Nathan David See

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BIO

Mr. Nathan See is a Technical Staff Member in the Thermal Hydraulics group in the Fusion and Fission Energy and Science Directorate at the Oak Ridge National Laboratory. He received his BS (2006) in aerospace engineering from Iowa State University and did masters level work at Syracuse University in Aerospace Engineering (2007-2008). Prior to joining ORNL, he spent 14 years in industry focusing on coupling CFD and physical testing, including wind tunnel and on-track testing; and everything from supersonic business jets to ballistics, and ground vehicles to race cars. Nathan is highly experienced in large scale HPC computing, utilizing some of the fastest machines over the last decade (Jaguar, JaguarPF, Kraken, EOS, Titan).

At ORNL, Nathan's focus is on large complicated geometries for HPC utilization and impactful research utilizing design optimization. This includes the Transformational Challenge Reactor (TCR), where work is being done to leverage the advancements in additive manufacturing to 3D-print a next-generation nuclear reactor; and projects within the Consortium for Advanced Simulation of Light Water Reactors (CASL).

PROFESSIONAL KNOWLEDGE

Computational Fluid Dynamics

CFD Pre/Post Processing and Scripting Software

- TecPlot, Boeing's AGPS, Fortran (F90, F95), SciLab, Siemens' Star-CCM+

CFD Grid Generation Software

- NASA's TetrUSS, Mississippi State's SimCenter (Solidmesh/AFLR3), Siemens' Star-CCM+, Pointwise

CFD Software

- NASA's USM3D, NASA's FUN3D, Siemens' Star-CCM+

CFD Design Optimization Software

- Siemens' HEEDS, Siemens' Design Manager

Clusters Utilized

- Oak Ridge National Labs: Titan, Jaguar, JaguarPF, Kraken, Smokey and Darter, Libby, Apollo, CADES
- Penguin Computing: S30, B30, T30, M40, H30

Physical Testing

Testing Data Acquisition Systems

- Stack, Mars Labs Titan Mini Recorder and HBM Somat eDaq

Scientific Instrumentation/Sensors

- Membrane pressure sensors, flow through pressure sensors, anemometers, thermocouples, infrared temperature, non-contact potentiometers, string potentiometers, GPS, inductive proximity sensor, photo encoders and Davis weather stations.

Testing Facilities

- Kennedy Space Center Shuttle Landing Facility, Automotive Research Center (ARC Wind Tunnel), Kirsten Wind Tunnel, Michelin's Laurens Proving Grounds, SCTAC and Uvalde Proving Grounds, Pecos RTC.

Testing Methodologies

- Wind Tunnel Testing, Flow Visualization Testing (Oil Drop, Kaolin, Smoke and Tuft), SAE J1321 Fuel Mileage Testing, SAE J1263 & J2263 Coast Down Drag Testing, GHG Phase 2 Coast Down, Wind Tunnel and CFD Certifications, Design of Experiment.

Miscellaneous Software

Advanced In

- SolidWorks, Microsoft Office Suite including Access and SharePoint, Linux, Unix, Mac and Windows operating systems

Experience With

- IDEAS, Rhino, AutoCAD, Paraview, LaTeX, Python, BASH

PROFESSIONAL EXPERIENCE

Oak Ridge National Laboratory July 2020 – Current

Technical Staff Member – Application Engineer in Computational Fluid Dynamics (CFD)

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- *Transformational Challenge Reactor (TCR) 2021 Flow Test Sprint Lead – 2020-Current*
  - Lead design and implementation of upgrades to TCR blowdown testing equipment.
  - Lead new test design and execution for validation and verification for core thermofluidic simulations.
  - Test will include surface roughness vs. channel width study, channel length study, and final core cooling channel design.
- *Spallation Neutron Source (SNS) Hydrogen Converter Assembly*
  - Lead an independent technical review of a newly designed Hydrogen Converter Assembly as part of the SNS Proton Power Upgrade (PPU)
  - Work included hand calculations and simplified CFD to estimate external heat source contaminations within the system.
  - Additional radiative shielding was recommended and adopted by SNS.
- *TCR Pressure Vessel Design – 2019-Current*

- Lead designer for pressure vessel thermofluidic design: including bottom plenum, riser section, top plenum, bottom reflectors and outlet plenum.
- Implemented design optimization capability reducing mechanical component design to days rather than months.
- Utilized design optimization to reduce the pressure drop of the pressure vessel inlet plenum by 13% while maintaining 89% flow uniformity.
- Utilized design optimization to maintain a 0.5psi pressure drop across the outlet plenum while optimizing geometry to allow for an instrumentation plane to measure average core outlet temperature within ±5C.
- Thermowell placement on instrumentation plane was able to statistically capture a safety event within 2min.

- *TCR Thermofluidic Physical Testing Lead – 2019-2020*
  - Led physical testing for TCR 2019 Sprint to evaluate surface roughens effects of additively manufacture parts on a mock up reactor core.
- *SNS Cryogenic Moderator System (CMS) Sapphire Glass Viewport – 2020*
  - Computational simulations were needed to understand physical test setups to represent the maintenance cycle's effect on fatigue of Sapphire Glass Viewports. Maintenance cycles saw temperature go from room temperature to 17K.
  - Cryogenic material properties are not well documented in known literature. Therefore, an expanded literature search was conducted to document missing material properties.
  - Final work resulted in a time depended CFD model characterizing cryogenic testing timetables and temperature tracking between embedded thermocouples and the sapphire glass viewport.
- *CASL NuScale Gen. 4 Reactor – 2019-2020*
  - A detailed look at the core bypass flow for NuScales generation 4 reactor was performed. Bypass flow included bypass into the shielding cooling channels as well as empty guide tube channels.
  - Significant amount of work was performed to reverse engineer all unknown nuclear reactor parameters.

SmartTruck November 2012 – February 2019

Principal Engineer Aerodynamics

A combination of CFD, wind tunnel and full scale test methods, including drag, fuel and various flow visualization techniques, were utilized to improve the fuel efficiency of a standard class 8 vehicle (semi-truck). Today SmartTruck sells five aerodynamic kit levels, the largest of which reduces drag by upwards of 10 percent.

- *Advanced Aerodynamic Trailer Skirt – 2018-2019*
  - With the use of Project *ARD130 – Oak Ridge National Labs Director's Discretionary Allocation – 2018-Current*, successful design and government verification on two new trailer skirt products were successful. An accelerated design cycle of 6months was used to: reverse engineer competitor products in the design space, complete size, shape and location sensitivity studies, perfect design shapes, cross correlate CFD data with wind tunnel and real-world data sets, and successful government verify two new products via wind tunnel testing.
  - A consistent 1% cross test correlation was found and the two new products were passed certification testing with approximately 4.65% and 5.25% estimated fuel savings.
- *ARD130 – Oak Ridge National Labs Director's Discretionary Allocation – 2018-2019*
  - Principal Investigator for Project ARD130 "Investigation of major drivers of the fully non-linear unsteady CFD and its application for numerical certification for the wide combination of trucks and trailers integrated system using K20 GPU's on Titan – Phase1".
  - 3 Million core-hrs were provided on ORNL's Titan hybrid-architecture Cray XK7 system.
  - Significant collaborative efforts with NASA's FUN3D team to port and benchmark FUN3D to the Kepler GPU architecture.
  - Yaw studies were performed on existing and new aerodynamic technologies for the purpose of Wind Averaged Drag assessments for further correlation to wind tunnel data sets.
  - Wind Averaged Drag correlations allowed for the ability to do cross test verifications and certifications on a new product line.
- *Government Certification of TopKit Aero Solution – EPA GHG Phase 2 – 2017-2018*
  - With the use of Project *ARD122 – Oak Ridge National Labs Director's Discretionary Allocation – 2017-2018*, SmartTruck's Stock Baseline Vehicle and TopKit Aero Solution were evaluated using the EPA GHGP2 CFD Protocols.
  - Highlights of the computational project consist of: FUN3D Unsteady Time Accurate computations with DES (LES off body and SA turbulence model integration directly to the wall), Grid Convergence Study (GCI), Iteration Error Estimation (IEE), and complete certification documentation creation from scratch.
  - Direct collaboration with EPA Regulatory Division and NASA FUN3D team ensured a smooth process.
- *ARD122 – Oak Ridge National Labs Director's Discretionary Allocation – 2017-2018*
  - Principal Investigator for Project ARD122 "Investigating Matching Unsteady CFD to Real-World Testing of Class 8 Trucks".
  - 9 Million core-hrs were provided on ORNL's EOS 736-node Cray XC30 cluster.
  - CFD studies were performed on the Stock Baseline to evaluate and address correlations between computational models and real-world test data gathered in Project *CFD Real World Calibrations – 2016-2017*
  - Design iterations of CFD gridding technics and vehicle geometric model updates were performed. Stronger correlations between stock baseline CFD simulation to real world data sets were obtained.
- *SideFairing (generation 3 redesign) – 2017 - 2018*

  - Further design updates were desired to further drive down the cost of the product and enhance profitability and further mobility for sales staff.
  - Multiple CFD design studies were performed in conjunction with Mechanical Engineering Design Group to ensure finalized production part's installation integrity.
  - Resulting efforts demonstrated a reduction of 1.36% drag with a 5% reduction in material cost or a reduction of 33% material cost for the same performance as SideFairing generation 2.
- *CFD Real World Calibrations – 2016-2017*
  - As a result of newly released governmental regulations, updated real world datasets were desired for stronger correlation with CFD and wind tunnel tests.
  - These datasets were not only near current test parts but also all aspects of the tractor to ensure proper airflows were leading into key design locations on the trailer.
  - Real-world data sets of: boundary layer rakes, off body flow via hot film anemometers, wake visualizations via smoke and kaolin/oil drop surface flows were collected.
- *Wind Tunnel Testing Program – 2016*
  - Due to market awareness and familiarity with wind tunnel testing, it was desired for SmartTruck to commission wind tunnel testing for validation purposes.
  - On account of known scaled model wind tunnel sensitivity to attached flow devices, it was determined to validate baseline datasets prior to product testing. To achieve this, pressure taps, boundary layer rakes, yarn tufts, kaolin and oil drop tests were conducted.
  - Dataset analysis and matching real world testing confirmed that boundary layers along the vehicle were not adequately sized and therefore current product lines wound not perform accurately.
- *Governmental Regulations – EPA GHG Phase 2 – 2016-2017*
  - Recent new governmental regulations were released regulating the Class-8 trailer market for the first time; US Environmental Protection Agency's Green House Gas Phase 2 (EPA GHG Phase 2).
  - To ensure compliance, and place SmartTruck in a favorable market position, an internal taskforce was formed to monitor and recommend any actions need for compliance.
  - During the rule making process, recommendations were made to the EPA regarding compliance testing procedures. Once regulations were finalized, direct collaborations with the EPA began.
  - Engineering guidance documents, spreadsheets, and tools were created for Management and Sales Team to help understand and educate the marketplace in new regulations and where SmartTruck Products fit in.
- *Coast Down Testing Program – 2010-2016*
  - Due to a need for real world validation of CFD drag predictions, coast down testing was selected. Trips to Kennedy Space Center's Shuttle Landing Facility permitted for full coast down tests from 70mph to 0mph. This in turn provided the data sets necessary to prove that testing 70mph-60mph and again 20mph-0mph was adequate to calculated equivalent drag predictions therefore allowing use of Michelin's Laurens Proving Grounds, a shorter overall track length.
  - This methodology was presented to the SAE, which in turn, validated and adopted SmartTruck's method into new coast down procedures.
  - Over the course of 1,100 plus coast down tests, drag precision levels were driven to a 95% Confidence Interval of ±0.25% CD.
  - This allowed for advancements in technology, scientific understand and assumptions to continually enhance and improve data set accuracy allowing for higher confidence on products entering the market place.
- *Ground Wind Station – 2016*
  - Due to new SAE and EPA regulations, it was determined that a ground station was needed to cross-verify on-vehicle wind speed/direction data during coast down testing.
  - Designed system included a National Institute of Standards and Technology (NIST) traceably certified flow through anemometer system comprising of a keil and static tube.
  - On account of a keil-static system's need to point into oncoming wind, composite sail plane fuselages and vertical stabilizers were mounted to the keil/static tubes and attached to a rotational pot which doubled as wind direction measurements. Track temperature was also read via an infrared thermometer.
- *LeadEdge Top Fairing – 2015*
  - Continuous design cycles lead to the desire for a part on the top front face of the trailer to allow for better attachment from the airflow coming off of the tractor towards the top of the trailer.
  - The LeadEdge Top Fairing was designed to operate in a cross flow to create thrust as well as overall drag savings.
  - The LeadEdge weights only 12lbs and saves up to 3.25% drag and 2% in fuel.
- *SideFairing (generation 3) – 2014-2016*
  - Due to increased demand to gain as much drag reduction as possible from each part, it became desirable to implement a new design cycle on SmartTruck's aerodynamic SideFairing, an attached flow device that uses boundary layer manipulation to redirect near body flow into a trailer's base wake.
  - Real world surface flow verifications were performed using oil drop testing techniques. Upon comparison to CFD, flow separation predicted correct within one eighth of an inch.
  - Upon further design cycles, the flow detachment was moved an additional one and a half inches further aft increasing projected performance by an additional 0.5% drag savings.

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- *TopKit Aerodynamic Trailer Kit – 2014*
  - Increased weight savings combined with a desire to remove all under trailer pieces led to the TopKit.
  - The TopKit was a re-combination of existing parts, the Aerodynamic Rain Guard (ARG) and SideFairings.
  - The TopKit reduced weight by 75% from the original UT6 (Advanced Kit) aerodynamic kit while still saving 9% drag and 5.5% fuel.
- *UT6Plus Kit (Premier Kit) – 2012*
  - It was determined that a maximum performing kit would sell well in the marketplace due to increasing fuel cost.
  - The SideFairing, an aerodynamic attached flow device that uses boundary layer manipulation to redirect off body flow into the base wake behind the trailer, was designed.
  - The SideFairing when added to the UT6 (Advanced Kit) increased performance to a total of 16% drag reduction equivalent to a 10% fuel savings.
- *UT1 Aerodynamic Trailer Kit (Classic Kit) – 2011*
  - Trailer owners often max out on their cargo weight, thus UT1 was conceived from a desire to reduce weight while still performing above the 5% fuel verification level from the EPA SmartWay voluntary program.
  - It was determined that the rear bumper treatment of the UT6 (Advanced Kit) could be removed while still maintaining necessary performance goals: 9% drag savings equating to 5.5% fuel savings and reducing weight by 22%.
- *Class-8 Tractor Mirrors – 2010*
  - With the vehicle's mirrors being in a cross flow, it is the idea chance to optimize the shape to not only reduce drag but also reduce noise and create thrust.
  - Two mirror sets where create, one traditional and one with video capability for internal monitoring within the cab. The video mirror option then had the ability to fold back out for a more traditional approach as a redundant backup.
- *UT6 Aerodynamic Trailer Kit (Advanced Kit) – 2010*
  - The original class-8 trailer marketplace had simple detached flow devices which were either damaged too easily in every day operations or required driver interactions to ensure deployment after every freight delivery.
  - The solution was SmartTruck's original aerodynamic trailer kit. Designed to be durable and require zero driver interaction, UT6, now called the Advanced Kit, utilized underbody fairings to direct flow beneath the rear tandem tires to a rear fairing just before the bumper that helped keep airflow accelerated close to the ground. This saves drag from underbody trailer components and creates a suction effect pulling the rear base wake of the trailer lower. The last component is the Aerodynamic Rain Guard (ARG). The ARG is an attached flow device that utilized boundary layer manipulation to redirect the off body flow downwards into the base wake behind the trailer.
  - The result is an 11% Drag Savings or a 7% Fuel Savings for customers.
- *Governmental Regulations – EPA SmartWay – 2010-2015*
  - Upon entering the class-8 trailer marketplace, it became necessary to comply with voluntary verification programs, like EPA SmartWay, to maximize sales potential.
  - It was determined that the most effective way to comply was to capture all suggested, non mandatory, as well as mandatory operations with data acquisition.
  - In doing so, verification procedures, as well as data submittal and EPA review, proceeded quickly and smoothly allowing SmartTruck to enter product to the marketplace in a timely manner.

BMI Corporation July 2008 – November 2012
Aerodynamics Engineer
BMI Corporation is an engineering consulting company specializing in computational fluid dynamics (CFD). A wide variety of projects were undertaken ranging from supersonic business jets to ballistics to ground vehicles.

- *SmartTruck Project – SmartTruck became its own entity in 2012; before that it was an internal project of BMI Corporation.*
- *Bright Automotive – 2010-2011*
  - Bright Automotive was attempting to enter the market of commercial vans with an energy efficient fuel cell vehicle.
  - To increase the range of the vehicle, CFD was performed leading to a reduction of 15% drag.
  - This performance was gained by helping to reshape the front 'nose' of the vehicle, the hood/windshield interaction, windshield roof interaction, side body panel shaping just before and aft of each wheel well, along with rear roof and side body shaping to redirect the airflow into the base wake.
- *Frag12 – 2010*
  - Frag12 had designed an explosive shotgun round to be used for military purposes. While the round was relatively accurate, it would cone and eventually tumble into the target.
  - From high-speed footage and schlieren images, CFD and 6 Degrees Of Freedom (6DOF) analysis was performed and found to duplicate the provided data.
  - It was recommended to move the center of gravity (CG) forward and a change from a three fin flat tail system to four fin cambered tail system to induce spin.
  - Recommendations were implemented and additional shooting range data showed that conning and tumbling were eliminated.
- *Aerion – 2008-2009*

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- Contracted to complete low speed aerodynamics of Aerion supersonic business jet program, including: take-off and landing configurations, sub-sonic cruise analysis, engine inlet and exit geometry performance and wind tunnel comparisons.
- Participated in low-speed wind tunnel tests evaluating flap and wing configurations confirming CFD estimates.

- *Aviation Fleet Services (AFS) – 2008*
  - A project to retrofit existing MD80 aircraft with wingtips to increase range.

Calmar Research Corporation August 2006 – July 2008
Project Engineer
Calmar Research Corporation is an engineering firm centering on CFD and grid generation software. Work included GUI development, software sales and CFD consultant work

- *Ford Motor Company – 2008*
  - Consulted with BMI Corporation to work with Ford Motor Company to steer concept vehicle aerodynamic design work for hydrogen fuel cell vehicles.
  - Each week Ford design engineers would give several concept vehicle for performance evaluation and each week input was given back on previous shape's aerodynamic design.
  - The overall achievement was to help the Ford design engineers to better understand key concepts of aerodynamic design of ground vehicles and how to avoid the biggest mistakes leading to increased drag of the vehicle.
- *Business Jet Package – 2008*
  - Due to software sales of Boeing's TRANAIR++, it was determined that a specifically suited piece of software tailored to the Business Jet community was desired.
  - GUI design and software package to automate gridding solutions were created.
  - Key programming features were: automation of wing and fuselage partitioning and automatic grid discretization.
- *NASCAR Car of Tomorrow – 2007*
  - Consulted with BMI Corporation to work with NASCAR on the new Car of Tomorrow body design.
  - Computational assessment was performed for down force, drag and handling characteristics.
- *Nemesis Grid Package Software – 2006-2008*
  - Due to a need for a more intuitive GUI front end for NASA's VGRID grid generation software, Nemesis was created.
  - Nemesis was built on top of Boeing's in house geometric modeling software, Aero Grid Paneling System (AGPS).
  - While working closely with customers Nemesis was tailored specifically to bring an intuitive, user friendly interface while taking advantage of AGPS' ability to automate surface partitioning and grid discretization.

PATENTS

Inventor on the following patents

- REAR FAIRING ASSEMBLIES FOR A CARGO ENCLOSURE
  - Patent Number: 20200207426
- MULTI-PANEL SKIRT SYSTEM FOR CARGO ENCLOSURES
  - Patent Number: 20200239088

EDUCATION

Syracuse University Syracuse, NY, USA Attended 2007-2008
Masters Level Class Work
MAE 643 Fluid Dynamics: A-, MAE 741 Turbulence: A

Iowa State University Ames, IA, USA Graduated May 2006
Bachelor of Science in Aerospace Engineering
Elective work in CFD and Astrodynamics

PUBLICATIONS

The following articles were published based on scientific work done

- SMARTTRUCK STEPS UP SIMULATIONS FOR CERTIFICATION BY COMPUTATION, Published August 29, 2018
  - Written by Rachel Harken, Science Writer for Oak Ridge Leadership Computing Facility
  - https://www.olcf.ornl.gov/2018/08/29/smarttruck-steps-up-simulations-for-certification-by-computation/

The following publications were published on scientific work done at Oak Ridge National Laboratory

- See, Nate, Betzler, Benjamin R., Cetiner, Sacit, Chesser, Phillip, and Heineman, Jesse. Pressure Vessel Design Optimization of the Transformational Challenge Reactor. United States: N. p., 2020. Web.
- Betzler, Benjamin R., Ade, Brian J., Wysocki, Aaron, Chesser, Phillip, Greenwood, Michael Scott, Wang, Peter, See, Nate, Hu, Xunxiang, and Terrani, Kurt. Design Downselection for the Transformational Challenge Reactor. United States: N. p., 2020. Web.