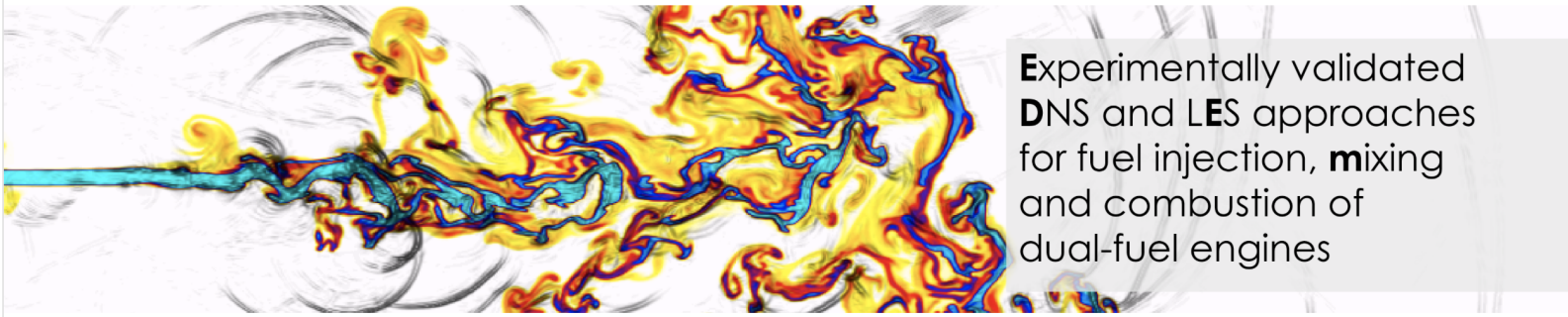
POLITECNICO MILANO 1863

DIPARTIMENTO DI SCIENZE E TECNOLOGIE AEROSPAZIALI

Marie-Curie, Early Stage Researcher Fellowships



EDEM PROJECT - ESR #13

Development of CFD Methodologies for Dynamic Mesh Handling and Application to the Simulation of Combustion in Dual-Fuel Engines

In the framework of a Marie Skłodowska-Curie European Industrial Doctorate (EID) program H2020, Perkins Engines Company Ltd. and the Department of Aerospace Science and Technology (DAER) at Politecnico di Milano (PoliMi) are actively looking for **1 PhD Candidate in CFD code development**. The position is funded by the Marie Curie-ITN-EID 'EDEM' (Experimentally Validated DNS and LES Approaches for Fuel Injection, Mixing and Combustion of Dual-Fuel Engines) project. EDEM is a unique international (EU, US, CN, UAE, KR), intersectoral (academic and non-academic institutions) and interdisciplinary research consortium based on high profile universities and world leading industrial partners. More information is provided in the following pages of the document.

ORGANISATION/COMPANY: Dept. of Aerospace Science and Technoloty (DAER) - Politecnico di Milano/Perkins Engines Company Ltd.
RESEARCH FIELD: Computer Science (Programming) / Aerospace, Computer or Mechanical Engineering

RESEARCHER PROFILE: Early Stage Researcher
APPLICATION DEADLINE: February 1st, 2020 12:00 - Europe/Rome

TYPE OF CONTRACT: Temporary (36 months)
JOB STATUS: Full time
OFFERING START DATE: February 1st to April 1st, 2020 (negotiable)
EU RESEARCH FRAMEWORK PROGRAMME: H2020-MSCA-ITN-2019
Type of Action: MSCA-ITN-EID
GRANT AGREEMENT No: 861002

To apply, please contact:

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Brief description of the Technical Program

The PhD topic is oriented at the capabilities of mesh handling methods based on non-conformal and overlapping (Chimera) grids for Computational Fluid Dynamics (CFD) simulation of Dual Fuel Engines.

Description of the PhD position. High-fidelity surface representation in automatic mesh generation of IC Engines, parallel mesh adaptation methods based on selective h-p strategies and Chimera grids. The PhD candidate will be required to work at the Politecnico di Milano (PoliMi) in Milan (Italy) at the Department of Aerospace Science and Technology (DAER); he/she will spend up to 12 months at Perkins Engines Company Ltd. in Peoria (IL, United States of America).

Profile of the applicant

We are looking for 1 enthusiastic Early Stage Researcher, who wants to apply know-how and experience in a challenging technical environment. In more specific terms:

- Applicant is in the first 4 years of his/her research career. This is measured from the date of graduation (MSc degree or equivalent), which formally entitles him/her to embark on a doctorate. Research experience should be $0 < 4$ years.
- Applicant should not have been living in Italy for more than 12 months in the last 3 years. For refugees under the Geneva Convention, the refugee procedure (i.e. before refugee status is conferred) will not be counted as 'period of residence/activity in the country of the beneficiary'.
- Excellent computational skills and interest in CFD programming (C++), python, bash scripting and fluid modelling are expected.
- Familiarity with the open-source CFD code OpenFOAM (www.openfoam.org), some knowledge of multiphase flows and turbulence modelling is not required but would be an asset.
- Good communication skills.
- A sound knowledge of the English language, both oral and written.

The successful candidates will receive a financial package including mobility and family allowance (if applicable), and will be employed according the rules for Early Stage Researchers (ESRs) in an EU Marie Skłodowska-Curie Actions Innovative Training Networks (ITN) and the general regulations of each institution.

How to apply?

Please send cover letter and resume plus relevant technical papers, reports, references, etc. to federico.piscaglia@polimi.it. Indicate clearly the reference job id: **EDEM-CFD13**.

Both teams, at DAER and Perkins Engines Company Ltd. have a strong background in Computational Fluid Dynamics, Multi-Physics and High-Performance Computing.

Project Background

a. Environmental and societal challenges: The constantly increasing energy needs associated with the expansion of urbanisation, population growth and the ever increasingly (road and maritime) transportation needs are/will be met by heavy-duty Diesel internal combustion engines (ICE), for which no foreseen electrification strategy is in place. Despite the immense reduction achieved, soot is one of the deadliest forms of air pollution: such particles inhaled at city centres, are linked to serious health effects, including premature death, heart attacks and strokes, as well as acute bronchitis and aggravated asthma among children. To mitigate the inevitable environmental/health effects, partial substitution of conventional Diesel engines by high-octane liquid or gaseous fuel with lower carbon-to-hydrogen ratio represents the only practical and imminent solution. The so-called dual-fuel internal combustion engines (DFICE) primarily burn a premixed high-octane fuel/air mixture, with a moderate quantity of pilot high-cetane fuel employed only as an ignition agent. DFICE have applications to a non-exhaustive list of applications, including power generation, cargo ships and tankers, light and heavy duty trucks, tractors, earth-moving machines and haul trucks.

b. DFICE potential in reducing emissions: Utilisation of suitable primary/pilot fuel mixtures enables engine operation to be in compliance with the strictest automotive emissions legislation imposed globally, e.g. EURO VI or Tier IV standards, in Europe and in the US, respectively, as well as with the Tier III limit of the International Maritime Organization (IMO) that dictates further reduction of NOx emitted by marine engines. Utilisation of a high-octane fuel or hydrogen produces virtually no soot. Moreover, it assists the oxidation of soot formed due to the liquid-fuel combustion. The margin for emissions reduction from DFICE has been found to be significant and lying in the range of 20-80% for NOx/PM emissions and 10-50% for CO2 (depending on the degree of bio-fuel/hydrogen utilisation) without significant penalty in their performance compared to conventional operation.

c. DFICE operational challenges: The high auto-ignition temperature of gaseous fuels requires injection of Diesel fuel as pilot necessary to initiate combustion. Hence, the principle of DFICE operation poses new challenges for the design of injectors that must be capable of handling Diesel fuel in the, so called, ballistic mode, where short injection duration under high pressure must be accomplished. Referring to gaseous fuels, natural gas and hydrogen are widely employed candidates to serve as primary fuels in DFICE. The concept, however, could be extended to an 'Octane on Demand' principle, i.e. using the octane number of the primary fuel as a designating factor of the combustion characteristics.

Computational fluid dynamics (CFD) models have been long utilised for the design of efficient ICE. However, existing models fail to predict processes where a variety of fuel mixtures are injected and combust simultaneously. This is due to simplifications made for the mixing, phase-change and combustion, which all are happening at scales not resolved by the grid resolution and require sub-grid scale physical modelling. The proposed programme is aiming to develop such models, which in turn will be utilised by engine and FIE manufacturers for the design of DFICE. The proposed studies provide a unique training opportunity to the ESRs to: (a) obtain new experimental data by utilising the most advanced experimental techniques, (b) develop, improve and validate new state-of-the-art CFD models and (c) trained in industrial practice on site at the non-academic partner institutions, which is expected to enhance their career perspectives. Training of the network's ESRs will comprise an integrated curriculum of local and intensive network courses, schools, and engagement with active cutting-edge research. Each recruited researcher will:

- be enrolled in a doctoral programme at one of the academic beneficiaries.
- be jointly supervised by at least two supervisors, one from each sector (Academia and Industry).
- spend at least 50% of their time in the non-academic sector (at beneficiaries or partner organisations).