Marie Curie Doctoral position at:
- Mines Saint-Etienne - Université de Lyon (France)
- HSL - Trento (Italy)

ESR08 - Simulating endovascular aortic repair towards assessing long-term treatment implications

Keywords: additive manufacturing, 3D printing, biomechanics, Aneurysm; Patient-specific Models, anatomical replica, endovascular aneurysm repair.

General framework: 14 Early Stage Researchers (ESRs) will be offered doctoral positions as part of the MeDiTATe project, which is funded through the H2020 program: Marie Skłodowska-Curie Actions (MSCA) Innovative Training Networks – European Industrial Doctorate. The whole MeDiTATe project aims to develop state-of-the-art image based medical Digital Twins of cardiovascular districts for a patient specific prevention and treatment of aneurysms. The individual research projects of each ESR within MeDiTATe are defined across five research tracks: (1) High fidelity CAE multi-physics simulation with RBF mesh morphing; (2) Real time interaction with the digital twin by Augmented Reality, Haptic Devices and Reduced Order Models; (3) HPC tools, including GPUs, and cloud-based paradigms for fast and automated CAE processing of clinical database; (4) Big Data management for population of patients imaging data and high fidelity CAE twins; (5) Additive Manufacturing of physical mock-up for surgical planning and training to gain a comprehensive Industry 4.0 approach in a clinical scenario.
The work of each ESR, hired for two 18 months periods (industry + research) and enrolled in a PhD programme, will be driven by the multi-disciplinary and multi-sectoral needs of a multi-disciplinary research consortium (clinical, academic and industrial) which will offer the expertise of Participants to provide scientific support, secondments and training. Recruited researchers will become active players of a strategic sector of the European medical and simulation industry and will face the industrial and research challenges daily faced by clinical experts, engineering analysts and simulation software technology developers.
During their postgraduate studies they will be trained by the whole consortium receiving a flexible and competitive skill-set designed to address a career at the cutting edge of technological innovation in healthcare. The main objective of MeDiTATe is the production of high-level scientists with a strong experience of integration across academic, industrial and clinical areas, able to apply their skills to real life scenarios and capable to introduce advanced and innovative digital twin concepts in the clinic and healthcare sectors.

Description of the ESR project: Currently endovascular aortic repair (EVAR) is used to treat the vast majority of aortic aneurysms (AA). This is a minimal invasive treatment, where a stent graft is delivered endovascular in order to cover the aneurysmatic part of the aorta. However, recent studies showed that the durability of EVAR requires improvement, and sack enlargement, different types of leakages and stent migration are typically observed long-term complications of this treatment. Especially for complex shaped AAs a particular challenge faced by clinicians is to select the most appropriate stent-graft for an individual patient. This project aims at modelling the stent delivery process as well as its interaction with the aneurysmatic wall using non-linear biomechanical simulations. Such models are currently under development at ARMINES and they will be extended by considering growth and remodelling of the aneurysmatic wall to predict the long-term outcome of the patient-specific EVAR treatment. The model will be validated against clinical follow-up data of AAs using modalities like Ultrasound and Computed Tomography-Angiography (CT-A).

In order to fully exploit the information contained in the simulations, the morphology of the aneurysmatic wall will be visualized and assessed using a reconstructed real size anatomical replica. This can be achieved by reproducing the AA's geometrical features with additive manufacturing (AM) technologies, mimicking tissue properties with different material types. This will allow clinicians to evaluate the long-term fitting of stent-graft within the simulated geometry on patient-specific phantoms.
Simulating EVAR treatment will not only improve the management of aneurysm patients, but could also be used for a surgery simulator to train clinicians (Digital Twin) and with the aid of 3D printed phantoms for planning surgical procedures. Most importantly, a sound understanding of EVAR treatment will decrease healthcare related costs by avoiding costly re-interventions.

Additional Information:
The ESR will be enrolled in the PhD programme of University of Lyon at Mines Saint-Etienne, France. The PhD thesis will take place at 2 different places: (a) HSL, Trento (Italy) is a leading company in Europe for Additive Manufacturing (AM) and Advanced CAE simulation; (b) Mines Saint-Etienne (France) in the CIS department, which conducts major international research projects in the field of soft tissue biomechanics, in particular aortic aneurysms. He will collaborate with other researchers involved in ERC projects (https://www.mines-stetienne.fr/en/author/avril/, https://www.emse.fr/~badel/). A one-month secondment will take place at Università Degli Studi di Roma Tor Vergata (Italy).

Benefits, salary and duration:
The selected candidate will receive a salary in accordance with the MSCA regulations for ESR. The gross salary includes a living allowance (€3,270 per month, subject to MSCA country correction coefficient, i.e. 115.7% for France and 104.4 % for Italy), a mobility allowance (€600 per month), and a family allowance (€500 per month, if the researcher has family by the date of recruitment, regardless of whether the family will move with the researcher or not). The guaranteed funding is for 36 months (i.e. EC funding).

Eligibility criteria:
Applicants can be of any nationality and must hold a Master of Science degree (or equivalent) in engineering. They need to fully respect both eligibility criteria (to be demonstrated in the Europass CV): (a) Early-Stage Researchers (ESRs) must, at the date of recruitment by the beneficiary, be in the first four years (full-time equivalent research experience) of their research careers and have not been awarded a doctoral degree. (b) Conditions of international mobility of researchers: Researchers are required to undertake trans-national mobility (i.e. move from one country to another) when taking up the appointment. At the time of selection by the host organization, researchers must not have resided or carried out their main activity (work, studies, etc.) in France for more than 12 months in the 3 years immediately prior to their recruitment. Short stays, such as holidays, are not taken into account.

Candidate profile: Candidates with strong skills in mechanics (modelling and experimental) and biomechanics are expected. Motivation and interest in bioengineering applications is recommended. Excellent knowledge of written and spoken English is required.

How to apply: Send CV, cover letter, BSc and MSc degrees, and letters of recommendation to all the following recipients: avril@emse.fr and pierluigi.digiovanni@consultants.hsl-italia.com.