

# Workshop IAR

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## **AMRA : Augmented Reality assistance in train maintenance tasks.**

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Laboratoire Systèmes Complexes (FRANCE)

# The AMRA project

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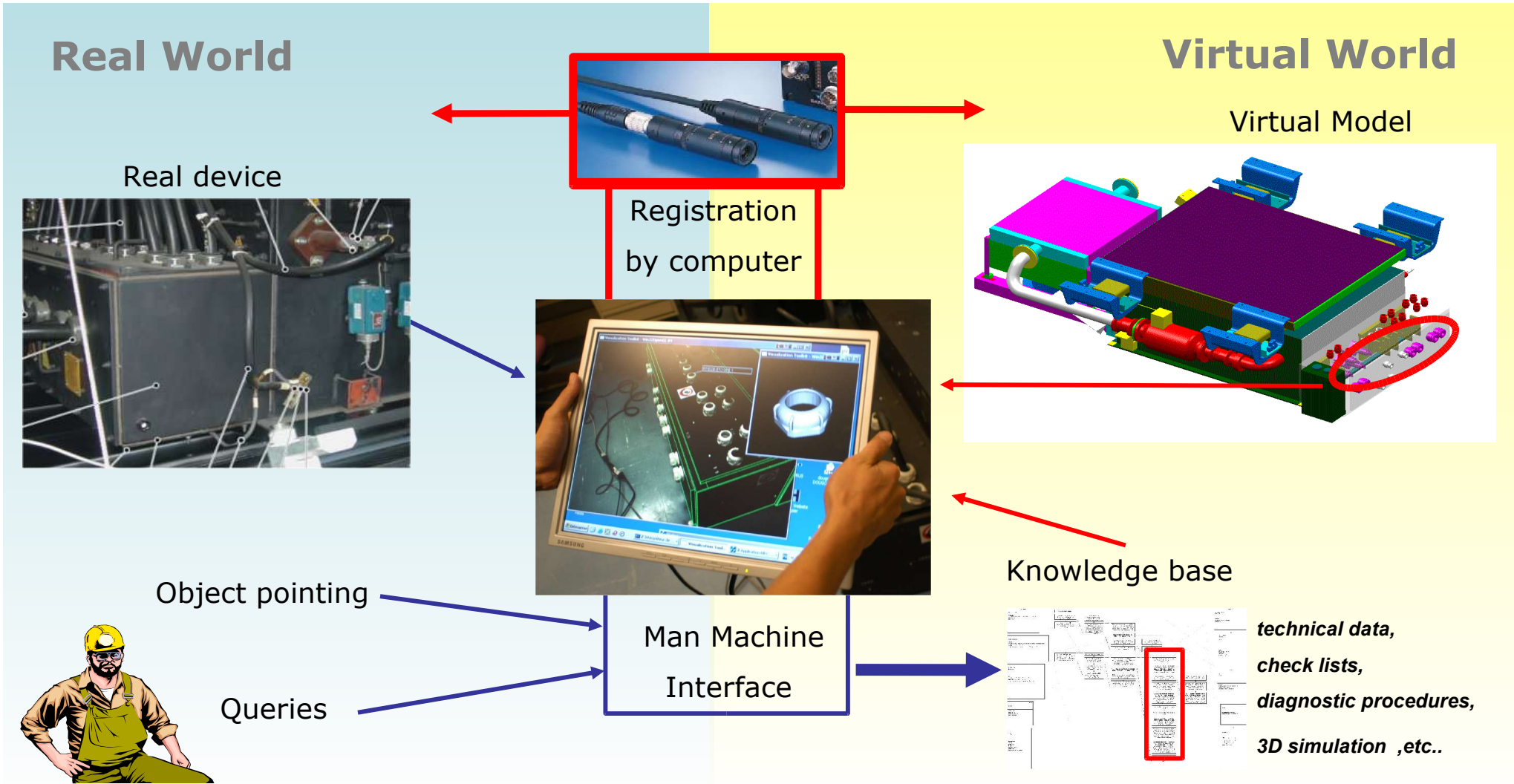
- **AMRA : Assistance à la Maintenance en Réalité Augmentée – Augmented Reality Assistance for Maintenance**
- **Started in May 2002, finished in May 2004**
- **A consortium of several French partners**
  - **ALSTOM Transport** (application provider)
  - **CEA – LIST** (research center)
  - **LSC** (university)
  - **ACTICM** (start-up)

# Challenging issues

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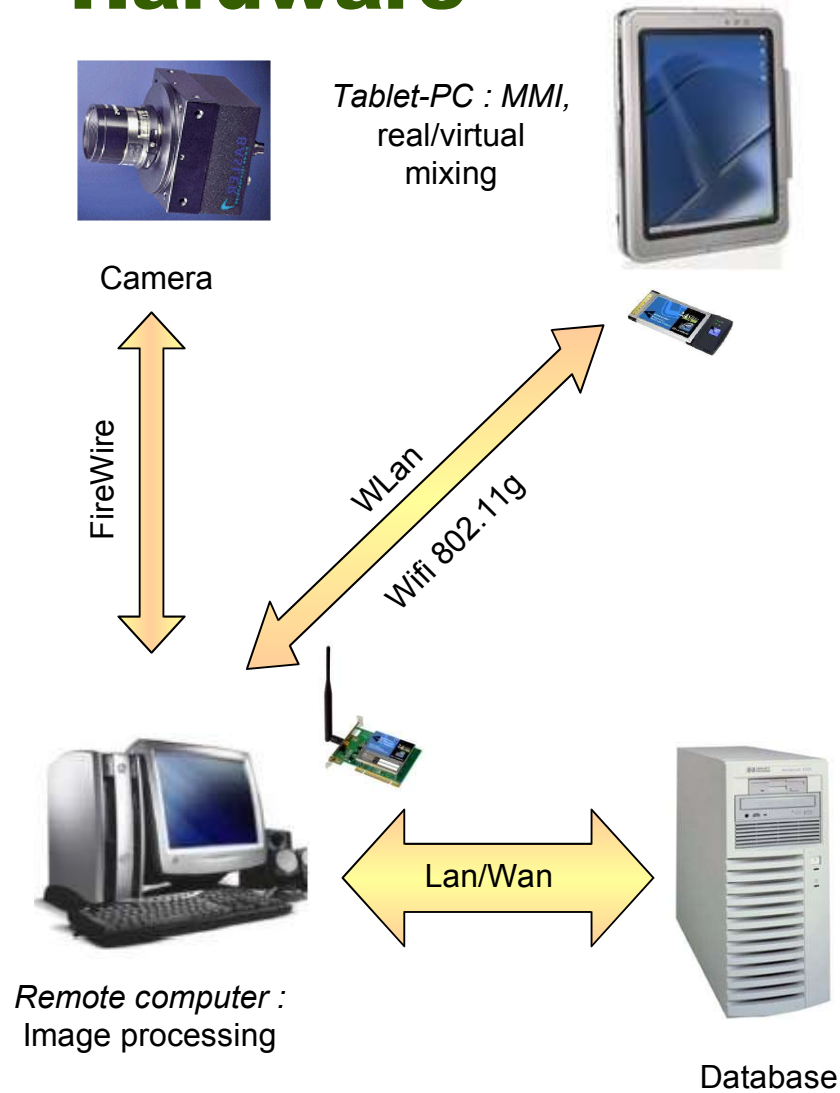
- **Alstom Transport's maintenance activity :**
  - Annual turnover : x100 Meuros
  - International contracts on the long term
  - Operating profits based on efficiency
- **Main issues**
  - Heterogeneity and complexity of equipment
  - Lack of local experience abroad
  - Mass of technical manuals (sometimes abroad)
- **How to access to adequate information ?**
- **How augmented reality can help ?**

# Overall Architecture (1/2)

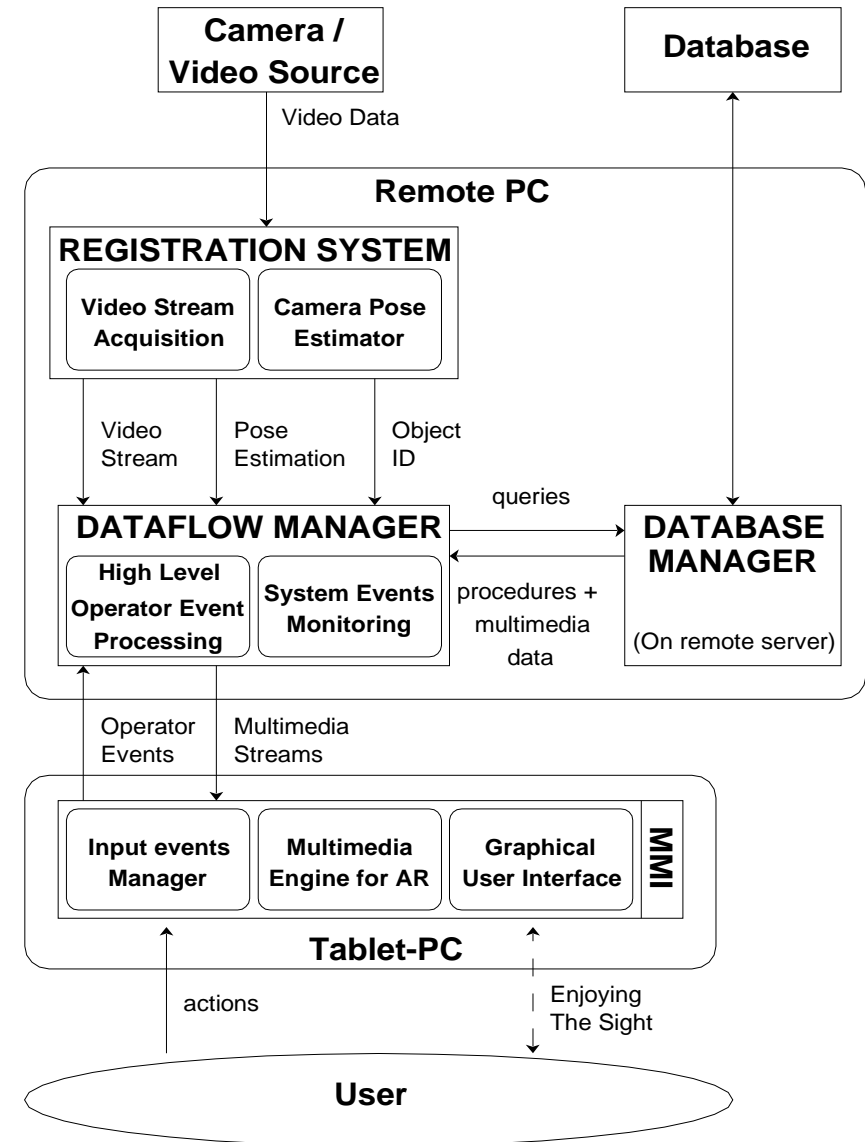


# Overall architecture (2/2)

## Hardware

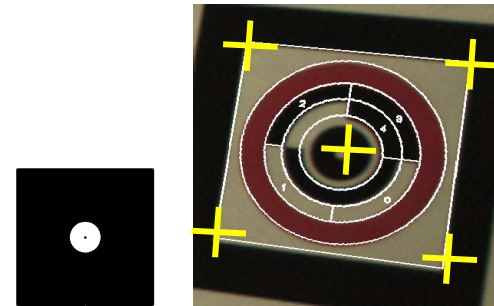


## Software



# Registration system (1/2)

- **Two kinds of fiducials**
  - Colored coded fiducials,
  - Simple fiducials
- **Coded fiducials detection**
  - Pose initialization,
  - Device identification
- **Iterative pose estimation**
  - Pose refinement using simple fiducials
  - Minimize 2D projection to find  $R$  and  $t$
- **Use CAD models for occluded fiducials culling**



# Registration system (2/2)

- **Processing rate**

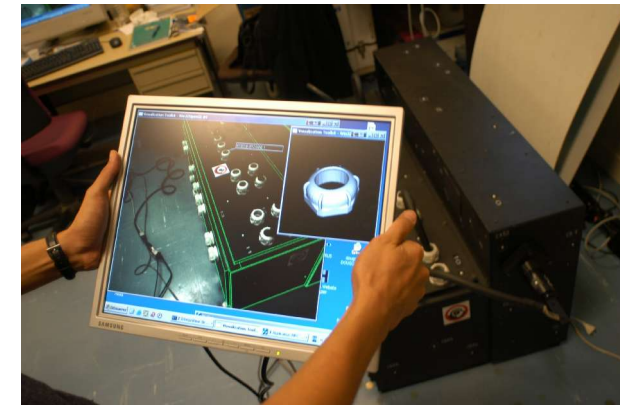
- 25 Hz ( P4 - 3GHz)

- **Accuracy (1 m range)**

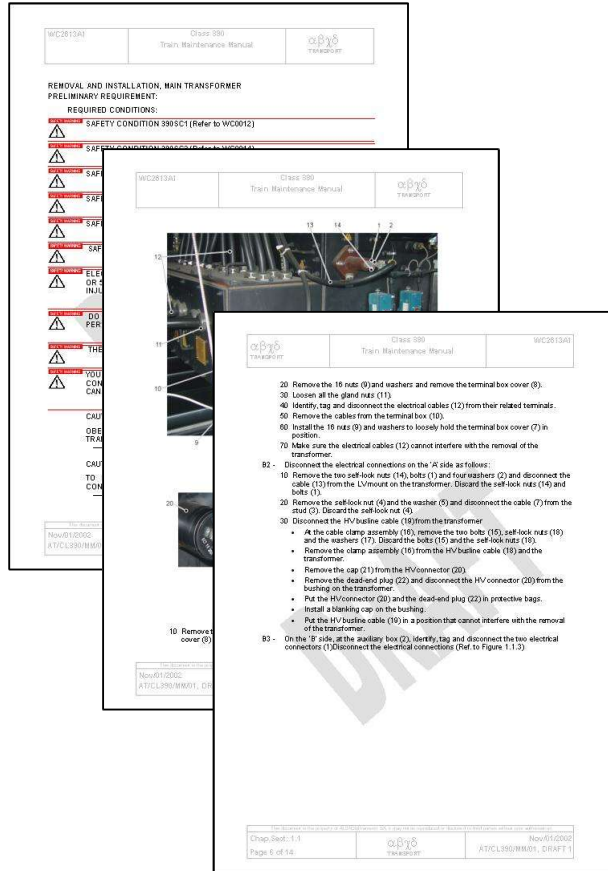
- +/- 3 mm in the worst case
- +/- 6° in the worst case
- always detected when slant < 60°

- **Prospects**

- Marker less tracking initialized using fiducials



# Transforming procedures (1/2)



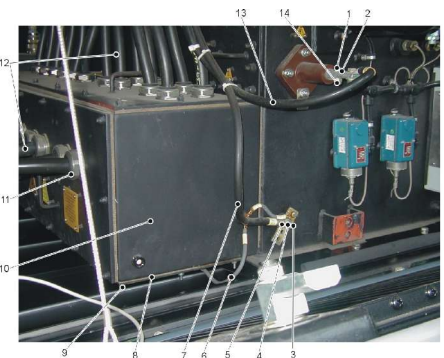
"Paper" technical manuals

```

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4   <!ATTLIST media mid CDATA      #REQUIRED>
5   <!ATTLIST media mfile CDATA    #REQUIRED>
6   <!ATTLIST media mtype (animation3D|photo|photoAugmented|comment|registered) #REQUIRED>
7   <!ELEMENT detail                (#PCDATA)>
8   <!ATTLIST detail link CDATA     #REQUIRED>
9
10  <!ELEMENT note                  (#PCDATA)>
11
12  <!ELEMENT procedure             (proc_title,pre_requirement,available_media, phases)>
13  <!ELEMENT proc_title            (#PCDATA)>
14  <!ELEMENT pre_requirement       (req_conditions,tools,spares,consumables)>
15  <!ELEMENT req_conditions        (safety*,caution*,note*)>
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21  <!ELEMENT spares                (req_spare*)>
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25  <!ELEMENT quantity              (#PCDATA)>
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27  <!ELEMENT consumable            (reference,name,quantity)>
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```

"XMLized" procedures  
+  
Multimedia data



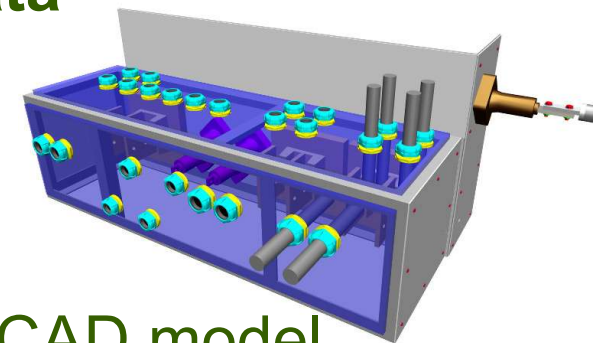
picture



sound



video

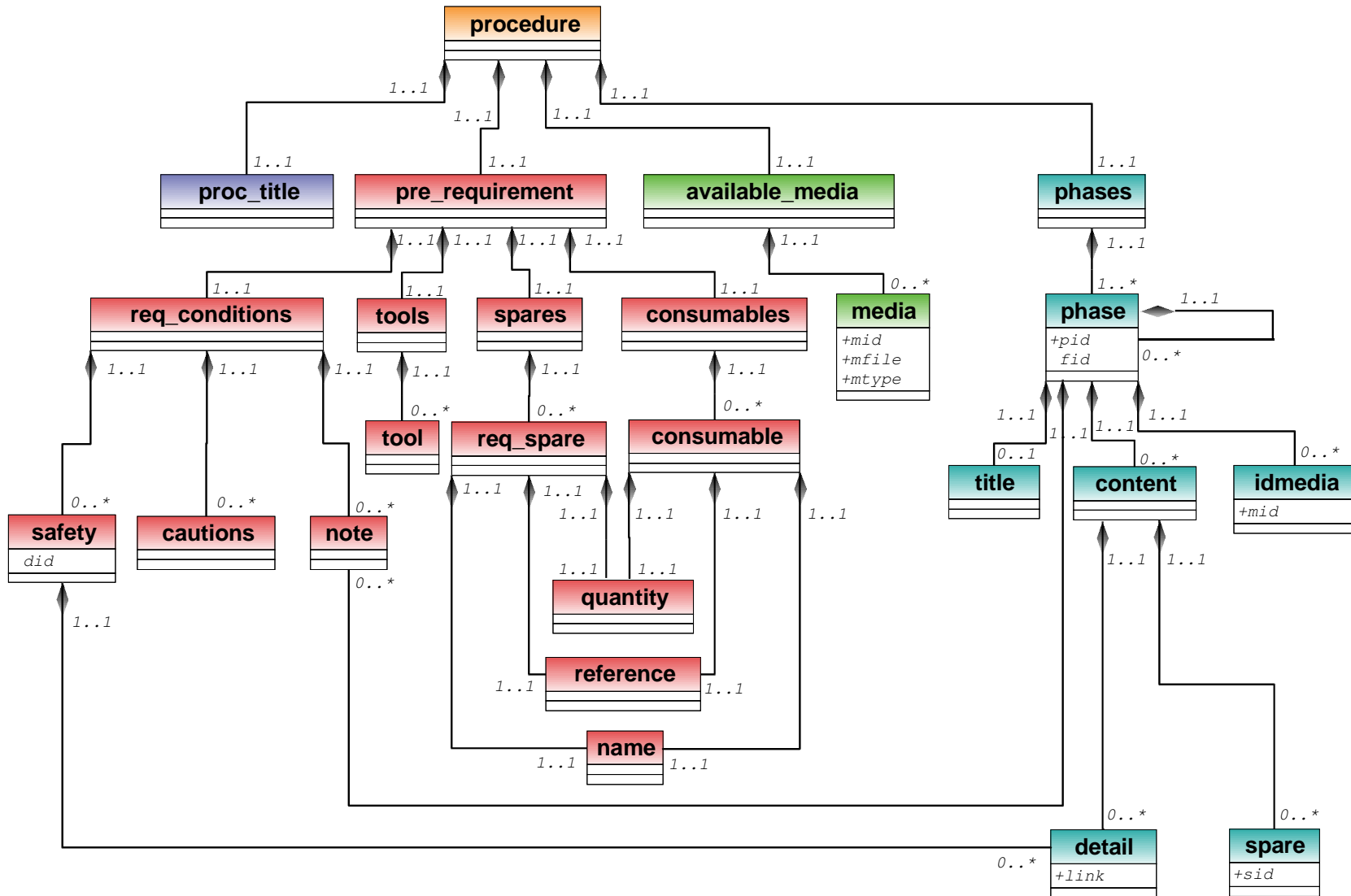


CAD model



# Transforming procedures (2/2)

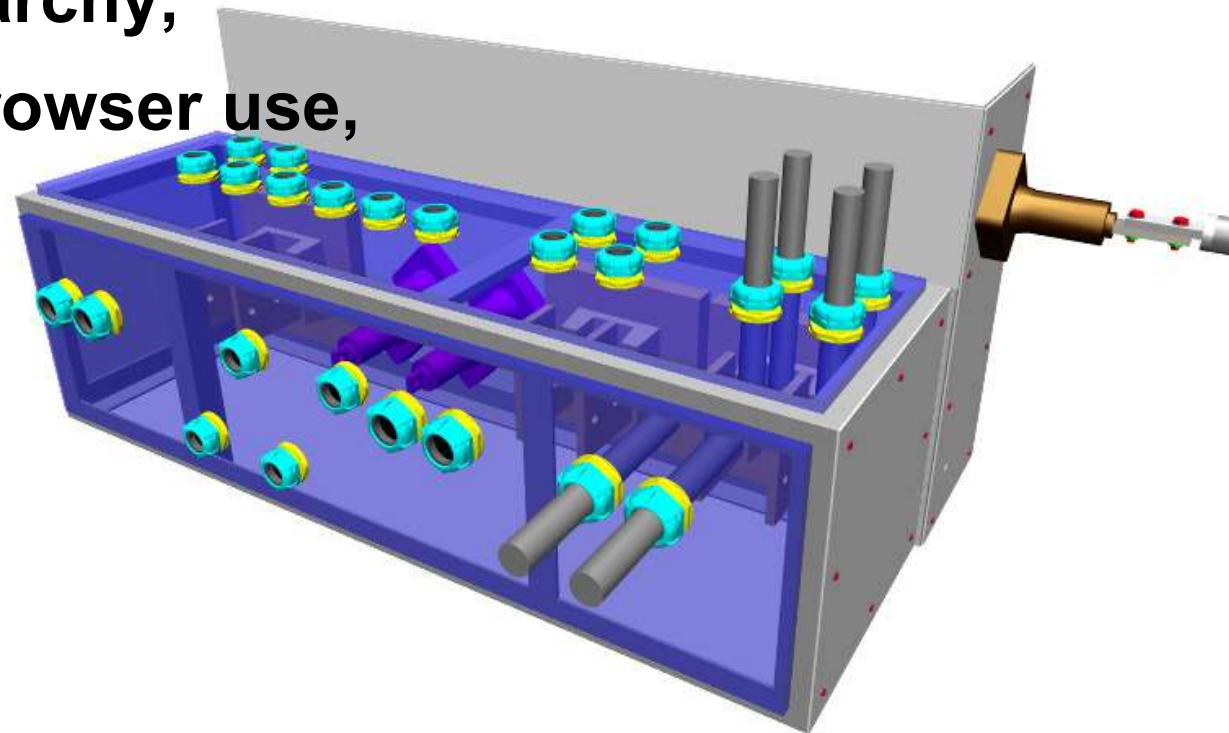
- XML Markups hierarchy



# Augmented 3D models (1/2)

- **VRML97 / X3D standards with Java/ECMA scripts for customized behavior,**
- **3D models extracted from CAD models, need :**
  - Polygonal reductions,
  - Scene graph hierarchy,
  - Interactivity, for browser use,

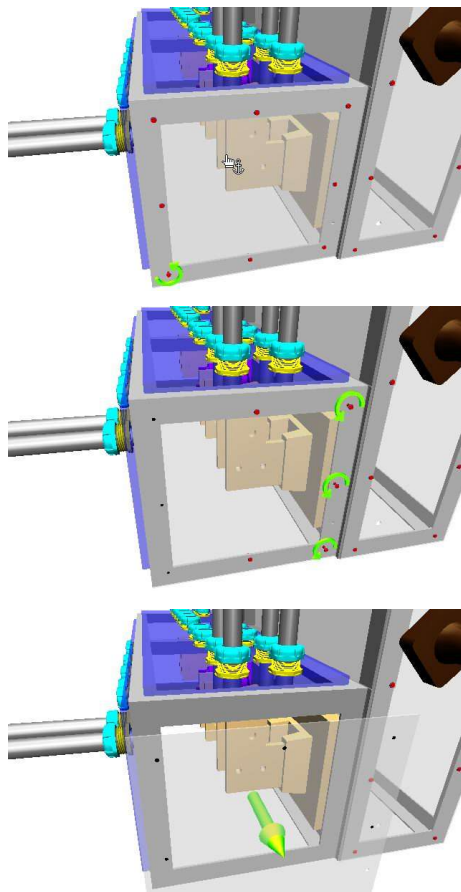
**A human hand  
is still needed  
for this part !!!**



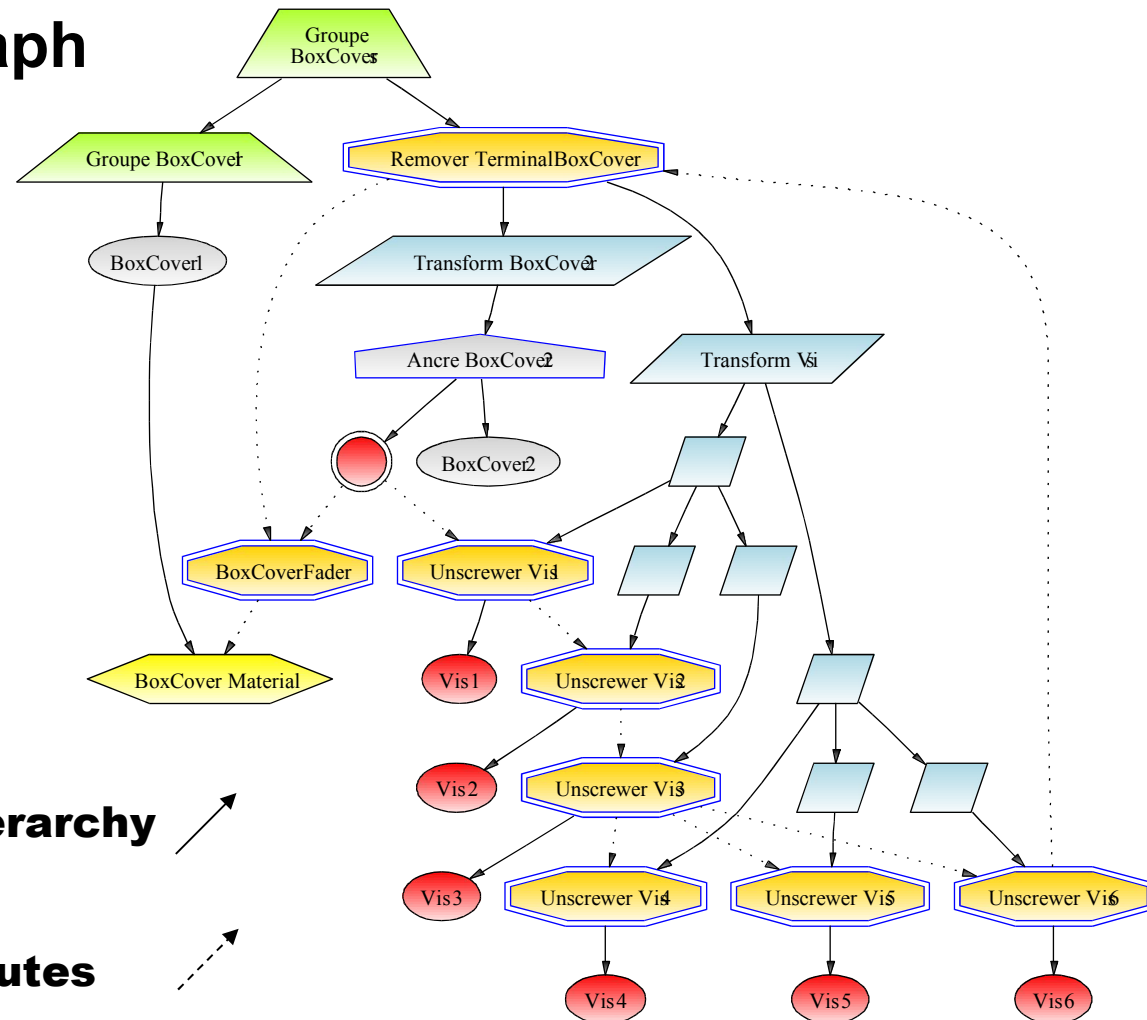
# Augmented 3D models (2/2)

- **New nodes for augmented reality (PROTOS)**
  - Graphical assistance to explain the procedure's steps

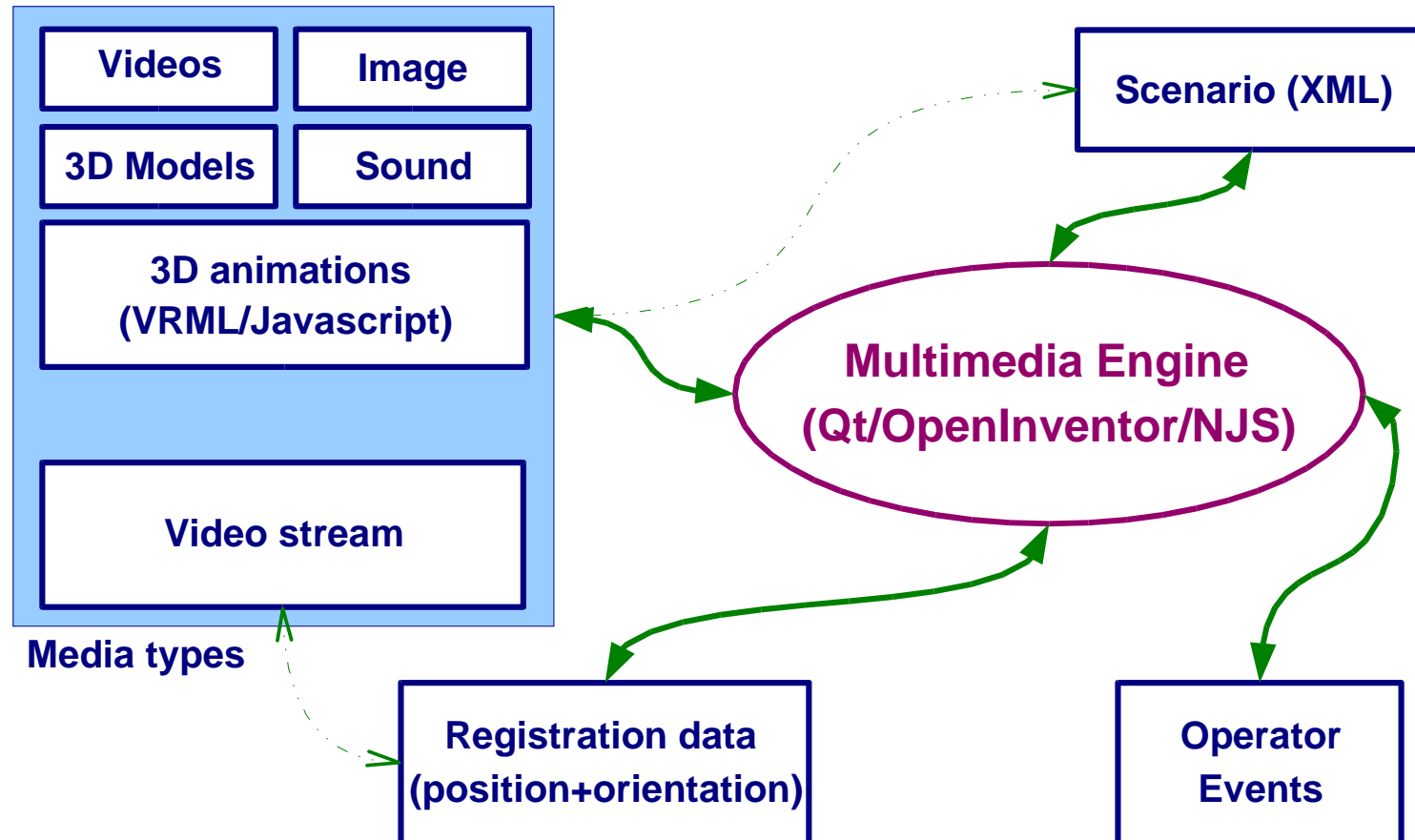
## Animations



## Scene graph

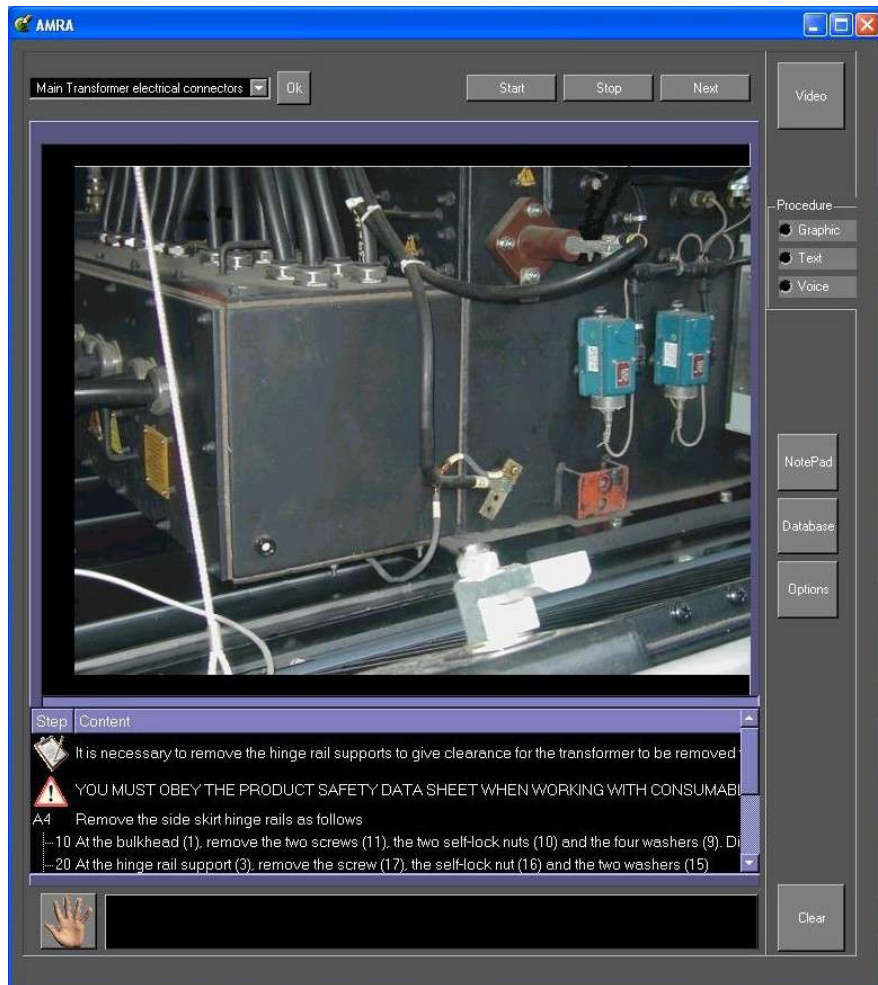


# Multimedia Engine

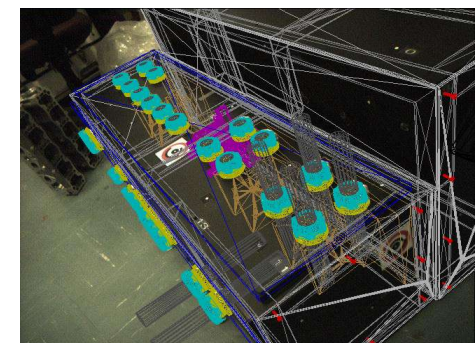
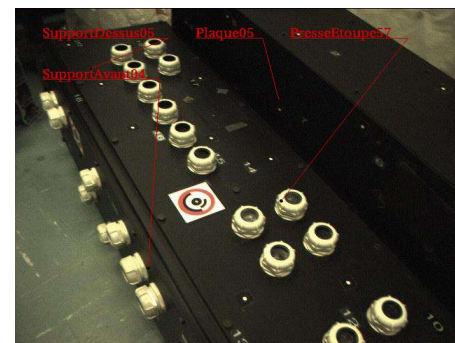
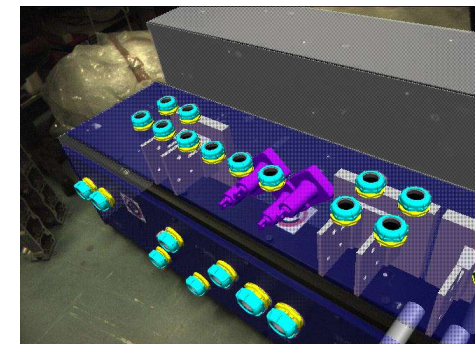
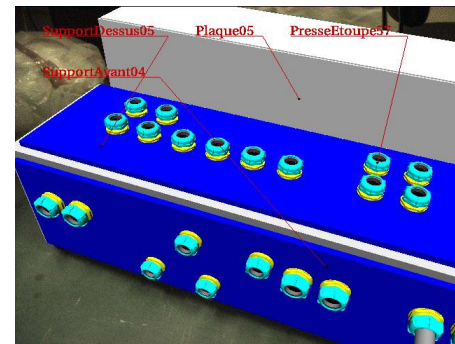
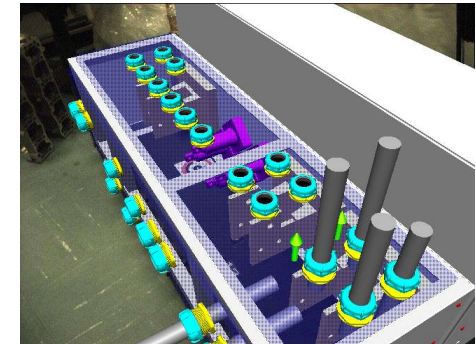
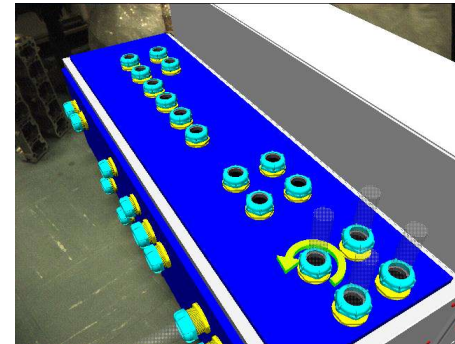


# Man Machine Interface

- **Overview**



- **Interacting with models**



# Early subjective evaluation (1/2)

- **One operator : subjective questionnaire**



	1	2	3	4	5	6	7	3.1.
Mauvais <input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Bien <input type="radio"/>
3. Erice l'écran est lisible selon les différentes conditions d'éclairage ?								
Mauvais <input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Bien <input type="radio"/>
3.1.								
	1	2	3	4	5	6	7	

### 3.2 CONFORT D'UTILISATION

Confort d'utilisation du Tablette PC	1	2	3	4	5	6	7	NBP
4. Comment jugez-vous le confort des mains ?	Mauvais <input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Bien <input type="radio"/>
5. Comment jugez-vous le confort du cou ?	Mauvais <input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Bien <input type="radio"/>
6. Comment jugez-vous la tenue ?	Mauvais <input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Bien <input type="radio"/>
7. Comment jugez-vous le poids du tablette PC ?	Mauvais <input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Bien <input type="radio"/>
8. Comment jugez-vous la posture liée au port du Tablette PC ?	Mauvais <input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Bien <input type="radio"/>

9. Quelle est l'inertie du support du Tablette PC ?	Mauvais	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Bien	<input type="radio"/>
		1	2	3	4	5	6	7		NBP

### 3.3 COMPREHENSION DE LA SIGNIFICATION DES ANIMATIONS

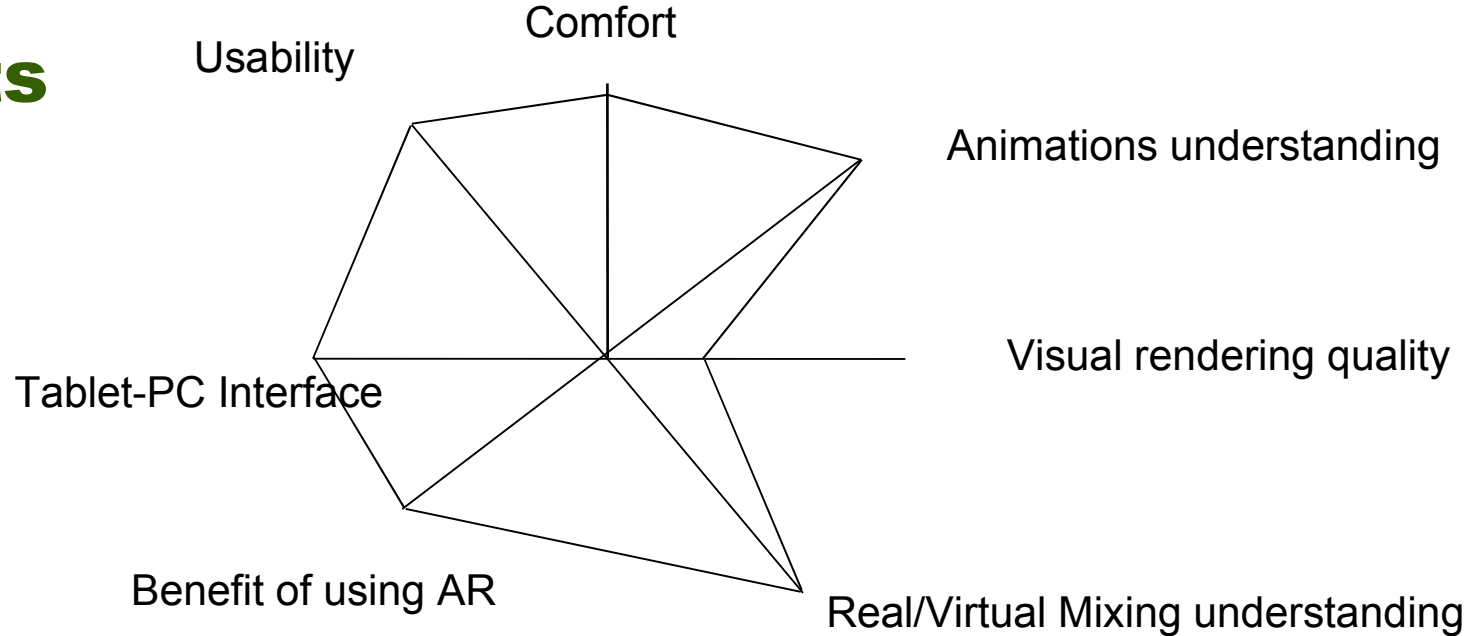
Compréhension de la signification des animations	1	2	3	4	5	6	7	NBP		
10. Comment jugez-vous le choix des couleurs utilisées ?	Mauvais <input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Bien <input type="radio"/>		
11. Comment jugez-vous la vitesse des animations ?	Mauvais <input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Bien <input type="radio"/>		
12. Comment jugez-vous le séquencement temporel des animations ?	Mauvais <input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Bien <input type="radio"/>		
13. Comment jugez-vous les représentations graphiques des animations ?	Mauvais <input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Bien <input type="radio"/>		
		1	2	3	4	5	6	7		NBP

### 3.4 COMPREHENSION DES ANIMATIONS EN SUPERPOSITION AVEC L'ENVIRONNEMENT

Compréhension de la signification des animations en superposition de l'environnement réel	1	2	3	4	5	6	7	NBP
14. Comment jugez-vous la visibilité des couleurs en superposition avec l'environnement réel ?	Mauvais <input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Bien <input type="radio"/>
15. Comment jugez-vous le raffinement des animations eu égard au monde réel ?	Mauvais <input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Bien <input type="radio"/>
16. Comment jugez-vous la visibilité des animations en superposition avec l'environnement réel ?	Mauvais <input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Bien <input type="radio"/>
17. Comment jugez-vous la compréhension de la signification	Mauvais <input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Bien <input type="radio"/>

# Early subjective evaluation (2/2)

- **First results**



- **Recommendations**

- use of visual hints for spatial positioning
- tablet-PC too heavy, use of pocket-PC recommended,
- touchscreen and stylus pen not recommended for maintenance environment.

# Conclusion

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- **Prototype fully operational,**
  - **Real-time registration,**
  - **Lightweight XML description of maintenance procedures,**
  - **Database customization for AR**
- **A real need of extended field studies !!!**



# Future works

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- **Alstom : AR media integration in technical database (TrainTracer)**
  - speech recognition for browsing,
  - use of VRML/X3D models,
  - use of XML specification for maintenance procedures.
- **LSC : investigating optical see-through systems and architecture for AR systems**
- **CEA : more ergonomic studies and registration on embedded systems coupled with cameras**

