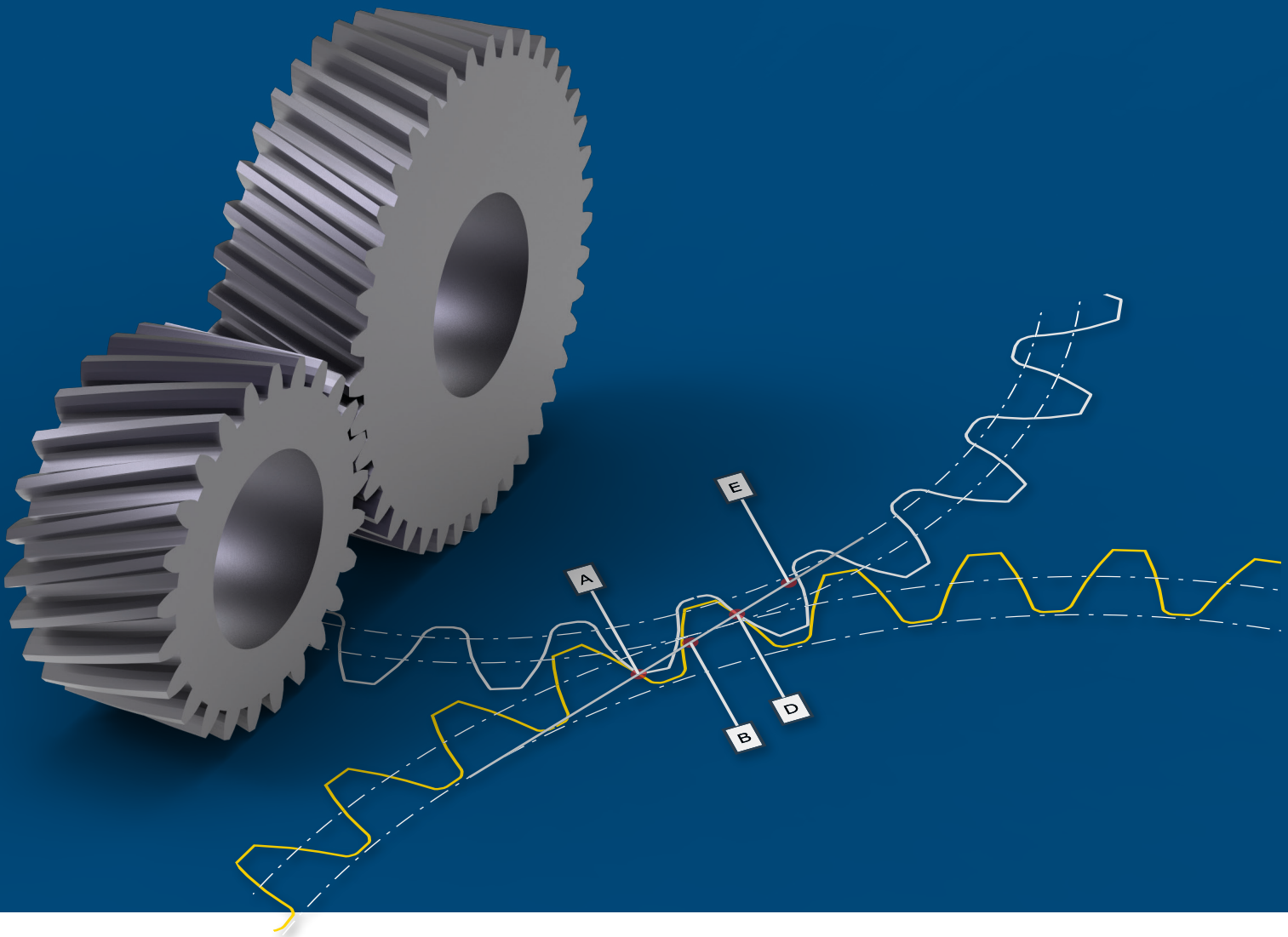# HOW FVA KEEPS THE GEARS TURNING WITH SPATIAL SDKS

FVA-Workbench puts 50 years of research at engineers' finger tips.

Challenge:

To maintain a competitive advantage, FVA needed to add additional functionality to FVA-Workbench:

- The ability to perform Boolean operations on gear models
- Performing FEA required detailed meshing support
- Calculating mass and column of a gear system

Solution:

- ACIS® 3D modeling kernel
- 3D Precise Mesh
- 3D InterOp for interoperability
- HOOPS Visualize

Results:

- The ACIS API allows FVA to model solid bodies with just a few lines of code, plus provide access to powerful Boolean operations
- 3D Precise Mesh powers the fast meshing needed for FEA
- 3D InterOp enables best-in-class CAD interoperability

Founded in 2010, FVA GmbH is a joint venture between FVA e.V. (Forschungsvereinigung Antriebstechnik, the Research Association for Drive Technology) and GzF (Gesellschaft zur Förderung des Maschinenbaues mbH, the Association for the Promotion of Mechanical Engineering) created to develop analysis and simulation software for drive technology, along with associated professional services and support.

FVA's solutions serve the entire driveline industry (automotive, industrial, aviation, marine, rail, and wind) with software capable of highly sophisticated and detailed simulation of the system behavior of virtual gearboxes and detailed analysis of individual driveline/gearbox components. Whether used in the early stages of design or to verify existing gearboxes, FVA's software package enables customers to visualize complex gearboxes in 3D while modeling system behavior, such as deformations and kinematics.

FVA-WORKBENCH

Targeted at significantly increasing the efficiency of the driveline design processes, the FVA-Workbench is a manufacturer-neutral software solution for the modeling, parameterization, and analysis of transmission systems. The software solution embodies fifty years of research and development from the FVA expert network, making this accumulated knowledge directly available to the individual designer. From individual machine elements to complete system analysis, the FVA-Workbench offers a unique variety of analysis methods for a wide range of gearbox designs and type.

This powerful tool can be used for all design tasks related to transmission optimization, greatly reducing overall design time and the number of needed prototypes. With FVA's proven solutions, most parametrized geometries can be described with validated analytical methods. In the case of more geometrically complex structures, numerical methods are used in addition to analytical methods.

The goal of FVA-Workbench is to significantly increase the efficiency of the design process. Through step-based modelling, even complex models such as helicopter gearboxes, ship propulsion systems, or wind turbines can simply be built successively, whereby a continuously analyzable gearbox structure is created. The torque and force transmission calculations between the individual mechanical elements are performed automatically. The derived loads and deformations are then taken into consideration for all further calculations, for example, modeling the deformation behavior of shaft-bearing systems and casing. This system-level analysis enables engineers to make well-informed decisions to achieve the optimal design of transmission systems.

3D MODELING IS KEY TO ANALYSIS

An accurate representation of driveline system behavior is essential for detailed analysis of its performance, and the behavior of the system depends on accurate physical modeling of the components.

Initially, FVA chose the route of an in-house solution to generate a surface model of the individual components as

"Working with Spatial enables our small and highly competent development team, staffed by the top experts from the industry, to focus on our core competency: numerical simulations. Thus, we are able to respond quickly to changes in the dynamic technology environment and new requirements from our customers."

— Norbert Haefke, CEO, FVA GmbH

opposed to modeling the solids geometrically. While this approach gave FVA total control over the modeling solution and proved initially successful, limitations to this approach soon became apparent:

- Inability to perform Boolean operations on driveline components — an essential function when modeling planetary gear systems and as a preparatory step prior to meshing.

- Finite element analysis (FEA) was not possible as it requires generating a detailed mesh from a solid 3D model.
- Calculating mass or volume (for example, the volume of lubricant) of a driveline was difficult.
- Anytime a new routine was needed for working with the model, FVA needed to spend precious engineering time to create the new routine needed downstream for their analysis software.

THE MOVE TO PROVEN 3D MODELING SOLUTIONS

As the limitations with the FVA's in-house physical modeling solution became apparent, the company was faced with the classic make-versus-buy decision — should the company invest more time and resources into improving their own modeling solution, or look to an outside solution that would allow the company to focus on its core competencies.

FVA realized that to truly succeed in the marketplace, they needed to add more functionality to their solution, and this additional functionality depended on having accurate 3D modeling. With time to market also being a key concern, FVA decided to partner with Spatial Corp. and gain access to proven 3D modeling solutions with a 30 plus year track record.

The Modeling Kernel

By centering their solution around the ACIS 3D modeling kernel, FVA's software solution gained access to a rich API to enable interaction with precise 3D models. Now FVA's solution could easily perform complex Boolean operations needed for analyzing planetary gearing systems or to determine the volume of oil in a transmission.

For over 30 years, 3D ACIS Modeler has led the 3D modeling kernel market, delivering flexible solutions that enable manufacturing, engineering, and design application providers to meet the demand for high-quality 3D applications in less time and with lower development costs.
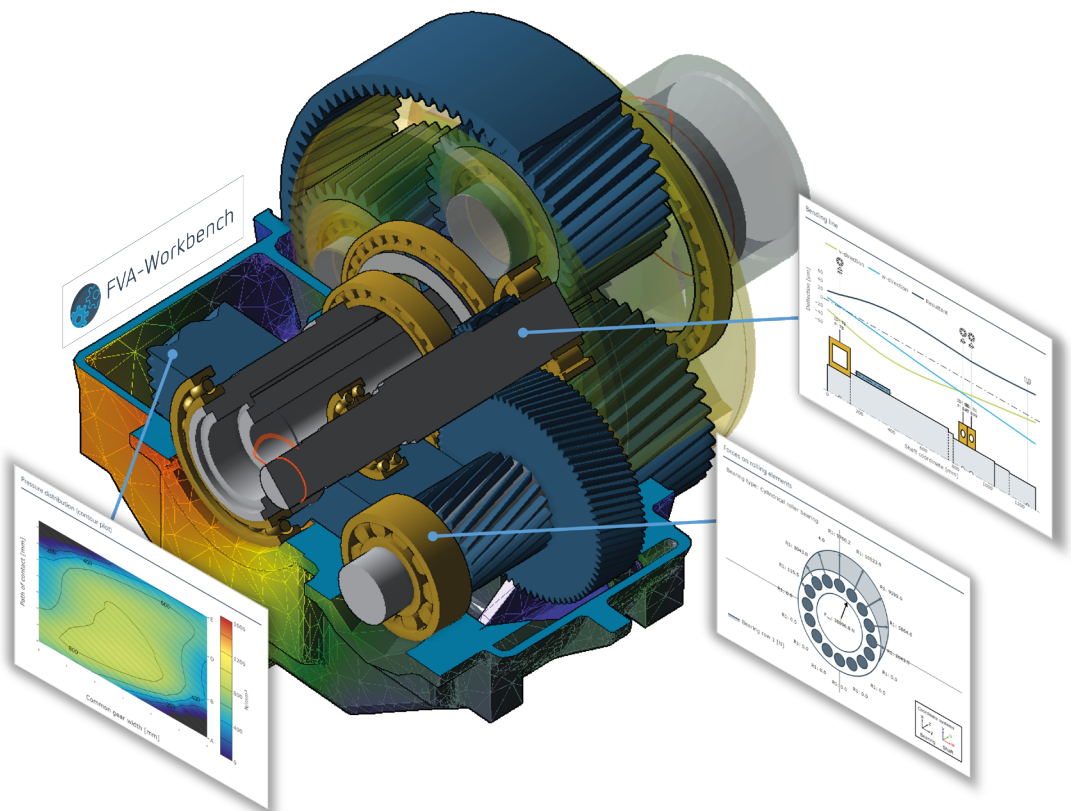
FVA-Workbench 5.5 – Efficient and user-friendly calculation of wind turbine gearboxes with results for shaft, bearings and gearing.

Supporting Interoperability

Within the modern design and manufacturing flow, data interchange is essential. FVA's partnership with Spatial gave the company access to 3D InterOp — the gold standard for 3D CAD data translation. By integrating 3D InterOp into FVA-Workbench, users could now perform imports and exports to/from various native CAD formats with a single click.

Users Require Visual Feedback

Performing analysis to determine driveline performance requires the user to interact with the 3D model, and this interaction best happens visually. Rather than spend time of developing 3D visualization routines, FVA turned to HOOPS Visualize to create interactive 3D renderings to be used within the FVA-Workbench GUI and animations for reporting.

HOOPS Visualize is the industry's most powerful, portable and complete graphics development component for creating or enhancing 3D applications. Developers use the advanced graphic API to accelerate high-performance 3D applications geared to desktop, cloud or mobile applications.

FEA Begins with Meshing

The first step when performing FEA is creating a mesh of the individual components of a system. Because FVA has standardized on Spatial's ACIS 3D modeling kernel, a natural choice for a meshing solution was 3D Precise Mesh. But the decision to employ 3D Precise Mesh came only after an extensive analysis of available meshing solution, where the Spatial mesher came out on top regarding the quality of the results.

3D Precise Mesh provides an integrated 3D meshing capability to power analysis applications that utilize simulation for design and testing. Combining world-leading 3D modeling and meshing solutions provides a rapid and precise CAD-to-mesh capability that analysis workflows depend upon.

FVA-WORKBENCH NOW POWERED BY SPATIAL SDKS

The result of this collaboration between the FVA and Spatial development teams has resulted in feature-rich and robust driveline modeling and analysis package. With the move to Spatial SDKs, FVA has developed a user-friendly GUI for modeling even the most complex gearbox designs, supported by powerful 3D visualization capabilities:

- The ACIS API allows FVA to model solid bodies with just a few lines of code, plus provide access to powerful Boolean operations.
- 3D Precise Mesh powers the fast meshing needed for FEA.
- 3D InterOp enables best-in-class CAD interoperability.

The result of this integration is that FVA's customers can focus on gear analysis while the FVA-Workbench, enhanced with Spatial SDKs, takes care of the cumbersome and time-consuming geometry details. Analysis is now extended by the ability to generate FEM bodies, with all the necessary steps needed for detailed driveline analysis being performed from within the FVA-Workbench:

- Import of CAD geometries in various native formats
- Assembling of CAD bodies relative to the gearbox
- Modifications to CAD bodies
- Automatic geometry simplification and meshing of CAD bodies
- Semi-automatic setting of boundary conditions
- Enabling of fast and reliable combinations of analytical models with FEM

BUSINESS BENEFITS OF THE COLLABORATION

From a business perspective, collaborating with Spatial provides specific benefits to FVA:

- Access to robust solutions tested on thousands of datasets from hundreds of customers as well as the Spatial engineering team's years of experience in 3D modeling
- Improved time to market because FVA's engineering team can now focus on their core competency of numerical simulations
- Timely support for new and updated CAD formats

THE END RESULT

In working with Spatial, FVA can now deliver high-performance software with powerful 3D visualization ahead of its competition. In turn, FVA's customers are able to develop prototypes faster and more efficiently, while easily integrating FVA-Workbench into their workflow.