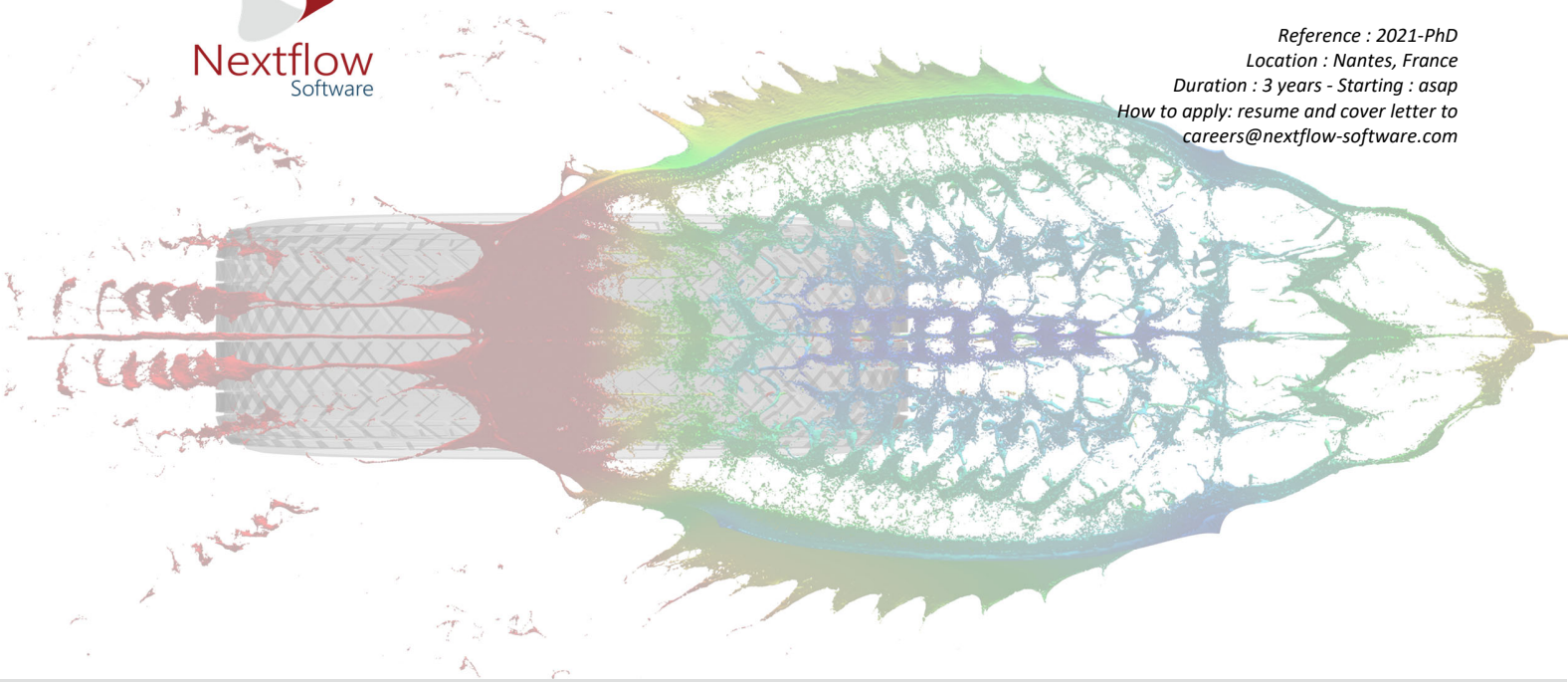

Reference : 2021-PhD
Location : Nantes, France
Duration : 3 years - Starting : asap
How to apply: resume and cover letter to careers@nextflow-software.com

Numerical modeling of soft soils by the Smoothed Particle Hydrodynamics method.
CIFRE PhD Nextflow Software-Ecole Centrale Nantes

PhD hosted by Laboratory: LHEEA (UMR 6598), Ecole Centrale Nantes

Nextflow Software is an Independent Software Vendor (ISV) startup headquartered in Nantes, France. Nextflow develops and sells advanced Computer-Aided Engineering (CAE) software in the field of Computational Fluid Dynamics (CFD).
Nextflow Software addresses engineering companies developing and manufacturing products and systems involving fluid flows, potentially with complex geometries and interactions with solids (e.g. moving parts, deformations), in the field of automotive, aeronautics, marine, and many other industries.

Thanks to its talented team of researchers and engineers, and based on more than 10 years of close partnership with leading academic research laboratories from Ecole Centrale Nantes (ECN) and other universities, Nextflow Software is pushing the limits of hydrodynamics simulation.

Context

Modeling large deformations of soft soil and its interaction with structures/tools is key to various applications : in agriculture with agricultural machines, in civil engineering with excavation machines, in geology with coastal and bank erosion or landslides. All those sectors are in high demand due to global warming and resulting natural phenomena such as increased occurrence of extreme weather events, rising water levels, warming of the soil.

Numerical simulation tools currently available remain too imprecise to consider large deformations of soft soils, therefore most manufacturers in these sectors use experimentation which leads to significant costs and delays.
Assuming that the soil is considered a continuous medium, there are several methods that can model its deformations. Conventional mesh-based methods have limitations in modeling large deformations and fractures due to errors generated by too large mesh distortion. Recent advances in mesh-free particle methods based on the continuous media mechanics allow to consider the modeling of large field deformations using constitutive models of conventional soils. Among these methods is the Smoothed Particle Hydrodynamics (SPH) method, for which latest technical advances made by the academic community are particularly promising. This method has the advantage of being conservative, Lagrangian and meshless.

The advances made during the thesis will contribute to develop a software technologically disruptive from current simulation tools. This innovative numerical method will allow to simulate the behavior of the soil and also to take into account its interactions coupled with deformable structures.

Nextflow Software

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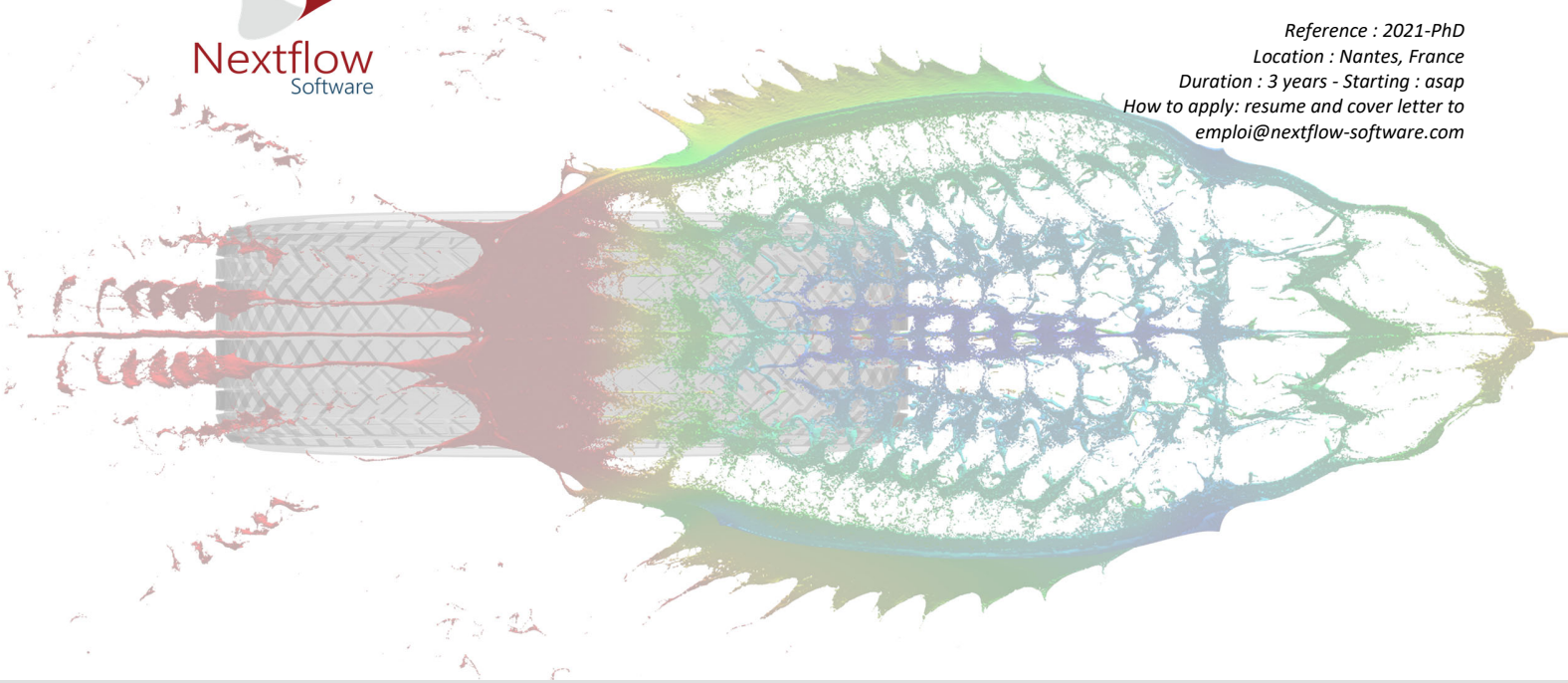


The work can be considered under the following axes :

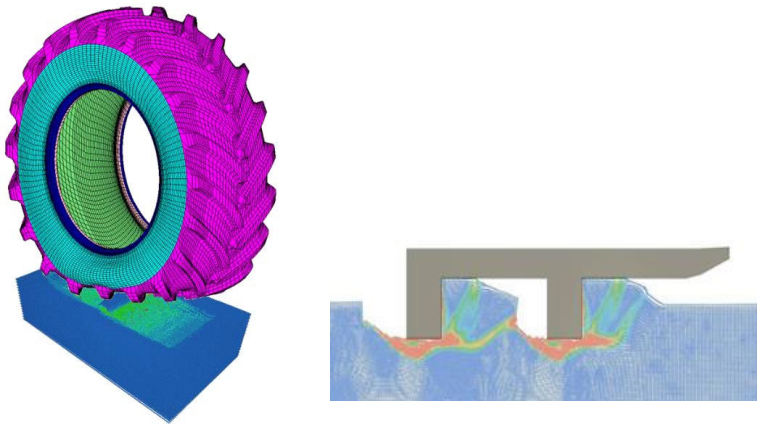
- Bibliography, first approach of calculation codes and current coupling algorithm, understanding of academic and industrial expectations, participation to a soil panel survey and its description, building a soil physical database for laboratory testing (tests performed out the thesis scope)

- Study of behavior laws to represent the physics of selected soils. These behavior laws will derive from the mechanics of continuous environments (but not necessarily transposed into the SPH formalism)

- Improvement of the elasto-plastic structure model implemented in the SPH-flow code (software based on the SPH method, developed in collaboration by Centrale Nantes and Nextflow Software for fifteen years). Work related to a partial implicitation of the diagram in order to maximize the size of the time steps. Validation of the elasto-plastic model on academic test cases

- SPH discretization of proposed behavior laws

- Assessment of the model on simplified cases such as indenter sinking or shearing in soft soil with controlled characteristics, validations by comparison with results obtained with an experimental set-up.



Examples of SPH simulation applied to soft soil