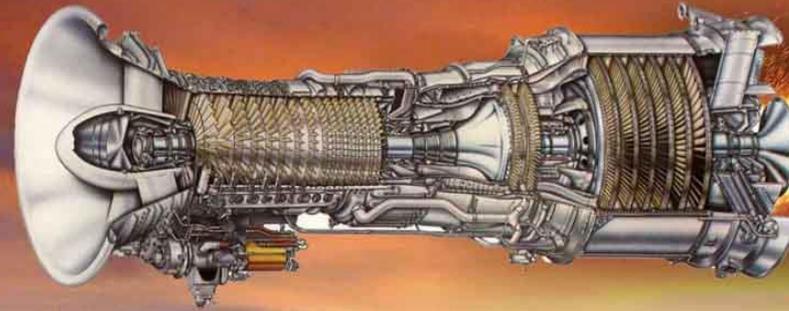




GTTT (V)



NATIONAL COMPETENCE IN MARINE GAS TURBINE PROPULSION



CDR CHV SUDHAKAR
GTTT (V)



ON THE ANVIL

INTRODUCTION

CHALLENGES – DESIGN, METALLURGY & MANUFACTURING PROCESSES

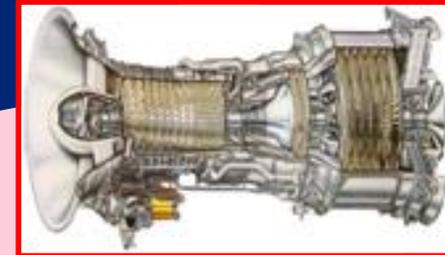
CURRENT INDIGENOUS COMPETENCE

WAY AHEAD



INTRODUCTION

LM2500 – 33000 HP



M3 – 13750 HP



M15 – 9000 HP



M36 – 19540 HP



M2 – 10000 HP

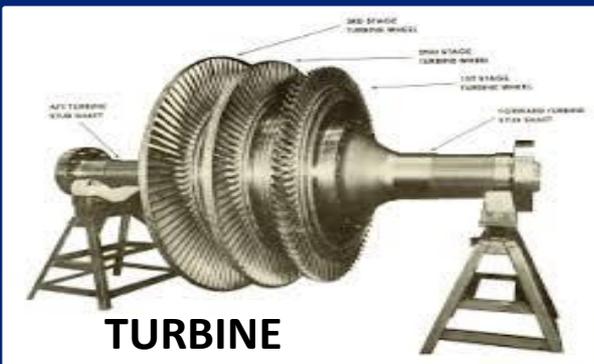
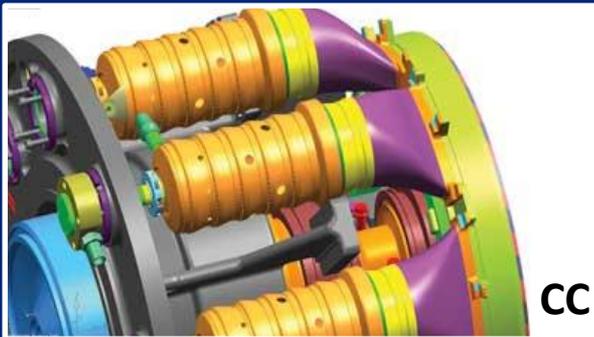
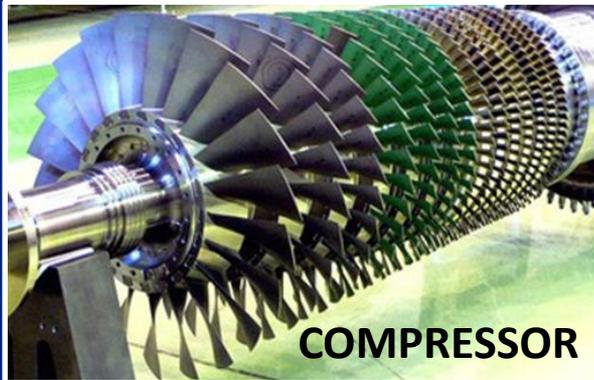


INTRODUCTION

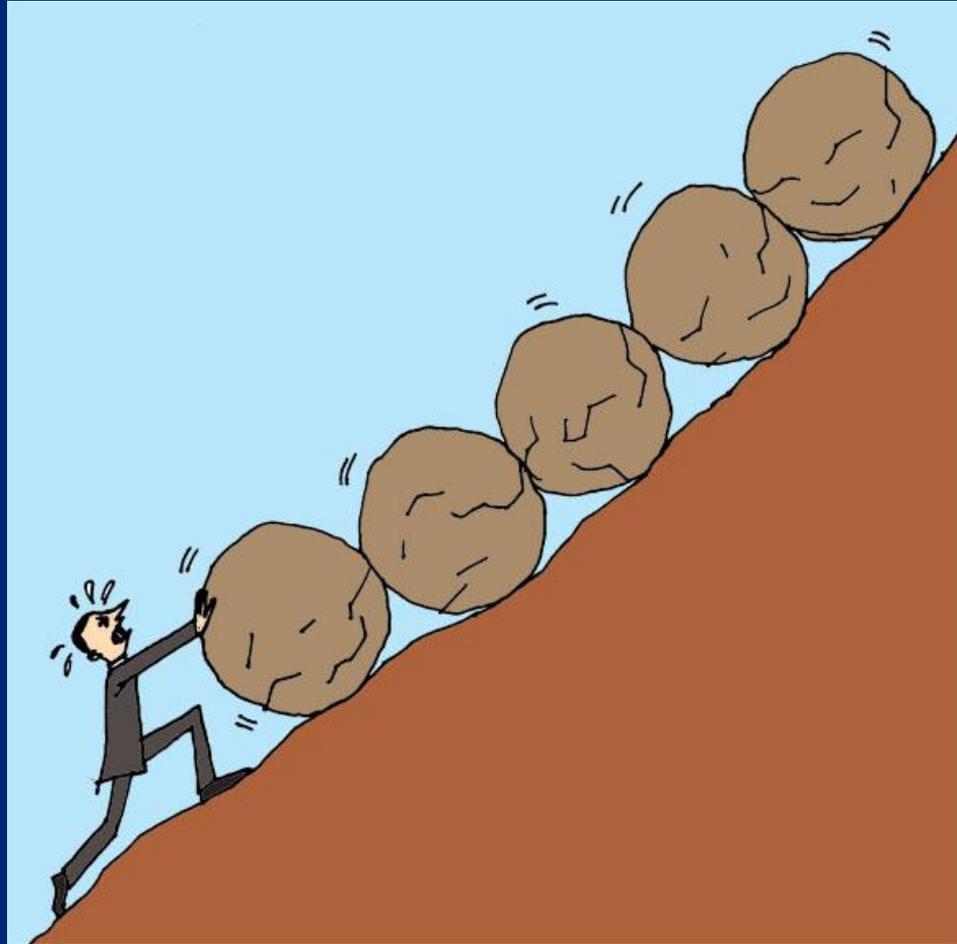




INTRODUCTION



- **THREE MAJOR COMPONENTS**
- **DESIGN OF EACH COMPONENT VERY COMPLEX**
- **R & D AND INNOVATION**
- **NEW MATERIALS & COATINGS**
- **IMPROVED ENGINEERING AND MANUFACTURING**



CHALLENGES



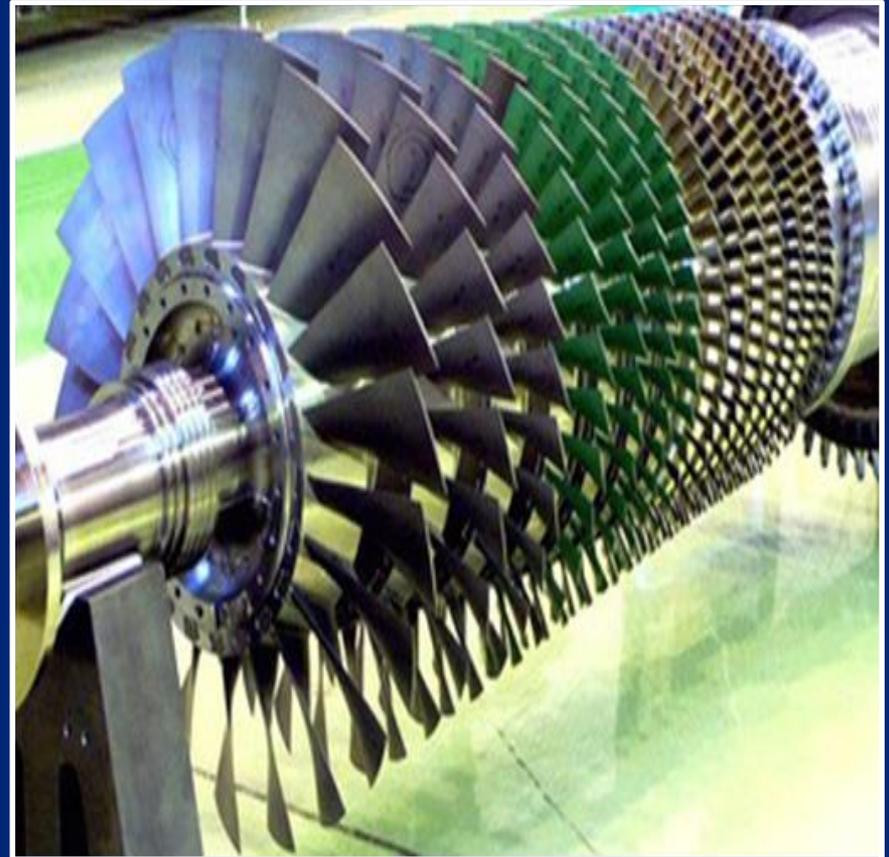
DESIGN CHALLENGES

**HIGHLY
SOPHISTICATED
AERODYNAMICS**

**ABILITY TO
MANAGE STALL**

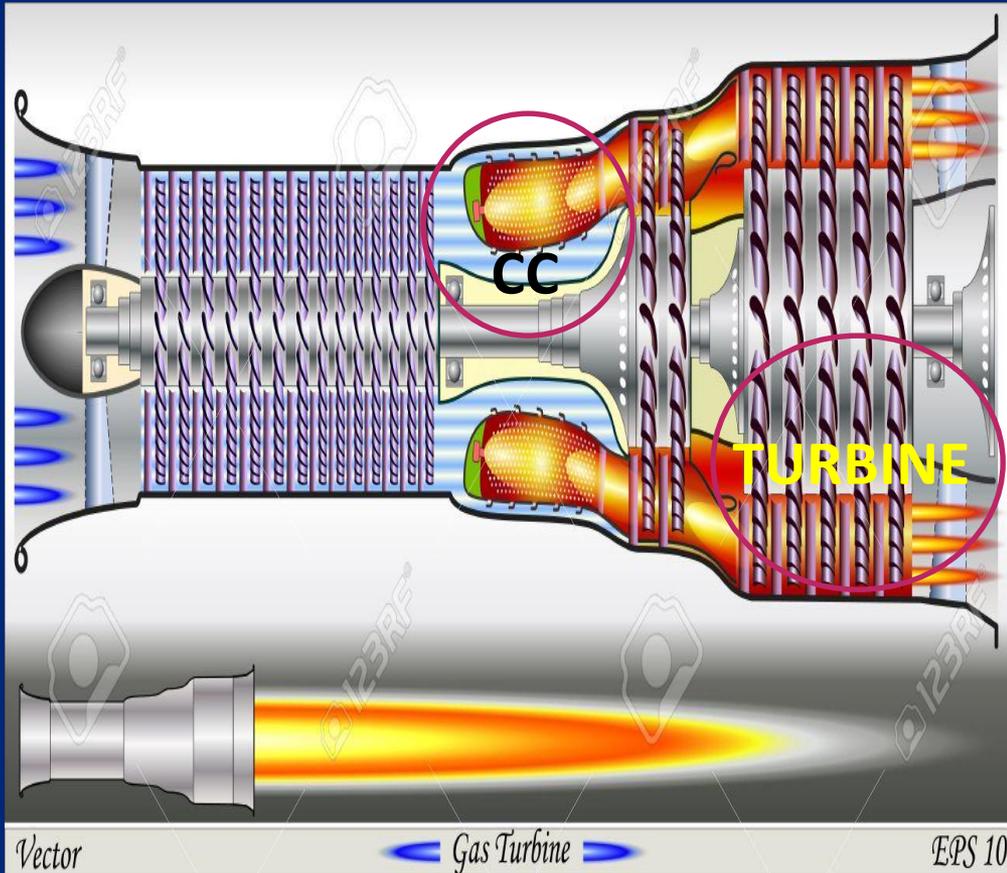
**INLET GUIDE VANES
AND BLEEDING AIR
FROM COMPRESSOR
STAGES**

COMPRESSOR





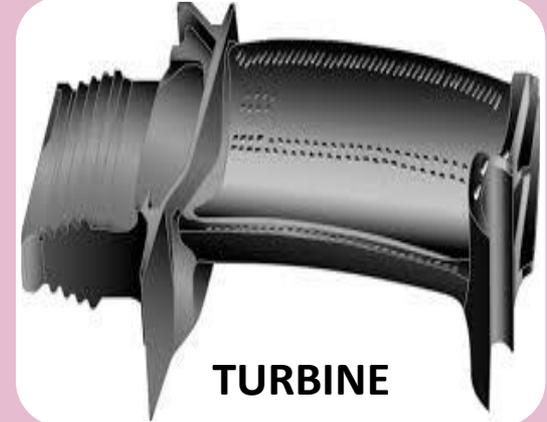
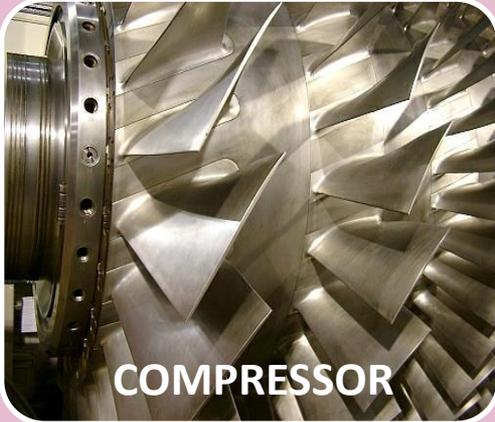
DESIGN CHALLENGES



- COMBUSTION AT HIGH TEMPERATURES WITH A MINIMUM PRESSURE DROP AND EMISSION
- COOLING TECHNOLOGY
- MATERIALS TO WITHSTAND HIGH TEMPERATURES



METALLURGICAL CHALLENGES



- * HIGH STRENGTH TO WEIGHT RATIO

- * TITANIUM ALLOYS

- * HT CREEP RUPTURE STRENGTH

- * OXIDATION RESISTANCE

- * EMISSION CONTROL

- * NICKEL BASE SUPERALLOYS

- * HIGHER FIRING TEMP & HOT CORROSION

- * NI BASE SAs WITH SPECIAL PROCESSING

- * TBCs



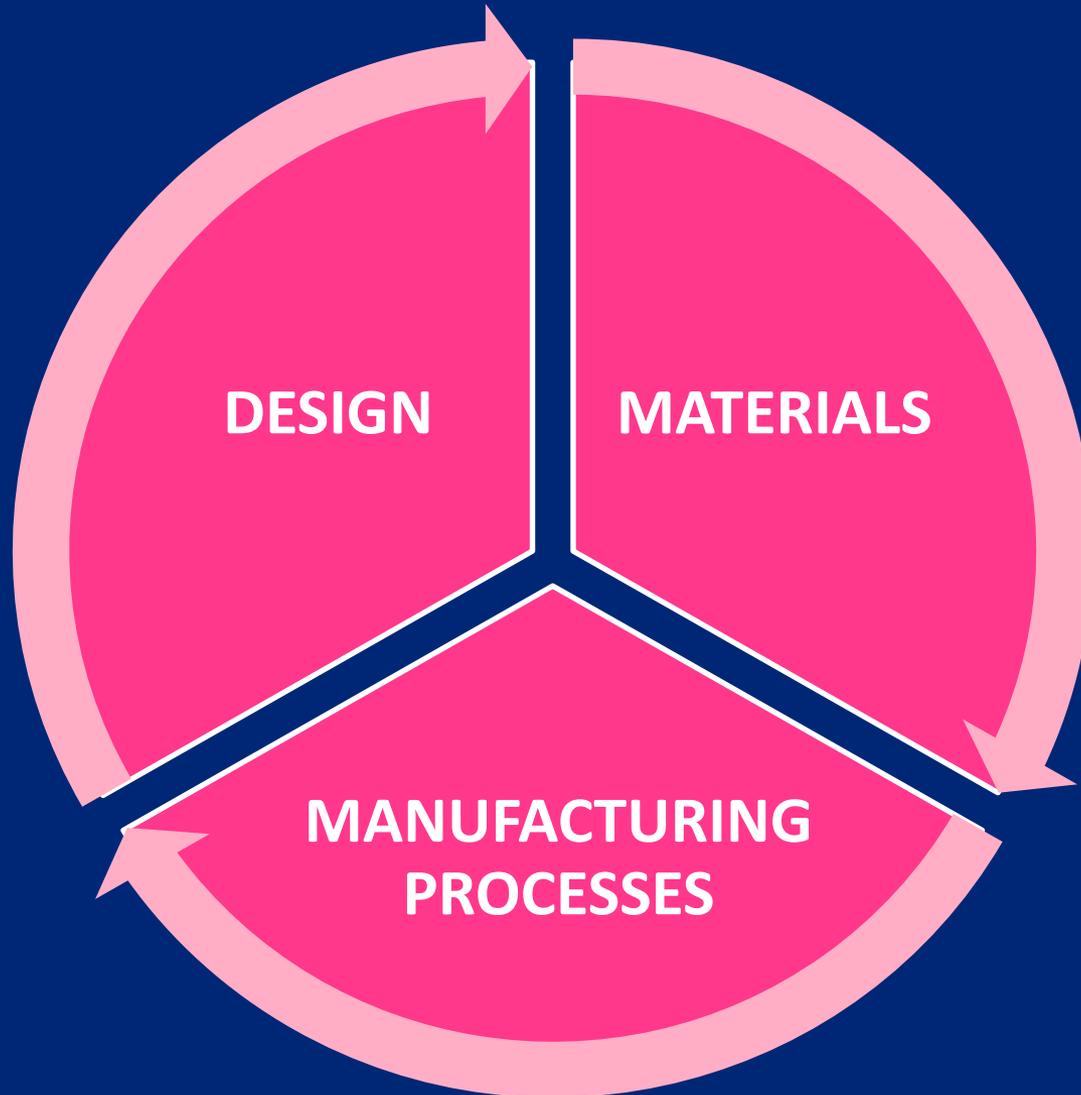
MANUFACTURING CHALLENGES



- **CASTING FOR STATIC COMPONENTS**
- **FORGING FOR ROTATING COMPONENTS**
- **POWDER METALLURGY**
- **EQUIAXED INVESTMENT CASTING**
- **DIRECTIONALLY SOLIDIFIED CASTING**
- **SINGLE CRYSTAL CASTING**



CURRENT COMPETENCE





GAS TURBINE DESIGN

- **CONCERTED EFFORTS OVER THE LAST 50 YRS PUT INTO DESIGNING A GAS TURBINE**
- **PREMIER ORGANISATIONS - GTRE, HAL AND BHEL**

GTRE

- **SUCCESSFUL DESIGNS INCLUDE GTX37-14U AFTER-BURNING TURBOJET AND TURBOFAN DERIVATIVE, GTX37-14UB**
- **'KAVERI' GAS TURBINE (GTX-35VS) FOR TEJAS & KMG T**



KAVERI GAS TURBINE



- **INDIGENOUS GAS TURBINE ENGINE FOR LCA OR TEJAS FIGHTER**
- **INTEGRATED WITH IL-76 AIRCRAFT AT GROMOV FLIGHT RESEARCH INSTITUTE (GFRI), RUSSIA**
- **82 KN THRUST ACHIEVED AGAINST DESIRED THRUST OF 90 – 95 KN**

LACK OF TECHNICALLY SPECIALISED MANPOWER, NON-AVAILABILITY OF TEST FACILITIES, DENIAL OF TECHNOLOGIES BY FOEMs AND TECHNOLOGICAL COMPLEXITIES



KAVERI MARINE GAS TURBINE (KMGT)



- **CLOSEST TO PRODUCE A MARINE GT**
- **CORE OF THE KAVERI ENGINE AUGMENTED WITH LP SPOOL AND PT**
- **TESTED AT VISA KHAPATNAM UPTO 12 MW SUITABLE FOR SNFs**
- **ACHIEVED RATED POWER BUT COULD NOT SUSTAIN**

SHORTCOMINGS ON METALLURGY OF HOT SECTION COMPONENTS AND COOLING TECHNOLOGY



GAS TURBINE DESIGN

HAL

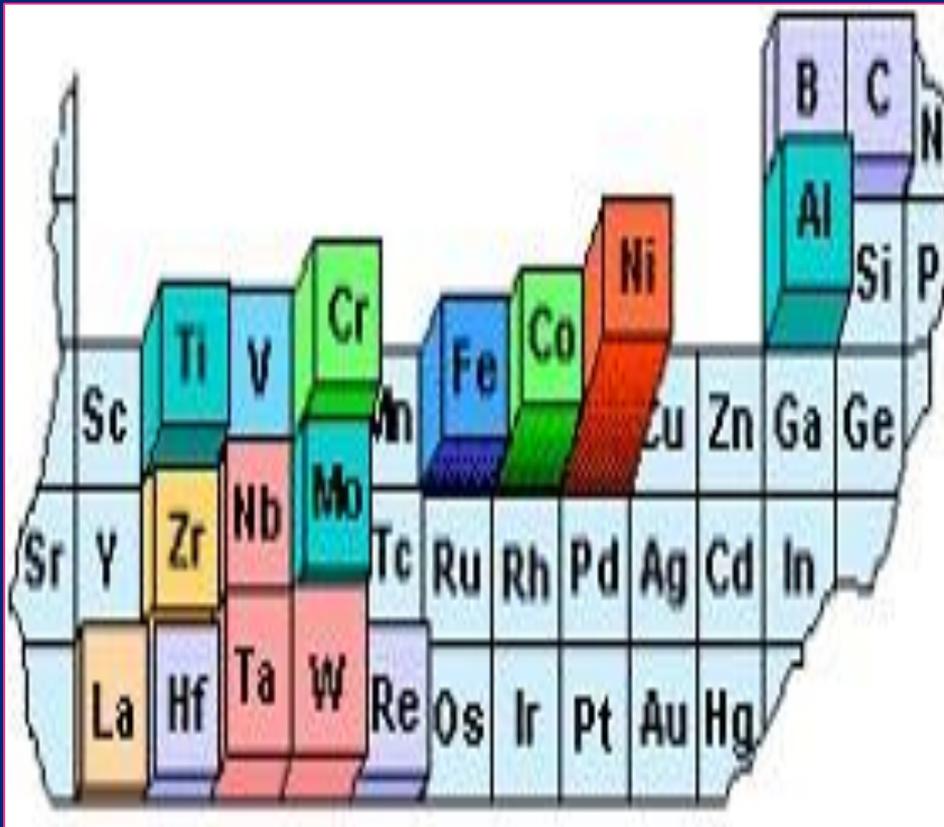
- AERO ENGINE RESEARCH & DESIGN CENTRE (AERDC). SUCCESSFULLY DESIGNED & DEVELOPED AERO ENGINES
- PTAE-7 ENGINE FOR LAKSHYA AIRCRAFT, GTSU-110 STARTER ENGINE FOR LCA (TEJAS) & 25 kN HTFE

BHEL

- HUGE CLIENTELE IN INDUSTRIAL GTs IN POWER AND PROCESS SECTORS
- 100 MACHINES AND ACCUMULATED EXPERIENCE OF OVER FOUR MILLION FIRED HOURS



MATERIALS



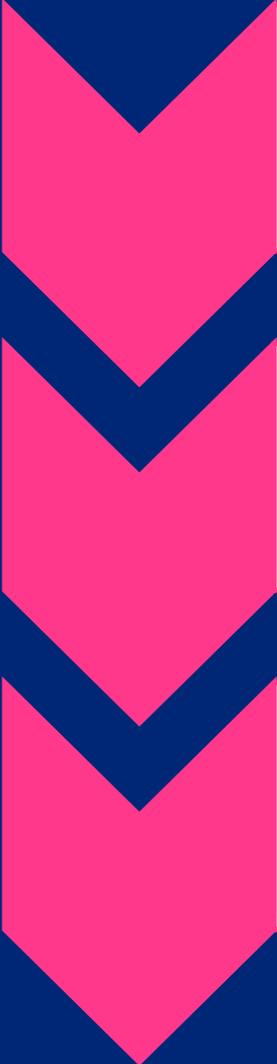
- DEDICATED METALLURGY R & D CENTRES

- MIDHANI DEVELOPED OVER 100 GRADES OF SPECIAL ALLOYS FOR STRATEGIC AND COMMERCIAL SECTORS

- TITANIUM ALLOYS **BT 14, TI 15** FOR COMPRESSOR

- NICKEL BASED SUPERALLOYS **HASTELLOY X, NIMONIC 263, NIMONIC 90 & INCONEL 601** FOR HOT SECTION COMPONENTS

MANUFACTURING PROCESSES

- 
- **CASTING**
 - **FORGING**

- **POWDER METALLURGY**
- **EQUIAXED INVESTMENT CASTING**

- **DIRECTIONALLY SOLIDIFIED CASTING**
- **SINGLE CRYSTAL CASTING**



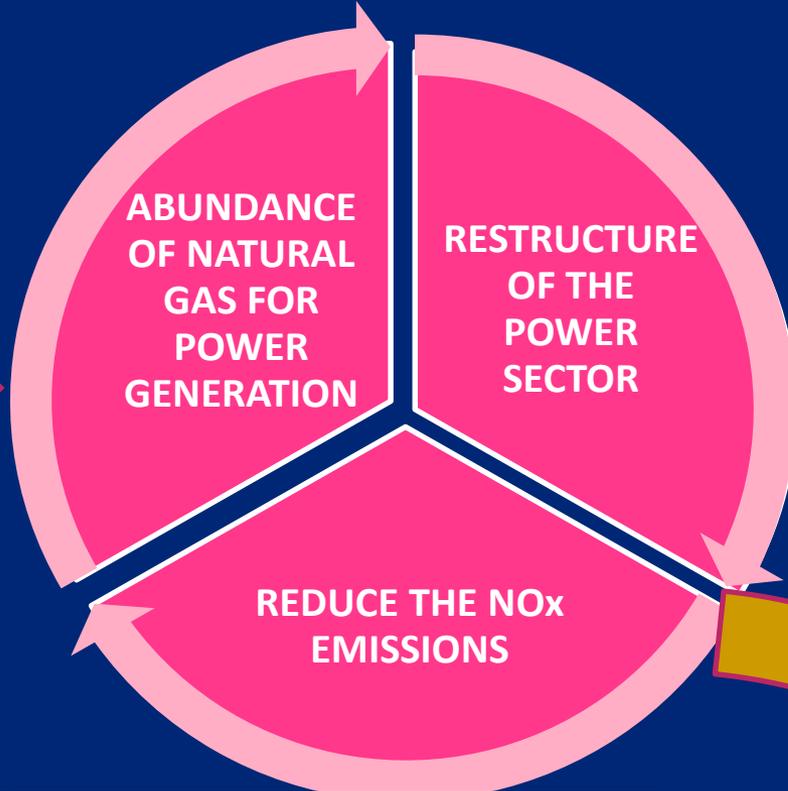
BOTTOMLINE



- **DESIGNING CAPABILITY**
- **MANUFACTURING TECHNOLOGY**
- **ADVANCED MATERIALS**



LESSON FROM HISTORY





WAY AHEAD



RESEARCH & DEVELOPMENT



- CONSISTENT EFFORTS IN R&D OF SUPERALLOYS AND TBCs WHICH CAN WITHSTAND HIGHER TEMPERATURES
- UNSTINTED SUPPORT FROM GOVT BOTH IN TERMS OF MONEY & TIME

- TIME TESTED CONCEPT OF 'BUILDING BLOCK' APPROACH
- COMPRESSOR, COMBUSTOR & TURBINE AS INDIVIDUAL UNITS





JOINT VENTURES



- **COLLABORATION BETWEEN FOEMs & PSUs ALREADY INVOLVED IN GAS TURBINES**
- **COLLABORATION BETWEEN FOEMs WITH INDIAN PRIVATE INDUSTRY**



INDUSTRY - ACADEMIA



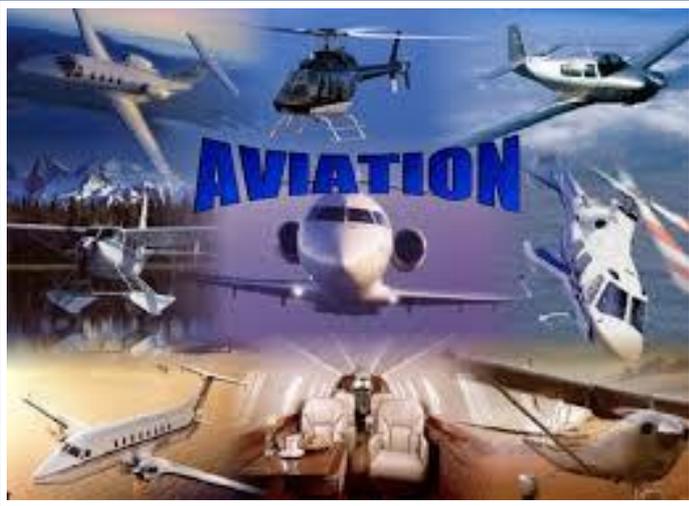
- TECHNOLOGICAL SHORTCOMINGS ARE BEYOND THE REACH OF INDIVIDUAL ORGANISATIONS
- CONSORTIUM TO PROVIDE IMPETUS IN SPECIALISED AREAS OF GT TECHNOLOGY

- PARTICIPATION FROM IITs/ TECH UNIVERSITIES, PSUs & POTENTIAL CANDIDATES FROM PVT INDUSTRY
- STEERED BY THE *INDIAN NAVY*
- BREAKDOWN MULTI-DISCIPLINARY PROBLEM INTO KEY RESEARCH AREAS

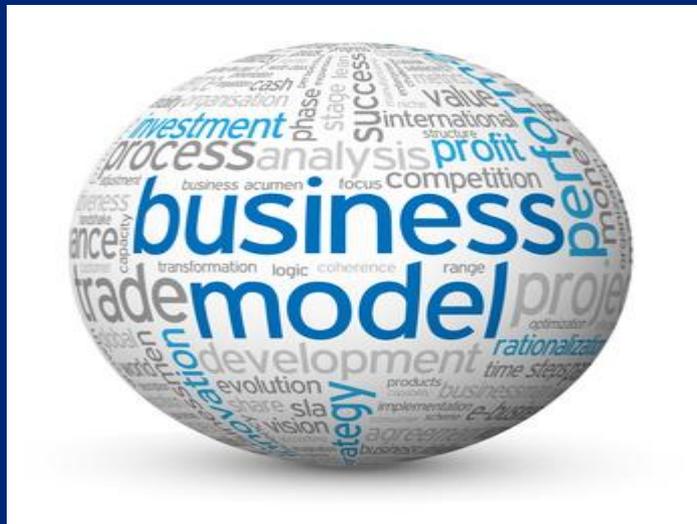




ROLE OF GOVERNMENT



- **INDUSTRY OF CIVIL AVIATION – THE MOST LUCRATIVE MARKET**



- **ENCOURAGING BUSINESS MODEL FOR THE ENTHUSIASTIC FIRMS**



ROLE OF GOVERNMENT



- EXTREME SHORTAGE OF COAL & NATURAL GAS RESERVES
- MIGRATION FROM COAL BASED THERMAL POWER PLANTS TO NATURAL GAS BASED GT POWER PLANTS

TECHNICAL EDUCATION



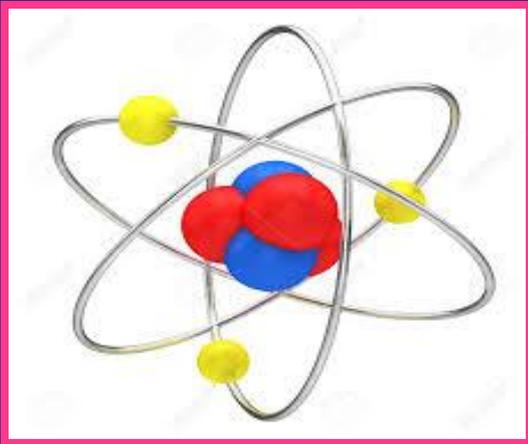
© Can Stock Photo

- TAP THE TALENT AT AN EARLY STAGE
- THRUST NEEDS TO BE GIVEN ON GAS TURBINE TECHNOLOGY AT UG/ PG LEVEL

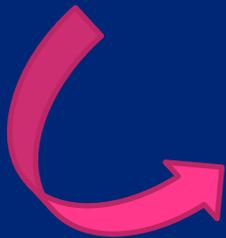


CROSS LEVERAGING

NUCLEAR ENERGY



SPACE



DEFENCE



ROLE OF *INDIAN NAVY*



***BE A FACILITATOR IN ALL COLLABORATIONS**

***SOTRs, SELECTING PROSPECTIVE OEMs & STARTING THE VENTURE**

OVERSEEING TEAMS DURING THE PROCESS OF DEVELOPMENT AND MANUFACTURING



ROLE OF *INDIAN NAVY*



AUGMENT EXISTING TEST FACILITY & ENHANCE INTO AN UNIVERSAL MARINE GAS TURBINE TEST BED

TO CO-ORDINATE & DEVELOP INDIGENOUS SOLUTIONS, SET UP NAVAL RESEARCH ORGANIZATION (NRO)



CONCLUSION

- R & D ON ADVANCED MATERIALS
- JOINT VENTURES WITH ToT

- ENCOURAGING BUSINESS ATMOSPHERE
- ORIENTATION TOWARDS GT TECHNOLOGY AT HIGHER TECHNICAL EDUCATION LEVEL

- SETTING UP OF A NAVAL RESEARCH ORGANISATION
- LEVERAGE EXPERTISE FROM NUCLEAR & SPACE SPHERES



THANK YOU