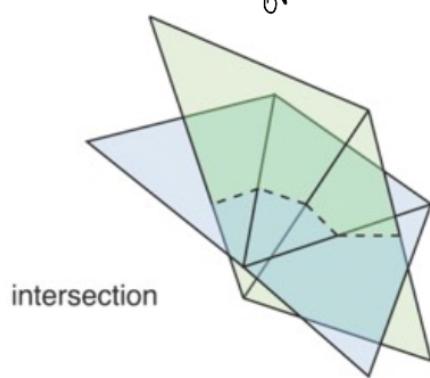
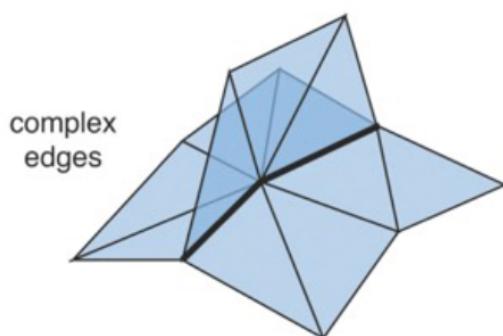
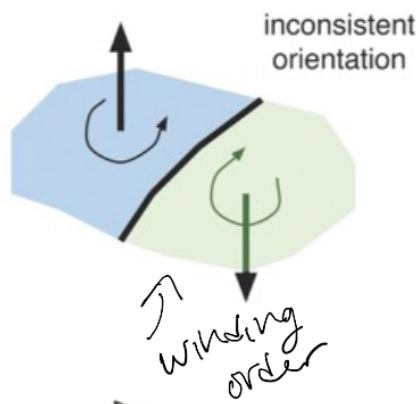
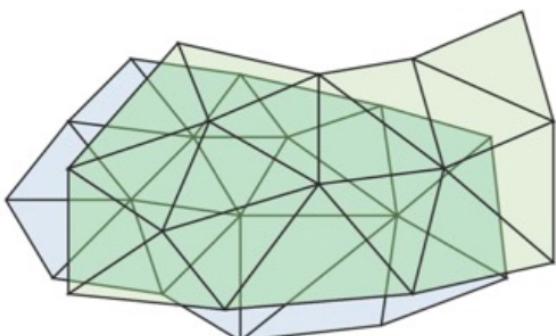
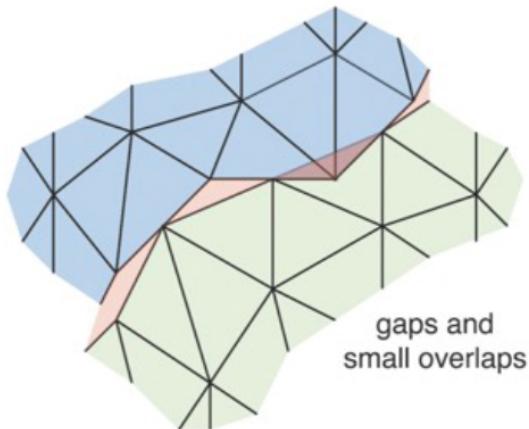
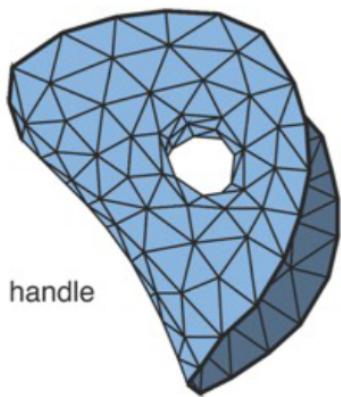
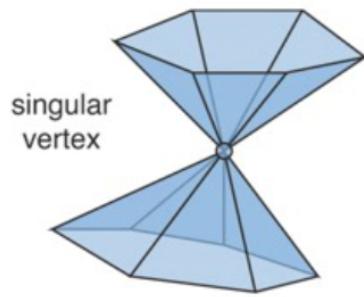
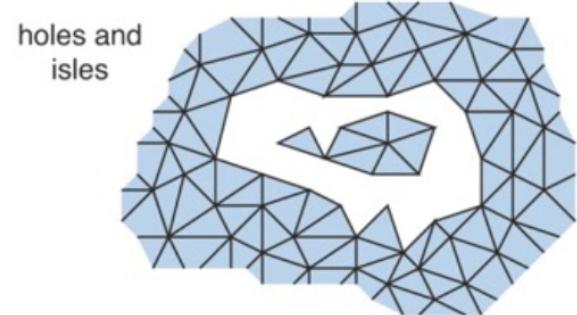


MESH REPAIR

What can go wrong?

Topology:

- non-manifold
- pinch points/edges
- holes
- interpenetration
- no Δ 's, just points
- winding order problems

Geometry:

- no normals
- duplicate Δ 's
- bad curvature
- non-uniform Δ size
- bad gluing of patches
- roundoff errors
- disconnection (topology)
- overlapping vertices/edges/
 Δ 's
- sharp vs. smooth edges
- bad Δ shape

ideal Δ equilateralAttributes:

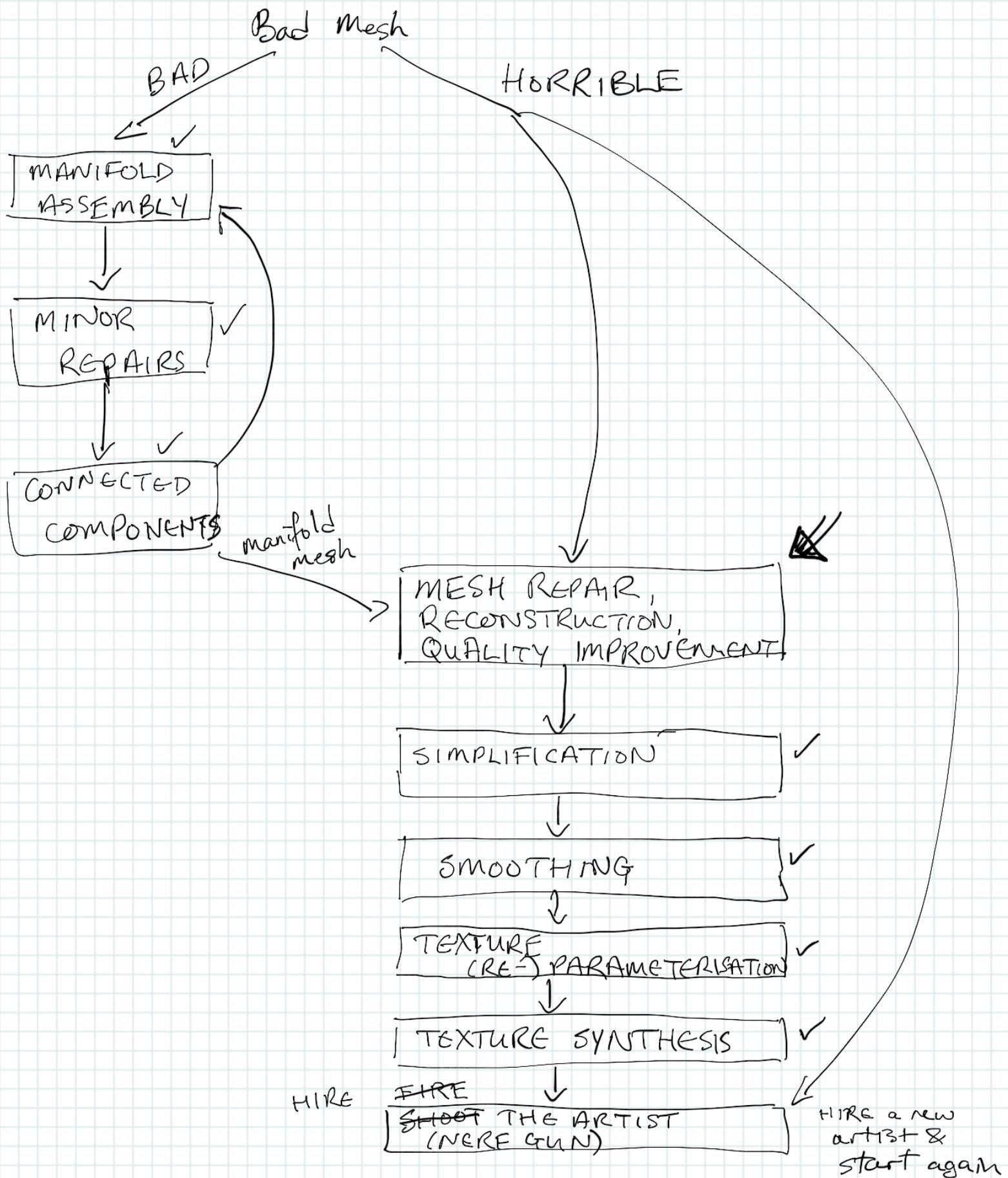
- no u,v coords
- bad u,v coords
- per vertex materials
- non-normalised attributes
- overlapping texture maps

Figure 8.1. The freak show. (Image taken from [Botsch et al. 06b]. ©2006 ACM, Inc. Included here by permission.)

Mesh Repair Pipeline

(not a hardware pipeline)

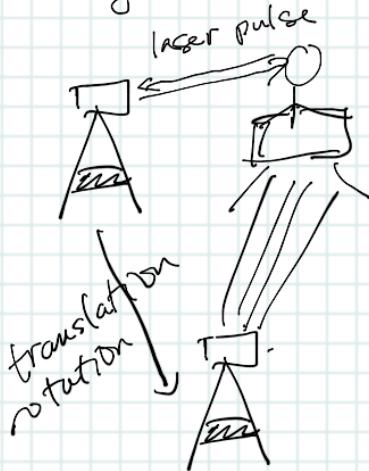
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Types of Input

1. LIDAR & similar

Registered Range Scans



measures distance

then rotates a small angle & does it again
but much of the object is shadowed
so we pick a new position & try again
- we will need accurate measurement
of the relationship between the scan locations
- "registration" of the scans

Output : point cloud: a set of (x, y, z) points

maybe (r, g, b) colours [coregistered camera]
 \hookrightarrow this is after lighting

maybe BRDF

do get large number of points

high accuracy

multiple angles

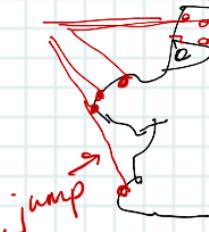
missing patches - i.e. holes

cannot assume adjacency (i.e. edges)

redundancy

problems:

might have topology



① redundancy

② missing bits

③ might have topology for patches

④ $10^n \Delta^1$'s $n \gg 2$

eg $n = 10 \quad 10^{10}$

② Fused Range Scans

- same, but already heavily processed
- spurious (incorrect) topology
- accidental geometry (jumps get connected)
- blends / interpenetration
- will need to parameterize it

③ Pure Triangle Soup

- CAD software (Blender / Maya)
- lowest common denominator
- assemblies built from libraries (pick an arm, head, &c)
- only have 1000's of triangles ($n \in [3, 5]$)
 - an artist had to make them in the first place
- intersections, pinch points, shared edges, gaps, holes
- bad normals / orientations
- partial/no/multiple textures
- most common & often easiest

④ Tessellated Patches

- output of CAD using higher-order surfaces
- modelled as patches, then broken into Δ 's
- i.e. it is structured
- gaps, &c. between patches
- bad normals
- relatively clean, especially if you know/can infer the patches

⑤ Contoured Meshes

- Isosurfaces / Marching Cubes ($> 20,000$ papers)
- from volumetric data (related to DVR)
- guaranteed to be:
 - ① watertight - no holes
 - ② manifold
 - ③ good connectivity (low vertex degree)
 - ④ far too many Δ 's
 - ⑤ spurious topology
 - ⑥ no u,v coordinates

MINOR MESH REPAIR:

MANIFOLD REPAIR:

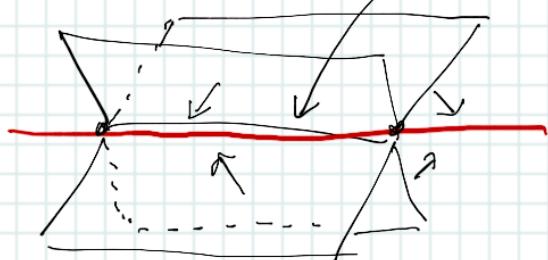
- ① CCW/CW orientation problems / bad normals

- modify our manifold mesh structures to allow cw/ccw
- pick one direction to be outside (eg first Δ)
- propagate that orientation across the surface
- unless it's a non-orientable manifold in the first place
(eg a Möbius strip)

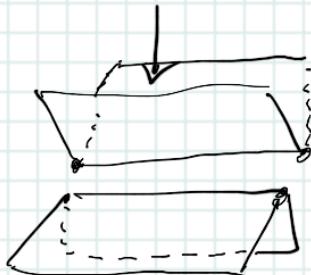
- ② shared edges

edge occurs 4 times

- hopefully have inside outside



- take the edge - make two copies
- push each copy towards its neighbours (DLBO)

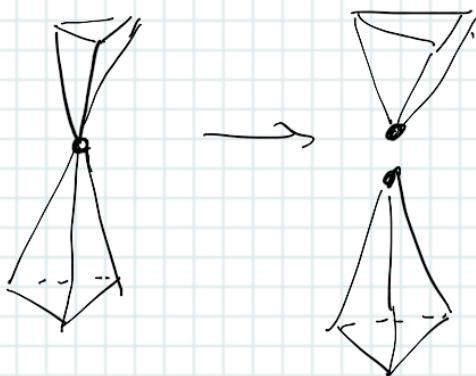


this works fine by manual editing
if there are only a few such edges

- pay an artist (highlight the edges)

- if many such edges \rightarrow horrible mesh

- ③ pinch points - same solution

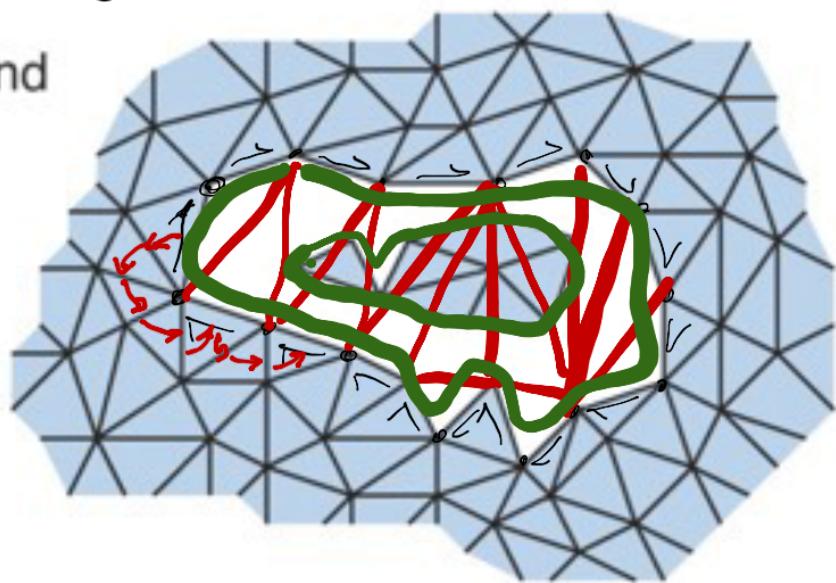


Holes / Islands

- detection:
 - this is a mesh boundary
 - consists of unpaired edges
 - take next previous away from the boundary
 - eventually we find the next bit of boundary
 - eventually we come back to where we started
 - finding a cycle of unpaired edges
- repair
 - hole repair
 - the hole is a missing polygon
 - triangulate it & done
 - triangles may be bad \rightarrow repair in the major pipeline
 - hole / island
 - artist identifies the two cycles to connect
 - then triangulate
 - frankly, faster if the artist does it
- variations
 - add a vertex in the middle of the hole
 - make Δ 's similar in size to the mesh Δ 's (subdivide)
 - run an optimising routine

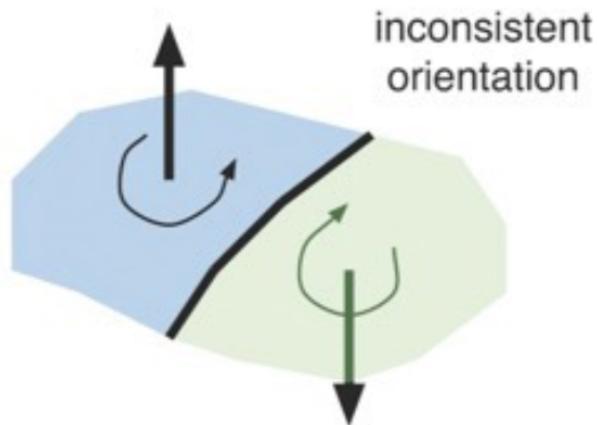
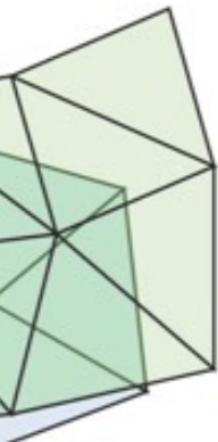
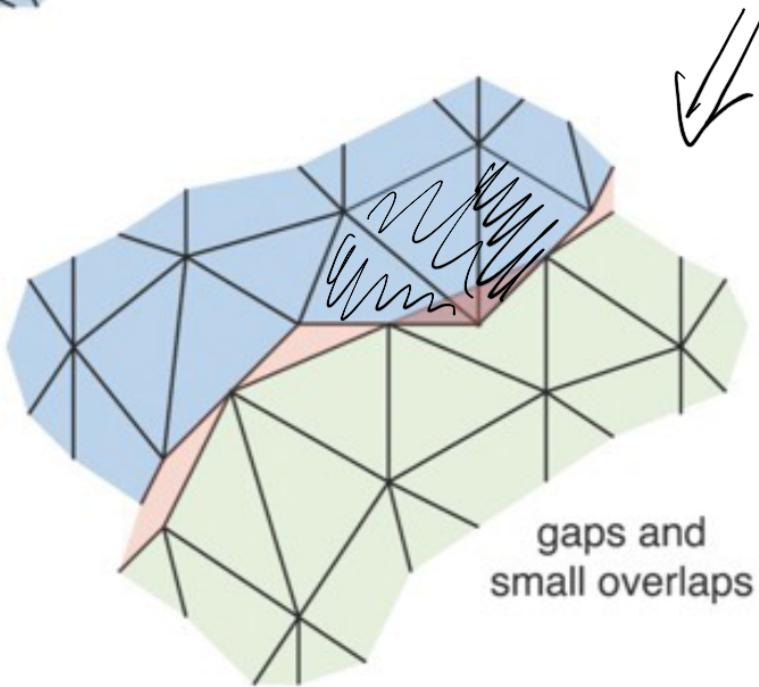
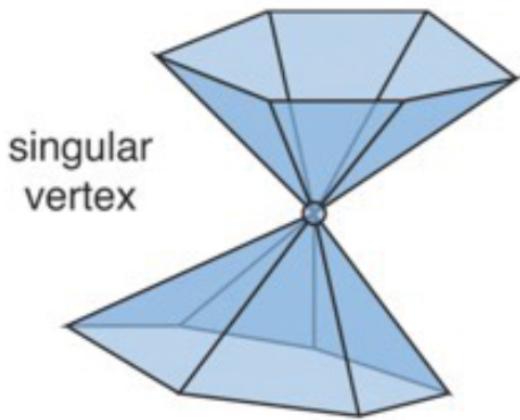
works well for small holes

holes and isles



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Intersecting strips



for every pair of intersecting Δ's, randomly delete one of them

- no intersections, just gaps
- same solution as for holes
- minor repairs are human-intensive

→ hire an artist