



## NSERC ENVIRONMENTAL DESIGN ENGINEERING CHAIR

### DEPARTMENT OF CHEMICAL ENGINEERING

### ÉCOLE POLYTECHNIQUE - MONTREAL

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École Polytechnique is a leading Canadian Engineering University with an exceptional Chemical Engineering Department located on the Campus of the University of Montréal. Our NSERC Environmental Design Engineering Chair has recently been renewed in the area of **Process Integration in the Pulp and Paper Industry**. We will be executing an exciting research program over the next several years, focusing on product and process design for the forest biorefinery – we are seeking to identify promising strategies that can transform pulp and paper mills into environmentally-friendly and profitable facilities.

We are currently offering an exceptional opportunity for a PDF who would execute leading edge product design analyses for the forest biorefinery, working closely with the Pulp and Paper Research Institute of Canada (PAPRICAN). The detailed objectives for this opportunity are attached.

We are also currently recruiting graduate students to join our research team, preferably at the PhD level but also the MSc level. We have a number of positions available for as early as September 2007, but also for January and May 2008. Students who join the Chair work closely with an industry partner – developing new systems analysis methodologies employing process integration tools to address critical industry needs. We seek to attract tomorrow's research and industry leaders. Fluency in either English or French is mandatory for all applicants. The Chair offers competitive stipends to all incoming graduate students.

The supporting partners of our NSERC Design Chair include the Natural Sciences and Engineering Research Council of Canada (NSERC), Natural Resources Canada (NRCan), and leading pulp and paper companies. For more information on the Chair, please consult our website at [www.pulp-paper.ca](http://www.pulp-paper.ca).

**If this opportunity interests you, please email your CV and a 1-page statement of interest to Professor Paul Stuart: [paul.stuart@polymtl.ca](mailto:paul.stuart@polymtl.ca)**

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## **Paprican Post-Doctoral Fellow Forest Biorefinery Product Design**

### **Overall Objective**

The overall objective of the Paprican Post-Doctoral Fellow (PDF) will be to identify forest biorefinery products having a high potential for success i.e. that are promising from market and competitive perspectives. The PDF will focus specifically on opportunities for products that feed existing mature supply chains; generally but not limited to the replacement of petrochemicals by green organic chemicals including transportation fuels, and building block chemicals through to specialty organics. 4 pulp and paper mill case studies are being proposed, that should be inspired by mill locations in each of Quebec, Ontario, Alberta and BC.

### **General Approach and Project Deliverables**

The PDF will work in close collaboration with two others - one focusing on novel biorefinery products for which there is currently no established market, and the second developing product and supply chain information on the petrochemical industry. This team of 3 PDFs will in turn coordinate with a separate process integration activity planned to evaluate the thermal integration of novel processes within existing pulp and paper mill processes and infrastructure. The basic results of the 4 case studies will be delivered in the form of (preliminary) business plans, contained as appendices to Paprican University Reports (PUR's). 3 PUR's are proposed as follow:

- Results of the first case study,
- Compiled results of the 4 case studies,
- Critical review of the methodology and case study results, and recommendations for biorefinery product design.

This strategy of (hypothetical) business plan development will be used in order to focus the broad range of product design considerations; however the business plans will not comprise commercially-viable proposals. The PDF should ideally be a Chemical or Pulp and Paper Engineer with some business knowledge. His or her work will involve compiling the expertise in biorefinery technology and processes being developed by scientists and engineers at Paprican, with systems analysis and business know-how residing at Ecole Polytechnique. Being university research, the generic methodological results will be published following appropriate internal reviews.



## Product Design Methodology

The NSERC Design Chair at Ecole Polytechnique has developed a systematic **product design** methodology suitable for identifying forest biorefinery products that have good potential from a market and competitive basis, and warrant further investigation. This “rapid market analysis” methodology considers biorefinery **process design** issues, but only in a limited context, i.e. systematic process design activities are not considered such as process simulation, energy efficiency analysis and integration, life cycle assessment, and supply chain management. These analyses are essential for further evaluating the preliminary results identified through this product design work, but will take place subsequently by others.

The overall product design methodology that has been proposed involves 2 overall activities: (a) SWOT and competitive analyses in order to narrow the slate of possible biorefinery products, and (b) BCG (Boston Consulting Group is an investment and diversification decision-making matrix) analysis and business plan development based on specific mill and company scenarios. The rapid market analysis methodology developed in the Chair has not been tested in a mill-specific, concrete manner. The PDF will accomplish this objective in 4 case studies and in close collaboration with the other PDFs working in related areas. The PDF will review work already accomplished in the NSERC Design Chair relative to activity (a), and will implement in detail methodology (b) for the 4 case studies.

More specifically, the PDF will address the following activities:

- Understand the rapid market analysis technique developed in the NSERC Design Chair, and previous preliminary work related to its implementation, as well as conventional methods for identifying markets and products,
- Review and revise results from the completed SWOT and competitive analyses in the context of the first case study,
- Gather preliminary product and process information regarding the first case study through close interaction with Paprican and mill personnel:
  - Feedstocks from mill operations,
  - Potential additional feedstocks, e.g. agricultural, biomass...
  - Promising biorefinery process pathways, i.e. chemical, biochemical, and thermochemical,
  - Potential product range for candidate biorefinery processes,
  - Likely process yields,
  - Production scenarios, i.e. potential by-product range.



- Complete order-of-magnitude mass balances for the first case study, in order to identify potential sources of carbon feedstocks from the mill processes and surrounding region; feedstocks available to a number of other mills may also be included where the study mill is considered atypical,
- Refine the order-of-magnitude balances considering the SWOT/competitive analyses, the specific mill context including regional and broader markets, as well as process uncertainty information from the literature and Paprican,
- Examine the current mill logistics for feedstock and product, and the changes implied by different product strategies in order to systematically identify opportunity for synergies,
- Determine the current market share and turnover of potential biorefinery products, in order to define a strategy of investment and diversification by identifying new product range activities, and to address the BCG Matrix,
- Examine likely market trends and market penetration strategies for different product scenarios including such factors as pricing, market pressures, growth/demand, etc.
- Using order-of-magnitude capital costs, determine an investment strategy for the short, mid and long term relative to the production scenario and the product range strategies,
- Develop the hypothetical business plan for the biorefinery including the following (addressed systematically but in a preliminary manner) in order to identify key issues:
  - Business profile and objectives definition,
  - Marketing plan,
  - Operating plan,
  - Financial plan,
  - Action plan.
- Involve Paprican, the participating mill, and other stakeholders in a critical review of the first case study results,
- Summarize the findings in the first PUR resulting from this work,
- Address the remaining 3 case studies and PUR's.

After initial activities have been completed at Ecole Polytechnique related to the first case study, it is anticipated that the PDF will spend time at Paprican in order to interact directly with researchers involved in the development of the forest biorefinery.



### Timeline and Collaborating Mills

It is anticipated that the first case study will require 9 months to complete, and each subsequent case study (all to be executed in parallel) should require 3-4 months of effort.

<b>Case Study Province</b>	<b>Anticipated Level-of-effort</b>
Ontario	9 months
Quebec	4 months
Alberta	4 months
British Columbia	4 months