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COMMUNICATING WITH THE PUBLIC: SPACE OF NUCLEAR TECHNOLOGY

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ABSTRACT

For two decades the Nuclear and Energy Research Institute (IPEN) has been developing activities for popularization of its R&D activities in the nuclear field. Some of the initiatives already undertaken by IPEN are lectures at schools, guided visits to IPEN facilities, printed informative material, FAQ page in the Web, and displays in annual meetings and technology fairs highlighting its achievements. In order to consolidate these initiatives, IPEN is planning to have a permanent Space of Nuclear Technology (SNT), aiming at introducing students, teachers and the general public to the current applications of nuclear technology in medicine, industry, research, electric power generation, etc. It is intended as an open room to the public and will have a permanent exhibit with historical, scientific, technical and cultural developments of nuclear technology and will also feature temporary exhibitions about specific themes. The space will display scientific material in different forms to allow conducting experiments to demonstrate some of the concepts associated with the properties of nuclear energy, hands-on programs and activities that can be customized to the students' grade level and curriculum.

1. INTRODUCTION

The public perception of the risks associated with nuclear activities is highly influenced by accidents and events that exacerbate the mistrust on the 'nuclear industry'. Experts and even government agencies seem to have different information concerning important events. Usually, there is a media noise that focuses the news on drama, depicting the worst case scenarios. General public lacks an understanding of basic nuclear energy concepts; for instance, the thought that nuclear power generation emits carbon dioxide. It expresses strong concern about the environment and "opinion elite" people are the most concerned about the effects of nuclear power, particularly safety and waste issues. The fact that some very negative words and expressions (bombs, Chernobyl, Fukushima, explosion) were frequently found among the interviewed people may be considered proof of the existence of a "common sense" definition of the nuclear fields, early and widely spread over the population.

To avoid the unfamiliarity and misunderstanding on radiation and nuclear issues, and the distorted perception, for instance, that ionizing radiation is uncontrollable and always harmful, some effort have to be made to deliver the education needs for public knowledge on this subject. The nuclear industry cannot afford merely to point out to a very creditable safety record in justification of its present action and future plans. There is a collective responsibility on addressing the critical issues in a much more substantive

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way by carefully examining the actions needed to place the nuclear and ionizing radiation knowledge in a social and ethical context. Education is the feature that can empower the transmission of this knowledge.

2. SOME EXPERIENCES

Some nuclear technology development programs have been demonstrating the importance of communicating with the public with a major goal of fostering broad conversations around the challenges of energy production and environmental conservation and the role that the nuclear technology plays in meeting the challenges of climate change and sustainable development. Some examples are the actions taken by the Brazilian Navy such as conferences in schools and guided visits to its Technology Development Center in Aramar, São Paulo; the Information Center at Itaorna of Electronuclear [1], the nuclear Brazilian utility; ENRESA Information Center [2] among others. The objective is to target a broad range of audiences, in order to build relationships with political, environmental and community-based audiences as a key to sustainable support.

In Brazil, the principles of radioactivity and nuclear energy are a part of the curriculum only in the last years of high school while students' priority is given to graduating and passing the selective for college exam. Moreover, these topics are relegated to courses in physics and chemistry, which are mandatory only for students choosing a major in engineering, sciences and mathematics. That's why most students coming to the education centers do not have any general or accurate knowledge about energy in general and nuclear energy and related topics in particular. Benites & Gordon [3] analyzed what the nuclear technology applications and implications are? The work methodology consisted in using a questionnaire applied to the students constituted of 3rd year secondary school as a data collection tool. In the first evaluation, 84% of the students were observed not to have a partial view of nuclear energy beneficial applications. The nuclear theme was verified not to have to be approached in São Paulo city secondary school.

Exhibits must also emphasize that nuclear is solely *part* of the energy solution, not the *only* solution. Adult visitors need also to find value in their experience at the education centers. In this point of view we would like to relate some interesting experiences about two education centers: VISIATOME and Energy & Environmental Resource Center (EERC). VISIATOME [4] is an information center for the general audience, focused on the atom, radioactivity and nuclear waste, created in 2005. Unique in France and in Europe, this center belongs to the French Atomic Energy and Alternative Energies Commission, the public body in charge of nuclear-energy research. Visiatome comprises a 600-square meter permanent exhibition.

The Visiatome welcomes around 20,000 visitors each year, of which a third are young students. Pupils from grammar, middle and high schools are welcome all year long. In addition to visiting the exhibition, this specific audience benefits from an introduction to various scientific themes – such as the atom and radioactivity – that are presented through educational workshops. The progression of publically funded research on nuclear waste is also explained to the public.

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In late 2010, the Visiatome welcomed its one-hundred-thousandth visitor – a student from a class of middle-school pupils from Avignon, the nearby "big" city; in a way, it symbolized the success of the facility objectives. The Center's main content lies in the permanent exhibition that comprises a main hall dedicated to radioactivity, nuclear concerns, radioactive waste, and various types of energy. An additional hall hosts temporary exhibitions (three to four exhibitions each year) on various topics (e.g., climate change, solar energy, journey to the centre of galaxy, and from alchemy to chemistry).

Furthermore, the Visiatome promotes sharing scientific knowledge through a comprehensive yearly program of public lectures and conferences. It also hosts big events three to four times a year that are either local adaptations of some European or national initiatives (such as the French science festival or the European researcher's night) or purely local initiatives. Usually, these events have the potential for attracting hundreds of visitors in a day.

The Visiatome, which is open year-round Monday through Friday, has developed a wide array of workshops on topics such as climate change, atoms and molecules, geology, and the states of matter. Two classrooms (one chemistry/physics lab and one computer-based lab) are equipped to accommodate these learning experiences that are conducted daily for the young audience. The Visiatome encourages visits from teachers and students by adapting to the specific needs of individual classes. Basically, the professor can choose content from an "a la carte" selection of subject matter and difficulty. The regular program alternates a guided tour of the permanent exhibition, pedagogical workshops and videos on scientific topics.

Fig.1. The Visiatome Information Center, in Marcoule, France: a) Students attending a workshop; b) Interactive software personalizes visitors experience; [5]

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When the students take their classes to the Information Center, they feel they are visiting a place dedicated to sharing scientific information "in general" rather than one completely focused on nuclear "propaganda." This probably helped a lot in establishing the credibility of the content.

Interactive booths or kiosks are scattered throughout the exhibits, as short quizzes – all intended to stimulate the minds of the visitors and allow them a much more self-based experience.

Teaching workshops at the Visiatome engage the students. Since the Visiatome opened in 2005, students consistently represent a third of all the Center's visitors. This audience is strategic when considering that today's students will be tomorrow's citizens. A general, yet quite informal, feedback from the operating team at the Visiatome indicated a good satisfaction among both the professors and the young visitors.

Another well succeeded enterprise is Energy & Environmental Resource Center (EERC). On January 25, 2010, Public Service Enterprise Group (PSEG) opened the Energy & Environmental Resource Center (EERC), a new learning center focused on building an understanding of energy, environmental challenges, and strategies for balancing energy demand with environmental stewardship [6]. Located in Salem, NJ, the EERC is a community resource, introducing new audiences to PSEG and uniting educators, students, policy makers, and environmentalists in conversations about a smarter energy future.

The EERC includes 6,000 square feet of hands-on, interactive exhibits, exploring the impact of technology, lifestyle, and public policy on energy consumption and the environment and challenging visitors to consider their own energy use and carbon footprint. Other exhibits offer the basics of electricity generation and focus on the need for a portfolio of solutions to the energy challenges, including conservation and efficiency efforts, renewables, and clean, central station power sources. To date, over 4,800 visitors have been to the EERC, including local, state and federal officials, students, regulators, industry representatives, environmentalists and community members.

The exhibits are divided into six content areas or zones. Zone 1 is titled *Imagine a World Without Electricity* and prompts visitors to consider the role that energy plays in daily life. Zone 2, *Energy 101*, provides an overview of basic energy principles and electricity generation (see Fig.2a).

Titled *Finding a Balance,* Zone 3 explores the impact of human activity on the health of the planet. Two key media elements support Zone 3. The first is the *Globe* interactive, which demonstrates that energy and environmental challenges are not unique to one particular region. The *Globe* is a touch screen interactive where the visitor selects a pulse point on the world map to read a profile on that region and watch a short video clip.

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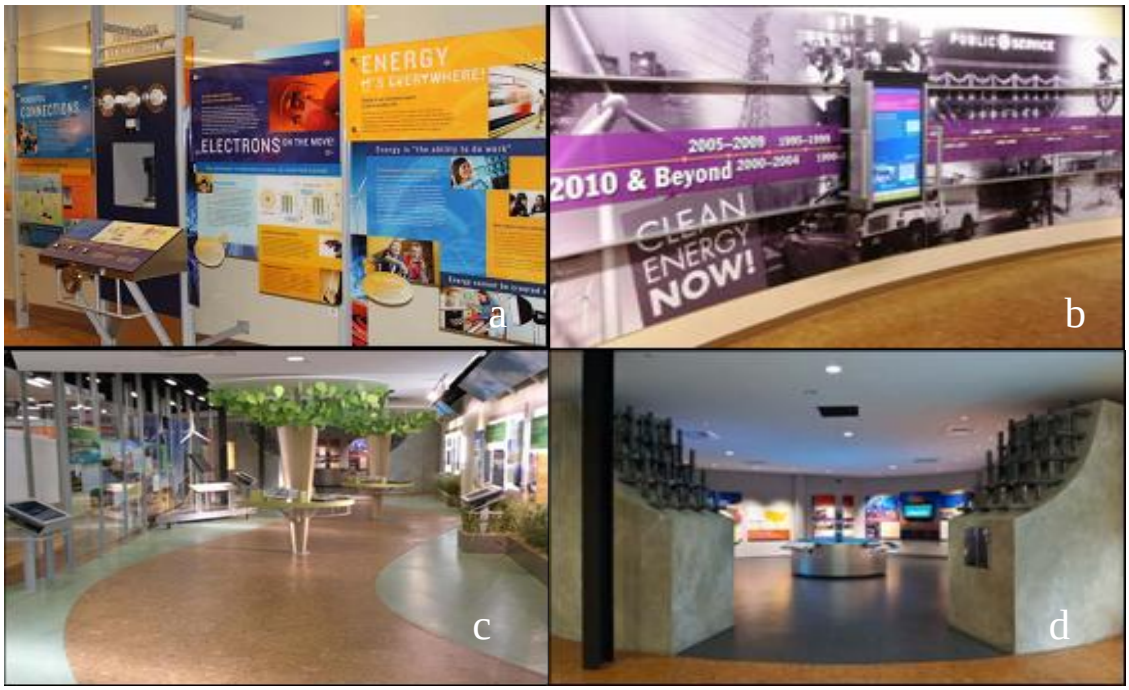

Fig. 2. Energy & Environmental Resource Center (EERC), in Salem, New Jersey: a) Zone 2 provides an overview of energy concepts; b) The I-Wall explores energy use through history; c) Zone 4 explores a broad approach to climate change; d) Visitors enter the nuclear section through a cutaway of a mock containment wall. [7]

The second media element in Zone 3 is the *I-Wall*, a touch screen computer programmed for showing different information on screen at each stop along the timeline, as the visitor slides the monitor along the rails. The theme of the *I-Wall* is *The Evolution of Energy*. It begins at the 1700s with the introduction of electricity and continues through 2010 and beyond. Stories in the timeline touch on a number of topics, including key technology developments, examples of an increasingly energy-dependent lifestyle, and key energy and environmental policy (see Fig.2b).

As the visitor rounds the corner into Zone 4, he learns that the quest for prosperity has had unintended environmental consequences over the last century. Despite this, energy demand will continue to rise in coming years. Zone 4 examines balancing future energy needs with environmental stewardship. The section explores energy conservation and efficiency measures, renewable energy sources, and clean central station power (see Fig.2c).

While the rest of the exhibit space explores a broad conversation around energy use and environmental impacts, Zone 5 was designed specifically to help visitors understand nuclear power and address stakeholders' questions and concerns.

The *Conversation* touch screen interactive summarizes the entire section by addressing the most common questions or concerns that visitors have about nuclear power (see Fig.2d).

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Zone 6 concludes the visitor's experience in the exhibit space with a call to action. The section includes opportunities for business and industry to reduce emissions and improve energy efficiency and promotes the need for a national energy policy. The section focuses on the role of the individual, specifically opportunities for individuals to reduce energy and resource consumption at home, on the road, and in the office. Two carbon footprint stations allow the visitor to create an avatar, or virtual "me," and based on his response to questions about food and goods consumption, housing, and transportation, calculates how many planets would be required if everyone in the world lived like the visitor.

Since opening on January 25, 2010, the EERC has hosted more than 4,800 visitors. The facility is open by appointment only, primarily due to staffing limitations. EERC staff provides educational programming to students in grades four through twelve on electricity generation, energy sources, climate change, and nuclear energy. Subject matter experts from the nuclear site are called in to provide more technical programs for upper-grade high school students, vocational schools, and college students.

As the EERC moves into its second year of operation, reaching new audiences continues to be a priority.

3. IPEN INICIATIVES

For two decades the Energy and Nuclear Research Institute (IPEN) has been developing activities for popularization of its R&D activities in the nuclear field. Some initiatives already undertaken by IPEN are: lectures at educational institutions, government agencies and companies; guided visits to IPEN facilities; printed informative material for the general public; FAQ page in the Web; exhibits in annual meetings, symposiums, technology fairs with displays highlighting its achievements. The public demand for information, invitations for lectures, participation in talk shows and debates, scheduling of visits, and accesses to the IPEN homepage in the Internet show that there is a growing interest in the nuclear subject by the Brazilian society, especially students and teachers.

In order to consolidate these initiatives, IPEN is planning to have a permanent showroom called Space of Nuclear Technology (SNT), aiming at introducing students, teachers and the general public to the current applications of nuclear technology in medicine, industry, research, generation of electricity, etc. This showroom will be accessible for students under eighteen, which currently are not allowed into IPEN because it is a controlled area. The SNT will constitute an open room to the public and will have a permanent exhibit with historical, scientific, technical and cultural developments of nuclear technology. Temporary exhibitions with specific themes will be also organized. These exhibitions may be itinerant and set up in other sites of science communication. The space will have scientific material in different forms which will allow conducting experiments to demonstrate some of the concepts associated with the properties of nuclear energy, hands-on programs and activities that can be customized to the visitors' grade level and curriculum.

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Panels with info graphs, pictures and texts will display many themes directly related to nuclear technology. By now, a series of twenty different main themes were already identified, some of them are under development or are foreseen, not necessarily in the order below:

1 “Applications of nuclear technology”, presents its current uses in medicine, industry, research etc.
2. “Energy sources”, with more than a dozen different sources, describing each fuel cycle, pros and cons.
3. “Public perception of radiation risks” – the change from a never ending vital power to an evil danger;
4. “Timeline of nuclear technology”, the basic steps of humanity to build the modern world.
5. “Professions in nuclear technology”, opportunities of career for future nuclear scientists.
6. “The pioneers of nuclear technology”, the biographies of those giants who shaped the 20^{th} Century.
7. “Radioactive waste” – where the wastes come from, how they are treated, where are they disposed of.
8. “Nuclear and radiological accidents”, the actual consequences of those unfortunate events.
9. “Nuclear cartoons” – how we, the nuclear sector, are seen and depicted in cartoons.
10. “Nuclear technology spin off”, the unexpected technological products of the nuclear industry.
11. “Nuclear fuel cycle”, a description of the uranium fuel, from cradle to grave.
12. “Natural and anthropogenic sources of radiation”, a snapshot of the Earth, by yearly radiation doses.
13. “Atomic bomb”, the history of the development of nuclear weapons.
14. “Nuclear power plants”, how many, where, how they are.
15. “Nuclear research reactors”, how many, where, how they are and for what.
16. “Nuclear future”, the emerging technologies that will change our world.
17. “Radiation and nuclear physics”, concepts about nuclear structure, reactions and radiations.
18. “Biological effects of ionizing radiation”, mechanisms, dose x effects relationships, hormesis, etc.
19. “Beauty, art”, applications of nuclear technology in restoring art objects, manufacture of cosmetics etc.
20. “Nuclear synthesis”, where does the matter we are made of come from?

Each theme will be explored using imagery, graphics and other visual resources to inform the visitors, but mainly in a way as to arouse curiosity and the desire to learn more.

4. CONCLUSIONS

The implementation of the project proposed here is an opportunity to consolidate these initiatives and will bring a very interesting additional benefit: because of the nature of

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the facilities, access to IPEN is only allowed for individuals older than 18 years, what excludes many students of the basic education courses. Moreover, the difficulties in bringing large groups of visitors into restricted areas, limit the size of the public who may attend. So, the production of multimedia material assumes an important role by providing access to information without requiring the physical presence in the restricted areas and will permit the expansion of the public satisfied with explanations.

To all above it is important to add that the country is starting several projects in the nuclear area of great social relevance: the resumption of the Brazilian Nuclear Program by building more nuclear power plants to generate electricity, started with Angra III , the construction of a nuclear reactor to be used in research and development - RMB, the construction of a plant for the production of radiopharmaceuticals, to meet the domestic and international markets, building a national final repository for radioactive waste of low and medium activity . These initiatives will naturally increase public's curiosity about the nuclear issue, making it almost an obligation of the institutions involved to provide means for society to get access to information in appropriate language and in a transparent and complete way.

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