



SUMMER INSTITUTE
2019

Networks for Nuclear Innovation



A Magazine containing the results achieved in the Network for Nuclear Innovation projects during the WNU Summer Institute 2019



The work described in this Magazine was prepared during the final two weeks of the World Nuclear University Summer Institute 2019. It does not represent the position or the official views of World Nuclear Association, World Nuclear University or any of the companies to which the participants are affiliated with.

FROM WORLD NUCLEAR UNIVERSITY PRESIDENT



Nuclear electricity generation is growing globally, but it needs to grow faster if the world is to meet future energy demand and mitigate the effects of climate change. The major goal that we have set to achieve by 2050 is to generate 25% of global electricity with nuclear power. Challenges in the technological, regulatory, economic, and social levels of our industry must all be addressed to achieve this growth. In such an international industry, this requires strong international collaboration. Networking is a vital component of international collaboration, and I am delighted to see the central role the Networks for Nuclear Innovation has played in this year's Summer Institute.

Fellows are selected to participate in the Summer Institute in part due to their ambition and enthusiasm for the future of nuclear. The Networks for Nuclear Innovation groups this year produced high quality reports with serious recommendations for diverse aspects of the nuclear future. Information does not respect national boundaries, and I anticipate that the innovative ideas generated during the NNI will be carried forward by the Fellows into their 39 countries. I support the endeavours of these future leaders, and fully believe in their future successes.

Agneta Rising
President
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ACKNOWLEDGEMENTS

The first edition of the Networks for Nuclear Innovations (NNI) magazine was completed at the Summer Institute 2016. The main concept is to compile the ideas that emerge from the Fellows collaborative work in a publication that could inspire future innovations and serve as reference for the continuous development of important topics in the nuclear area.

We are extremely impressed by the efforts the Fellows and Mentors dedicated to finalize the text within the Summer Institute timeframe, at the same time they were preparing their impactful oral presentation.

We are grateful for the NNI Magazine Editor, Alina Constantin, who made sure all the pieces were correct and in place for its timely publication. The digital version of the NNI magazines can be found at: www.world-nuclear-university.org

Patricia Wieland
Head
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FOREWORD

This year the Summer Institute attracted 82 Fellows representing 39 countries. They bonded in Romania and then gathered in Switzerland, under the close guidance of their mentors, to intensively work on the dedicated projects of the programme – the Networks for Nuclear Innovation. The thematic chosen reflects actual aspects of nuclear industry, which are or have to be driven even more by innovation, to cope with the global context of climate change and accelerated digitalization.

The Fellows developed ideas, concepts and practical solutions to promote innovation in their area chosen while addressing the Sustainable Development Goals. The presentation of their results achieved, during the closing day of the Summer Institute, called for reflection, adaptability and international cooperation. Institutional changes needed, short term, mid-term and long term perspectives, economical aspects and implementation ways were carefully studied by the teams. Some of the messages derived are captured in this brief introduction, being in the same time an invitation for the reader to carefully consider each of the projects described, engage in dialogue and disseminate the most feasible proposals.

Innovative nuclear reactors, the Gen IV and the small modular reactors can be the ingredients of a nuclear renaissance, having increased safety capabilities and ability to target specific customer needs.

In order to encourage the development of Gen IV reactors, it is needed to collaborate at international to consolidate the fundamental features of Gen IV design and simplify the process of validation.

When communicated nuclear energy outside the industry, the Fellows highlighted how important is to come from the same shared values to the social and ethical level in order to be understood and build solid partnerships based on trust. This is key in gaining more acceptance for nuclear and going towards the goals of the Harmony programme.

Different aspects and criteria have to be considered when assessing the feasibility of a nuclear project, this being the base of creating openness and support, as every country has its own particularities. A forum for providing technical advice on feasibility studies and sharing of information has been proposed by one of the teams.

People are a company's most important resource. Even with the most expensive and safest equipment and systems, high-performing organizations shall invest in their people and culture to truly achieve their vision and mission. In order to maintain a proper organizational environment, favourable to development and progress, periodical checks and assessments of the organizational health and state of the culture in the organization have to be performed.

Another message strongly reinforced was that creating and maintaining a valuable and well prepared human capital is crucial for nuclear but has also to keep the pace with the technology infusing now all aspects of people's life. Organizations have to be aware and prepared to allocate the needed resources while having a sound and adaptive strategy. Governments, academia, and nuclear industry stakeholders can join efforts to create an internationally connected nuclear industry network where individuals possessing qualifications needed are much easier identified, as well as shortages or surpluses of particular skills.

We hope that the reader will enjoy the content and find value in it.
Yours sincerely,
Alina Constantin
Editor-in-Chief

HUMAN RESOURCES DEVELOPMENT FOR FUTURE NUCLEAR POWER PLANTS

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Abstract

The Harmony Programme envisions an increase of 1000 GWe nuclear capacity by 2050. This increase in capacity coupled with advancement in technological innovations in the nuclear power industry provides an opportunity for socio-economic advancement and flexible workforce.

Harmony Resources is a fictional company focused on revolutionizing how the international nuclear power industry approaches human capital development. Harmony Resources achieves this mission leveraging the coordinated regulatory process envisioned by the Harmony Programme and implementing innovative technologies. By analyzing the impacts of future Industry 4.0 (I4.0) technologies on new nuclear power plant staffing demands, Harmony Resources has proposed three products that the nuclear energy industry can implement to succeed in the future. These products include using innovative technologies to expand recruitment of nuclear professionals, a standardized nuclear power-related education system, plant-specific gap training, and a database of globally available, appropriately trained professionals that is accessible to the international nuclear power industry.

This white paper provides a strategy for implementers to prepare the workforce for the new nuclear power industry.

1. Introduction

The Harmony Programme is a global initiative of the nuclear industry that provides a framework for action to provide at least 25% of electricity via nuclear power by 2050 as part of a clean and reliable low-carbon mix [1]. The Programme is a framework for action to help the nuclear industry reach out to key stakeholders to remove barriers for growth by addressing three objectives (Figure 1).



FIG. 1 The three objectives of the Harmony Programme [1].

The nuclear power industry will need to build 1000 GWe of new nuclear capacity by 2050 to meet the Harmony goal, increasing the workforce by one million new nuclear workers [1]. Experts estimate that a lack of well-prepared professionals leads to a substantial annual profit loss for the global economy. Current human resource development is geared towards the past norms of the nuclear power industry, and as a result, will need to adapt to the nuclear power plant of the future. One vision for the nuclear power plant of the future exploits the benefits of I4.0 to reduce costs throughout the nuclear lifecycle [2]. I4.0 blurs the differences between the work of people and the work of machines resulting in improved information management and decision-making [3].

The nuclear power plant of the future will require a highly skilled, mobile workforce. Current licensing and operating schemes at nuclear plants are heavily specialized, even between nuclear plants of similarly designed reactor types. This requires significant re-training of individuals relocating to a different plant. In the United States for example, the Crystal River Nuclear Plant and the Davis Besse Nuclear Plant are both Babcock & Wilcox PWRs. When the Crystal River Nuclear Plant was permanently shut down, a licensed control room operator wanting to use his/her skills at Davis Besse would require years of re-training and license certification at the Davis Besse plant. This process is not only inefficient, but very costly for the operating company (so much so that many United States utilities require contractual obligations to stay with the company for several years after completing licence training or else pay penalties to the company upon leaving). In addition, this process can create significant career setbacks for specially trained individuals since they essentially “start over” if they move between nuclear sites. This risk can decrease interest of future professionals to join the nuclear field, and it also leaves the global nuclear community at a constant risk of losing valuable knowledge and experience.

Harmony Resources believes a revolutionized approach to human capital development is necessary for the future success and relevancy of nuclear power in the energy sector. We aim to redefine the needs and expectations for human capital in the field of nuclear energy by focusing on revolutionizing three key aspects of the current nuclear energy workforce structure.

This approach involves:

- standardizing the nuclear power-related education system and recruitment for nuclear professionals,
- facilitating an internationally mobile nuclear power workforce, and
- providing an international database of available and qualified individuals to aide nuclear energy stakeholders to easily identify the right talent worldwide.

This paper provides a strategy to best position the nuclear industry workforce to meet the Harmony Programme goals by leveraging a future harmonized regulatory process and implementation of I4.0 capabilities.

2. Human resources development for future nuclear power plants

In an I4.0 focused Nuclear Power Plant (NPP), organizational structures will be decentralized and become more flexible. We predict a transition a combination of large scale nuclear plants and small modular reactors, spread over an increased area, but operated and maintained remotely through network systems, with minimal human interface. I4.0 will change the career landscape as workers may be expected to work remotely on systems globally and deploy minimal staff to physical stations [4].

This new approach will require a workforce with a different skill set than traditional nuclear plant workers. Workers will be expected to have basic knowledge in big data, information technology, data analysis, and decision making. Technology adoption causes significant short-term labor displacement, but in the longer run, it creates a multitude of new jobs opportunities and increases demand for existing ones.

Figure 2 depicts the predicted skill transition required for Industry 4.0 [4].

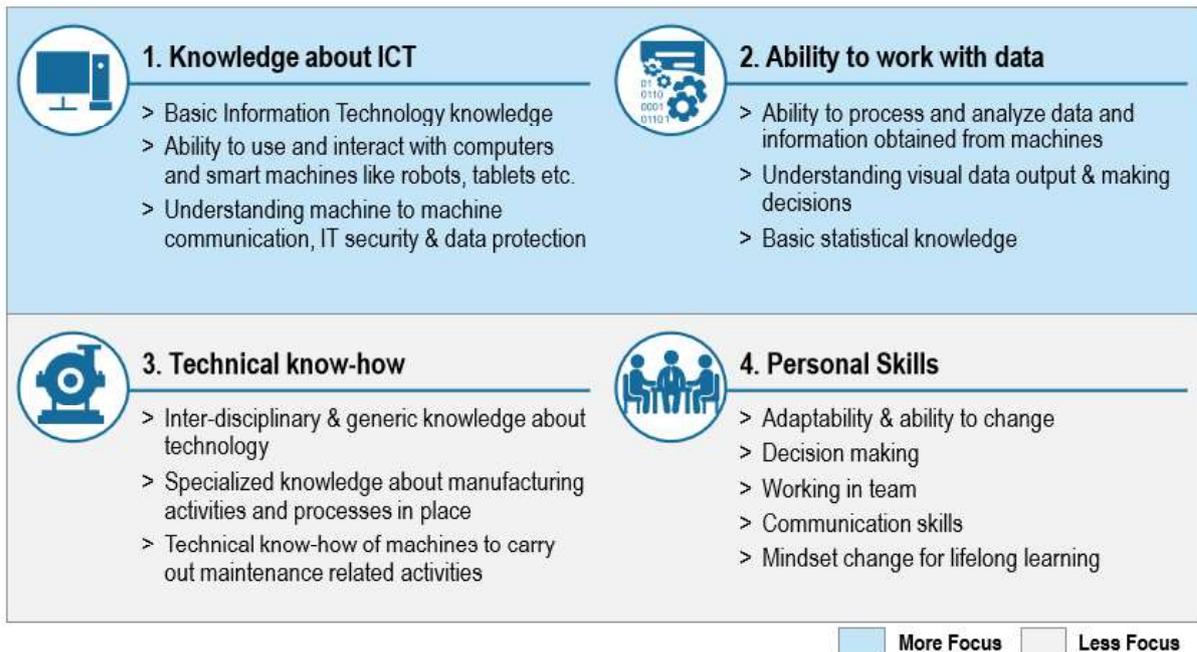


FIG. 2. Predicted skill transition required for Industry 4.0 [4].

Substantial workplace transformations means approximately 15% of the workforce will need to transition to other occupations, as more tasks will become automated. Also with modernization new occupations will be created, trends predict up to 9% by 2030 and up to 15% by 2050 [5]. This extensive transformation represents an opportunity to integrate and prepare the new workforce for critical stages of nuclear design, manufacturing, and construction through a standardized education and training for future and existing workforce.

2.1. Standardized Education System and Recruitment

Today, many countries show a keen interest in nuclear power development while others are exploring creating a national nuclear programme for the first time. It is critical for the nuclear industry to understand how to reach the local communities to expand the talent pool of available nuclear professionals.

Before entering the nuclear business, people must have access to the appropriate level of education and training to perform competently. Since the industry does not have a standardized education system, the traditional recruitment method has been to find suitable personnel after graduation from university. The scope of training required varies by countries and companies. Furthermore, with the integration of innovative technologies in the future NPP, training and education will also be required for the existing professionals to understand this new technology.

Harmony Resources proposes a standardized international education system for the nuclear power industry by utilizing technologies such as artificial intelligence, virtual reality (VR), big data, and cloud computing. Figure 3 shows the schematic of four sub-programmes of the standardized education system. Tier 0 targets kids aged 12 to 15 to raise awareness of nuclear related concepts. Tier 1 targets high school students to develop skilled workers, then Tier 2 targets university students to develop a more tailored curriculum. Tier 3 prepares existing professionals for changing technologies as a result of I4.0.

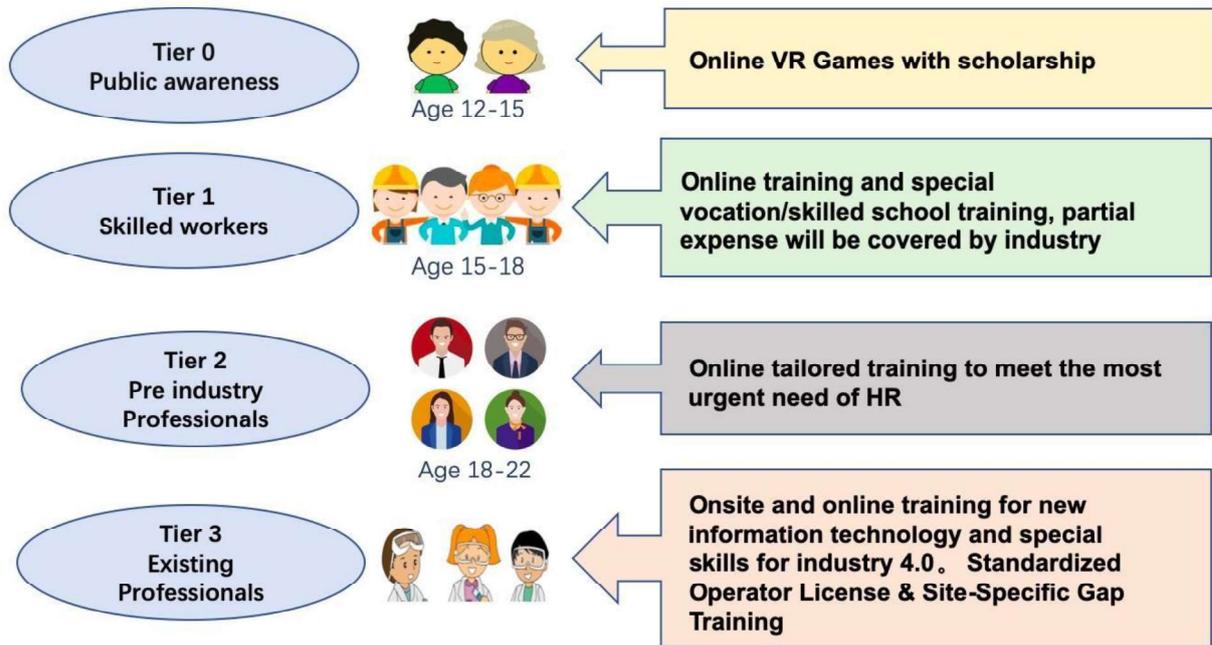


FIG. 3. Schematic of four sub-programmes of the standardized education system.

Harmony Resources believes that with the cooperation of and investment from government, academia, and industry, we could create appropriate programs focused on increasing public awareness of nuclear power as a career. It is crucial to target future talent, as well as existing professionals, by providing more tailored education and training courses to the individual's need to reduce the training time as well as increase the cost efficiency for the readiness of the nuclear project. Figure 4 shows the proposed smart education pipeline of the standardized education system. The Smart Training System uses I4.0 technology to provide a tailored training program to the general public as well as future and current employees who need proper training to be a competent professional for the nuclear industry.

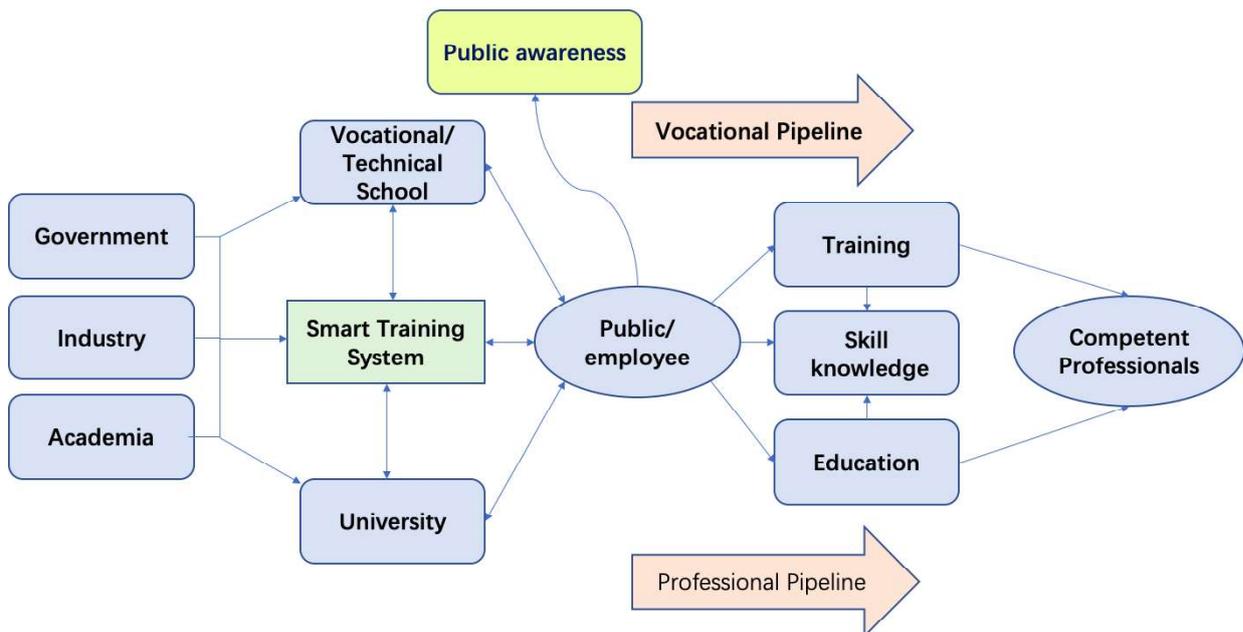


FIG. 4. Stakeholders in the proposed standardized education system.

2.2. Global Mobility

(a) Standardized Licensed Operator Training

The 448 nuclear reactors currently operating worldwide fall into six major reactor design types: pressurized water reactor, pressurized heavy water reactor, boiling water reactor, gas-cooled reactor, light water graphite reactor, and fast neutron reactor [6]. Current Licensed Operator programs at nuclear plants are heavily individualized, even between nuclear plant operators of similarly designed reactor types, requiring significant re-training of individuals relocating to a different plant. Standardized Operator License training provided through the aforementioned international training program would increase the available workforce and global mobility of operators.

(b) Plant-Specific Gap Training

Harmony Resources also supports an internationally-accepted plant-specific Gap Training strategy aimed at eliminating costly re-training and supporting global mobility. Much like the current approach to pilot's license transfers between countries, Gap Training for Licensed Operators would address only the plant-specific differences and conclude with a Gap exam to ensure high standards of knowledge and safety are maintained. This gap training would reduce training time from several years to only months, or possibly weeks, depending on the similarity of technology. By using the proposed international virtual training program, the process would be streamlined even more by not requiring individuals to be on-site or fit into a physical training course schedule before gap training can begin.

(c) Workforce evaluation and improvement

Harmony Resources understands the value of an internationally connected nuclear industry network. In the future, a database of individuals possessing qualifications needed for areas of Nuclear Design, Nuclear Construction, and Nuclear Operation will allow organizations to not only find needed staff, but to help identify shortages or surpluses of particular skills. Using advanced database technologies, the industry will have access to a global picture of available talent. We can dynamically understand the current and future needs and trends of various fields around the world, enhance the effectiveness and pertinence of personnel training, proactively manage knowledge and experience transfer, and better meet the development needs of nuclear I4.0.

3. Conclusion

Harmony Resources envisions that the ideas outlined in this white paper will be coordinated by an international organization comprised of government, academia, and nuclear industry stakeholders. The strategies outlined in this white paper provide tangible benefits to the nuclear power industry.

These benefits include:

- access to the nuclear power community through education and training regardless of location,
- standardized licensing and site-specific gap training to facilitate the global mobility of the workforce,
- increased interest in NPP careers and career progression opportunities due to mobility between plant sites,
- reduced costs for re-training and better access to an experienced workforce, and
- access to database of nuclear power professionals to recruit and train for the roles that are anticipated in the future.

Implementation of the human resources framework outlined above will align the nuclear industry for the changing environment and necessary workforce growth expected of the Harmony Programme by 2050, ensuring the nuclear power as a reliable and sustainable energy source of the future.

Are you ready to join us 4 future nuclear?



REFERENCES

- [1] World Nuclear Association, 2019. Harmony Brochure, [online]. Available at: https://www.world-nuclear.org/getmedia/1469af6e-d615-4ac0-9b0f-13ffa093d00a/HARMONY_2019.pdf.aspx. [Accessed 22 July 2019].
- [2] Integrated Digital Nuclear Design Programme, 2019. Integrated Nuclear Digital Environment, [online]. Available at: http://www.digitalnucleardesign.com/wp-content/uploads/2019/02/DRD_phase1_multimedia_presentation.pdf. [Accessed 22 July 2019].
- [3] Ślusarczyk, B. (2018). Industry 4.0 - Are We Ready?. Polish Journal of Management Studies, Vol. 17. No. 1.
- [4] BRICS Skill Development Working Group, 2016. Skill Development for Industry 4.0, [online]. Available at: <http://www.globalskillsummit.com/Whitepaper-Summary.pdf>. [Accessed 22 July 2019].
- [5] McKinsey & Company (2017). Jobs Lost, Jobs Gained: Workforce Transitions in a Time of Automation, [online]. Available at: <https://www.mckinsey.com/~media/mckinsey/featured%20insights/Future%20of%20Organizations/What%20the%20future%20of%20work%20will%20mean%20for%20jobs%20skills%20and%20wages/MGI-Jobs-Lost-Jobs-Gained-Report-December-6-2017.ashx>. [Accessed 22 July 2019].
- [6] IAEA, 2017. Reference Data Series, No. 2, 2017 Edition, [online]. Available at: https://www-pub.iaea.org/MTCD/Publications/PDF/RDS_2-37_web.pdf. [Accessed 22 July 2019].



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