

Alliance spacesystems inc.

Business



Company: SRACCustomer: Alliance Spacesystems Inc.

Submitted by: SRACDate: February 2002Alliance Spacesystems Inc. (ASI) provides end-to-end aerospace systems design and fabrication services. Its focus is building and designing spacecraft mechanical systems for government clients such as the Jet Propulsion Laboratory (JPL). It often subcontracts forBoeingand other companies that build “ smart” spacecraft.

JPL is one of NASA’s nine field centers. It is chartered to explore deep space for the US government. Its spacecraft must meet the toughest standards for survivability, reliability, and cost-effectiveness. One current project of JPL is MER, the Mars Exploration Rover. JPL’s goal is to launch two missions to Mars in 2003 that will drop essentially identical rovers on the planet. Similar to the Mars Pathfinder mission, they’ll deploy airbags to bounce to a safe landing.

ASI is designing the robotic arm on the front of each rover. These arms are four feet long with five degrees of freedom and scientific instruments at the end. The MER will drive to a likely location, extend its mechanical arm, and hold the instruments near a rock. The end of the arm will rotate so each instrument can scan the spot in turn. The robotic arms weigh only 3.

5 kilograms (7. 7 pounds). They have five actuators, several moving joints, and conductor wires along their lengths. The arms must meet exacting requirements for factors such as stiffness while staying below a certain mass. Jim Staats, ASI’s vice president of engineering, notes that mass is the crucial component of any space mission.

“ You just can’t get there from here if you can’t get the mass within the envelope,” he says. Because its protective aeroshell can hold only so much mass, the MER lander must be within limits. If it isn’t, it will either burn up or hit the ground like a bullet. ASI has been using COSMOS/Works and its optimization functions for detailed stress analysis and mass minimization of the arms’ parts. The engineers vary the parts’ geometry to reduce mass while controlling the maximum allowable stress or deflection. The results are often striking.

“ Using some of the optimization features,” says Staats, “ we can typically take 15-20% additional mass out.” That doesn’t sound like much, but if you wanted to reduce your car 20%, he observes, “ you’d have to take the whole engine and transmission and throw it out. So it’s a big chunk.”

COSMOS/Works is the tool that makes that possible. Other critical factors also demand the software’s capabilities. One is Mars’s crushing extremes of temperature, from a low of -133° C.

(-207° F.) to 27° C. (80° F.) on a balmy summer day. Another is the bone-crunching impact of landing.

The lander will hit the ground at 50-60 mph with a force of 50 Gs. ASI’s engineers use SolidWorks for design and COSMOS/Works for finite element analysis (FEA) whenever they can, says Staats. The programs were instrumental in designing robotic arms for the Mars Odyssey mission, a hopping exploratory robot for Caltech, and part of the nanorover for the MUSES-CN asteroid mission. Staats calls the integrated software “ a very straightforward and efficient tool, less complex but very powerful.”

Sold from the Beginning

From the first SolidWorks and COSMOS/Works demos, the ASI team thought the integration of CAD and FEA would save them time and effort.

The training time was virtually nil, they found. People could do something useful with the program after an hour. They were impressed with COSMOS/Works' efficient equation-solving capability, which made large models easy to do. "It used to be that you'd have to reduce the number of equations to something manageable," says Staats. With COSMOS/Works, analysts leave the equations intact and let the automatic meshing capabilities take care of them. The software generates tens of thousands, even hundreds of thousands, of equations in a short time.

"Ten minutes is a long run for COSMOS," he adds. Another advantage is how COSMOS/Works has streamlined ASI's design process. Most aerospace companies have a design group and a stress or analysis group. When a conceptual design is created, it usually requires many iterations of analysis to see if it's in the right ballpark. For each round the design engineers throw the design "over the fence" and into the queue for analysis jobs, where it may languish for several days or a week because the analysts are busy.

With COSMOS/Works' integration, ASI's engineers don't have to manipulate CAD data to get it into a form suitable for FEA. The data transfer is automatic and doesn't require a cumbersome file export and import. "This is the smoothest connection between any of these tools that I've personally seen," says Staats. The upshot? Iterations take only a couple of hours rather than a couple of days or more. In fact, ASI's design engineers are routinely doing

their own analyses—dumping loads on them, seeing if they're strong or stiff enough, and so on. They don't have to ask anybody or wait in line.

“ You have very young engineers doing what I believe are very advanced analyses,” says Staats, and “ we're getting better designs as a result.”

Besides ASI's design engineers doing more analysis, its analysts are becoming more familiar with CAD tools. They routinely use SolidWorks to take dimensions, model small parts, and look at assemblies. “ These tools have become a communication tool between the two types of engineers,” says Staats. “ They both speak each other's language better than I've ever seen before.” Yet another advantage is the PC environment.

Team members can cut-and-paste COSMOS/Works data into a PowerPoint presentation, e-mail it to someone, or post it on a project website. “ That's really, really helping us out a lot,” says Staats. It's a big improvement over mainframe or Unix-based systems with their constant problems exchanging information.

Keeping Customers Satisfied

Not only has COSMOS/Works impressed ASI, it has impressed ASI's customers as well. In one case, a commercial spacecraft customer requested a new design for a part that had failed. ASI had to redesign it in aluminum while matching the original part's stiffness.

As Staats tells it: “ The customer was very, very pleased that we were able to turn the design around, complete with analysis, through a number of iterations in only three weeks. Three weeks could have easily gone to three months in that case. So that was a really good workout for COSMOS/Works.”

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Staats concludes that COSMOS/Works has helped ASI in the marketplace because the company can crank out designs faster. The software gives ASI a competitive advantage. “ But our main thrust is to get parts that are better,” he says, and COSMOS/Works does that too.