

NYSEARCH Technologies for the Inspection and Assessment of Natural Gas Pipelines

Focusing on Unpiggable Pipelines

Dr. George Vradis

NYSEARCH -NGA

Polytechnic Institute of NYU

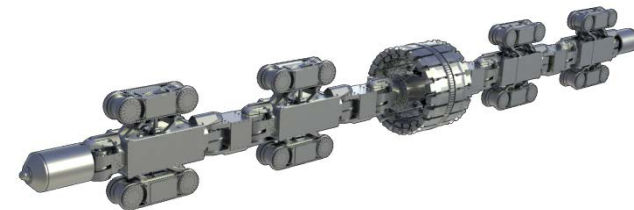
July 2012

NYSEARCH Robotics Program Overview

- Initiated in 2001 in anticipation of the PHMSA 2002 Rule
- Focus on developing technologies for the inspection of unpiggable natural gas pipelines
- Funded by:
 - NYSEARCH
 - PHMSA
 - OTD
 - DoE
 - PRCI
- Over \$20M over 11 years
- Technology is now commercialized via [Pipetel Technologies](#)

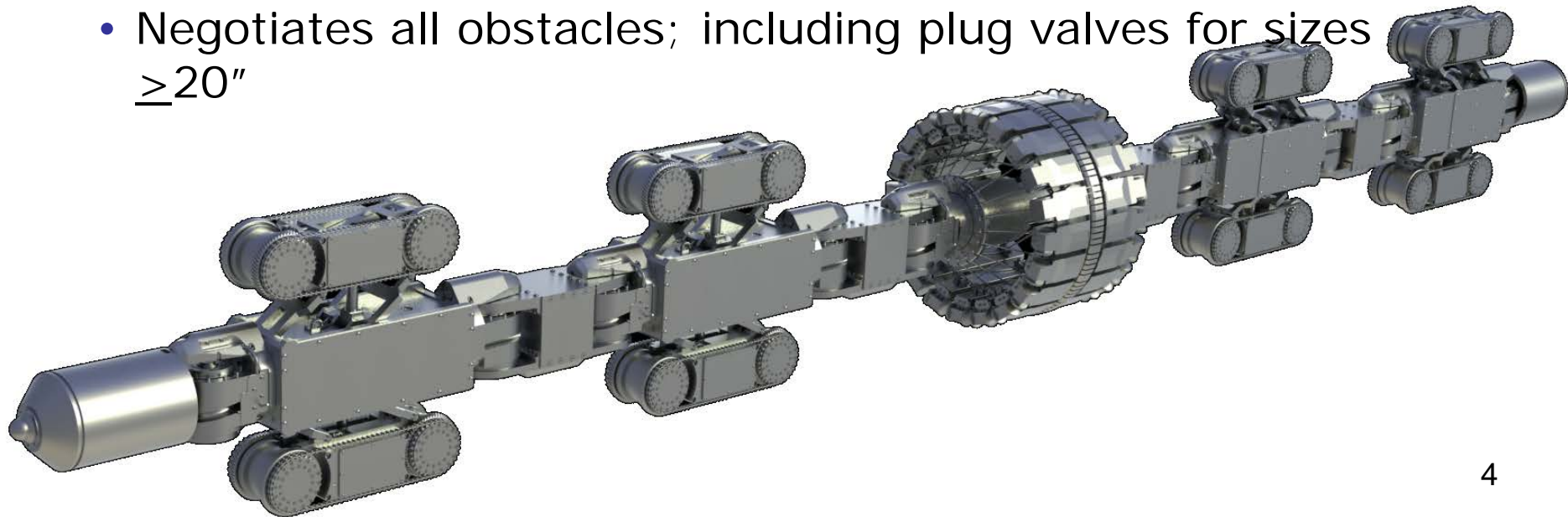
NYSEARCH Robotics Technologies

- **Explorer 6-8:** currently commercially available; RFEC sensor; negotiates all obstacles but plug valves
- **Explorer 10-14:** currently commercially available; MFL sensor; negotiates all obstacles but plug valves
- **Explorer 20-26:** undergoing field demonstrations; to be commercially available in Fall 2012; MFL Sensor; negotiates all obstacles including plug valves
- **Explorer 30-36:** under development; to be commercially available in Fall 2013; MFL sensor; negotiates all obstacles including plug valves



Technology Features

- Unpiggable natural gas pipelines application
- Modular, tetherless robotic platforms; wireless communication
- Launch/receive through hot tap into live pipeline
- RFEC or MFL sensing for metal loss
- High Resolution Visual Capability for Navigation
- Modular for easy add-on functionality
- Negotiates all obstacles; including plug valves for sizes ≥ 20 "



Available Sensor Specifications

- **RFEC**

- Minimum anomaly size: 20% wall loss with a diameter of 3x pipe wall thickness
- Anomaly axial length sizing: +/- 0.5 in with 75% confidence
- Anomaly depth sizing accuracy: +/- 20% pipe wall thickness with 75% confidence

- **MFL**

- Minimum Anomaly Size: 10% wall loss with a diameter of 3x wall thickness
- Anomaly axial length sizing accuracy: +/- 0.5 in with 80% confidence
- Anomaly depth sizing accuracy: +/- 10% pipe wall thickness with 80% confidence

Field Testing Program

- All systems undergo extensive field testing prior to commercialization

- Explorer 6-8



- Explorer 20-26

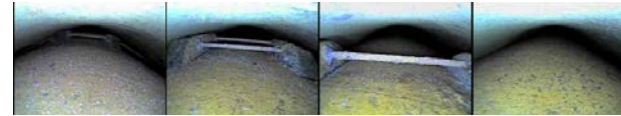
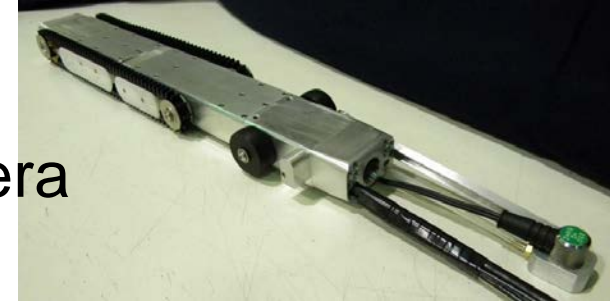


Current Explorer-Related Development Efforts

- Explorer Sensing
 - Combination transverse MFL, EMAT for crack detection
 - Optical mechanical damage and ovality
- Explorer supporting technologies
 - In-line charging
 - Rescue tools

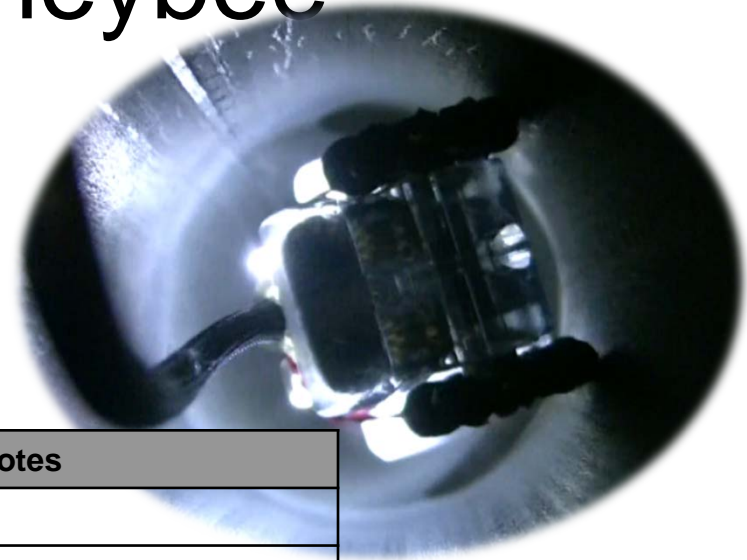
Development of Annular Space Direct Inspection Robot

- Development, field testing & implementation of visual inspection camera
 - Ultrasonic metal loss sensor
 - Humidity and temperature sensors
 - Inclinometer for radial positioning
 - Video tool for precision measurement of features and defects
- Video Inspection can provide data
 - Integrity of Coating and environmental conditions
 - Physical placement & condition of insulators
 - Presence of Electrical contacts
- Second generation system field tested successfully



Vent-Entry Cased Pipe Inspection System – by Honeybee

Development of a robotic system capable of pre-inspection and ultimately inspection of carrier pipes through vent entry- completed feasibility study



Requirement		Notes
Navigate 2" vent pipe	✓	
Navigate compression elbow	✓	
Navigate screw elbow	✓	
Enter casing thru large hole	✓	
Enter casing thru small or jagged hole		To be investigated in next phase
Navigate carrier pipe	✓	
Navigate past isolator		To be completed in next phase
Vent entry in mock-up	✓	Tele-operated entry with video capture
Vent entry in field		To be completed in next phase

NYSEARCH/Kiefner Interactive Threats

- Identify and quantify effects of interacting threats
 - ✓ Identify Interacting Threats
 - Kiefner Failure Database
 - ASME B31.8s 9 x 9 matrix
 - SMEs from NYSEARCH funder Advisory Group
 - Industry papers, past experience
 - PHMSA 'Reportable Incidents Database'
 - ✓ Develop consensus-based Rationale/Technical Support for selected interacting threats
 - ✓ Develop method for quantifying (scoring/weighting) risks from interacting threats
 - ✓ Develop/modify software for calculating risk from interacting threats
 - Kiefner Risk model & Stand-alone software
- Currently developing software

Technology Gaps Requiring R&D and Cofunding

- Need to keep enhancing the capabilities for inspection of unpiggable pipelines
 - Validate new generation sensors
 - Combination transverse MFL, EMAT for crack detection
 - Optical mechanical damage and ovality
 - RFEC
- Inspection supporting technologies
 - Unpiggable pipeline cleaning – completed feasibility study; development needs to follow