AR IS EASY

VUFORIA STUDIO
BEST PRACTICES TO CREATING AR EXPERIENCES

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Superimposing digital onto the physical world – sometimes including human machine interface (HMI).
Vuforia
Studio Best Practices

• What are you going to do?
• How are you going to do it?
• What are your resources?
• How are you going to make it?
• How are you going to make it better?
WHAT ARE THE COMPONENTS IN AN AR EXPERIENCE?

Physical Object + 3D Digital Scene (CAD, images, IOT gauges) + 2D Digital Overlay (buttons, images, pop-ups) = AR Experience
Five Steps to Create a Meaningful AR Experience

1. Answering Framing Questions
2. Storyboarding & Design
3. Gather Data
4. BUILD IT
5. Application Styling
Brainstorming the Concept

• “Who” is the target user?
• “Why” is this experience interesting and useful?
• “What” is the goal of the experience?
• “What” are the source data required for this experience?
• “How” will the user interact with the experience?
• “How” does the experience change after being used multiple times? (by the same user? Different users? Other factors?)
• “How” does the experience adapt itself in response to the user’s knowledge, background & experience?
• “Where” would someone be using the experience?
WORK YOUR WAY UP TO IT

- **CRAWL**
  - **3D CAD Standalone**: 3D Model is projected from ThingMark

- **WALK**
  - **2D & Sensor Overlay**: Graphics, add. information & sensor data overlaid on camera view

- **RUN**
  - **3D CAD Augmentation**: 3D Model augmentation interacting with physical part

- **FLY**
  - **Application**: 2D landing page links to / combined with AR view
STEP #2 – DESIGN & STORYBOARD

Design your Experience - Create a Storyboard

• Design considerations
• Identify all data sources
• Identify what will be displayed
• Identify key “scenes”

“By failing to prepare, you are preparing to fail.”

— Benjamin Franklin
What are the business needs for the experience(s)?

What type of experience?

What is role of the target user?

What is the experience level of the target user?

Are multiple experiences needed?

User Experience
DESIGN CONSIDERATIONS

What device will target user be using?

What orientation will experience be used in?

Does experience need to be operated with one hand?

Device
IDENTIFY ALL DATA SOURCES

Will experience need to display live data (e.g. from sensors)?

Will experience need to display 3D content (e.g. CAD parts). What is the source?

Will experience need to show (animated) instructions?
User Interface

IDENTIFY WHAT WILL BE DISPLAYED

- Will experience need to display text information?
- What types of controls will be needed on experience?
AR EXPERIENCE USE CASE MAPPING

Operator & Assembly Work Instructions

Virtual Product Demonstration

Service Manual & Instructions

AR Hardware

Content Source

AR Capabilities

Dev Approach

Operator & Assembly Work Instructions

Virtual Product Demonstration

Service Manual & Instructions
Identify key “scenes”

- Where will the user be standing?
- What are their tasks?
- What type of device?
- What information needs to be displayed?
User presses Play button
• Turn remote over
• Enable Next and Precious buttons
• Disable Play button

User presses Next button (press next between each step)
• Remove battery cover
• Remove one battery
• Remove other battery
• Replace first battery
• Replace second battery
• Replace battery cover
• Turn remote back over
• Disable Next and Previous buttons

…

…

SIMPLE STORYBOARD SAMPLE
DETAILED STORYBOARD SAMPLE

• Tools...

STEP 1: DESKTOP EXPERIENCE

**STAGE 1: menu**

Choose the menu options to view the storyboard. Select and edit steps to explore different ideas. Use the search function to find specific elements.

**STAGE 2: desktop**

Click on the desktop icon to access the menu options. Choose the menu options to view the storyboard. Select and edit steps to explore different ideas. Use the search function to find specific elements.

**STAGE 3: sensor data**

Click on the sensor data icon to view the data. Select and edit steps to explore different ideas. Use the search function to find specific elements.

STEP 2: SEQUENCE

**STAGE 1: menu**

Choose the menu options to view the storyboard. Select and edit steps to explore different ideas. Use the search function to find specific elements.

**STAGE 2: desktop**

Click on the desktop icon to access the menu options. Choose the menu options to view the storyboard. Select and edit steps to explore different ideas. Use the search function to find specific elements.

**STAGE 3: sensor data**

Click on the sensor data icon to view the data. Select and edit steps to explore different ideas. Use the search function to find specific elements.

STEP 3: SENSOR DATA

**STAGE 1: menu**

Choose the menu options to view the storyboard. Select and edit steps to explore different ideas. Use the search function to find specific elements.

**STAGE 2: desktop**

Click on the desktop icon to access the menu options. Choose the menu options to view the storyboard. Select and edit steps to explore different ideas. Use the search function to find specific elements.

**STAGE 3: sensor data**

Click on the sensor data icon to view the data. Select and edit steps to explore different ideas. Use the search function to find specific elements.
• Sometimes a quick POC shows you what you need to know (or not know) – it doesn’t always work…
STEP #3 – GATHER DATA

Pulling Together Your Resources

- CAD Models
  - Performance vs Aesthetics
- Graphics
  - Images, videos, PDFs
- ModelItems
CAD DATA
Re-purposing “real” CAD data for AR is an important differentiator for Vuforia Studio.

Reality already does a great job of displaying the physical product.

It is very important to have optimal 3D data for augmentation.
WHAT ARE THE IMPORTANT FACTORS FOR 3D DATA?

Size of data impacts:
- Publish time to VES
- Download time over the “network”
- Load time into Vuforia View

Polygon count impacts:
- Display time and frame rate
- Memory & GPU limited on mobile

Part count impacts:
- Frame rate (to a lesser extent)
- Animation performance

3D content contains IP
Accurate geometry, meta-data & more
Removal reduces size and reduces IP leakage concerns
GOALS TO AIM FOR

**Size of data**
- < 10Mbyte is ideal
- < 20 Mbyte is likely acceptable

**Polygon count**
- < 200,000 polygons is ideal
- < 500,000 polygons is likely acceptable

**Part count**
- Only show what is needed. Aim to keep this low for best performance

**Intellectual Property (IP)**
- Remove accurate geometry (not needed)

**Visual appearance**
- Depends on the experience!

How do we do this?
FROM HIGH TO LOW QUALITY
OTHER THINGS TO OPTIMIZE YOUR MODEL

Performance is key when you consider that you are running a 3D model that was built on a multi-processor workstation and GB's of memory!

- Remove unseen details
- Remove unseen parts
- Combine non-interactive parts (shrinkwrap)
- Remove parts that are not being augmented

“High” Setting
Size: 5.2Mb
133X compression

“Med” Setting
Size: 2.6Mb
267X compression

“Low” Setting
Size: 1.4Mb
496X compression

Creo Parametric model size: 695Mb
Creo View default data size: 88Mb (8x compression)
LEVERAGING PTC’S 3D KNOWLEDGE: RE-USE YOUR ENTERPRISE 3D DATA

• **Directly import multiple 3D file formats:**
  - Creo View PVZ
  - STEP
  - IGES
  - STL
  - OBJ*
  - VRML
  - DGN
  - Solidworks
  - AutoDesk Inventor
  - FBX

• PTC and Partners provide adapters to translate the following to Creo View:
  - Siemens NX,
  - JT,
  - Creo Elements/Direct
  - Shipbuilding adapters available from Virtalis
  - CATIA V5 from Theorem

*No texturing support yet*
MODEL ITEMS – MODEL STRUCTURE
ADDING AND CONFIGURING MODEL ITEMS

• Model Items can be controlled independently from the assembly model.

• Example Use Cases:
  – Change visibility/opacity
  – Modify component color
  – Move/Rotate component

• Drag Model Item widget onto the component to designate it as a model item.

• Define properties:
  – Visible
  – Opacity
  – Color
  – Location
  – Rotation
  – Friendly Name
STEP #4 – BUILD IT

Putting it All Together in Vuforia Studio

• Physical vs Digital
• AR Tracking
• Sharing Your Experience
• Keeping the Illusion
THE BASIC COMPONENTS OF AR
STUDIO ENABLES AR

- **ADD Virtual Gages**
- **ADD Graphical Labels**
- **Manage Experience Structure**
- **Define occluded geometry on physical product**
- **Control item properties and data binding**
Creating Experiences with Vuforia Studio

1. Launch Vuforia Studio, login and create project

2. Open and place 3D data

3. Place AR Target

4. Decorate with augmentations; define UX, form factor, import animations

5. Bind augmentations to Thing definition

6. Save and Publish Experience to Vuforia Experience Service

Experience and resources are saved to Vuforia Experience Service and ready for delivery to Vuforia View

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AR TRACKING TECHNOLOGY
HOW AR WORKS

A "digital eye" inside an app

The eye "sees" parts of the world where content can be placed

Developers control what content is placed where
ADVANCED AR TRACKING TECHNOLOGIES

1. ThingMark Tracking
   Image-based tracking with a coded marker
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   Image-based tracking with a coded marker

2. **Spatial Tracking**  
   Scan the world and detect planar surface
ADVANCED AR TRACKING TECHNOLOGIES

1. **ThingMark Tracking**
   Image-based tracking with a coded marker

2. **Spatial Tracking**
   Scan the world and detect planar surface

3. **Model Tracking**
   Align digital 3D CAD and physical model
**TRACKING – THINGMARKS**

**ThingMark** is the next generation bar code. It allows encoding data and acting as an AR target.

**Optimize Tracking**

- Make sure that there is **enough light** in your room or operating environment so that the **scene details and target features are well visible** in the camera view.

- You can estimate the **minimum size** that your target should have by dividing your **camera-to-target distance by ~10**.

- The **quality** of the tracking can **degrade significantly when the printed targets are not flat**.

- The target features will be harder to detect and **tracking can also be less stable** if you are looking at the target from a **very steep angle**.

- To establish good **extended tracking** requires the user to make zoom-in or zoom-out motion followed by a sideward motion to detect more features.

**Use Cases**

- Identify unique instance of a product
  - Use instance specific IoT information
- Product visualization
- Augmented product instructions

Additional information about Image targets and ThingMarks
Spatial Tracking (based on Vuforia’s ground plane tech.) creates anchors in the environment using the visual details to detect and track planes, as well as the user's position in the world.

Use Cases

• Design & Product Review / Visualization
• Product viewing with no physical object
• “Try before you buy”

Optimize Tracking

• Ground Plane utilizes images from the device camera to understand the basic geometry of your environment.

• Recommendations:
  – Stable lighting conditions
  – Moderate lighting - not too bright or too dark
  – Avoid glare and dark shadows
  – Surface details help to reveal geometry and improve accuracy and performance
  – Ground Plane will work both indoors and outdoors, in a variety of conditions, if these recommendations are followed.

• Creating and maintaining correspondence between spaces requires tracking the device’s motion.

Additional information about Spatial targets

Model Targets enable physical objects to be recognized and tracked using a digital 3D model of the object.

### Use Cases
- Work instructions on object
- Service procedures on object
- Operational procedures on object
- Training procedures on object
- Design Visualization on object

### Optimize Tracking
- **Non-moving objects.** Objects are assumed to be static, they would have to remain static in the environment after having been detected. The user can move around the object, but should not move the object itself.
- **Colored.** Objects with colors on them are going to work well typically. Objects that are in a single uniform color are difficult to track, though they can typically be reliably detected. Some variation in surface appearance is required to distinguish the object. For this reason 3D printed objects made from a single color material.
- **Sufficient geometry.** Geometric complexity is useful to distinguish an object from other shapes in the environment. Simple shapes such as cuboids, or very elongated simple shapes may be easily confused with other objects in the user’s setting. Models with 70k poly count, up to 400k
- **Non-flexible and rigid.** Objects should have the exact same shape as their 3D model. While the Model Target tracker can tolerate some deviation in their respective geometry, expect that objects that articulate a/o flex may fail to be detected or tracked effectively.
AR TRACKING USE CASES

- **ThingMarks**
  - Product visualization
  - Augmented product instructions (small)

- **Spatial Targets**
  - Design Review
  - Product viewing with no physical object
  - “Try before you buy”

- **Model Targets**
  - Complex work instructions
  - Service procedures on object
  - Non-ThingMark surfaces
Many things contribute to successful tracking depending on your method:

- ThingMark location & size
- Surrounding environment
- Lighting conditions
- User motion/ Camera Focus
- Environment Motion
- Model fidelity
- Publish and test it!
THINGMARK TRACKING BEST PRACTICES

ThingMarks are a coded image that allows for unique identification and tracking of AR experiences

- Tracking requires that the ThingMark be in full view while experiencing. Determine best placement and size based on the use
- Objects and details around the ThingMark help stabilize tracking
- If augmenting, note that the ThingMark must be printed and placed precisely
- Lighting should be consistent
- Supported on all platforms and devices
Enables content to be placed on horizontal surfaces without markers. Tracks to the environment, not an object

- Spatial Tracking creates anchors in the environment using the visual details to detect and track planes, as well as the user's position in the world
- Vuforia Fusion: SLAM, ARKit, ARCore, VIO
- Inherent behavior to move, rotate and scale model
- Must have: stable light conditions, moderate lighting, no glare
- Platforms: iOS 11+, Android, MS
Shape-based recognition overlaying the digital 3D on the physical object without markers

• Most robust tracking in best conditions!

• Best Conditions:
  – Objects of any size with distinctive contour
  – Sufficient detail in 3D CAD models
  – Wide range of environment, lighting and proximity conditions
  – Models with 70k poly count, up to 400k
ANIMATED SEQUENCES
ADDING A SEQUENCE TO THE 3D MODEL

You can play back a disassembly sequence of the 3D models in the AR experience.

- Sequence must be created in Creo Illustrate and published.

- Sequence must be selected from the Model Component Sequence URL Property drop-down list.

- Button Click action must be bound to the 3D Model Component’s Play service.
Add Animations and Sequences

1. Show step by step instructions
2. Re-purpose content from Creo Illustrate
3. Directly import .pvz files
4. Control the playback via interactive buttons
5. Bring your AR to life!
OCCLUSION
3D DESIGN CONSIDERATIONS - BLEND IN WITH REALITY

• Some things just don’t look right!

• Solution
  – Add more data
  – In this case, occlude the part

Should not be in front
MAKE IT BETTER

• Opening the experience – first impressions
• Mixed Use: creating spatial tracking and model tracking targets – use of views
• Plain vs CSS vs Image – BUTTONS
• 3D interaction vs 2D interaction
OPENING THE EXPERIENCE

The User’s First Impression

• Make it look like an app
• Give the user some information on how to interact
• Lead the user to the next steps with knowledge of what they are doing
• Mixed Use
UI Authoring

1. Designed for building mobile experiences

2. Drag’n’drop from pre-defined widgets

3. Make connections:
   Display data from IoT values and services. Control displays from actions

4. Full editing control
   Justification, layout, undo/redo, etc.

5. Interactive design preview
   Review prior to publishing
STYLING

The User Interface

• Style to your brand – many different ways to make a button

• Appeal to your user

• Stand out when standing out is needed!

• Visual cues (e.g. tracking)
CSS STYLING OF 3D LABELS/GAUGES

• Feature
  – CSS styling and state based formatting are now available for 3D labels and 3D gauges.
  – State Definitions are collections of Style Definitions, along with rules on when to apply them defined and managed in ThingWorx.

• Benefit
  – This allows to do data based formatting of 3D labels and gauges, based on the value of a column in the data service bound to it.
VIEW EXPERIENCES ON YOUR FAVORITE DEVICE

Mobile

3D Eyewear

2D Eyewear
SHARING AR EXPERIENCES

How AR is distributed to the end user

• ThingMarks
• QR Codes
• Deep Links
• Bookmarks
• Library
• Locally Downloaded
OFFLINE EXPERIENCE

• Allow download for offline viewing of experiences under the Info page of an experience project.

• Currently available on iOS, Android, Hololens and Windows 10.