

2014-2015 FACULTY GRANTS FOR INTERNATIONAL CONNECTIONS, LU-OIA

Natasha Vermaak, PhD

Assistant Professor of Mechanical Engineering & Mechanics

Summary

- Host: Dr. Rafael Estevez (Letter of invitation attached)
Institut National Polytechnique de Grenoble (Univ. of Grenoble)
Domaine Universitaire, 1130 Rue de la Piscine, 38402 St. Martin d'Herès Cedex, France
- Goal: The purpose of the proposed trip is to enhance and develop collaborations with the Univ. of Grenoble and partners in the area of computational materials design. University level impact will be pursued through the formalization of center and department-based memorandums of understanding for student and research exchange.
- Date: June 7 - 21, 2014
- Cost: \$3,810

Professional and Personal Goals

Traditionally, materials design involves the ability to predict and tailor the properties and responses of a material for a given engineering application while controlling chemistry and processing history. Over the past few decades, materials design has expanded to take advantage of advanced optimization algorithms and methods such as shape and topology optimization. In this approach, "spatial heterogeneity" is controlled such that combinations of materials or of material and space are arranged in configurations and with connectivities that offer enhanced performance. Along with the advance of optimization tools, simultaneously, cooperative feedback with emerging processing and manufacturing methods is required to ensure integrated design optimization. The integration of optimization techniques with materials processing information is a focus of my research. I have recently established a collaboration between the Materials Dept. at the Univ. of Grenoble (R. Estevez, G. Parry, Y. Brechet), the Applied Math Dept. at Ecole Polytechnique (G. Allaire) in Palaiseau, France, and the MEM Dept. at Lehigh (N. Vermaak) to address the interdisciplinary problem of materials-based topology optimization and processing. The team leverages unique expertise and facilities and together we have created level set-based optimization protocols that have already led to a joint publication (in press).

The professional research goal of the proposed visit is to establish the foundation and working outline for a major collaborative international research grant proposal by the team that will be jointly funded by the NSF and the corresponding French agency (ANR – Agence Nationale de la Recherche). The target grant is the NSF-MWN: Materials World Network – Cooperative Activity in Materials Research between US Investigators and their Counterparts Abroad, due November 2014. Intensive discussions regarding the computational scope and most promising processing directions are needed in order to craft a NSF-ANR-MWN program with broad and significant impact in the area of cellular or periodic materials design and fabrication. The proposed trip will allow for these in-depth discussions and developments.

The professional service goal of the proposed visit is to both cement and promote formalized research and student exchange relationships between Lehigh and Univ. of Grenoble centers and departments. For example, the collaboration involves two potential partner centers: Lehigh's Center for Advanced Materials and Nanotechnology (CAMN member N. Vermaak) and Univ. of Grenoble's Center of Excellence for Multifunctional Architected Materials (CEMAM members R. Estevez, G. Parry and CEMAM director Y. Brechet). Grenoble is a pole of European scientific research and it is Europe's nanotechnology capitol. The Univ. of Grenoble is one of Europe's leading technology universities and is ranked as the 2nd engineering school in France; it also has the top rated Materials Science department in France. Recently, the Univ. of Grenoble's Vice President for International Relations, Dr. Jeanne Duvallat visited me and Lehigh (Jan., 2014) and met with several Lehigh administrators, staff, and faculty, including the MSE and ISE Chairs. The

goal is to further these initial discussions towards center-level and department-level memorandums of understanding (MOUs) for student and research exchange. My personal goals for this visit include maintaining my level of fluency in French as this is an invaluable tool in working relationships in France.

Expected Outcomes

Short-term: The short-term goal is to draft a full working outline of a collaborative research proposal for the NSF-ANR-MWN. I will also meet with potential joint PhD students (current Univ. of Grenoble Masters students) in order to identify immediate student exchange opportunities.

Long-term: The long-term goals include securing two-way student exchanges and exploring options for dual-PhDs between LU-MEM and the Univ. of Grenoble. The Univ. of Grenoble would like to establish opportunities for french MS students to do research at Lehigh and to grow their collaborations with US institutions.

Nature of Interaction

The focus of the collaboration is integrating computational optimization algorithm development and materials science understanding of emerging additive manufacturing methods. The visit will enable the team to become more familiar with the combinations of expertise and unique additive manufacturing facilities available at the Univ. of Grenoble and at Lehigh. I will give several research and overview presentations at the Univ. of Grenoble and also within the CEMAM to describe my fabrication facilities and access to facilities at Lehigh, Lehigh's CAMN, engineering departments, LU-OIA resources, and Lehigh's involvement with the US NAMII-National Additive Manufacturing Innovation Institute.

Pre-trip Planning & Preparation

Prior to the proposed trip, I will collect advice and examples for successfully crafting a NSF-MWN by discussing the process with past Lehigh and Univ. of Grenoble NSF-MWN recipients. Together with my collaborators, I will define a detailed agenda for proposal development during the visit and team meetings. This preparation will be achieved via Skype meetings, shared dropbox documentation, and continued email contact. Before the trip, I will meet with Lehigh MSE and ISE Chairs and the CAMN director in order to collect overview information to present to Univ. of Grenoble audiences. With the help of my collaborators, I will schedule follow-up meetings with J. Duvallet and other Univ. of Grenoble center and department heads.

Follow-up Activities

Following the proposed trip, the submitted NSF-ANR-MWN proposal will serve as the foundation for several related proposals to provide Lehigh and Univ. of Grenoble students with international research experiences. We plan to take advantage of US and French-based funding opportunities for student exchange, such as the International Center for Materials Research (ICMR), the US-France Fulbright, Chateaubriand Fellowship, Rhone-Alpes International Cooperation and Mobilities fellowships, and Eiffel Grants. As part of the collaboration, we will continue to pursue joint funding opportunities, co-supervision of graduate students, joint publications, and conference presentations.

Budget

<i>Plane tickets:</i>	\$1,000
<i>This is half of the roundtrip airfare from ABE to LYS (peak time) in order to leverage planned conference travel to Greece (June 4-6, 2014) before the proposed trip to France</i>	
<i>Accommodations (14 nights):</i>	\$710
<i>French university guest housing (Residence Galilée \$ 355/week)</i>	
<i>Meals, local travel, incidentals:</i>	\$2,100
<i>\$ 150 per day based on Dept. of State per diem for nearby Lyon, France</i>	
Total:	\$ 3,810



Grenoble, March 6th 2014.

Subject : Letter of invitation for Dr. Natasha VERMAAK for a visit at University of Grenoble, in June 2014.

Dear Natasha VERMAAK:

It is my pleasure to invite you at the University of Grenoble, laboratory SIMaP (Materials Science department of Grenoble-INP and University Joseph Fourier) for a visit scheduled in June 2014.

During your visit, we will have the opportunity to strengthen and continue the research project on the optimization of structures and microstructures based on level sets techniques you initiated during your post-doc here. In particular, we would like to discuss in-depth our approach to apply for major US-French funding (National Science Foundation (NSF) - Agence Nationale de la Recherche (ANR) Materials World Network (MWN): Cooperative Activity in Materials Research between US Investigators and their Counterparts Abroad). We would also like to discuss ongoing work carried out by a co-supervised master student that we will host between March 17th to July 20th.

Related to the NSF-ANR-MWN opportunity for future collaboration we would like to discuss with you the facilities at Grenoble and Lehigh for 3D printing, identification of cohesive models with digital image correlation and related topics on interface and fracture mechanics. In addition, you will have the opportunity to attend and participate in center and departmental seminars, in which you could benefit from discussion with others scientists and researchers.

Thus, if you could visit us in June, it is certainly the best timing to brain storm on ongoing work and shape future actions.

I hope you could get such opportunity and we will be very happy to host and see you again at Grenoble.

Best regards,

Rafael ESTEVEZ

Professeur de l'université Joseph Fourier de Grenoble.



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