3D Maintenance Project

VR in outage units at EDF

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3D Maintenance Project

Presentation plan

The EDF context

The maintenance project

- The equipment replacement simulation topic
- The moving packages topic
- The data topic

Conclusions

EDF context (1)

4 main maintenance evolutions for EDF

- Due to the open market, having a high level of ***availability*** is essential all the year
- Important constraint of ***time*** on the outage :
  - ✓ from the basic outage (25 days)
  - ✓ to the steam generator replacement (120 days)
- Extension of **life duration**
- Evolution of the **Safety Authorities rules** (evolution of the process for EDF)

EDF context (2)

2 main maintenance constraints in the Reactor Building

- The lack of ***space*** on the floor (reactor building dimension)
- Only one ***mean of handling*** : the polar crane (on critical path)

EDF context (3)

Tool constraint

- There is no efficient tool to manage the « moving packages » expertise : only a 2D drawing tool currently exists
- People of maintenance are not computer specialist, their job is on the “ground”

Expertise constraint

- The expertise in coordination and moving packages are in the memory of people and not formalized
  - ✓ these people go into retirement in a short term
  - ✓ EDF subcontracts these tasks to external suppliers (loose of knowledge for EDF)
- The planning isn’t enough shared between maintenance staff

EDF context (4)

3 main consequences

- Need to optimize organization :
  - ✓ preparation of the outage
  - ✓ coordination during the outage
  - ✓ space on the floor
  - ✓ use of the polar crane
- Need to share knowledge : the experience, the expertise between power plants (especially about the incidents)
- Need to transfer expertise : teach suppliers or new EDF employees

3D Maintenance Project (1)

Our short term goals

- Provide to the maintenance staff the definition of an organization and a method of work to help them to optimize the coordination during :
  - ✓ the preparation
  - ✓ the outage
- Enhance “memory”, teaching, sharing

3D Maintenance Project (2)

Our long term goals

- Use 3D day by day in maintenance outage (a way to help everyday activities of the maintenance staff) :
  - ✓ “Re-think” 3D to bring it from the design world to the maintenance world
  - ✓ Fit the 3D software with the existing Information System

3D Maintenance Project (3)

Our developments in progress

- The equipment replacement simulation tool : to simulate precisely a component replacement operation
- The moving packaging tool : to link the outage planning with a 3D view of the reactor building to study and to show the different packages places during the outage
- Define an Information System to gather and manage the objects (3D geometries and attributes)

3D Maintenance Project (5)

Project organization (1)

- 7 people in the R&D team with different expertise (activities analyze, model, software architecture, software technology)
- Three years project budgeted (2003 – 2006)
- Inner customer : EDF Nuclear Production Division

3D Maintenance Project (6)

Project organization (2)

- Way of working focus on the end user
- Very frequent interactions with the power stations :
  - ✓ 14 power plants are involved in this project
  - ✓ two workgroups, one focused on the planning issue, the other on the data issue;
  - ✓ experiments inside power plants

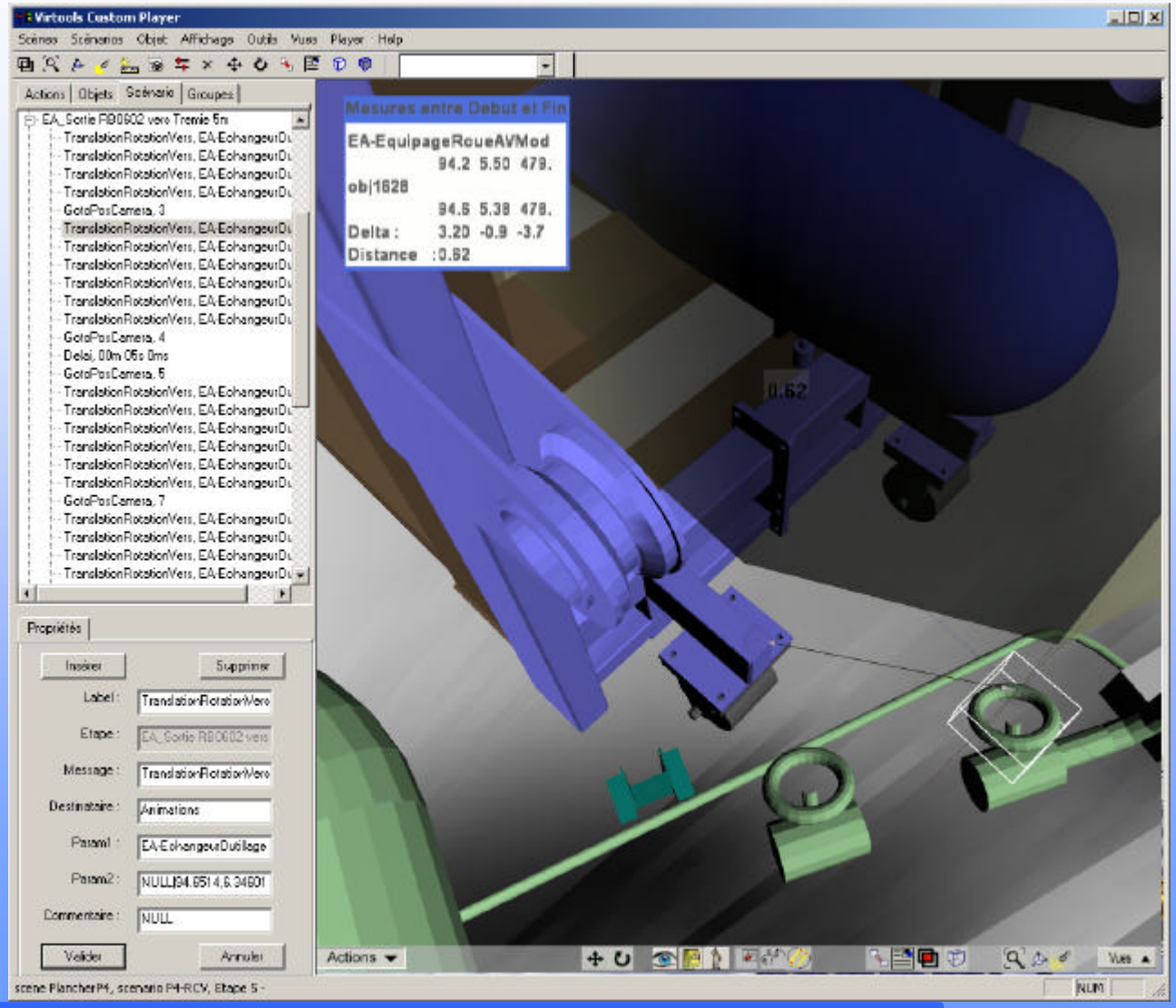
The equipment replacement simulation (1)

Definition and prototyping phase

- Analyze real cases to find out the requirements
- We use a game programming tool to build a mockup
  - ✓ Take into account physic (weight and cinematic)
  - ✓ Allow to use different type of data (3D geometry, point cloud)
  - ✓ Define interactive functions in the 3D scene

The equipment replacement simulation (2)

Demonstration



The packages moving tool (1)

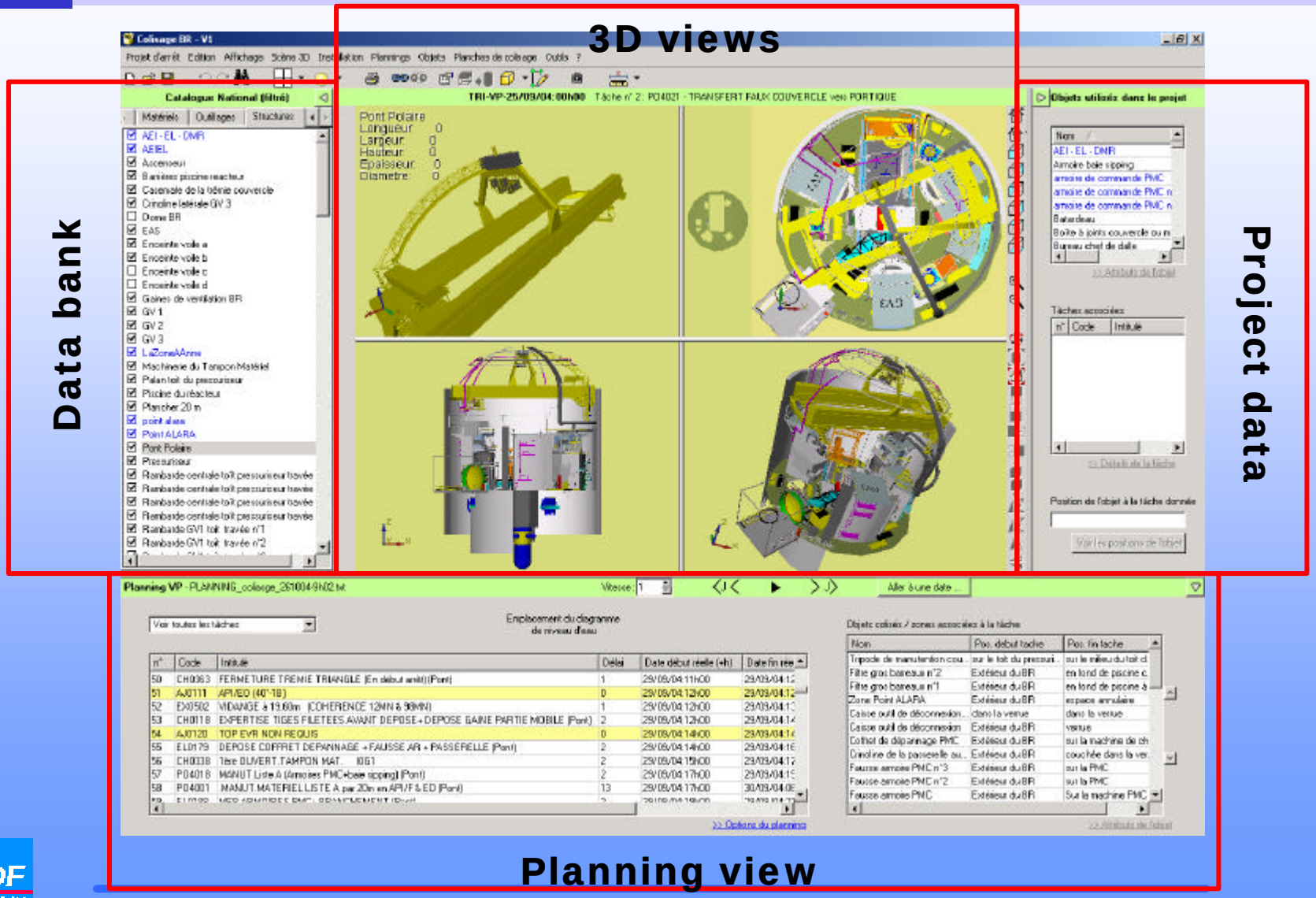
Beta release development phase

- To link the objects positions with the tasks of the outage planning
- First EDF industrial release at the end of 2005

Technology

- Platforms : Windows / Linux
- C++ development
- Use of free or open source technologies :
  - ✓ Qt for GUI and Framework,
  - ✓ MySQL for data,
  - ✓ Open Inventor Coin for 3D view;
- 3D data format : VRML

The packages moving tool (2)



The packages moving tool (3)

Demonstration

- The General User Interface : 3D data bank, planning, 3D views
- The link between a task and a 3D object
- The key positions : an object at a position in a task
- The creation of an object, of a zone
- The creation of a key position
- Load a new planning and identify the differences
- (The relative position)
- The player mode
- The 2D drawings

The packages moving tool (4)

Experiment in Tricastin NPP

- Tricastin → Nuclear Power Plant in the south of France
- Power: 900Mw
- Simple outage for refulling

The packages moving tool (5)

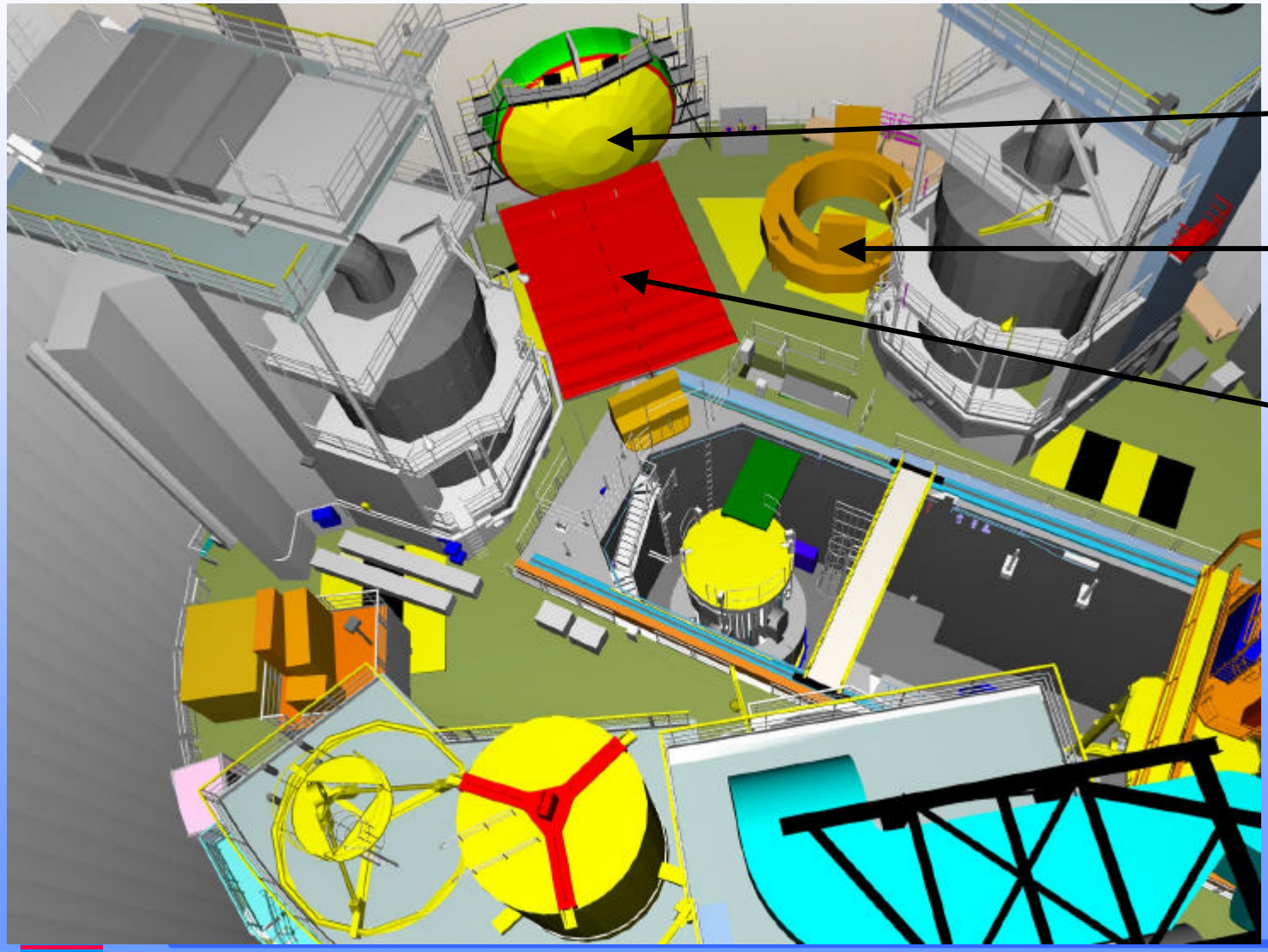
3 main steps in the experiment

1. Preparation of data → one month by R&D team :
   - ✓ Gather objects from the 3D scan and CAD data
   - ✓ Build a “landmark” for each object
   - ✓ Define all attributes
   - ✓ Define the most useful positions for each object

2. Preparation of the test before the outage → one week in Tricastin NPP realized by R&D team and by the coordination department staff of Tricastin :
   - ✓ Extract the planning from the planning tools
   - ✓ Fit the 3D scene with the real state of the reactor building before the outage
   - ✓ Link all the planning tasks to the objects and define the different object positions
   - ✓ Test new scenarios (for instance stock multistud tensioning machine close to the gate of the reactor pool to save one “open-close” of the equipment hatch door)

The packages moving tool (6)

Sample



The packages moving tool (7)

3 main steps in the experiment

3. Follow up the outage → 5 weeks in Tricastin NPP with the coordination and planification departments of Tricastin and with the R&D team for the observation :
   - ✓ Follow day by day the outage and take care of the incidents and delay
   - ✓ Load everyday the new planning and follow the difference with the previous one
   - ✓ Publish 2D drawings for the daily outage meeting where all expertise resources participate in

The packages moving tool (8)

The benefits in using moving packages tool

- Preparation :
  - ✓ Evaluate the feasibility of several scenarios regarding to their constraints and goals
  - ✓ Find out problems of coordination in the planning
  - ✓ Check the position of all the packages
  - ✓ Get a presentation support to illustrate the follow up of the outage and communicate about it
- During the outage :
  - ✓ Check all the inputs and outputs of the element
  - ✓ Check available spaces in real time
  - ✓ The outage team can consult the tool to follow up the state of the reactor building before their daily work
- After the outage :
  - ✓ Save the “memory” of the outage (with the incidents)
  - ✓ Save the state of the reactor building at the end of the outage
  - ✓ Demonstrate their expertise to the security inspection

The data topic (1)

What we have specified

- Define an Information System to gather and manage the objects (3D geometries and attributes)
- Because of project constraints, we have limited :
  - ✓ The functional scope (4 NPP, one unit, one outage)
  - ✓ The 3D geometry (one building and one flour have been scaned and rebuild)
- Develop a pilot version of the tool

The data topic (2)

The goals

- Extended the Information System to the 58 units (19 NPP) in France
- Not only the reactor building but also the turbine hall, fuel building
- The IS have to :
  - ✓ Gather the data from the scans and the packages moving projects
  - ✓ Check, organize and share the data between NPP
  - ✓ Manage life cycle of data
  - ✓ Manage composition of data : different for a simple refueling outage or a steam generator replacement
  - ✓ Allow consultation of an object geometry or attributes, of a previous outage (planning + 3D scene), of a scan (points cloud)

The future evolutions (1)

- The milestones of the project :
  - 2005 :
    - ✓ First specification of the equipment replacement tool
    - ✓ First release of the packages moving tool in EDF power plants
    - ✓ Finalized specification of the data information system
  - 2006 :
    - ✓ First development of the equipment replacement tool
    - ✓ Second release of the packages moving tool
    - ✓ First development of the industrial IS tool starts

The future evolutions (2)

- Extending to other business activity like petrol, chemistry, shipbuilding…
- Extend capacities of the IS by including links between different optimization : room on the ground, dose rate, services etc…
- Create a strong software structure for the different tools to support the outage unit projects : moving packages, dose, workshops interaction, all based on the outage planning

3D in maintenance : a challenge for VR research and development

- We have to prove that 3D can be used in wide scale during the maintenance outage
- We must develop tools which are a “real time” help for maintenance staff
- Expertise rule integration
- Physic – cinematic integration