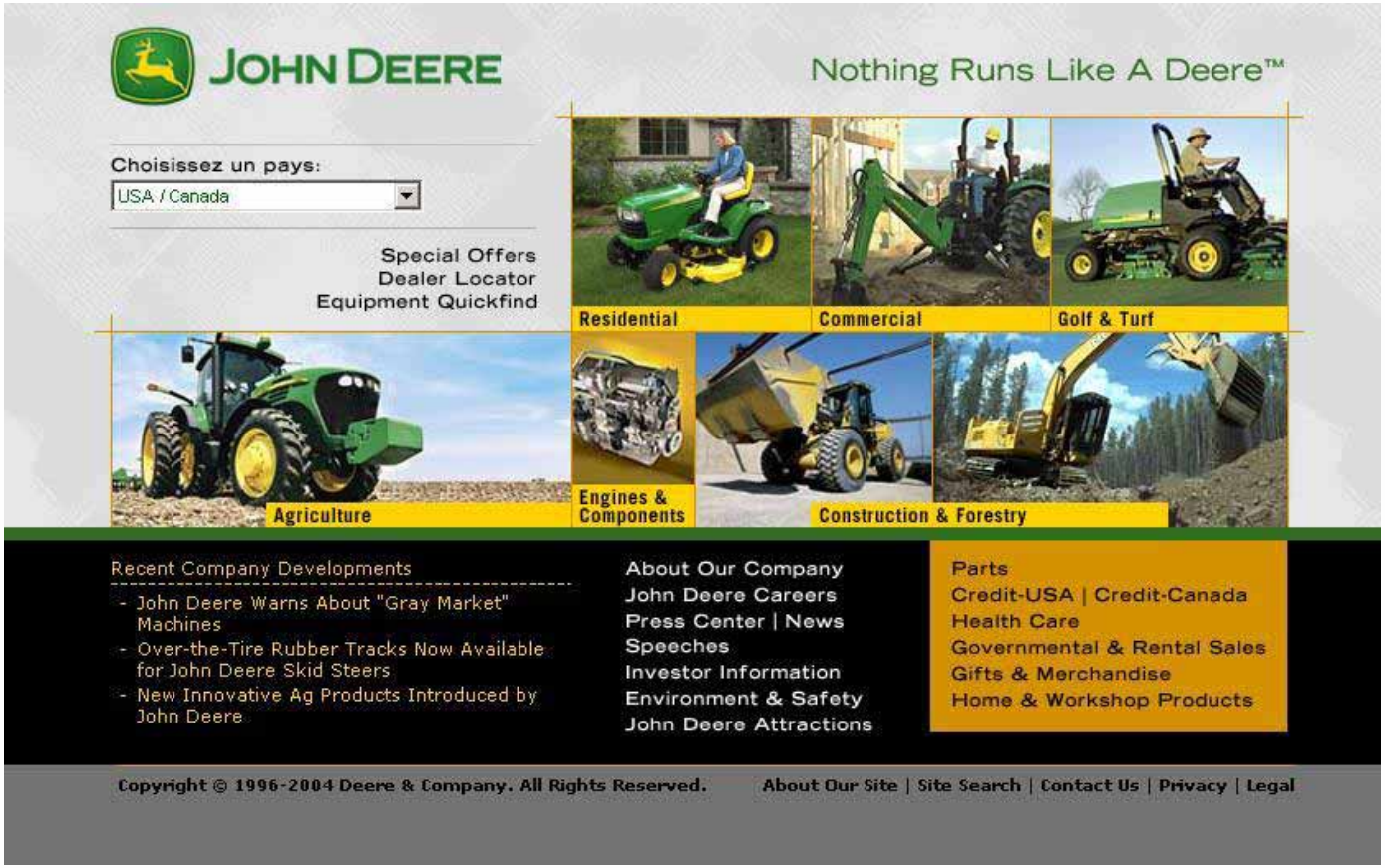
Integrating Virtual Reality with MSC.ADAMS

David B. Jackson, Deere & Company
Kurt Chipperfield, John Deere Dubuque Works

Introduction

- Background
- Virtual Reality Hose Utility
- Dynamic Simulation
- Results
- Conclusions
- Acknowledgements
- Questions?

Introduction



Background

The Problem:

- Most agricultural, construction, and forestry equipment rely on hydraulics to move around, lift, dig, drive auxiliary motors, etc.
- If these hoses are not routed properly they can become pinched or have excessive wear resulting in warranty issues.
- Defining the routing procedure to minimize the risk of hose damage due to interference during normal machine use is a challenge:
  - Hoses change length when under pressure.
  - They also become more stiff under pressure.
  - Predicting the correct length and route can be difficult.

Background (Cont.)

Build-Test Cycle:

- Estimate hose length.
- Cut and add fittings.
- Attach hoses to hardware attachment points and connectors.
- Pressurize hoses.
- Visually identify problem areas.
- Empty hoses and repeat.

Problems:

- Fluid Waste & Cleanup.
- Hose Waste.
- Time.

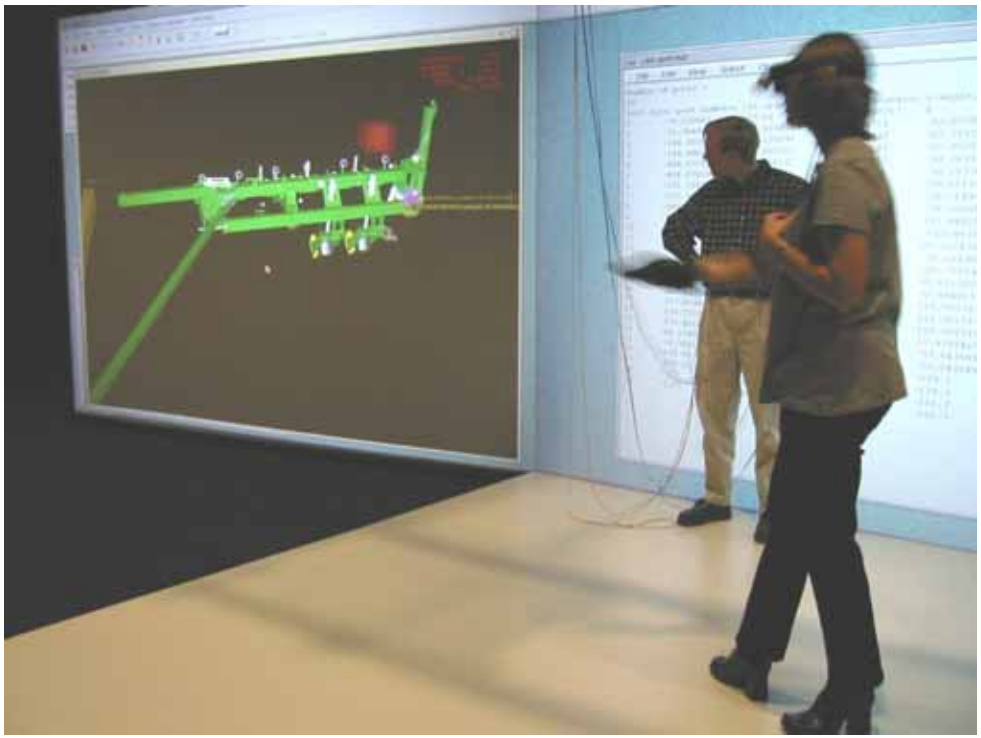
VR Hose Utility

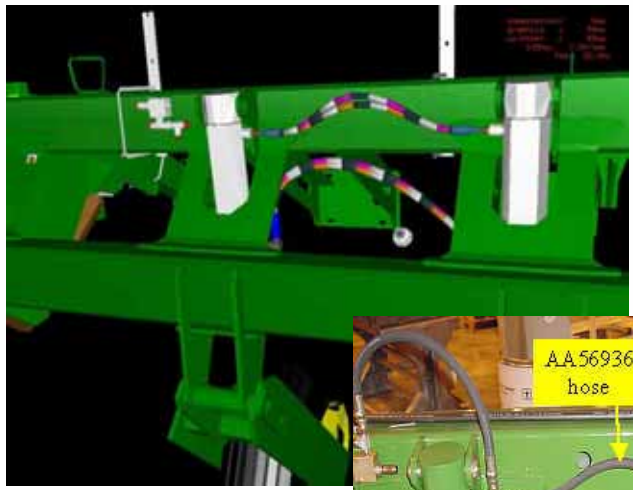
Virtual Reality Hose Tool

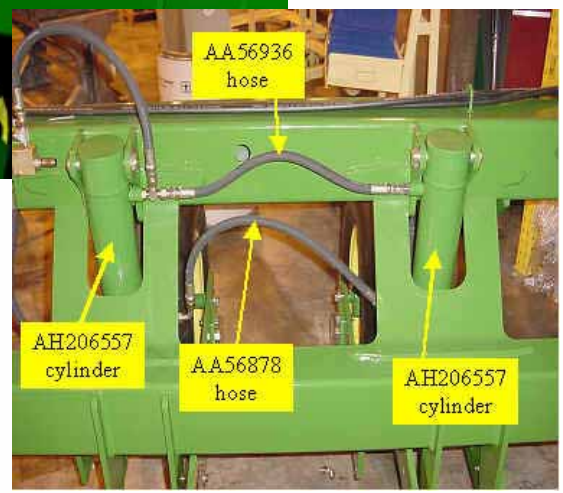
- Developed as a joint venture with Iowa State University.
- Uses Virtual Reality technology in conjunction with MSC.ADAMS:
  - VR technology provides 3-D environment to estimate placement on virtual hardware.
  - MSC.ADAMS predicts pressurized/un-pressurized hose length and static position.
- Is a static solution.
- Uses beam elements within MSC.ADAMS to capture flexibility.
- Beam properties are derived from hose testing.

VR Hose Utility

JOHN DEERE







Dynamic Simulation

Hoses often pass through areas of articulation.

- Hoses need to be flexible.
- Need to have sufficient slack.
- Need to be clamped & guided properly, otherwise:
  - Excessive wear can occur.
  - Hose can become pinched and cut.

Developing process to use VR Hose static data in a dynamic world.

- Properly place guide loops and clamps to minimize wear and eliminate hoses being pinched or cut.
- Capture:
  - Dynamic motion of hoses.
  - Interaction with other hoses.
  - Interaction with guides and hardware surfaces.

Dynamic Simulation (Cont.)

JOHN DEERE

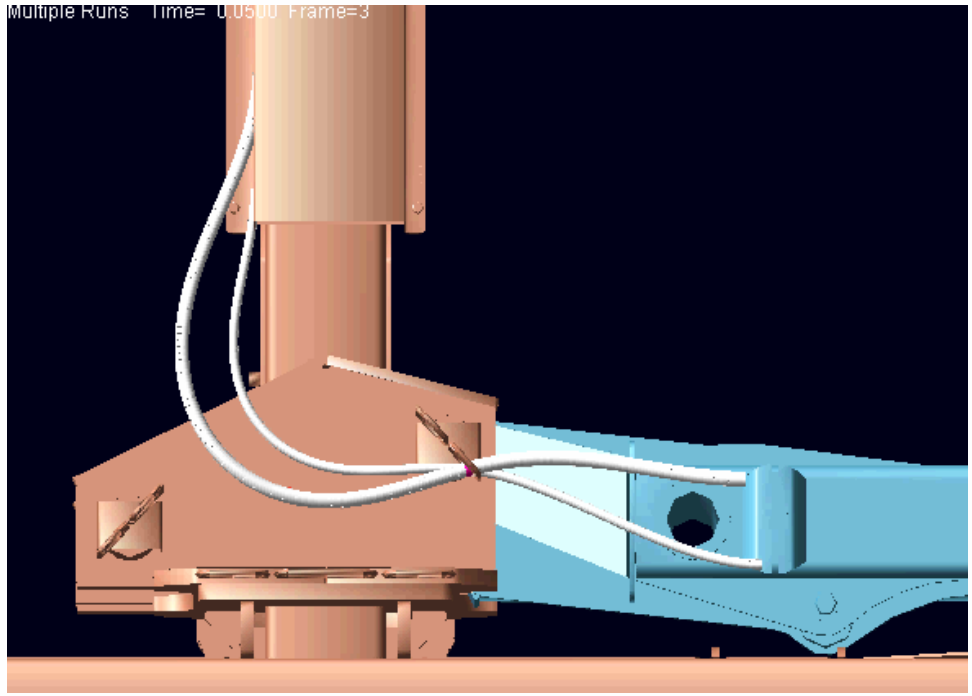
MSC.ADAMS Dynamic Model:

- Create MSC.ADAMS Rigid body model simulating dynamic motion of hardware.
- Import MSC.ADAMS hose model from VR Hose utility.
- Add contacts between hoses, guides, and hardware as needed.
- Simulate motion.
- Evaluate.
- Move guides and/or clamps as needed.
- Redefine hoses in VR Hose utility and re-import as needed.

Results

Example 1 (Articulating Joint)

- Initial hose routing of two pressurized hydraulic hoses.
- Contact with D-ring captured.
- Identified potential issue with excessive wear:
  - Near manifold cover.
  - Along D-ring.
- Solution:
  - Hydraulic engineer repositioned and reoriented D-ring.

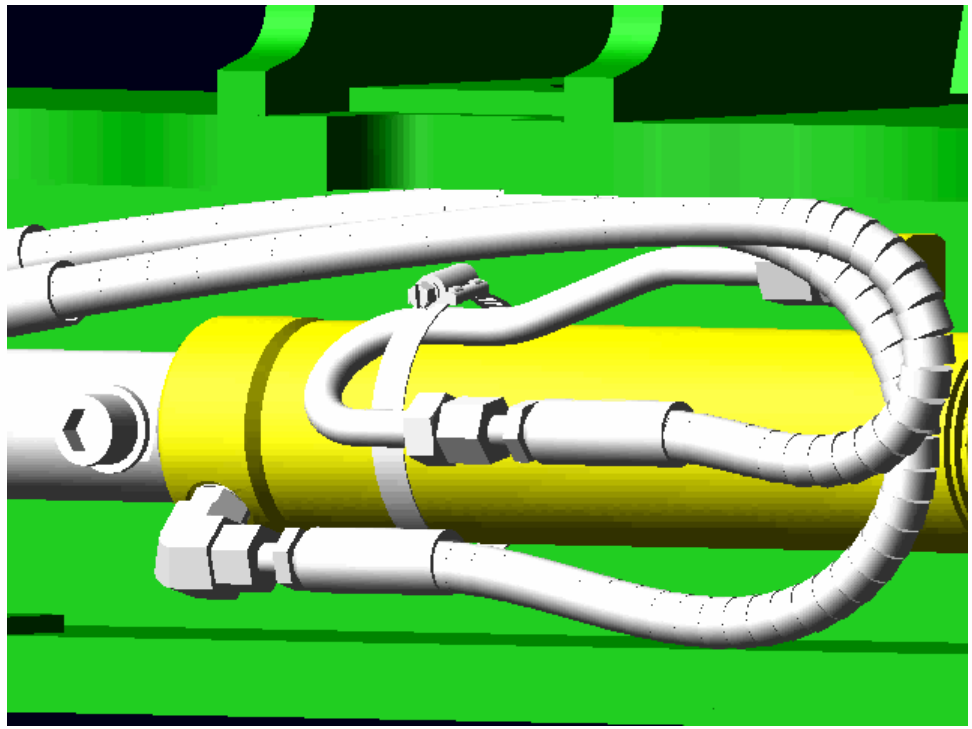


Results (Cont.)

JOHN DEERE

Example 2 (Sliding)

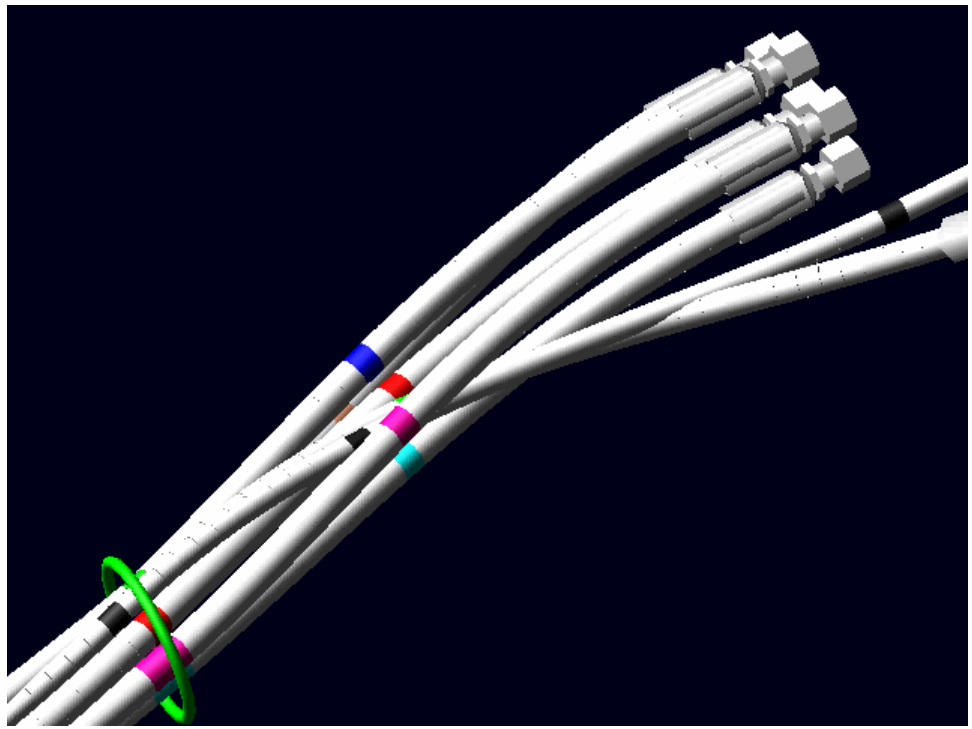
- Simulate pressurized hydraulic hoses trapped between surfaces.
- Objective: Check for correct hose length.
- Capture Hose to surface interaction.
- Identified potential issue with tight bend in hose.
- Solution: Replace straight coupler with 45 deg coupler.



Results (Cont.)

Example 3 (Multiple Hoses)

- Simulate bundle of hoses through articulation joint.
- Objective: Verify correct hose lengths.
- Hose-to-hose contact not modeled.
- Verified hose length.
- Visualize potential hose interaction.
- Next step is to simulate hose-to-hose contact.



Conclusions

- Effectively utilizing VR and MBD technologies to improve our hose design process.
- Developed process for capturing hose dynamics under various types of motion.
- Can effectively model various hose interactions.
- MSC.ADAMS has been an effective way of capturing the flexibility and a few contact interactions of hoses.
- Continuing to improve the process through:
  - Automation.
  - Developing additional interactions.

Acknowledgments

- Judy M. Vance & Andrew G. Fischer at Iowa State University for initial development of the VR hose methodology.
- D. Brad Keleher, Deere & Company for use of the VR Lab.
- Peter Nedved, John Deere Seeding Group for initial hose routings.
- Aric Halloran, Deere & Company for providing geometry.
- Kurt A. Chipperfield, John Deere Dubuque Works for most of the work.

Questions?