Practical Augmented Reality in the PLM World

GLOBAL PRODUCT DATA
INTEROPERABILITY
SUMMIT
2015

ELYSIUM   Parker Aerospace   NORTHROP GRUMMAN   BOEING

Eric MENOU
Augmented Reality Expert
DIGINEXT / VMH

AGENDA

- **Augmented Reality … what for?**
- **AR uses cases**
- **Technical challenges**
- **Inscape AR in the PLM ecosystem**

- **Live demo**

- **Q&R**

Aircraft assembly and maintenance challenges

- **Recent years have seen an increase in the complexity of maintenance operations**
  - **Human factors are the largest contributor to aircraft accidents**
  - **Major cause of flight delays and cancellations**
  - **Maintenance errors are one of the top three causes of aviation accidents**

- **Aircraft assembly lines mostly rely on human tasks**

- **Documentation efficiency is critical**

Aircraft assembly and maintenance challenges

- **Common documentation support**
  - **Paper or electronic (PDF) documentation**
  - **Interactive electronic technical manual (IETM)**
- **Hierarchical procedures**
  - **Steps, sub-steps…**
  - **Illustrations, exploded views**
- **Most advanced tools provide 3D animated procedures**
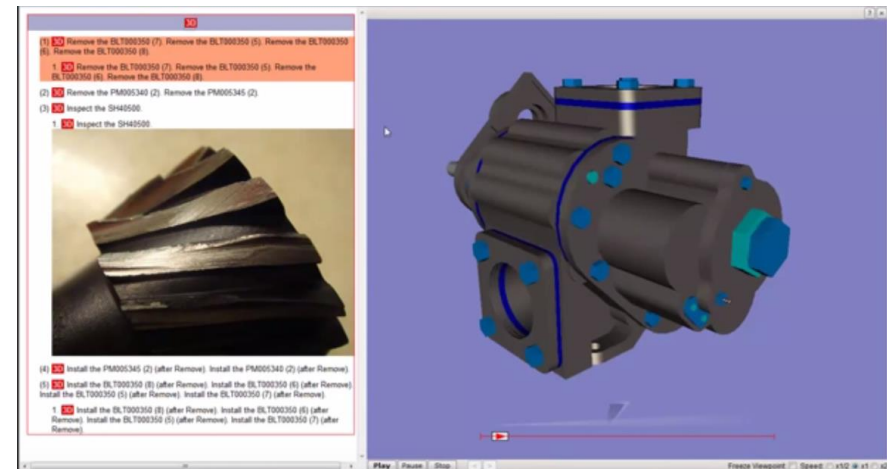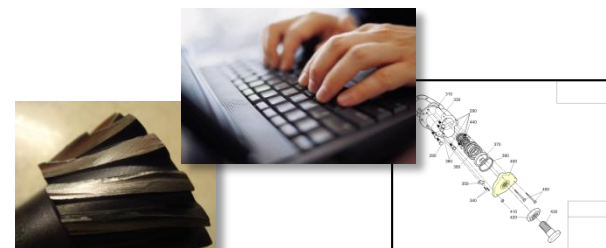
Traditional Process of Technical Publications

The Product Design Lifecycle

Design → **Test** → **Build** → **Deliver** → **Support**

CAD / BOM / PLM / ERP

Technical Documentation

- Disparately Sourced **Information**
- **Costly** Author and Review Cycles

Documentation Lag

Launch **Delays**

- **Effort** Duplication
- **Limited** output formats

Compliance **Issues**

- **Multi-format/Translation** Issues

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OEM – Business Value

Cost

Authoring

Authoring

3D/2D Interactive
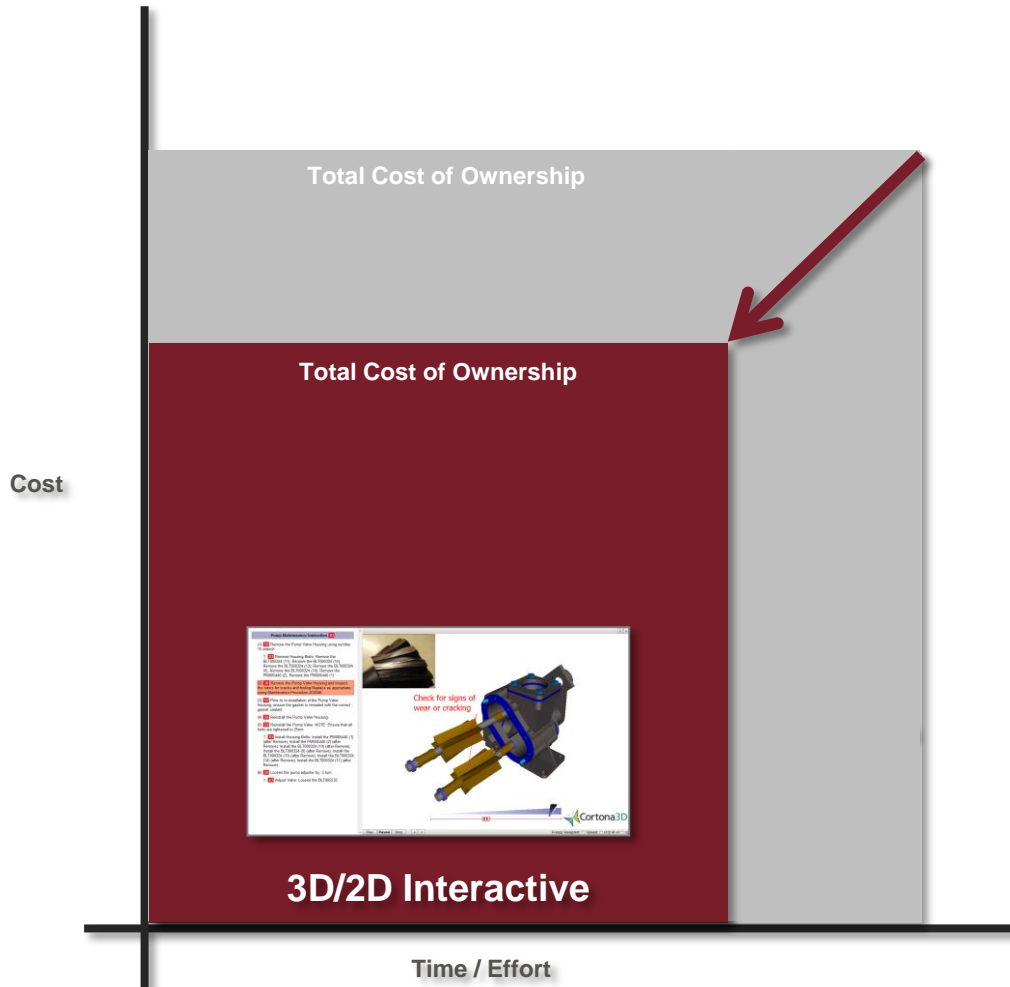
Time / Effort
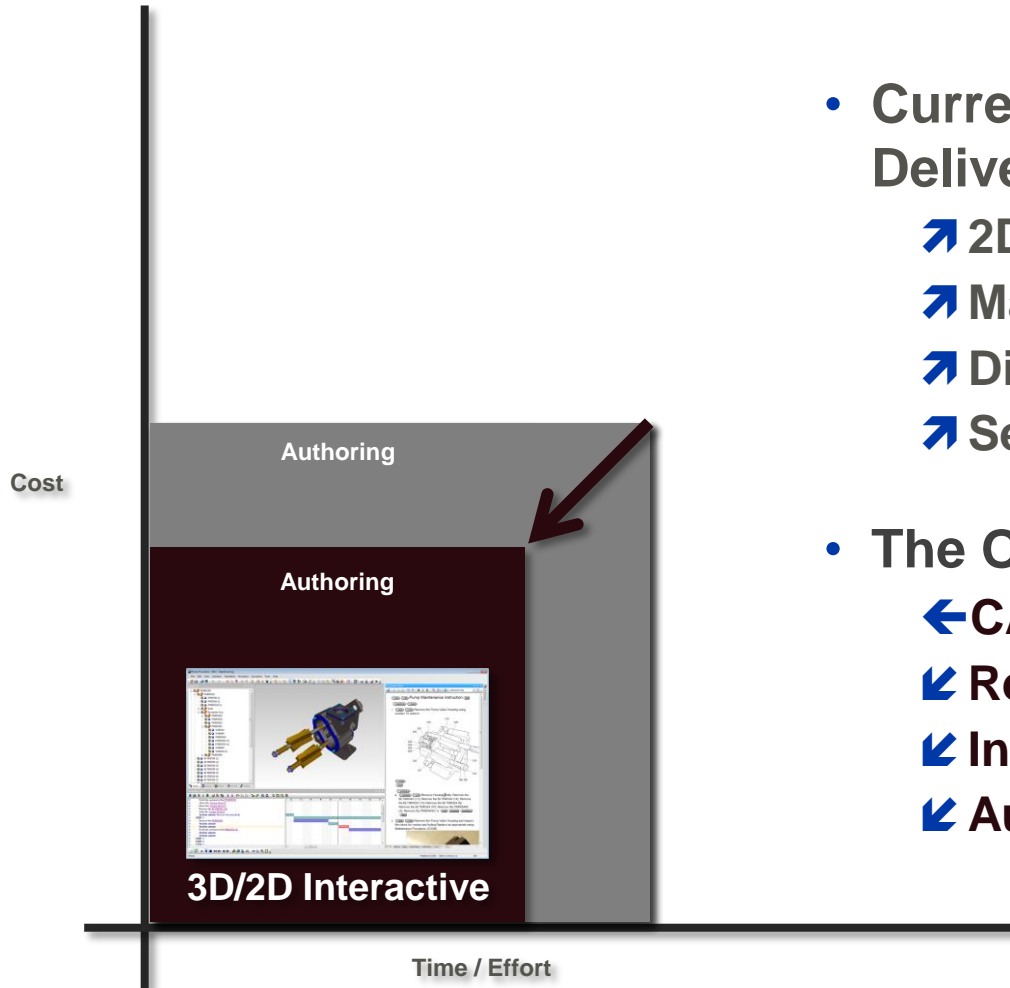
- **Current Process Deliverables**
  - ↗ **2D / Static Print or PDF**
  - ↗ **Manually Illustrations**
  - ↗ **Digital Photography**
  - ↗ **Separate Text /Graphics**

- **The Opportunity**
  - ← **CAD/BOM/PLM driven**
  - ↙ **Reuse/Repurpose data**
  - ↙ **Integrate Text /Graphics**
  - ↙ **Automate updates**

Operator – Cost Reduction

Cost

Total Cost of Ownership

Total Cost of Ownership

3D/2D Interactive
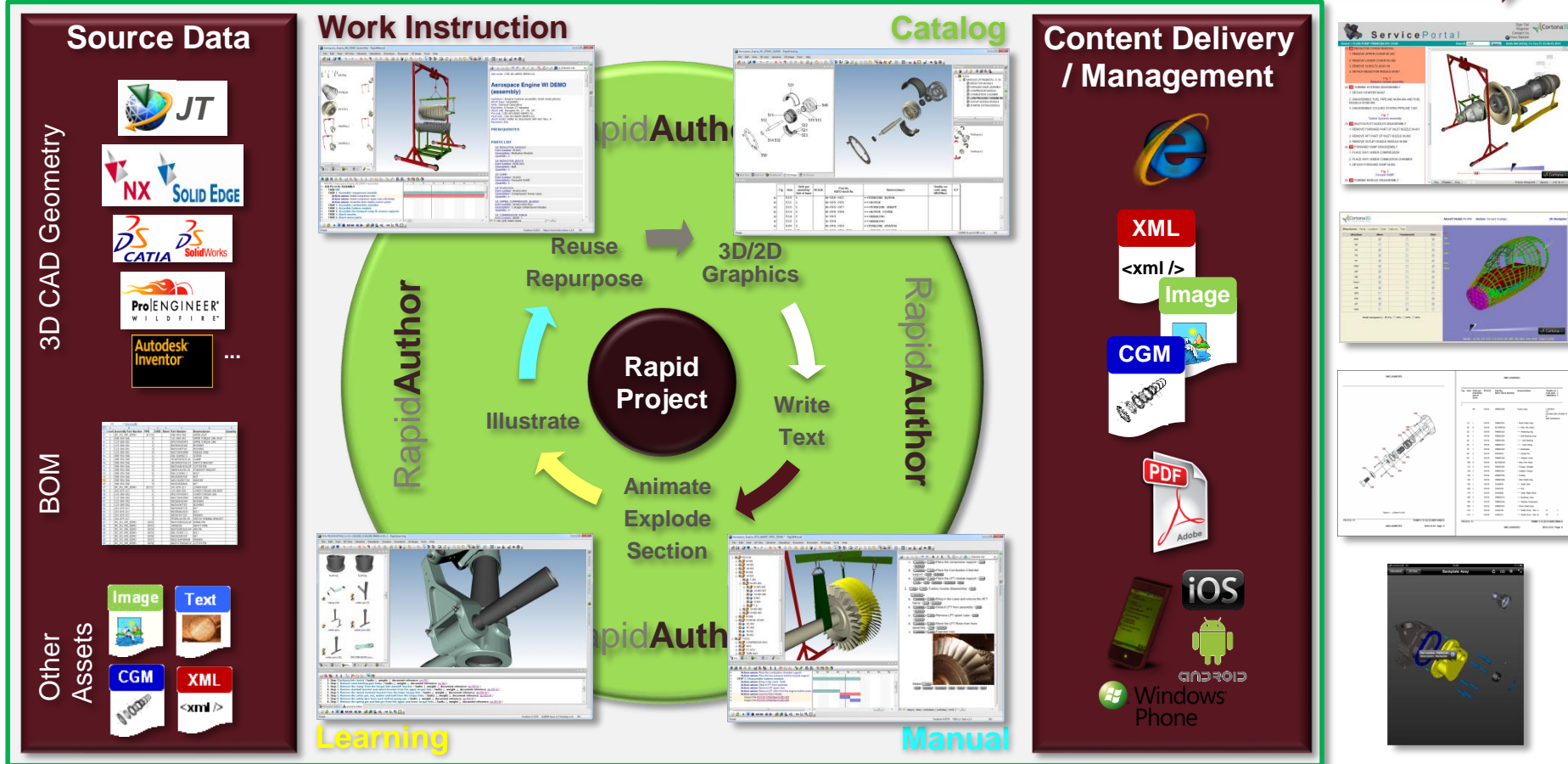
Time / Effort

- **Operator Issues**
  - ↗ **Product reliability/downtime**
  - ↗ **Parts identification errors**
  - ↗ **Cost of training**
  - ↗ **Maintenance effectiveness**

- **The Opportunity**
  - ← **Better quality documentation**
  - ← **Faster understanding / training**
  - ↙ **Accurate parts identification**
  - ↙ **Decrease downtime**

Integrated Technical Authoring Solution

Author Once, Publish to Any Format

SIEMENS TEAMCENTER

Source Data

3D CAD Geometry

BOM

Other Assets

Work Instruction

Catalog

Content Delivery / Management

Rapid Project

Reuse Repurpose

3D/2D Graphics

Write Text

Animate Explode Section

Illustrate

RapidAuthor

Learning

Manual

XML-based Architecture / Open Standards

- **Even IETM suffer from several limitations**
  - **Do not provide direct and easily accessible support**
    - **Searching the documentation is not efficient**
    - **Lots of eye/head movements between the equipment and the manual**
  - **Lack of spatial context**
    - **Operations to perform may be ambiguous**

- **Efficiency can be improved dramatically**
  - **Same documentation material**
  - **Better contextualization**

Augmented Reality

- ## Augmented Reality (AR)

Augmented Reality Manuals

- **Information superimposed within the user's view**
  - **Display relevant information at the right place and the right time**
  - **Documentation content overlaid onto real objects, directly on the location of interest**
    - **Describe which tasks to perform in what way**
    - **Display additional descriptions: security notice, tools**
    - **Link with other media: drawings, images, videos, HTML content**
- **Provide "on the-job support"**
  - **Direct and easy-to understand**
  - **Intuitive access to the relevant information**
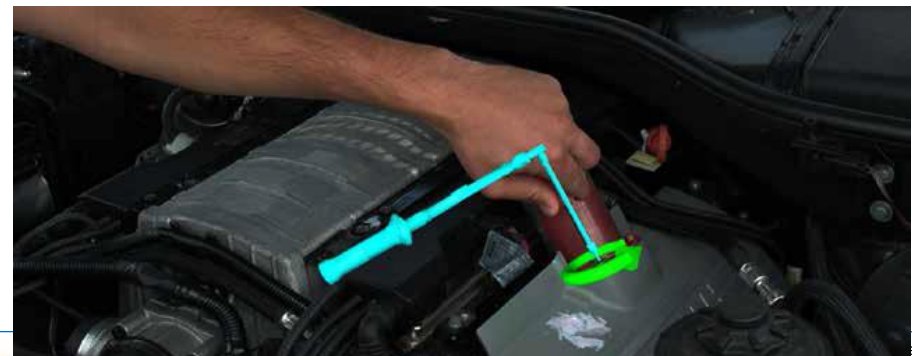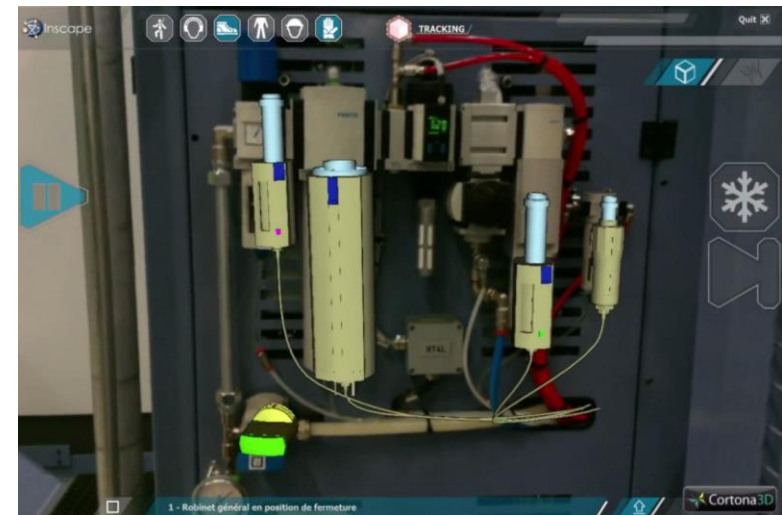
Augmented Reality Use Cases

- **Many uses-cases, similar needs**

  - **Studies**

  - **Manufacturing**
    – **Assembly**
    – **Inspection**

  - **Support**
    – **Marketing**
    – **Training**
    – **Maintenance**
    – **Remote Assistance**

Augmented Reality use-cases

- **Assembly / maintenance support / training**
  - **3D animated procedures**
  - **Textual documentation**
  - **Contextual multimedia content**
  - **Component location**
  - **Annotations**
  - **Report generation**
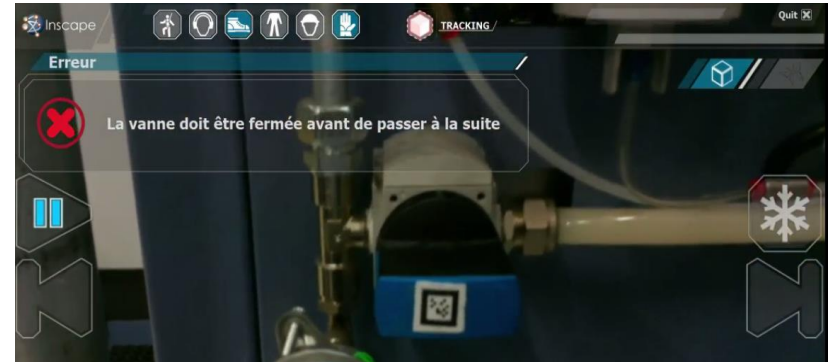 - **Automatic task validation**
  - **Link with troubleshooting guide**

Augmented Reality use-cases

- ## Inspection
  - **Step by step instructions**
  - **Measurements**
  - **Alignment tools**
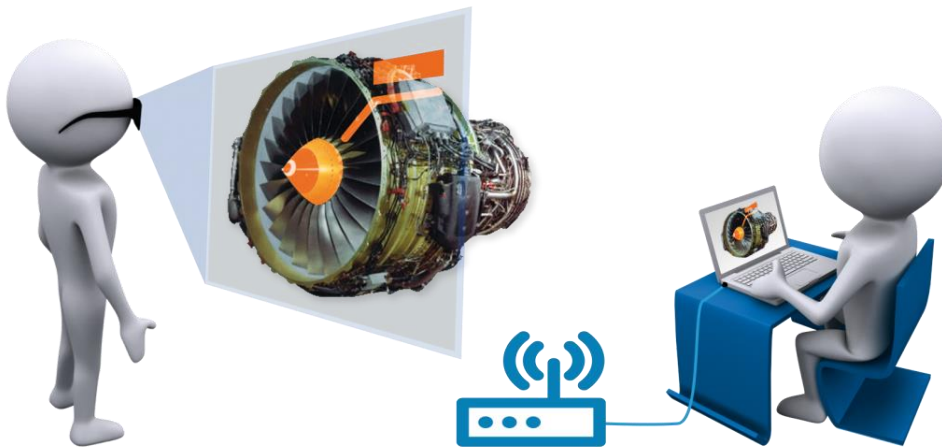
Augmented Reality use-cases

- ## Marketing
  - **Add virtual content**
  - **Show hidden parts**
  - **Contextual multimedia content**
  - **Component location**

Augmented Reality use-cases

- **Remote Assistance**
  - **3D animated procedures**
  - **On-the-fly annotations : labels, icons, hand drawing**
  - **Component location**

Augmented Reality Use Cases

- **Videos**

Challenges: Tracking technologies

- **Alignment of virtual objects with real environment**
  - **Augmentations overlaid to camera images or direct vision**
  - **3D virtual data must be aligned with the physical objects**
  - **Synchronize parameters of physical and synthetic cameras**

- **Tracking is one of the biggest technical challenges**
  - **Measure the exact position and orientation of the physical camera**

Challenges: Tracking technologies

- **Tracking with external sensors**
  - **IR cameras**
  - **Magnetic sensors**
  - **Inertial motion sensors**
  - **Measuring arm**

- **Tracking: External sensors**
  - **Reliable and accurate**
  - **Requires a fixed reference (not mobile)**
  - **Instrumentation of the environment (sensors, cables…)**
  - **Occlusions**

Challenges: Tracking technologies

- ## Tracking: Image processing
  - **Use device camera**
  - **Calculate position and orientation of the camera relative to some features of the environment**
  - **Markers can be attached to the equipment**
    - **Try to avoid this (Foreign objects damage)**
    - **Markerless tracking: detect labels or shape of the environment**

- **Tracking: Image processing**
  - **Lightweight**
  - **Requires extra work for each use-case**
    - **Define which feature is tracked**
    - **Retrieve and process the geometry**
    - **Calibrate and initialize the initial viewpoint**
  - **Not the most reliable, but most widely used solution**

- **Many products on the market**
  - **Few are really mature and can track 3D shapes markerless**

- **Lightweight**

Challenges: Display technologies

- **Tablet**
  - **Proven solution requiring standard devices**
  - **Portable and lightweight**
  - **No latency**
  - **Intuitive user interface (touch screens)**

  - **Augmentations displayed onto a video stream**
  - **<u>Not</u> hand free**
    - "Freeze"
    - Mobile mount

Challenges: Display technologies

- **Projection**
  - **Hand-free**
  - **Intuitive: augmentations displayed directly on the equipment**

  - **Single user**
  - **Not suitable for animated content**
  - **Requires flat and matt surface**
  - **Occlusions**
  - **External surfaces only**
  - **Heavy instrumentation**

Challenges: Display technologies

- **Head-up display (see-though)**
  - **Direct view of the real world**
  - **Individual light-weight device**
  - **Hand free**

  - **User-dependent**
    - **Requires calibration**
  - **Latency**
    - **Requires high computing power**
  - **Narrow field of view**
  - **Current devices are not mature**
    - **Poor comfort**
    - **Low quality**

- **Might be the best solution … at middle term**

Challenges: System and Application Design

- **Application must be comfortable to use**
  - **Take into account the industrial context**
- **Meet specific needs of each client / use-case**
- **Always provide a fallback strategy**

Challenges: Workflow and integration

- **AR is worthless without relevant content to display**
  - **Content must be adapted to fit AR constraints**
  - **Reduce geometric complexity**
  - **Keep only augmented parts**
- **Retrieve content from the PLM**
  - **Not just DMU and 3D animations**
  - **Hierarchical work instructions**
  - **Part catalog**
  - **Hyperlinks between textual instructions and 3D**
- **Conversion and processing cost can become significant with regard to the system development**

- # Inscape AR
  - ## Graphical tool to quickly create AR interactive applications

Inscape AR in the PLM Ecosystem

- **Strong re-use of existing data**
- **Direct support of PLM formats**
  - **DMU**
  - **Technical documentation**
    - **Hyper-text work instructions**
    - **Animations**
    - **Part catalog**
  - **No external tool required**
  - **Instant update from PLM**
- **Display Cortona3D animation**
  - **Not an exported file**
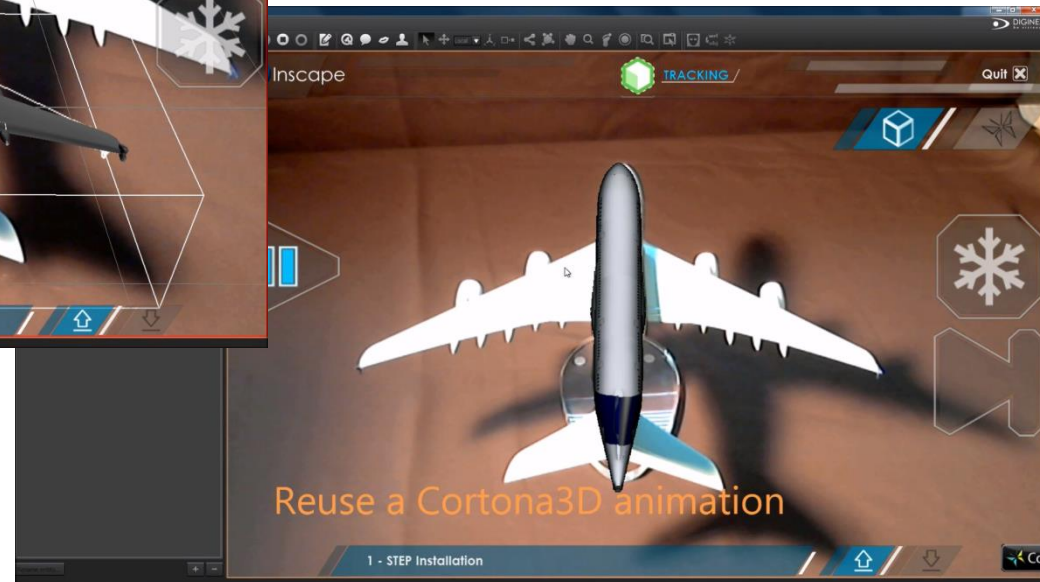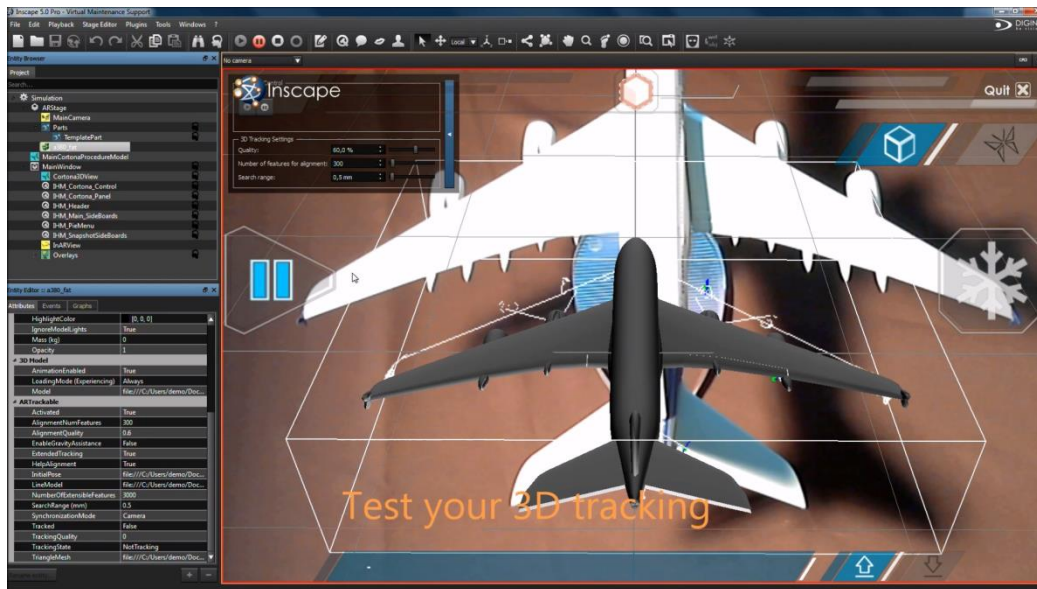 - **Integration of Cortona3D Engine**
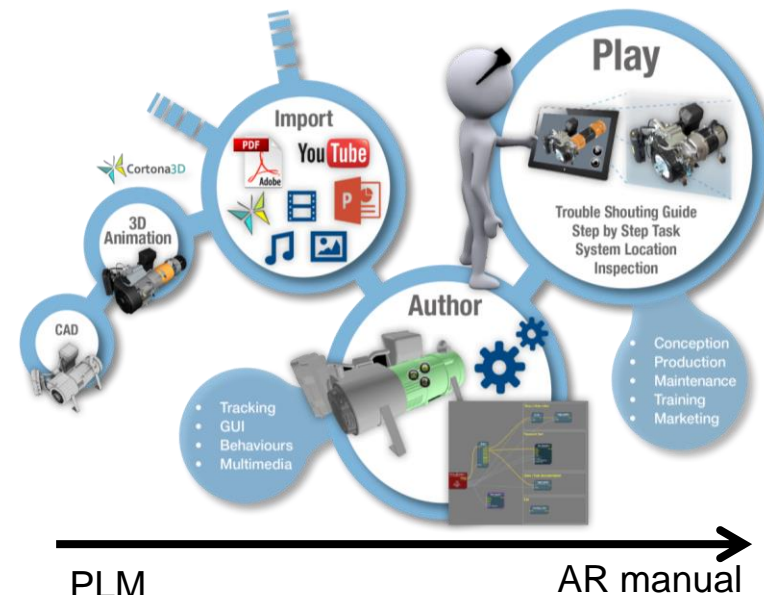
PLM → AR manual

Inscape AR in the PLM Ecosystem

Cortona3D
DMU
Technical documentation

On-site video captures

Re-use

Use-case implementation
 Assembly
 Maintenance
 Inspection
 Training
 Remote assistance
 Marketing
 …

Tracking setup

Publication
 Many platforms
 Many devices
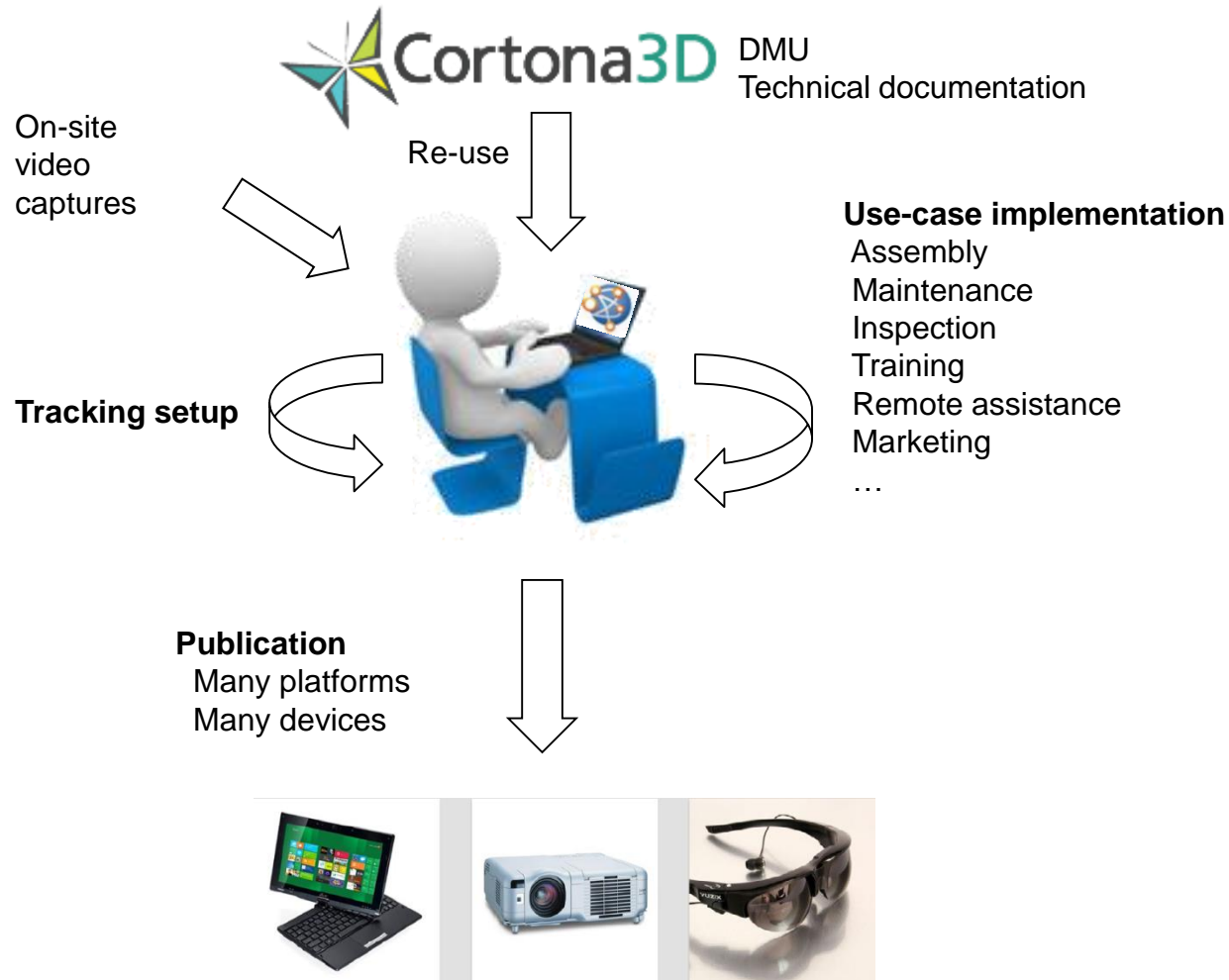
- **Inscape AR in action**

Inscape AR Key Factors

- **Support of all major standard formats**
  - **3D**
  - **Multimedia**
  - **Documentation content**
- **Full autonomy**
  - **Client not captive from a 3rd party company**
- **Mixed usages: 3D and AR**
  - **AR sometimes doesn't have any added value**
  - **Fallback solution when tracking fails**
- **Very fast creation of custom applications**
  - **Template projects**
  - **Graphical definition of user interface and applications logics**
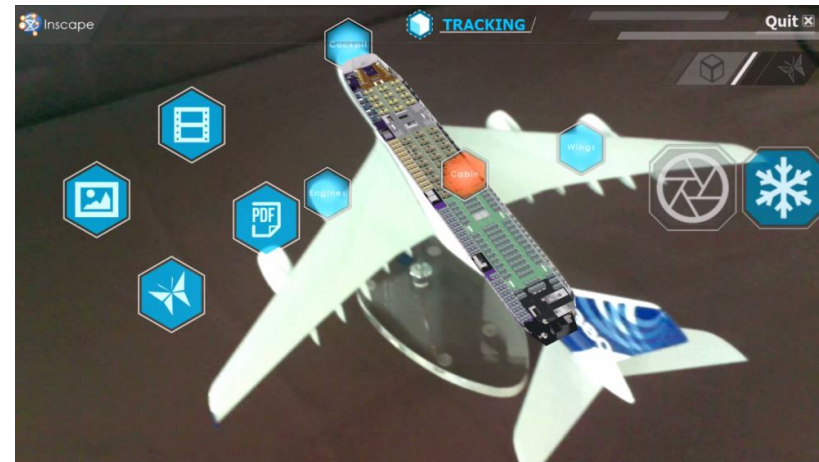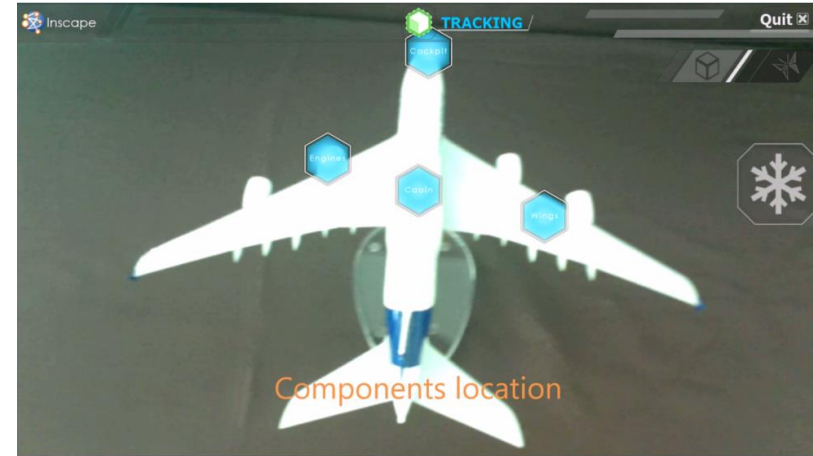
Inscape AR Key Factors

- **Technology agnostic**
  - **Interchangeable tracking and display solutions**
  - **Instantly benefit from the latest version of these products**
- **Open architecture**
  - **Interconnection with external systems (IT infrastructure)**
- **Multiplatform publication**
  - **Standalone executable for MS Windows**
  - **Android and iOS apps**
  - **Web application (standalone documentation)**
- **Offsite video testing**

Augmented Reality Application Demonstration

- **Component location**
- **Contextual information access**
- **Hidden components display**
- **Virtual content display**
- **3D parts installation/removal**
- **Pictures and annotations**
- **Report generation**

Questions?