

transmission

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INTERVIEWS

Jim Lanzon, VP for global transmission engineering, General Motors

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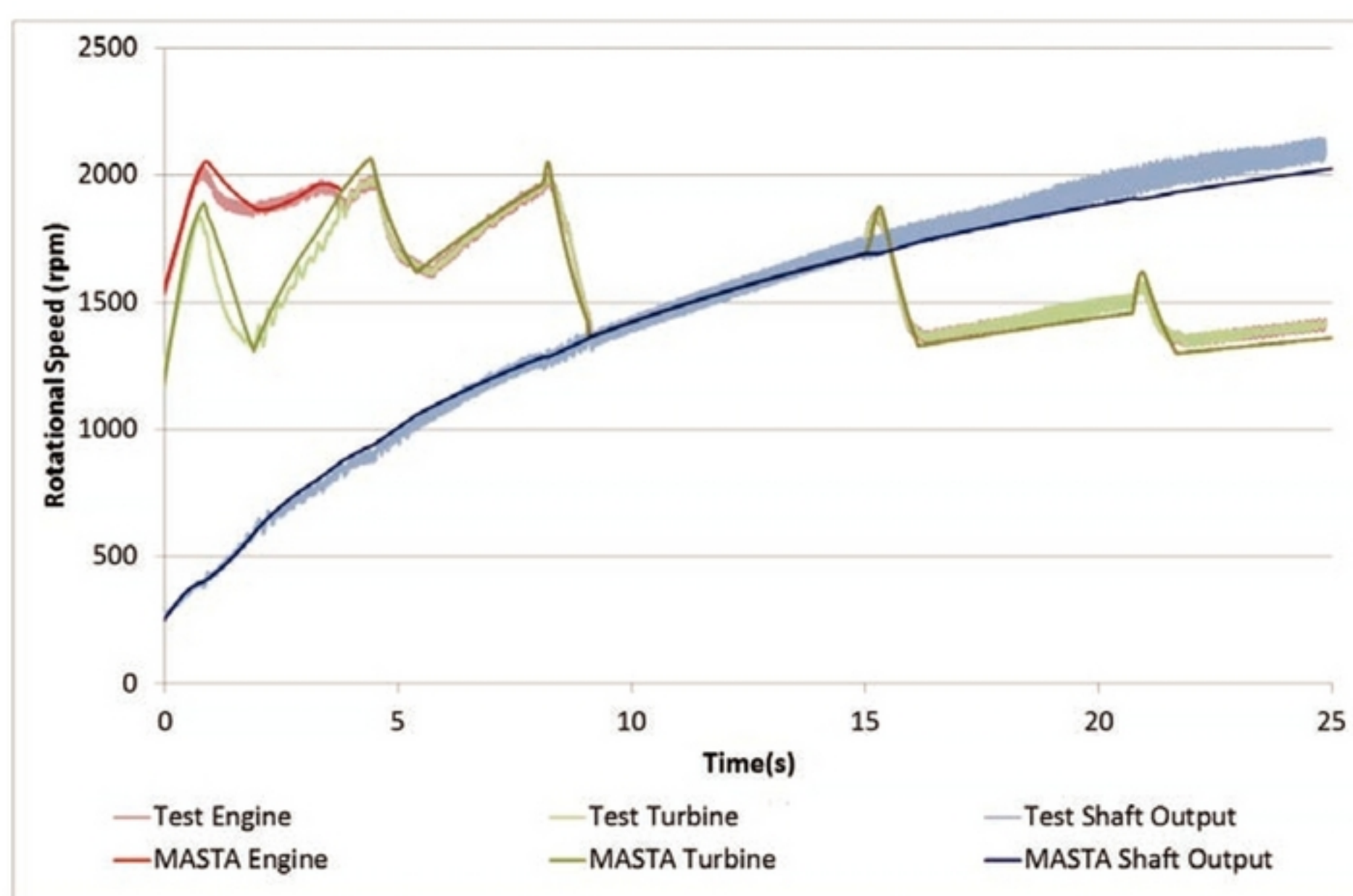
A high-tech software environment has been created to provide development engineers with comprehensive and accurate analysis results for both individual components and for the transmission system as a whole

■ In today's competitive market environment, transmission engineers are facing ever-increasing pressures to deliver innovative transmission designs while meeting requirements for shorter design to production timescales, increased reliability, lower production cost, and greater power densities. Coupled with the availability of new materials and manufacturing methods, this means that reliance on highly specialized transmission design and analysis software is becoming increasingly commonplace in the automotive industry.

Smart Manufacturing Technology (SMT) has developed Masta, a leading software environment for the complete design, analysis and optimization of complex transmission and driveline systems. Masta is able to provide the engineer with comprehensive and accurate analysis results, to recognized international standards and using state-of-the-art proprietary analyses, for both individual components (such as gears, bearings, shafts, and splines) and for the transmission system as a whole. These results include static analyses for durability and rating under steady loads, and modal and frequency domain analyses for the investigation of vibration, whine, and rotor dynamics.

However, as comprehensive as these analysis results are, they are often not valid under the highly time-dependent load conditions that are frequently present within a transmission operating as part of a complete driveline in its intended working environment. In addition, current solutions available for simulating such dynamic conditions often mean that the engineer has to move away from their transmission-orientated design and analysis environment to a more general software package that's capable of performing such dynamic simulations.

Having identified an opportunity for an integrated and specialized transmission



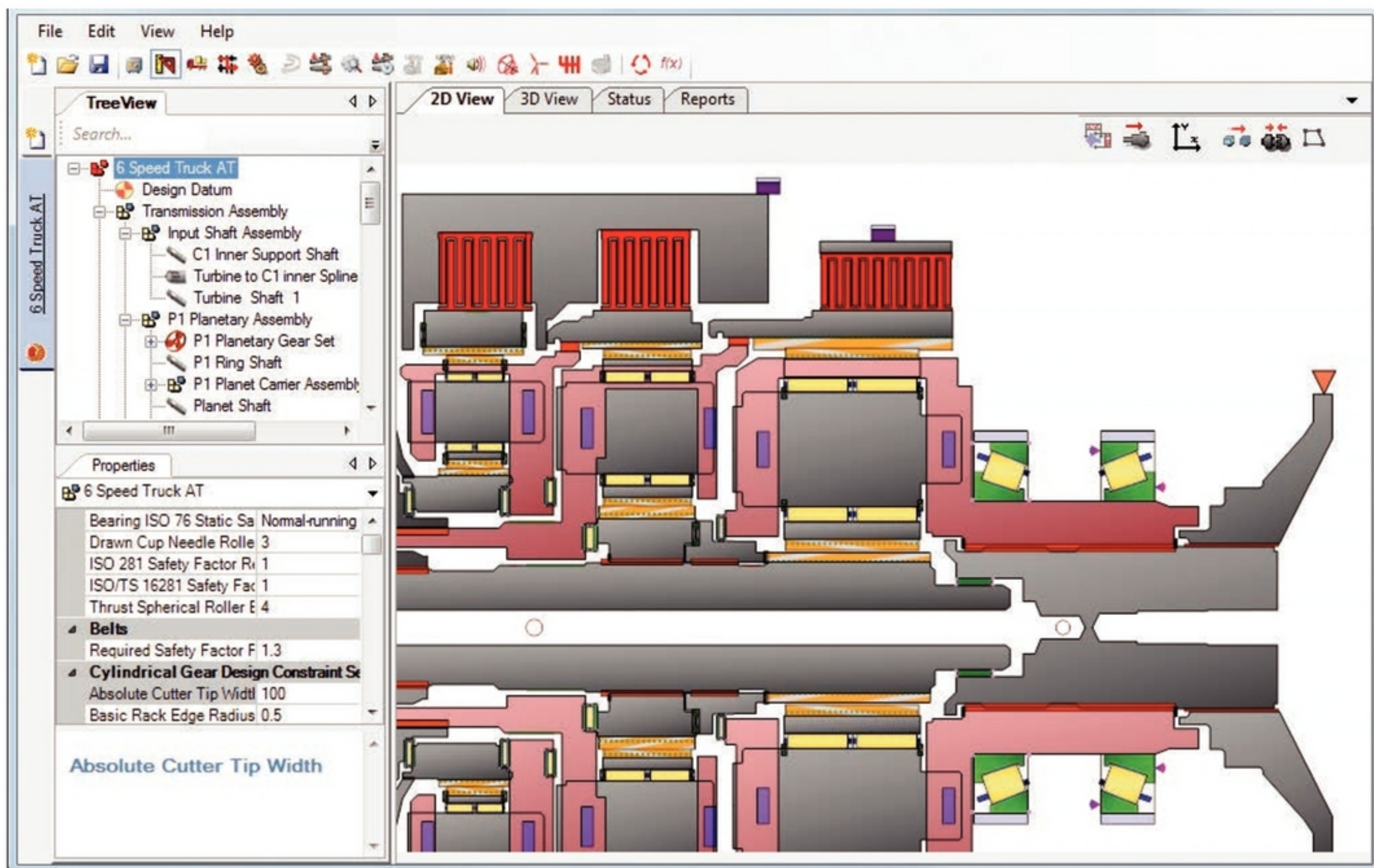
The graph outlines in detail how the MBD-based analysis compares with the measured data from the test vehicle

design and analysis solution that includes a comprehensive time domain dynamic analysis capability, SMT has further extended Masta to include a powerful drivetrain simulation using a flexible multi-body dynamics (MBD) approach. With options tailored towards automotive transmission systems, this highly specialized and integrated approach enables the engineer, for the first time, to perform both rigid and full 6DOF flexible MBD analyses as part of a single, complete, transmission-orientated design, analysis and vehicle performance environment.

This innovative solution enables the rapid creation of a complete vehicle driveline model that incorporates key driveline components such as the engine, driveshafts and wheels, along with a detailed transmission design from Masta. The results of a subsequent MBD

analysis then enable the engineer to assess how the loads on individual components in the gearbox vary during dynamic events, and this in turn provides valuable data to enable the further optimization of the transmission design.

An example application in which the SMT MBD approach has shown to be beneficial is in the investigation of driveline dynamics during gearshifts and the consequential driving experience. A dynamic analysis performed on a driveline model including a detailed Masta model of the transmission has been compared with the measured rotational speeds of the engine, torque-converter turbine and transmission output shaft of a test vehicle during full-throttle acceleration through the first six gears. As can be seen, the MBD-based analysis compares extremely well with



Masta technology provides engineers with comprehensive and very accurate analysis results to recognized international standards by using state-of-the-art proprietary analyses

the measured data from the test vehicle and accurately simulates dynamic conditions during the gear shifts including, for example, the engine flares when the off-going clutch is released too soon. This is shown in the graphic on the opposite page and confirms the validity of the approach adopted by SMT.

Other applications for this innovative integration of design, static and dynamic analyses include assessments of the dynamic loading of transmissions, gear rattle analyses, hybrid vehicle power-source transition analyses, and simulation of transient effects in hydro-mechanical CVTs. A similar wind turbine-focused solution has also been developed that enables, for example, modeling of variable ratio wind turbines.

Further benefits of Masta include the accurate and rapid design of transmission systems and identifying potential failure modes early in the product development cycle; rapid

prediction of key performance characteristics at the design stage; easy exploration of changes in transmission layout, component selection and/or design materials and manufacturing processes in the convenience of a virtual environment; the ability to perform full system simulations for any transmission or driveline configuration; and the option to incorporate manufacturing simulation at the design stage to reduce process development time and cost.

Additional major technological features of Masta include designing the entire transmission and driveline systems using a comprehensive selection of components and design databases; gear tooth geometry optimization; system deflection analysis and minimization; system NVH analysis and optimization; loaded tooth contact analysis; gear strength maximization; shaft fatigue and stress analysis; overall shift performance and quality; gear manufacturing design and simulation; gear scuffing analysis;

drivetrain simulation and validation; and planetary load sharing.

SMT is a world-leading company with a proven track record of supplying unique tools, procedures and expertise for the design, simulation, analysis, and development of complete transmission and driveline systems. The company offers leading knowledge of the design and manufacture of automotive, wind turbine, industrial, aerospace, and marine transmissions, and the company's engineering teams are able to advise on all aspects of transmission design, analysis and optimization.

In addition to Masta, the SMT provides the market with a comprehensive engineering consultancy service for the design, analysis and troubleshooting of gearboxes, transmissions and drivelines, and also designs and supplies test rigs and in-service instrumentation to enable testing and benchmarking of transmission systems and components. **TTI**

