*Faculty of Engineering and Architecture*
*Dept. of Electrical Energy, Metals, Mechanical Construction and Systems (EEMMeCS)*
*Soete Laboratory; Fracture Mechanics research group*

# Researcher vacancy

## 3DNDE-FEA: Automated finite element analysis based assessment of (weld) defects, based on output of 3D non-destructive examination

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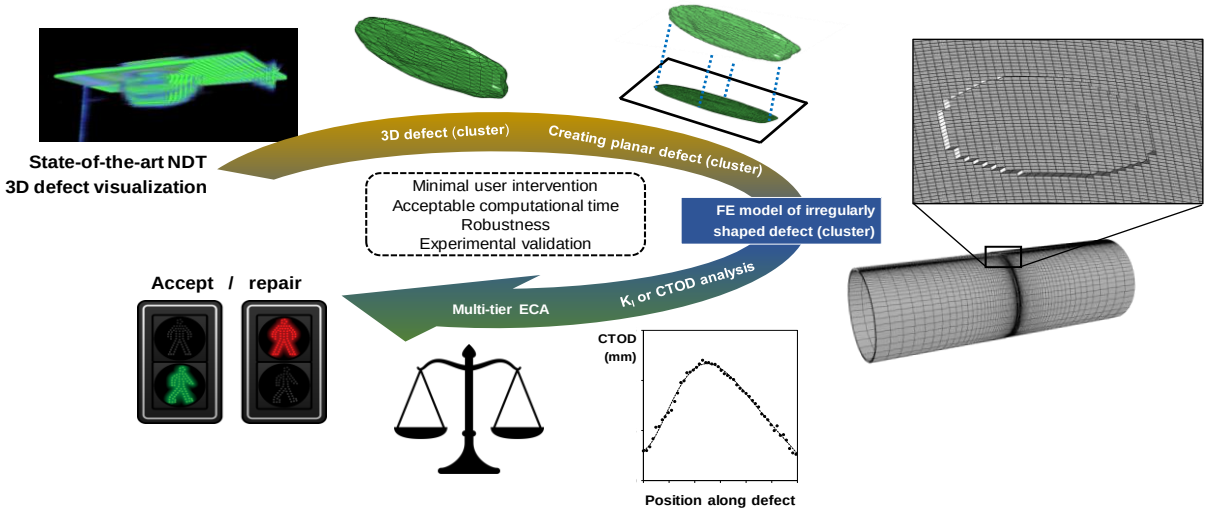
| Contract | 1.5 years (start: summer 2019) |
| Degree | Master of Science degree in mechanical engineering is required |
| Occupancy rate | 100% |
| Vacancy type | Research staff (predoctoral or postdoctoral) |

### *Project description*




Traditionally, the development of acceptance criteria of defects (lack of fusion, slag inclusion, …) in pipeline girth welds has been strongly influenced by the technological limitations of non-destructive examination (NDE) technology. Typically, a defect with simplified shape (rectangular, elliptical) is assumed, its dimensions being derived from an envelope surrounding the NDE scanned defect. Very often, the actual shape of a real defect restrains the development of crack driving force to a larger extent than predicted by assuming a simplified defect shape. Defect interaction criteria (e.g. informed by BS7910, ASME BPVC Section XI, API 579) are necessary to assess multiple defects in close vicinity, potentially introducing excessive conservatism.

There are reasons to assume that the abovementioned defect simplifications will no longer be required in the future. First, the pipeline community witnesses the development of advanced girth weld 3D NDE tools (e.g. Full Matrix Capture ultrasonics, radiographic tomography) with the capability for detailed visualisation of detected features and weld geometry (e.g., weld cap height). Their market breakthrough is hampered by the inability to use these highly detailed results to their full extent. Secondly, the rapidly increasing computational speed of computers has created the opportunity for time-efficient numerical integrity calculations, based on finite element analysis (FEA).

In the framework of a feasibility study funded by EPRG (European Pipeline Research Group) 2018, Ghent University has developed an innovative FE modelling technique to automatically assess the proximity to fracture of irregularly shaped defects, using output obtained from advanced 3D NDE scans. It is based on the deletion of elements in a fine, regular mesh grid, thus creating a defect at voxel locations indicated by the scan. Devoted novel postprocessing routines allow for defect assessment based on the theories of linear-elastic and/or elastic-plastic fracture mechanics.

Albeit promising, more work is required to tune the developed method into a practically applicable defect assessment. Hereto, a two-year follow-up project is funded by PRCI (Pipeline Research Council International). Concrete objectives are:

- to perform a theoretical analysis of variables that characterize the performance of a 3D NDE system, and of a computational fracture mechanics analysis. Grade the sensitivity of the 3D NDE – FEA based assessment with respect to these variables. Suggest a unified coupling routine between 3D NDE output and FEA input.
- based on the above, to develop a three-level assessment framework, where higher level assessments allow for more accurate predictions (but require more detailed information with respect to geometry, materials and loads). This philosophy is highly similar to that of standardized engineering critical assessment methods (BS7910, …).
- to design and execute an experimental validation of the multi-tier assessment framework, based on large scale (wide plate) tension testing of welds containing defects. Comparing the test results with predictions will allow to judge the soundness of the abovementioned sensitivity ranking of variables, and to set limits of applicability (ranges of allowable variable values) to the assessment.

## *Profile of the candidate*

- you possess a Master of Science degree in mechanical engineering; postdoctoral researchers are also considered for this vacancy;
- you have a strong motivation for (and preferably a history of) conducting scientific research and working with complex questions;
- you possess structured and creative problem-solving abilities;
- you possess strong analytical and technical skills and take responsibility for the development of your work;
- you can work independently as well as in team;
- you have affinity with both analytical, numerical and experimental work;
- experience with fracture mechanics is a prerequisite;
- experience with non-destructive evaluation techniques is an advantage;
- you have excellent English communication skills (written and presentation);
- you are willing to travel for project progress reporting, conference attendance, … (specifically to the USA)
- knowledge of Dutch is a plus.

## *Salary and appointment terms*

- Depending on your background and situation, an estimation of your salary is possible.
- The progress of the project will be evaluated after one year, and prolonged upon positive evaluation.
- The expected starting date is around **July 2019**.

## *How to apply*

The application form[1] should be sent in pdf format to Prof. Stijn Hertelé (stijn.hertele@ugent.be), including:

- CV;
- an official record of transcripts (bachelor and master are required; PhD is possible) and a copy of degree certificates;
- a brief motivation letter, showing why the applicant wishes to engage in the scientific research;
- two or more references.

For further information on the vacancy and/or how to apply, contact Prof. Stijn Hertelé (stijn.hertele@ugent.be).

[1] See https://www.ugent.be/ea/eemmecs/en/research/soete/vacancies