Elements of a Sustainable Educational Experience in Nuclear Security and Safeguards

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Oregon State University
Nuclear Science & Engineering

• PhD/MS programs Health Physics & Nuclear Engineering
• 10 Core Faculty/ 4 Research faculty
• 127 Grad Students
• 208 Undergraduates
• OSU Radiation Center
  1.1 MW TRIGA Reactor
• Thermal hydraulics, advanced reactor design, radioecology, detector development, radiation transport methods, radiochemistry, nuclear security and nonproliferation
Facilities

- Integral Test Facilities
  - APEX (AP1000 scaled model)
  - ATHRL (NuScale NIST Prototype)
  - ANSEL (Adv. Nuclear Systems Engineering Lab)
    - High temperature gas reactor test facility
    - Hydromechanical Fuel Test Facility
- LIFT laser imaging lab
- Radiation detector development labs
- Digital instrumentation labs
- TRULab (radiochemistry)
- Radioecology greenhouse
- D-T source / Detection lab *in process
NNSA–NA22 Radioxenon Detection
A. Farsoni and CVT

- Plastic scintillator gas cell
- Tight ROIs
  - High resolution
  - 30 keV detection
  - Low noise

CASP
CZT, an Array of Silicon Photomultipliers, and a Plastic Scintillator

PIPS-CZT
Passivated Implanted Planar Silicon (PIPS)

Sponsored by NA-22 Michigan CVT
**Soft Robotics for Radiation Environments**

**C. Palmer and NA-241**

**Goal:** Characterize performance of soft robotic materials in various radiation environments for potential nuclear safeguard applications

- Inexpensive – 3D printable
- Perform manipulative tasks in hard to reach areas
- Hydraulic or pneumatic controls for underwater applications
- Soft liquid metal – self healing properties

**Tensile testing, functional testing for Galinstan, EGain, PDMS**

Sponsored by NA-241 HCD through INL
Other Related Research

- H. Yang – DOE-NEUP
  - Active interrogation technique based on photofission
  - Muon imaging to monitor dry storage cask
- Advising 2 Graduate Students at PNNL (HCD)
  - PhD – Verification of Gas Centrifuge (chemistry)
  - MS – Spectral radiograph of uranium oxide powders
- Undergraduate Senior Design Teams
  - Safeguards by design – dry cask storage to repository
- Spin-off scoping studies
  - Production-depletion calculations (ORIGEN-ARP) for isotopic predictions of epsilon phase metals in used nuclear fuel
  - Phonon transport to predict thermal conductivity for verification of burnup in single fuel rod
Progression of Curriculum

- 2014 – 2016 DHS Nuclear Forensics Educational Program
  - Introduction to Nuclear Forensics, NSE 599
    - 2014, 2015 - Enrollment ~20 students
  - Detection of Special Nuclear Materials, NSE 599
    - 2016 - Enrollment ~12 students
  - Nuclear Fuel Cycles (Radiochemistry), NSE 440/540
    - 2016 - Enrollment ~15 students

Photos courtesy of Jens Odegaard, OSU
Progression of Curriculum

- Collaborations with NA-24 Human Capital Development

Seminar Series (1 Cr)
- Going to Zero Nuclear Weapons, 2014
- Modeling and Simulation in Nonproliferation Science and Policy, 2015
- Current and Future Challenges in Nonproliferation, Safeguards and Arms Control Regimes 2016, ** Enrollment exceeded 45 graduate NSE/PP students
- The Evolution of Technology and Policy for Arms Control ~40 NSE Students

Nonproliferation and Arms Control Graduate Course (3 Cr)
  → 2-week simulation of treaty negotiation, 2016
- Enrollment ~ 20/yr split between PP/NSE

Seminar Speakers 2018
- Alex Montgomery – Reed College
- Morag Smith – LANL
- Ambassador Thomas Graham
  - Chris Pickett – NNSA
  - Michael Whitaker – ORNL
  - Sarah Frazar – PNNL
  - Carolyn Pura – Sandia
  - Jacob Benz – PNNL
Nuclear Security Educational Initiative

NA21 (ORS)/PNNL

<table>
<thead>
<tr>
<th>Course</th>
<th>Home/ Instructor</th>
<th>Years /Enrollment</th>
</tr>
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<tbody>
<tr>
<td>Nuclear Nonproliferation and Arms Control</td>
<td>D. Bernell (Public Policy)</td>
<td>Fall 2014-2016, 20 (avg.)</td>
</tr>
<tr>
<td>Terrorism and National Security*</td>
<td>D. Bernell (Public Policy)</td>
<td>Fall 2016, 35</td>
</tr>
<tr>
<td>Nuclear Security System Design*</td>
<td>S. Reese (NSE)</td>
<td>Fall 2017, 22</td>
</tr>
<tr>
<td>Detection of Special Nuclear Materials*</td>
<td>H. Yang (NSE)</td>
<td>Fall 2015-2016, 9</td>
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* Indicates a new course for OSU developed out of NSEI

TAMU NSEI curriculum evaluated at OSU

→ Gaps / overlaps aligned with OSU learning outcomes

→ Organized into module-based format for dissemination

→ Adapted for online delivery at OSU’s Ecampus MHP
OSU INMM Student Chapter

Membership: ~35 undergraduates/graduates (~20 active)

Activities: Seminars – Socials – Movie Nights – Joint ANS reactor tours, INMM Workshops!

INMM National Meeting
Palm Desert - 2017

NA-41 Nuclear Facility Experience Tour – UK
Elements of ‘Successful’ Academic Program/Emphasis

• Goal: Develop next generation experts in nuclear security and safeguards

• Ideally benefit:
  – NNSA Programmatic Office and National Laboratories
  – Students
  – Academic Unit at University

• Achieving goal is interdependent
  – For a graduate emphasis to be able to be sustained long-term, all parties involved must have a path that enables success
Elements of Student ‘Success’

Efficiently and affordably obtaining the education and skills necessary to acquire a degree and secure a professional position

- Didactic Coursework
  - Ideally aligned with research project
- Research Project/Thesis
  - Generates resources to sustain coursework
  - Typical source of student funding
- Faculty Advisor
  - Assists in navigating graduate school
  - Technical advisor and editor
- Bonus: ‘Real Life’ Experience / Internship
  - Can possibly derail educational track
  - Can minimize role of university and advisor
Elements of Faculty Success

• 9 month appointment

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<thead>
<tr>
<th>Position Description</th>
<th>Time/Effort</th>
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<tbody>
<tr>
<td>50% Teaching</td>
<td>25%</td>
</tr>
<tr>
<td>40% Research</td>
<td>70%</td>
</tr>
<tr>
<td>10% Service</td>
<td>5%</td>
</tr>
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NEEDS...
• Graduate Students
• Research Funding
• Research Products

“...the importance of teaching and community service in professional performance evaluation (such as tenure and promotion standards) has been diminished, crowded out in many instances by a “publish or perish” mentality. The end result of this shift has often been a reduction in the time and effort faculty members dedicate to other professional functions, such as teaching, advising, and community service”.

Path Forward

• Considerations
  – Student experience
  – Student graduation timeline
  – University funding for faculty and student time, stipend, tuition
  – Research products
    • Journal publications, thesis, conferences, IP
  – Programmatic relevance

"Coming together is a beginning, staying together is progress, and working together is success."
  – Henry Ford