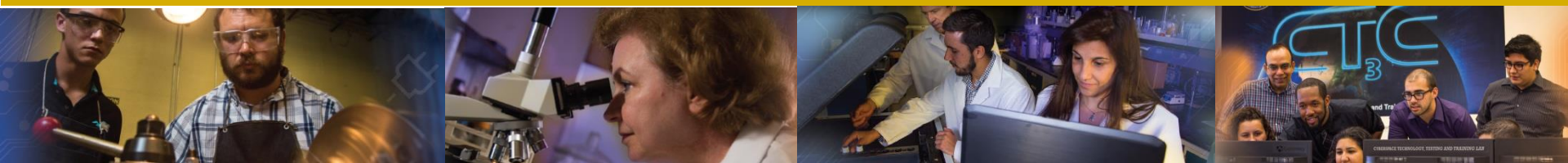
Development of Inspection Tools for DST Primary Tanks & WRPS Internship Summer 2019

Patrick Uriarte (DOE Fellow)

DOE-FIU Science and Technology Workforce Development Program
Applied Research Center
Florida International University

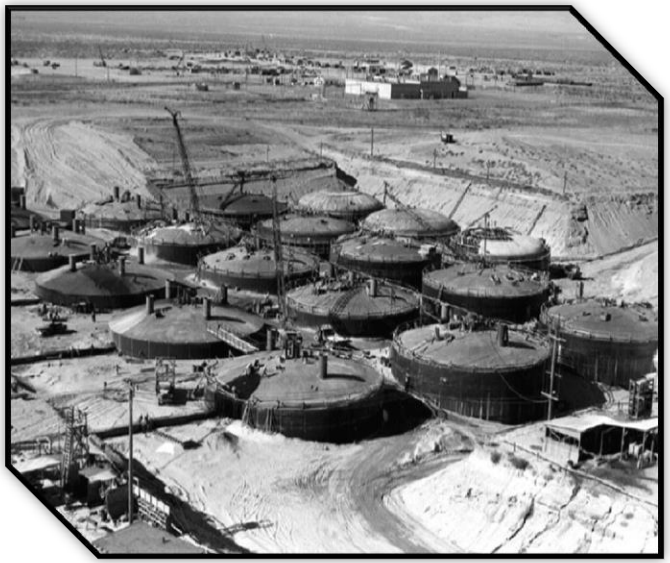
FLORIDA INTERNATIONAL UNIVERSITY



Project Description/Background

DOE Hanford Site

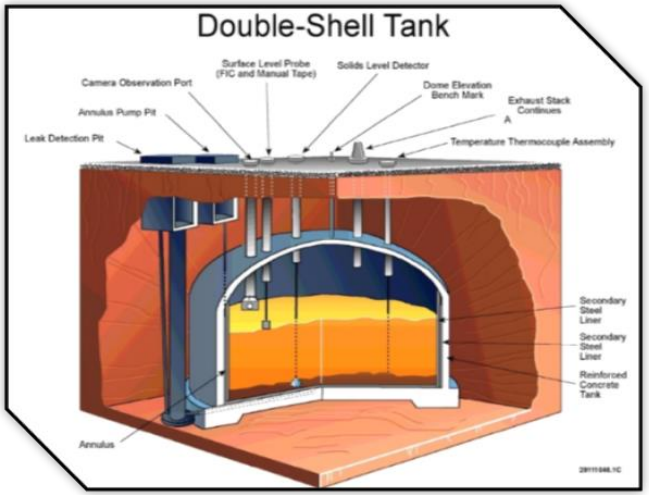
- Location of underground "Tank Farms" containing nuclear waste produced from nuclear material processing for bombs during WW2 and Cold War.
- Aged Tanks, most passed their expected usage date.
- Tank Leakage of nuclear material threaten local environment and health of interstitial Columbia River of the Northwest US.

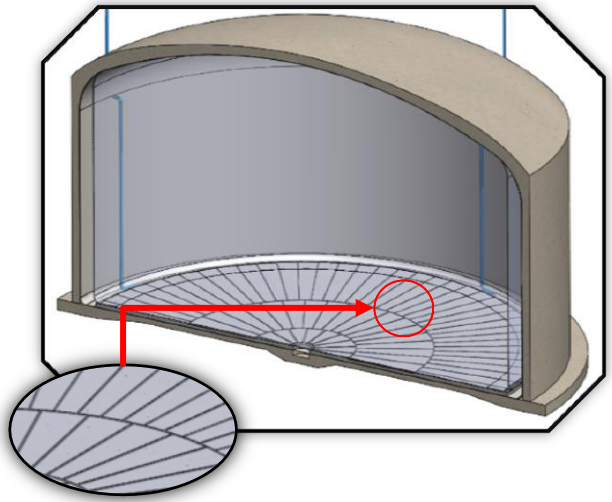


Scope/Objective

- **Double Shelled Tanks (DSTs):**
  - Primary shell sits on Refractory Pad, used to allow air cooling underneath waste holding tank.

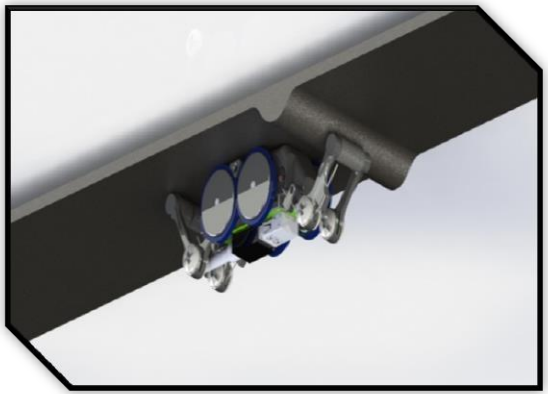
- **Develop Inspection Tool – Mini Inspection Rover**
  - Provide visual of images of and sensor readings from undercarriage of DSTs containing 90° refectory pad air slots.
  - Overcome conditions within air slots: debris and varying weldments ridges.
  - Assist Tank & Pipeline Integrity Team of Washington River in monitoring health of the primary liners.



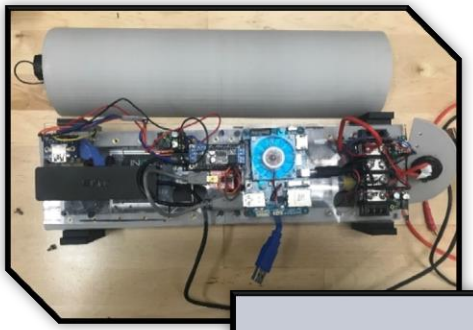


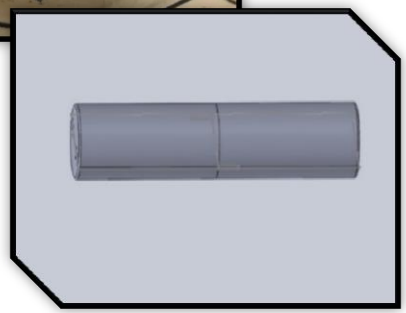
Method / Approach

- Defined Project Scope
  - Cost effective
  - Optimized size for dimension constraints of air slot
  - Overcome debris and weldment seams
  - Easily retrievable
  - Provide consistent Visual and multi-sensor data



- Concept: Two Part Robotic System
  - Miniature Magnetic Adhering Miniature Rover
    - Adheres to Primary Shell of DST, enters refractory pad air slots.
    - Contains camera, lights and other sensors (humidity, temperature, Ultra-sonic)
    - To be Train-like, multiple rovers attached each with different sensors.
  - Controls Capsule [The Egg]
    - Acts as “robotic brain“ contains robot computer, voltage regulators, video converters and wireless transmission capabilities.
    - Lowered and stays in annulus space while rover traverses.
    - Middle man between operator controls and rover movement/ collected sensor data.
    - Sends Mini-Rover movement commands from a distance.
    - Receives and relays sensor reading data back to the surface.

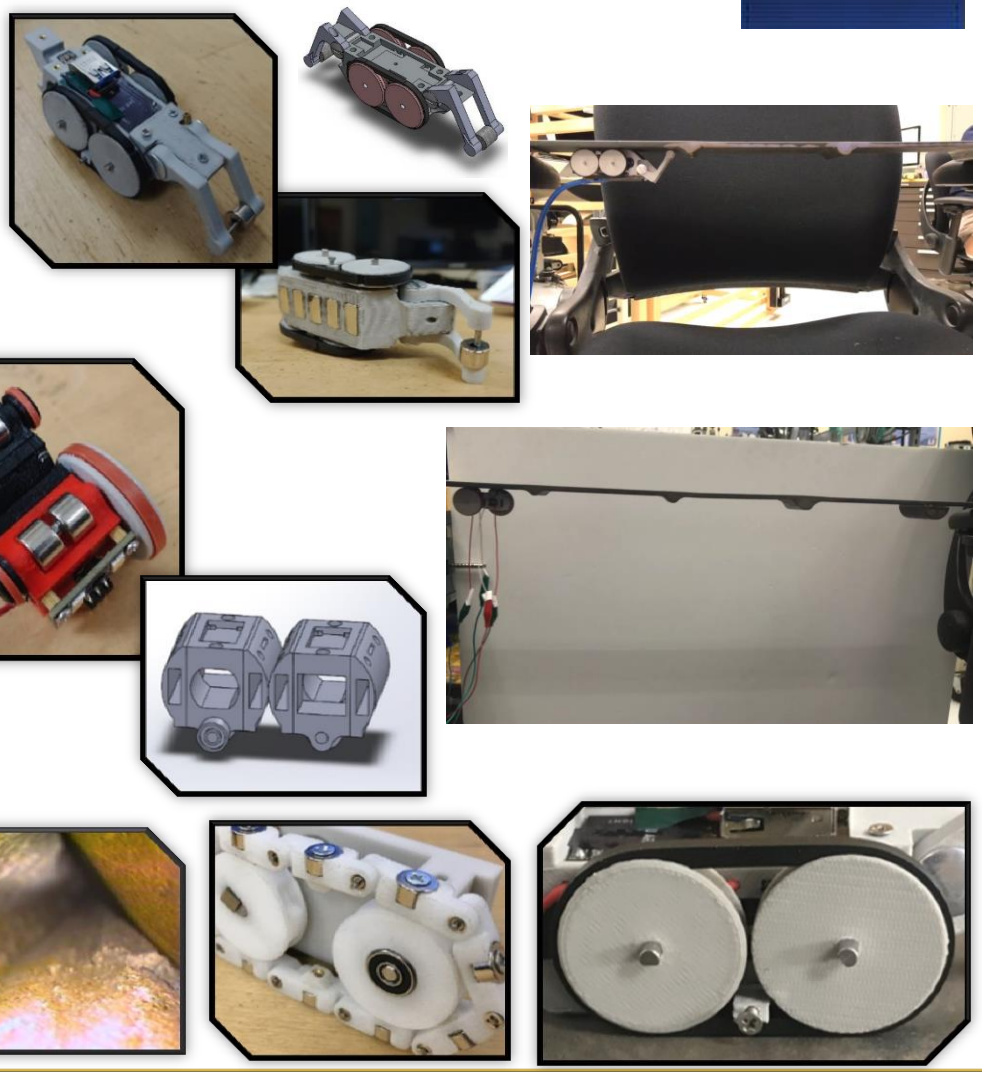




Preliminary Results/Discussion

FIU Applied Research Center

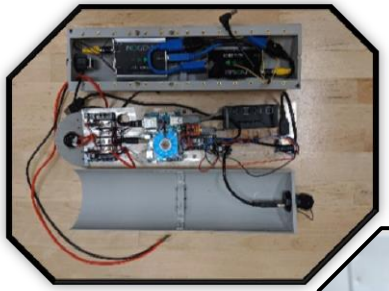
- Mini Rover Body Design + Movement
  - Uni-Body + Arm Design:
    - Utilizes stabilizer arm to maintain magnetic adhesion over weldments
    - Risky potential loss of magnetic adhesion during weld climbing maneuver
    - Large Rigid Body
    - Traverse 3/8 inch weld seam
  - Caterpillar Design
    - Adaptable to overcome curved surfaces
    - Modular, each unit can be swapped
    - Traverse up to 1-inch weld seam
    - Increased moving part complexity
  - Tank Tracks
    - Help overcome debris within air slots
    - Provide better traction between Mini Rover and Primary Shell

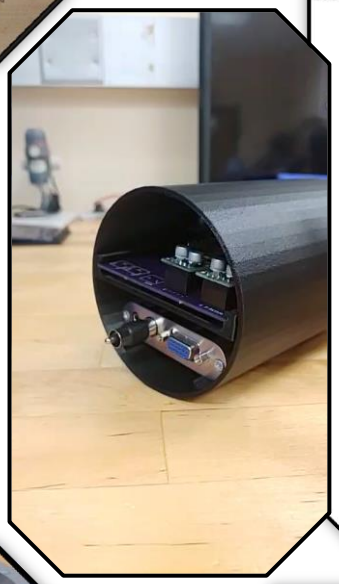


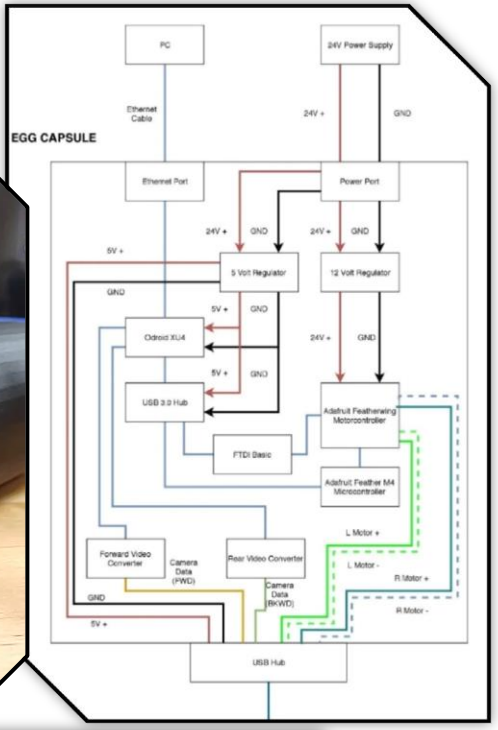
Preliminary Results/Discussion

FIU Applied Research Center

- Controller Capsule Design Purpose: Core of the Robotic System
  - Receives operator commands, relays commands to Mini Rover.
  - Receives Visual and sensor data, relays data to operator.
  - Acts as voltage regulator.
    - Solves voltage drop issue which occurs if the operational voltage line was directly connected to the rover over large cable length
  - Improves video signal transmission.
    - Analog camera signal converted to digital earlier, solving issue with camera feed quality. Analog camera feed suffers from voltage drop over long cable distances.
  - Onboard computer has wireless capabilities. Although not currently used, potential data transfer usage in the future.

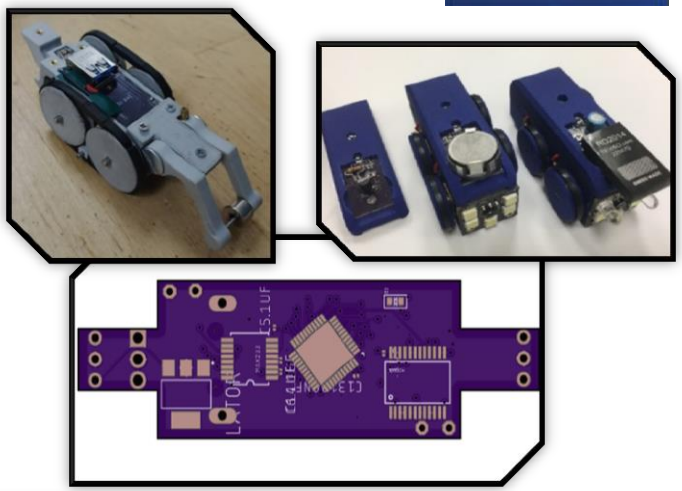




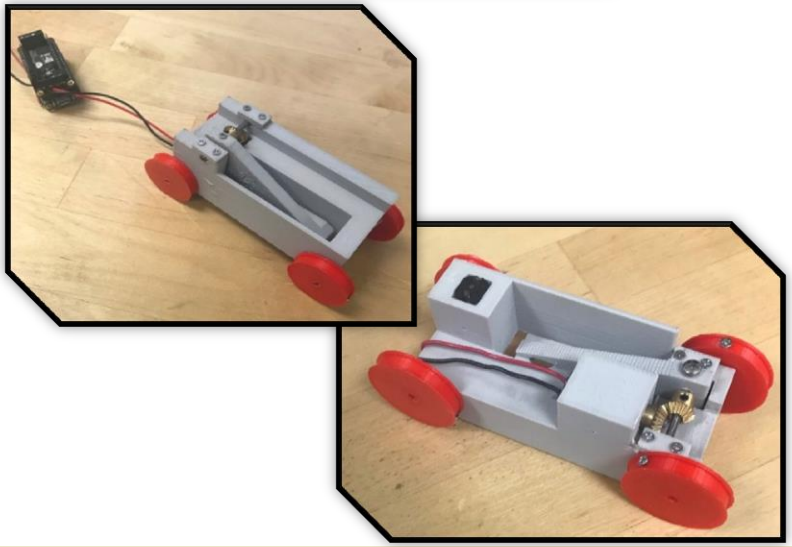


Preliminary Results/Discussion

- Rover Electronics Board and Sensor Cap Status
  - Current electronics boards and Sensor caps are adapted for the unibody + arm rover
  - Moving forward with Caterpillar would requires adapting sensor hubs and electronics boards to be spread across multiple units

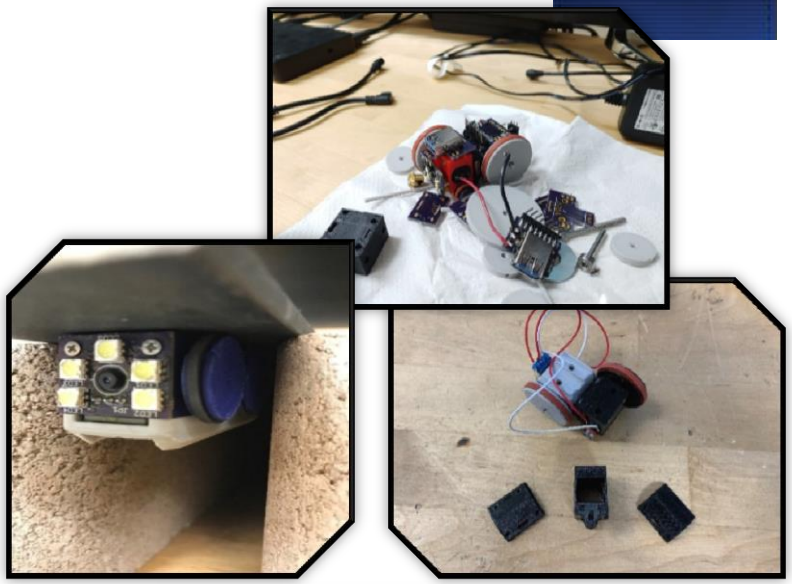


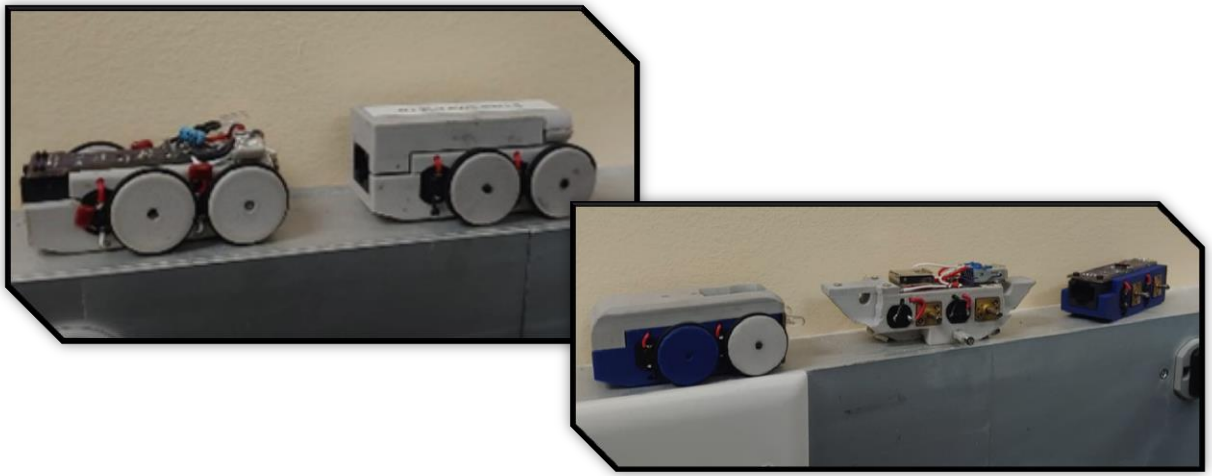
- Ultrasonic Testing
  - Investigation into adapting this non-destructive, crack and thinning detecting technology
  - UT sensors require special deployment system to properly scan, therefore separate rover unit must come attached to main rover.



Conclusions

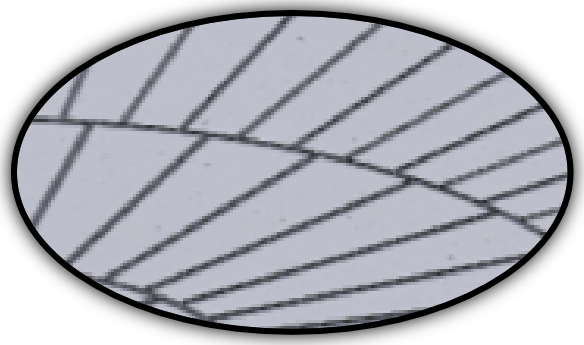
- Design and capabilities have changed over time. Finalization of design is underway.
- Push forward optimization of Rover design, sensor integration and demonstration on a full-scale mockup.



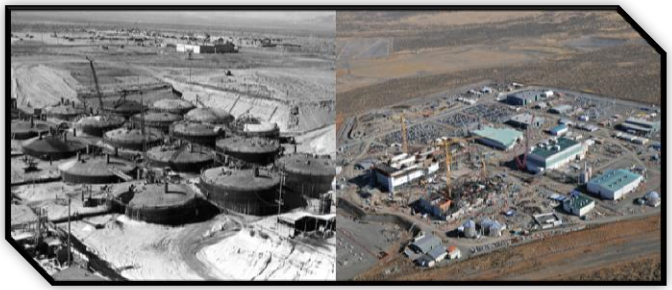


Future Work

What remains to be done?

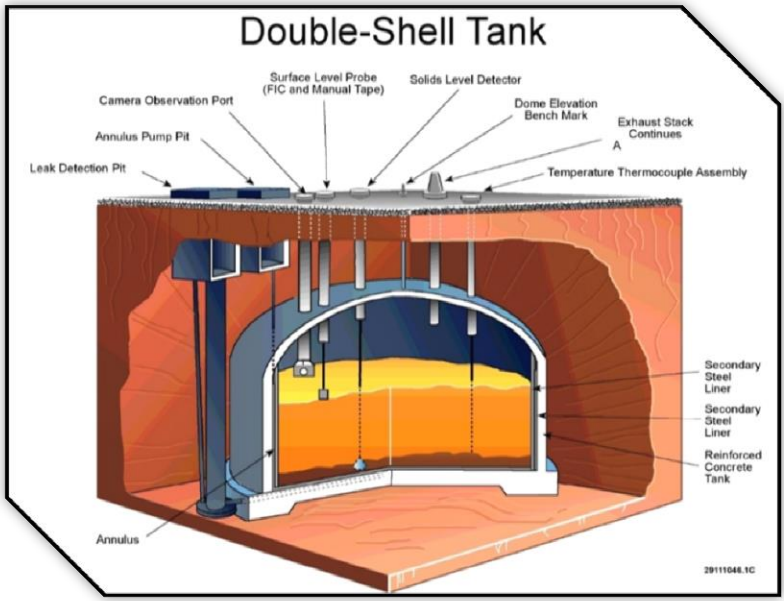


- Tank Tracks Selection; Rigged Rubber
- Adapt ultrasonic sensor and its deployment mechanism to scan the undercarriage of the primary tank shell in DST
- Further development of reliable 90 degree turning capabilities for traversing cornered refractory pad channels.
- Preparation for deployment at Hanford Site. Construction of main power and data cables and interchangeable sensor module caps.



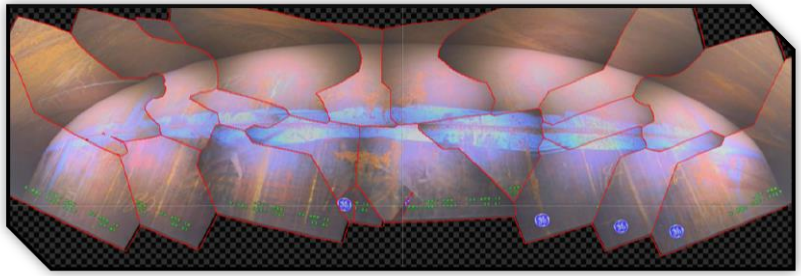
WRPS Internship Scope/Objective

- Tank & Pipeline Integrity Team [TAPI]
  - Investigate areas of Tank leakage and monitor overall Tank Structure Integrity
  - Double Shelled Tank Visual Inspections Reports Due by end of fiscal year
  - Assist Tank & Pipeline Integrity Team meet report deadline



WRPS Method / Approach

- Visual Inspections Reports Due end of fiscal year
- Visual Images of upper and lower tank knuckle required
- About 128 Panoramas needed complete for the report (128-256h)
- Recognized Time Constraint
  - Previous Average Time: 1~2 hour/panorama
- Reviewed reports to mimic established panorama quality standards
- Tracked Various Work Flow Methods

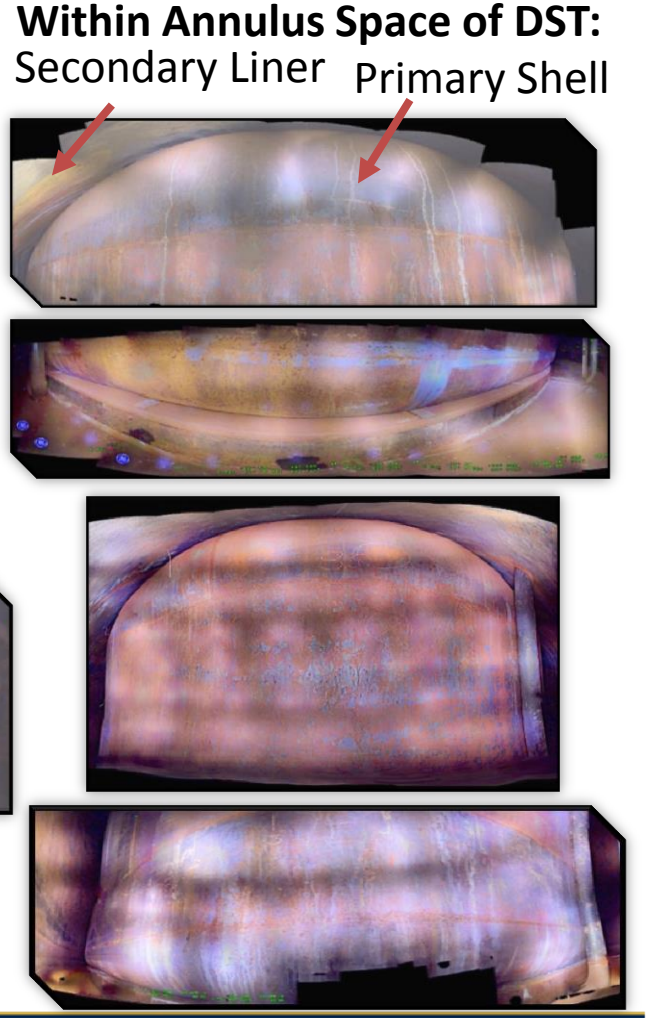


		Glue		7:19	7:27		
	Layer 1	Photo Organiza	22-Jul	7:35	7:37		
		Control Points		7:37	7:57	0:	
		Clean UP		7:57	7:59	0:02	
AZ-101 Riser 79		Glue		7:59	8:01	0:02	0
	Last Layer	Photo Organiza	22-Jul	8:03	8:06	0:03	
		Control Points		8:06	8:19	0:13	
		Clean UP		8:19	8:20	0:01	
		Glue		8:20	8:23	0:03	0:20
	Layer 1	Photo Organiza	22-Jul	8:29	8:31	0:02	
		Control Points		8:31	8:43	0:12	
		Clean UP		8:43	8:44	0:01	
		Glue		8:44	8:50	0:06	0:21
AZ-101 Riser 81	Last Layer	Photo Organiza	22-Jul	8:52	8:54	0:02	
		Control Points		8:54	9:01	0:07	
		Clean UP		9:01	9:02	0:01	
		Glue		9:02	9:04	0:02	0:12
	Layer 1	Photo Organiza	22-Jul	9:07	9:09	0:02	
		Control Points		9:09	9:26	0:17	
		Clean UP		9:26	9:28	0:02	
		Glue		9:28	9:30	0:02	0:23
AZ-101 Riser 82	Last Layer	Photo Organiza	22-Jul	9:33	9:35	0:02	
		Control Points		9:35	9:45	0:10	
				10:21	10:32	0:11	
		Clean UP		10:32	10:34	0:07	
		Glue		10:34	10:39	0:05	0:24
	Layer 1	Photo Organiza	22-Jul			0:00	
	Video skips upper knuckle	Control Points		0:00		0:00	
		Clean UP		0:00		0:00	
		Glue		0:00		0:00	0:00
AZ-101 Riser 83	Last Layer	Photo Organiza	22-Jul	10:45	10:46	0:01	
		Control Points		10:46	11:06	0:20	
		Clean UP		11:06	11:08	0:02	
		Glue		11:08	11:20	0:12	
		retry		11:20	11:31	0:11	0:46
	Layer 1	Photo Organiza	22-Jul	12:48	12:51	0:03	
		Control Points		12:51	13:04	0:13	
		Clean UP		13:04	13:05	0:01	

WRPS Conclusions

- Current Panorama Times: 15-30 mins
  - Implemented automatic video frame collector.
  - Located and reduced timely sections of panorama making process.
  - Utilizing new software: AutoPano => PTGui.
- Work Document for TAPI
  - To utilize software efficiently and match new standard set.
- Support Work, Assisted Tank Monitoring Team
  - Transitioning Databases, PCSACS to OsiSoft PI
    - Backed up legacy documents and data.
  - Transferred & compiled AOI images in SST Visual Inspection Reports to dedicated digital notebook.
  - Compiled & reorganized weather and waste level data.

Within Annulus Space of DST:



Acknowledgements

- **FIU ARC Mentors**
  - Dr. Dwayne McDaniel
  - Anthony Abrahao
- **WRPS Mentors**
  - Ruben Mendoza
  - Natalie Young
  - Shawn Campbell
  - Rest of TAPI Team
- **DOE-FIU Science and Technology Workforce Development Program**

- **Sponsored by the U.S. Department of Energy, Office of Environmental Management, under Cooperative Agreement #DE-EM0000598.**