# The Real Options Approach to Risk Management

**Responsable du projet :**

**Pierre Lasserre**
(CIRANO), Département d'économique, UQAM
Tél. : (514) 987-3608
Fax : (514) 987-8494
Courriel : lasserre.pierre@uqam.ca

**Andrey Pavlov**
(CIRANO - nouveau chercheur), Finance Department, Concordia University
Tél. : (514) 848-2919
Fax : (514) 848-4500
Courriel : apavlov@mercato.concordia.ca

**Chercheurs principaux :**

**Marcel Boyer** (CIRANO) Dép. de Sciences économiques, Univ. de Montréal
**Peter Christoffersen** (CIRANO - nouveau chercheur), Faculty of Management, McGill Univ.
**Gérard Gaudet** (CRT - chercheur associé), Dép. de sciences économiques, Univ. de Montréal
**Jean-Yves Trépanier** (CERCA), Dép. de Génie mécanique, Ecole Polytechnique de Montréal

## Description du projet

**Importance and Relevancy of the Project** :
A real options approach to management considers strategic decision making as a process to actively reduce exposition to downside risk and to actively promote exposition to upside opportunities. From a research point of view, real options stand at the hinge between pure finance and softer areas of decision making under risk such as project evaluation, market entry and exit, organizational restructuring and re-engineering, technology adoption, etc. The approach underlines a frame of mind and uses methodologies that appeal to a wide array of researchers, thus providing a common language. Real options have applications in many areas that are central to our research centers (CIRANO and CERCA) and other partners in rcm2 : economics, finance, health management, technology management, etc. The approach represents a major shift in strategic management but remains relatively unknown in spite of its adoption by firms such as Airbus, GE, Hewlett Packard, Intel and Toshiba (see 2000: Business Week June 7, Financial Times May 9, Forbes May 5 and 29, WSJ Feb 22 and 24).

**Specific Objectives :**

*Methodology*. Each component of our project (see below) has its own methodological contribution. The plant portfolio model provides a bridge between the real options view and the neoclassical view of technological and organizational flexibility. It uses numerical dynamic programming methods to find the value of acquiring a specific new technology or production unit, given an existing plant portfolio. The site rehabilitation model emphasizes decision tree analysis with precise engineering data combined with optimal starting and stopping decisions at various nodes. The reservoir management model adapts least-square Monte-Carlo simulation procedures to a real asset management context.

*Knowledge transfer*. The above methodological developments use and adapt existing knowledge creatively. They require multidisciplinary work and collaboration with potential users and will permit knowledge transfers between researchers with different specialties (economics, finance, OR, computer science, management) as well as transfers between researchers and corporate managers.

*Education and training*. Each project component is advanced but well defined and has been designed in such a way that Ph. D. and M.Sc. students can appropriate themselves the topic. We expect that at least two Ph.D. students and two M.Sc. students will write their theses and dissertations within the project.

**Themes** :

The following three variations on project evaluation and risk are presented from the most applied to the most theoretic. They do not constitute an exhaustive list of topics the team will consider.

*Site remediation.* This sub-project uses stochastic dynamic programming to optimize the level of remediation eventually achieved and the choice of techniques, as well as the amount of information collected at various stages. The program will identify each step and characterize each decision in terms of its probabilistic effect on the state variables, its cost, its information content, its degree of reversibility or flexibility. Although site specific, the software developed for the project and the work methods used in the process (especially the cooperation between engineers, various scientists, and economists) will be transferable to other projects.

*Reservoir management under climate and market uncertainty*. To exploit demand and supply (technology) differences, variations and complementarities, Hydro-Québec can exploit its built-in technological flexibility to buy electricity from the US and thus to reduce production when power is cheap (at night when US thermal plants cannot be shut down and in winter when there is excess thermal capacity) and to sell when power reaches high prices. The price at which HQ should switch from being a seller to being a buyer depends on water reserves: when reserves are low, the opportunity cost of producing hydro power is higher. In fact, uncertainty about replenishment rates and future domestic demand implies that HQ is exposed to the risk of not being able to serve its customers if it lets water reserves become too low. There is an arbitrage between that risk and immediate profits. The methodology for addressing that problem is stochastic dynamic programming. However, the complexity of the problem is such that it is very difficult to obtain the value function explicitly. We will adapt the Monte Carlo method developed by Brennan and Schwartz in a financial option context (Longstaff, F. and E. S. Schwartz, “Valuing American Options by Simulation: A Simple Least-Squares Approach”, mimeo, UCLA 1998). The project will also provide dynamic shadow prices for reservoirs, that can be used for new reservoir project evaluation.

*Plant portfolios, flexibility, and the value of new projects.* Real options theory has stressed the role of uncertainty on project value. We want to explore how the effect of uncertainty on the value of a given project is affected by the existing portfolio of technologies in place. The evaluation of a new "plant" development project should yield different results, other things being equal, when the new plant is explicitly considered as an addition to an existing portfolio of "plants", in the firm itself and in the industry as a whole (preemption and signal extraction motives under asymmetric information in specific strategic competition frameworks). The evaluation of a new aircraft project for instance requires real option evaluations. The "Multidisciplinary Design Optimization (MDO)" project (with Bombardier) at CERCA is a project which involves a series of option-like design decisions. We will develop models of real options for successive investments in alternative technologies. The treatment will be theoretical but we know that analytical solutions will not be reachable so that numerical solutions will be developed. Extensions of the project will include not only applied evaluation procedures of plant portfolios and of plant projects given existing portfolios, but also such applications as the valuation of biodiversity or valuation of new medications or medical treatment techniques.
partners the value of well designed and well focussed University-Industry collaboration and alliances.