Institut Supérieur de l'Aéronautique et de l'Espace

Date of issue : 22nd March 2010

Validity date: 1st September 2010

Reference : PDoc/01/14/46/2009/ChE

Contact : Christine ESPINOSA

Validation : Jacques HUET

Post-Doctoral Position Proposal

GENERAL RECEPTION

Company / organism **ISAE**
Induction structure **Département Mécanique des Structures et Matériaux**
10 Avenue Edouard Belin, BP54032, F-31055 TOULOUSE Cedex 4

Location 1 **Campus ENSICA**
1 place Emile BLOUIN, F-31056 Toulouse Cedex 05

Location 2 **IMPETUS Afea France**
rue du Lanoux, F-31330 Grenade Sur Garonne

Duration : 12 months **dates : sept. 2010 – august 2011 (before is possible)**

Candidate : CV + interview, PhD or Research Engineer in Comput. Mechanics or Applied Math.

SUBJECT

Title : Damage-Rupture Coupling in composites structures using the SPH method

Industry : o aeronautics/aerospace o terrestrial transport o energy
o mechanics/metall. o engineering ■ SSI o other :

Speciality : o aero/fluidmech o combustion o thermics
o structure ■ materials ■ informatics/numerics

Work field : ■R&D model. numer. o R&D numer./exper. o R&D exper.
o technico-com. o project o other :

Confidentiality : o no ■ yes o nature: **industry**

Context of the subject

The proposed project is scheduled in the frame of Research and Development of Advanced Numerical Methods for Computational Design of composites structures subjected to dynamic non linear loadings (impacts, machining, …). In this field, appeal to conventional numerical methods comes up against the major issue of damage modelling, e.g. delamination: fractures, ruptures, openings, losses of rigidity. Indeed, the use of classical FE industrial codes to represent such behaviours "small" compared to the whole structure is limited in two ways. The computational cost is prohibitive if it is needed to capture the physics typical dimensions, and it becomes necessary to find out a trade-off between the non circumventable use of numerical potentiometers and the physics intrinsic complexity. Alternative methods do exist. Among these, meshless methods are more and more though about and even used. Meshless methods are based on interpolation and approximation methods that avoid fixed nodal connection that is there is no need of element like neighbourhood. In the case of Smooth Particle Hydrodynamics method, massive points, i.e. the Particles, are placed in the volume occupied by the matter and allow for the Smooth approximation of continuous functions (mass, momentum) in the neighbourhood of each particle. Advantages of this method that will be used are the lack of rigid links between particles, the possible fine local approximation, the natural opening management and the creation of new boundaries due to fractures with almost no influence of the space discretization. For instance, this method has already been used successfully by the project team to predict the size and shape of chips during High Speed Machining, or the fragmentation of a projectile and the target of a High Velocity Impact for space applications (spalling, shrapnel…).

The objective of the present work is to improve the method for low velocity phenomena, for composites damage, on pieces that are representative of aeronautical or aerospace structures.

Precise objective

The aim is to improve the SPH (Smoothed Particle Hydrodynamics) method and propose physical criteria and algorithms to model progressive damage and/or brutal rupture. Typical applications are low velocity impacts on thin curved panels. The development will sweep across the following fields: multi-scale mechanics, damage initiation and propagation, rupture, numerical methods. The developed method will be validated and used for real tests comparisons and aeronautical structures close to industrial applications.

The following stepping is proposed: theory and algorithm development, numerical tests for feasibility and limits of use, improvement of the method, applied study on elementary structures then technological samples, application to different impact configurations.

Involved means

The work will begin with a bibliographic study and on the theoretical, numerical, empirical models developed at the DMSM.

Necessary courses on the software or theory or experimental devices will be given for free to the applicant, by the professors and associate professor of the Department, together with introduction to some physical knowledge: machining, fatigue, computation, etc. IMPETUS Afea will help and give a support.

The applicant will work with professors and associate professors of the Composite Material or the Numerical Method teams, and with engineers of IMPETUS Afea. Experimental tests, measures, observations and analyses will be conducted together with technical engineers or technicians of the Department. The applicant will also have the opportunity to discuss with researchers who work in collaboration projects with the Department.

PROFILE

The applicant will have a PhD diploma or an engineer diploma with a research experience, in Computational Mechanics or Applied Mathematics. He/she will have an enhanced knowledge in approximation/interpolation algorithms, code development, FORTRAN, C, C++, CUDA. A deep knowledge on problems encountered in composite modelling will be greatly welcome.

Contacts

To apply, send references and CV, contact

Name : **Christine ESPINOSA** email: **Christine.Espinosa@isae.fr**
Name: **Frédéric LACHAUD** email: **Frederic.Lachaud@isae.fr**
Name : **Jérôme LIMIDO** email: **jerome@impetus-afea.com**