UNIVERSITY OF LIVERPOOL

POSTDOCTORAL RESEARCHER

Job Ref:

Department: Department of Computer Science

Salary: Depending on qualifications and experience **Range**: £30,747 to £35,646

Location: University Campus **Hours of work:** Full-Time

Tenure: 3 years **Grade: 7**

Closing Date: Friday 10 December 2010 **Interview Date: To be confirmed**

Informal enquiries to: Frans Coenen (coenen@liverpool.ac.uk) or Clare Dixon (CLDixon@liverpool.ac.uk)

Application Procedure

Applications should comprise:
*A completed **applicant information form**
* A copy of your **full curriculum vitae**
*A statement indicating the reasons for applying for this post and how your training and experience is relevant.
If you have any particular requirements should you be invited to interview, please make this clear in your application.

Submitting Applications

Applications may be submitted by e-mail to jobs@liv.ac.uk or by post or in person to: The Director of Human Resources (Recruitment), The University of Liverpool, Hart Building, Mount Pleasant, Liverpool L3 5TQ
ROYAL MAIL – Postal Pricing System. Please ensure that postal applications carry the correct postage according to the weight and measurement of the item, as items with insufficient postage will be held and delayed by the Royal Mail. Details of their pricing system are available online at www.royalmail.com or from a Post Office branch.

Acknowledgement of Applications

Please note that we are unable to acknowledge postal applications. If you would like an acknowledgement please enclose a stamped addressed card or envelope, and place it at the front of your application. If you e-mail your application you will receive an automated acknowledgement.

Shortlisting and Interviews

Shortlisting and interview arrangements are the responsibility of the recruiting Department. Please contact Frans Coenen **(**coenen@liverpool.ac.uk**)** or Clare Dixon **(**CLDixon@liverpool.ac.uk**)** if you have a query after the closing date.

Outcome of Applications

Vacancies at the University often attract a large number of candidates and it is not always possible to respond individually to every application. If you have not heard from the recruiting Department by Friday 7 January 2011 please take it that your application has not been successful.

Asylum & Immigration

The University will comply with the Immigration, Asylum and Nationality Act 2006, which requires all employees to provide documentary evidence of their legal right to work in this country prior to commencing employment. Please be aware that you will be required to bring your passport (and visa if applicable) to interview so that it can be copied and verified by a member of the Selection Panel. For posts requiring a recognised degree level or equivalent qualification, and where there is no suitable UK or European Economic Area candidate, the University will take the necessary steps to secure UK Border Agency permission for a foreign national to take up employment.

Should a candidate require a Certificate of Sponsorship in order to take up a post they will need to meet the UK Boarder Agency Tier 2 Points Based Criteria. A self assessment tool can be found on the UK Border Agency website at: www.ukba.homeoffice.gov.uk/pointscalculator

A candidate may also be required to undertake an English Language test prior to commencing work at the University. Details of Home Office approved tests can be found at: www.ukba.homeoffice.gov.uk/sitecontent/newsarticles/pbsapprovedenglishlanguage

Further information on the eligibility criteria for Certificates of Sponsorship can be found at: www.ukba.homeoffice.gov.uk/employers/points

Diversity and Equality

The University of Liverpool is committed to diversity and equality of opportunity. All employees and applicants for jobs will be considered on their abilities and will not be discriminated against on the grounds of age, caring responsibilities, colour, disability, employment status, gender, gender identity, marital status, nationality, race or ethnic origin, religion or belief, sexual orientation, socio-economic status or any other irrelevant distinction. Training is available to support career progression within the University.

Two Ticks Disability : Guaranteed Interview Scheme (GIS)

The University of Liverpool is commitment to the employment of disabled people, and as part of our commitment, we guarantee to interview all disabled applicants who meet the essential criteria for a post and consider them on their abilities.

To apply for a post under the disability GIS, you must disclose your disability (as defined by the Disability Discrimination Act, 2005), and mark **X** in the **yes** box on the Equal Opportunities Employment Form. This form **must** be returned with your application form. Full details of the scheme are available at www.liv.ac.uk/hr/organisational-development/Two_Ticks.htm

Accessibility

If you require copies of documentation in alternative formats, for example, large print or Braille, please contact jobs@liv.ac.uk or telephone 0151 794 6771.

If you have any other requirements which will help you access the application or interview process or employment opportunities at the University of Liverpool, please let us know by contacting jobs@liv.ac.uk or telephone 0151 794 6771.

Smoking

The University has adopted a Code of Practice on Smoking, copies of which are available from the Human Resources Department website www.liv.ac.uk/hr

1. **Background**

We are looking for a high calibre post doctoral researcher with a PhD in Computer Science or a closely related subject (such as information technology, software engineering, etc.) to work on the **INnovative**

MAanufacturing of complex Ti sheet components (INMA) project. The INMA project is a Framework 7 European project between eleven partner orgnisations:

i. Fundación Fatronik
ii. EADS Innovation Works G
iii. Denn
iv. Vyzkumny A Zkusebni Letecky Ustav
v. University of Patras/LTSM
vi. TWI Ltd.
vii. Rheinisch-Westfaelische Technische Hochschule Aachen
viii. Wytwornia Sprzetu Komunikacyjnego PZL–Rzeszow
ix. The University of Liverpool
x. The European Aeronautics Science Network Association
xi. Airbus Operations SAS

INMA Project Summary

The INMA project aims at developing an intelligent knowledge-based (KB) flexible manufacturing technology for titanium shaping that will lead to drastically reduce current aircraft development costs incurred by the fabrication of complex titanium sheet components with a minimal environmental impact. In particular, this project aims at strengthening European aircraft industry competitiveness, by transforming the current non-flexible and cost intensive forming processes into a rapid and agile manufacturing process. This brand new technology, based on Asymmetric Incremental Sheet Forming (AISF), will transform the way many titanium sheet aeronautical components such as after pylon fairings, fan blades, exhaust ducts or air collectors are manufactured today. The innovative, cost-efficient and ecological forming technology to shape complex geometries in titanium that will contribute to strengthen the European aircraft industry competitiveness meeting society's needs.

Currently, aircraft industry uses complicated and cost intensive forming processes to shape complex Ti sheet components, such as deep drawing, hot forming, super plastic forming (SPF) and hydroforming. In some cases parts are even obtained by hand working. These techniques show severe drawbacks which include high costs, long industrialisation phases and high energy consumption rates. On the contrary, main features of the innovative AISF technology to be developed will be an increased flexibility, cost reduction, minimised energy consumption and a speed up in the industrialisation phase.

The major impacts of the results obtained in the INMA project will be:

- Cost incurred by dedicated tooling will be reduced in a 80%
- The component lead times will decrease in a 90%
- Buy-to-fly ratios will be up to a 20% lower

The INMA Consortium is integrated by 2 end-users, 1 equipment provider, 4 research organisations, 3 universities and the EASN network. Participation of industrial partners who will directly exploit the project results will guarantee the impact of the project.

2. **Description of Tasks Related to the Post**

Liverpool's contribution is primarily related with Work Package 4.

Work Package 4: Intelligent KB process modelling for dieless Asymmetric Incremental Sheet Forming (AISF).

This work package will be devoted to implement an intelligent process model that makes use of process knowledge to correct the tool path and thus compensate shape deviations when no die is used.

The associated objectives are:

- To identify and analyze all possible variables that take part on the shaped geometry definition and

the forming strategy process
- To infer which process variables have the biggest effect on part geometry deviations, by means of data mining and KDD (Knowledge Discovery in Data) techniques
- To explore the capabilities of advanced and hybrid Artificial Intelligence methods and algorithms to develop an Intelligent Process Model, IPM, based on previously inferred variables of interest
- To implement and validate an IPM that will support most relevant process parameters selection and tool path generation, avoiding part geometric deviations
- To define a set of guidelines to generalize the intelligent process to other realistic components

Asymmetric Incremental Sheet Forming (AISF).

AISF has the potential to produce parts using no die but, in practise, it is difficult to meet geometric tolerances if one support die is not used. This makes the process less flexible and economical than originally expected.

The problem is especially relevant if AISF of titanium is addressed. In cold forming operations material spring-back is very high, leading to significant shape deviations. If hot forming is addressed (required to deform high strength alloys such as Ti 6-4), spring-back is expected to decrease. Therefore, material spring-back makes that, the geometry of the shaped part is different from the geometry of the programmed part.

The idea is to develop an Intelligent Knowledge Based Process Model, IPM that is able to generate a CNC tool path, different from the part CAD, which provides after material spring-back a part with no geometric deviation.

Task 4.1 Transformation of process data into knowledge

Many process parameters have an effect on ISF process performance and its capability to achieve a specific forming geometry (forming angle, according radius, etc.). In order to develop an ISF process model it is first necessary to identify, from the global set of ISF process parameters, the subset of such process parameters that most strongly influence on the part geometric deviations. The main objective of this task is to accomplish this analysis by using Data Mining and KDD methodologies.

A key issue is to define how the shaped geometry and the forming tool path will be represented, in order to consider specific geometric parameters in terms of deformability. Both, the shaped geometry and the forming tool path are usually defined by a “cloud” of points. However, different representation models are going to be considered in order to optimize the final result. Distribution of the forming angle along the part depth, mathematical description of the geometry, a sub-set of the cloud of points and other inputs will be considered. Although the identification of sensitive variables will be made on the basis of a particular shape, defined in terms of parameters such as the nature of the material, thickness, geometry, size, etc., INMA aims at supporting the generalization of the IPM to other forming geometries.

Into this task, KDD, data warehousing and data mining methodologies will be applied to identify the process variables that most influence on the process. Variables of interest are ISF process parameters (tool, feed rate, pitch, etc.), the type of path described by the tool and the cloud of points describing the programmed tool path. The result is the cloud of points describing the shaped geometry that will differ from the programmed part due to spring-back effect. FE simulations using the numerical model of Task 1.1 will be run to support the generation of additional process data (strain, force).

The process will start with several preliminary forming experiments that will allow the acquisition and collation of the available data into a single “data ware house”. It is anticipated that this will entail a certain amount of data cleaning and pre-processing, in order to transform stored data into information and to extract useful knowledge from it.

Data mining and KDD techniques such as Principal Component Analysis, Frequent and Sequential pattern mining, rule mining and different classification and prediction algorithms (clustering, regression, decision trees, etc.) will be applied so as to identify the process variables that have the most influence over the geometry deviations. The identified variables will serve as inputs to the IPM.
This task takes as main sub-tasks:

- Task 4.1.1 Preliminary forming experiments definition and data generation
- Task 4.1.2 Data acquisition, data ware house and data pre-processing over generated data
- Task4.1.3 Data Mining and KDD techniques analysis for the Identification of key variables (knowledge extraction process)

T4.2 Intelligent process modelling for tool path simulation

Into this task, an Intelligent Process Model (IPM) that predicts the part geometry derived from some specific process parameters will be implemented and validated. The resulting model will be used to generate tool paths that lead to no part geometric deviations.

The intended functionality of the IPM and its expected inputs and outputs will be addressed. Advanced and hybrid Artificial Intelligence (AI) techniques (such as Neural Networks, Genetic Programming and Genetic Algorithms, Knowledge Base Fuzzy Logic Systems, etc.) will be tested and analysed to support the implementation of an IPM prototype/demonstrator.

The preliminary model prototype will provide an in-depth understanding of the application domain, but also an early opportunity for assessing the capabilities of knowledge extraction and AI techniques to implement an IPM for ISF. The results from this study will allow establishing the technique, or group of techniques, which provide the best performance on this context. In a second stage, a fully operational IPM will be established. The knowledge acquisition process will require performing a wide set of forming experiments.

Finally, the resulting IPM has to be validated. The model will support the definition of a set of process parameters and a tool path that allows forming without any die, the specific aeronautic geometry in Ti alloys, without lost of accuracy due to spring back effects.

This task includes the following sub-tasks:

- T4.2.1 Conceptualization of the IPM
- T4.2.2 Generation of process data
- T4.2.3 Artificial Intelligence methods analysis and testing over generated process data
- T4.2.4 Construction of a preliminary prototype/demonstrator of an IPM for ISF
- T4.2.5 Full implementation and validation of the resulting IPM

T4.3 Generalization of model to different shapes

The resulting IPM will be done on the basis of a specific geometry of a real aeronautic part. A CNC tool path is composed by many points, even for small parts. Therefore, the development of a generic IPM to support the definition of the tool path can be addressed if a properly definition of the shaped geometry and the CNC tool path is achieved.

This task takes the elaboration of a methodology for generalization of the IPM to other geometries. Based on lessons learnt a set of recommendations and guidelines will be defined in order to provide the basis to a fast development of a IPM for another part geometries.

3. **Department of Computer Science**

The University of Liverpool is one of the UK's leading research universities with a reputation nationally and internationally for high quality research. In the course of its history the University has been associated with no fewer than eight Nobel Laureates. In the most recent (2008) UK Research Assessment Exercise (RAE) 75% of research conducted within **The Department of Computer Science** was rated as 4* or 3*, and the proportion of world-leading research publications was the third highest in the UK.

The Department has a research-active Data Mining group and significant experience in the development of intelligent systems. As one of Merseyside's largest employers, The University of Liverpool is a major source for innovation and plays a key role in the economic development of the region in terms of employment, skills, research and technology.

The holidays and hours of work will be by arrangement with your supervisor.

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