

Annex E – GLOSSARY

Term	Description of Term
0-D model	A model which presents the gas conditions at discrete stations along the engine and where no physical length is implied.
1-D model	A model which presents the gas conditions at stations along the engine where the longitudinal location is defined in units of length.
2-D model	A model, which presents the gas, conditions at stations along the engine and provides profile information either in the radial or circumferential sense (usually radial).
3-D model	A model, which presents the gas, conditions at stations along the engine and provides profile information both radially and circumferentially.
A8	Exhaust nozzle throat area.
Accuracy	The measure of a model's ability to replicate the true physical entity.
Adaptive model	A model which adjusts itself to a set of observations.
Additive drag	Pressure force on external stream tube surface in front of inlet.
Adiabatic	A process which occurs without loss or gain of heat.
Adjusted performance	The performance, which is a result of trimming, engine inputs following an analysis process – automated or manual.
Adverse weather	Phenomena, such as clear air turbulence, thunderstorms, and low altitude wind shear that may affect safety of flight on each route to be flown and at each airport to be used.
Aero acoustics	The study of sound transmission through the air, in terms of the effects of environmental noise from machinery, vehicles, aircraft.
Aerodynamic forcing functions	Force on blade(s) due to aerodynamic flow over the blade; in conjunction with blade vibration analysis.
Aero-elastics	Coupled motion of solid surfaces due to elasticity of solid materials and aerodynamic forces.
Aerothermo-dynamics	The analysis of aerodynamic phenomena at high gas speeds incorporating the essential thermodynamic properties of gas into the examination.
Afterburning, Reheat, Post Combustion, Augmentation	Addition of fuel and combustion after the last turbine to provide additional thrust.
AIR	Aerospace Information Report (SAE).
Airframe designers	Project team in charge for the entire process of vehicle definition/development: from requirement and specification to production, qualification and in service use.
Airframe propulsion integration	Optimization of the airframe and propulsion flow-field interactions: Lower drag, inlet characteristics, and nozzle characteristics.
Analog simulation	Simulation of processes on an analog computer. An analog computer represents data using continuous rather than digital signals. Analog computers are not frequently used anymore.
Analysis	The process of understanding the behavior of an engine by inspection of measured data from test.
Annular cascade	Set of blade profiles set up axi-symmetrically.
AnSyn	Analysis by Synthesis: the process of replicating a set of measured data by the automated varying of a model's thermodynamic assumptions.
ANSYN Factors (matching)	The factors on a model's baseline assumptions which are generated in the AnSyn process.
API	Application Programming Interface. An API is a series of functions that application programs (such as gas turbine simulation programs) can use to make the operating system do specific tasks.

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Application software	The application software represents the programs that are executed on a computer to perform tasks for the user such as gas turbine simulation calculations.
APU (Auxiliary Power Unit)	Generally addition gas turbine engines to provide electrical power to other aircraft components.
ARP	Aerospace Recommended Practice (SAE).
AS	Aerospace Standard (SAE).
Average engine	Fictitious engine, described by nominal/mean global performance or operability (thrust/surge margin/fuel flow/bleeds/turbine temperature).
Average passage	A method of averaging blade flow conditions to be able to provide conditions for the next blade row.
Axi-symmetric model	A 2D representation of a flow process.
Bandwidth	The range of input frequency over which a model gives valid results.
Beta lines	Set of external lines draw on a compressor map to aid in the construction of appropriate tables that describe compressor performance in a numerical simulation.
Blade geometry	Turbomachinery blade description in terms of blade shape, stagger, lean, inlet and exit metal angles, camber, thickness, solidity, etc.
Blade loading	The work capacity of a stage; Loading is increased as angle of attach is increased until flow separation occurs.
Blade row stacking	Stacking of steady state blade performance to provide overall compressor performance.
Blade surface roughness	Surface roughness that can effect aerodynamic and thermodynamic performance over a compressor or turbine blade.
Blade untwist	Compressor blades are usually twisted from hub to tip to obtain an optimum angle of attack or loading at all radii; Aerodynamic forces can untwist the blade while in motion.
Bleed flows	Airflows to or from a component used for cooling or external air condition within the aircraft.
Body forces	Any external force that act on a volume element of a body and is proportional to the volume, such as gravity force.
Buzz	Usually associate with the inlet where the shock is moving back-and-forth in the throat causing a “buzzing” sound.
Bypass ratio	The ratio of cold stream mass flow-rate to hot stream mass flow rate in a turbofan engine. Ratio of the amount of air that bypasses the core of the engine to the amount of air that passes through the core.
CAD	Computer Aided Design. CAD programs help engineers in the design processes. For example, CAD programs can help design gas turbine components and check compatibility of parts in an assembly. CAD tools often have advanced visualization capabilities to show the geometry of parts and assemblies.
Calibration	The process of adjusting a model to replicate a specific set of data.
Camber	The difference in the inlet and outlet blade angles.
Casing treatment	Refers to compressor or fan tip casing refinements to increase stall margin; may be in the form of circumferential grooves or cross-blade slots.
Cause-effect relationship	An empirical or computer-generated exchange rate of an input to an output of a physical process.
CFD	Computational fluid dynamics – a numerical simulation technique usually solving 3D viscous equations.
CFD turbomachinery	Computational Fluid Dynamics simulation using Navier-Stokes equations for turbomachinery applications.
Choked nozzle operation	An operating point corresponding to the maximum mass flow-rate through the nozzle.
Class	A class defines the structure of an <i>object</i> in <i>object-oriented</i> software code. A synonym for class would be ‘object type’.
Clean inlet performance	No inlet distortion present.

Closed loop control	Control system with a feedback mechanism from the output.
Cold flow rigs	Testing facility providing ambient inlet temperature generating conditions in the test section.
Combustion aerodynamic load	The effects of mass flow rate, combustion volume, and pressure on the stability of the combustion process.
Combustion efficiency	A measure of the combustion process; measures the completeness of the combustion process.
Combustor blowout	Flame-out of the primary combustor.
Combustor primary zone	Part of combustor where combustion is stoichiometric (i.e. all fuel is burned with 100% O ₂).
Combustor relight	Re-ignition of the primary combustor.
Compact engine model	A simplified engine model.
Complexity	A measure of the rigor of thermodynamic treatment within a model.
Component characteristics (CHICS)	Representative performance of an engine component such as a compressor map; Overall pressure ratio and efficiency as a function of corrected airflow rate and corrected speed.
Component level cycle code (CLM)	See Cycle Deck.
Component matching	The process of integrating engine components such that each component operates at the appropriate operating point, working line or trajectory.
Compressor axial gap	The axial spacing between rotor and stator blades of a compressor.
Compressor recovery	Compressor operation that recovers from stall or surge.
Computer platform	The computer platform is the combination of the hardware and software needed for gas turbine performance calculations. The <i>hardware</i> is the physical part of the computer; the <i>operating system</i> represents the software required to use the hardware with application software such as gas turbine simulation programs.
Configuration management	Management of a computer program either by software or by a manual process that sets version control and checks out code to users and checks it back in without ‘stepping’ on the work of others.
Consistency	The measure of a model’s ability to replicate the reference database.
Control logic	Process by which the engine is controlled; usually imbedded within an on-board computer.
Control loops	Feedback loops in a control system. Deviation from a desired output is detected, and an input related to the difference is applied to reduce the deviation.
Control volume	An imaginary boundary encompassing a component which allows it to be considered as a gross entity.
Convergence	The ‘homing’ onto a solution by iteration.
Convergent-divergent nozzle	Type of exhaust nozzle to accelerate the gas flow to supersonic speeds.
CORBA	Common Object Request Broker Architecture. CORBA provides an <i>object-oriented</i> approach to writing <i>distributed applications</i> . Distributed applications and CORBA would enable integral gas turbine simulations using simultaneous execution of different programs simulating separate engine modules, on separate computers at separate locations.
Core flow	Fractional flow that runs gas generator of the turbofan engine; hot stream flow.
Corrected parameters (referred parameters)	Turbomachinery operating point characterizing parameters corrected by inlet thermodynamic conditions to eliminate the dependence (sometimes referred to as non dimensional parameters (mass-flow, rotational speed, pressure ratio) although not truly non-dimensional).
Cowl lip	Front part of an inlet; usually where an oblique shock develops.
Cradle drag	Loads, induced by parasitic airflows, on the engine installation in the test cell.
Customer bleed	External bleed generally used for aircraft air conditioning.
Cycle decks	An engine model/program (usually 0D type) using the cycle match technique.
Cycle match model	A model using iteration to achieve flow compatibility between engine components.

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Data base	A collection of organized data, usually residing in a number of files in a computer system. A database can be as simple as a shopping list or as complex as a collection of thousands of sounds, graphics, and related text files.
Data validation	The process by which input (and output) data is checked for correctness.
Debugging tools	Computer programs that help find errors in computer program code. Often, debugging tools are integrated in the <i>development environment</i> . Modern debugging tools enable computer programmers to monitor the execution of the program, line-by-line in the program code while being able to query all relevant program parameter values.
Deck	Originally describing the set of punched cards comprising a computer program – this term is still used to refer to digital computer models.
Degree of reaction	A measure of the extent to which the rotor contributes to the overall static pressure change in a turbomachinery stage.
Design	1) An operating point corresponding to the design values of mass flow-rate, pressure ratio and rotational speed in a turbo-machine.
Design and verification	Also known as the Program Definition and Risk Reduction phase.
Deterioration	Loss in engine performance due to mechanical degradation of components.
Deterministic	Describes a process which given the same inputs will always produce the same outputs.
Development and validation	Also known as the Engineering and Manufacturing phase.
Development environment	Software (and sometimes hardware) used to develop software. Usually at least including a programming language such as FORTRAN. Often additional software tools are used for design, documentation, version control, etc.
Development process	Begins as soon as hardware to new design is available; main phase complete at production/service release; is also known as Engineering and Manufacturing Development.
Development testers	Team in charge of the evolution of the system definition, gradually implementing improvements to an initial design in order to enhance its physical/ industrial capabilities.
Diagnosis mode	A mode of operation of a model where measured data is used as input.
Diagnosis techniques	Techniques applied to the determination of the condition of an engine.
Digital simulation	Simulation of processes on a digital computer. A digital computer represents data using digital signals in electronics corresponding to binary formats (arrays of “0”s and “1”s). Almost all computers in use to date are digital computers.
Direct numerical simulation	No approximations are made such as the Reynolds averaging technique of mean flow and fluctuating flow.
Discretization	The breaking down of a continuous process into several portions.
Displacement pumps	Pumps that physically displace a volume of fluid, rather than inducing flow via a pressure difference.
Dissociation	The process by which a chemical combination breaks up into simpler constituents by collision with a second body.
Distortion (circumferential and radial)	Airflow distortion to the compressor or fan face commonly caused by high angle of attack or roll rates; usually manifests itself as total pressure distortion but could be temperature or inlet swirl.
Distributed computing	A new trend is to apply <i>parallel computing</i> to multiple computers that are interconnected over a network. This <i>distributed parallel computing</i> requires special software controlling the distribution of different computing tasks in a simulation.
DLL (Dynamic Link Library)	A DLL file contains a library of functions and other information that can be accessed by a Windows program. DLL files allow programs to share common resources, such as memory and hard drive space, and use them more efficiently.
Dry/wet operation (Afterburner)	Dry operation = non augmented operation; Wet operation = with augmentation.
Durability	Engineering methodologies related to the life characteristics: by considering mission profile segment power usage, operational severity exposure of the engine components and maintenance and support factors.

Dynamic model	A model having high bandwidth (e.g. 30Hz).
Effective nozzle area ratio, A9/A8	Exhaust nozzle exit to throat area reduced by boundary layer effects.
EGT (Exhaust Gas Temperature)	The flow weighted mean total temperature of the working fluid at a plane immediately downstream of the last turbine stage.
Electro hydraulic servo units	Hydraulically powered servo units that are electrically controlled.
Embedded engine model	An engine model implemented as part of a control system.
EMD (Engine Manufacturing Development)	Life cycle phase that translates the most promising design approach into a stable, interoperable, producible, supportable, and cost-effective design; validate the manufacturing or production process; and demonstrate system capabilities through testing.
Emissions index	The ratio of mass of pollutants to unit mass of fuel.
Empirical model	A representation of an engine set up in terms of a priori observations.
End wall effects	The boundary layer formation effects at the hub and casing of a turbo-machine causing pressure losses and blockage.
Engine aging	cf. deterioration.
Engine altitude facility	Wind tunnel whose working section can simulate altitude conditions of pressure, temperature and humidity.
Engine anomalies	Difference between current engine behavior and the predicted one.
Engine component model	A simulation of a gas turbine engine using major components (compressor, burner, turbine, etc.) as the smallest breakdown.
Engine condition monitoring	The process of inspecting measured data in order to determine the health of an engine.
Engine configurations	A list of engine specific components, type and model or designation.
Engine controls	Hardware and/or software (depending upon the age of the engine) that controls the fuel flow and the size of holes that the gas flow must flow through.
Engine cycle	The set of thermodynamic processes (often depicted as a trajectory on a Enthalpy-Entropy chart) which constitute an engine.
Engine design process	The succession of the various phases, from requirement/specification to project definition.
Engine deterioration	Worsening of components in terms of performance and mechanical potential.
Engine fleet management	Activity of analyzing operation data for aircraft engines to ensure engine safety by adapted repair and maintenance planning.
Engine health	Quantified performance engine status described by component characteristics difference relative to a status.
Engine model	A set of thermodynamic assumptions representing an engine.
Engine operators	People or company involved in engine operation/usage.
Engine simulation	A computer implementation of a model run to give the time response of an engine.
Engine to engine scatter	Diversity of engine behavior due to: component characteristics variance, generated by the bill of material tolerance transducer/controller accuracy causing dispersion of component throttling and command.
Environmental effects	Extraneous effects on an engine imposed by environmental conditions.
EPR (Engine Pressure Ratio)	The pressure ratio of an engine cycle available to the turbine and nozzle.
Euler equations	The equation of motion for frictionless flow.
Evaluation testers	Team in charge of the assessment of a technical proposal (design or hardware) usually by an engine-to-engine comparative basis or by comparison with an expected behavior (from simulation or requirement).
Event driven	A computer program that executes tasks after receiving messages. The transmission of a message is called an 'event'. Event driven programs usually are <i>object-oriented</i> with the messages transmitted among objects and the input and output devices of the program.
Exhaust nozzle	The gas path exhaust nozzle used to accelerate the gas flow to produce thrust.
External loads	External engine loads to run auxiliary equipment.

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Factors, deltas (adders, scalars)	Adjustment scalars or multipliers to aid in the calibration of turbine engine component maps.
FADEC, DECU	Full Authority Digital Electronic Control; Digital Electronic Control Unit.
FAR (Fuel Air Ratio)	The ratio of the mass of air to the mass of fuel for a combustion chamber.
Fault detection	The process by which malfunctions in a system are identified.
FHV (Fuel Heating Value), LHV	Amount of energy available in the fuel; Lower Heating Value; Amount of energy available in the fuel with all water from the combustion process in a vapor state.
Finite element model	The solution of (typically) heat transfer, stress or aerodynamic systems by subdivision (meshing) of the problem to local, small linear subsets, compatibility of which must be assured.
Finite rate chemistry	Modeling the combustion process considering forward and backward reaction rates.
Flame-holder	Combustor or augmentor hardware which aids in the stabilization of the combustion process by developing eddies and swirl to allow combustion to take place.
Flat rated engine	An engine designed to deliver constant power or thrust over a range of ambient temperature.
Flight simulators	Devices that are able to simulate the operation of an aircraft to a pilot. These may range from just computers with screens and keyboards (e.g. Microsoft Flight Simulator for the PC) to ‘moving base’ systems including a fully equipped cockpit.
Flow coefficient CD	Nozzle discharge coefficient; Ratio of actual flow rate to ideal flow rate.
Flowpath	The path that the working fluid follows during the flow through a machine.
Fluid dynamic blockage	The available flow area excluding the flow blockage due to boundary layer growth or separation in a duct, nozzle, and intake or within a compressor. (Net flow area / Total area)
Flutter	A self-induced (flow induced) oscillating motion of improperly designed fan or rotor blades.
FOD	Foreign Object Damage, damage caused by ingestion of external material.
FORTRAN	FORmula TRANslater. One of the earliest ‘third generation <i>programming languages</i> ’ with origins going back to the 1950’s. FORTRAN is the traditional computer language for the scientific community and the majority of gas turbine simulation code to date is implemented in FORTRAN.
Free vortex	Flow with concentric circles in which there is no change of total energy per unit weight with radius.
Frozen	When the time for a change in state of a chemical process is shorter than the relaxation time, than the gas is said to be frozen at a fixed composition.
Functionality	Logical process action expected from the system.
Fundamental pressure losses	The stagnation pressure drop in a combustion chamber associated with the rise in the temperature due to combustion.
Gas generator	Compressor-burner-turbine; the internal gas path power cycle.
Gas path analysis	See Analysis.
Gas properties effects	Effects of gas properties on a thermodynamic process.
Gas sampling	Specific process of chemical analysis by gas extraction for combustion efficiency, emissions and temperature assessments.
Global iteration	An iteration loop around a complete engine model.
Global system level analysis	Overall characterization of the system described by sole inputs/outputs relationships.
Grid generation	Division of 2 or 3 dimensional flow domain into ‘finite volumes’. For <i>CFD</i> , grid generation is required to divide the space in which the flow is analyzed in small grid elements: spatial discretization.
Groaning, screech, organ noise, chugging, and growl	Colorful ways of describing unsteady gas path behavior; Usually associated with Combustion.
Grooves	Type of compressor tip casing treatment to increase stall margin.

Gross thrust	Total thrust of a jet engine without deduction of the momentum drag of the incoming air (momentum thrust plus pressure thrust).
GUI (Graphical User Interface)	Graphical User Interface (pronounce “gooey”).
Gutter	A flame holder in an afterburner system.
Hardware in the loop	Set of components (ECU, actuators and sensors) which change the actual engine/plane state into the desired state by the pilot connected to the simulation loop.
HCF high cycle fatigue	Blade failure due to rotor stator interaction or rotor interaction with inlet distortion.
Heat balance method	A method of calculating engine core flow by considering the balance of energy into and out of the cycle.
Heat released	The amount of heat given in a reaction or combustion process.
Heat soakage (heat transfer)	Time for thermal equilibrium to take place usually between the gas path and the engine metal components.
Heat transfer effects	Effects of heat transfer on component performance.
Honeycomb	Type of compressor tip casing treatment to increase stall margin; Type of seal.
Hot gas ingestion	Inlet ingestion of exhaust gases from a missile, rocket or from another engine or the engine itself (VSTOL, reverse).
Ideal thrust	Thrust without any irreversibility; i.e. friction or shocks in the system not accounted for.
Idle	Engine power at which the system is at minimum power; ground idle or flight idle.
IGV & VSV	Inlet Guide Vane and Variable Stator Vane.
Incipient stall cells	Stall cells that initiate rotating stall; may be multiple cells prior to full stall.
Incompressible flow	The flow of a fluid where the changes in density with other thermodynamic parameters is negligible (low Mach number flows).
In-flight thrust	Thrust of an engine while in flight; fully installed.
Influence coefficients	Partial derivatives.
Initialization	The process of setting up a model such that the initial conditions are as required (often at steady-state).
Inlet capture area	Inlet airflow area.
Inlet engine compatibility	The ability of the inlet and the engine to interface for prolonged periods without interference under prescribed environmental conditions.
Inlet engine compatibility	The ability of the inlet and the engine to interface for prolonged periods without interference under prescribed environmental conditions.
Inlet recovery factor	Intake losses expressed in terms of the ratio of total pressure at the compressor inlet to that defined in front of the intake.
Inlet spillage drag	Drag due to more air.
Inlet unstart	The inlet normal shock is not at the minimum area and may be expelled out the front of the inlet.
Input	A parameter which perturbs a system, e.g. fuel flow, intake conditions.
In-service support	Technical and commercial activities involving the engine operators, with a technology to operate satisfactorily the engine population provided by engine manufacturers.
Installed performance	Engine performance with all external bleeds and power extraction activated.
Intakes	The entry duct into an engine, which may be used to induce compression.
Integration (implicit and explicit)	The process of estimating the time-dependent behavior of state variables.
Integration time step	The time increment in a numerical integration technique.
Internal air system (secondary air system)	Airflow pathways between the rotors and disks used for transferring cooling air between compressor and turbines.
Iron bird	Ground rig to test major aircraft system.
Isentropic	A process which takes place without change of entropy.
IT&E	Integrated Test and Evaluation; Alludes to the intertwining of experimental data and numerical simulation results to provide a full analysis process.

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Iteration	A mathematical process where a set of inputs are varied to achieve a required set of constraints.
Jacobian matrix	A matrix of partial derivatives of constraints w.r.t. variables.
Kalman filtering	An analysis method using linear theory to produce a ‘best estimate’ of system performance.
Kernel	The innermost part of an operating system.
Labyrinth seals	Seals between the primary and secondary flow systems.
Labyrinth seals windage	Losses due to leakage and turbulence, retarding torque.
Large eddy simulation	Solution of the time-dependent Navier-Stokes equations for the evolution of the large eddies with model(s) for the smallest, sub-grid scale, eddies.
Legacy system or code	The term ‘legacy system’ or ‘legacy code’ usually refers to computer systems respectively programs of an outdated technology level designed in the past, but still in use because of complications and costs of migrating to state-of-the-art systems.
Level of detail	See Fidelity.
Life assessment	Estimation of the allowable total period of operation of hardware item.
Life cycle	The set of phases which define the ‘cradle to grave’ lifespan of an engine.
Lifing model	Computer models for the estimation of the allowable total period of operation of hardware item.
Linear cascade	Set of blade profiles set up in a planar fashion for profile loss assessment purposes in rig test.
Linearization	The process by which the partial derivatives which characterize the dynamic behavior of a system are derived.
Liner cooling	Airflow used to cool combustor or augmentor liner metal temperature.
Local equilibrium	The condition of having thermal, mechanical and chemical equilibrium at a specified point in a thermodynamic system.
LPP (Lean Premix Pre-vaporized)	Type of combustion process; fuel is premixed and already vaporized; very lean.
LRU (Line Replacement Unit)	Component that can be replaced at a first line maintenance unit.
Lubrication and fuel systems	Pipes, pumps, and controls for the oil lubrication process and the fuel delivery process.
LVDT	Linear Variable Differential Transformer – a type of displacement transducer.
Man in the loop	Human-piloted action for generating demands to the hardware by visual monitoring of states engine/plane indicators connected to the simulation loop.
Manufacturers	Company in charge of a product (from design through development to manufacturing and certification) with specified technical use.
Manufacturing tolerances	Range of acceptable characteristics described in the bill of materials.
Maps (CHICS)	Component performance characteristics, generally steady state.
MAR (Moving Actuator Ring)	Nozzle hardware to allow the changing of a convergent nozzle to a CD type nozzle.
Mass flow function	Mass flow times square root of the temperature all divided by the pressure times the flow area; can be viewed as an inlet Mach number.
Mass, momentum, energy conservation	IN GENERAL: Conservation laws of nature namely continuity of flow, Newton’s second law and first law of thermodynamics respectively.
Master/Slave petals	Nozzle hardware to allow the changing of a convergent nozzle to a CD type nozzle.
Mathematical engine model	A set of equations defining the behavior of a physical system.
Max AB	Gas turbine engine running at near design conditions with maximum afterburner.
Mean line , row-row model	Blade row stacking model using mean-line blade information (not a function of radius).
Measurement uncertainty	The scatter inherent in measured parameters.
Mil power	Gas turbine engine running at near design conditions without afterburner.
Mil specification	Official standards of requirements in the military aircraft business.
Min AB	Gas turbine engine running at near design conditions with minimum afterburner.

Minimum engine	Individuals of the engine population, minimum in global performance or operability (thrust/surge margin/fuel flow/bleeds/turbine temperature) – to be described statistically.
Mixer	A device used to mix the flow; can be a device to mix flow within a mixed flow turbofan augmentor or a device to mix the exhaust jet flow.
Mixer efficiency	Efficiency of a mixing device.
Model assumptions	The assumed behavior of the various subsets of an engine model, e.g. compressor characteristic and associated scaling factors.
Model creators	The people who build or develop the simulation code, reproducing synthetically a functioning system.
Model fidelity	The level of detail inherent in a model.
Model user	The operator of the engine computer simulation code, reproducing a functioning system synthetically.
Monte Carlo	A statistical method whereby a information is obtained based on the exposure of the model to a (large) set of random variances on inputs and assumptions.
Moore's law	More than 25 years ago, when Intel was developing the first microprocessor, company cofounder Gordon Moore predicted that the number of transistors on a microprocessor would double approximately every 18 months. To date, Moore's law has proven remarkably accurate.
Multi-disciplinary	Work by combining several (academic) disciplines or methods.
Multi-stream model	A model where the flow conditions are assumed to be some combination of two or more modeled flow-paths, each of which describe some specific aspect of the total stream (e.g. stalled and unstalled flows, multi-phase flow).
Navier-Stokes equations	The non-linear differential equation of motion applicable to incompressible, viscous fluid and fundamental to all aspects of fluid dynamics.
Net thrust	Gross thrust minus the momentum drag in a propulsion engine.
NGV	Nozzle Guide Vane – Refers to the inlet guide vanes of the turbine.
NH, N2, XNH	Rotational speed of a high pressure rotor of a multi-spool engine.
NL, N1, XNL	Rotational speed of a low pressure rotor of a multi-spool engine.
Non-recoverable stall	Engine can not recover from a compressor stall condition without shutting the engine off; Usually caused by development of rotating stall in the HPC.
NO _x	Oxides of Nitrogen, pollutants created in the combustion chamber.
Nozzle area ratio	Exit to throat area ratio for a CD nozzle.
NPR	Nozzle pressure ratio; Ratio of mean total pressure at a plane at the entry of a nozzle to the back pressure.
NPSS	The Numerical Propulsion System Simulation NPSS [Ref. 17 in Ch. 4] is a concerted effort by NASA Glenn Research Center, the aerospace industry and academia to develop an advanced engineering environment – or integrated collection of software programs – for the analysis and design of aircraft engines and, eventually, space transportation components.
Numerical optimization	A mathematical process aimed at minimizing a certain function.
Numerical stability	The property of a numerical process to behave in an orderly manner.
Object	Primary entity of <i>object-oriented</i> software. An object is the <i>instantiation</i> of a specific <i>object class</i> . Instantiation is the actual creation (claim of a chunk of computer memory) of an object variable of a specific class.
Object-oriented	Object Orientated Design (OOD) provides significant benefits in terms of software development efficiency and maintainability.
Off-design	Any operating point of a turbo-machine, which is not the design operating-point.
On-board engine performance	Installed-engine characteristics comprising aircraft/engine interaction effects such as inlet efficiency, bleeds, power off-takes, nozzle efficiency, scrubbing drags.
One stream model	A model where the properties of any flow path is modeled using a single calculation process.
Open loop control	Control system with no feedback mechanism.

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Operability	Engineering methodologies dealing with maneuverability envelope and engine handling quality achievement: by implementation of satisfactory compressor surge margins, combustor/reheat blow out limit margins...and adapted control system characteristics.
Operating point	The thermodynamic and flow and engine operating conditions (pressure, temperature, flow-rate and rotational speed) represented by a point on the compressor or turbine characteristics.
Operating system	The operating system represents the software required to use the computer hardware with application software.
Operation	Planned activity or mission involving many actions aimed at a specific result on the utilized system or hardware.
Output	Calculated parameter.
Over under expansion	The expansion of a nozzle to a pressure above or below nozzle design pressure, where there is no shock formation within the nozzle (but oblique shock or expansion wave formation happen outside the nozzle) respectively.
Parallel compressor	An example of a multi-stream model.
Parallel computing	Technology to perform several tasks of the same calculation (simulation) job simultaneously, on different processors in one or more computers.
PC-based	(Program or software) able to be executed on a desktop or laptop PC (Personal Computer).
PDF (Probability Density Function)	A mathematical function describing the shape of a statistical distribution.
Perfect gas	A gas for which the product of the pressure and volume is proportional to the absolute temperature.
Performance	Overall engine characteristics contributing to aircraft propulsion requirements.
Performance seeking control	A control technique making use of optimization techniques to locate a peak in a particular function.
Physical model	A model that represents a physical process; A physical model can then be represented in a numerical simulation.
Piecewise linear	A set of linear models linked by scheduling a base parameter.
PLA	Power Lever Angle: The pilot's throttle.
Plausibility check	A check for a credible answer on the basis of basic engineering judgement.
Polytropic, isentropic efficiency	Isentropic efficiency is the ratio of ideal to actual work transfers of an isentropic process in a compressor or vice versa in a turbine. Polytropic efficiency is the isentropic efficiency of an infinitesimal stage in the process such that it is constant throughout the whole process (compression or expansion).
Portability	Ability of the software to run on different <i>computer platforms</i> without (large) efforts to adapt the program code or recompile the program.
Post certification	Check – during engine service – compliance with MIL specifications requirements, expected from the engine qualification process.
Post stall	Compressor operation beyond instability on-set; usually involves reverse flow.
Power balance	Power compatibility between the compressor, the turbine and/or shaft power output of a gas turbine.
Power off-take	External power requirement to run some axially equipment.
Power turbine	Turbine used solely for extraction of power for an external shaft; Usually, the last turbine in a series of turbines.
Preliminary design	Also known as the Concept Exploration phase; consists of competitive, short-term concept studies: define and evaluate the feasibility of alternative concepts and assessing their relative merits.
Pressure loss	Pressure changes due to (changes in elevation, flow velocity, and) viscous effects.
Pre-swirl system	A system to adjust the direction of the flow to provide a circumferential component of the flow.
Profile losses	Pressure losses associated with friction across a turbomachinery blade.

Programming languages	A programming language is the set of commands that can be used to tell a computer what to do in a computer program. Usually strict rules apply to using the programming commands and arranging them in a certain sequence.
Pump and tap architecture	A pump design that maintains fluid at a high pressure and controls the outflow by modulating a downstream valve.
Quasi 3-D	Three-dimensional representation usually with some form of empiricism – not a true 3D simulation.
Ram drag	Drag produced by the momentum of air entering the inlet of an engine in flight.
Reactive chemistry	Combustion process that allows for differing species of products to exist during the process.
Real gas	A gas whose properties deviate from those of the hypothetical ideal gas due to interactions between the gas molecules.
Real-time engine models	A model where the outputs are produced commensurate with the rate at which the inputs are changing.
Relaxation	A method of iteration which converges rapidly.
Research	Intellectual process of collecting and analyzing facts and information in order to achieve reliable/physical understanding of the processes involved in the technical system behavior.
Reverse flow combustor	Combustor design process involving combustion gases flowing in a channel back toward the front of the engine; usually to accommodate radial compressors.
Reverse flow compressor	Airflow going the wrong way; caused by compressor instability such as surge or rotating stall.
Reynolds number	Non dimensional number which represents the ratio of the inertial forces to viscous forces.
Rig-engine effects	Engine components behave in a different way when tested on rig test and when installed on the engine.
Risk reduction	Diminution in the combined effect of the likelihood of unfavorable occurrence and the potential impact of that occurrence.
RNI (Reynolds Numbers Index)	It relates Reynolds numbers of installed compressor to altitude and flight Mach number, at a defined engine corrected flow.
Robustness	Quality of a computer program to handle errors without causing abnormal termination or ‘hanging’ (program stops to respond to user commands) of the program.
Rossby number	Ratio of inertial forces to the Coriolis force for a rotating fluid.
Rotating distortion	Inlet pressure distortion that is rotational; can be simulated by a rotating screen.
Rotating holes	Holes in a rotating component.
Rotating stall	Blade stall that seems to rotate in the direction of rotor revolution; usually near 50% rotor speed.
Rotor moments of inertia	Moment of inertia used to determine shaft spool-up timing.
RQL (Rich Quench Lean)	A combustor type, using an over-stoichiometric stage followed by a rapid quench, with dilution air followed by a lean burn region.
Rumble	Description of a combustion instability which sounds like a “rumble” due to its low frequency(50 Hz) content pressure perturbation.
Safe operational limits	Limits on certain engine performance for safe and correct operation.
Sauter mean diameter	The ratio of the sum of all volumes of droplets in a spray to the total surface area of all droplets.
Schedule	Refers to a variation of a parameter or hardware (such as fuel flow or variable vane position) as a function of some measure of flight condition (such as burner pressure for fuel flow and rotor speed for variable vane position).
Screech	Description of a combustion instability which sounds like a “screech” due to its high frequency (400 Hz) content pressure perturbation.
Scrubbing	Cleaning of exhaust gases.
Secondary air system	Airflow system used to bring relatively cool air to hotter parts of the engine such as turbine blades; Airflow system uses cavities within the rotor shafts and bladed disks to transfer cool air to hotter parts.

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Sensors	Instrumentation to provide information to control logic for proper engine operation.
Separation	A situation occurring when the streamlines cannot follow the contour of the body because of the adverse pressure gradients.
Shell	A computer program that provides an external interface for another program. This may be an operating system shell (such as the various UNIX shells) that provide enhanced user interfaces, or shells that provide a <i>GUI</i> around a particular application program.
Shock boundary layer interactions	Transonic or supersonic flow interacting with the boundary layer resulting in shocks and boundary layer separations and causing losses in intakes nozzles or turbomachinery.
Shock wave	A pressure wave passing through a fluid medium in which the pressure, density and particle velocity undergo drastic changes.
Signal noise	Parasitic measurement perturbation induced by measurement system (acquisition electronics).
Simulation mode	A mode of operation of a model where measured data is used as input. Frequently relates to models that can describe transient behavior.
SLS (Sea Level Static)	Ambient conditions represented by air at a temperature of 15 °C (59 °F), a barometric pressure of 1.01325 bar (14.696 psia) corresponding to average sea level atmospheric conditions at middling latitudes.
SOT (Stator Outlet Temperature)	The flow weighted mean total temperature of the working fluid at a plane immediately upstream of the first stage turbine rotor blades. (See TET)
Spatial resolution	A measure of the ability of a model to resolve differences in properties in terms of physical proximity.
Specific fuel consumption	Fuel consumption per unit thrust or per unit specific work output.
Specific thrust	Net thrust per unit mass flow-rate of air inflow.
Splitters	Generally a flow splitter between the fan and the high pressure compressor.
Spool down	The deceleration of a shaft rotor usually due to combustor extinction.
Stage by stage	Modeling each stage of turbomachinery as a separate thermodynamic process.
Stagger	Angle between the blade camber line and the axial direction.
Stall	Compressor instability; Sometimes synonymous with Surge. May be rotating stall or non-recoverable stall.
Stall line	Locus of stability points for all speeds beyond which the compressor will stall or surge.
Stall margin	Measured at a constant airflow rate; the amount of pressure rise available between the stall line and the operating line: stall margin can be affected by inlet distortion, engine-to-engine tolerances, deterioration, and clearances.
Stalling pressure rise	The pressure rise @ constant corrected airflow that will cause the compressor to stall.
Standard atmosphere	Ambient conditions represented by air at a temperature of 15 °C (59 °F), a barometric pressure of 1.01325 bar (14.696 psia). ISA corresponds to average values of temperature and pressure at middling latitudes.
Standards	Technical requirements expressed by certifying organizations.
State space model	A linear representation of a dynamic system.
State variables	Parameters in a model whose rate of change is defined by a dynamic equation.
Steady-state	The description of a system where there are no unbalanced forces or energies.
Stepped labyrinth seals	A type of seal design.
Straight model	The model that satisfy the engine matching equations for a given component characteristics.
Stratification	Separation into layers.
Stream line curvature code	A type of 2D turbomachinery code which uses blade geometry, correlations of blade loss and flow exit deviation to determine blade steady performance.
Sub idle	Engine power at which the system is in start up mode.
Surface cooling	Associated with cooling across a metal surface by convection using cooler airflow from some source within the engine.

Surge	Compressor instability; Violent reversing of flow within the compressor; Usually 3 – 15 Hz.
Surge cycle	Reoccurring compressor surge with periods of recovery; Cyclic in nature 3 – 15 Hz.
Surge line	Locus of stability points for all speeds beyond which the compressor will stall or surge.
Swirl losses	Pressure losses in a duct or turbo-machine due to the swirl component of flow.
Swirling flow	Flow that has a circular motion on top of its principal direction.
Synthesis	The generation of a prediction based on a collection of component assumptions.
System identification	A process by which the transfer function of a dynamic process can be derived by observing its outputs.
T&E (Test and Evaluation)	Strong coupling between modeling and simulation technology with experimental data during the development process.
Tappings (bleed ports)	Holes or slots in the casing for extraction or introduction of air from some other source.
Temporal resolution	Dealing with time stepping or time domain.
Test cell	Installation embedding the engine or component to reproduce their actual theoretical environment for characterization of global and detailed behaviors.
TET (Turbine <i>Exit</i> Temperature) OR (Turbine <i>Entry</i> Temperature)	1) The flow weighted mean total temperature of the working fluid at a plane immediately downstream of the last stage turbine rotor blades. 2) The flow weighted mean total temperature of the working fluid at a plane immediately upstream of the first stage turbine rotor blades.
Thermal efficiency	The ratio of the net power output to the heat consumption based on the lower heating value of the fuel.
Thermal management system	A design that controls the temperature of a component or region.
Thermodynamic parameters	Parameters defining the state of the working fluid during the engine cycle, such as temperature, pressure, enthalpy, entropy, etc.
Through flow code	Another name for streamline curvature or meridional type codes.
Thrust	Unbalanced force caused by the pressure forces across and the difference in the momentum of air entering and the exhaust gasses leaving a gas turbine engine.
Thrust coefficient C_g	Ratio of actual thrust to ideal thrust.
Thrust vectoring	Off centerline axis thrust produced by a vectoring exhaust nozzle.
Time average equations	Equations that do not consider fluctuating pressure perturbations – mean flow type equations.
Time between overhauls	Time spent on wing between required major planned maintenance action on engine component to restore hot parts temperature margin – relative to the declared red-line.
Time lag	A time-based delay or skew.
Tip clearances	Physical distance between the rotor tip and the casing; generally the larger the clearances the worse the performance.
TIT (Turbine Inlet Temperature)	The flow weighted mean total temperature of the working fluid at a plane immediately upstream of the first stage rotor blades.
Total/static conditions	Static Conditions refer to thermodynamic properties not considering the flow velocity. Total (or Stagnation) Conditions refer to thermodynamic conditions hypothetically reachable by decelerating the flow to zero speed (Stagnation) isentropically.
Transfer function	A mathematical expression defining the dynamic response of a system.
Transient	Unsteady state. Also used to described low bandwidth dynamic models.
Trending	A process of averaging/smoothing a time series of data.
Trim setting	Engine control settings to provide a certain engine performance.
Trimming	The process of obtaining a set of initial states which give a steady state.
Turbine flow capacity method	An method of deriving core flow by assuming a value for HP turbine flow capacity.
Turbine nozzle	Turbine inlet guide vane used to direct the gas flow at an optimum angle on to the first turbine rotor.

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Turbofan	A gas turbine engine propulsion where a portion of flow bypasses the gas generator.
Turbojet	An engine where the turbine(s) produce just enough power to drive the compressor(s), the remaining energy is used for propulsion, expanding through a nozzle.
Turbomachinery matching	Matching the operation of compressors and turbines operating in line in a gas turbine engine to give the desired equilibrium operating point.
Turboshaft	A gas turbine engine where all the power produced is shaft power as in helicopters, marine applications and electrical power production.
Turbulence model	Model of the Reynolds Stress terms of the Navier-Stokes Equations. Models turbulence generation – variety of models used, some better than others depending upon the application.
Two phase flow	Any combination of two distinct phases under flow conditions: gas-liquid, liquid-liquid, or gas-solid particles.
Two-spool or Dual-spool	Twin shafts; Low pressure turbine usually turns fan compressor; High pressure turbine turns high pressure compressor.
Unsteady	Description of a process which is time-varying.
User environment	User interface of a computer plus additional peripherals such as printers, scanners and network connections.
User friendly	“Easy to use by the user”. Qualification for a software user-interface that requires a relatively small learning effort from the user before he can operate the program. User friendly interfaces are usually <i>GUI</i> 's that “speak for themselves” as to how the user can perform certain tasks.
Utilities	Auxiliary software programs that provide additional capabilities to application programs or the operating system. Examples are file format conversion programs, separate visualization programs, corrupt file repair programs and disk compression tools.
Variable area turbine	Turbine design that allows adjustment of the nozzle guide vanes or downstream stator vanes. Usually done to optimize turbine performance.
Variable cycle engine	Jet engine in which path of working fluid can be altered by shutters/valves/doors, thereby modulating gross engine properties such as SFC and specific thrust.
Variable geometry	Refers to changes in gas path geometry such as variable inlet guide vanes (IGV) or variable exit nozzle area such as CD nozzle.
Variable nozzle	Variable area nozzle; A nozzle design that allows the exhaust nozzle to change area ratios and/or go from convergent nozzle to CD nozzle; Most commonly used in military turbofan engines.
Velocity coefficient, C_v	Nozzle Coefficient base upon ratio of actual velocity to ideal velocity.
Velocity triangles	Turbomachinery velocity triangles describing the absolute and relative velocity magnitudes and direction.
Vitiated air	Air with products of combustion; usually experienced when the objective is to get heat air via combustion; sometimes O_2 is injected in the air to make up the loss due to combustion.
Volume dynamics	Volume changes usually due to acoustic pressure changes.
Warm flow rigs	Testing facility providing controlled inlet temperature generating conditions in the test section (more representative of the actual system environment – but not actual conditions).
Weak extinction	Combustion flameout due to fuel lean conditions.
WFB burner fuel flow	The total fuel flow-rate to the combustor.
Wind tunnel	Any of family of devices in which fluid is pumped through duct to flow past object under test.
Windage losses	External energy loss occurring on the disc surfaces, etc. due to air friction.
Windmilling	Phenomena in which the fan rotation is caused by the momentum of the incoming air only.
Zero order model	A model which has no dynamic content.
Zooming	A process where the fidelity of a model can be modified at user request.