MSC Software

CASE STUDY

MSC Software: Case Study - BL Advanced Ground Support Systems

Developing New Vehicle Concepts Faster

Robotic Military Vehicle Developed in Under 18 Months Using Simulation

BL Advanced Ground Support Systems (BL) specializes in developing vehicles used by air and ground forces. In the past, when the company relied on outside consultants for simulation support, it found that considerable time was wasted in communications and waiting for simulation results. Building the internal capability to do multibody dynamics and multidiscipline simulations with MSC Software's Adams and SimXpert has been key to developing the capacity to design vehicles to its own specifications that can later be configured to meet a range of specific customer requirements.

The company is developing a robotic vehicle platform called the BLR that will handle a wide range of military missions without requiring a human driver. While previous robotic vehicles have taken 6 to 7 years to develop, the company is on track to finish the design of the BLR robotic vehicle in well under 18 months. "Simulation gives us the ability to evaluate the performance of many different design alternatives early in the design process and select the best design in less time at a lower cost than would be required using conventional design methods," said Ronen Veksler, Analysis Department Manger for BL Advanced Ground Support Systems. "The BLR's extraordinary capabilities and compressed development time is a direct result of the huge number of simulations that have driven the design process."

BL Advanced Ground Support Systems is a privately held company that has 30 years experience in designing, developing and producing ground support equipment for fixed wing and rotary wing aircraft, vehicles for ground forces and mixer feeders. The company was recently selected by Lockheed Martin through its subsidiary PDI/BL International to design and manufacture a weapons loader for the F-35 Joint Strike Fighter. BL customers include the Israeli Air Force, Israeli Ministry of Defense, Israeli Ground Forces, Israel Aerospace Industries, Israel Military Industries, Rafael, Soltam, UK Ministry of Defense, Italian Ministry of Defense, Lachish Industries and Elbit.

Key Highlights:

Industry

Defense

Challenge

Develop a robotic vehicle platform that will handle a wide range of military missions without requiring a human driver.

MSC Software Solutions

Adams, SimXpert

Benefits

- Cost & time savings
- Design optimization
- Greater understanding of design behaviors

“BLR’s extraordinary capabilities & compressed development time is a direct result of the huge number of simulations that have driven the design process.”

Ronen Veksler, Analysis Department Manager

Developing Internal Simulation Capability

Simulation has long played a key role at BL Advanced Ground Support Systems by providing the ability to evaluate the performance of alternate design concepts prior to the physical prototype stage. Up to two years ago, the company worked with outside consultants that provided simulation services. “The problem with this approach was that a considerable amount of time was required to communicate the design concept to the external consultant and then there was a long wait while they performed the simulation and communicated the results back to us,” Veksler said. “It normally took weeks to find out how well our design performed.”

“The BLR robotic vehicle is a very ambitious project and it was obvious from the beginning that it would require an enormous simulation effort to develop a vehicle that could deliver world-class performance on each of the missions that we envisioned for it,” Veksler said. “If we had continued with our previous practice of using outside consultants, simulation would not only have been a serious bottleneck, it would have been impossible to design this vehicle.”

“To address this challenge we set about developing our own internal analysis capability,” Veksler said. “We had considerable experience in working with simulation results so we had a good idea of what we were looking for. Adams is the de facto standard in vehicle engineering because of its ability to model every aspect of the design process. MSC Nastran is the leader in structural analysis. MSC Software now provides both of these tools and others within the SimXpert environment behind a single user interface that allows teams to share data, models, results and best practices. With our own internal analysis capability, we have reduced simulation turnaround time from weeks to hours.”

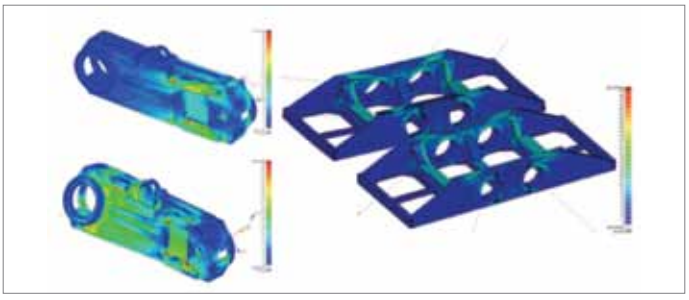
Developing a New Robotic Ground Vehicle

BL’s new robotic ground vehicle is unusual in that the project was initiated by the company itself rather than by a customer request for proposal. The company defined aggressive specifications for a vehicle that can be produced in a range of configurations with wheels or tracks and can carry different payloads including weapons and surveillance systems. A key requirement is the ability to maintain speeds of 50 kilometers per hour over extremely rough terrain. The vehicle is designed to cross over steps 3 feet high and other challenging obstacles that will allow it to operate in nearly every potential battlefield around the world.

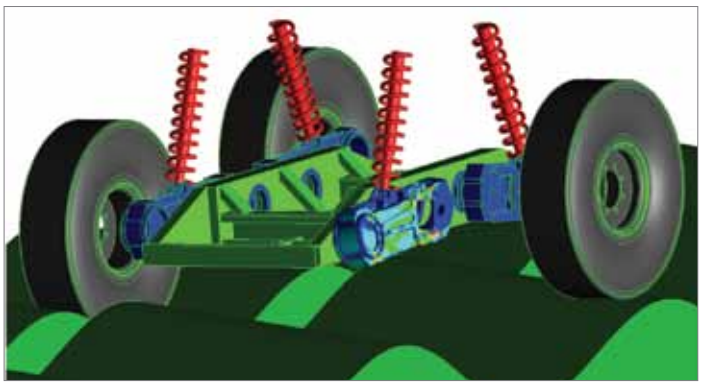
Before beginning simulation, engineers defined the basic configuration of the vehicle. They decided to use a trailing arm suspension because it allows for large travel by each wheel. The powertrain consists of hydraulic hub motors for each wheel with skid steering. BLR used what it calls a ladder chassis consisting of a space frame made of rectangular tubes.

The simulation process started with examining potential suspension components and geometry. “We defined the basic suspension components as rigid bodies in Adams without going into a lot of detail,” Veksler said. “We used code to define the skid steering. We ran the initial design over test tracks including alternating sine and co-sine roads. We defined a number of mission profiles consisting of turns

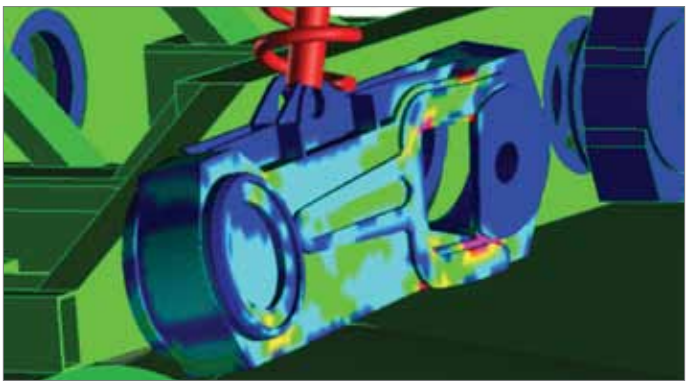
BLR Concept Drawing (featuring tracked wheels)



FEA Analysis carried out on the trailing arms and chassis following an Adams simulation



Adams Analysis using a flexible trailing arm on a Sin&Cos ground



Adams Analysis using a flexible trailing arm on a Sin&Cos ground

and steps and hill climbs. We used this very basic model to make basic high-level design decisions such as the type and position of the bearings used to support the trailing arms and the power requirements for the hub motors."

Moving into Detailed Design

The detailed design began while BL engineers were at the final stages of determining concept geometry using early analysis stages.. The de-featured CAD model was exported from the computer aided design (CAD) software into the SimXpert multidiscipline simulation environment. SimXpert was then used to automatically mesh the model, create special elements as needed and define loads and boundary conditions. This process is nearly completely automated and can be accomplished so quickly that dozen of design iterations can be simulated in a single day. With the CAD geometry associated to SimXpert, it was easy to utilize the detailed geometry in the analysis to take the flexibility of critical structural components into account in the vehicle simulation. For example, by converting the trailing arms to flexible bodies, BL engineers were able to determine the impact of the trailing arm geometry on the vehicle performance. Likewise, components' structural strength and dynamic properties can also be easily determined.

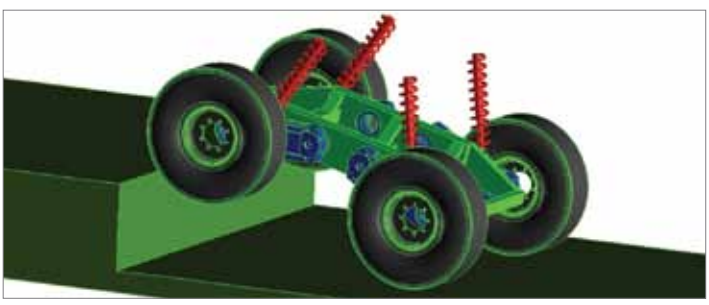
"Without a complete understanding of the design's behavior, critical failures can be overlooked," Veksler said. "The ability to easily deploy multiple solvers on a single design within the SimXpert environment is crucial to our work. SimXpert gives us the ability to run linear FEA, nonlinear FEA, multi-body dynamics, thermal simulations, crash tests, virtually any type of simulation we need with a minimum of additional work." For example, one of the vehicle applications involves carrying a firing system. Engineers incorporated the firing event as a load using a force vs. time graph and used transient response analysis to understand how the vehicle would react to firing.

Support is Critical

Support provided by both MSC Software and its Israeli business partner MSI is crucial to BL's success. "Having a knowledge-base as vast and as professional as MSC and MSI helps us improve our analysis abilities and is a strong factor that differentiates us from our competitors," Veksler said. "Knowing that we have strong professional backing allows us to rely more on our analysis results and produce a better first article every time."

"Simulation helps encourage innovative design methods because engineers can easily explore alternative design concepts in very little time or expense," Veksler concluded. "Simulation also provides detailed diagnostic information that helps us understand why a design is performing as it is. With SimXpert we spend less time translating and fixing CAD data, meshing, reworking models, and creating the same plots and charts over and over. This means that our engineers can devote more time to developing new vehicle concepts and bringing them to market faster than our competitors." BL is nearing the completion of the detailed design of the BLR robotic vehicle and will soon begin production of the prototype.

Motor selection simulation - inclined slope with "gravel like" traction



Step climbing simulation (incorporated skid steer controller - motor speed state variable control)

About MSC Software

MSC Software is one of the ten original software companies and the worldwide leader in multidiscipline simulation. As a trusted partner, MSC Software helps companies improve quality, save time and reduce costs associated with design and test of manufactured products. Academic institutions, researchers, and students employ MSC technology to expand individual knowledge as well as expand the horizon of simulation. MSC Software employs 1,000 professionals in 20 countries. For additional information about MSC Software's products and services, please visit www.mscsoftware.com.

Please visit www.mscsoftware.com for more case studies

About Adams

Multibody Dynamics Simulation

Adams is the most widely used multibody dynamics and motion analysis software in the world. Adams helps engineers to study the dynamics of moving parts, how loads and forces are distributed throughout mechanical systems, and to improve and optimize the performance of their products.

Traditional "build and test" design methods are expensive, time consuming, and impossible to do sometimes. CAD-based tools help to evaluate things like interference between parts, and basic kinematic motion, but neglect the true physics-based dynamics of complex mechanical systems. FEA is suited for studying linear vibration and transient dynamics, but inefficient at analyzing large rotations and other highly nonlinear motion of full mechanical systems.

Adams multibody dynamics software enables engineers to easily create and test virtual prototypes of mechanical systems in a fraction of the time and cost required for physical build and test. Unlike most CAD embedded tools, Adams incorporates real physics by simultaneously solving equations for kinematics, statics, quasi-statics, and dynamics.

Utilizing multibody dynamics solution technology, Adams runs nonlinear dynamics in a fraction of the time required by FEA solutions. Loads and forces computed by Adams simulations improve the accuracy of FEA by providing better assessment of how they vary throughout a full range of motion and operating environments.

Optional modules available with Adams allow users to integrate mechanical components, pneumatics, hydraulics, electronics, and control systems technologies to build and test virtual prototypes that accurately account for the interactions between these subsystems.

About SimXpert

Multidiscipline Simulation

SimXpert is a next generation CAE application that empowers engineers to perform an expansive range of multidisciplinary simulations by delivering new tools that accelerate learning curves and shorten model preparation and setup times all within a fully integrated user environment.

"Doing more with less" is a common theme in most companies today, but designers, engineers and CAE analysts spend most of their time and effort on manual, labor intensive tasks. Translating and fixing CAD data, meshing, reworking models, creating the same plots and charts over and over – all of these mean that engineers are spending more time developing expertise in using tools rather than on evaluating and understanding their products. SimXpert changes that by providing native access to CAD data and easy to use tools to automate their simulation jobs and get results fast.

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