Reinvigorating University-Based Nuclear Education and R&D

Dr. Bill Garland garlandw@mcmaster.ca

Exec. Dir, of UNENE www.unene.ca
Acad. Dir. of CANTEACH http://canteach.candu.org
Prof. of Nuc. Eng., McMaster Univ. www.nuceng.ca

Background

- World is experiencing a nuclear revitalization.
- Details aside, it is clear that we need to address the gap between the intellectual capital that we have in place and what we will need.
- Given the lead times involved in ramping up the knowledge sector, this is an immediate issue.
- Path forward is uncertain for any one company to make solid commitments to new hires.
- This has translated directly, in the minds of potential nuclear students, into an uncertain career path and, consequently, sluggish enrolments in colleges and universities.
- Collectively, the trends are strongly positive.

Challenges

- Technological complexity and challenges are there as always.
- Demographical challenges are immense.
- The supply of bright and qualified engineers and skilled trades people are inadequate.
- Restructured electricity sector has diminished in-house capacity for professional development.

The unfolding nuclear renaissance

- **Canada has joined 10 other countries to develop advanced nuclear reactor systems (Gen IV)**

- **AECL is marketing newly developed ACR systems**
- **Canadian utilities are returning shut down plants to service and keeping aging plants fit for service to meet the electricity demand**
- **Search for smart plant life extensions continues**

Conclusion: the entire nuclear industry needs a dependable supply of bright, intelligent, well educated and skilled professionals on all levels to meet the current and emerging demand.

Scale and Perspective

- On the positive side, we are witnessing a number of local and international gatherings to address this issue.
  - Canada/UK skills initiative, CNA workshop, ESC meetings, NEWG, …
- At these meetings a number of activities for cooperative exchanges have been identified.
- Need to provide scale and perspective if we are to keep these activities properly directed.
- What is the over-riding theme that can keep us centered?

It is self evident…

- We can all agree on the desirability of access to energy supply as an underpinning of society. It powers our ability to provide stability, safety, security, …
- We all see nuclear as a significant component of the supply mix. **That is our center**.
- We also can all agree that intellectual capital is one of our main assets and that it is in limited supply for a number of reasons (demographics and competition from other industrial sectors to name just two).

Presentation Objective

- Identify the gaps.
- Explore how to close the gaps.

The Gaps

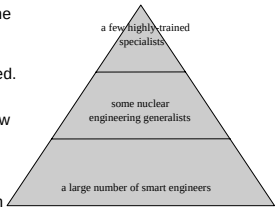
- Ad hoc gap analysis tells me there are at least 3 dimensions to the gap between where we are and where we want to be:
  - **Demographic:** there is a distance between the current age profile and a healthy age demographic for succession planning.
  - **Institutional:** there is a distance between what universities produce and what industry needs.
  - **Geographic:** there is a distance between people geographically.

The Demographic Gap

- The demographic gap spans most countries and sectors.
- Much of the intellectual capital we need is non-nuclear.
- Need to coordinate with non-nuclear sectors, else we have an unhealthy competition for this scarce resource.
- We have the institutions and mechanisms to handle skill-based training (but we need more of it).
- The universities are also doing a good job at the research level (but we need more of it). We just need to fund more exchanges between universities and industry and between countries.
- Let's get the machine going without regard for where these people will end up.

The Demographic Gap

- We need that feed stock to create nuclear welders and the bigger and better the feed stock, the easier it will be to generate the nuclear grade welders that we so sorely need. Ditto for generating that rare Ph.D. in nano-corrosion. We need good undergrads to draw from.
- As a colleague recently observed, let's make the existing pie bigger rather than try to get a bigger piece of the existing pie.



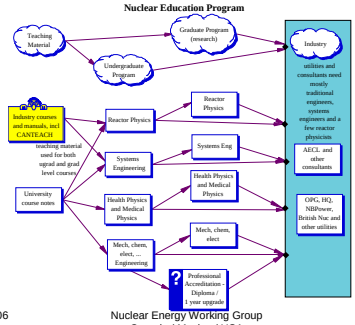
The Institutional Gap

- Universities traditionally provide broad-based degrees at the undergraduate level and specialized education at the graduate level.
- Industries typically hire from the traditional disciplines and then train them for the specifics of the job. This leaves a gap: there is currently a limited path forward for the professional development of the working professional who is not so academically inclined.
- These are often the best engineers in the field but they do not qualify for graduate school.
- Perhaps more to the point, graduate school will not give them the skill set that they need anyway.

Professional Development

- 'Nuke-ify' our good engineers by a series of workshops or courses at the undergraduate level. Chem engineer -> nuclear engineer.
- Many of the courses should be of the type found in company internal training courses and in nuclear specific undergraduate level courses.
- Companies should share these courses. Again, let's not worry about where these people might end up.
- Think bigger pie.

What's the education situation?



What's the problem?

- Professionals come from the universities
  - Inadequate preparation for industry
  - Research emphasis over development and teaching
  - Lack of systems approach
  - Self-reinforcing myopia
  - No upgrade path for C students
  - Grades not a good measure of the person
  - System shuts out and destroys people
- University is not going to change its mandate or structure for industry
  - It is answerable to the public, not to industry

Where is industry in all this?

- Industry is faced with a huge hiring and expertise gap problem
  - They cannot afford the training cost
  - Industry time horizon is too short
  - Industry cannot give accredited courses
  - Big mismatch between what industry needs and what universities supply

What do we need?

- We are not going to change industry or the university mandates.
- Therefore, need
  - Access to information
  - Professional development upgrade path
  - Access to mentors and apprenticeship
  - Better measures of the person
  - Remedial programs
  - Bridging programs

The Geographic Gap

- Should decide on a common shared whiteboard / VOIP platform so that an expert in Mexico can give a course to students in Canada,
- The lives saved alone warrants the expense.
- Use of the Tablet PC and Lecture recording (via BB Flashback for instance) is cheap, works and is a good start.
- Again….bigger pie.

Sharing Our Strengths

- Thus we have:
  - a heading,
  - a broad measure of the gaps,
  - and a broad sweep of how we might collectively close the gaps.
- But, sweeping statements does not give us a bigger pie to share.
- Allow me to outline a few 'bigger pie' initiatives that I am directly connected with.

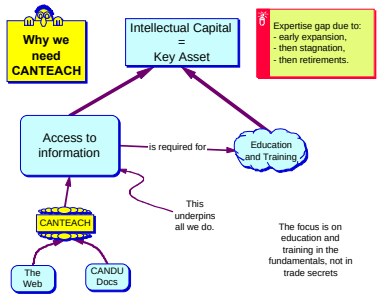
Canadian Initiatives

- In Canada, we have these uncoordinated nuclear elements:
  - CANTEACH – an open CANDU document repository (2001)
  - UNENE – a nuclear centre of excellence (2002)
  - NUCENG – an university based portal and repository (1998)
  - CNS – a society of nuclear individuals (conferences, bulletin, …) (1979)
  - COG – an industrial consortium of operators and designers (1984). Sponsors CANTEACH and member of UNENE

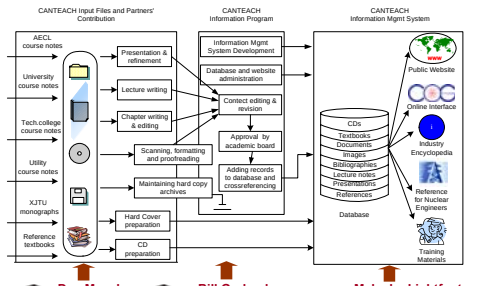
CANTEACH

- **Mission** To preserve technical knowledge of CANDU nuclear-electric generating system for use by present and future members of the CANDU community.
- **Mission** To provide educational and training material for Highly Qualified Personnel.
- Thus target audience is primarily at the level of the working professional.
  - ***NOTE:*** ***<u>This target, as it turns out, leads to the identification of a serious problem that needs to be addressed.</u>***
- Aimed at capturing Know-how and Know-why.

CANTEACH Justification



CANTEACH

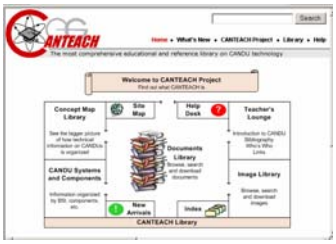


Current CANTEACH Focus

- Database access
  - Scripting
  - Keywords
- Knowledge Acquisition
  - Steam Generator expert interviews
  - Nuclear Fuel expert interviews
- Document acquisition
  - Ontario Power Generation (older training courses)
  - CNSC (regulator) (new training material)
  - Chulalongkorn University courses
- Image database
  - Extraction and presentation of images in documents, etc.
- Recent paper:
  - Why it makes sense to give stuff away.

CANTEACH Web Site Tour

http://canteach.candu.org



Some issues

- Document acquisition hampered by
  - Unavailability of experts (too busy, too decayed, too retired…)
  - Unavailability of documents (lost, hidden, …)
  - Unwillingness to release documents (IP, security, expertise self-protection, …)
  - Unavailability of people to do knowledge acquisition (we have other full time jobs, …)

UNENE

University Network of Excellence in Nuclear Engineering

- CANTEACH is about info. Low budget ($150k/yr)
- UNENE is about delivery ($3M/yr).
- UNENE generates Highly Qualified Personnel.
- Hope to make CANTEACH the repository for UNENE.

What is UNENE?

- UNENE = University Network of Excellence in Nuclear Engineering
- UNENE is an industry driven alliance of prominent Canadian universities and nuclear industry
- It is created to assure a dependable supply highly qualified personnel needed for innovation in nuclear generation while ensuring nuclear safety and achieving performance excellence
- It is reinvigorating university – based, mid to longer term nuclear research and adding new faculty

UNENE has three distinct objectives:

- Enhance the supply of highly qualified graduates in nuclear engineering and technology.
- Reinvigorate university-based research and development in nuclear engineering and technology focusing primarily on mid to longer term research.
- Create a group of respected, university-based, nuclear experts for public and industry consultation.

Current UNENE Focus

- 5 new professors installed (Industrial Research Chairs)
  - Need to ensure that research activities and products are archived.
- Joint Master's Degree (course based)
  - Course material is being captured; some lectures are recorded.
  - Gaining experience with modular format → web casting to come.
  - Access restricted to people with good academic marks.
  - Professional Development gap identified.
  - Remedial courses needed.
  - Course needed on modelling. Incorporate JUMP lessons.

Activities

- Through UNENE funds, 13 new, world-class, faculty members have been added in member universities
- Funds are provided to faculty members for nuclear research and graduate assistantships
- Courses and expertise of one university are made available to students from other universities
- UNENE member universities are offering a joint course-based M. Eng. Degree for the professional development of employees, in particular new hires
- Government funds have been received to match industry investment in universities

Current Industry Membership

– 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)

University Members

– McMaster University
– Queen's University
– University of Toronto
– University of Waterloo
– University of Western Ontario
– University of Ontario Institute of Technology
– Ecole Polytechnique
– University of New Brunswick
– Royal Military College
– University of Guelph

First Phase Funding

•Cash Funding (first phase)
Industry: $ 7.8 M
Universities: $ 0.81 M
NSERC: $ 7.12 M (estimated)
(Not including other nuclear research chairs and programs)

•Other In-kind Support:
Industry and Universities: $4.97M

➢ **Total impact ≥$20.7M**

University Research Areas

- **McMaster: Nuclear Safety Analyses and Thermal Hydraulics (Dr. John Luxat, Associate Chair Dr. Dave Novog)**
- **Queen's: Advanced Nuclear Materials (Dr. Rick Holt, Associate Chair Dr. M. Daymond)**
- **Toronto: Nano-Engineering of Alloys (Dr. Roger Newman + Junior Chair)**
- **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: Health Physics and Environmental Safety (Application under preparation)**
- **Ecole Polytechnique: (Dr. Daniel Rozon, Dr. Michel Pettigrew)**
- **New Brunswick: (Dr. Derek Lister)**

Other Research

- About 11, 3 year projects, proposed by existing university faculty from any Canadian university will be funded at approx. $90,000 each from UNENE and these funds will be matched by NSERC through Collaborative Research and Development grants.
- In addition to research output these projects will support Masters and Ph.D. graduate students.

Educational Programs

- Professional Development: Joint M. Eng. Degree in Nuclear Engineering has been accredited by OCGS. Currently about 25-30 students are active. The program is delivered by faculty from UNENE universities.10-12 graduates are expected each year.
- Full-time studies: New and continuing professors, supported by UNENE, supervise research based Masters and Doctoral students. Approx. 90 Masters, 30 Doctoral and 15 Post Doctoral people will be trained in the first phase. Currently 10 doctoral, 16 masters and 10 postdoctoral candidates are registered.

UNENE

- UNENE has created an alliance of prominent Canadian universities and nuclear industry to reinvigorate university-based research and train highly qualified nuclear engineers and scientists to meet current and future challenges.
- UNENE seeks greater investment from government in support of its activities.
- UNENE is a Canadian initiative addressing a human resource challenge confronting nuclear industry worldwide and is seen to be a leader by US, IAEA and WNU.

UNENE Web Site Tour

http://www.unene.com

NucEng

Nuclear Engineering at McMaster University+

- CANTEACH is about info.
- UNENE is about delivery.
- NucEng is about students.
  - Courses
  - Who's Who
  - Careers
  - Links
  - Forums and List servers

NucEng Web Site Tour

http://nuceng.mcmaster.ca

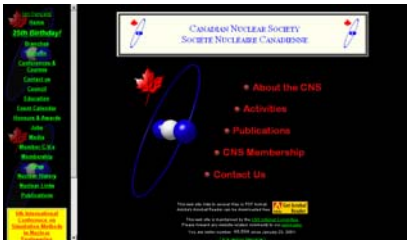
CNS

Canadian Nuclear Society

- CANTEACH is about info.
- UNENE is about delivery.
- NucEng is about students.
- CNS is about professionals as individuals.
  - Seminar type courses
  - Conferences
  - Fellowship and contacts
  - Forums and List servers

CNS Web Site Tour

http://www.cns-snc.ca



COG
CANDU Owners Group

- CANTEACH is about info.
- UNENE is about delivery.
- NucEng is about students.
- CNS is about professionals as individuals.
- COG is about industrial partnerships in R&D
  - Shared R&D cost
  - Shared R&D facilities
  - Creation of and access to closed information databases

COG Web Site Tour

www.candu.org

Where does a portal fit in?

- The portal needs to provide access to information on
  - Documentation (technical and otherwise)
    - IP issues – standardizations?
    - Security protocols?
  - Education and training programs
    - Emphasis on professional development
  - Information on education and training opportunities such as
    - Scholarships
    - Reciprocal agreements and exchanges
    - Etc.
  - Promotion of International accreditation
    - Provide information on what we should measure, etc.
  - Web enabled learning

A Worldwide Solution?

- The IAEA Nuclear Knowledge Portal is attempting to
  - Provide access to technical information
  - Provide access to information to help address structural issues like
    - Document acquisition
    - University – industry programs and problems
- Roll out of the portal seems mired.

Barriers?

- One barrier to bridging these gaps is the concern for security on a national and institutional level.
- Solution: limit our collective efforts to base level education, training, research and development.

Incentives

- The best solution to security issues is to build a community, ie to widen the circle of trust.
- Shared experiences and joint efforts are the stuff of understanding, respect and trust.
- The process of bridging the gaps is as important as the solutions they enable.

Conclusion

- Have demographic, institutional and geographic gaps
- The gaps can be bridged by activities like the few mentioned above.