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Strategic Knowledge Management Issues and Approaches in the Canadian Nuclear Industry

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Strategic Knowledge Management Issues and Approaches in the Canadian Nuclear Industry

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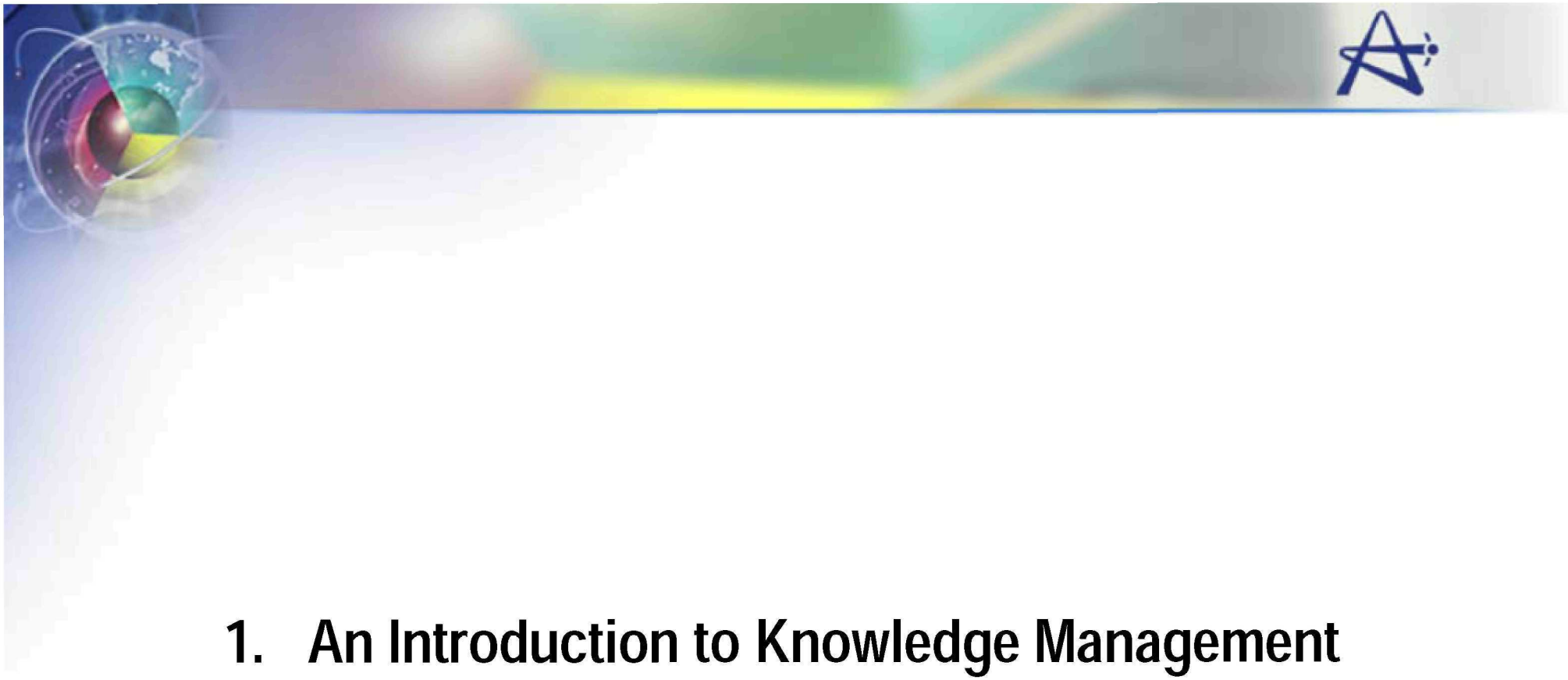
Canada

AECL Atomic Energy of Canada Limited

EACL Énergie atomique du Canada limitée

Outline

1. An Introduction to Knowledge Management
2. Knowledge Management in the NPP Context
3. Examples of KM in NPP Maintenance
4. The Canadian KM Scene
5. AECL's KM Strategy
6. KM Initiatives with Canadian NPPs
7. Conclusions



1. An Introduction to Knowledge Management

Issues and Challenge

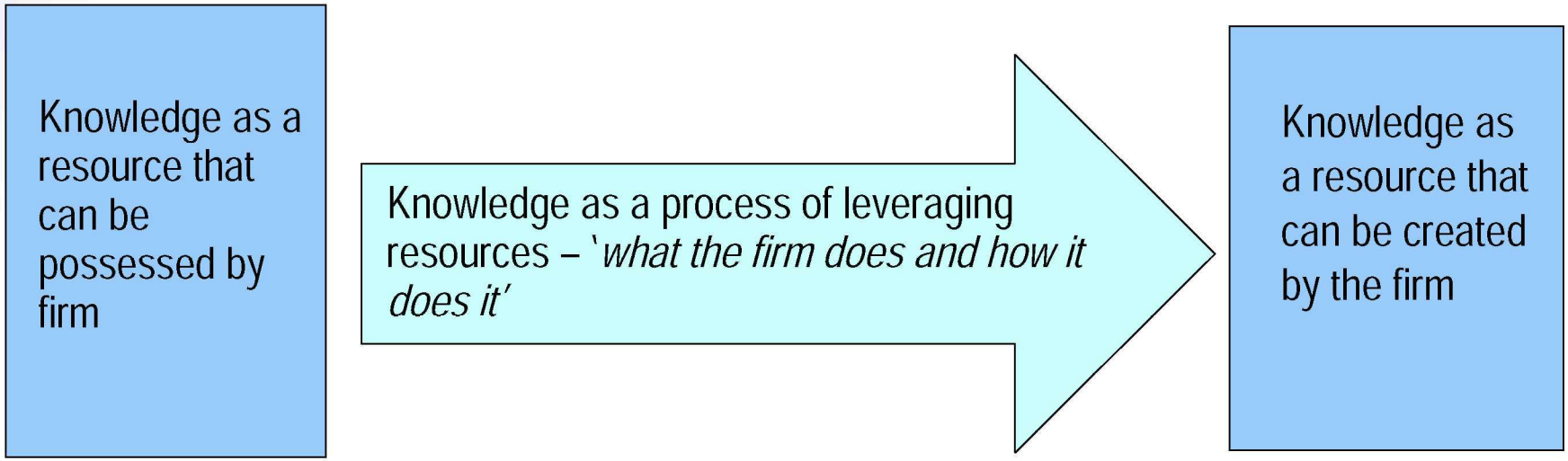
- Knowledge is increasingly recognized as being of central importance to organizations.
- It should be managed and leveraged in order to maximize returns and improve efficiency.
- An effective knowledge management system is viewed as a mandatory condition of sustainable success for organizations.
- Difficult to judge if a KM System is working well and how it may be improved.
- Understanding and definition of KM is somewhat "perspective-driven"

Definitions of Knowledge

- '...information whose validity has been established through the tests of proof...' (Liebeskind, 1996)
- '...information that is contextual, relevant and actionable...' (Soliman and Youssef, 2003)
- '...what the firm knows in terms of best practices...' (Szulanski, 1996)
- '...mix of framed experience, important values, contextual information, and expert insight that provides a framework for evaluation and incorporation of new experiences and information...' (Davenport and Prusak, 1998)

Types of Knowledge

- Knowledge as a resource and as a process (Assudani, 2005)



- Knowledge at the individual, group or organization level (Hedlund, 1994)
- Tacit versus explicit knowledge (Nonaka and Takeuchi, 1995)
- Factual, conceptual, procedural and metacognitive knowledge (Anderson et al., 1998)

Unique Characteristics of Knowledge

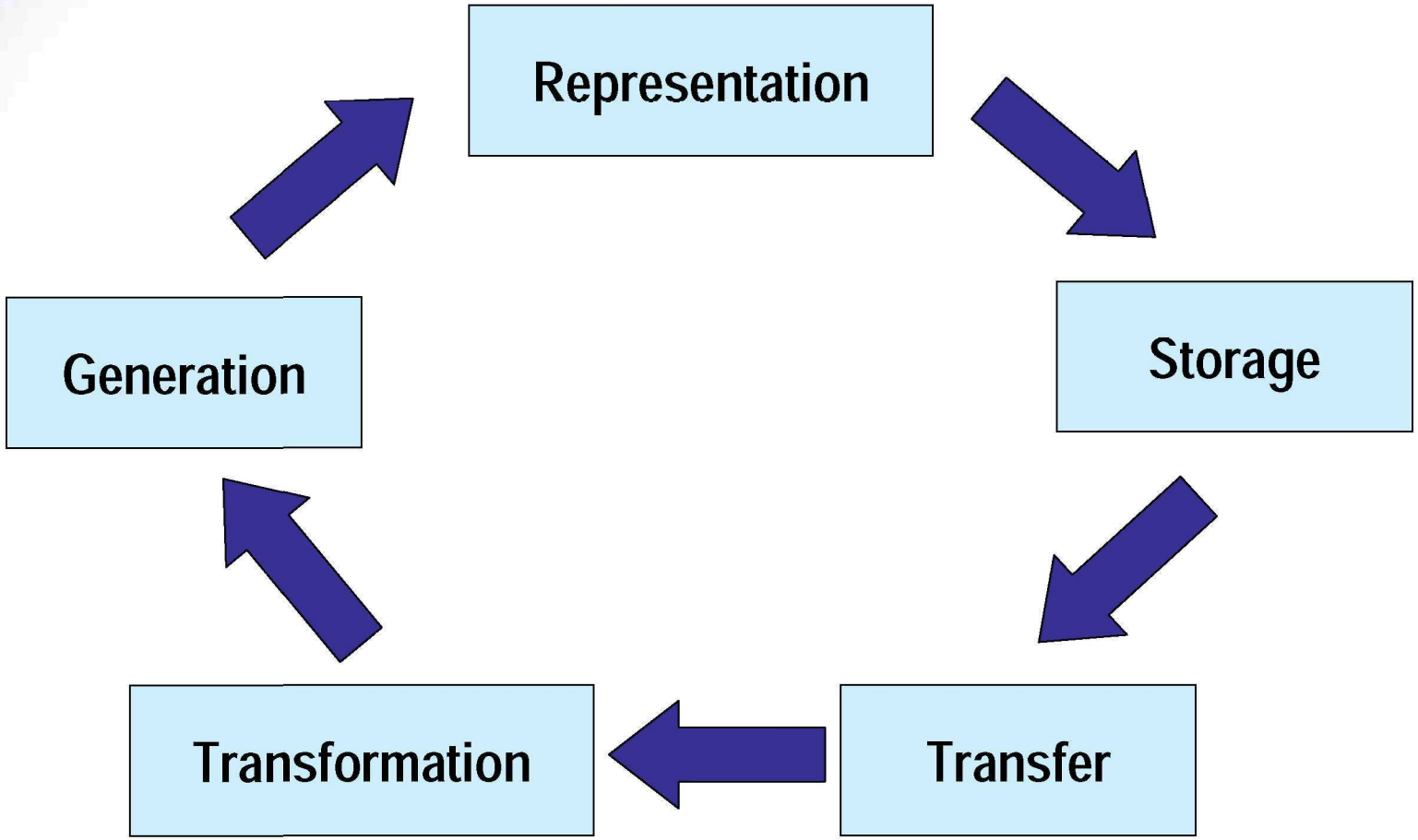
- Knowledge is contextual
- The value of knowledge may change over time
- Knowledge as to be renewed or maintained
- It can be difficult to transfer, capture, distribute
- Knowledge facilitates learning
- Rate of acquisition of knowledge depends on memory, experience, expertise
- Accumulates through learning processes
- Facilitates effectiveness and efficiency
- Improved ability for "sense-making"

  (data->information->knowledge)
- Creation/utilization can be enhanced significantly with technology

Knowledge Management: Definition

- '*...the collection of processes that govern the creation, dissemination, and utilization of knowledge...*' (Newman, 1992)
- '*...managing the organization's knowledge through the process of creating, structuring, dissemination and applying it to enhance organizational performance...*' (O'Leary, 1998)
- '*...deployment of a comprehensive system that enhances the growth of an organization's knowledge...*' (Salisbury, 2003)
- '*...systemic and organizationally specified process for acquiring, organizing, and communicating the knowledge of employees so that other employees may make use of it to be more effective and productive in their work...*' (Alavi and Leidner 1999)

Knowledge Management: Processes



Hedlund (1996)

Knowledge Management: Objectives

- Promote creating new knowledge and promote innovation
- Reduce the cost of being effective and increase the pace of innovation
- Preserve existing knowledge
- Reduce the loss of intellectual capital from employees who leave
- Increase collaboration and hence enhance the skill level of employees
- Increase the productivity of workers by making knowledge accessible to all employees
- Enable "pro-active" quality culture (knowledge helps staff do the right things, and do them right)

Examples of KM Initiatives

- The use of intranets and portals for knowledge retention/sharing.
- Technology licensing and transfer programs.
- Methods to assess core competence skills inventory and availability
  - HR programs to manage key skills loss due to attrition.
  - Tracking tacit knowledge loss and its impact on the organization.
- Initiatives focused on knowledge retention

Knowledge Management System

- KMS: the tools and processes used by knowledge-workers to identify and transmit knowledge into the knowledge-base contained in the organizational memory. Can be project, task, or process based, or infra-structure based
- Organizational Memory: set of repositories of information and knowledge that the organization has acquired and retains (Huber, '98), or the means by which knowledge from past (stored information) is brought to bear on the present activities (or decisions) resulting in higher or lower levels of organizational effectiveness
- Organizational Memory System: the process and IS components used to capture, share, search, retrieve, display, and manipulate organizational memory

Knowledge Management System

- When managed company-wide, KM can be viewed as a "*knowledge management system*" (KMS), and ideally is an integrated and coordinated approach to affect the management of knowledge and is manifested in a variety of implementations including document repositories, expert databases, work processes, etc. (Davenport et al. 1998)

Knowledge Management Success Drivers

- It is widely recognized in the literature that designing and implementing a successful firm-wide KMS depends on five components:
  - Leadership support
  - Technological infrastructure
  - Supporting culture
  - Organizational processes
  - Performance measurement

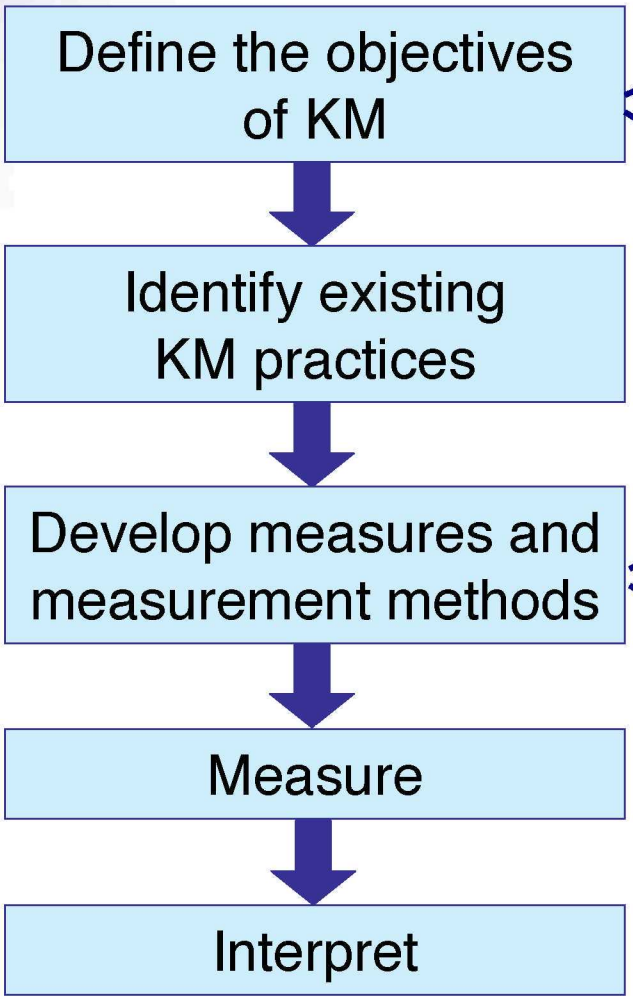
Implementing a KM System

- Implementing and optimizing a knowledge management system (KMS) usually implies:
  - taking a more systematic and corporate-wide approach KM activities
  - the activities and tools and culture that promote and facilitate improved corporate knowledge creation, retention & storage, sharing, utilization, and transfer

Typical KM Focus Areas

- KM approach may encompass multiple areas of focus (at all levels in the organization):
  - establish corporate KM culture,
  - knowledge (and information) organization and repositories (OM systems),
  - human resource initiatives (personnel skills, learning and training),
  - codification of work processes, methods, and practices,
  - supporting technology (e.g. Decision Support Systems/Tools, IS/IT infrastructure),
  - intellectual and knowledge asset utilization/commercialization, and
  - monitoring and feedback

KM Performance Assessment



Identify knowledge flows and core competencies

Consider different stakeholders and their goals and definitions of success

Measures should be reliable, valid, actionable etc.

Define what data will be collected and how it will be collected and how often

2. Knowledge Management in the Nuclear Power Plant Context

Why KM Important to NPPs

- a complex technology base (design and OM&A infrastructure)
- long technology & plant life cycles, high capital intensiveness
- a need for life-cycle asset management strategies that are knowledge-driven (i.e. economic and risk informed decisions)
- dependence on multi-disciplinary technologies, expertise
- competing operational objectives (safety, production, cost)

Why KM Important to NPPs (cont'd)

- an ongoing need for simultaneous and integrated coordination of many complex physical and human systems
- potentially high hazards must be managed to low tolerable risks
- a regulated industry environment (safety, EQ, & NQA compliance)
- configuration management consistency must be maintained between "design basis" and "real plant state" and "documentation"

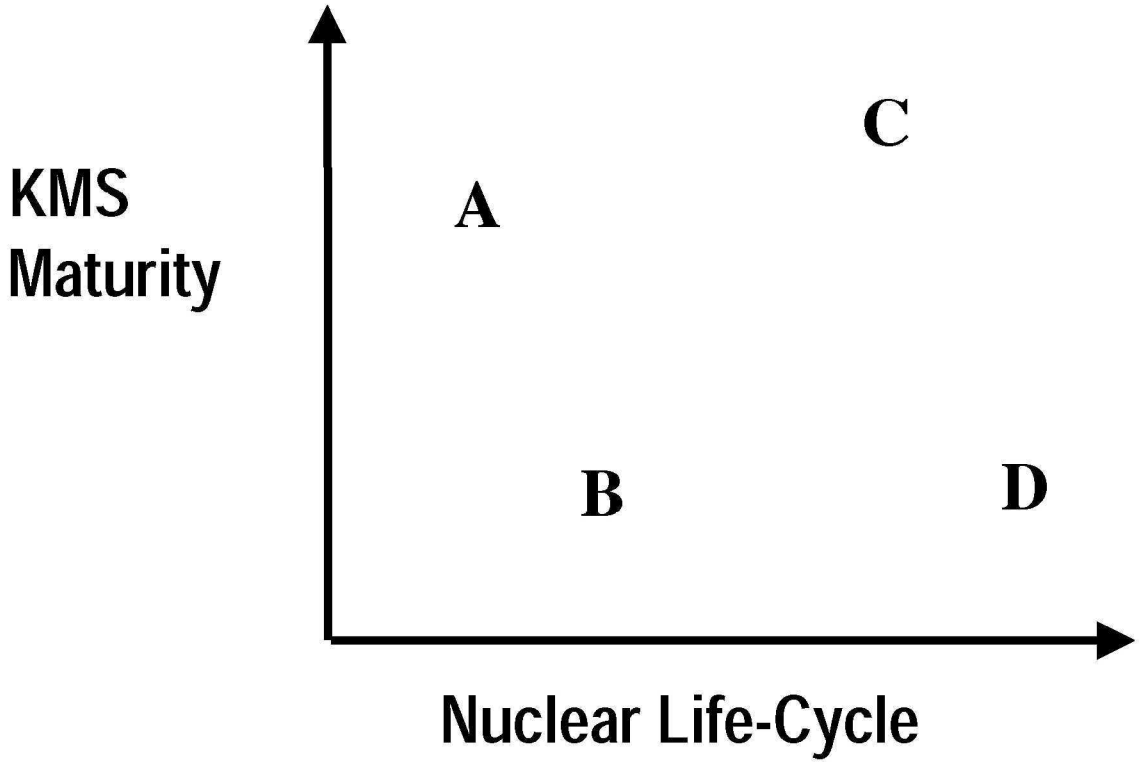
Why KM Important to NPPs (cont'd)

- Maturing industry:
  - Attrition has highlighted vulnerability to loss of tacit knowledge (lack of systematic knowledge retention approach)
- Aging fleet of plants and need for refurbishment
  - Design basis information critical (keep up to date)
- Need for the next level of productivity gains:
  - deregulation and competition
  - rising operating costs
  - opportunities arising from technology convergence and organizational/industry maturity
  - move towards "lean" operations and maintenance

Factors Influencing KM Adoption in NPPs

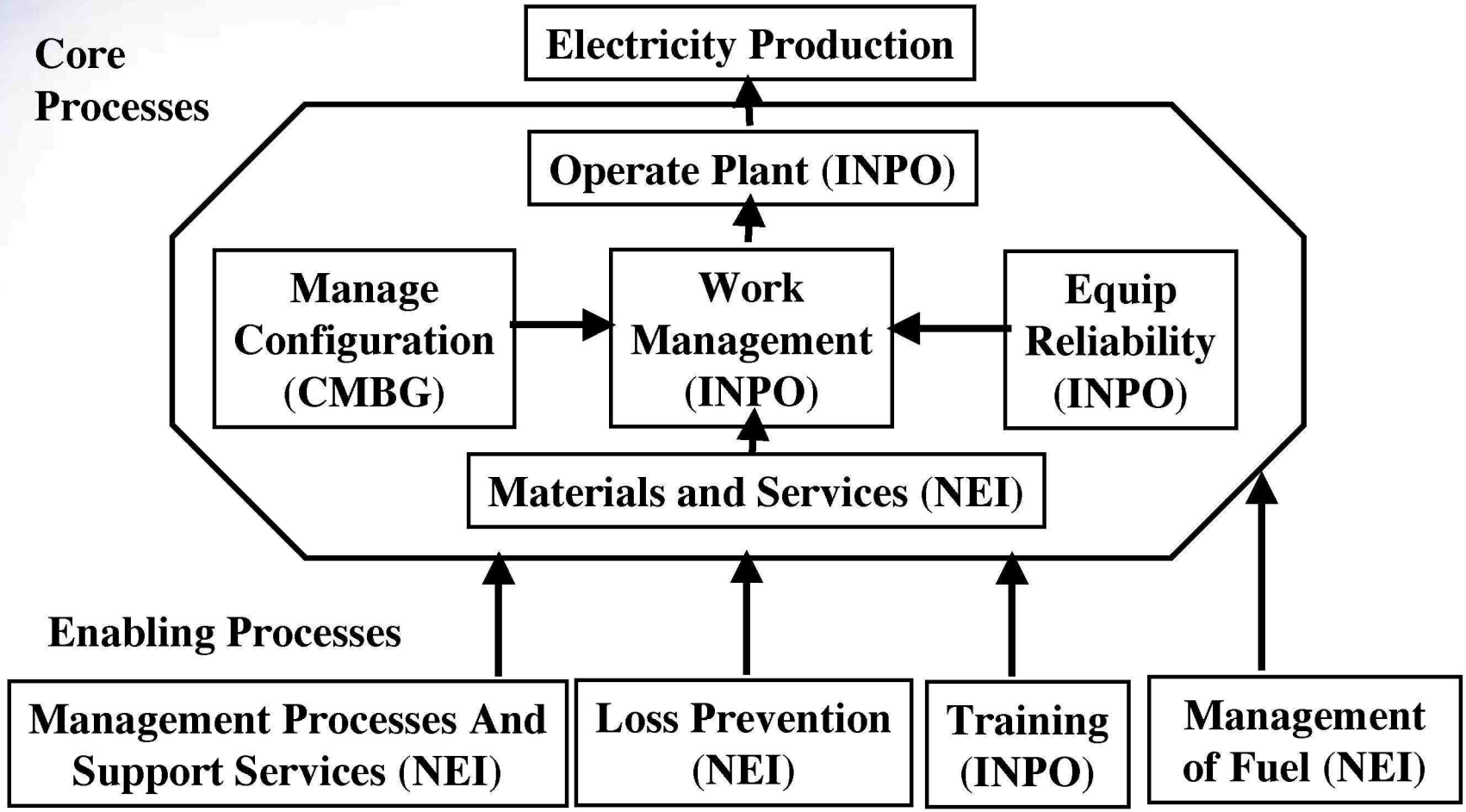
- Local availability of skill types (supply)
- Type of facility (NPP, research reactor, # units)
- Station organizational culture
- Specific KM risks
- Specific KM opportunities
- Existing staffing levels/profile
- Governance (owner – operator relationship)
- Regulatory Framework, relationship
- Design Organization Issues (IP, acquisitions, support etc.)
- High local labour rates (incentive for "lean" OM&A)
- Current KM maturity

Factor's Influencing KM Adoption (Interpretations, Priorities, and Approaches)



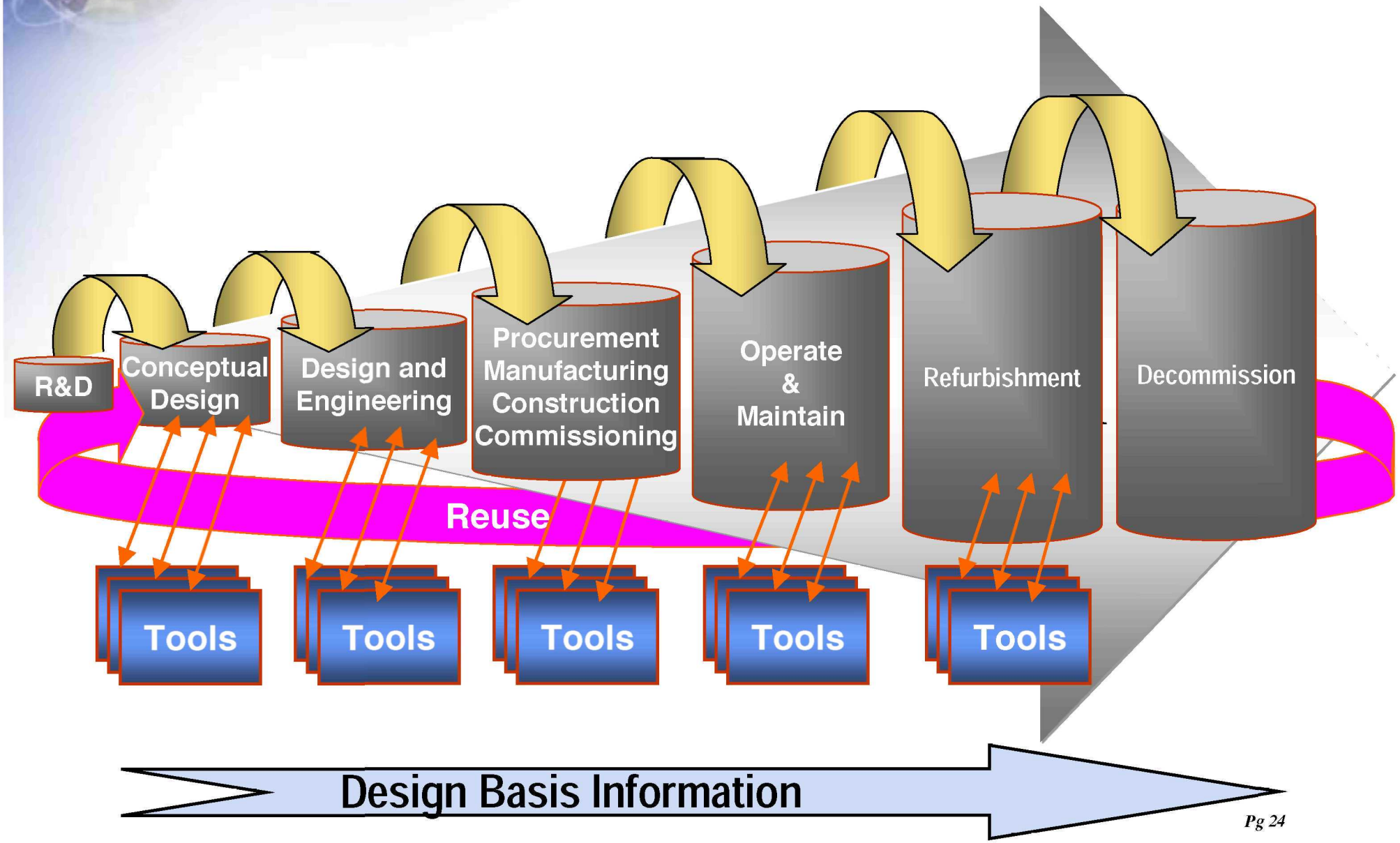
Note: A,B,C,D: represent organizations and their relative mapping

KM Applicable to All Plant Processes



(Source: The Standard Nuclear Performance Model (SNPM) from NEI, EUCG, and INPO)

KM in the Nuclear Life-Cycle



3. Examples of KM in NPP Maintenance

KM in the NPP Maintenance Context

Goal: effective KM processes:

- –Increase production
- –Reduce workload
- –Improve maintenance processes
- –Improve productivity
- –Permit measurement maintenance performance

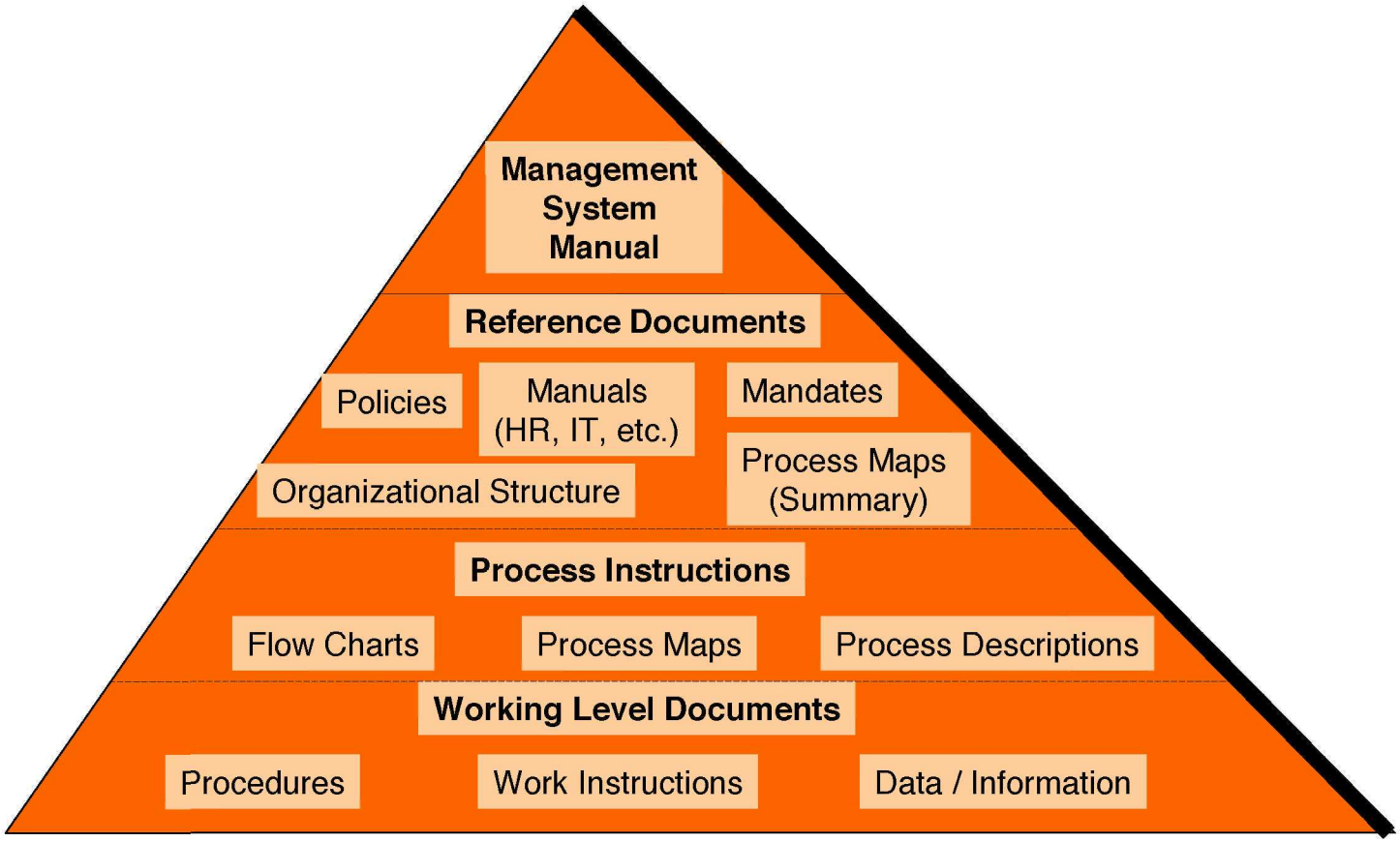
Method: enhance and enable the information and knowledge "flows" and "stores" in the maintenance process:

data -> information gathering -> learning -> knowledge -> knowledge capture/retention -> knowledge sharing -> knowledge utilization -> pro-active improvement

Examples of Knowledge Management in Nuclear Power Plant Maintenance

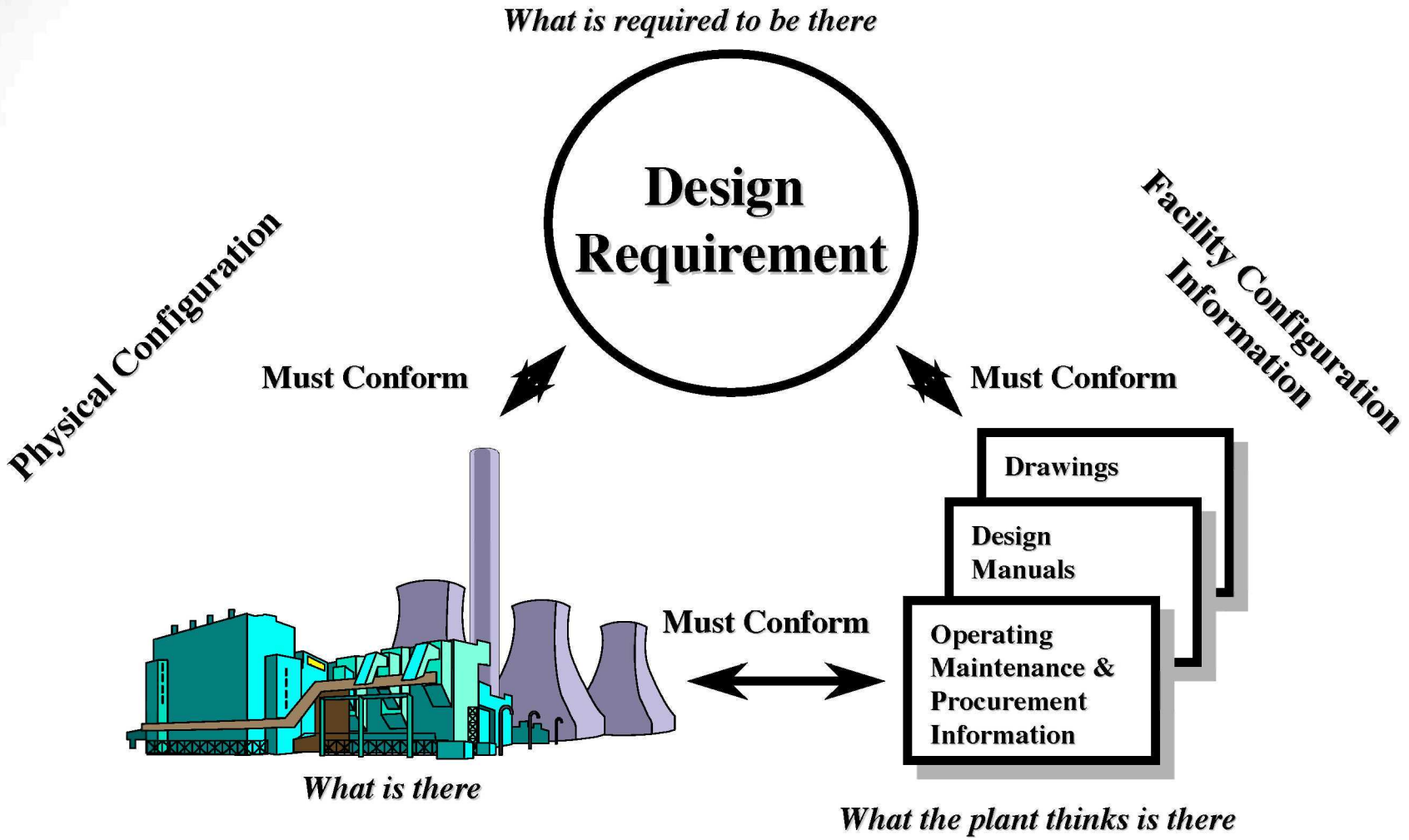
1. Work Process Management System
2. Plant Design Basis & Configuration Management
3. Specific Configuration Management Tools
4. Tool Integration Supports Plant Configuration Management
5. High Fidelity 3D CADDS Model
6. Equipment Status Monitor

Example 1: the Work Process Management System

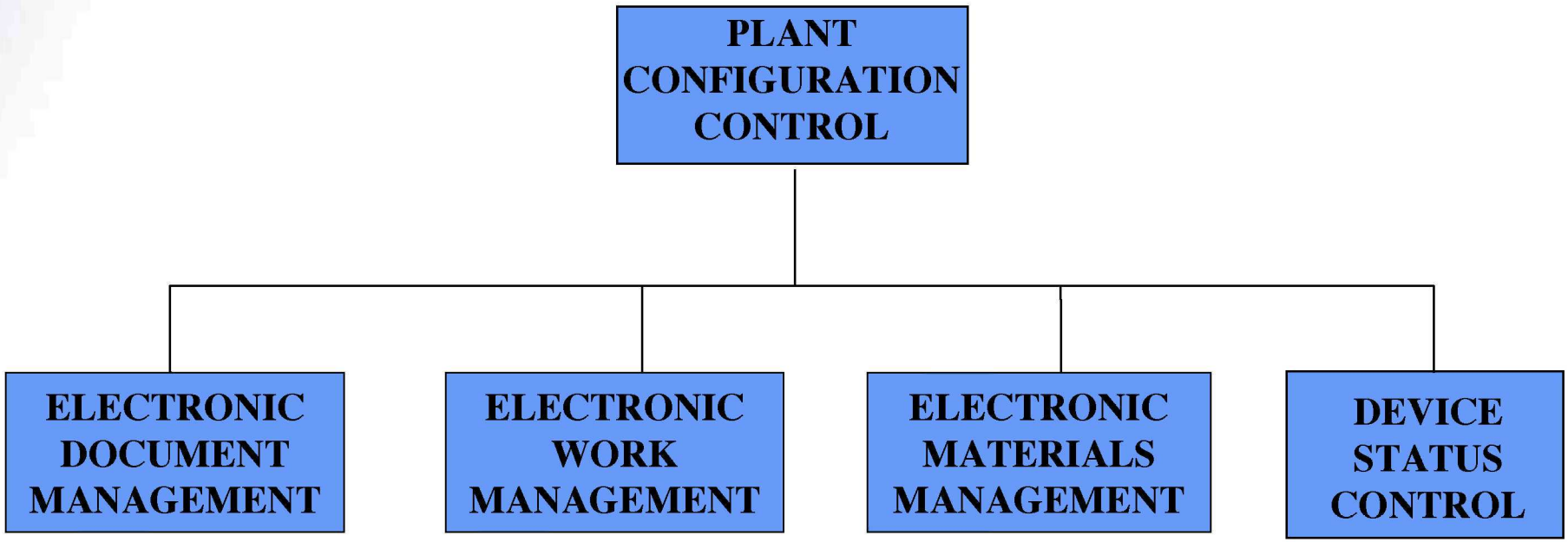


(also applies to NQA, EQ, Safety Compliance)

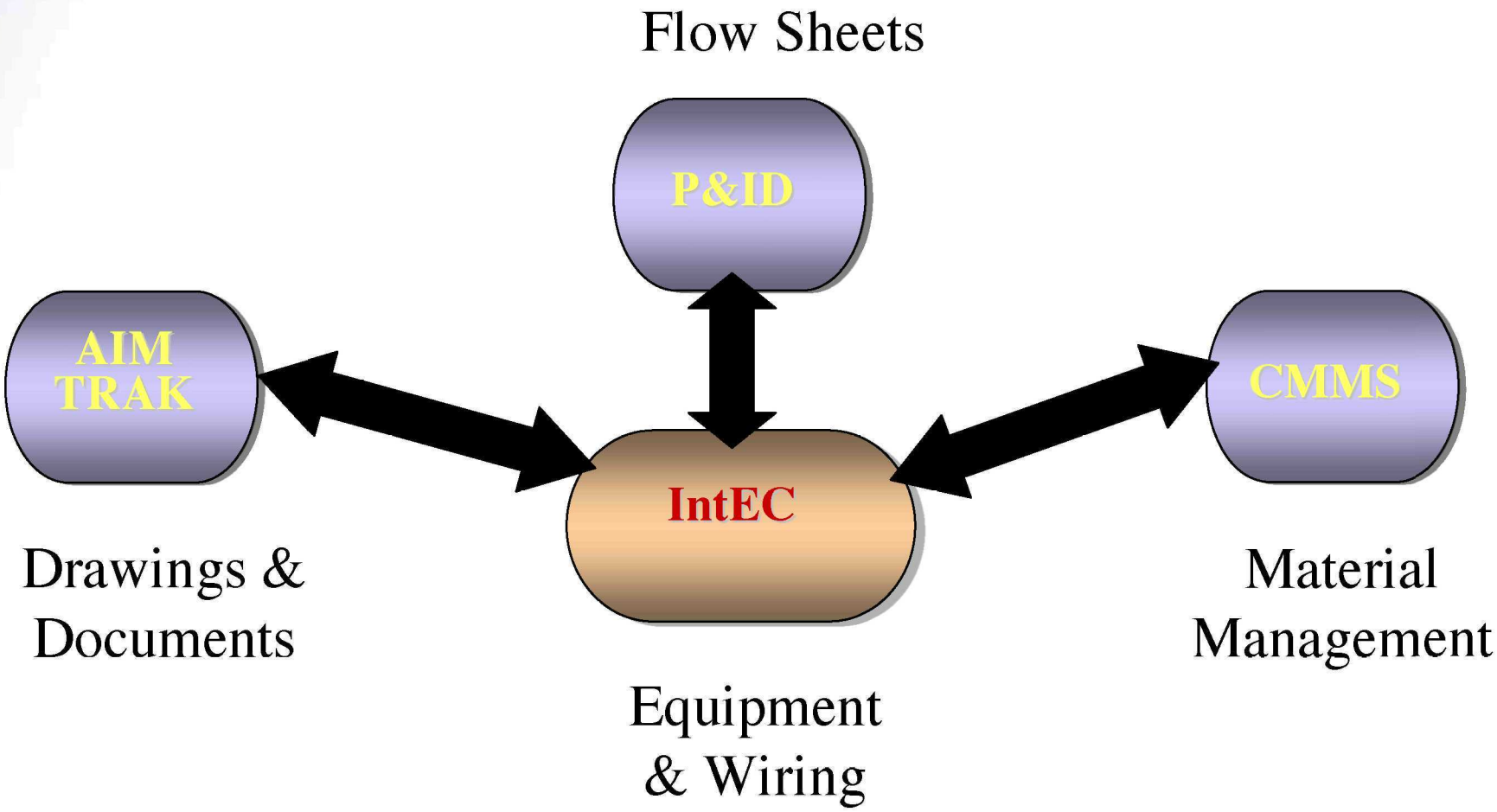
Example 2: Plant Design Basis & Configuration Management



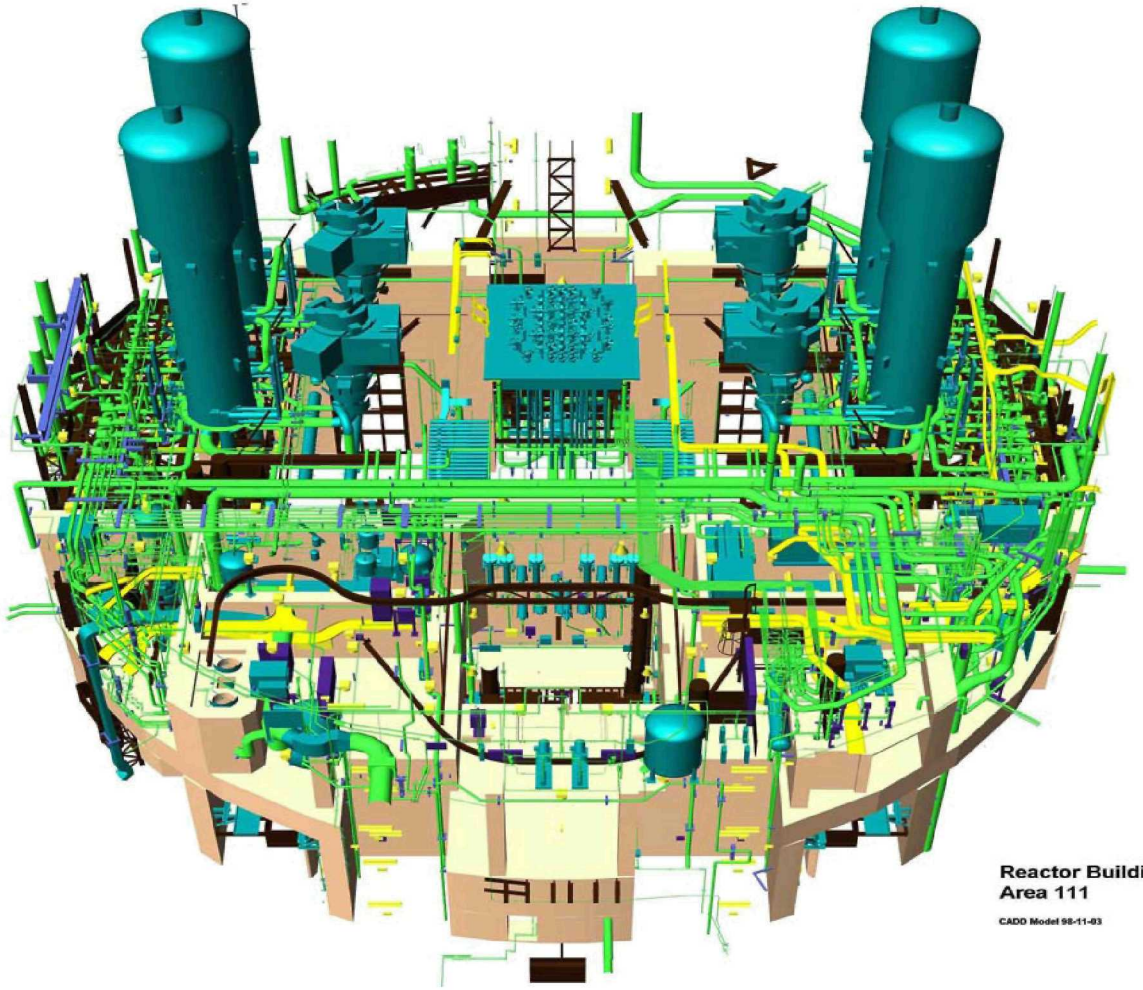
Example 3: Specific Configuration Management Tools



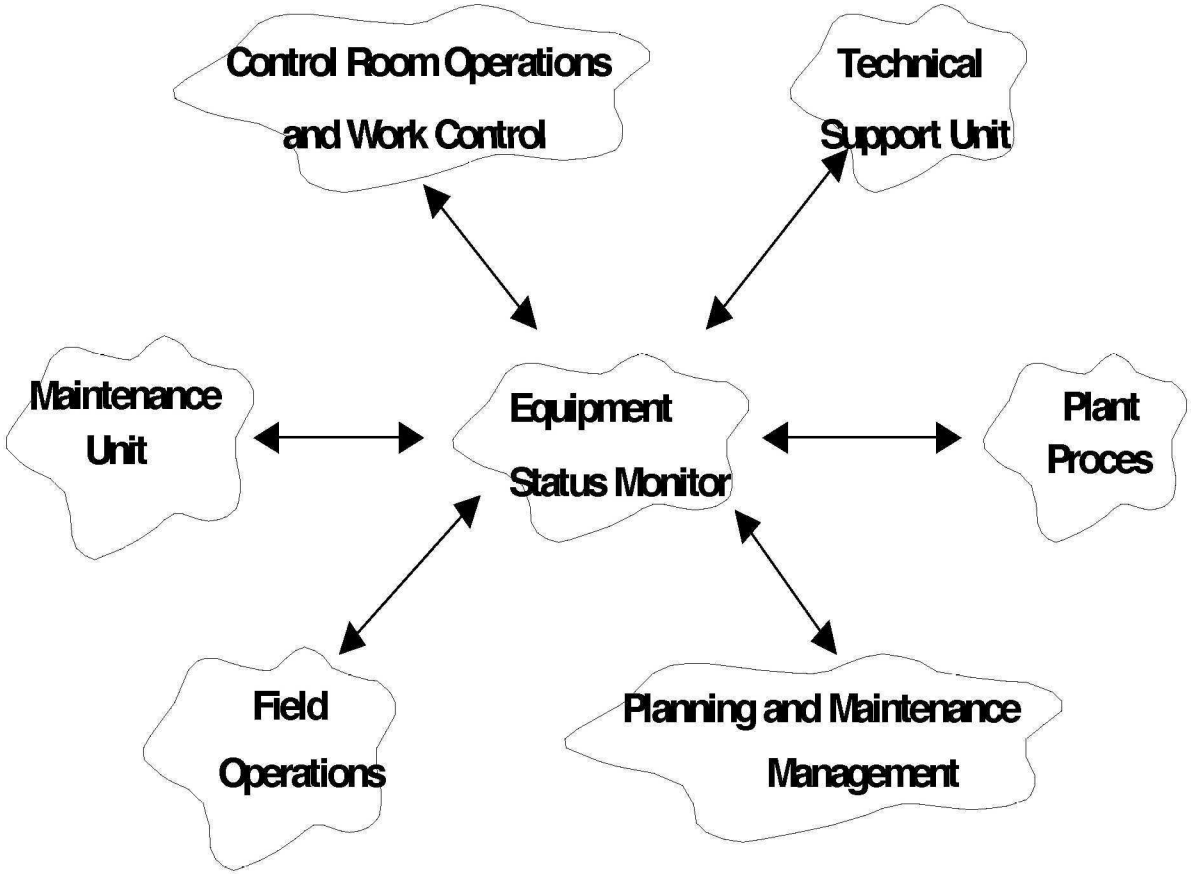
Example 4: Tool Integration Supports Plant Configuration Management



Example 5: High Fidelity 3D CADDS Model



Example 6: Equipment Status Monitor

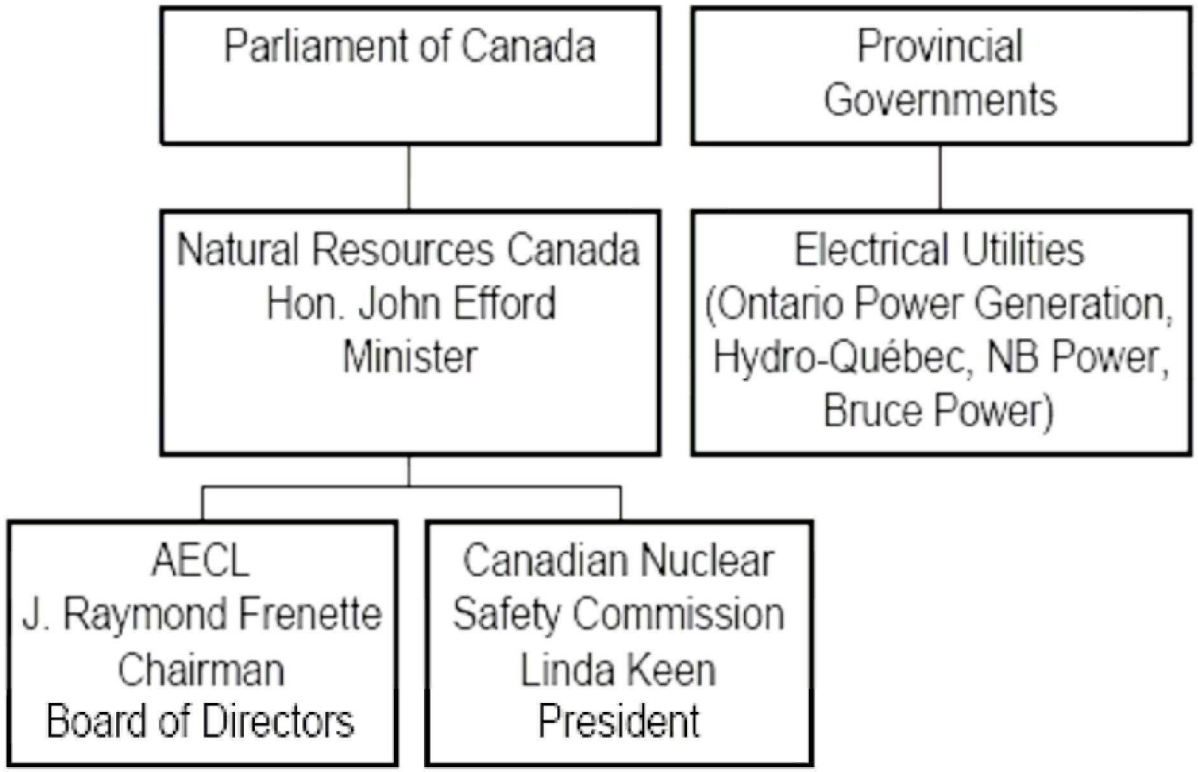


The Canadian KM Scene

The Key Players

- Atomic Energy of Canada Limited (AECL)
- Canadian Nuclear Safety Commission (CNSC)
- Canadian Nuclear Utilities
  - Ontario Power Generation (OPG)
  - Bruce Power
  - Hydro Quebec
  - New Brunswick Power
- CANDU Owners Group (COG)
- Canadian Universities and Technical Colleges
- CANDU Suppliers & Consultants
- MDS Nordion (medical isotopes)

Organization of Canada's Nuclear Industry

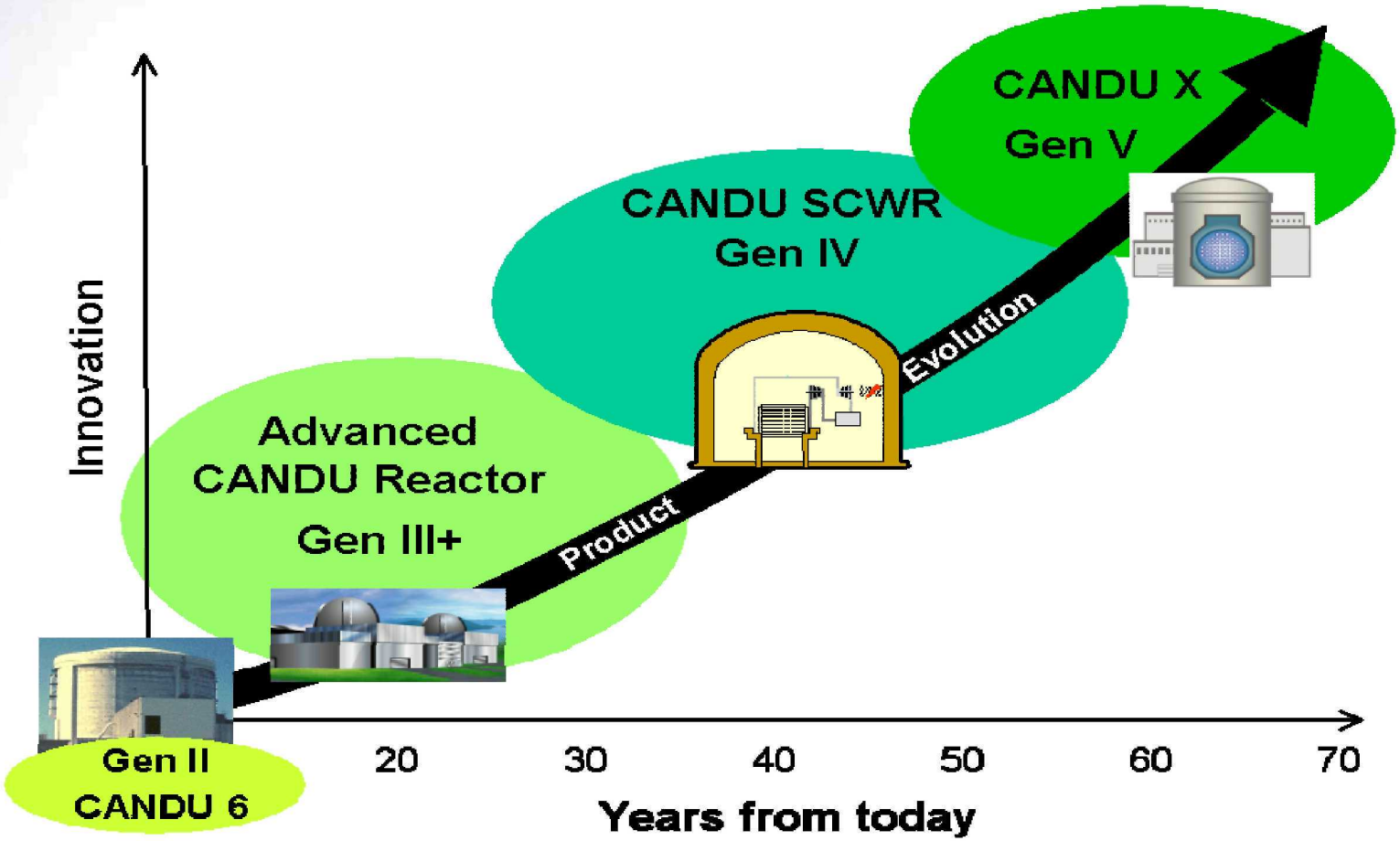


- CANDU Owners Group (COG)
- Canadian Universities and Technical Colleges
- CANDU Suppliers & Consultants
- MDS Nordion (medical isotopes)
- **about 150 private companies also benefit from the industry**

Regulator Concerns re. KM

- Resources (adequate technology capability)
- Loss of knowledge (attrition)
- Resistance to change (cost & use of new technology)
- Strategic risk areas for regulator:
  - aging of nuclear facilities
  - new reactors
  - new reactor technology
  - Long term nuclear waste management

Evolution of CANDU Systems



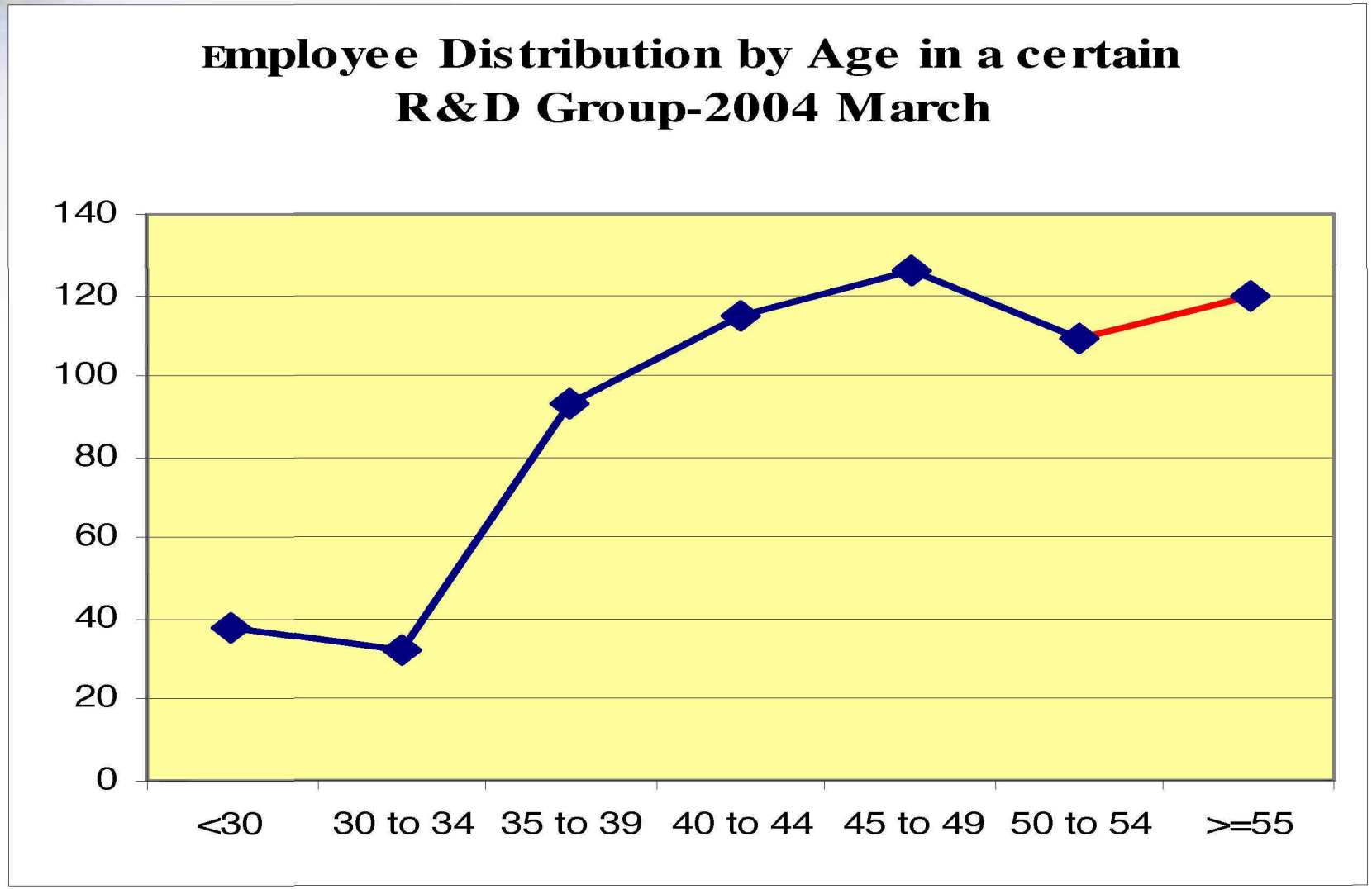
AECL's KM Strategy

Elements of AECL's Nuclear Knowledge Management Strategy: 4 Key Areas

1. Maintain Required Staff Levels and Competency – Human Resources Management
2. Capturing and Preserving Existing Knowledge - Engineering Tools
3. Sharing and Pooling Knowledge - Information Management Systems
4. Develop New Technology (and Knowledge)

1. Maintain Required Staff Levels and Competency – Human Resource Management

- Hiring, training, retain, career development, etc.
- Education
- Change business approach
  - Economies of scale
  - Introduce technology and improve processes to ensure focused preventive maintenance program
- Demographics of Nuclear Workers (next slide)
  - HR Capability Study
  - Impact of retirements, Succession plan developed
  - Hiring / training strategy (short, medium and long term)


Employee Distribution by Age in a certain R&D Group-2004 March
140
120
100
80
60
40
20
0
<30
30 to 34
35 to 39
40 to 44
45 to 49
50 to 54
>=55

2. Capturing and Preserving Existing Knowledge with Engineering Tools

- Computerized Engineering Tools (3D CADDS, TRAK)
- Preserving and Advancing Maintenance Technology in support of Plant Life Management:
  - Robotics and remote technologies
  - Inspection and repair
  - 3D simulation or Virtual Prototyping
- On-going CANDU Projects (recently in China, Romania)

3. Sharing and Pooling Knowledge – Information Management Systems

- Knowledge Sharing Systems
  - Operating Experience
  - Feedback Monitoring System
  - Project Reporting System
  - Customer Connect
  - Others (AIMS, QIS, etc.)
- SMART CANDU Technology (System Health Monitoring)

4. Develop New Technology (and Knowledge)

i. Advancing Nuclear Technology

ii. Maintaining R&D Capabilities (People and Facilities)

iii. Collaborations and Partnerships

i. Advancing Nuclear Technology

- Design and Development of Advanced CANDU Systems
  - GEN II (CANDU 6) & GEN III (Advanced CANDU Reactor / ACR)
  - GEN IV (Supercritical Water Reactor (SCWR)
  - GEN V (Evolution of the SCWR)
- Preservation of Design & Analysis Competency
- Maintenance of extensive Network of CANDU Suppliers
- Work is done under a formal Quality Management System
- Adopting the Canadian Framework for Business Excellence

ii. Maintaining R&D Capabilities People and Facilities

- Pre-requisite to advancing Nuclear Technology
- Comprehensive reviews through AEACL, COG & CNSC
- Major Canadian Facilities are still available
- Supplementary R&D to support the ACR is in progress
- R&D in support of Plant Life Management is on-going

People

Required elements:

- R&D in support of Plant Life Management is on-going
- Identify core capabilities & key supporting skills
- Analysis of AECL business needs
- Analyze existing skill/talent mix& demographics
- Forecast future skill/talent requirements
- Identify gaps and action plan
- Identify, attract & hire qualified staff
- Retain & develop expertise

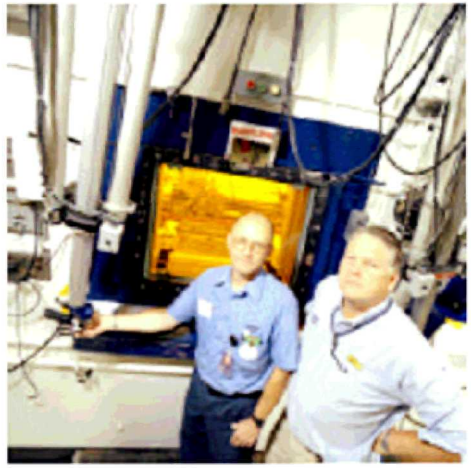
Facilities

Fuel Fab Lab

Thermalhydraulics Lab

Surface Science Lab

Hot-cells



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iii. Collaborations and Partnerships

- International
  - GEN IV, & bilateral US cooperation (Idaho National Lab; INERI)
  - EURATOM, JRDC (Korea), NPIC (China), EPRI (US)
  - Other international bilateral – China, Korea, Argentina, Russia, Japan
- National
  - Federal & Provincial Governments, NRCan, CNSC, NRC
  - Nuclear Utilities – OPG, Bruce Power, NBP, HQ
  - R&D labs - Kinectrics, Stern, B&W, GE, RPC
  - CANDU suppliers and manufacturers
  - CANDU Owners Group
- Educational Institutes
  - UNENE
  - NSERC, Industrial Research Chairs
  - Universities and Colleges

KM Initiatives with Canadian NPPs

Status of KM in Canadian NPPs

- Growing awareness of strategic importance of and dependence on effective KM (aging NPP fleet, attrition)
- Growing awareness that KM has many components and should viewed as a system and managed strategically
- Supporting IS infrastructure and KM tools are diverse and degree of integration limited
- Utilities not always able to determine effectiveness of KM and to identify key areas in need of improvement
- Implementation of IS infrastructure improvements slower than expected due to complexity and diversity of systems
  - e.g. implementation experience with ERP systems adoption

Why KM in NPPs Important to AECL

- AECL is lead NPP designer and a full-service supplier
- Stations are AECL's primary customers
- Performance of existing CANDUs important to sale of new reactors
- Improved KM seen as one of the vital elements in achieving better plant performance
- 22 generating units in Canada
- KM is key to our ability to support existing plants.
- Good KM is a long-term objective
- Improve plant performance by providing KM support tools
- Organizational effectiveness improved with more integrated plant KMS
- Effective KM leverages human capital and enables pro-active decision making and a quality culture

AECL's KM Initiatives with CANDUs

1. SMART CANDU™ development program
2. Improved awareness fundamental KM principles (workshops)
3. Implementation of KM tools and support
4. Establish "communities of practice"
   - Sharing of KM best practices (e.g. chemistry, I&C)
5. KMS Assessment (monitoring and feedback)
   - Sharing of best practices (assist visits)
   - Industry benchmarks and self-assessment tools
   - Specific KM analysis & guidance (key result areas)

Conclusions

- Nuclear is a knowledge-driven industry.
- KM plays a key role in organizational performance
- Nuclear Knowledge Management is of strategic importance.
- A key element is collaboration of all sectors of the industry (e.g. CANTEACH, UNENE, COG / AECL / utilities programs etc.)
- Advancement in Nuclear Technology requires preservation of a critical mass of R&D Capabilities
- Much still to be done to ensure a smooth transfer of Knowledge to a new generation of Nuclear Knowledge Workers
- KM initiatives can improve O&M performance of NPP staff.
- Development of the KMS in AECL and our CANDU plants a priority.