



Controllable snake-like inspection robots

15th July 2014

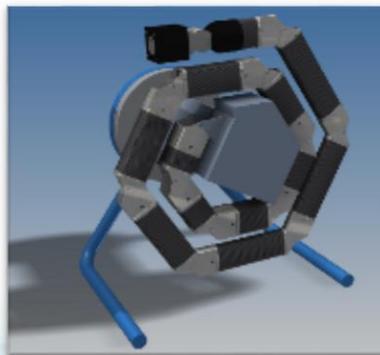
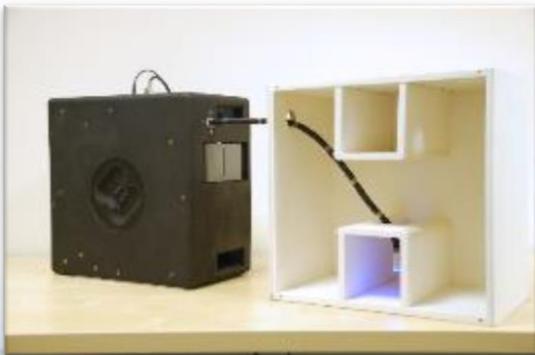
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- Life extension and maintenance of infrastructure requires routine inspections
- Confined and hazardous environments exist in many industries
- New robotic technology allows to access these areas to conduct inspections



Snake-arm robot



Borescopes



Snake-arm robots



Industrial robots

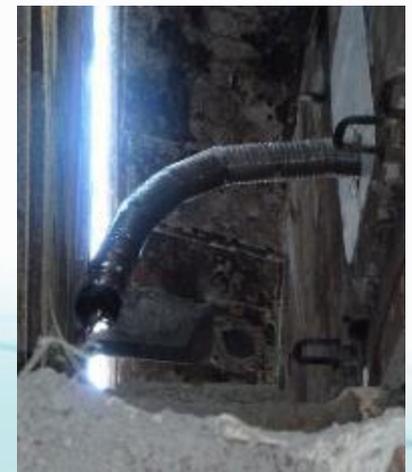
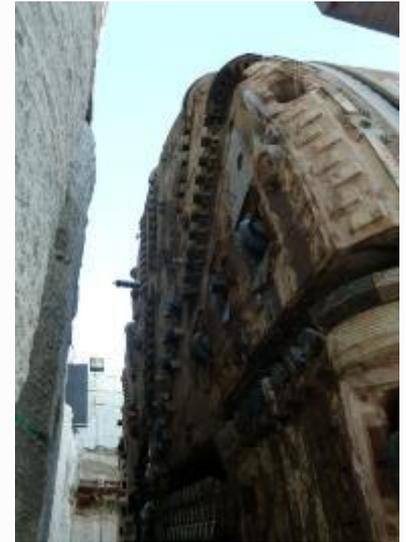
Control: Nose following





APPLICATIONS

- Tunnel Boring Machine (TBM)
- Reduce frequency of human interventions
- Conduct cleaning within dirty construction environment
- Visually inspect cutting head
- Used routinely and for emergent issues





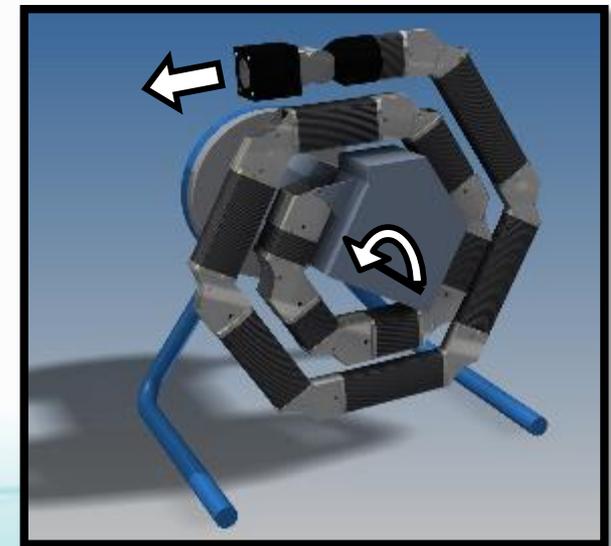
- Produced for DOD – DTRA
- Man portable introduction box
- Small diameter
- Visual inspection and wire cutting



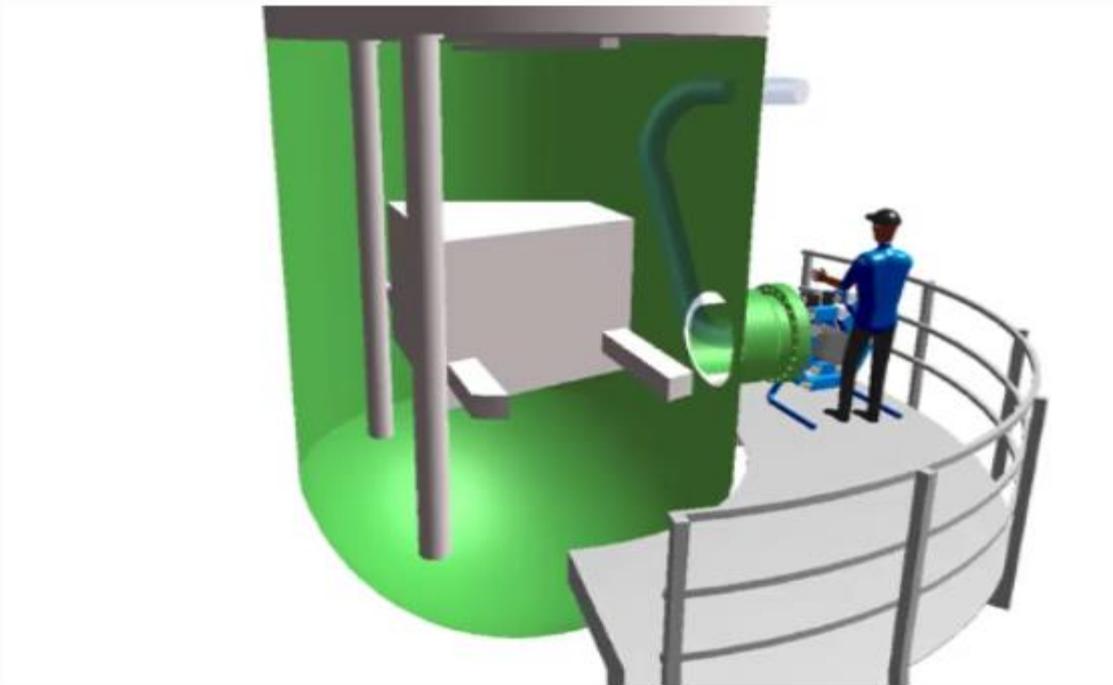


Larger Planar

- Routine maintenance of O&G pressure vessels
- Reduce frequency of human inspection
- Reduce required cleaning of vessels
- Visual inspection and NDI
- Man portable



Larger Planar

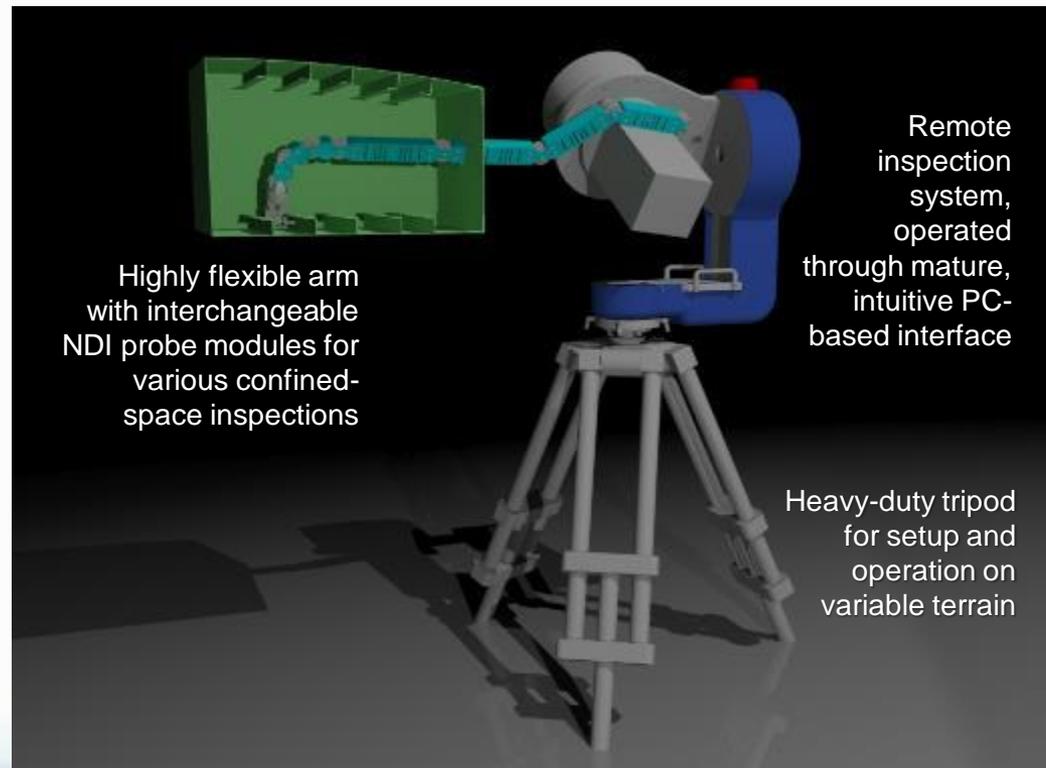
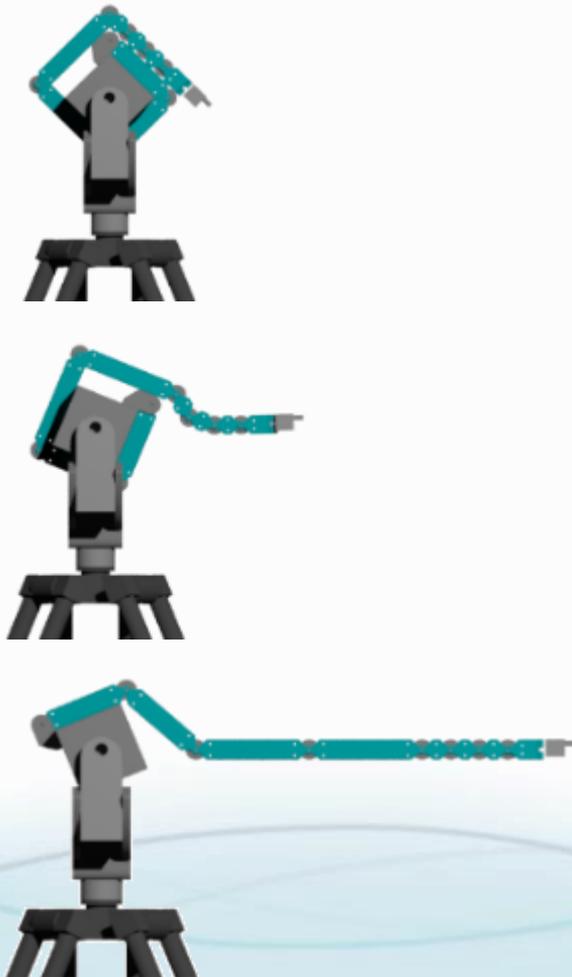


Aerospace inspections

- Aircraft Structural Integrity Program (ASIP) required inspections inside wingboxes often requires structural disassembly or inspectors working in a constrained space.
- Reliable inspection tools for limited-access areas are needed.
- Remote Access NDE (RANDE).
 - Develop a robotic inspection tool capable of offering remote access, increased situational awareness and improved inspection-head alignment for field and depot NDI technicians.



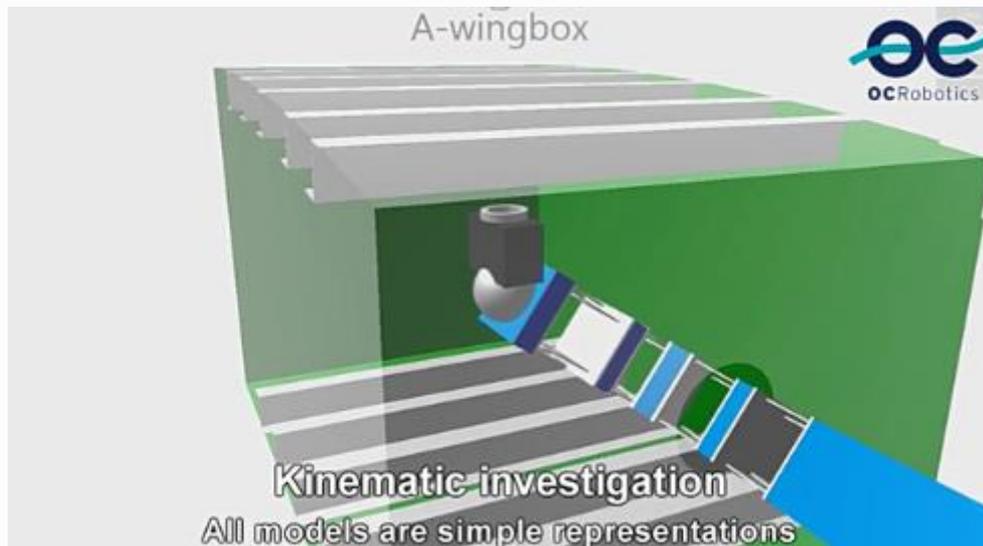
System general overview



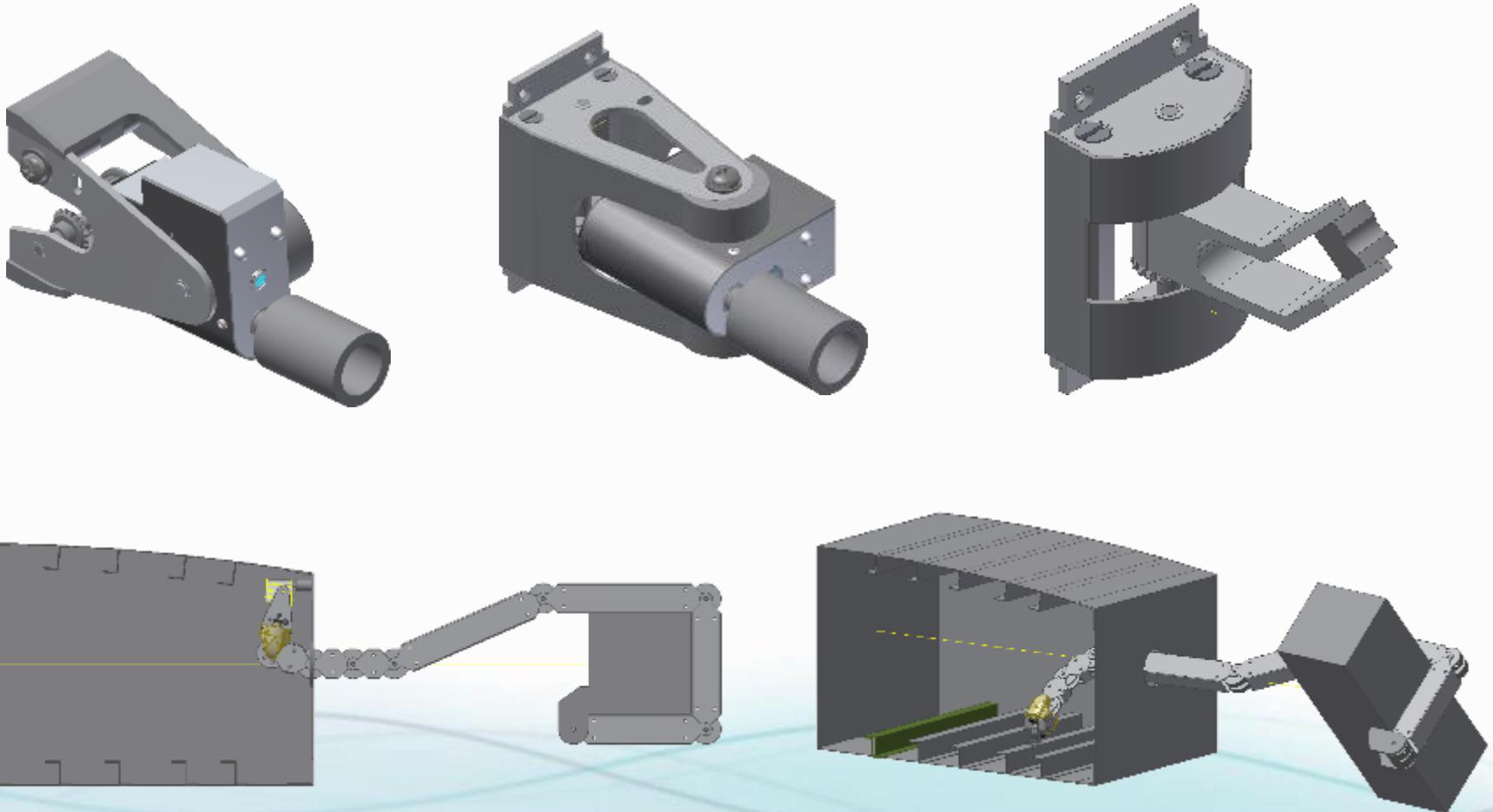


RANDE system vs. manual inspection

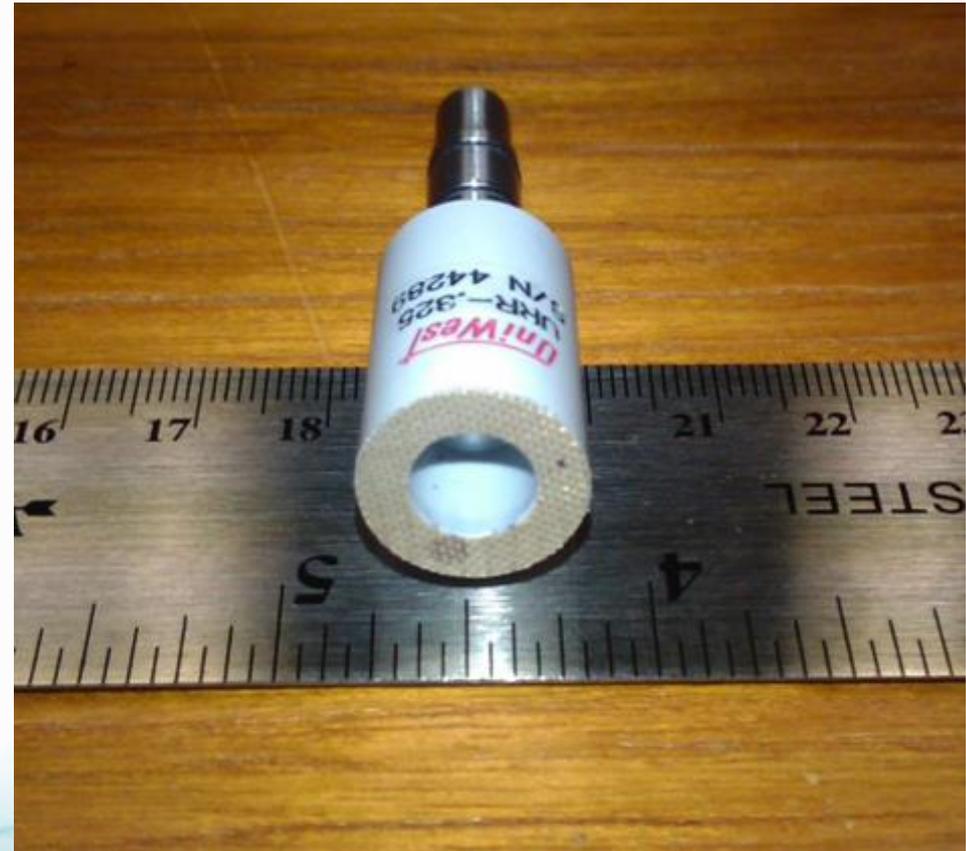
- Current NDI is performed manually, either by the inspector entering the confined space themselves, or through disassembly of the structure in order to reach inspection sites.
- The RANDE prototype presents a number of advantages over manual inspections:
 1. No disassembly is required, and no inspectors need to enter the confined space.
 2. The RANDE system knows the probe position and orientation.
 3. The RANDE system includes cameras which allows the inspector to more precisely position the NDI tools
 4. The system is remotely operated and does not tire.
 5. The snake-arm can access small access holes and has a high flexibility.
- The RANDE prototype will provide greater reach and better positioning and coupling than can be achieved by a human inspector inside the same confined space.



NDI modules



Raised Head Fastener Probes



Probability of Detection Demonstration

Std. Pencil Probe POD = 0.200 inch +
fastener head overlap



RHF Probe POD = 0.100 inch +
fastener head overlap



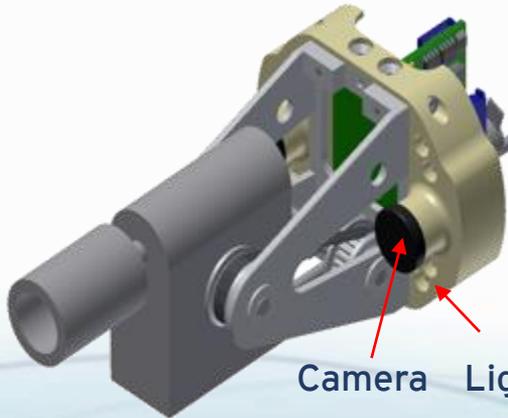
Scanner/probe Integration

Scanner
& probe



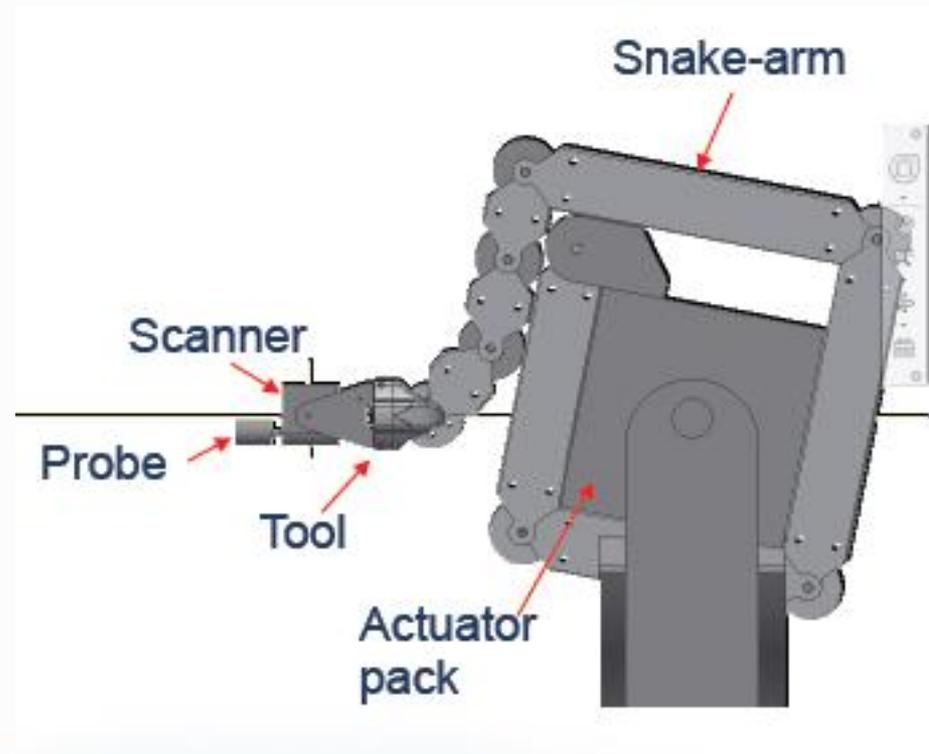
Camera and
lights
on scanner

Protective
cover not shown



Camera Lights

Camera and lights
also on opposite side.



Snake-arm

Scanner

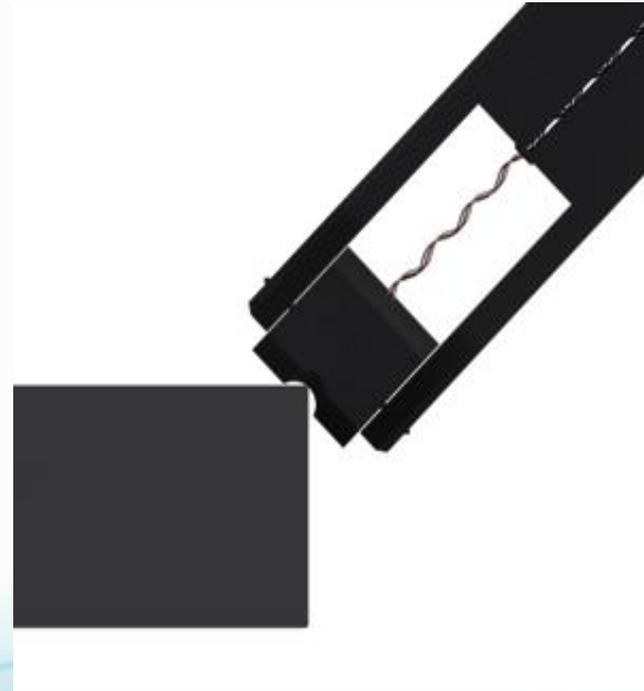
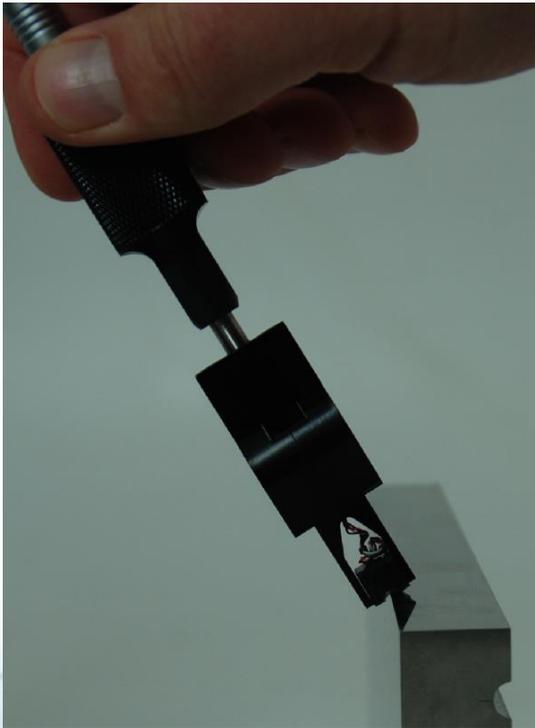
Probe

Tool

Actuator
pack

Edge Probes

Impressive Eddy Current Field Coupling: 0.080 inch POD



Other Probe Designs

Articulating Swivel Probes



Flexible Extended Technology Probes

