



# Krishnan Balasubramanian

Head of The Center for Nondestructive Evaluation  
Institute Professor, Indian Institute of Technology Madras,  
Chennai, INDIA

[balas@iitm.ac.in](mailto:balas@iitm.ac.in)

<https://scholar.google.co.in/citations?user=yYFBxAwAAAAJ>

<https://www.linkedin.com/in/krishnan-balasubramanian-534145157/>

- **1989: PHD from Drexel University, USA**
- **1991-2000: Assoc. Professor, Mississippi State University, USA**
- **2000-2021: Institute Professor, IIT Madras, India**

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**Fellow of INAE and NASI**

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**ROY SHARPE PRIZE**

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**NATIONAL NDT AWARD**

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**DRDO Academic Excellence Award**

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**APJ KALAM National Technology Innovation Award**

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**IITM Lifetime Research Achievement Award**

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Assoc. Editor for **NDT&E International**.

**A Center of Eminence**  
Striving for Excellence

# Asset Integrity Monitoring of Physical Infrastructure

A Lab to Market Journey

Krishnan Balasubramanian  
[balas@iitm.ac.in](mailto:balas@iitm.ac.in)

Center for Nondestructive Evaluation  
IIT Madras, Chennai INDIA 600036

[www.cnde.in](http://www.cnde.in)



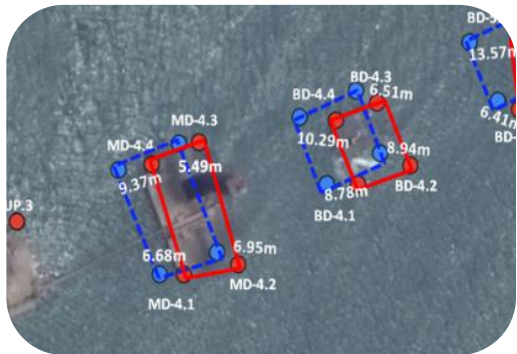
## Dams



## Railways



## Roadways



## Ports



## Transport



## Storage

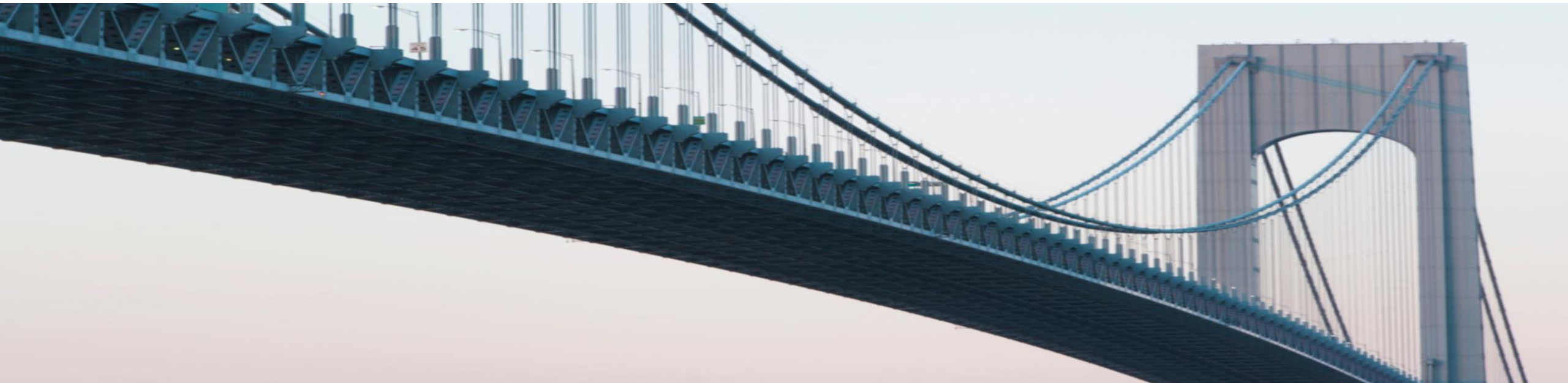
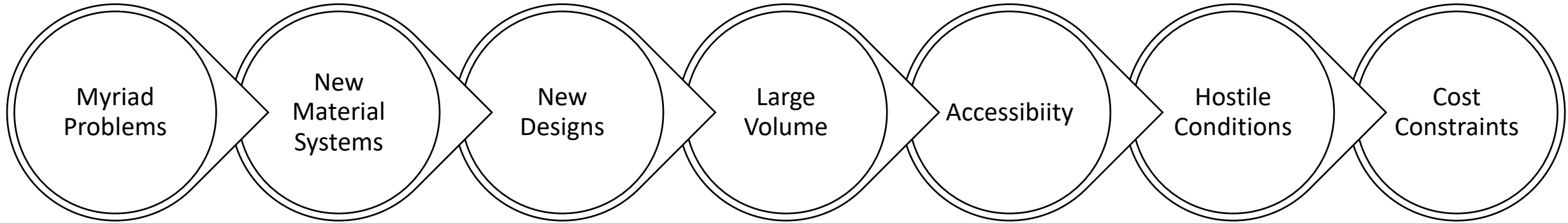
India has the 2<sup>nd</sup> longest road network in the world (~6mn km).

Ports in India handle 95% of international (merchandise) trade in and out of India

Indian Railways (IR) is one of the largest rail network in the world under one management

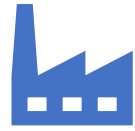
India is currently the 4th largest consumer of energy after USA, China, and Russia.

India has over 40,000 km of cross country pipelines and underground oil reserve storage facilities





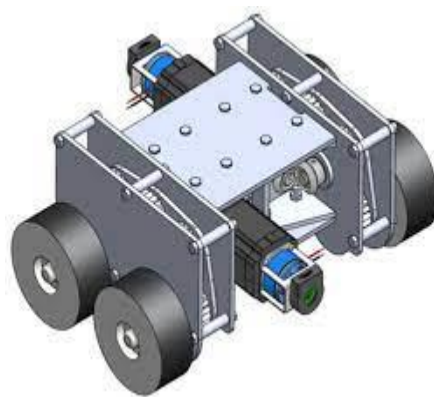
Inspection Systems in Shop Floor



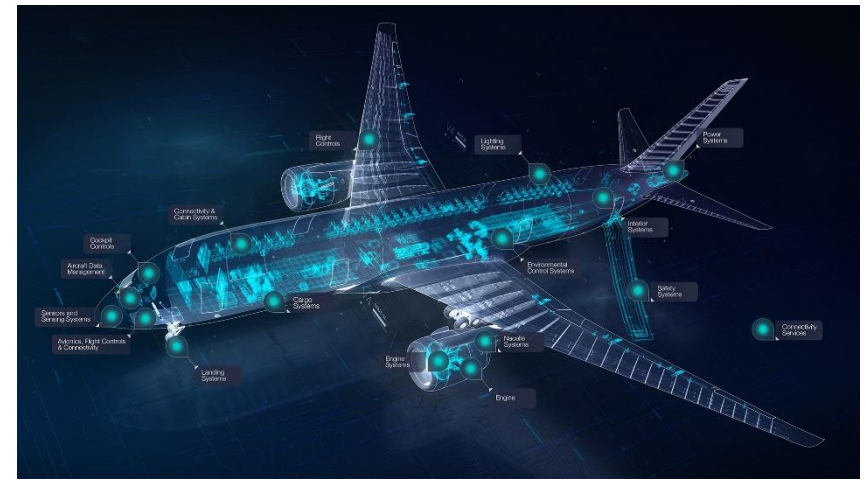
Post Manufacturing Inspection Systems



Robotic and Manual Deployment



Structural Health Monitoring



Remote Diagnostics



# CNDE@IITM Startup Eco-System



2001 → 2010 → 2015 → 2016



[www.cnde.in](http://www.cnde.in)



[www.dhvani-research.com](http://www.dhvani-research.com)



[www.planystech.com](http://www.planystech.com)



[www.detecttechnologies.com](http://www.detecttechnologies.com)




[www.maximl.com](http://www.maximl.com)



[www.solinas.in](http://www.solinas.in)



[www.xyma.in](http://www.xyma.in)



[www.azeriri.com](http://www.azeriri.com)

2017 → 2018 → 2019 → 2021

**10 #s**

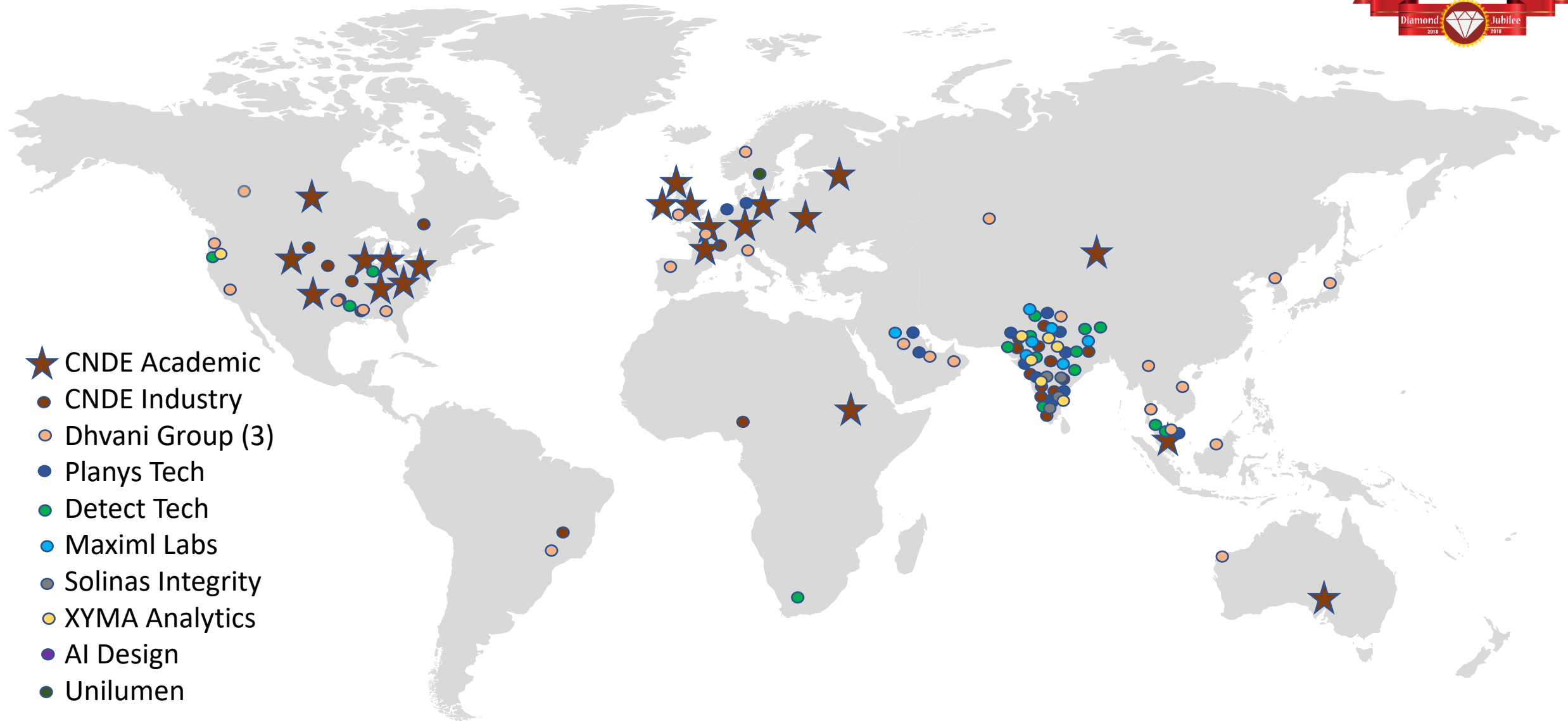
**500+ HC**

**\$100+ M**

**60+ IPs**

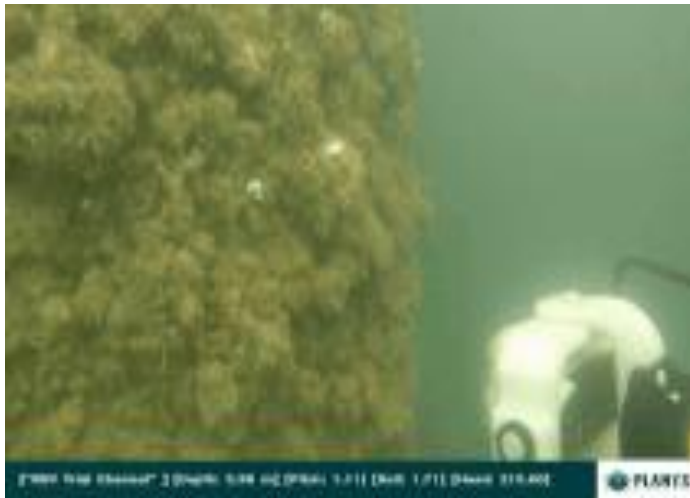


# Current Global Impact of CNDE Eco-System

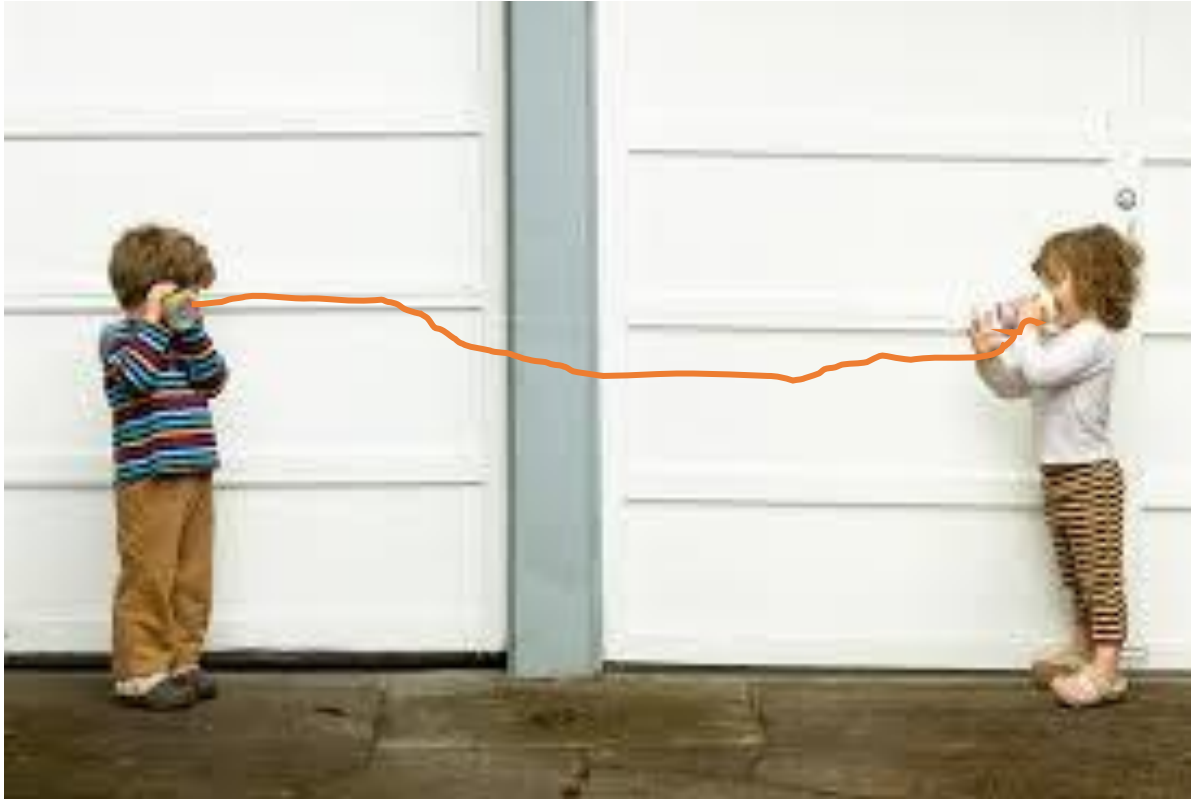




# Hidden Corrosion Inspection : Innovations@CNDE



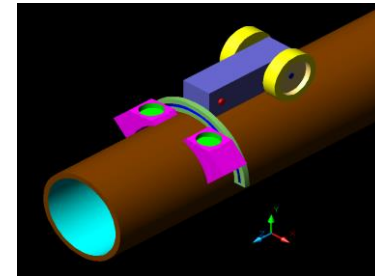
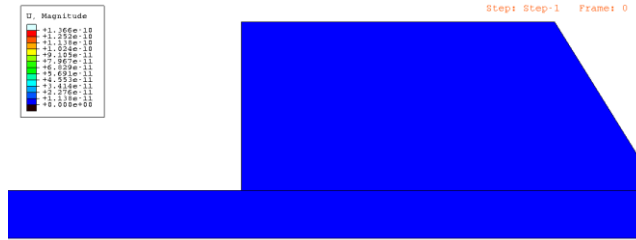




- **Waveguides are everywhere...**
- Plates and shells (aircraft skin)
- Rods (cylindrical, square, rail, etc.)
- Hollow cylinder (pipes, tubing)
- Multi-layer structures (composite laminates)
- Curved or flat surfaces on a half-space
- Layer or multiple layers on a half-space
- An interface



# The HOMC Guided Waves Journey



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2
3
ODB: E:\10_weg\9_gx4pte9_p37_8-7-08_p3mlg.odb  ABAQUS/EXPLICIT Version 6.6-3  Sun Jun 08 10:46:17 India BT
Step: Step-1, transaction
Increment: 0, Step Time = 0.6
Primary Var: U, Magnitude
Deformed Var: U, Deformation Scale Factor: *1.000e+09
  
```

Over 1000 Storage Tanks and 20000 Pipe Supports under Monitoring in 12 Countries

Standardization and Robotic Deployment

2012 Commercialization through Dhvani Group

2012 Acceptance by Exxon Mobil

Discovery of High Frequency Guided Wave Modes

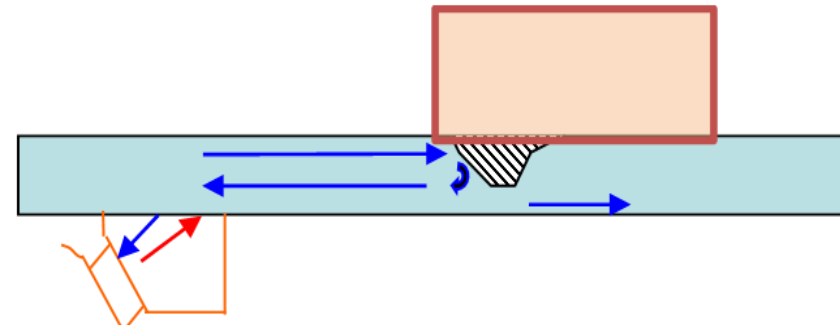
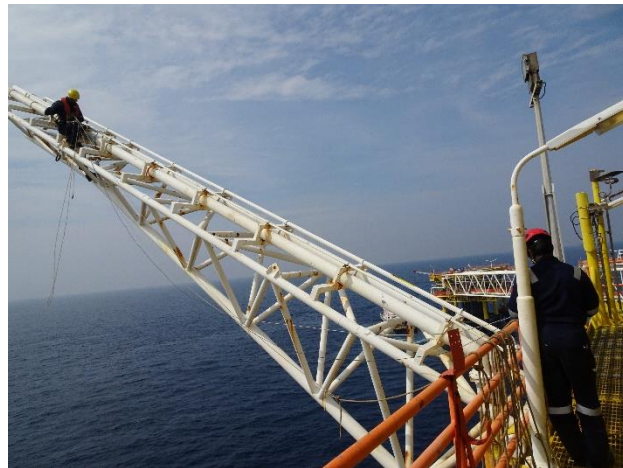
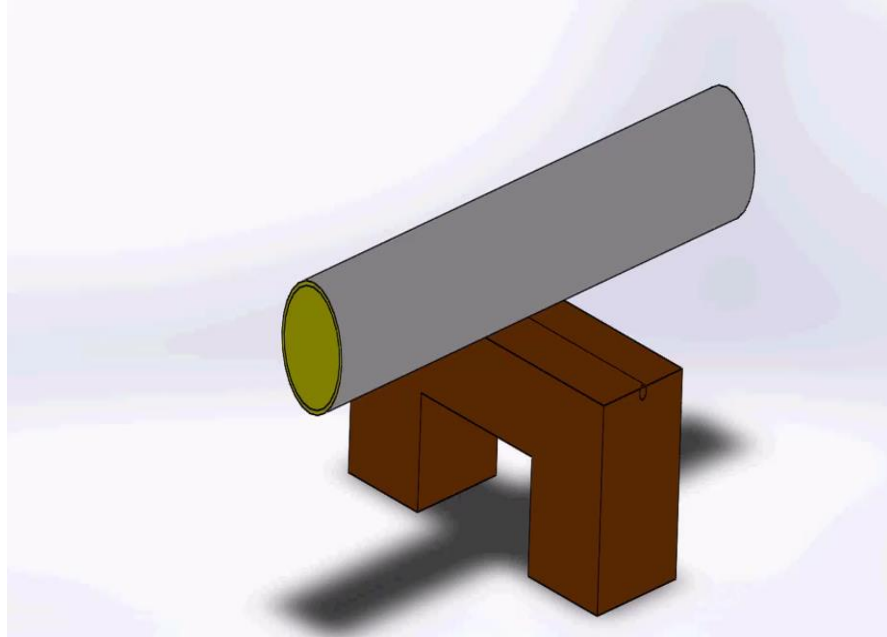
2007 Aaha Moment.

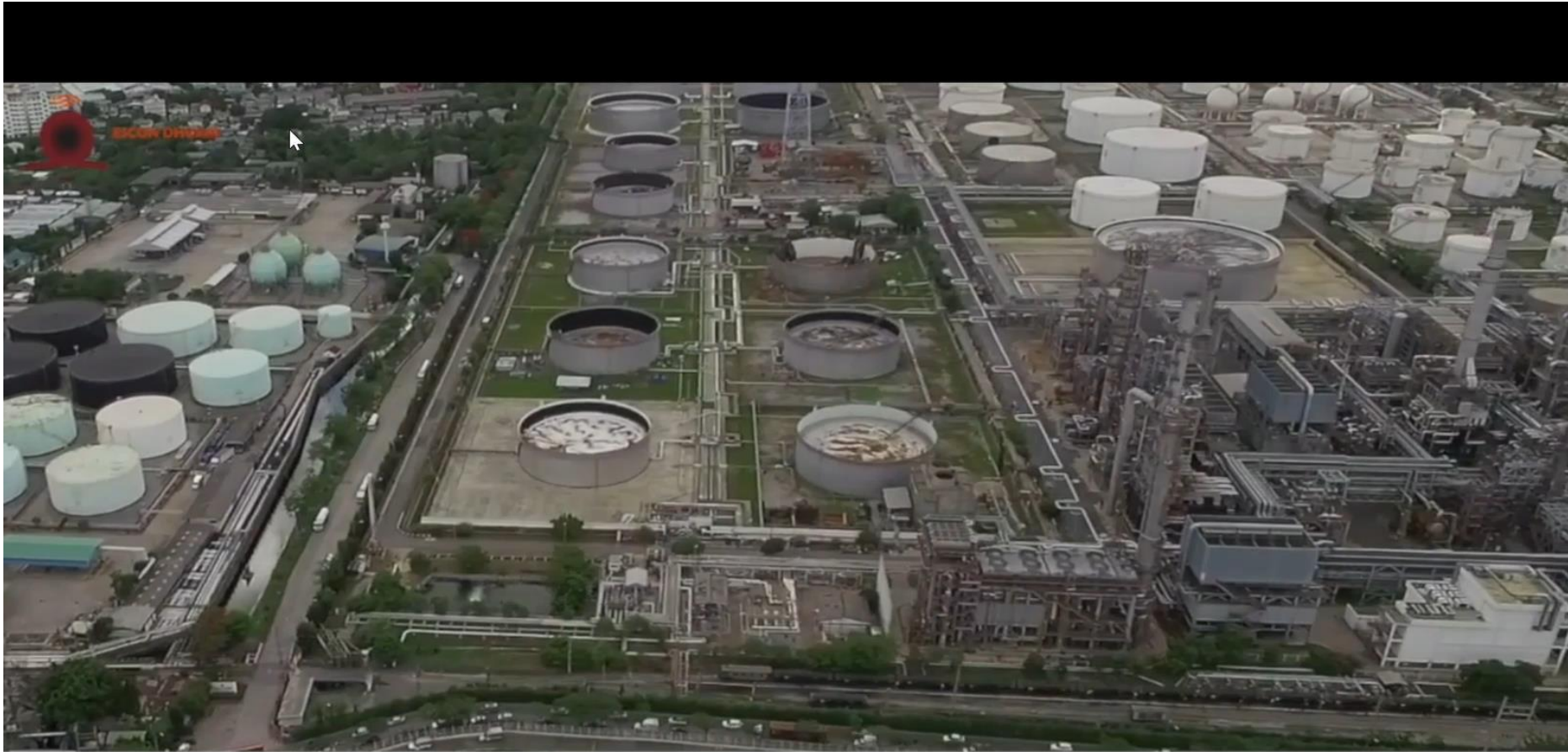
No method to inspect for Pipe Support Sections

2006 Big Problem.

Low Frequency GW for Monitoring Pipes and Plates

Before 2006





## HOMC Guide Wave based Tank Annular Plate Scanner (TAPS)

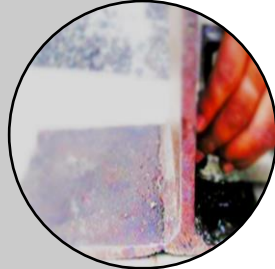
**Enhancing a Storage Tank's Reliability by Detecting and Assessing Corrosion in the Critical Zone**



HOMC is an Indian Technology Employed Worldwide



CUPS/CRISP for Pipe Supports, Pipe Interfaces, Saddled Supports, and Pitting Corrosion in MTF – **FIELD Proven Technology**



TAPS for Annular Plate Critical Region Inspection employed in **1000+ Tanks** in 12 Countries ACROSS 4 Continents.



**Dhvani Group** provides worldwide service and support directly or through its channel partner **WAYGATE TECHNOLOGIES** (a Baker Hughes Business) in select countries.



Shell





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The **CNDE eco-system at IIT Madras** is a Leader in the field of Asset Integrity Monitoring

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Several **Technology** initiatives have been developed and commercialized worldwide.

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Focused on **Lab to Market** Transition.



Thank You for Listening  
Contact Information below:

Prof. Krishnan Balasubramanian

Email: [balas@iitm.ac.in](mailto:balas@iitm.ac.in)

URL: [www.cnde.in](http://www.cnde.in)