR	16.65	15.91	15.36
	$SFC_{installed}$	15.30	15.25	15.28
	Overall mass flow rate [kg/s]	690.29	638.33	602.35
	FPR_{inner}	1.17	1.20	1.23
Fan size [inch]		143.17	137.97	134.25
Sea-level static thrust [lbf (kN)]		89181.91 (397)	88900.94 (395)	88287.72 (393)

Mach number 0.80

Installed SFC [mg/Ns] (blue) and Fan size [inch] (magenta) for different FPR and BPR

TOC	FPR	1.44	1.49	1.53
	BPR	14.61	13.91	13.44
	OPR	69.22	63.15	58.85
CRUISE	FPR	1.35	1.39	1.42
	BPR	16.67	15.85	15.31
	$SFC_{installed}$	16.29	16.19	16.19
	Overall mass flow rate [kg/s]	730.11	669.84	631.68
	FPR	1.16	1.19	1.22
Fan size [inch]		143.78	137.96	134.19
Sea-level static thrust [lbf (kN)]		90377.02 (402)	90258.16 (401)	89814.15 (399)

Mach number 0.85

CONCLUSION

- ”Installed SFC”
- Slow variation
- Mach number 0.85
- Fan diameter of 138

$$SFC_{installed} = \frac{b}{F_{Net} - D_{engine\ mass} - D_{nacelle}}$$

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	BPR	14.61	13.91	13.44
	OPR	69.22	63.15	58.85
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