“Already Available Training Solutions to the Global Challenges of the Nuclear Renaissance from the Simulation Industry”

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The Nuclear Re-birth

• The crisis at Fukushima plant has refocused world’s attention on the future of nuclear power → a review of nuclear safety standards is called for

• While still too early to estimate final impact of the accident on the forecasted nuclear expansion, the need to train a new generation of nuclear engineers and technicians is real

• We present 4 innovative applications already available from simulator providers:
  – End-user friendly simulation platform T-REX
  – Training & engineering EPR Simulator
  – PWR Basic Principle Simulator SIREP
  – On-line Micro Simulation tool MicroSEL
T-REX (Thunder Real Time Executive)

- The only **totally brand new** platform built in the last decade
- **End-user friendliness** as main design objective: engineers, instructors or students need **minimal training to take the most of the tool**
- **Very low requirements**, easy to set-up, install and upgrade, widening usage to classrooms and other staff
- Technology allowing simulators to be run off of storage media or remotely over the Internet
On the way to become a standard in the U.S. market

- Among all the simulator upgrading projects delivered or planned since the product was launched in 2006, only two plants have chosen a different platform:

  - Bellefonte
  - Calvert Cliffs
  - Catawba
  - Columbia
  - Davis-Besse
  - Duane Arnold
  - Ginna
  - Grand Gulf
  - Hope Creek
  - Indian Point 2
  - Indian Point 3
  - Millstone 2
  - Millstone 3
  - Monticello
  - Perry
  - Prairie Island
  - U.S. NRC
  - V.C. Summer
  - Watts Bar
  - Callaway
  - Crystal River
Next generation reactors, new generation simulators

- Antecedent: Ling Ao II
  [CPR-1000, CGNPC, China]
  V&V simulator was also used in specific training sessions, before full-scope training simulator – delayed for months – was ready

- Nowadays, both uses are possible with the same simulator thanks to advanced tools like ALICES

- Plant design evolves and simulator role increases, becoming significant from early stages

- Innovative strategy applied to: Flamanville 3
  [EPR, EDF, France] & Taishan [EPR, CGNPC, China]
  Early identification of design mistakes and data voids ...
  ... therefore, time and costs savings

<table>
<thead>
<tr>
<th>Simulator features</th>
<th>Training</th>
<th>Engineering</th>
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<td>Scope of simulation</td>
<td>Full</td>
<td>Limited</td>
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<tr>
<td>Physical phenomena models</td>
<td>Simplified</td>
<td>Accurate</td>
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<td>Real-time results</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Instrumentation &amp; Control</td>
<td>Accurate</td>
<td>Simplified</td>
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</table>
**Engineering and training support all-in-one**

- **Engineering** and design:
  - $t_0 - 3.5$ years: Validation of accidental strategies, Safety probabilistic studies
  - $t_0 - 2.5$ years: Validation of accidental procedure, Overall validation, human factor studies

- **Training** and operation:
  - $t_0 - 2$ years: Support and validation of periodic tests procedure, Initial operator training on dedicated functions of plant
  - $t_0 - 1.5$ years: Beginning of operators full-scope training

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**Fuel Core Loading**

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**Fuel Core Loading**
The need: Skilled new nuclear staff

• Many of the largest companies have started recruitment programs due to:
  – Retirement of senior professionals
  – Development of new projects

• Specific case: GDF Suez
  – Operates all reactors in Belgium (7x PWRs)
  – Currently employs about 4000 people with nuclear skills
  – 2015 hiring forecast: + 1000 engineers and technicians

«Nuclear Trainees Program» 1-year course since 2006:
  – Mixing theoretical learning and field experience
  – More than 400 hours of hands-on training
  – Covering the entire nuclear chain: engineering & design, construction, operation, waste and fuel management, maintenance and dismantling
  – CORYS T.E.S.S. is in charge of the PWR training → SIREP simulator
**The tool: Basic Principle Simulator**

- Developed with ALICES
- **Scope:**
  
  Normal operation, start-up from cold shut-down to full power, stretch-out operations

- Although models are simplified, it comprises:
  
  - **Main hydraulic systems:**
    - SGs, PZR, BOP
    - RHR, CVCS
    - Turbine Bypass
  
  - **Physical phenomena:**
    - Feedback effects
    - Xenon poisoning

- Main control systems allow automatic and manual modes

*SIREP-1300 is based on French 1300 MW PWRs*
New concept: On-line Micro Simulation

• In 2008, EDF’s Training Department (UFPI) requested CORYS T.E.S.S. to develop a new solution to address the gap between theory classes and simulator sessions:
  – Basic skills acquisition before focusing on more complex notions
  – Courses more attractive to the young audience

• MicroSEL:
  – Light weight self-contained modules dedicated to specific subjects
  – User interacts with a real-time simulation model in a virtual environment
  – 2 different applications:
    • Under instructor supervision in a classroom → theory support
    • Stand-alone learning tool managed with LMS → practical exercises

• 17 modules were delivered in 2010, 9 more are scheduled for 2011
  – After that, EDF engineers will be able to develop new modules in-house
Better interaction, better learning

• Advantages:
  – Interactive graphics
  – Model scope can be adapted to the need
  – Modules created using CBT multimedia content generation software → easy to update in-house
  – Runs on standard PC or Web browser

• Limitations:
  – Models are simplified
  – Simulation scope to be taken into account during the pedagogical specification
Thank you

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