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INDIAN SOCIETY FOR NON DESTRUCTIVE TESTING

COFREND
Confédération Française pour les Essais Non Destructifs

NDE 2025
DEC 11-13, 2025 • MUMBAI

Indo-French
Pre Conference Tutorial

Simulation and Modelling for NDE 4.0

11th December 2025

Jio Convention Center, Mumbai

PCT Coordinators

Prof. Krishnan Balasubramaniam,
Center for NDE at IIT Madras (India)

Pierre Calmon
CEA (the French Atomic Energy Commission), France

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Prof. Krishnan Balasubramaniam,
Center for NDE at IIT Madras (India)

Dr. Pierre Calmon
CEA, List (France)

Overview

NDE 4.0 is adding several advancements to the conventional NDT approach by using mechanisms such as robotics, networked sensing, AI based data interpretation, among many others. With the rapid development of computational hardware and algorithms, the use of numerical models and simulation tools are becoming increasingly used by operators and managers. These advancements will allow for inspections to have the luxury of the simulations to be done in the field and not wait for post analysis, thereby making critical decisions faster and more efficient.

This Pre-Conference Tutorial at **NDE 2025** will bring together researchers and practitioners from both COFREND (French Society for NDT) and ISNT (Indian Society for NDT) in a one day interactive mode. The Tutorial will cover the different advancements in computational tools and approach. This includes modelling methods, use of AI for computation, and illustrate practical implementation of these tools for **NDT.**

The Tutorials will comprise of 3 Sessions, with 4 talks and an interactive demonstration post lunch session. EXTENDE from France will demonstrate the different modules of CIVA, a very popular commercially available software tool for modelling and simulation of **NDT and SHM.**

New challenges and Opportunities for NDE Simulation in a Digitalized Industry by Edouard Demaldent, Christophe Reboud, and, Pierre Calmon, Université Paris-Saclay, CEA LIST, France;

Presenter : **Edouard Demaldent** (E-mail: edouard.demaldent@cea.fr)

Abstract: NDE simulation has been a powerful tool for several decades, widely used for the design of inspections, as well as for the analysis and demonstration of performance. Today, the transition toward NDE 4.0, which is increasingly being adopted by industry, further strengthens its importance, opening new applications and, consequently, new challenges that will be explored in this presentation.
NDE 4.0 involves the digitization of acquisition data, its traceability, and particularly its use by artificial intelligence (AI). One of the main challenges for AI in NDT is the lack of available experimental data. Simulation offers a valuable solution by enabling the generation of synthetic data, in addition to its traditional roles.
In the context of NDE 4.0, new inspection techniques combining digitalization, imaging, and robotics are being adopted by industry to replace more traditional, manually operated methods. This is the case, for example, with electromagnetic induction thermography, which is increasingly used as an alternative to penetrant testing and magnetic particle testing. We will illustrate how simulation serves as a central component of a Digital Twin for designing such inspections.

More generally, simulation now faces increasing challenges related to the complexity of geometries and materials to be modeled, alongside growing demands for accurate quantitative predictions that incorporate sophisticated structural descriptions. The issues of computational performance and, above all, user confidence in the predictions, encourage the development of simulation strategies that involve multiple levels of accuracy. We will illustrate such an approach in the context of ultrasonic inspection of welded parts.

Pierre Calmon
CEA (the French Atomic Energy Commission), France

Edouard Demaldent is a senior expert of CEA (the French Atomic Energy Commission) in the field of numerical simulation and non-destructive testing (NDT). He is currently head of the Simulation, Modelling and Analysis Laboratory of the CEA LIST institute, which designs and develops the physical models for the CIVA software platform. Edouard Demaldent obtained his PhD in applied mathematics from Paris-IX University in 2009. His early research focused on electromagnetic simulation for radar applications at ONERA. He then worked on numerical acoustics and the propagation of ultrasonic waves in composites for aeronautics as a post-doctoral researcher at INRIA. He specialized in the development of high-order finite element (FEM) and boundary element (BEM) methods for wave phenomena. Since 2010, he has been working on modelling non-destructive testing at CEA LIST, where he promotes BEM and FEM for eddy current and ultrasonic inspections in the CIVA software platform.

Role of Physics based models in solving Inverse problems in Mechanics Under Deep/Machine Learning Environment, by Dr S Gopalakrishnan, Honorary Professor, Department of Aerospace Engineering, Indian Institute of Science, Bangalore 560012

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Abstract: Inverse problems are those where we need to determine the cause from its effects. They normally do not have unique solution. In the case of mechanics, we have two different inverse problems, namely force identification from the measured response and system identification from known input and measured output. Some of the well known system identification problems are the material property identification and damage detection and/or damage localization. Non-uniqueness of the solution requires alternative solutions methodologies and it is here Deep and machine learning approaches can be a good alternative since it is completely data driven and in addition, one can incorporate all the uncertainties in measured responses can be easily incorporated under this environment. However, the success of the Deep/Machine Learning approaches depends on the quality of the data and in many cases, the failure data is not available experimentally for all cases. It here, the role of physics based models are important. In my talk, I will show how the hybrid approach, that the fusion of physics based model and experimental data) can be used to solve a variety of inverse problem in mechanics

Prof. Gopalakrishnan
Professor, Department of Aerospace Engineering, Indian Institute of Science

Prof. Gopalakrishnan received his BE degree from UVCE, Bangalore, Master's Degree in Engineering Mechanics from Indian Institute of Technology, Madras, Chennai and Ph.D from School of Aeronautics and Astronautics from Purdue University, USA. His main areas of interest are Wave Propagation in complex media, Computational Material Science, Computational Mechanics, Smart Structures, Structural Health Monitoring, MEMS and Nano Composite Structures. He has a total of 248 international journal papers, 9 graduate level textbooks, two undergraduate books, 13 book chapters, and 175 international conference papers. He has an h-index of 56 in Google scholar with nearly 13000 citations, which is highest in India for any researchers in Aerospace domain. He is in the editorial board of 5 international journals and is the Editor-in-chief of ISSS Journal for Micro and Smart Systems and is the Associate editor for Smart Materials and Structures and Structural Health Monitoring international journals. Prof. Gopalakrishnan is decorated with many awards and honors, which include, International Structural Health Monitoring person of the year awards 2016 instituted by SAGE Publications, Fellow of Indian National Academy of Engineering, Fellow of Indian Academy of Sciences, Associate Fellows AIAA, Distinguished Alumnus Award, Indian Institute of Technology, Madras, Chennai, Satish Dhawan Young Scientist Award by Government of Karnataka, Biren Roy Trust award of Aeronautical society of India, Alumni Award of excellence in research at IISc in the year 2013 and the Royal Academy of Engineering, UK Distinguished visiting Fellowship. He was elected Fellow of Institute of Mechanical Engineers, UK in the year 2020. Prof. Gopalakrishnan figures in the Stanford list of top 2% of scientist in the world for four consecutive years. In July 2025, he received the ASME Founder's award for his contributions to SHM and NDE. He has guided 33 Ph.D's, 7M.Tech (Research) and 23 M.E students.

Magneto-elasticity for stress detection: a simulation approach, by Abdellahi ABDERAHMANE1, 2 and Laurent DANIEL1, 2 1Université Paris-Saclay, CentraleSupélec, CNRS, Laboratoire de Génie Électrique et Électronique de Paris, FR-91192 Gif-sur-Yvette, France

Sorbonne Université, CNRS, Laboratoire de Génie Électrique et Électronique de Paris, FR-72525 Paris, France

Many industrial steels are ferromagnetic, and their magnetic behaviour is highly dependent on the stress state. Magneto-elasticity is therefore a promising approach to stress characterization in steels. This paper presents a numerical methodology to explore this approach. First, forward models describing the magneto-mechanical response of ferromagnetic materials are required. Models based on multiscale approaches are now becoming available. To enable stress estimation from magnetic response, an appropriate inversion strategy is necessary. One possibility is to define surrogate models, based on an interpolation of the multiscale approach. These surrogate models, either analytical or based on machine learning techniques, then serve as a foundation for inversion algorithms. They can be used to identify the number and type of measurements needed to ensure that the magneto-mechanical effect is invertible. Given the non-linear and multiaxial nature of the magneto-mechanical behaviour, as well as measurement uncertainties, initial inversions – using few measurements – define only a local solution space. Adding targeted complementary measurements iteratively refines this space, progressively converging towards the true stress state.

Prof. Laurent Daniel
(PhD 2003, Hab. 2011)

Prof. Laurent Daniel (PhD 2003, Hab. 2011) is full Professor at CentraleSupelec, University Paris-Saclay, and researcher at the Group of Electrical Engineering Paris (GeePs). At GeePs, he is notably involved in the study of magneto-mechanical couplings and their application in non-destructive evaluation, using both experimental and simulation-based approaches. He is currently the Director of the Graduate School of Engineering and Systems Sciences at University Paris-Saclay. From 2022 to 2025, he was a member of the Industrial Research Committee of the Indo-French Centre for the Promotion of Advanced Research (CEFIPRA/IFPCAR). He also serves as a member of the scientific committee of COFREND, the French NDT society. He is co-chair of the next International Workshop on Electromagnetic Nondestructive Evaluation (ENDE'26) organised in June 2026 at University Paris-Saclay.

Deep Learning Framework for Simulating FMC-TFM Technique in Non-Destructive Evaluation, by Thulasiram Gantala,

Department of Mechanical Engineering, IIT Hyderabad.

Abstract:
This talk will provide a broad overview of Machine Learning (ML) models, specifically Data-driven Simulation-Assisted Physics Learned AI (DPAI), which is used to simulate real-time ultrasonic wave scattering in a 2D solid. DPAI utilizes an ST-ConvLSTM encoder-decoder architecture to learn complex wave physics and train on comprehensive Finite Element (FE) datasets that feature varied defect characteristics. The DPAI model is applied to simulate the Full Matrix Capture (FMC) scanning strategy, processing the resulting FMC matrix via the Total Focusing Method (TFM) for high-resolution image reconstruction. Validation against experimental FMC-TFM and FE simulations demonstrates superior accuracy and computational speed.

Thulsiram Gantala
Assistant Professor
Mechanical & Aerospace Engineering Department

Bio: Thulsiram Gantala is an Assistant Professor in the Mechanical & Aerospace Engineering Department at IIT, Hyderabad. His PhD studies on AI models for virtual source phased array ultrasound imaging. The thesis studies include the development of a novel phased array ultrasonic imaging technique, a Generative AI model for generating synthetic phased array imaging, and simulating ultrasonic wave propagation in solids with defects, which have won wide acclaim, including the Best Thesis Award in Data Science at IIT Madras. He also received a Prime Minister's fellowship for doctoral research during his PhD studies. He has contributed to the development of AI techniques in both classical and quantum forms. His research interests include Nondestructive Evaluation, Materials Characterization, Wave Propagation, Ultrasonic Imaging, and Applied Machine Learning.

AGENDA

09.00 - 09.30 REGISTRATION

09.30-11.00 Session I

9.30-10.15 TALK 1: New challenges and Opportunities for NDE Simulation in a Digitalized Industry by Edouard Demaldent

10.15-11.00 TALK 2: Role of Physics based models in solving Inverse problems in Mechanics Under Deep/Machine Learning Environment, by Dr S Gopalakrishnan,

11.00-11.30 TEA BREAK

11.30-13.00 Session II

11.30-12.15 TALK 3: Magneto-elasticity for stress detection: a simulation approach, by Laurent DANIEL

12.15-13.00 TALK 4: Deep Learning Framework for Simulating FMC-TFM Technique in Non-Destructive Evaluation, by Thulasiram Gantala,

13.00-14.00 - LUNCH

14.00-15.00-Session III (Demos)

14.00-15.00 Demo on the Modeling and Simulation software CIVA by Benoit Puel, Extende, France

15.00 End of PCT

Venue: Hall No. 202

Contact - Prof. Balasubramaniam at Balas@iitm.ac.in

FEES FOR PCT

Registration fee Rs 2000 + 18%GST , including kit, lunch, and coffee.
Sp. discounted rate for students Rs 1000 + 18% GST

On spot registration can be done.

Participants are eligible for an additional ₹500 discount on NDE 2025 registration. To avail the discount, please ensure that the registration form is completed in full with accurate details.

ACCOUNT DETAILS

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