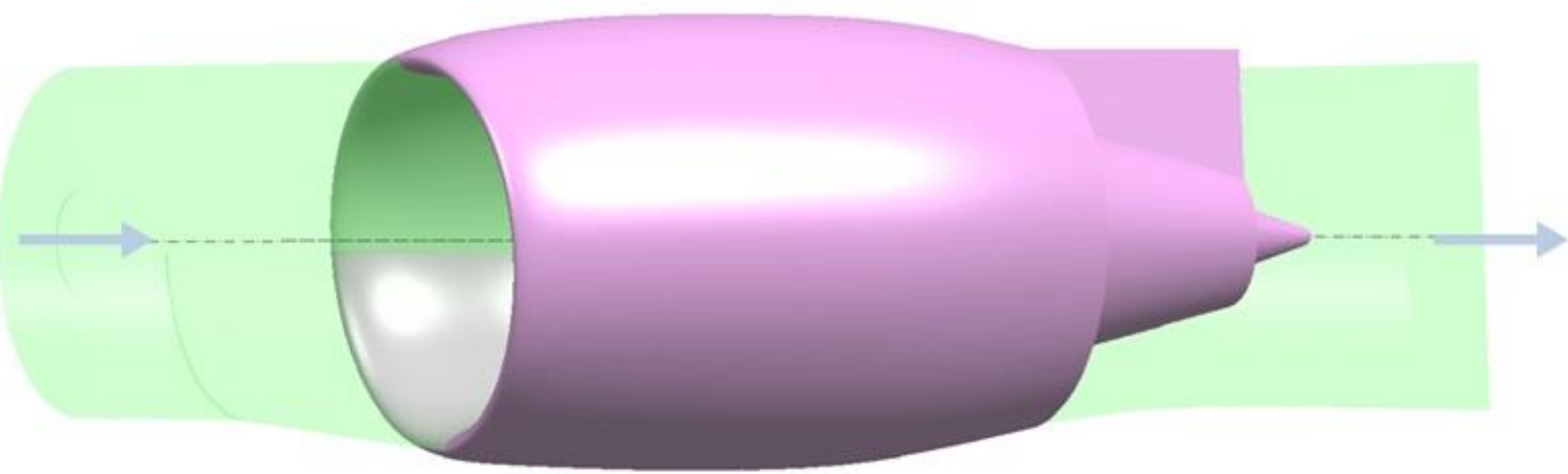
Newly Proposed Multi Stream Turbofan Engine with Built in Regenerative Heat Exchanger



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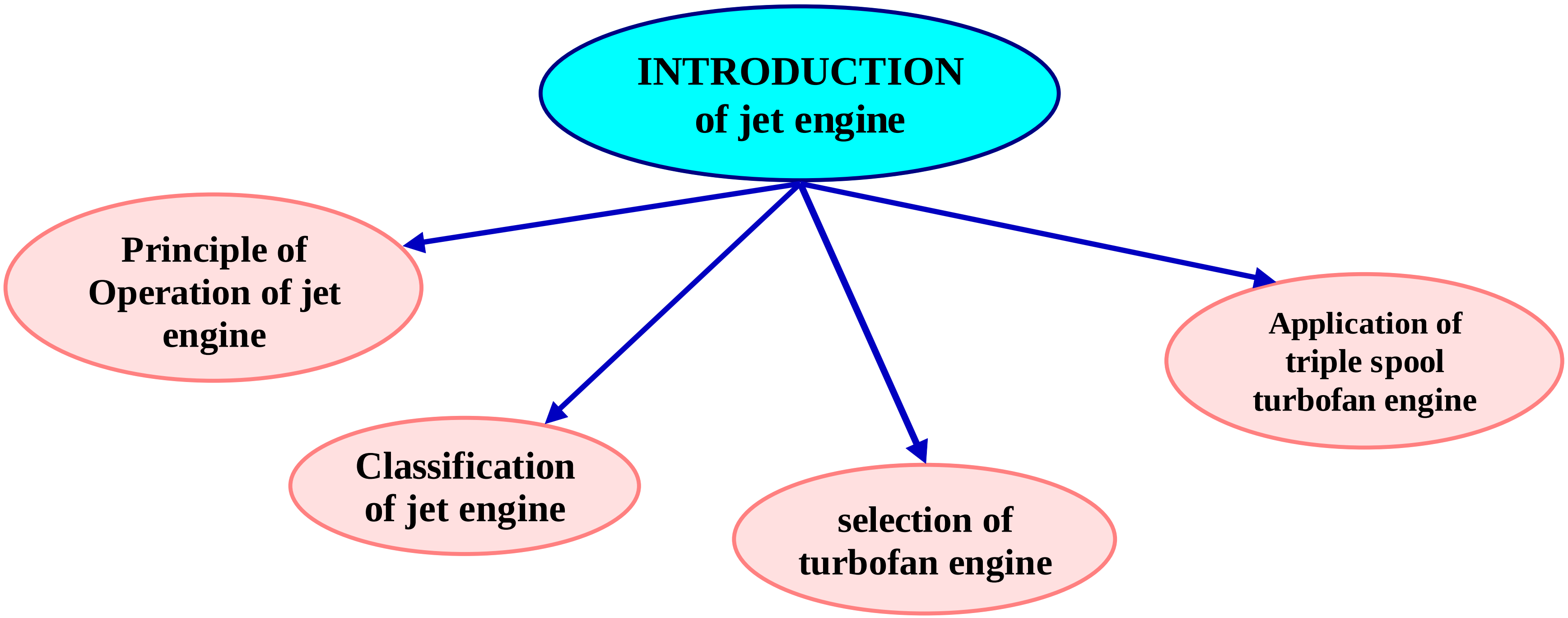
INTRODUCTION
of jet engine
Principle of
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Classification
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selection of
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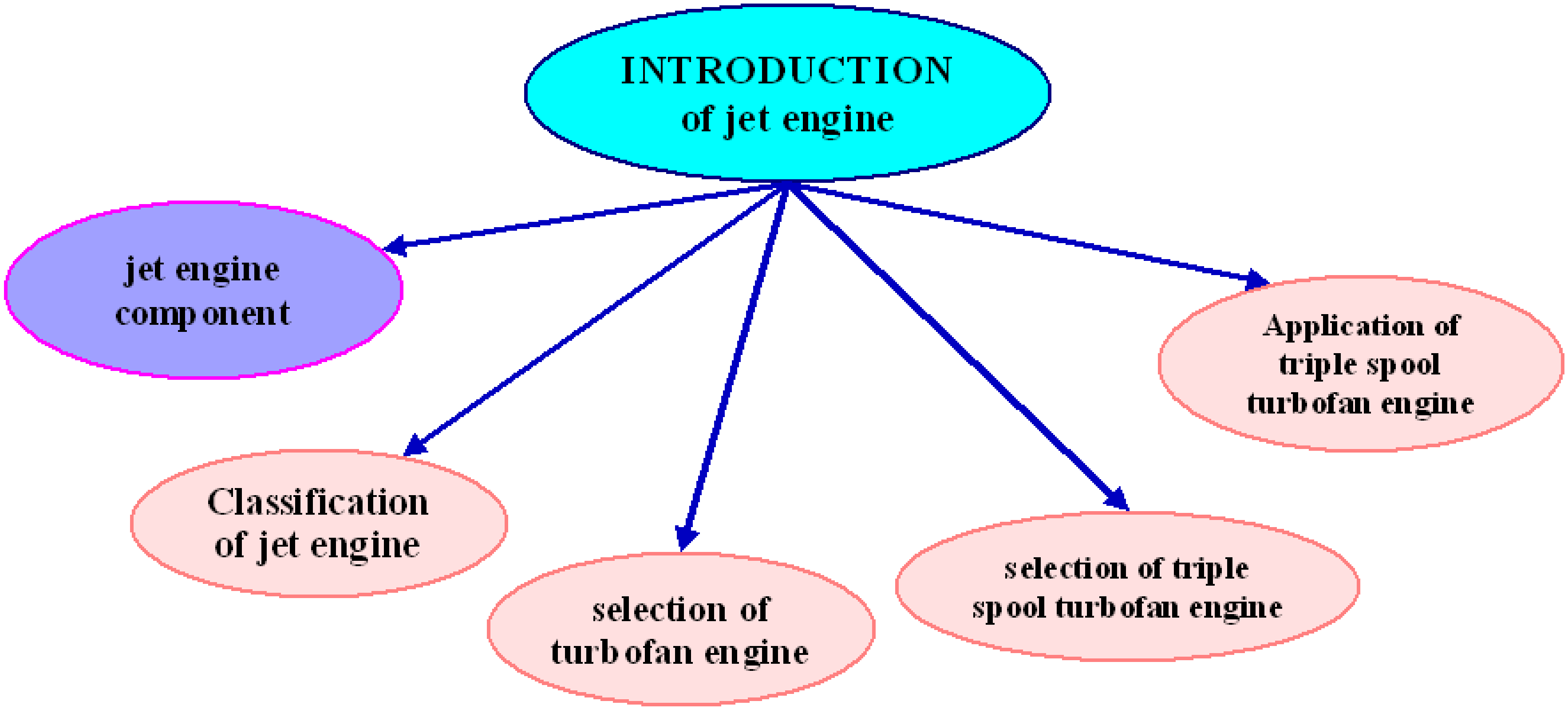
Application of
triple spool
turbofan engine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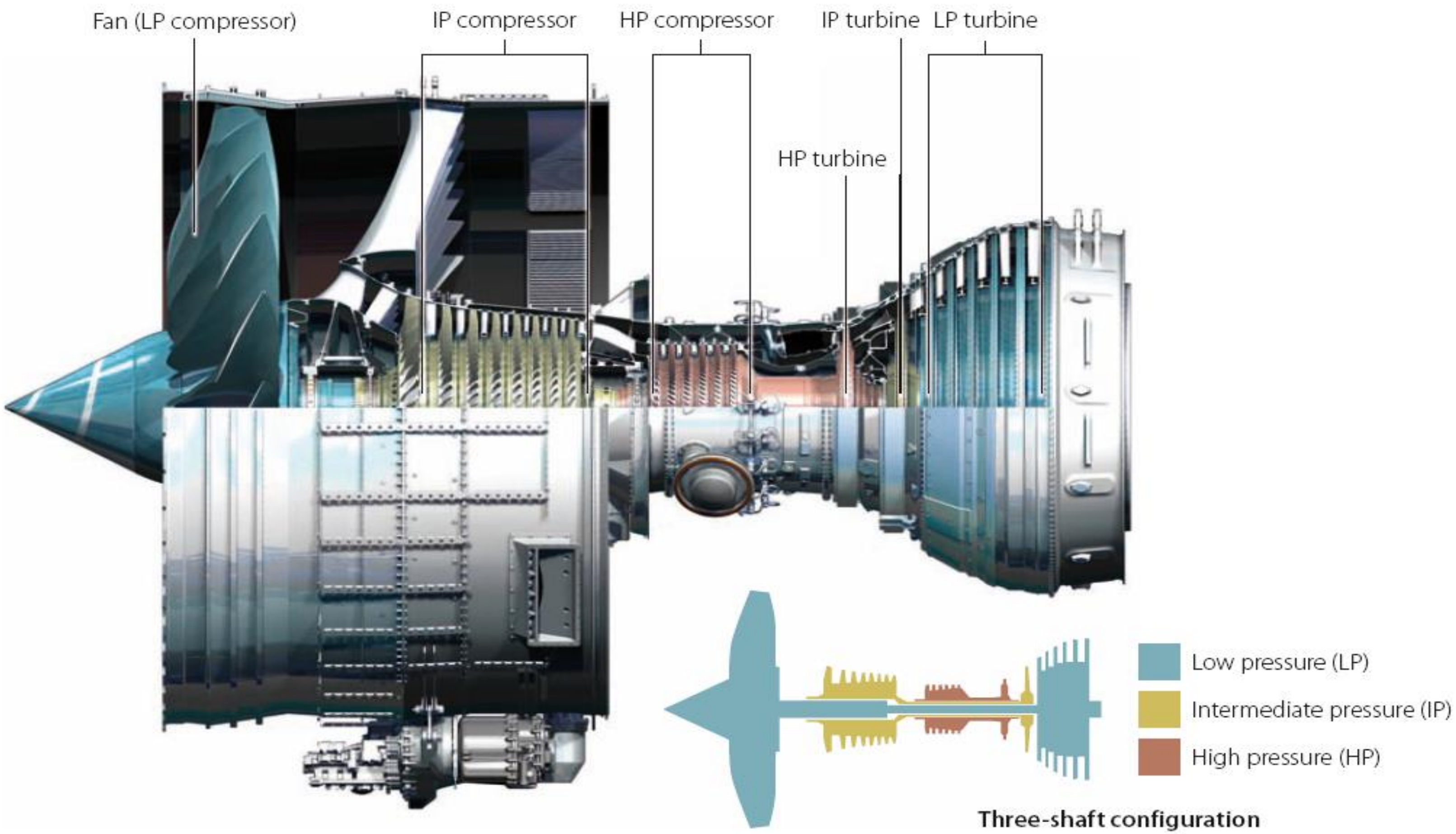
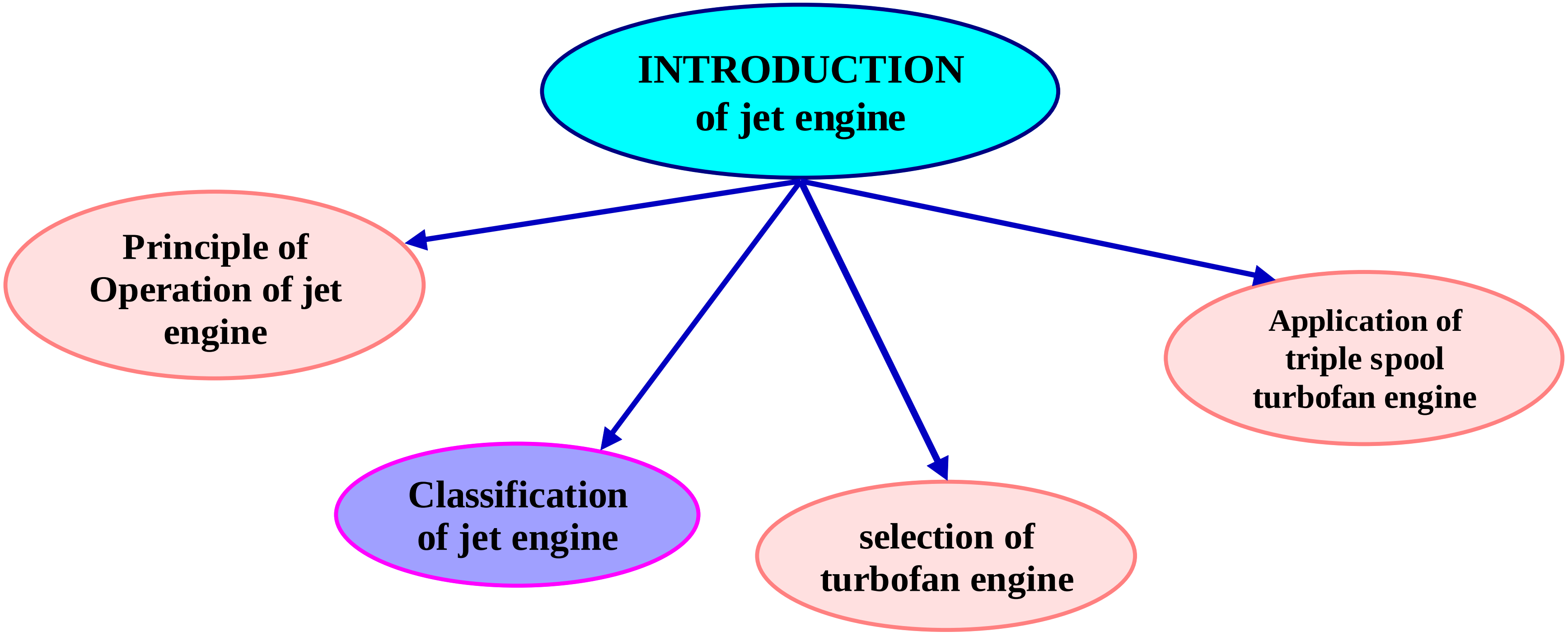
TURBOFAN TRIPLE SPOOL TRENT 700

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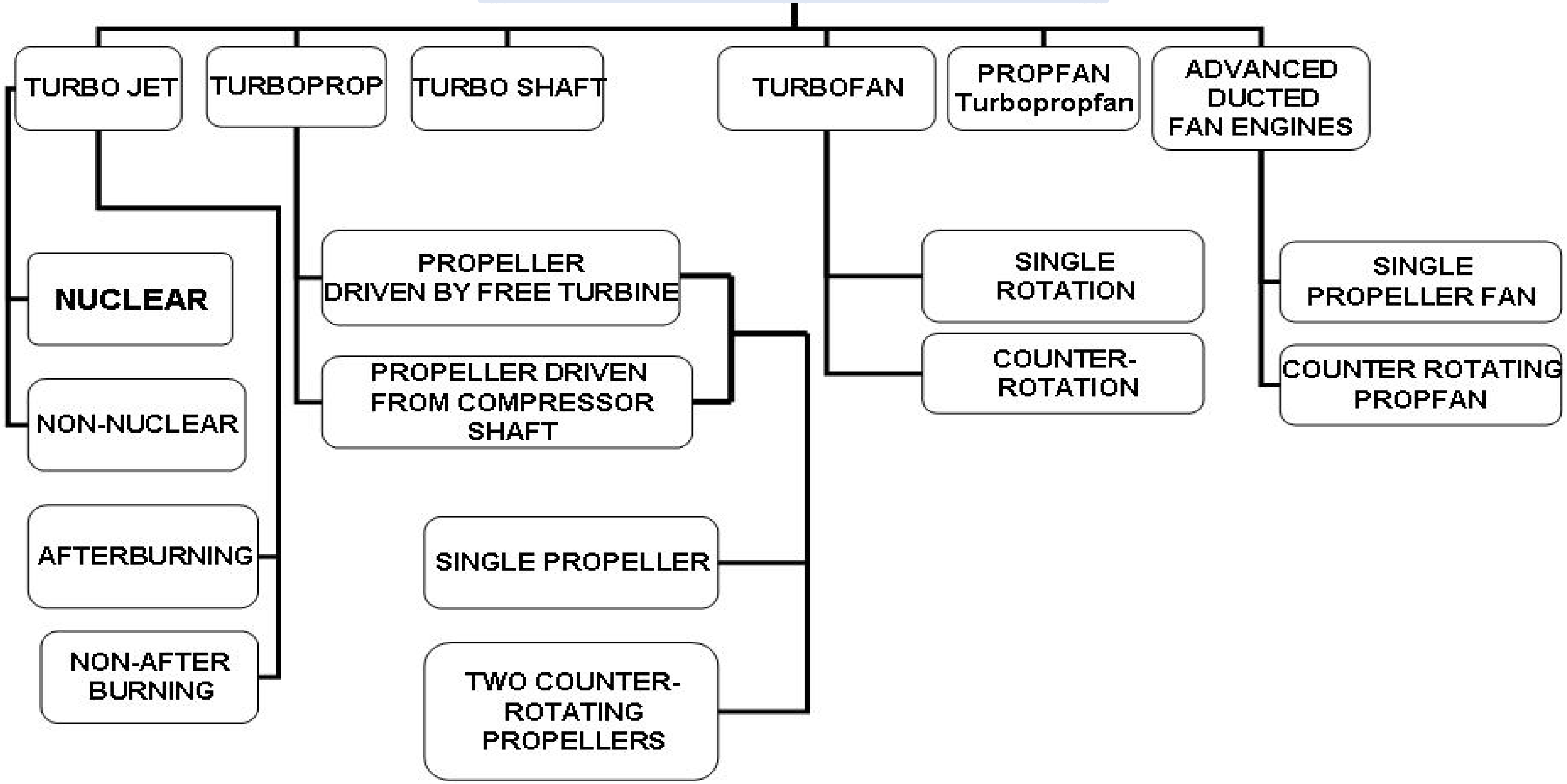
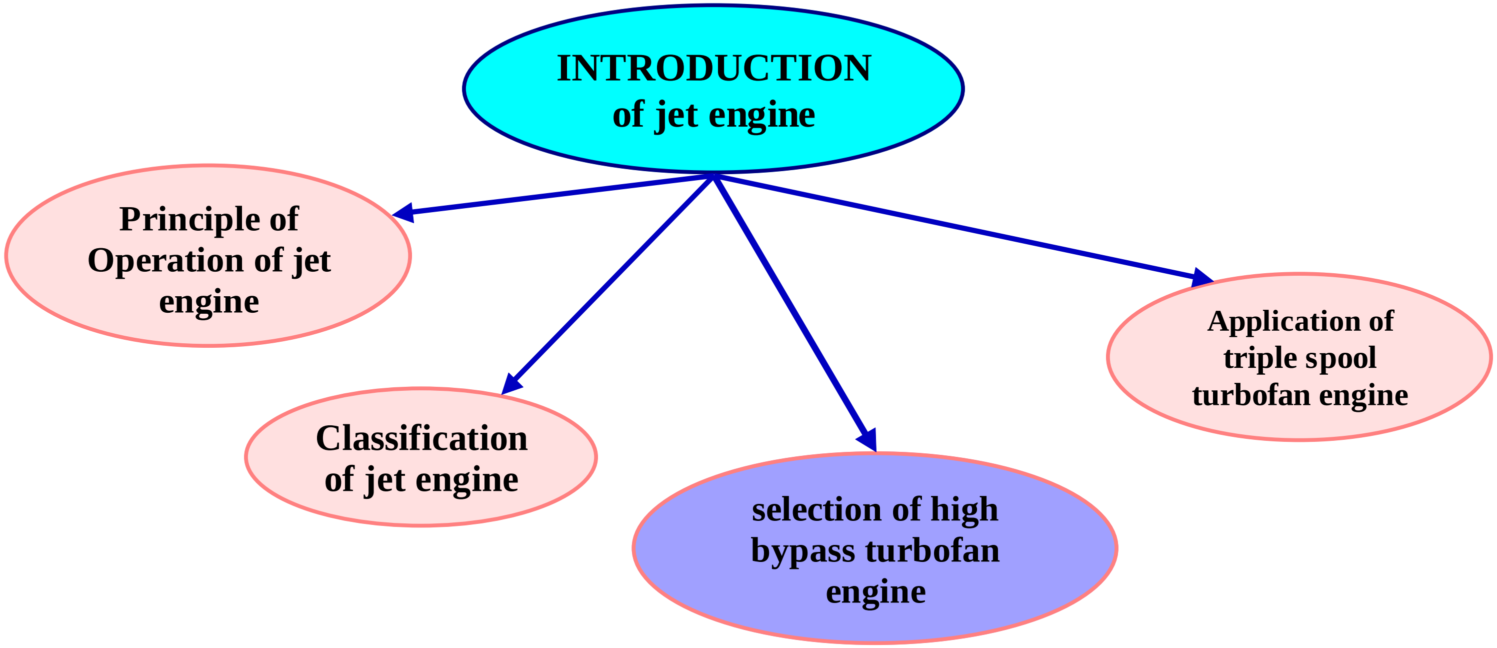
Jet engine classification

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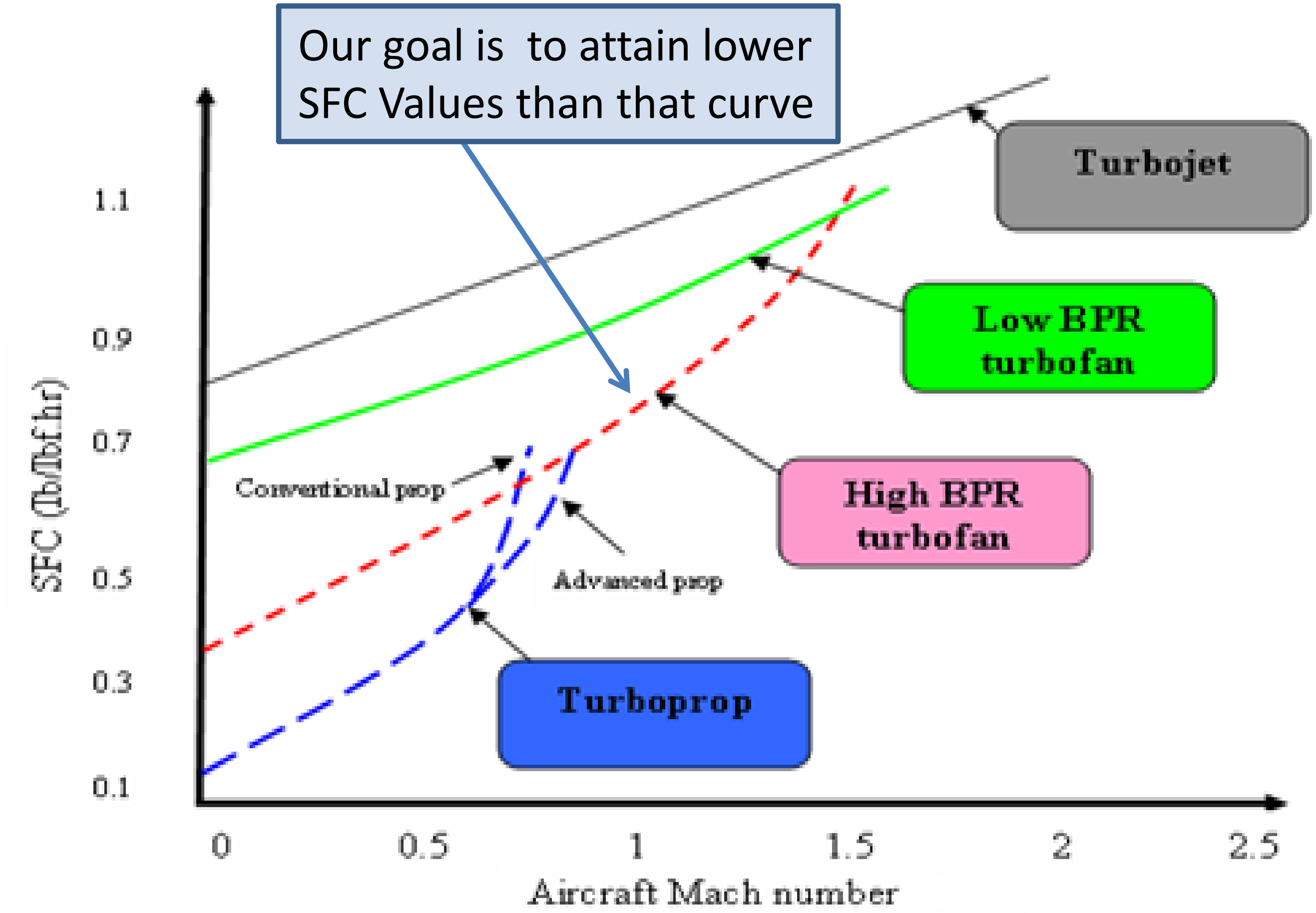
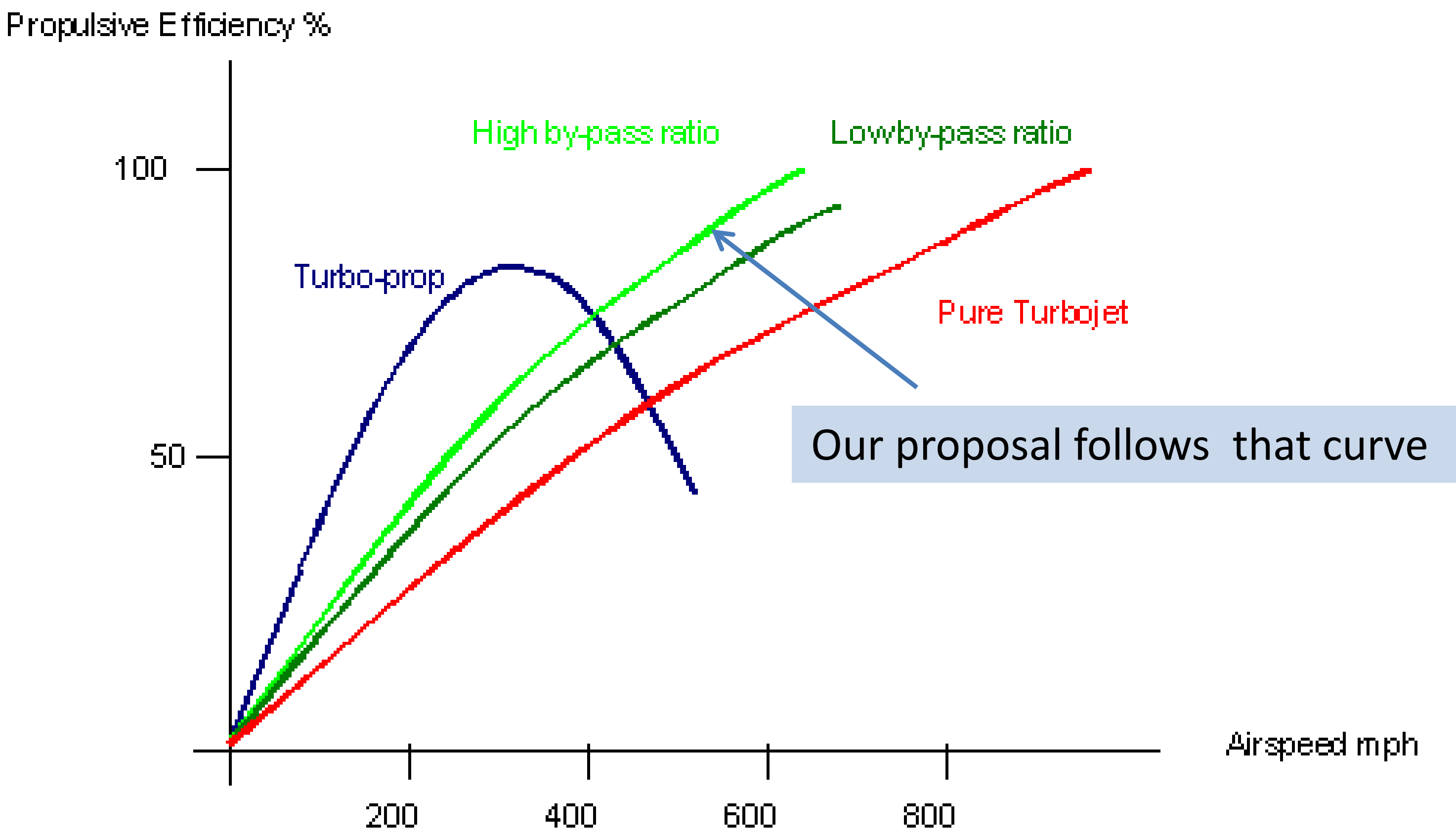
1- Lower SFC than turbojet and low bypass turbofan



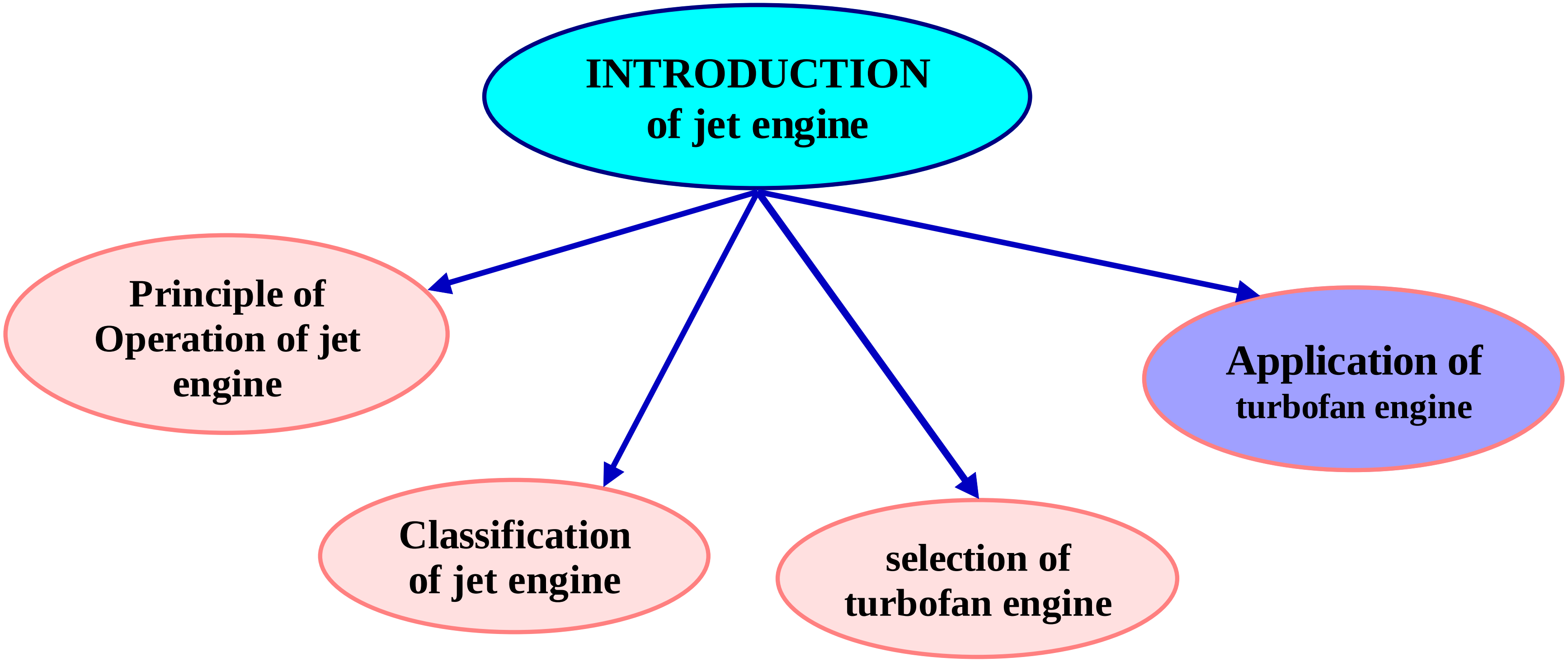
1- Higher propulsive efficiency than other engines at high air speed



3- Higher thrust provided by high-bypass

4-Lower emission

5- Lower noise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Rolls-Royce Trent 700

A 330

Rolls-Royce RB211

Boeing 757

General Electric GE90-115B1

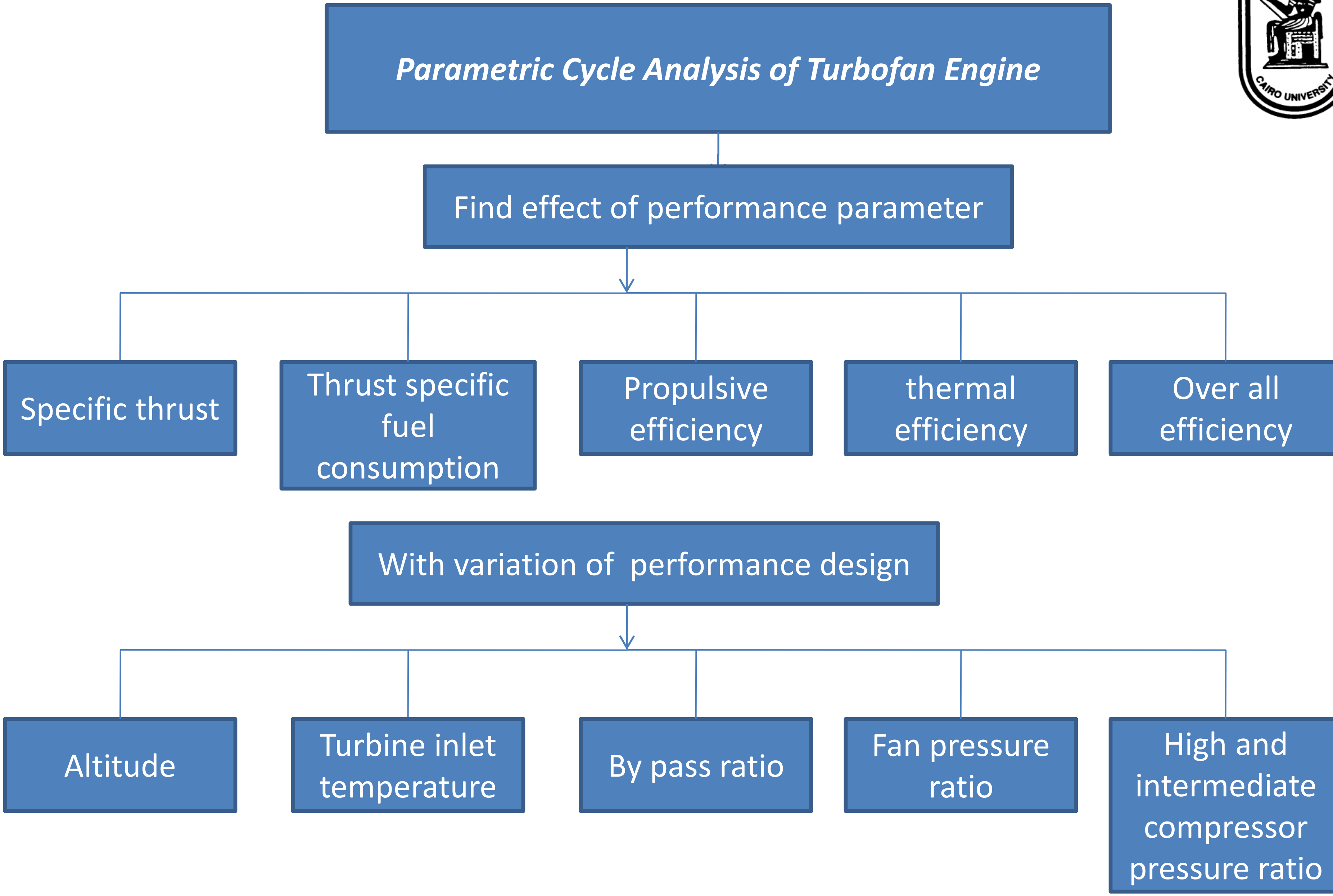
Boeing 777

GP7200

A 380

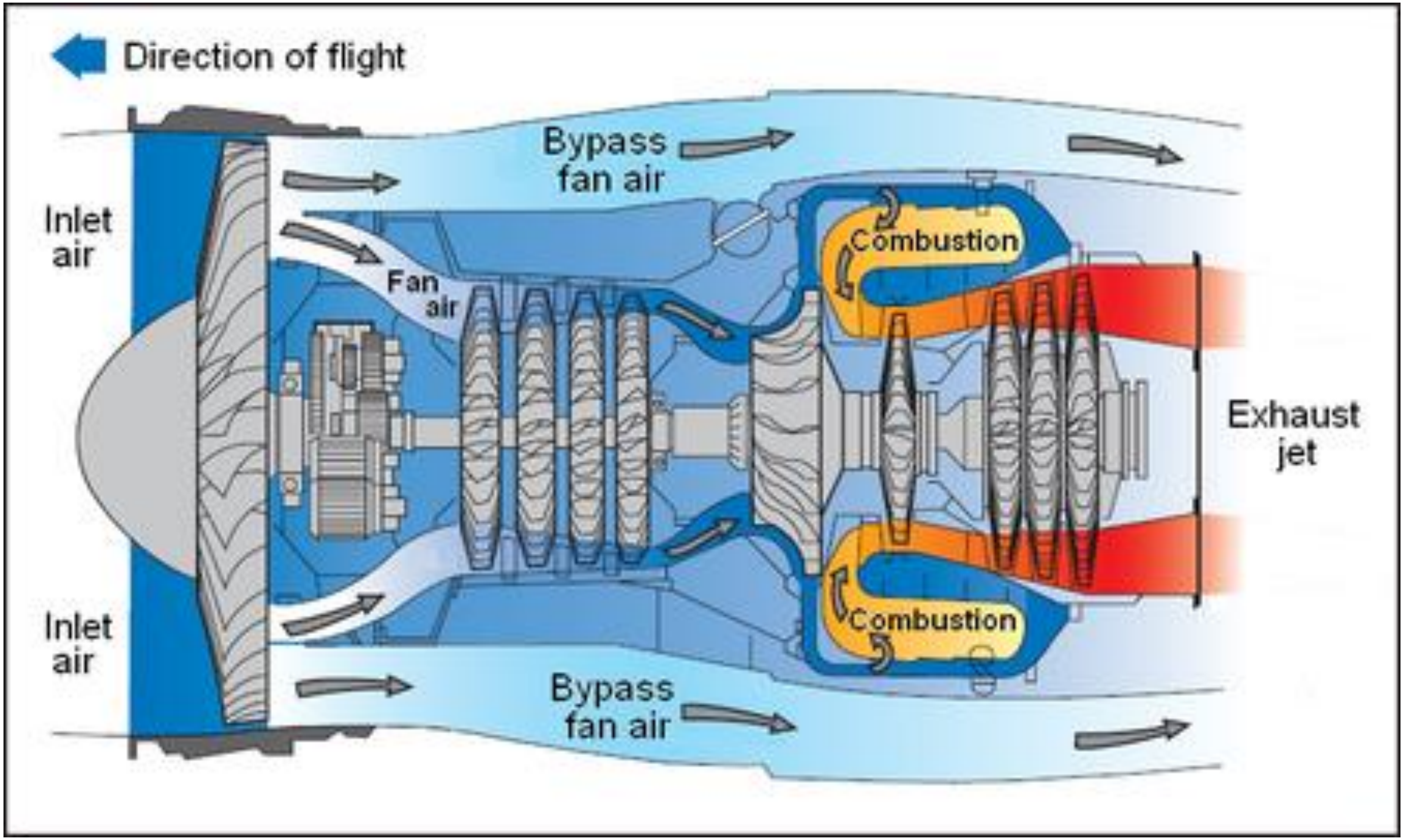
Aim of this research

The proposed system (closed Core System) would solve erosion and corrosion problems as there will be no need for blades made of very special and costly materials to withstand all high temperature problems associated with older designs . It will naturally be safer from **bird strikes**. Any external air disturbances will have no significant effects on core performance due to the closed independent nature of the core and especially at very high Bypass ratio up to 40:1 that will help to achieve lower fuel consumption rates than conventional engines.

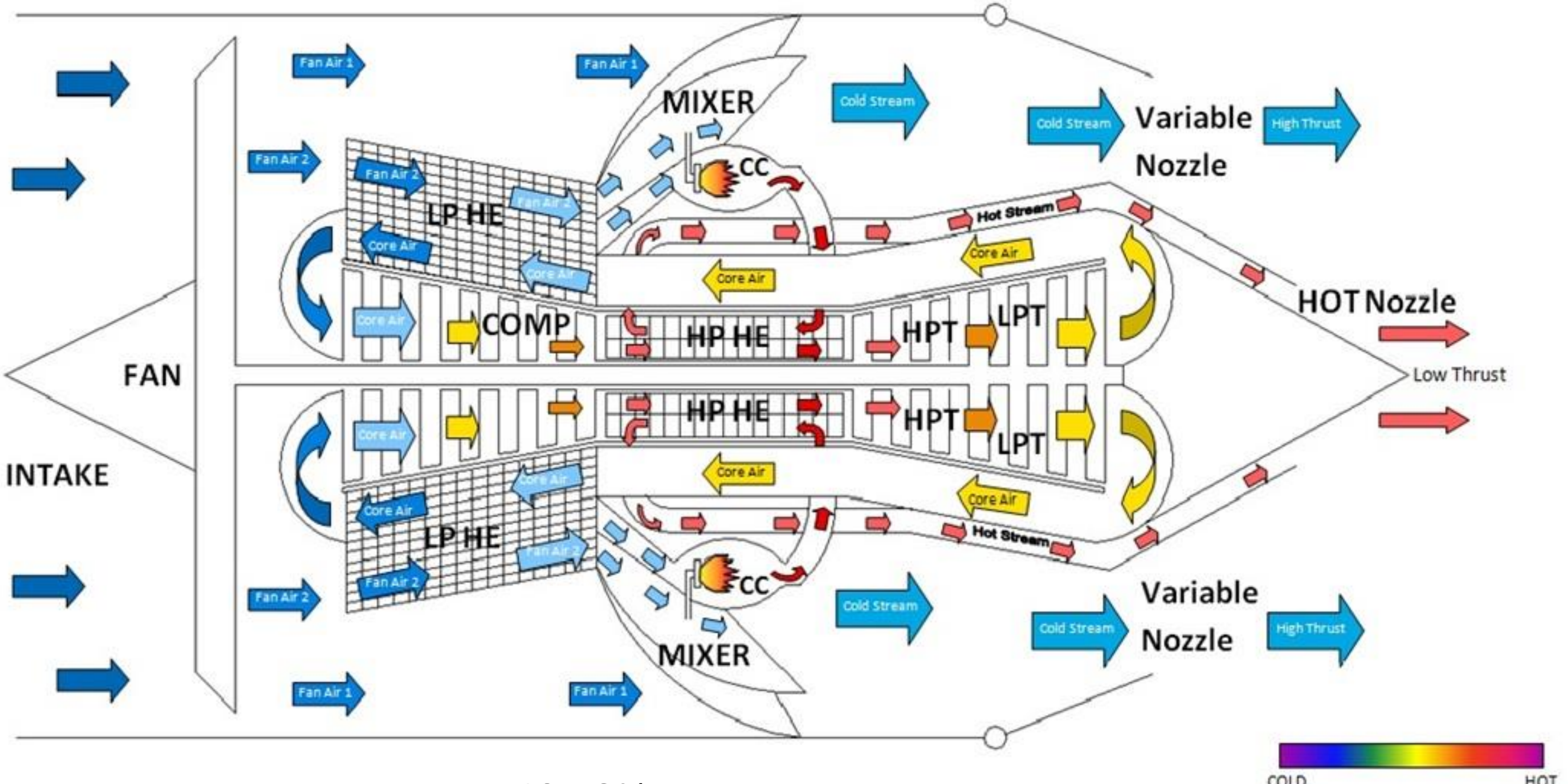

Parametric Cycle Analysis of Turbofan Engine
Find effect of performance parameter
Specific thrust
Thrust specific fuel consumption
Propulsive efficiency
thermal efficiency
Over all efficiency
With variation of performance design
Altitude
Turbine inlet temperature
By pass ratio
Fan pressure ratio
High and intermediate compressor pressure ratio

Simple flow chart for Turbofan Engine

η = 10-15%
Bypass ratio up to 10:1



Triple Stream Turbofan New Engine (TSTE) Flow Chart



η = 40-53%

Bypass ratio = 40:1

Triple Stream Turbofan Engine [TSTE]

Areas of Research Development

- Heat exchanger Design   plate to plate exchanger   is optional
- Heat exchanger materials   Aluminum Nitride is an option
- Flow reversal losses

- Amount of air in inner loop variation versus flight faces
- Control of various parameters
- Pay back period and cost analyses

Layout of engine`s states

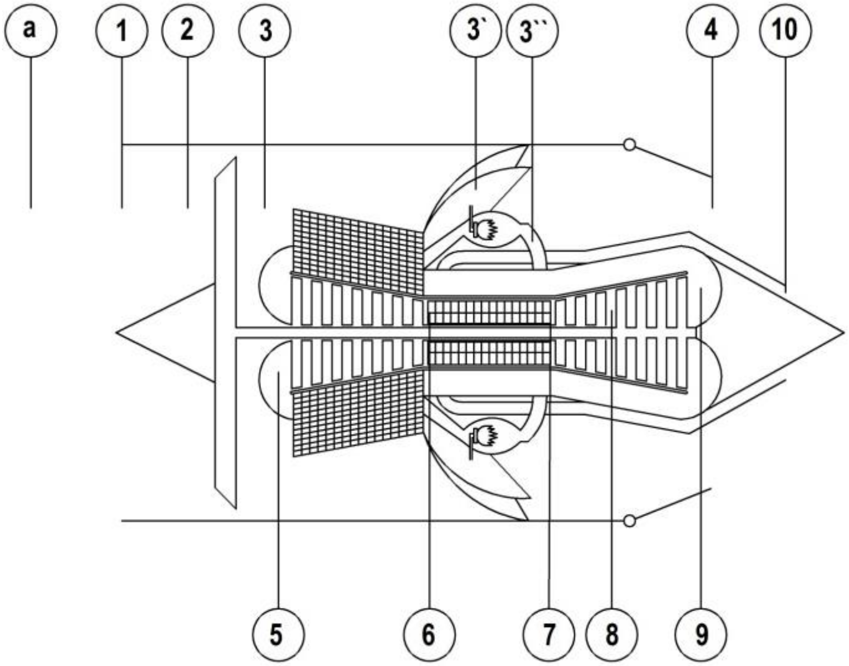


Table 1: Triple Stream Turbofan Engine thermodynamic cycle

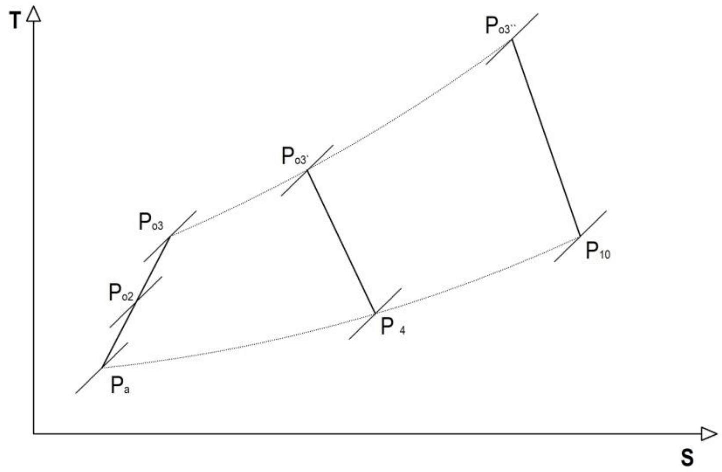
Process	Description	Process	Description
a - 2	Diffuser	3`` - 10	Hot Nozzle
2 – 3	Fan	5 - 6	Compressor
3 – 3`	Second Heat Exchanger and Mixer	6 - 7	First Heat Exchanger
3 – 3``	Combustion Chamber	7 - 8	High Pressure Turbine
3` - 4	Cold Nozzle	8 - 9	Low Pressure Turbine

Engine`s cycle is consists of two sub cycles:

– External cycle (Fan, second heat exchanger, Combustion Chamber and Nozzles).

- Internal cycle (Closed Core System) (Compressor, First heat exchanger and Turbines).

Triple Stream Turbofan New Engine`s T-S diagram of External Cycle.



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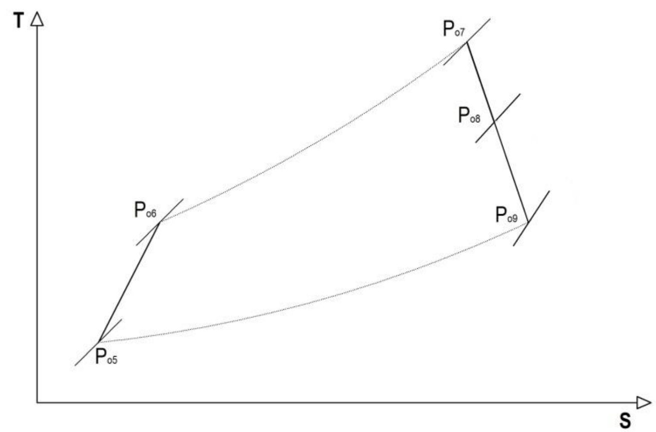
Triple Stream Turbofan Engine`s T-S diagram of Internal Cycle (Core)



Forms of performance equations are given

Thrust specific fuel consumption

$$TSFC = \frac{\dot{m}_f}{T}$$

Thermal efficiency

$$(\eta_{th})_{\text{static}} = \dot{m}_a (1+f) \frac{u_e^2}{2\dot{m}_f Q_R}$$

•

Propulsive efficiency

$$\eta_p = \frac{u(T_h + T_c)}{u(T_h + T_c) + W_h + W_c}$$

A comparison between some similar engines to TSTE and TSTE in some parameters such as (Fan Diameter, Bypass Ratio, Overall Pressure Ratio, Static Thrust and TSFC) is listed below in Table 2

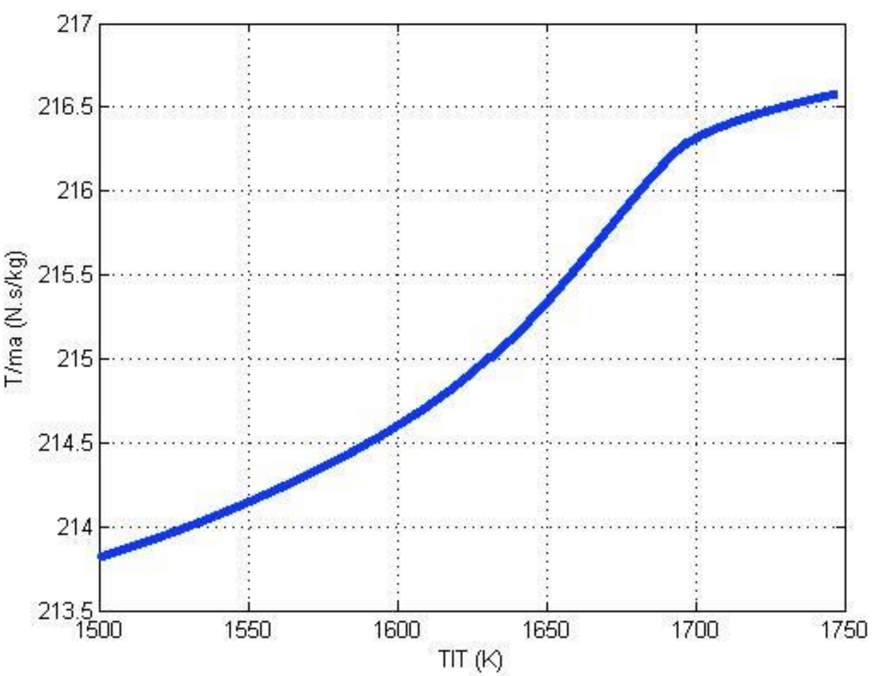
Table 2: Comparison between Triple Stream Turbo Fan Engine (TSTE) and Some Similar Engines i Performance at Static Condition (Takeoff).

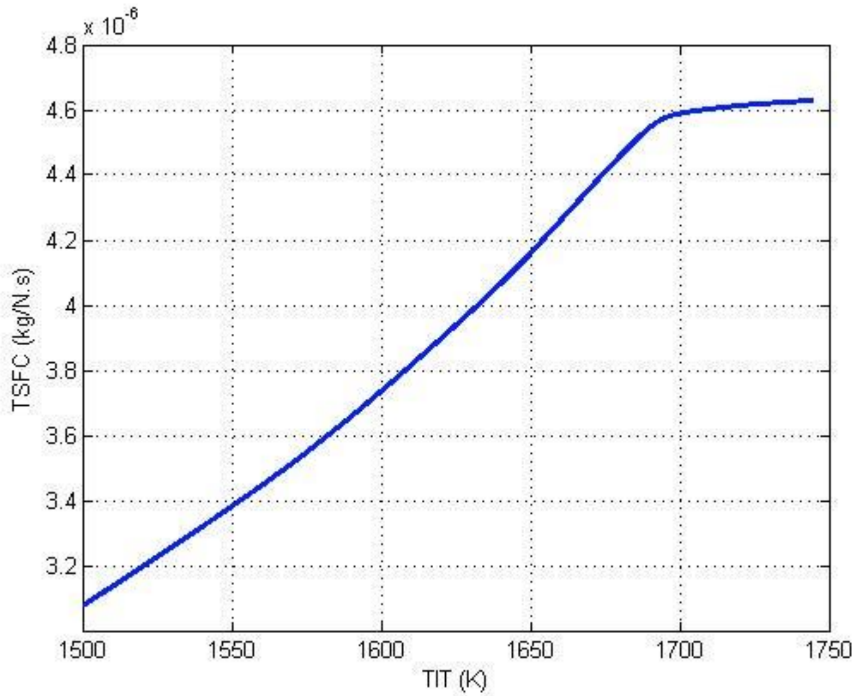
	TSTE	GEnx-1B70	GEnx-2B67	GP 7200	Trent 900	Trent 7000
Fan Diameter m (in)	3.1 (120)	2.82 (111)	2.67 (105)	3.16 (124)	2.95 (116)	2.84 (111.8)
Take off Bypass Ratio	40:1	9:1	8:1	8.8:1	8.7:1	10:1
Overall Pressure Ratio	10	43.8	44.7	43.9	39	50
Static Thrust KN (lbf)	340 (76440)	310 (69800)	295.8 (66500)	363 (81500)	340 (77000)	320.4 (81000)
TSFC Kg/N.h (lb/lbf.h)	0.012 (0.11)	0.0581 (0.567)	0.0486 (0.532)	0.0557 (0.58)	0.0558 (0.55)	0.0484 (0.47)

From the previous table one can notice that:-

- Fan Diameter is nearly equal to the other engines listed above.
- Idea in TSTE is to increase the bypass ratio up to 40:1 and to decrease the overall pressure ratio to 10:1.
- Static Thrust of TSTE is roughly equal to the other engines listed above.
- TSTE achieved lower TSFC 70% than the other engines listed above.

Variation of T/ma & TSFC for Triple Stream Turbofan Engine with TIT.





As shown above we can notice the very low TSFC which can save to 70% from Take off fuel.

Needed Actions

- Further develop the concept
- Seek sponsoring agents
- Seek financial support for implementation

Conclusions

- One can have a Turbofan engine with a core that has cheaper integrated components.
- This also would imply lower maintenance costs.
- This new core would mean an aircraft that is safer from bird strikes.
- Lower fuel consumption is also an added asset.
- This core is more resistant to debris or any air disturbances than the present modern turbofan engines.

Thank You