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Re: Report on the Industrial Training of student Juan Pedro Roldán.

OVERVIEW. Cell and tissue dynamics is central to a vast number of significant biomechanical processes in developmental and cellular biology like morphogenesis, cancer metastasis and tissue repair. In all such processes, physiological epithelial function requires cell force generation and stress transmission to create, sustain and coordinate motion at tissue level and, thus, prevent the insurgence of pathological biomechanical function. In order to infer forces from biological tissues having known (or assumed) mesoscale material properties we must be able to retrieve tissue deformations from time-lapse in vitro or in vivo images of biological processes. The goal of Juan Pedro during his Industrial Training with us at the Institute for Bioengineering of Catalonia was to implement key new features on a pre-existent FEM code that would allow the computation and characterization of forces driving tissue deformations during the morphogenesis of the *Drosophila melanogaster* embryo – he specifically focussed on the formation of the ventral furrow (tissue folding and cavity ingression) and central nervous system (tissue migration and extension).

OBJECTIVES & TASKS.

1. Development of custom and interactive FEM-code modules to perform inverse analyses on a time-set of tissue strains determined through in vivo microscopy performed on the *Drosophila melanogaster* embryo.
2. Testing how variability in the number of unknown forces with respect to the number of available (known) displacements impacts on the inferred tissue forces.
3. Testing how tissue rheology impacts the inference of tissue forces and possible physical mechanisms driving tissue deformations (purely viscosity vs pure elasticity vs Maxwell or Kelvin-Voight viscoelasticity).
4. Producing user interface and documentation for the code in order to increase its user-friendliness for future usability.

PERFORMANCE. I supervised Juan Pedro during his permanence with us and I can gladly attest the outstanding level of the overall student's performance. Juan Pedro has shown a fast and deep understanding of the theoretical and computational tools he has been working with and developing – he managed to improve and widen the applicability of the force-inference code by bringing it to a whole new stage. He accomplished all objectives we set out for his training programme and we will now be able to conduct further testing to a more advanced level for non-profit research purposes. Thank to this industrial placement, Juan Pedro showed to be able to critically assess the importance of the specifications and requirements of product design, which in this case consisted in the code, its user interface and respective manuals. Also, Juan Pedro demonstrated his commendable learning ability in processing and integrating cross-disciplinary information simultaneously at multiple levels. This is a fundamental skill when carrying out physical modelling (e.g. the PDE's derivation in which the FEM code is based on) for multi-scale biological behaviour (e.g. subcellular, cellular and tissue levels). There are a few minor suggestions I have been bringing to Juan Pedro's attention throughout his Industrial Training, which concern the fundamental importance in his future career of a more thorough planning of progress-meetings and a higher degree of organisation of his working duties to optimise workload distribution. This is indeed one more skill that Juan Pedro could practice thank to this Industrial Placement. All things considered, I reckon that Juan Pedro undoubtedly places himself within the top 5% of his peers and I would not be surprised to see him graduating with the highest marks in your taught-postgraduate degree.

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