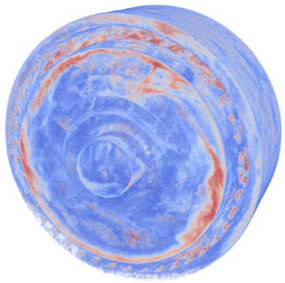
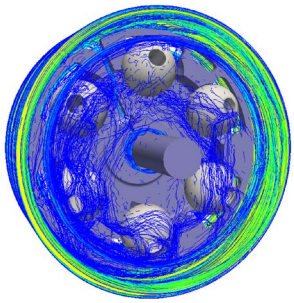
Fallbrook Technologies Inc.

Simulating Lubrication Flow to Predict Traction Oil Distribution Inside a NuVinci® Product





Fallbrook Technologies Inc. (Fallbrook) is a technology development company headquartered in Cedar Park, Texas. The company's core technology is traction-based, patented NuVinci® transmission, a continuously variable planetary (CVP) technology which enables performance and efficiency improvements for machines that use an engine, pump, motor, or geared transmission system – including urban mobility vehicles, cars and trucks, industrial equipment etc. Fallbrook's unique collective development model and community approach to leverage NuVinci technology helps accelerate product development, resulting in improved energy management, higher performance, more effective, reliable controls and sustainable solutions.

Fallbrook's initial commercial product, a continuously variable transmission (CVT) for bicycles, now includes a rider-needs-based portfolio comprised of five group sets, city, trekking, sportive, cargo, and commercial, all available in a manual and automatic version. Cycling products are developed and managed by Fallbrook's enviolo Division headquartered in Amsterdam, the Netherlands.

Continually improving the energy efficiency of their product lies at the heart of on-going innovation at Fallbrook. The company leverages simulation to facilitate understanding of critical physical phenomena to optimize design for the right balance of energy economy at competitive prices.

Improving Oil Flow Inside the NuVinci Products

Cost-sensitive, effective, simple, robust, and efficient methods for providing lubrication internally is always challenging, as is predicting the effectiveness of a design scenario or having an effective solver/software to efficiently guide the design process in the innovation process.

FALLBROOK® TECHNOLOGIES

Industry
Energy, Automotive

Challenge
Predicting traction oil distribution to improve oil flow within the NuVinci system

Altair Solution
Providing an integrated solution to Fallbrook including advanced GPU hardware high-performance computing (HPC) job management capability and the Altair nanoFluidX™ software

Benefits
- Ease and convenience in logging in to Altair PBS Professional™ for remote updates to solution status
- Cost-effective, viable computing resource in the cloud for small businesses

Brad Pohl, Chief Engineer, Advanced Engineering, supporting the Licensing and Technology Commercialization Division at Fallbrook has been working on improving oil flow inside the NuVinci products as it affects the transmission's efficiency, durability, power, capacity, and cost. Being able to physically see inside a complex transmission system to evaluate the design is practically unfeasible, leading Fallbrook to perform an evaluation to use the smoothed-particle hydrodynamics (SPH) method to predict traction oil distribution in the system.

Advanced CFD Simulations in the Cloud

Altair nanoFluidX™, an advanced CFD solver, optimized on the cloud to provide overnight simulation results for the most complex cases, was used by Fallbrook to simulate lubrication flow inside of a NuVinci product. nanoFluidX predicts the flow in complex geometries with complex motion, such as oiling in powertrain systems with rotating gears and shafts, using the SPH simulation method. It is specifically designed to run on Graphics Processing Unit (GPU) hardware, which offers considerable performance advantages over traditional CPU-based computing for certain applications.

Altair worked with Amazon Web Services (AWS), a secure cloud services platform, to provide an integrated solution to Fallbrook including advanced GPU hardware, high-performance computing (HPC) and the nanoFluidX software through industry-leading workload management and job scheduler, Altair PBS Professional™.

The model for simulation was generated with process-oriented finite element modeling software, Altair Simlab™. This included meshing of the system, material and property assignment, motion definition for all internal parts, and particle generation for the SPH mesh to represent the oil.

"The cloud computing resource is the only viable solution, and it can fit in our potential budget constraints. During the project it was very easy and convenient to login to PBS Professional and check solution status remotely. An added benefit was that having the solution running on the cloud made it significantly easier for Altair support engineers to step in and help or advise as required to keep the project moving along."

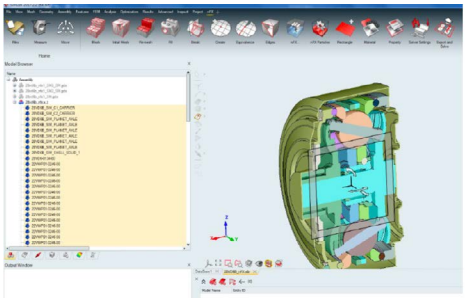
Brad Pohl
Chief Engineer, Advanced Engineering, Fallbrook Technologies Inc.

A model of this scale is computationally expensive regardless of the numerical methods used to solve the physics at hand. Altair's HPC cloud computing solution helped alleviate this issue, without a need for the end user to deal with maintenance of the cloud computing system and associated hardware. For a small organization like Fallbrook, this was an extremely viable solution allowing them to leverage a system of eight Nvidia Tesla V100 GPUs. "The cloud computing resource is the only viable solution, and it can fit in our potential budget constraints," said Mr. Pohl. "During the project it was very easy and convenient to login to PBS Professional and check solution status remotely. An added benefit was that having the solution running on the cloud made it significantly easier for Altair support engineers to step in and help or advise as required to keep the project moving along."

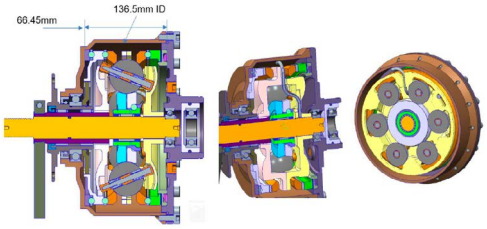
Looking Forward

The SPH method provided benefits over traditional grid-based methods, particularly in the area of preprocessing, making it more likely for a non-expert to succeed using this method and tool-set of SimLab and nanoFluidX. Splash lubrication was simulated at a reasonably high-surface velocity (30m/s) involving numerous imposed motions (12) and a large particle count (>20million).

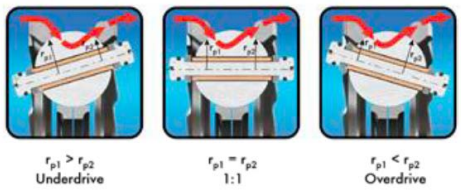
Oil lubrication inside of the NuVinci design continues to be a need, and as the product develops, the team anticipates an opportunity/need to optimize the design with simulation playing a role.



CAD model imported to SimLab



CVP design used for study



CVP power path

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