SHAREDSPACES

3D Production Pathways:

Testing and assessment of 3D modelling software

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Overview: shARed spaces 3D production pathways

In the Fall of 2023, the shARed spaces team undertook research to identify and develop user-friendly and accessible production pathways so artists and community members could incorporate 3D scanning, 3D modelling, and augmented reality into their creative practice. Our criteria for selecting apps and software for testing was based on accessibility, ease of use, cross-platform compatibility, cost, and privacy agreements.

We identified a number of mobile, web-based, and desktop apps and software to test, and we made many discoveries along the way. A number of programs exist that are intended for specialized applications, and new apps are constantly being developed. In addition, software is continually updated, new features are added, ineffective features removed, and apps discontinued without notice. With regards to updates, at the time of writing.

The information provided in this document reflects the outcomes of testing that was conducted from October 2023 to March 2024 and thus future results may vary. For example, during this testing window, we encountered a number of changes in app functionality, user interface, quality of scans, privacy settings, and cost, which required us to re-learn the user interface, re-scan objects, and/or remove apps and programs from further consideration.

3D Modelling Apps

The information provided in this document reflects the outcomes of testing that was conducted from October 2023 to March 2024 and thus future results may vary. Our tests were not exhaustive, as there were a number of variables that came into play when using the software. This resource stands as general information only, and it is a snapshot within a specific timeframe with limitations. However, this information offers an invaluable starting point for exploring 3D modelling software, and information about 3D scanning to 3D modelling pathways.

Phase One: Identifying 3D modelling apps for consideration

We identified thirty-two modelling apps for testing on iPhone, Google Pixel phone (Android), iPad, iPadPro, Samsung Galaxy Tablet, PC and Mac Desktop, and web. Not all modelling apps were compatible with all devices or platforms; however, our list included apps that provide a range of access options across devices. In some cases, the modelling apps were part of a scalable package of applications designed to offer different levels of complexity and functionality for novice to experienced users. 'Scalable' apps are included in the list as individual modelling apps for testing because subscription to each level of the app is separate. The modelling apps were created for consumers, designers, educators, industry professionals, and for commercial applications. They include apps for vector-based building with individual vertices/edges/faces or ready-made geometric forms, what we will hereto refer to as "geometric"; "clay sculpting" or modeling from a simple starting shape; the manipulation of meshes of imported or scanned 3D objects; and parametric design or building/manipulation through use of modifiers.

When selecting and testing the modelling apps additional considerations became apparent that would enable us to cater to individuals with different levels of experience, and simultaneously expand options

for the types of projects we could workshop, support, and develop. As a result, the criteria for our selection of modelling apps for further testing included the following:

- a range of modelling apps to accommodate beginner, intermediate and advanced users but with a primary focus on users at a novice level for our purposes
- scalable options so work created in a beginner-level app can be exported and imported into more advanced applications for further development
- a range of modelling apps so several devices and platforms can be accommodated (for example, some modeling apps are browser-based meaning that they work best on a laptop or tablet and require a network connection to access; while others are exclusively mobile applications or downloadable software for Mac or PC but that can be used without a connection)
- a range of modelling apps to accommodate various types of projects including:
    o geometric and clay sculpting from scratch
    o geometric and clay sculpting using an imported scanned object
    o conversion of 2D images into 3D objects
    o development of scenes that use multiple objects
    o basic animation of objects
- free or low-fee subscriptions, as well as free or subsidized options for students

Selected apps for review

Our search generated a list of 33 modelling apps and software for review (See Table 1).

Table 1: 3D modelling apps and software

3D App: Design My Model	Morphi	Shapr3D
3D App: Design My Model Premium	Mudbox	SketchUp
3D App: Sculpt and Draw	Nomad Sculpt	Spline
Adobe 3D Substance Collection	OpenSpace 3D	TinkerCad
Blender	Prisma 3D	Vectary Starter
Cinema 4D/Cinema 4D lite	ScandyPro	Vectary Pro
echo3D	Sculpt+	Wings 3D
Forger	SculptGL	Womp
LeoPoly	Sculptris	ZBrush Core Mini
Maya	SelfCAD	ZBrush Core
Mesh Mixer	Shapelab	ZBrush

After completing preliminary research and testing of each app or program, we identified the following prohibitive factors for use by the shARed spaces project:

- a paywall in the form of high monthly or yearly subscription fees, and/or in-app purchases at each stage of importing, modelling, exporting
- functionality and user interface too complex or not intuitive
- apps in Alpha or Beta testing phase, which means long-term accessibility and cost uncertain
- proprietary functionality, meaning the applications are designed to work in tandem with other applications offered (sold) by the same company in order to access full functionality

- limitations associated with importing and/or exporting files, which limits functionality
- the app required knowledge of coding rather than having a simple UI

Phase Two: Shortlisted apps and programs for testing

As a result of this first phase of testing, we shortlisted nine apps for deeper testing: 3D Modelling App: Design My Model Premium, 3D Modelling App: Sculpt and Draw, Blender, Mudbox, Nomad Sculpt, SculptGL, ZBrush Core, Womp, and ZBrush CoreMini. In the case of Womp and ZBrush CoreMini, users cannot import files so we did not include these apps in further testing. However, it was noted that they are great sculpting apps for beginners to get a feel for digital sculpting tools. Objects can be exported from each of these apps and imported into another app, enabling the user to scaffold up to more complex applications. ZBrush CoreMini is specifically designed with this intention as it has two additional levels available - ZBrush Core and ZBrush - for intermediate and advanced users respectively.

At the second phase of testing, we prioritized no cost/low cost, we focused on a range of apps to accommodate various devices and platforms, we considered functionality and level of difficulty, as well as compatibility for the scanning-to-modelling pathway

Table 2: Shortlist of 3D modelling apps for further testing

Modeling App	$	Device/Platform	Level
3D Modeling App: Design My Model	$7.49/mo	iOS, MacOS	Beg - Inter
3D Modeling App: Sculpt and Draw	$7.99/mo	Android	Inter - Adv
Blender	Free	Windows, MacOS	Inter- Adv
Mudbox	$15/mo	Windows, Mac OS, Linux	All levels
Nomad Sculpt	$21/once	Android, iOS, Chrome OS	Inter-Adv
SculptGL	Free	Web, Windows, MacOS, Chrome OS	Beginner
Womp	$9.00/mo	Web	Beg-Inter
ZBrush Core	$13/mo	Windows, MacOS	Inter - Adv
ZBrush CoreMini	Free	Windows, MacOS	Beginner

Phase Three: Preliminary testing of production pathways using Blender 3D modeling

Before proceeding with testing of 3D modelling apps, we tested the compatibility of our selected scanning apps with Blender software. Blender is a "3D creation suite" but it can also be used for 2D creation. The shARed spaces team uses Blender, which in comparison with other software available we have identified as an intermediate to advanced program. While Blender was compatible with all four selected scanning apps, through this process we got a sense of any issues related to importing of files, file formats, and whether scanned objects would maintain their fidelity when imported (some scanned objects looked much better when viewed in their home application than when brought into secondary software).
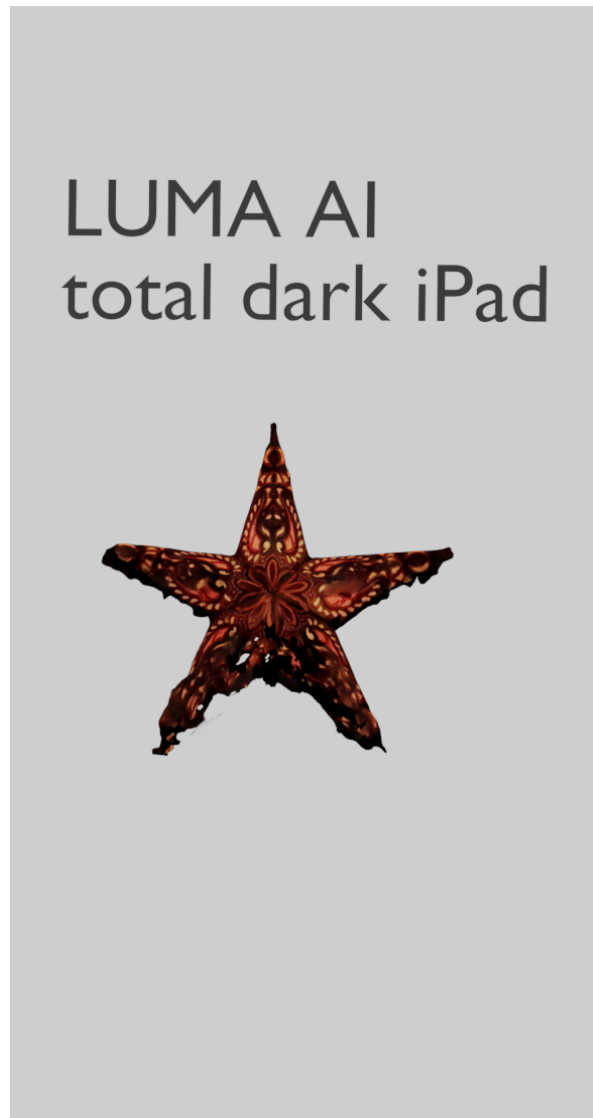
Figure 1: The same lamp but seen in the app LUMA AI on the left and the same model brought into Blender on the right

We chose to push the limits of this testing by working with a variety of scanned objects, devices and lighting conditions. The results were informative and made us aware of idiosyncrasies that may arise when testing 3D modelling apps and building production pathways.
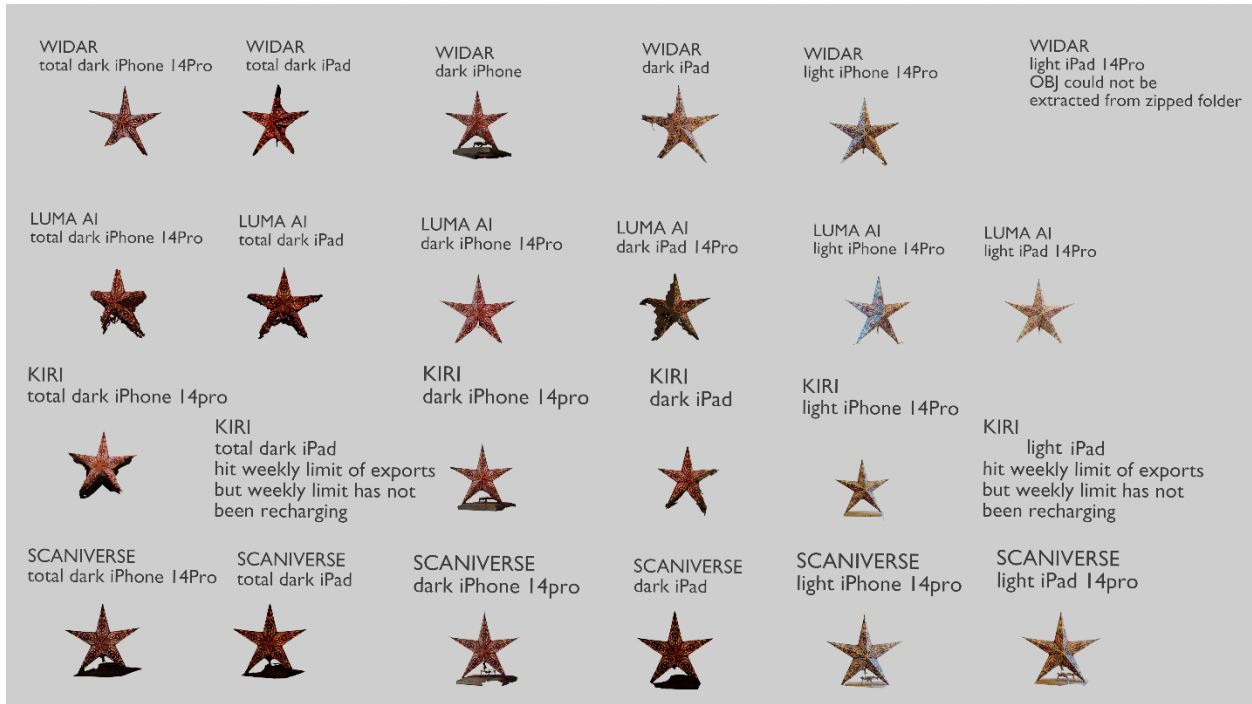
Figure 2: Comparison of scanning results when imported to Blender

Table 3: Blender tests w/ objects from scanning apps

OBJECT	KIRI ENGINE	LUMA AI	SCANIVERSE	WIDAR
Carnival glass (iPad, artificial light)	✖	◗	✖	✖
Carnival glass (iPad, natural light)	✖	◗	✖	✖
Cast iron teapot	✔	✖	◗	✔
Human figure	◗	✔	◖	n/a
Plastic statue (iPhone, natural light)	✔	✔	◗	◖
Plastic statue (iPad, artificial light)	✖	✖	n/a	n/a
Plastic statue (Android, natural light)	✖	◗	n/a	n/a
Porcelain Cat (iPad, artificial light)	◖	✔	◖	✔
Porcelain Cat (iPad, natural light)	✔	✔	◗	◖
Plushy cat toy (iPad, artificial light)	◖	✔	✔	◗
Plushy cat toy (iPad, natural light)	◗	✔	◗	◖
Sage bundle	✔	◗	◖	✔
Silicon whisk	◖	✖	✖	◖
Star lamp (iPhone Pro, total dark)	✖	✖	◖	✖
Star lamp (iPad Pro, total dark)	n/a	✖	◗	✖
Star lamp (iPhone Pro, dark)	✔	✔	◖	✔
Star lamp (iPad Pro, dark)	✖	✖	◗	✖
Star lamp (iPhone Pro, light)	✔	✔	✔	✔
Star lamp (iPad Pro, light)	n/a	✔	◖	n/a
Terracotta ceramic cat figure	✔	✖	✖	◖
Wooden clothespin	✔	✔	◖	◖

✔ high fidelity　◖ mid-high fidelity　◗ mid-low fidelity　✖ broken, holes　**n/a** not available

The results of this phase of testing revealed unanticipated challenges when developing a scanning-to-modelling pathway. Using scanned images from our four selected scanning apps – KIRI, LUMA AI, SCANIVERSE, and WIDAR – we attempted to upload images in various file formats including FBX, GLB/GLBT, OBJ and USDZ. These selected file formats were based on the types of exportable files available in the scanning apps, and/or the types of file formats that were importable into Blender.

However, importability this was also about the ease with which the scanned images could be imported/exported, and the fidelity of the scanned image once it was imported into Blender. This was one of the most surprising outcomes, as there was considerable variation in object fidelity depending on any combination of the following: object type, texture, and colour; the lighting set-up used during scanning, for example, interior and exterior light sources, and singular or multi-light set-up; the specific device used to scan; and the quality of the camera on that device. Because of this multitude of variables, the results associated with a particular scanning app and a particular object varied considerably. We are able to generalize outcomes and anticipate some challenges; however, it is beyond the scope of this testing to account for all variations to arrive at definitive conclusions. An overview of the outcomes of the scan-to-modelling pathway using Blender can be found in the following table.

Phase Four: Final selection for deep testing

With the knowledge gained from Blender tests, we proceeded with six modelling apps: 3D Modelling App: Design My Model Premium, 3D Modelling App: Sculpt and Draw, Mudbox, Nomad Sculpt, SculptGL, and ZBrush Core. After preliminary testing, the two "3D Modelling Apps" for android and iOS) were removed from further testing due to limited functionality.

With the knowledge gained from our initial review and Blender tests, we proceeded with four modelling apps for deep testing: **Mudbox, Nomad Sculpt, SculptGL, and ZBrush Core.** In addition to satisfying the selection criteria we developed, these four apps/programs offer compatibility across operating systems, they provide options for all levels from beginner to advanced, and they are available free or for a low fee. At this stage, we did not replicate all the variables considered in our Blender tests. Rather, we tested a smaller selection of objects based on textures, colours, shininess (or roughness), and translucency (transmission). We focused on OBJ files only, as they were the most compatible and stable within our pathway. The following variations were identified across the six apps: image imported with material; image and material imported separately; image imported as monochromatic object without material; image could not be imported.

The remaining four modeling apps were used in the next phase of testing and assessment: **Mudbox, Nomad Sculpt, SculptGL, and ZBrush Core.**

In this next phase of testing, each member of the team chose one 3D modelling app to explore in depth. The following steps were taken by each tester:

- imported one object from each of the four scanning apps shortlisted (KIRI, LUMA AI, SCANIVERSE, WIDAR) to test for compatibility.
- identified issues within the production pathway related to whether scanned objects could be imported based on file export limitations and whether scanned objects imported with or without material.

- for the objects that were successfully imported into the 3D modelling app, we explored options for manipulating each object with attention to the range of tools, the quality of the mesh, as well as painting and stamping options.
- we explored options for sculpting an object from scratch using various tools in the 3D modelling app.

The following tables provide an overview of the outcomes of our testing.

Table 4: 3D modelling apps overview

App/Platform	Usability	Community considerations	App Access	End-Users
	Intuitive Complex	"One-stop-shop"	Subscription	Level
Mudbox	Intuitive	Yes, sculpture, texture, painting, import/export	Yes	All levels
Nomad Sculpt	Complex	Yes, sculpture, texture, painting, import/export	Yes	Intermediate - Advanced
SculptGL	Intuitive	Yes, sculpture, texture, painting, import/export	No	Beginner
ZBrush Core	Complex	Yes, but complicated!	Yes	Intermediate - Advanced

Table 5: 3D modelling app compatibility and cost

App	Platform / Compatibility					Cost		
	Android OS	iOS	Chrome OS	Web	Desktop	Free	Cost / month	Cost / yr
Mudbox	-	-		-	Windows, MacOS, Linux	Free trial	$15.00	$100.00
Nomad Sculpt	Phone, Tablet	iPhone, iPad	Yes	-	-	Free trial	One time purchase, $19.99	
SculptGL	-	-	Yes	Yes	Windows, MacOS*	Free		
ZBrush Core	-	-	-	-	Windows, MacOS	No	$13.00	**Maxon One Student Suite = $90.00

*SculptGL is primarily a web-based program. It is also downloadable as a desktop application through third-party sites.
**Maxon One Student Suite includes: Cinema 4D, Red Giant, Redshift, ZBrush, Forger, Capsules, access to Maxon training.

Table 6: 3D modelling apps import and export formats

App/Platform	Import / Export			
	Import Format	Export Format	Export Location	Notes
Mudbox	OBJ, FBX, MUD	OBJ, FBX, MUD	Local drive/device	OBJ imports w/o texture FBX imports w/ texture
Nomad Sculpt	OBJ, GLB, GLTF, STL, PLY, FBX, NOM	GLTF, OBJ, STL, NOMAD	Default = Projects file in Nomad folder on device	Same developer as SculptGL
SculptGL	SGL, OBJ, PLY, STL	SGL, OBJ, PLY, STL	Local drive/device, or Sketchfab	Same developer as NomadSculpt. Works with Sketchfab
ZBrush Core	OBJ, MA, MESH, MESHB, GoZ, STL, FBX	OBJ, MA, x3D, GoZ, STL, VRML, FBX	Default = ZBrush folder on local drive/device	Scaffold up through Maxon ZBrush suite: ZBrushCoreMini, ZbrushCore, ZBrush

Table 7: 3D modelling apps image file and mesh details

App/Platform	Image File				Mesh			
	Texture File	Normal	Bump	Displacement Map	Visible	Retopo*	Decimate	Tri / Quad
Mudbox	FBX, GLB, USDZ	Yes	Yes	Yes	Yes	Yes	Yes	Quad
Nomad Sculpt	PNG	Yes	Yes	Yes	Yes	Yes	Yes	Tri, Quad
SculptGL	JPG, PNG	No	No	No	Yes	Yes	Yes	Tri, Quad
ZBrush Core	BMP, PSD, JPG, TIF, PNG, GIF, HDR, EXR	Yes	View only	Yes	Yes	Yes	Yes	Quad

*Retopo = retopology

Table 8: 3D modelling app sculpting and painting options

App	Sculpting		Image Mapping	Texture Painting						
	Mesh*	Geo**	UV unwrap	Flat	Gradient	Blend	Erase	On existing texture	With image texture	Tablet press
Mudbox	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Nomad Sculpt	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SculptGL	Yes	No	No	Yes	No	No	No	Yes	Yes	Yes
ZBrush Core	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Mesh: sculpting (the program has tools that allow for shape manipulation, pushing, pulling, inflate, clay strips/paint, etc.)

** *Geometry: vector-based building with individual vertices/edges/faces or building with ready-made geometric forms*

Table 9: Summery overview of selected 3D modelling apps

App	Benefits	Limitations
MUDBOX	- user-friendly, intuitive UI - lots of great tools - sculpting functions easy to use - painting and stamping options - users can also import patterns to add	- limitations with import/export file formats – limited to OBJ and MUD files. - program sometimes freezes and crashes. - models import w/o material (easy to add)
NOMAD SCULPT	- lots of functionality, great results - great way to 'level-up' from SculptGL - objects import with material - painting and stamping options - users can also import patterns to add to models	- complex program - steep learning curve - recommended for advanced learners
SCULPTGL	- user-friendly, great for beginners - 'lighter' version of NomadSculpt - sculpting function easy to use - painting and stamping options	- lacks some object editing function - cannot delete or erase vertices - models import w/o material (easy to add)
ZBRUSH CORE	- part of Maxon ZBrush suite - scaffolding from basic to complex application is possible - lots of tools, great results	- more advanced program - complex sculpting interface - UI is a little complicated - difficulty importing scanned objects

Video tutorials

To learn more about the 3D modelling apps and programs we tested, check out **our shARed spaces YouTube channel** where you will find video tutorials for Mudbox, NomadSculpt, and SculptGL. Our deep testing of ZBrush Core revealed a complex interface that we determined was not ideal when working with community. As a result, we did not proceed with video tutorials for this 3D modelling program.
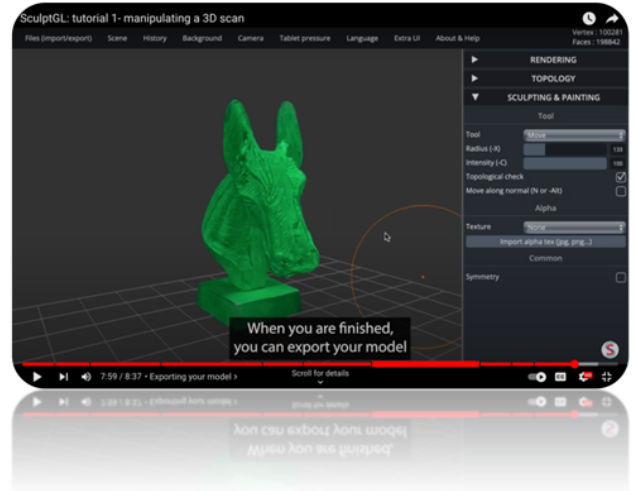
Phase Five: Creating a 3D scanning to 3D modelling production pathway

Each stage of our testing has come with its own challenges as the variables expand exponentially. We began our testing using Blender, as this is the program currently used by shARed spaces and our team is already familiar with its user interface. Blender is also a popular program used by 3D digital designers, and it is free to download. This program is very complex as it is designed for intermediate to advanced users. Beginners can work with Blender but it can lead to frustration and comes with a steep learning curve.

2D to 3D image conversion

Some apps include the option of importing 2D images and converting them into 3D objects. In the modelling apps we reviewed, however, this conversion is primarily manual conversion. For example, in Blender, images can be brought in as planes, meaning that the image is a flat rectangle/square if a jpg and is shaped along edges of the transparency if a png with an alpha channel. These images remain completely flat (like a piece of paper floating in space). The user can also import a 2D image as a reference image and build a 3D object with mass from scratch. Manual conversion is labour intensive so AI-generated conversion apps in which a 2D image (imported or hand-drawn in app) can be transformed into a 3D object open up new possibilities for working with community. We have subsequently undertaken a dedicated search for 2D-to-3D conversion apps that are compatible with modelling apps.

Challenges when developing a production pathway

When creating a production pathway, we experienced a number of challenges related to:

- limited and/or varying export file formats available in scanning apps
- export of scans with and without material (some materials are embedded others exported as image and/or material file, for example: .obj, .mtl, and .jpg
- import functionality of modelling apps
- ease with which material could be added to object if imported without (if possible at all); limitations of modelling apps that did not import with material
- limitations of modelling apps that allow painting and stamping only
- Very large file size, resolution, and/or very high vertex count which is not ideal for AR
- Image textures lost when decimating model to bring down file size
- Mutation or awkwardness of mesh when altering a scanned object (especially acute in apps with no dyntopo or remesh capabilities)
- Variation of tris and quads between scanning and modeling apps
- Overall complexity of file export and import—some files would export as zipped folders and that were empty, others were missing file package components, and still others wouldn't transfer or email at all, or weren't accessible to second level apps

3D modelling apps user manuals

Mudbox	Mudbox Help: What's New in Autodesk Mudbox
NomadSculpt	Overview | Nomad (nomadsculpt.com)
SculptGL	Homepage (stephaneginier.com)
	Introduction to SculptGL - A Free 3D Sculpting Tool | STYLY
	SculptGL (sculpteo.com)
	A-Z Guide to SculptGL for Beginners | OnlineDesignTeacher
ZBrush Core	ZBrush (maxon.net)