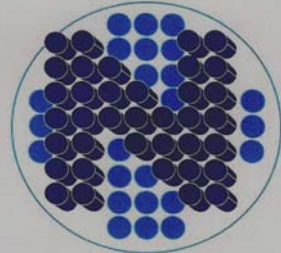


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University Network of  
Excellence in Nuclear  
Engineering

# Industry, university and government partnership to address research, education and human resource challenge for nuclear industry in Canada

**Mohan Mathur, Ph.D., P.Eng., FCAE**  
President and CEO  
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<http://www.unene.ca>



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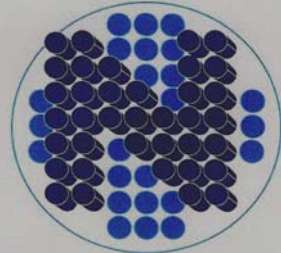
# Background

In unfolding nuclear renaissance  
our challenges are to:

- replenish retiring workforce
- keep aging plants fit for service
- execute smart plant life extensions
- select and implement new nuclear generation technologies
- use preferred suppliers for special services

***Therefore, the entire nuclear industry needs a dependable supply of bright, intelligent, well educated and skilled professionals.***

This paper is about university educated professionals



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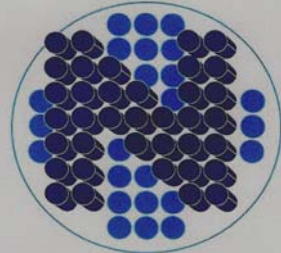
# What is UNENE?

UNENE is an industry driven initiative to create an alliance of prominent Canadian universities and nuclear industry.

## Board of Directors

- Research Advisory Committee
- Education Advisory Committee

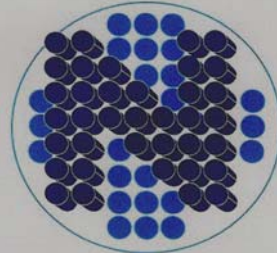
This alliance attracts government support on a case-by-case basis



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# Objectives

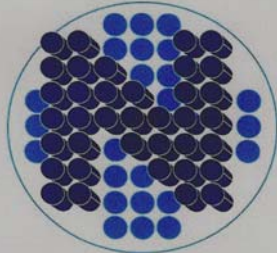
1. To assure a dependable supply of highly qualified personnel needed for ensuring nuclear safety and achieving performance excellence
2. Reinvigorate university – based, mid to longer term research by investing in it in cash and in kind
3. Create a pool of arms-length experts accessible to public for advice and consultation



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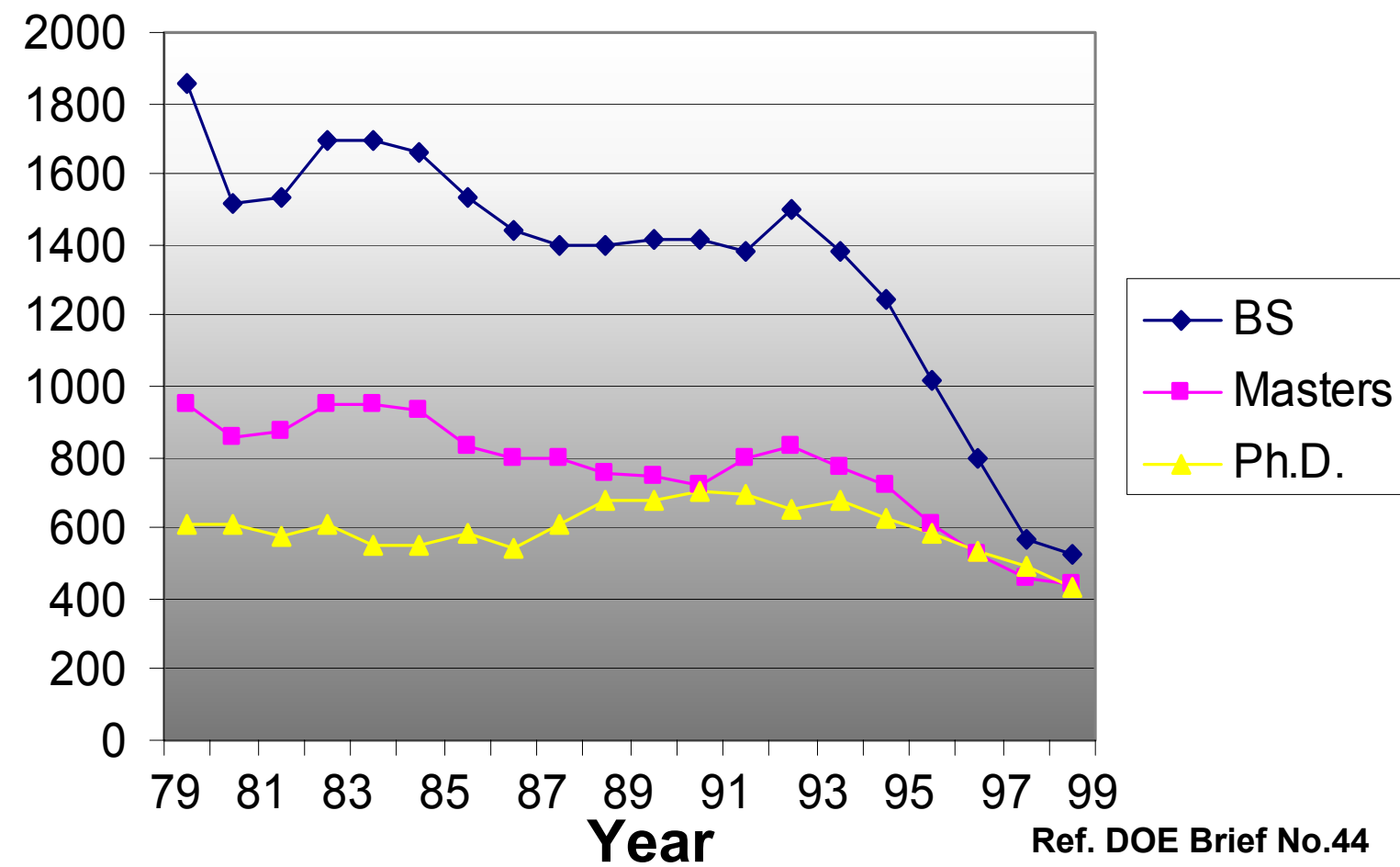
# Why do we need UNENE?

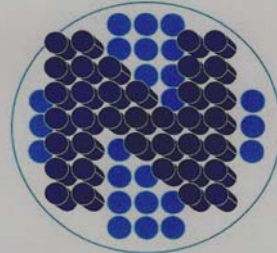
- During the last two decades Canadian nuclear industry has neither invested appropriately in university-based research nor hired many graduates. Consequently, nuclear programs have weakened and the numbers of professors and students pursuing nuclear research have dwindled.
- There is an inadequate supply of nuclear engineers and scientists to meet the current demand and mitigate forthcoming retirement of nuclear experts.
- Canadian public needs trustworthy information on safe application of nuclear technology, its environmental considerations and waste management.



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# Nuclear Engineering Enrollment in US Universities

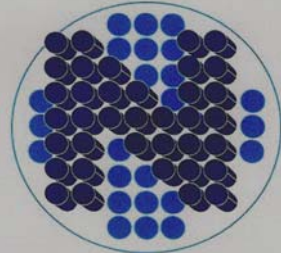




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# Strategy (win-win-win)

- Build on partner strengths and interests
- Strengthen university resources
  - Add world-class researchers on the faculty of selected universities because professors attract bright students to pursue research based Masters and Doctoral degrees
  - Reinforce nuclear research by funding projects proposed by existing faculty
  - Persuade universities to leverage government funding to match industry investment
- Concentrate on graduate programs
  - Offer a joint course-based M. Eng. Degree for professional upgrading of industry employees
  - Support students pursuing Ph.D. and M.Sc. degrees
- Ensure active university-industry Collaboration
- Make university expertise accessible to graduate students, industry and public

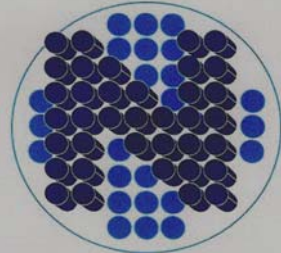


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# Industry Membership

## Industry Partners:

- Ontario Power Generation (OPG)
- Bruce Power (BP)
- Atomic Energy of Canada Limited (AECL)
- CANDU Owners Group (COG)
- Canadian Nuclear Safety Commission (CNSC)
- Nuclear Safety Solutions (NSS)



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# University Membership

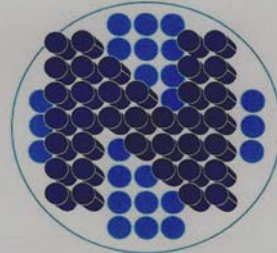
- **Universities**

- McMaster University
- Queen's University
- University of Toronto
- University of Waterloo
- University of Western Ontario
- University of Ontario Institute of Technology

- **Other universities**

- Ecole Polytechnique
- University of New Brunswick

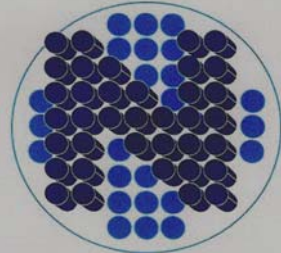
Royal Military College participates in partnership with Queen's



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# University Research Areas

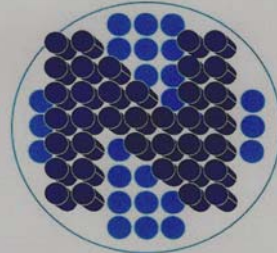
- **McMaster: Nuclear Safety Analysis**  
(Dr. John Luxat, + Junior Chair)
- **Queen's: Nuclear Materials**  
(Dr. Rick Holt, Associate Chair Dr. M. Daymond)
- **Toronto: Nano-Engineering of Alloys**  
(Dr. Roger Newman)
- **Waterloo: Risk-based Life Cycle Management**  
(Dr. Mahesh Pandey + Junior Chair)
- **Western: Control, Instrumentation and Electrical Systems:**  
(Dr. Jin Jiang + Junior Chair)  
**Nuclear Chemistry (Dr. David Shoesmith)**
- **UOIT: Knowledge Management (Application under preparation)**
- **Ecole Polytechnique: (Dr. Daniel Rozon, Dr. Michel Pettigrew)**
- **New Brunswick: (Dr. Derek Lister)**



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## Other Research

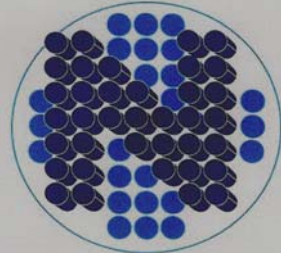
- About 11, 3 year projects, proposed by existing university faculty from any Canadian university will be funded at approx. \$180,000/project. UNENE funds will be matched by NSERC through Collaborative Research and Development grants. In addition to research output these projects primarily support Masters and Ph.D. candidates.



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# Educational Programs

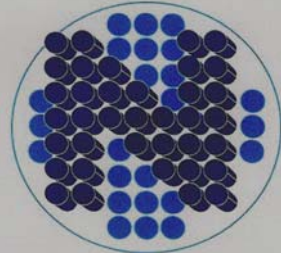
- Part-time Studies: Accreditation application for a Joint M. Eng. Degree in Nuclear Engineering has been submitted to OCGS. **Currently 28 students are registered in the program and 4 courses have been delivered.** The program is delivered by faculty from UNENE universities. In steady-state 15-20 graduates are expected each year.
- Full-time studies: Each Chair-holder and other professors supported by UNENE will supervise research-based Masters and Doctoral students. Approx. 3 Post Doctoral Fellows, 6 Doctoral and 18 Masters graduates are expected each year. **Current registration: 6 PDF; 8 Ph.D. and 13 Masters candidates**



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# Special Features

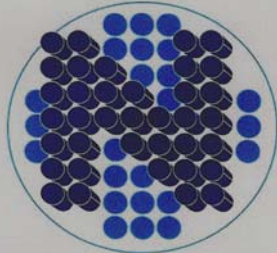
1. Industry - the major stakeholder, is the driving force
2. Quality assurance is provided by NSERC and OCGS accreditation
3. Industry, university, student and government interests are well looked after
4. No single university is able to provide sought services
5. Brightest candidates are attracted to nuclear industry



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# Summary

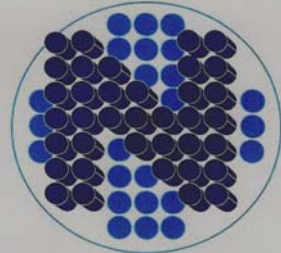
- UNENE has successfully created an alliance of prominent Canadian universities and nuclear industry to reinvigorate university-based research and training of highly qualified nuclear engineers and scientists.
- UNENE seeks new industry members and greater investment from government in support of its activities.
- UNENE is a Canadian initiative addressing a challenge confronting nuclear industry worldwide and expects to collaborate with WNU, ENEN, ANENT and US universities.



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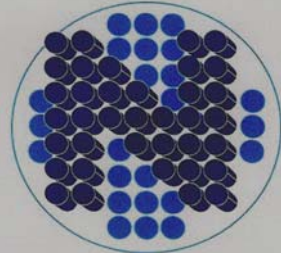
# Background Information



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# M. Eng. In Nuclear Engineering

- **Courses delivered:**
- UN0802 Reactor Physics
- UN0801 Nuclear Plant Systems and Operation
- UN0803 Nuclear Reactor Safety Design
- UN0804 Reactor Thermal-hydraulics.

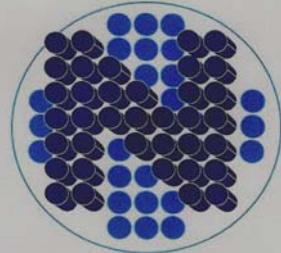


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# Industry Membership

Two types of memberships of UNENE are available:

- Voting Membership is granted with a minimum contribution of \$1.5M over 5 years. These members enjoy preferred IP rights
- Non-Voting Membership is granted for \$30,000/yr annual fees. These members attend all Board and Member business meetings and provide input to Research and Education Committees

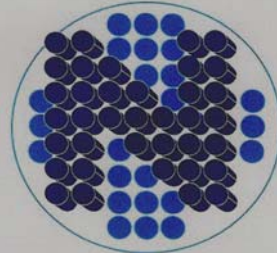


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# UNENE Organization

- Board of Directors (9 voting and 5 non-voting members)
- Officers:
  - President, Dr. Mohan Mathur
  - Secretary/Treasurer, Dr. Bill Garland
- Committees:
  - Research Advisory Committee
  - Education Advisory Committee

Web sites: [www.unene.ca](http://www.unene.ca)



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# First Phase Funding

- **Funding (first phase - 5 years)**

OPG: \$5.0 M; BP; \$1.5M; AECL: \$1.5M

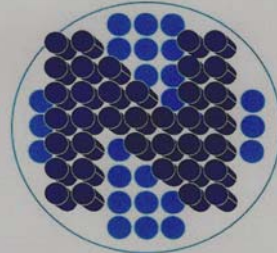
COG: \$0.5M; CNSC: \$150K; NSS: \$150K; NuTech: \$100K

**NSERC: \$5.119 M, Other grant applications are being processed**

(Not including support for Nuclear Waste Chemistry, UNB and Ecole Polytechnique Chairs)

- **Other Industry Support:**

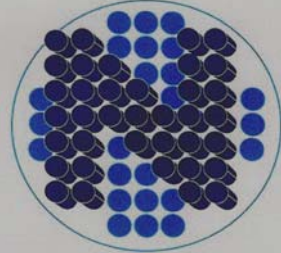
- Equipment, software, data, e-learning material
- Guest lecturers, joint supervisors
- Research opportunities for faculty and students
- Contacts for each IRC, advisory committees
- Training and classroom facilities



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## University Status, US Data

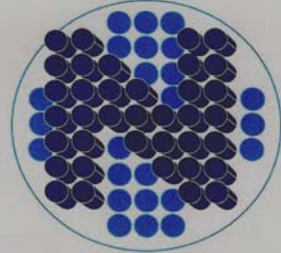
- The number of Nuclear Engineering programs (48) peaked in 1972-73
- The number has thereafter gradually dropped to 50% (24) in 2000
- The number of university reactors has dropped from 65 to 30
- Enrollments have recently been increasing
- DOE invested Approx. \$30M in 2002
- New House Bill introduced in March 2004 to invest \$183.7 M from 2005 to 2008



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# IRC Research Topics - 1

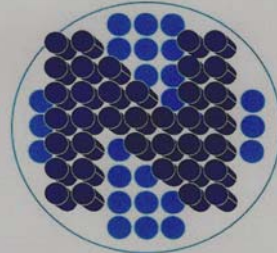
- Dr. Rick Holt (Queen's): Nuclear Materials
- Control of microstructure/texture of zirconium alloy tubes; Experimental study of anisotropy and deformation of zirconium alloys; Modeling anisotropy and deformation of zirconium alloys; Effects of deformation on plastic instability and failure; Improvements in measurement of crystallographic texture; Micro-structural characterization and qualification; Experimental study and modeling of macro- and microscopic stress and strain development during manufacture and evolution during service; Theory of radiation damage and in-reactor deformation.



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## IRC Research Topics - 2

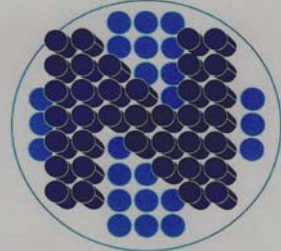
- Dr. Jin Jiang (Western): Control, Instrumentation and Electrical Systems.
- Fault detection/isolation and control loop stability monitoring/enhancement; Probabilistic based maintenance optimization for control and instrumentation systems; Applications of distributed control systems in CANDU power plants; Load-following control of CANDU power plants; Enhancement of training simulators for engineering applications.



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## IRC Research Topics - 3

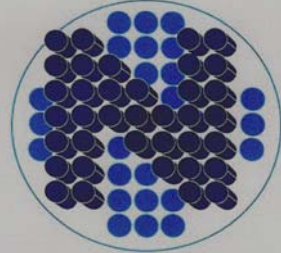
- **Dr. Mahesh Pandey (Waterloo): Probabilistic-Based Life Cycle Management**
- Assessment methods: Probabilistic models of load and resistance variables; Mechanics-based failure models; Digital image analysis for condition assessment; Reliability estimation models and computation methods.  
Management models: In-service inspection models; Maintenance plans and repair technologies; Decision analysis.  
Maintenance optimization strategies



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## IRC Research Topics - 4

- **Dr. John Luxat (McMaster) Nuclear Safety Analysis**
- Best estimate and uncertainty based nuclear safety analysis; vapour generation and boiling heat transfer; modeling dryout, post-dryout and quench processes; thermal-mechanical behavior of reactor components at high temperature accident conditions; computational fluid dynamics models for two-phase flow



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## IRC Research Topics - 5

- **Roger Newman (Toronto): Nano-engineering of Alloys for Nuclear Power Systems**

Mechanisms of oxidation and cracking in hot water under reducing conditions; Alloy design for corrosion resistance; Building on atomistic understanding to promote favorable interface structures; Exploiting alloy corrosion processes for the fabrication of useful nano-structured materials; Corrosion and stress corrosion research for Canadian nuclear industry