Role: Thermal Analysis Specialist, Mechanical/Electronics Designer/Engineer, Prototype Builder

Availability: remote consultant/contractor

Professional Experience

Specialization in the heat transfer analysis and optimization of internal flows. I also offer my own proprietary software to convert Mesh data (STL, OBJ, GEO, NAS, MSH, etc.) to multiple user software formats (CAD, CAM, CAE) and have developed proprietary processes to handle a number of complex and growing CAD and CAE tasks. A list of my available analysis tools used for these optimization processes is provided at the end of this document. Custom software can also be developed to address a specific engineering need both as standalone (Windows® based) or implemented in a Web Application on either our server or a client server. Web development (Html5, CSS3) applies to servers running Asp.Net 4 or later.

Customers: Multiple Aerospace OEM and equipment suppliers in the USA and Europe

Provided below are some examples of my recent work in the following pages, such as: • Engine cooling, ventilation and fire suppression distribution optimization • Nose cone cooling and solar load evaluation • Passenger cabin environmental optimization • Windscreen heating air duct optimization • Avionic rack cooling and heating • Hot air impingement analysis • Vapor cycle compressor heat exchanger • Time Based (1D) simulation of thermal system • Time Based (1D) simulation of thermal system, Electrically Propelled Aircraft

Engine Cooling, Ventilation & Fire Suppression Optimization

Task: • Determine the position, size and number of intakes/exits in order to satisfy engine cooling and ventilation according to CS/FAR and the engine manufacturer's requirements. • Determine the amount of agent and position of the distribution nozzles in order to satisfy the CS/FAR 23 regulations on engine fire suppression

Inputs: • FAR/CS Regulations • CAD Geometry of engine with external services and systems (original design data) • CAD Geometry of nacelle (original design data, not 'cleaned' for CFD) • Critical Aircraft flight conditions • External nacelle pressure maps

Analysis: 1) Optimization of mass flow to ensure adequate cooling of all critical components for multiple defined flight cases. Optimization of size and position of inlets and outlets. 2) Based on 1), analyze fire suppression distribution and ensure that regulator suppressant concentration is achieved at all critical stations.

Output: • Pressure, flow velocity and engine carcass temperature plots • Fire suppression concentration evaluation • Formal reporting of the results

Notes: • CFD Analysis based directly on CAD data with only minimal manual cleanup required (due to frequent changes/iterations) • Level of detail of the geometry included exceeds industry standards (1cm resolution of geometric detail, including fasteners, harnesses, etc.) • Total Mesh size approx. 110M Elements.

Nose Cone Cooling & Solar Load Evaluation

Task: • Determine the position and number of intakes and exits and potential requirement for heaters and fans in order to maintain the installed equipment within their max/min temperature limits during and post flight

Inputs: • Proposed arrangement of equipment • Preliminary design of equipment placement • Heat output of each piece of equipment, fan flow rates • Solar load definition & approximated radiation from tarmac. • Heat rejection of equipment (conduction, convection, active fans) & Structure. • Optimum and maximum allowable temperature for each piece of equipment

Analysis: • Different flow conditions showing amount of ambient air flow required to maintain sufficient cooling performance during peak conditions, failure conditions of component fans, components in need of additional cooling.

Output: • Proposal for equipment re-positioning, fan flow requirements • Maximum and minimum temperature plots for each piece of equipment for each flight condition investigated. • Formal reporting of the results

Passenger Cabin Environmental Optimization

Task: • Define the required cabin airflow and distribution in order to achieve a comfortable passenger environment throughout the aircraft flight envelope

Inputs: • CAD data of the cabin, seats and window placement • Proposed ducting routing for the heating and cooling/ventilation • Available engine bleed flows, pressures and temperatures • Available cooling flow

Analysis: • Optimize the cabin airflow in the Pilatus PC24 aircraft. This project involved modelling of the complete cabin structure and determining the optimum placement of heating and cooling outlets for passenger comfort. • The duct outlets were varied for minimum noise level while achieving airflow targets • The study predicted the timing of cockpit and cabin warm-up/cool down modes, steadystate comfort during cruise as well as the optimization of smoke-clearing procedures.

Outputs: • Generation of temperature plots • Cool-down and warm-up temperature/time plots per seat position • Proposed positioning of cooling/ventilation and heating outlets • Passenger comfort analyses

Tools Used: • Siemens NX • ANSYS software • InStep1 used to convert CAD to CFD

Misc. other projects

Windscreen Heating Air Duct Optimization

Task: Provide an optimized heating flow over the windscreen and cockpit side windows to provide defog/defrost capability using the available hot air system airflow and temperatures.

Inputs: • CAD data of the cockpit: windshield, side windows, glare shield, instrument panel and surrounding structure • Proposed heating ducting routing to the windshield • Available engine bleed flows, pressures and temperatures

Analysis: • This project involved modelling of the heating ducting and the flow through the holes • The duct diameter and "piccolo" hole pattern was varied • The analysis was run in iterative steps to ensure that the flow from the different portions of the ducting was uniform • The duct outlets were varied to ensure minimum noise level while achieving the airflow targets

Outputs: • Design of an optimum duct dimensions and piccolo hole size and placement • Generation of temperature plots on the windscreen • Prediction of duct noise levels

Tools used: • Siemens NX • ANSYS software • InStep used to convert CAD to CFD

Avionic Rack Cooling & Heating

Task: Define active cooling flow required so that no equipment exceeds its target or maximum specified temperature

Inputs: • CAD data of avionic rack with proposed allocated space of standard and optional avionic equipment

• Definition of equipment with cooling fans and their performance • Heat output of each avionic box – max and average • Max allowable temperature for each box • Target maximum temperature for each box (reliability) Analysis: • Thermal analysis of heating of each piece of equipment in the compartment • Steady state temperature of each piece of equipment • Temperature profile in the compartment during max usage and after switch-off • Iterative addition of cooling flow and adding baffles

Outputs: • Propose optimum placement of cooling outlet, required cooling flow, baffles and venting to bring all equipment temperatures below their target values

Tools: • Siemens NX (Data import, cleanup, modification) • ANSYS software (CFX, DesignModeler, Workbench)

Hot Air Impingement Analysis

Task: A hot air bleed duct has a potential failure case to rupture, causing a leak. Does a critical structural element close to the duct require special insulation or instrumentation?

Inputs: • Duct dimensions • CAD data of the duct and the proximity of the critical structure • Hot air temperature, pressure and flow rate • Potential failure case description

Analysis: • A pin hole in the duct was analyzed to correspond to the maximum potential hot jet velocity diverted onto the structure • Thermal mapping of the area was conducted to establish the temperature at defined distances from the duct rupture point

Outputs: • Plot of temperature versus distance • Report

Tools used: • Siemens NX • ANSYS software

Vapor Cycle Compressor Heat Exchanger

Task: Design, Analyze and procure a cold plate for a vapor cycle compressor and controller module using a proprietary cooling system that minimized pressure drop and maximized efficiency at minimum weight.

Inputs: • Compressor heat load, dimensions and maximum weight/pressure drop.

Analysis: • Using a proprietary cold-plate concept developed for the computer industry, the design was adapted to the requirements of the aviation vapor cycle compressor and analyzed prior to having a prototype made.

Output: • Design of the cold plate • Manufacture of the components (using an associated company) • Delivery of the components

Tools used: • Siemens NX • Alibre • Ansys CFX • Algor/Simscale FEA

Time Based (1D) simulation of thermal system

Task: Determine System performance in an early stage cargo vehicle concept to ensure that aircraft compartment(s) receive sufficient bleed air to maintain minimum temperature. Optimization of bleed flows and temperatures based on preliminary mission profile.

Inputs: • Mission Profile / Boundary Points • Compartment Sizes & General insulation parameters

Analysis: • Using OpenModelica (an open source Object Oriented Modeling application), a time based, transient analysis of the conceptual system was generated. This included consideration of compartment volume, insulation and exterior convection. The model consisted of a simplified, lumped system to account for inflow and outflow from each volume and ideal mixing within to approximate time dependent heat capacitance and conduction through the walls together with bleed flow entering.

Outputs: • Time based plots of temperature and heat flow • Multiple Iterative results to investigate effects of insulation thickness on temperature profile. • Multiple iterative results to show difference in temperature distribution based on location(s) of outflow valves (per compartment) • Determination of generic ducting layout to provide varying flow amounts to different cargo compartments based on a single source of bleed air.

Tools Used: • Alibre Design (for interrogation of concept model for dimensions) • OpenModelica 1.14 & 1.15 • MS Excel

Time Based (1D) simulation of thermal system, Electrically Propelled Aircraft

Inputs: • System Schematic of Electrically powered aircraft • Thermal behavior of sub systems

Analysis: • OpenModelica was used to generate a system layout of the thermal components and their interaction to determine heating & cooling requirements and to estimate temperatures during different flight profiles. • Several full-mission profiles were used to determine heat load/loss and to estimate the amount of power required to maintain performance numbers

Outputs: • Multiple performance plots showing component-based heat loads due to changing behavior.

Analysis tools

Utilizes the following software packages over the course of these and similar projects: • Siemens (Unigraphics) NX 7.5 • Ansys Workbench / CFX 14.0 • OpenModelica 1.15 • CD-Adapco Star CCM+ 10.06 • Alibre Design 21 with SimWise 4D V9.86 & MecSoft VisualMill CAM 2019 • Microsoft Office 2016 Professional • MS VisualStudio 2019 • InStep V2.3 FE (In-House developed) • mikroBasic for PIC/PIC32/VisualTFT/VisualGLCD • DesignSpark PCB • GWizard • ScanStudio & MeshRoom

In-House Computing Capabilities: • Standalone 32 Core Compute Cluster (128GB Ram, 4x 8 Core Opteron CPUs) • Quad Core 4.5GHz Workstation (32GB RAM), Nvidia Quadro GPU • Quad Core i7 3.6GHz Workstation (32GB RAM)

Other/Prototyping Capabilities • Sieg KX1 4Axis Benchtop CNC Mill (for Plastics, Aluminum, Steels, etc.) • Replicator 2 FDM 3D Printer • Duplicator 7 SLA 3D Printer • K40 Based CO2 Laser Cutter • NextEngine HD 3D Scanner • IR Reflow Oven, Hot Air Rework station, Pick & Place machine • DS Oscilloscope, Logic Analyzer, Function Generator • Lathe, Bandsaw, MIG/TIG Welder, etc. • Silicone & Urethane mold making tools for short run castings.