LOSING NUCLEAR KNOWLEDGE –
– A SAFETY CONCERN AND A THREAT TO DEVELOPMENT

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Managing Nuclear Knowledge

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SPHERES OF APPLICATION FOR NUCLEAR KNOWLEDGE

1. Weapons
2. Energy
3. Other applications of nuclear technology:
   - Medicine
   - Industrial diagnostics
   - Production and preservation of foodstuffs
   - Academic research

CONTENTS OF THE PRESENTATION

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2. Status of nuclear knowledge in the fields of its application
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STATUS OF NUCLEAR KNOWLEDGE IN THE FIELDS OF ITS APPLICATION

	Importance of			Availability of			
Application	experiment	computation	simulation	experts	database	experimental facilities	codes
creation of nuclear weapons	vital (explosions)	low	none	lacking	none	immature	none
current problems of nuclear weapons	none	high	exceptional	redundant	in the making	in dynamic development	mature
establishment of nuclear power	high (critical assemblies, pilot reactors)	average	in development	sufficient	in development	in development	in the making
nuclear power operation	none	average	vital	sufficient	in the making	moderate	available
nuclear power development	decreasing	growing		shortage of physicists, redundancy of engineers	available	in decline	available
other nuclear areas	low	low	low	sufficient	available	sufficient	in development

INTELLECTUAL RESOURCES

- **Reduction of nuclear education programmes at universities of basic profile in the 1980s-90s**
- **Predominance of engineers among experts of the nuclear community**
- **Fairly advanced average age of personnel in the main areas of nuclear expertise**
- **Reduced access of students to field experiments and state-of-the-art software**
- **Revival of interest in nuclear *science* and engineering in the last 2-3 years**

EXPERIMENTAL AND COMPUTATIONAL BASIS OF NUCLEAR KNOWLEDGE

- **Reduced experimental capabilities across all areas of expertise**
- **Pinpoint investments in experimental facilities for severe accidents and verification tests, integrated test rigs, simulators**
- **Vigorous development of computer hardware and simulation facilities**
- **The need for preserving earlier experimental data as a basis for software verification**
- **Identification of gaps in experimental knowledge (verification matrices) for experimentation to focus on**

NUCLEAR KNOWLEDGE BASES

- **Variety of data bases and lack of information systems to describe them**
- **Ample regulations and mature procedures for data qualification**
- **Varied development of data bases (e.g., for nuclear data and radiation protection)**
- **Systematisation of data bases – translation into knowledge bases**
- **Problem of updating**
- **Benchmark – processing of data from previous experiments**
- **Benchmark – staging of new experiments to fit the verification matrices**
- **Data preparation for use – adaptable knowledge portal**

OPERATIONAL KNOWLEDGE BASES

- **10,000 reactor-years – a statistically meaningful collection of operational data**
- **Development of national data bases on operation of nuclear facilities (NPPs, research reactors, fuel cycle facilities)**
- **WANO’s role in working out criteria for assessing the performance of nuclear generating units**
- **IAEA’s role in global pooling of the knowledge on NPP operation and of the information on the non-proliferation status**

SOFTWARE

- **Computer power increased by many orders of magnitude**
- **Parallel application of analytical and statistical tools**
- **Progressive transition to 3-D codes**
- **Advent of coupled software packages and problems of validation, verification and qualification**
- **Vital importance of verification tests under conditions of deteriorating experimental facilities**
- **Development of cross-verification computations**
- **High dependence of results on the code maintenance level**
- **Is it possible for computer-based simulation to replace experiments altogether?**

ROLE OF THE IAEA IN MANAGING NUCLEAR KNOWLEDGE

- Development of information systems to describe nuclear data bases
- Phased transition from bibliographic systems to factual data systems
- Development of unified formats for data representation and sorting in bases
- Updating of knowledge bases by incorporation of processed results from earlier experiments
- Expert assessment to assure data quality and to guard against deliberate falsification of difficult-of-access data (blackmail, terrorism)
- Optimisation of nuclear knowledge accessibility and protection of intellectual property rights
- Support to establishment of specialised knowledge bases (data from non-commercial programmes) for educational purposes
- Transformation of National INIS Centres into National Centres for accumulation and storage of knowledge on nuclear science and technology as a way towards global knowledge management

CONCLUSIONS

1. **First stage in nuclear technology development:**
   - **priority of experiment without comprehensive analysis of its results**
   - **knowledge accumulation – irregular and outpacing its interpretation**
   - **computers – unavailable**
   - **absence of specialised knowledge bases**
   - **high level of governmental support**

CONCLUSIONS (continued)

2. **Current knowledge exceeds the demand for it, on account of:**
   - **stabilised requirements for upkeep of nuclear weapons;**
   - **commercialisation of nuclear power and loss of governmental support;**
   - **industrial conservatism;**
   - **predominance of engineering pragmatism over systemic thought;**
   - **weak mechanisms of passing knowledge from one generation to another – risk of losing expensive know-how due to its poor formalisation**

CONCLUSIONS (continued)

3. Future demand for nuclear knowledge:

- grounds for decisions on the role of nuclear technologies in the context of further development;
- phased transition to large-scale nuclear power through closing the nuclear fuel cycle and deploying fast reactors;
- increasing importance of software and simulation of real processes;
- involvement of governmental resources in nuclear power development and comprehensive solution of environmental problems;
- foundation for safe management of nuclear technologies regardless of their future development scale