Establishing Requirements for Nuclear Engineering Educational Programs

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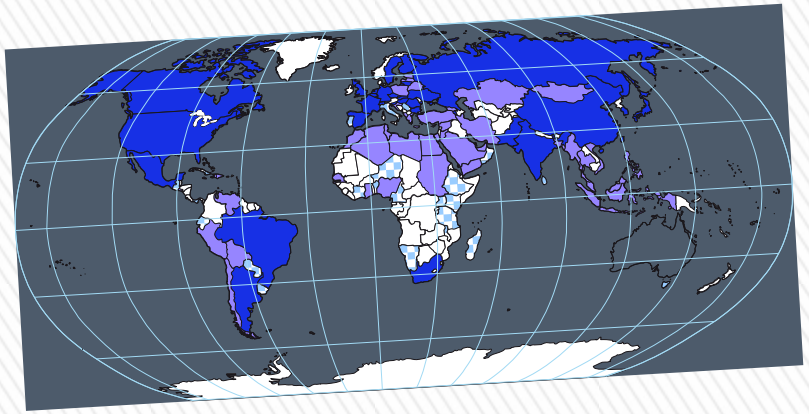
International Conference on Human Resource Development for Nuclear Power Programmes: Building and Sustaining Capacity.

Vienna, Austria
12–16 May 2014

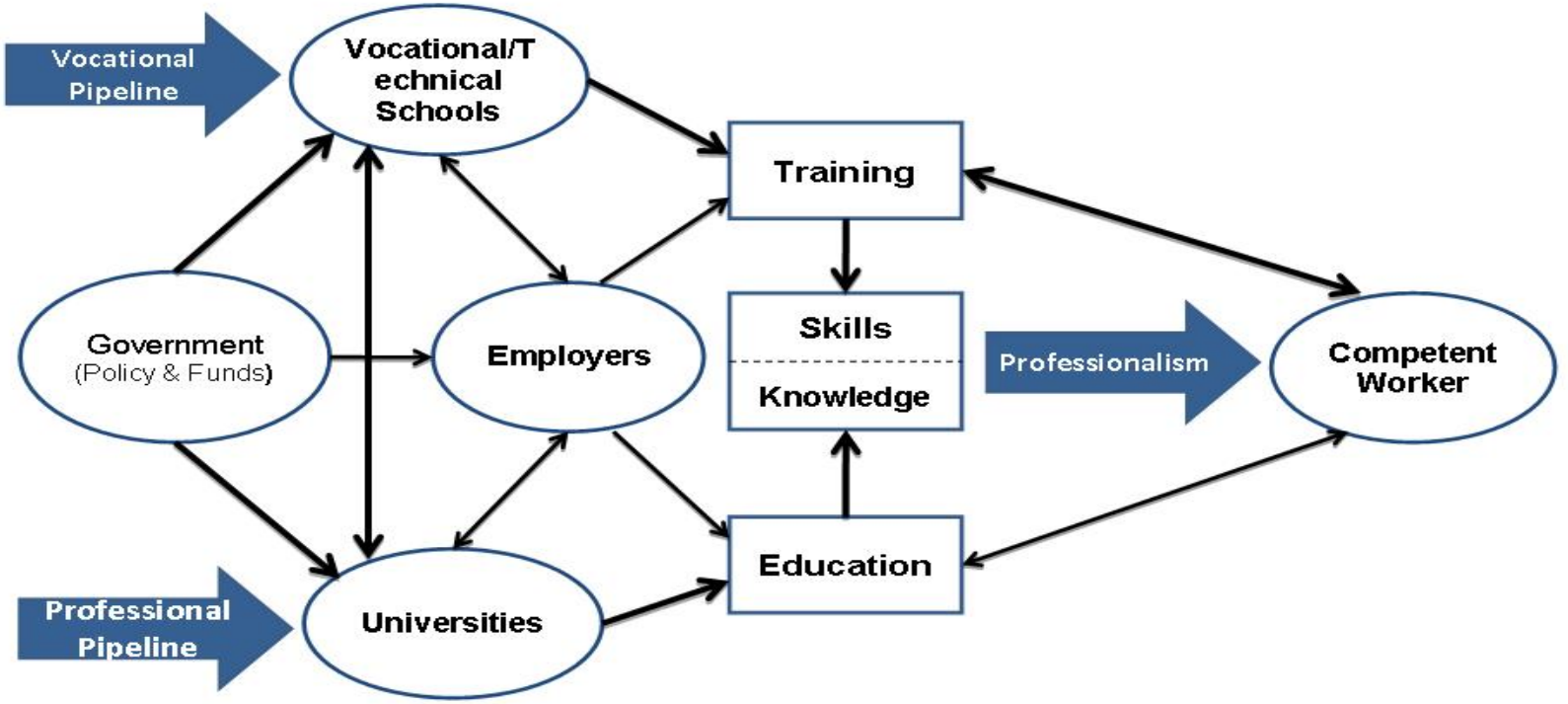
Challenges

Aging of nuclear personnel, retirement,
Loss of valuable nuclear knowledge,
Eventual degradation in technology skills and know-how.



With a forthcoming high growth in nuclear industry worldwide, maintaining nuclear competencies in technical support organizations , industry and nuclear regulatory authorities will be the most critical challenge in the near future.

Government-University-Industry Interaction to Produce a Competent Worker



General Observations

- A substantive curriculum is vital for a successful Nuclear Engineering programme.
- No international standard to the contents of nuclear curricula.
- There is substantial consensus among nuclear educators around the world of what constitutes a good quality nuclear engineering curriculum.
- Each country and region has its own unique format and approaches.
- The curricula must represent the depth and breadth of the scientific and topical areas needed for a successful Nuclear Engineering programme.
- Core courses and supported courses.

NUCLEAR ENGINEERING EDUCATION: A COMPETENCE-BASED APPROACH IN CURRICULA DEVELOPMENT

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Available as the IAEA Nuclear Energy Series No. NG-T-6.4, 2014.

Scope of this Report

- Key considerations in developing nuclear engineering curricula
- Content, courses, subjects and the resulting competencies
- The focus is on the common requirements in developing the curricula, and outlines the competencies at the Bachelor (first degree) and Masters (second degree) levels.
- Experience in several of the countries with active nuclear programmes.

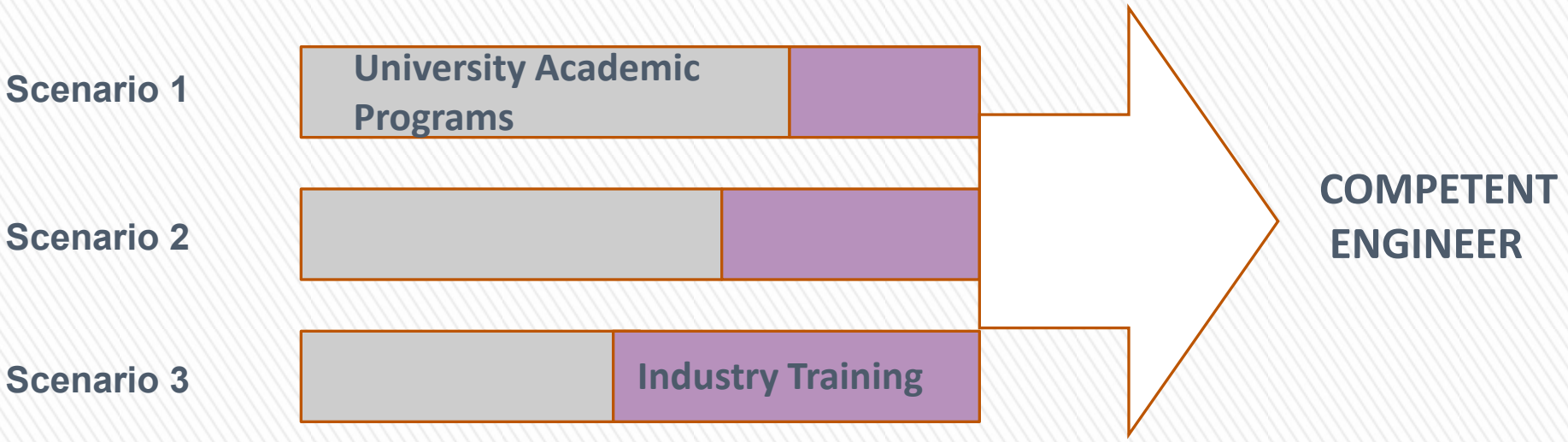
Purpose of this Report

- To provide guidance to decision makers in Member States on common curriculum requirements in the field.
- It is aimed at providing an understanding of the competencies expected of nuclear engineering graduates at the Bachelor and Masters level.
- This should result in facilitating the formulation of strategies to create and/or adopt curricula to meet the appropriate degree-level requirements.

This document contributes to five areas that are needed to ensure a viable and robust nuclear industry:

- Developing policies and strategies in nuclear knowledge management, including key issues of nuclear education and national and regional needs and expectations;
- Fostering strong regional or inter-regional nuclear education networks;
- Facilitating the harmonization of curricula in nuclear education and training programmes;
- Promoting the awareness and use of nuclear facilities and engineering and training simulators as effective tools to enhance education, research, and to maintain capability;
- Providing specific consultancy services (assist visits) to address emergent problems and long term issues related to nuclear education;
- Analysing and sharing information to facilitate nuclear education development.

Various Approaches for Producing a Competent Nuclear Engineer



University Programmes in Nuclear Engineering

- The Bachelor, or first degree, based on approximately four years of study
- Second more advanced degree, the Masters, which involves two years of study beyond the Bachelor
- The Engineering Diploma - typically involves five years of study
- June 1999, the Ministers of Education in the European Union entered into the Bologna Convention.

Expectations of degree recipients at the Bachelor and Masters level

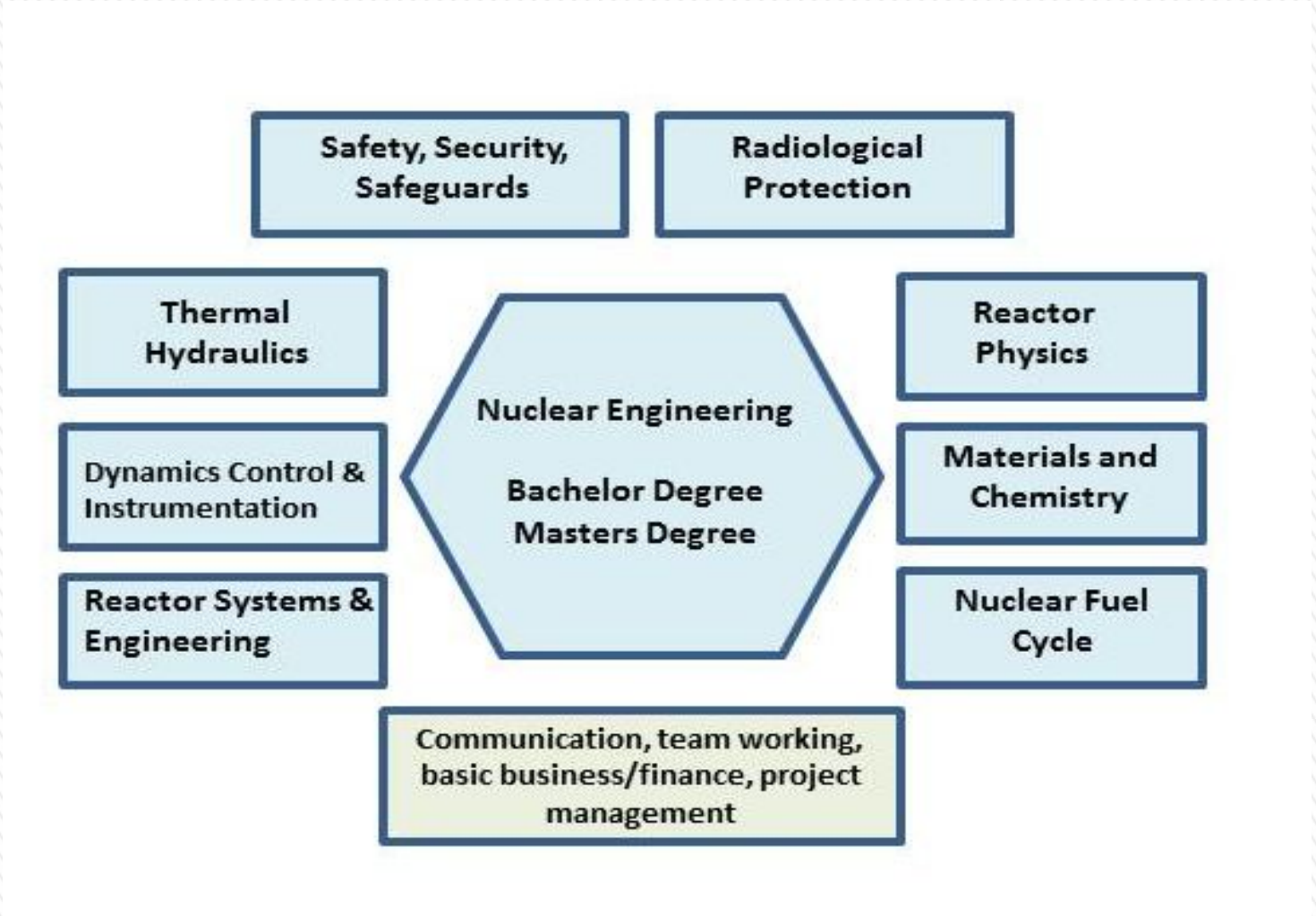
- On completion of a Bachelor level qualification, it is expected that the student will have comprehension and knowledge of nuclear engineering systems.

- On completion of a Masters level qualification, it is expected that the student will be able to analyze, synthesize and evaluate knowledge gained, and apply this knowledge to nuclear power plant systems.

Specific outcomes at the Masters level

- Identify, assess, formulate and solve absolute and abstract complex nuclear engineering problems creatively and innovatively,
- Apply advanced mathematics, science and engineering from first principles to solve complex nuclear engineering problems,
- Utilize procedural and non-procedural design and synthesis of components, systems, engineering works, products or processes in a nuclear environment,
- Design and conduct advanced investigations and experiments,
- Use appropriate advanced engineering methods, skills and tools, including those based on information technology,
- Use appropriate economic and management methods, skills and tools, including knowledge management,
- Communicate effectively and authoritatively at a professional level, both orally and in writing, with engineering audiences and the community at large, including outreach,
- Work effectively as an individual, in teams and in complex, multidisciplinary and multicultural environments,
- Engage critically in independent learning and new thinking through well-developed learning and analytical skills,
- Have a critical awareness of and diligent responsiveness to the impact of nuclear engineering activity on the social, industrial and physical environment with due cognisance to public health and safety,
- Recognition of the need to act professionally and ethically with considered judgment and take full and appropriate responsibility.

Scope of Nuclear Engineering Academic Programmes



- Introduction to Nuclear Energy
- Introduction to Nuclear Physics
- Nuclear Reactor Theory
- Nuclear Thermal-Hydraulics
- Nuclear Materials
- Nuclear Fuel Cycle
- Instrumentation, control and operation
- Radiation protection and Nuclear Measurements
- Safety Principles and Practices
- Advanced nuclear courses

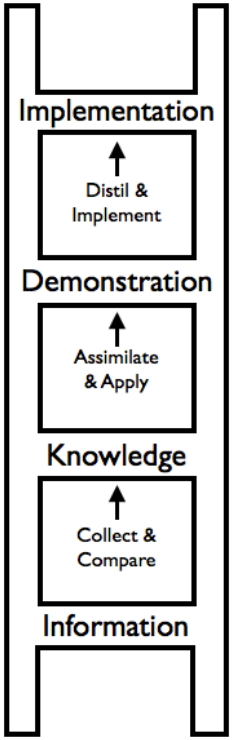
Typical core courses of any Nuclear Engineering programme

Defining Competences – General Approach

- Each student should
- "*Know, Be Able* (i.e. demonstrate the ability), and
- *Possess* (i.e. be able to use)".

- The focus is for those who will specifically be employed at nuclear power plants.

The Knowledge ladder



Each student should know a specified level of knowledge (Knowledge), be able to demonstrate application of the knowledge (Demonstration), and know when to implement the knowledge (Implementation).

General and Specific Competencies

- General Competencies describe those basic and fundamental areas in which all engineers should have capabilities.

- Specific Competencies are more directed to the field of nuclear engineering.

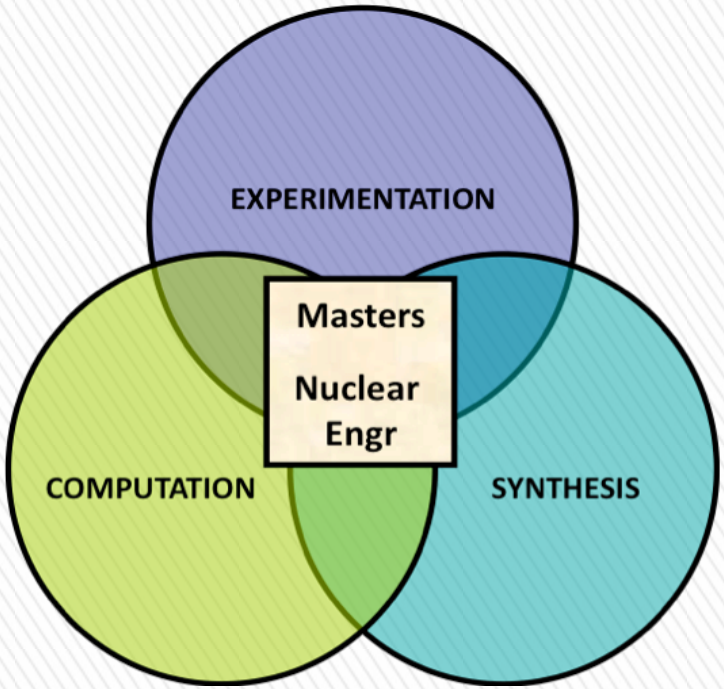
- BC-III. The ability to carry out independent activities within the framework of his or her professional qualifications, and have a commitment to professional development throughout his or her career.
- BC-IV. The understanding of basic laws of natural sciences including classical physics, chemistry, atomic and nuclear physics.

Example of General Competencies (Bachelor)

» BC-VIII. The ability to perform radiation protection and measurement experiments, and analyze resulting experimental data.

» BC-IX. The commitment to safety and an understanding of safety culture.

Example of Specific Competencies (Bachelor)



Schematic for the Masters degree

The importance of "soft-skills"

Sample requirements for Bachelor and Master Degrees

BC-V	—	Understand the basic approaches for acquiring, storing and processing knowledge, information and data; be familiar with standard computer code packages, including computer-aided graphics and design.
MC-II	—	Work collaboratively within a team and to exercise effective leadership of that team with good management skills while working towards a well-defined goal.
M2.10	—	Develop management strategies for carrying out the mission of a nuclear power plant to generate electricity in a safe, economical and secure way.
M3.12	—	Project management skills to carry out collaborative efforts with other team members, for assessing the quality and efficiency of the personnel, and upgrading the personnel performance.
M3.13	—	Organizational and managerial decision tools including knowledge management to achieve optimum outcomes with respect to quality, reliability, economy, safety and the protection of the environment.

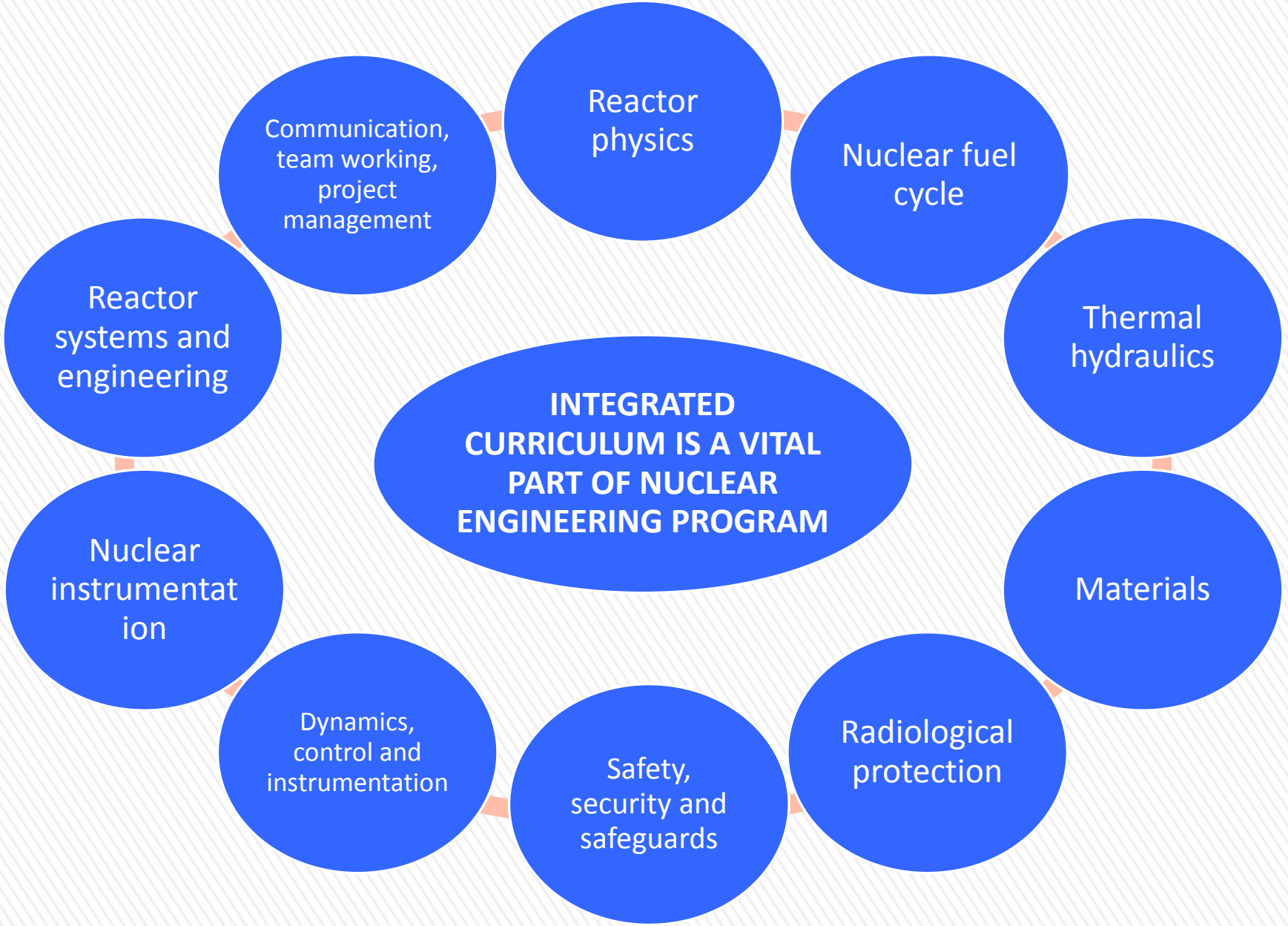
Nuclear Engineering Education at MEPhI

Nuclear Engineering Programs are based on:

- High standards of education and training;
- An inherent adherence to a strong culture of safety and security;
- Compliance with the national system of education;
- Cooperation with industry.




Nuclear Engineering Education at MEPhI



Conclusions

- There is no single approach in curricula development.
- New programmes must fit into national requirements.
- Because of the strong international interdependency of all nations using nuclear energy, it is critically important that a competent staff is engaged at all nuclear power plants in every country.
- International approach for benchmarking university programs is to be in place with a direct benefit to the countries with new nuclear power projects.

Final remarks

Adequate Human Resources and a reliable supply of competent workforce is one of the biggest challenges for the entire nuclear field

Sustainable education is the key for reliable and continuous development

There is a shortage of resources

Synergy, cooperation, sharing , networking , extensive use of innovative tools is a must

Thank you for your attention!

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