## **Evaluation: Paint360 Prototype**

### **Objective and validation metrics**

The aim of this test was to evaluate the usability and effectiveness of the Paint360 prototype as an interactive XR painting tool. Success was defined by whether participants could:

* Navigate the toolbar and identify the painting tools (brush, color picker, eraser, scene changer).
* Use the mouse to paint, erase, and change settings with minimal confusion.
* Complete defined tasks (painting, erasing, changing wall colors, resizing/moving toolbar).
* Report satisfaction and ease of use on post-test debrief questions as well as complete tasks within the predicted timeframe and think aloud when using the application.

To measure these goals, we employed three complementary evaluation methods:

* **Time on Task** to quantify efficiency and highlight areas where tools slowed participants down.
* **Think Aloud Protocol** to capture immediate impressions, confusion points, and user strategies during interaction.
* **Post-test Debrief Questions** to collect reflections on usability, satisfaction, and suggestions for improvement.

Together, these methods provided both quantitative measures of performance and qualitative insights into the user experience, ensuring a well-rounded evaluation of Paint360’s functionality and design.

### **Results**

**UI recognition:** Participants successfully identified toolbar buttons and related them to familiar MS Paint counterparts.

**Painting:** Brushing shapes and colours was intuitive and enjoyable; users appreciated painting from different angles in 3D.

**Engagement:** Despite challenges, participants consistently enjoyed the immersive painting environment.

**Eraser tool:** This was a common difficulty. Participants often required more time than predicted to erase drawings, and many expressed frustration with its precision and speed.

**Toolbar manipulation:** Moving and resizing the toolbar was unintuitive. Participants struggled to distinguish drag handles from other UI elements, and resizing caused frequent simulator resets.

### **Analysis/Insights**

### **Key Patterns**

* Participants adapted quickly to basic drawing tools but encountered friction with secondary features (toolbar manipulation, eraser, and screenshot saving).
* Multiple participants activated more than one tool at once, highlighting a need for clearer tool state management.
* Lack of feedback (e.g. visual crosshair for brush positioning) reduced user confidence and slowed down task completion times compared to predicted timing.

### **Themes**

* **Strengths:** intuitive painting interaction, accessible colour manipulation and strong creative engagement.
* **Weaknesses:** limited system feedback, unintuitive toolbar resizing/moving and difficulty with erasing precision.

### **Insights**

The concept effectively supports creative exploration in XR, but usability issues with control feedback and toolbar management reduce immersion and flow. Future design should prioritise clarity, tool state visibility, and gesture-based interaction to align with user expectations. This can improve the productivity of users and help with the flow of the application and further demonstrate XR affordances.

### **Evaluation of Aims**

**Validated:**

* Painting and erasing were functional and engaging.
* Participants reported that the prototype successfully conveyed the feeling of creative expression in XR.
* Toolbar layout and switching between tools was easy to pick up.

**Invalidated:**

* Toolbar manipulation was unintuitive, the white and black boxes on the right side of the toolbar were far too ambiguous

**Unclear:**

* Screenshot/save functionality lacked clarity, with inconsistent user understanding of outcomes.
* Whether the toolbar UI was best suited as a HUD or something that is in the worldspace for example attached to an arm or fixed position

Overall, the core aim of demonstrating that Paint360 enables interactive digital painting in XR was **partially met** with strong feedback and suggestions given in certain categories.

### **Concept Iteration**

**Toolbar:** Simplify resizing by constraining proportions or adding visual anchors; consider detachable or wrist-mounted versions.

**Tool switching:** Auto-deactivate previously selected tools to prevent multi-tool activation errors.

**Feedback:** Add confirmation messages, visual highlights, or sound cues for key actions (e.g. paint tool active with green coloured button).

**Eraser:** Introduce variable brush sizes and an undo function to reduce tediousness.

**UI clarity:** Use active/inactive button states, colour coding, or icons to clarify tool status.

**New interactions:** Explore gesture-based controls (e.g. hand grabs, finger-based brushes) to increase immersion and interaction. Hand posture and gestures can be used to adjust sliders and dials rather than relying on raycasting onto the toolbar.

### **Reflection on the concept/design/methodologies/future testing and planning**

### **What Worked**

* Participants enjoyed the freedom of **painting in 3D space**.
* Although our tasks were simple we ended up with a variety of unique artworks
* Basic controls (painting, colouring & scene changes) were easily picked up.
* The concept successfully mapped familiar MS Paint tools into an immersive XR context.
* Colour slider was intuitive and easy to manipulate

### **What Didn’t**

* Toolbar manipulation and resizing led to frustration and simulator resets.
* The eraser tool’s limitations slowed task completion.
* Lack of system feedback (e.g. no crosshair, unclear save states) reduced usability.

### **Next Steps**

* Refine toolbar interactions and state visibility.
* Conduct further usability testing with a broader set of creative tasks.
* Introduce advanced tools (stamps, patterns, layer systems) to expand creative expression.
* Consider A/B testing toolbar layouts (floating, wrist-mounted, HUD-style) to evaluate ease of learning and productivity.

### **Appendices**

Link to testing videos

<https://drive.google.com/drive/folders/1Rjpvie6ZRs0XYTKz8wNAt3k30swJ5OR1?usp=sharing>

Time on Task Results (seconds)

| Task 1 (Draw) | 28 | Task 1 | 48 | Task 1 | 38 | Task 1 | 45 | Task 1 | 43 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Task 2  (Paint Bucket) | 24 | Task 2 | 26 | Task 2 | 24 | Task 2 | 18 | Task 2 | 7 |
| Task 3  (Colour Slider) | 3 | Task 3 | 4 | Task 3 | 4 | Task 3 | 4 | Task 3 | 4 |
| Task 4  (Scene Change) | 6 | Task 4 | 4 | Task 4 | 16 | Task 4 | 6 | Task 4 | 4 |
| Task 5  (Move UI) | 3 | Task 5 | 26 | Task 5 | 5 | Task 5 | 7 | Task 5 | 26 |
| Task 6  (Eraser Tool) | 25 | Task 6 | 4 | Task 6 | 18 | Task 6 | 94 | Task 6 | 15 |
| Task 7  (New File) | 4 | Task 7 | 3 | Task 7 | 1 | Task 7 | 2 | Task 7 | 3 |

Think Aloud & Notes from each participant including debrief questions

Participant 1:

* Straightaway knew how to operate the colour slider and use paint bucket tool
* User assumed that colour slider would affect the change scene colour
* Difficulty noticing that activated tools need to be deactivated otherwise dual functionality bugs may occur. Suggested that when clicking a new tool the old one automatically deactivates.
* Brush tool was intuitive
* Eraser tool could have had a bigger brush size to make deleting objects quicker
* Suggested that we could have a segmented paint bucket tool to colour half a sphere or a quarter of an object etc.
* Felt like this was a 3d modelling application

Participant 2:

* Difficulty moving UI mixed up between black square and white rectangle
* Would appreciate a ray to show where the drawing is happening (crosshair), brushing range can be adjusted (showcased by the length of ray)
* Brushing was hard due to no depth-perception/crosshair
* Toolbar buttons were a bit close together (due to size of screen), icons would be helpful
* Simulator broke when trying to drag the toolbar, (resize functionality not supported yet) had to hard reset the test
* Potential to add a layer style feature like Adobe PS

Participant 3:

* Activated paint bucket and brush accidentally for Task 1
* Used the colour slider to change scene (change scene currently chooses a random colour for the room)
* When asked to change scene, the participant manually tried to colour the walls individually instead of using the change scene button
* Liked the interactiveness of the 3d objects in the scene (physics)
* Liked that the toolbar was like a HUD
* Like how easy the colour slider was to use, suggested RGB instead of a single slider
* Liked the immersiveness of application (being in a room)
* Found WASD movement difficult since camera direction was not bound to the mouse
* Switching tools had some difficulties due to multiple tools being active at once but mentioned it was easy to pick up this error
* Mentioned that being able to interact with the 3d objects like warping and resizing with hand gestures could be something to look to add (already planned)

Participant 4:

* Would like ability to change brush size, found the erasing particularly tedious
* Gives a good idea of XR interactions, button clicking could be adjusted such as for colourslider a hand grab and rotate to adjust a colour dial
* Toolbar could be attached to arm or made more “productive”
* Suggested attaching different coloured brushes to different fingers to mix colours and to draw multiple lines at once
* Suggested palm press for paint bucket tool
* 3d drawing was cool, but was limited by distance (depth control)
* Intuitive mapping to MS Paint tools
* Erase tool was frustrating as you had to precisely mouse over all the brush elements one by one
* Gave an example of thickness slider being a dot on a finger and using the other hand to expand/contract the size of the brush or eraser
* Add the interaction to fill in the drawings that the user made

Participant 5:

* Confusion between colour picker and paint bucket functionality
* Liked the colour slider
* Difficulty noticing that multiple tools were active
* Had trouble noticing the UI elements on the toolbar used for dragging it and resizing it, resulted in having to restart the simulator as resize functionality isn’t implemented yet
* Asked if we can import models in or 2d images to edit them
* Noticed that the initial implementation of the brush created 3d spheres where the mouse hovered instead of a flat line
* Mentioned that the file size will be massive with the current implementation of the brush tool due to the amount of sphere game objects being created
* Mentioned that saving and re-opening files will be difficult if when saved it only takes a screenshot of the image
* All the tools were easy to use the brush tool was very fun to use
* Suggested hand gestures to control tools and sliders
* Suggested that an easy way to get around tools being forgotten to be turned off to is add active and inactive colours to the buttons
* Suggested adding 3d models a human one per say, and adding the ability to colour parts of it and draw on parts of it

Screenshots of Artworks





