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CASE STUDY

ANSYS DesignSpace Helps Leading Robotics Company Reduce Weight, Save Time

MOTOMAN INC.

EXECUTIVE SUMMARY

Challenge:

To design the new MotoSweep O, a boom and riser system on which to mount a 6-axis robot, which would be able to service multiple vertical and/or horizontal machines from overhead, addressing installations in a linear, rotary, or facing configuration, with a rotating arm that would be able to reach all of the machines at once, while freeing up significant floor space

Solution:

Use ANSYS DesignSpace to reduce the boom's mass and increase the reach, efficiency, and maximum payload of the system

Benefits:

Saved time and hand calculations

Helped to eliminate trial-and-error

Precluded the necessity for numerous prototypes for testing

Reduced material cost

Enabled engineers to create and analyze many different designs

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Introduction

Motoman, Inc., founded in August of 1989, is the second-largest robotics company in the United States, as well as one of the fastest-growing, with more than 17,000 robots installed in North America.

Motoman is the offspring of two powerful companies; Yaskawa Electric America (YEA), which manufactures numerical control products, inverters, and AC servo motors and drives, and Yaskawa Electric Corporation (YEC) of Japan, one of the world's largest manufacturers of industrial robots, with more than 85,000 installed worldwide.

Motoman's wide variety of robots is used in a broad range of applications, including material handling for machine tool load/unload, injection mold machine load/unload, arc and spot welding, and process applications, such as die spray, dispensing, and trimming. Motoman's biggest customers are integrators and suppliers to the top auto manufacturing companies.

Images courtesy of Motoman, Inc.

MotoSweep O UP50 (280kg robot).

Challenge

Motoman's 6-axis robots have been used in conjunction with a boom, which is a swinging gallows arm mounted on a riser, to make a 7-axis robot that can be used from an overhead position. Recently, Gary Schutte, Senior Mechanical Engineer for Motoman, Inc., set out to replace Motoman's existing servo gallows system, which was made for overhead arc welding. His intention was to design a system that could also be used for material handling, in which the boom's mass would be reduced, and the overall payload would be increased. This improvement was meant to allow a robot larger than 280kg, the maximum for the present system, to be mounted on the boom, and more efficiently service single or multiple workstations, gaining access from the front or the top of the work cell.

Motoman's Product Development team of Ken Harbaugh, Senior Mechanical Engineer, Wade Hickle, Senior Electrical Project Engineer, Gary Schutte, Senior Mechanical Engineer, and George Sutton, Associate Chief Engineer, designed the new system. From this, they would also create a manually operated boom, and a fixed boom, to be mounted on a self-supporting overhead structure. Another objective was to solve the problem that they were having with backlash in the main drive assembly of the boom. The backlash, which caused the boom to shake when the robot reached its program point, was increasing the robot's settling time, as well as MotoSweep O's cycle time. Therefore, they would have to develop a dampening system for the drive unit.

Solution

Schutte and his team used DesignSpace to create a boom with less mass, so that they could increase its reach and payload. DesignSpace also enabled

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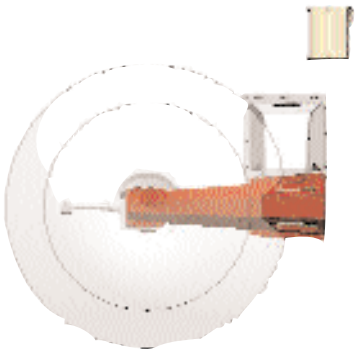
them to reduce the base structure size, as well as the floor mounting requirements for the riser on their new product line.



Top view of the UP50, the 550kg robot

The MotoSweep O allows a 550kg robot (UP50), which has an allowable working payload of 50kg, to be mounted 2 meters from the axis. That's double the payload and twice the mass of the 280kg robot (UP20), whose payload is only 20kg.

Motoman's team also was able to devise a dampening system to eliminate the backlash and increase the stiffness of the structure. An important element in this system was a friction roller that would be mounted to a top plate. It would have to be flexible, so as not to work against the main bearing. To see how it would react within the MotoSweep system, the team built a model of the main drive unit in DesignSpace.

Through hand calculations, they acquired its spring rate, then used the value they obtained to alter the material properties of the model to simulate the flexing that would occur. This analysis was used to determine the spring rate that would be necessary for the top plate. DesignSpace then helped them to find the exact thickness they would need for the plate to achieve the desired deflection. Now, although the main bearing is still taking most of the load, the roller is dampening the backlash and reducing the deflection of the boom.

The MotoSweep O also has a higher rotational speed and an increased allowable payload over the old gallows system. In addition, its settling time has improved from a second and a half to less than one second, and the application and process times have been reduced dramatically. The MotoSweep O has a velocity of 10.6 rpm and a rotation of plus or minus 180°. The standard MotoSweep O axis-to-robot base radial distance is 2000mm, while the floor-to-robot base height is 2595mm. The MotoSweep O UP20, available with ceiling and wall mounts, has an overall reach of 3.8 meters from the turning axis, while the UP50, available with the ceiling mount, has a reach of 4 meters.

The analysis of the MotoSweep O was done on an 800 MHz, 512K-ram system, with a 20 gig hard drive. Each run on the MotoSweep O took about 4 hours. The large and complex MotoSweep O could have been simplified to reduce the processing time, but the engineers wanted to test the capabilities of the software. Normally, Schutte runs ANSYS DesignSpace software on a 2.8 GHz dual processor, with 2 gig of ram, and an 80 gig hard drive.

Benefits

"Using DesignSpace saved time and hand calculations, and helped to eliminate trial-and-error," Schutte said. "We didn't have to keep building new structures, which reduced the cost of materials."

The MotoSweep O has the ability to service multiple vertical and/or horizontal machines, and the flexibility to address installations in a linear, rotary, or facing configuration. It can be used from overhead to service a group of machines, by rotating the arm so that the robot can have access to all of the machines at once. It also frees up a lot of floor space.

Schutte, who uses DesignSpace to help other departments at Motoman with custom robots and risers, says, "FEA plays a major role in Motoman's Product Development Group. It helps us to look at different designs we would not even have tried in the past, because of the expense and time restraints involved in prototyping new products. Now we can look at three or four different designs and determine which will be the most cost-effective. We can also incorporate more functions in the designs."

Motoman's engineers had used Cosmos FEA software for about five years, but switched to DesignSpace in 2002. Schutte says, "We changed from Cosmos to DesignSpace, because it is easier to use. It has the ability to solve complex assemblies, and provides better customer support. Cosmos doesn't support Solid Edge as much as it should. It also had trouble meshing components and solving the boom and base structures of the MotoSweep O, without making major changes to the designed model."

Other features in DesignSpace are easier to use as well. Schutte notes, "With the old system, it was kind of difficult to put the pictures into the reports generated by the software; but it's very easy to do with DesignSpace."

Released in January 2003, the MotoSweep O is the fastest rotary overhead robot transport, 2-meter boom, with a 50kg 6-axis robot payload available on the market.

Simply put, Schutte says, "DesignSpace adds value to standard robotic systems."

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