

# **Virtual Reality as a Human Computer Interface to Mechanical Design**

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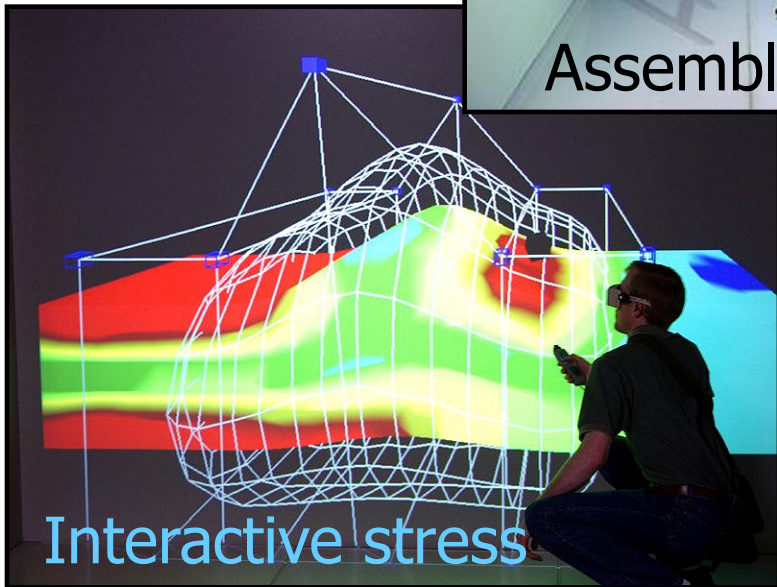
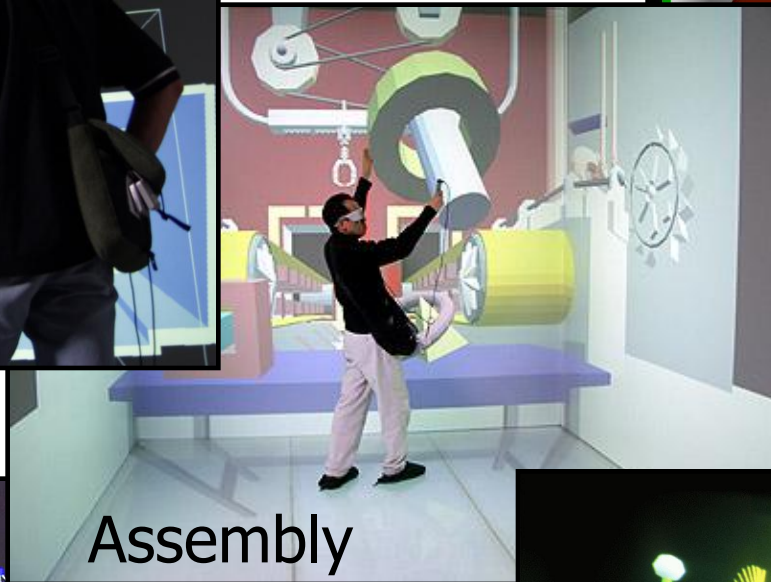
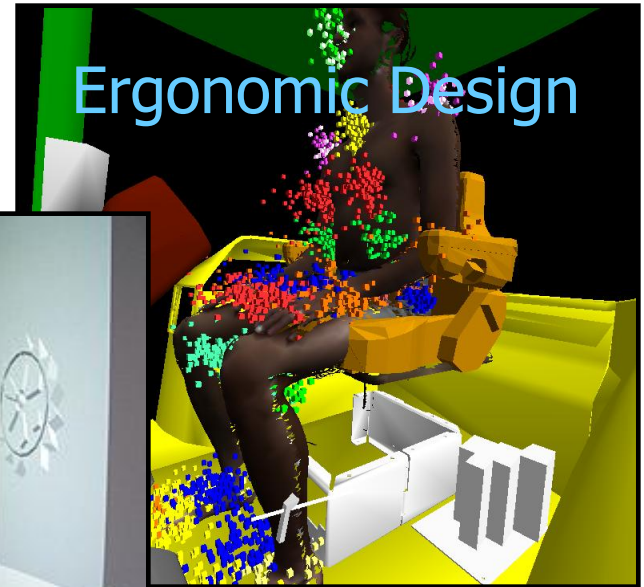
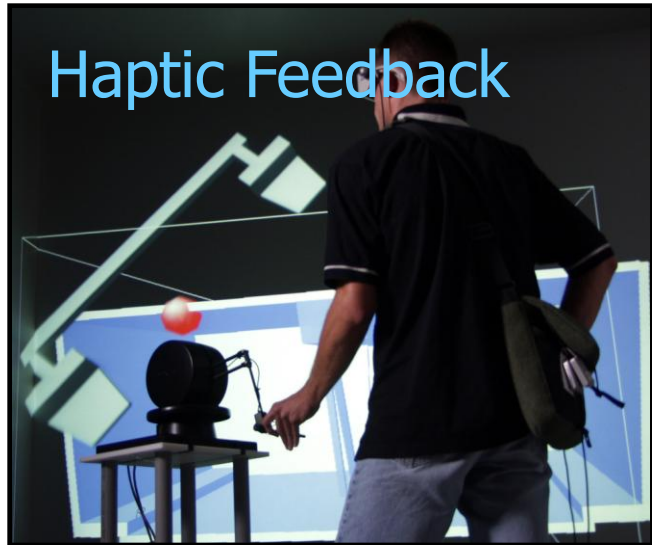
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# Virtual Reality Technology

Position tracking  
Stereo viewing  
Multisensory stimulation



# Position Tracking

## Head tracking

Used to change the visual display to correspond to the orientation of the person in the environment

## Position tracked input devices

Allow the user to reach out and grab computer generated objects and move them around in the computer environment



# Object Manipulation

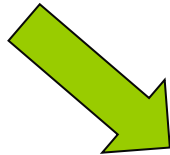
User triggers the selection process



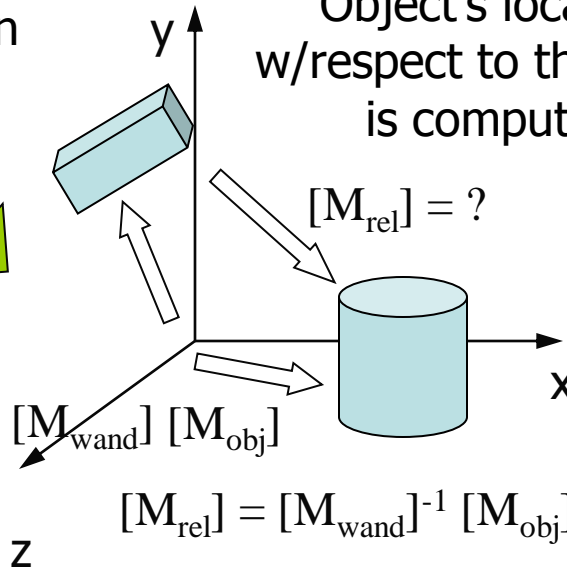
Object is released



Environmental objects are checked for collision with the wand



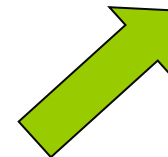
Object's location w/ respect to the wand is computed



$[M_{rel}] = ?$

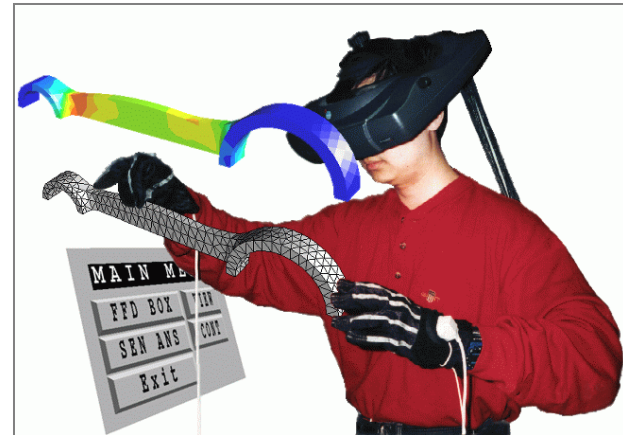
Object's location is updated with wand's motion

$[M_{obj}] = [M_{wand}] [M_{rel}]$

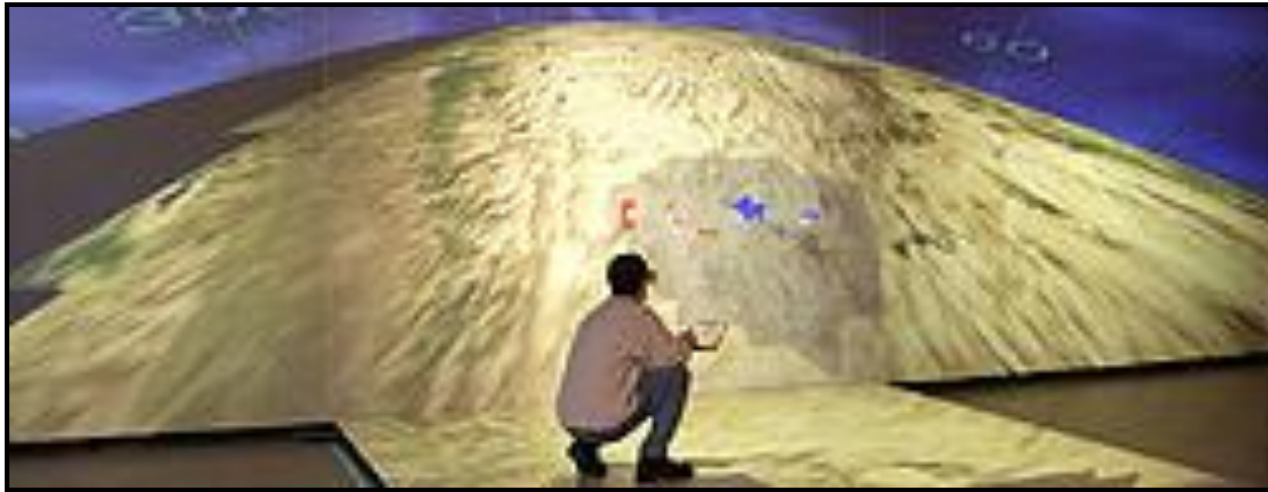




# Facilities



# C4: MD Flex™ (1117 Black Engr)



- 12' x 12' x 9' facility
- 3 walls and floor stereo projection
- Outer walls can fold out to provide a 36' x 9' viewing surface
- SGI ONYX with 3 - Infinite Reality graphics pipes and 16 - R10000 processors
- Nuvision and StereoGraphics active stereo glasses
- Ascension Technology Wireless MotionStar tracking system
- Barco projectors



# The C6 (Howe Hall Atrium)

Entire facility is 3 stories  
high

Occupies the atrium of  
Howe Hall





# Construction of the C6



[www.vrac.iastate.edu/new/c6page.html](http://www.vrac.iastate.edu/new/c6page.html)



# C6: 6 walls, wireless tracking



- 10' x 10' x 10' facility
- 4 walls, floor, and ceiling stereo projection
- Surround sound audio system
- SGI ONYX2 Reality Monster
  - 6 - Infinite Reality2 graphic pipes
  - 24 - R12000 processors @ 400 MHz
  - 56MB texture memory, 12Gb RAM
- Nuvision and StereoGraphics active stereo glasses
- Ascension Technology Wireless MotionStar tracking system
- Barco Projectors



# Hydraulic Hose Routing in Virtual Reality

**GOAL:** To develop a virtual reality design tool that allows designers to accurately route hydraulic hoses early in the product design process.



# The Hose Routing Problem

- Difficult to predict installed hose shape
  - Hoses vary in flexibility
  - Installation affects hose shape
  - Operation affects hose shape
- Multiple hoses are needed for many products
- Hose wear occurs when hoses rub against other objects or other hoses



# Current State of the Art

Hoses added to CAD model

- ProPiping
- Adams Hose Routing Module

or

“Enough room” for hoses is left in product design

or

Expert hose designers take their “best guess” on hose shape for the stiffest or most critical hoses



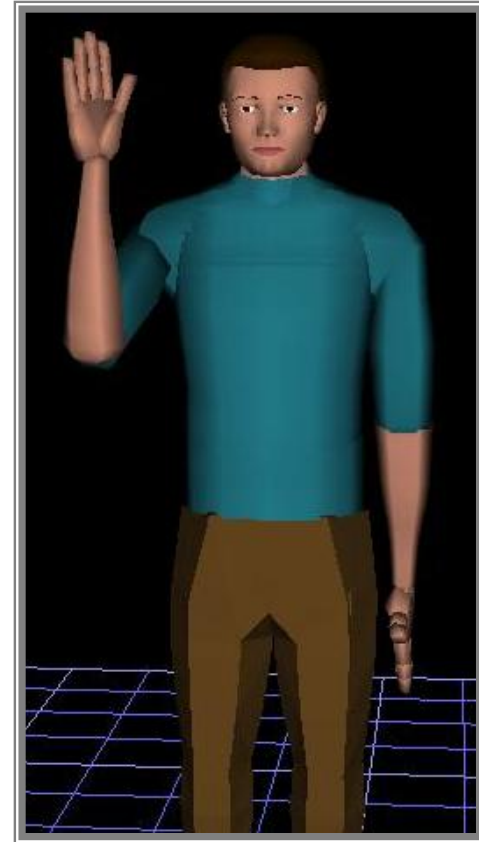


# JACK™

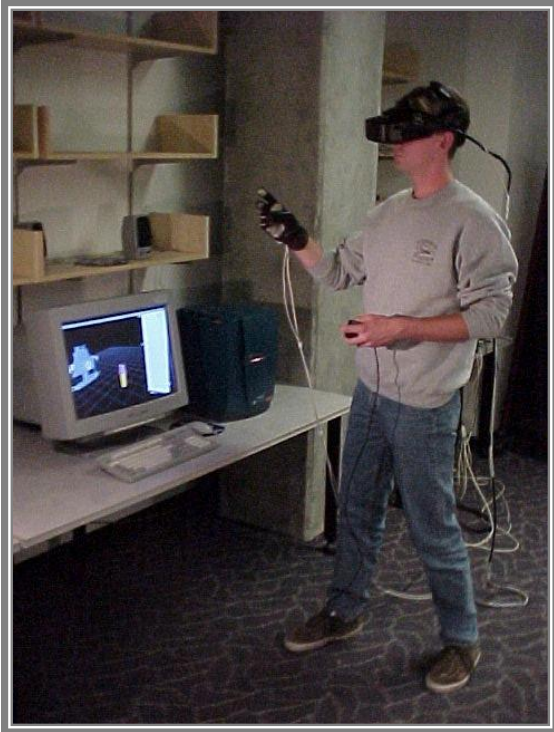
## Human figure modeling software

### Advantages

- Loads CAD geometry
- View geometry in the HMD through JACK's eyes
- Position tracking
- JackScript (Python + JACK)



# VRHose Hardware

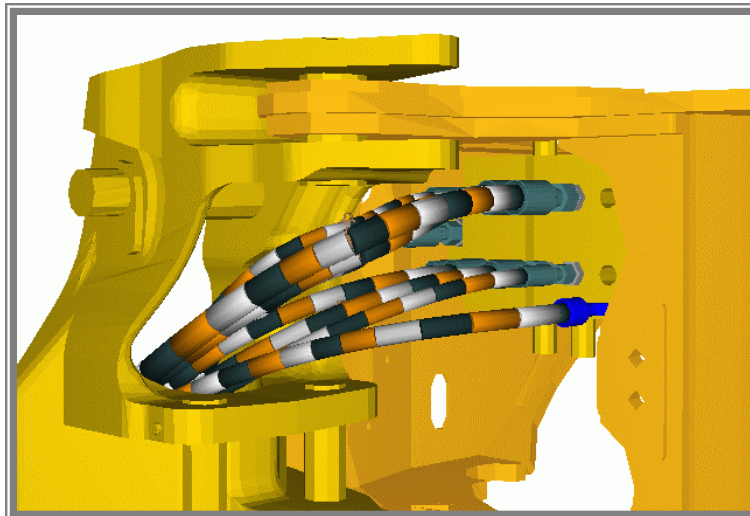


- Virtual Research HMD
- Ascension Flock of Birds Trackers
- Fakespace Pinch Gloves
- Switch Box for menus
- SGI ONYX2 or Octane



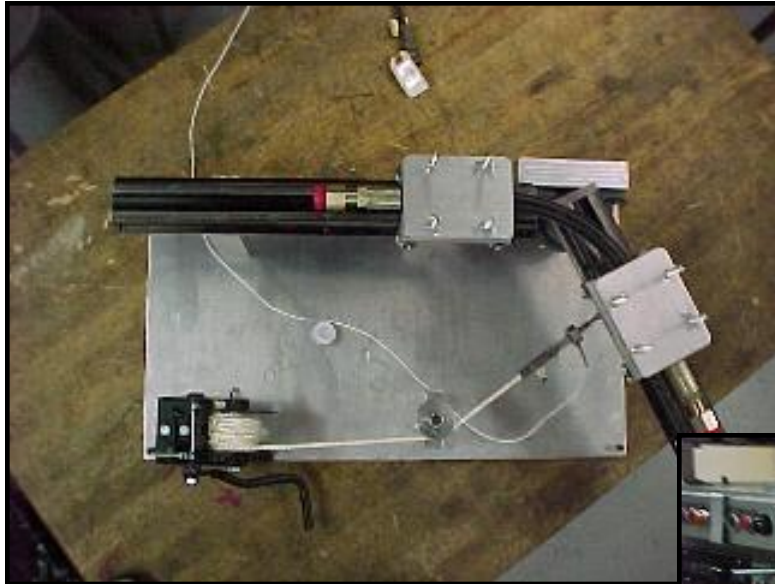
# VRHose Program

- Series of JackScript code classes
- Geometry loaded from existing CAD models
- Custom menu system
- Analyzes hose shape with ADAMS
- Load and Save hose routes

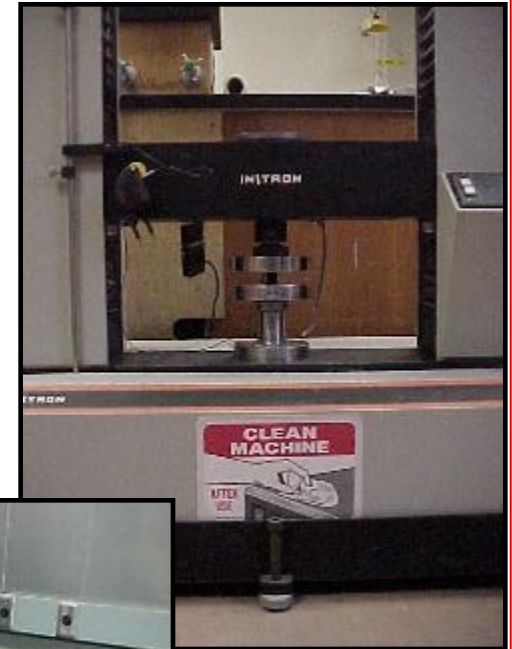


# Hose Testing

Axial



Torsion

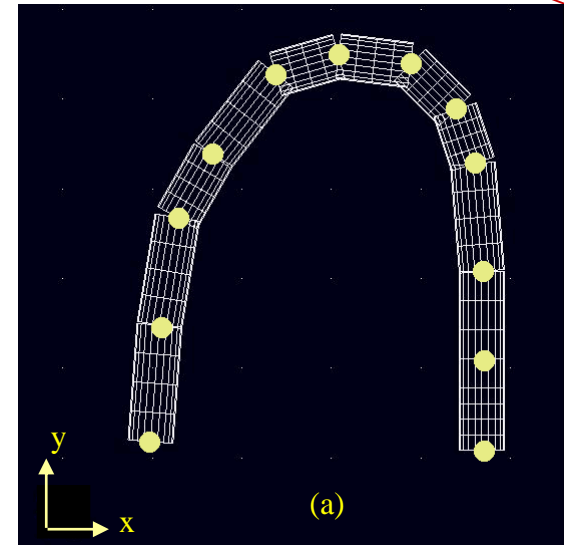


Bending

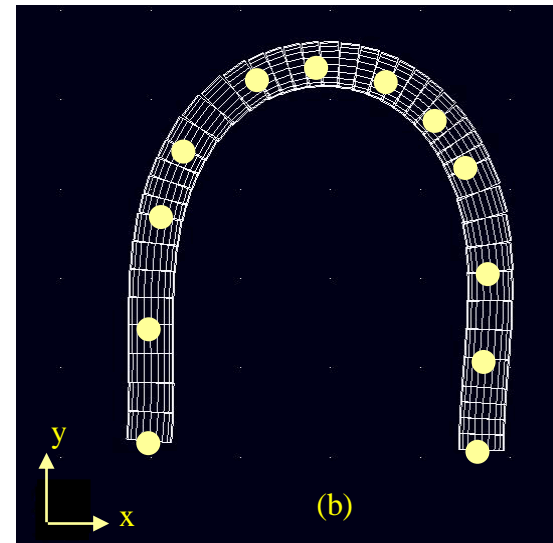


# Hose Modeling

- Hose points
- Clamping constraints
- Physical hose properties
  - Weight per unit length
  - Inside diameter
  - Outside diameter
  - Axial stiffness
  - Torsional stiffness
  - Bending stiffness



Initial hose points

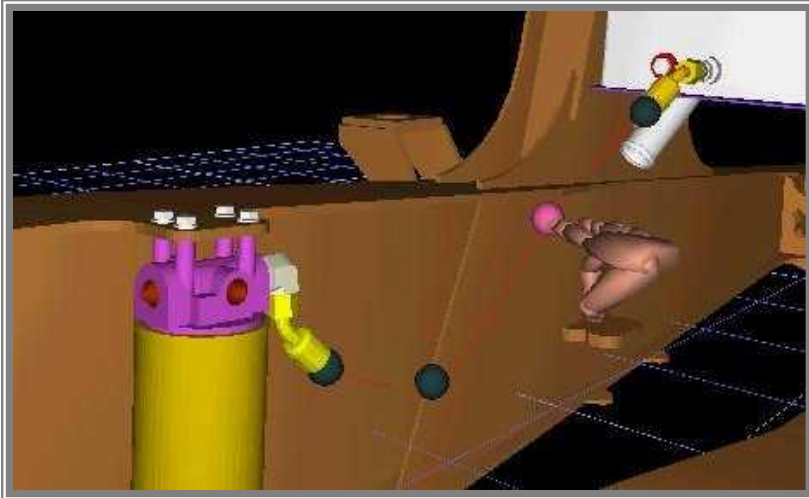


Calculated hose shape



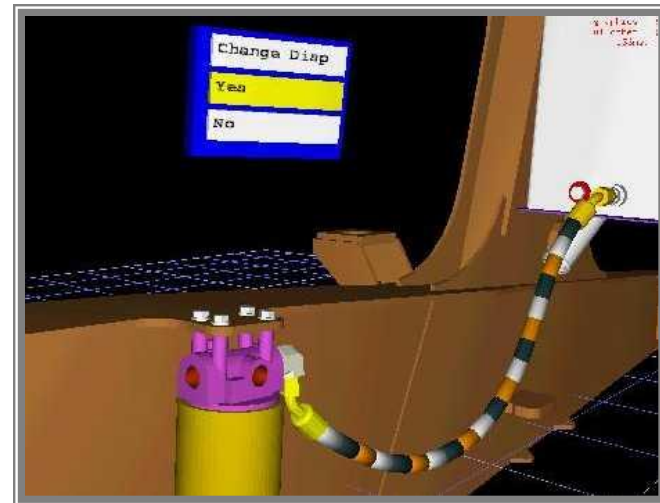


# Hose Routing Steps

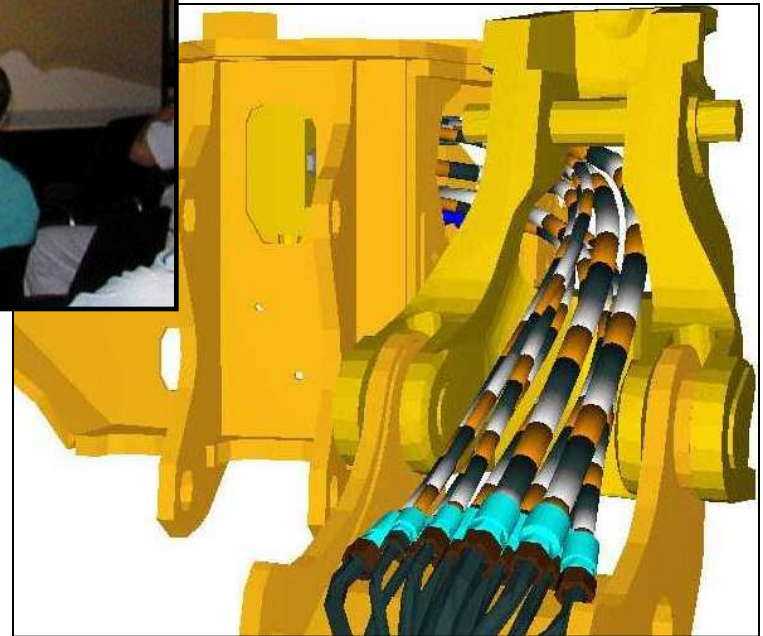


1. Load part geometry and hose port locations
2. Select hose type and size from menu
3. Choose and place connecting hardware
4. Specify hose path with “hose points”

5. Observe B-spline interpolation of hose path
6. Modify “hose points” as needed
7. Analyze hose path to obtain actual hose route
8. Repeat 6 and 7 until satisfied
9. Save final hose route



# Results



# More Information

[www.vrac.iastate.edu](http://www.vrac.iastate.edu)

[www.vrac.iastate.edu/~jmvance](http://www.vrac.iastate.edu/~jmvance)

[www.vrjuggler.org](http://www.vrjuggler.org)

C4 Public Tours: 3<sup>rd</sup> Friday of every month

Call: **294-3092** to make a reservation

