repn's

difficulty w/ CSG is its slow to render

raytrace)

to a boundary or B-rep.

ent each primitive with a mesh of

ns.

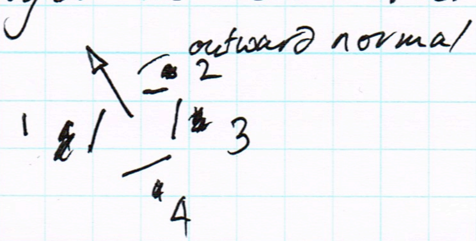
typically represented with winged edge solid

of

- faces (faces) w/ ptrs to relevant edges, verts
- faces (edges)
- faces (vertices)

entions

~~[illegible]~~ list edges in CW order going around a face



dge repn as

first vert   last vert   left face   right face

next, prev moving along left   n,p along right repn

least

rt . one incident edge.

ert all incident edges

repn

least

face one edge

face list of edges

...ne operations are straightforward

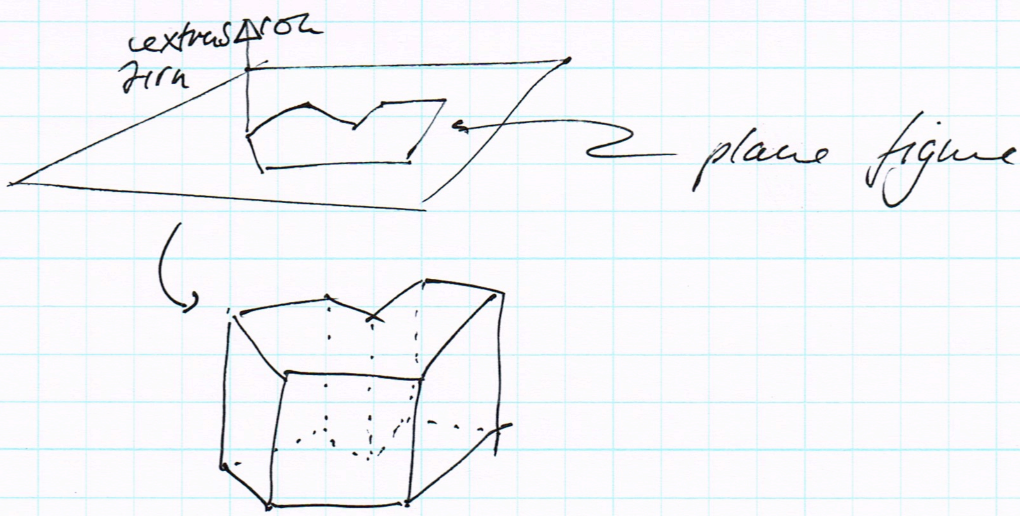
- rendering — throw faces into polygon renderer
- Some joins
  - eg. paste two objects together on shared face

    cases: • faces are "the same"

    • not ...

extrusion

- important operation to produce solids



- many objects are made like this.

ection is relatively easy
faces of $\cap$ are pieces of faces
of components.

convex components are particularly
easy
- only one connected component
- ~~only one~~ no more than 1
face of $\cap$ from any face
of component.
- verts are
(some of component verts) $\cup$

e (• face(A) $\cap$ edge(B))) $\cup$

some (face(B) $\cap$ edge(A)))

- each of these sets is easy
to find.

- rest is pointer chasing (example)

~~secting WES is relatively straightforward~~

~~GHLY~~

~~· find edge-face Δs, chase~~

---

pass from WES to general

oup of polygons
ometimes w/ combinatorial structure

· note tough to have much
if it isn't a solid.

HE not usually a solid

UE many computations can be tricky

E hard to spot core geometric properties

E · interpolation over meshes is easy

· ∴ normals are NOT piecewise const (or at least, not required to be)

WE MAKE ONE?

WES

elling system

h a set of sample points.

NG

meshes usually come from an assembly

of surface patches

These are usually built w/

- splines
- subdivision surfs
- height maps (less often)

MAPS

mplest)

- have $(x_i\ y_i, z_i)$,

scattered data.

(e.g. image data)

interpolate or smooth, grid, resample

triangulate (x_i, y_i) use this to get mesh.

- Hard to avoid "bad" 3D triangles
- hard to sew together pieces
- resampling may bias.

$\equiv$

ed Data interpolates, smoothers

have N pts (x_i, y_i, z_i)

OT on grid

should like to build approximation

erpolate)

<u>strategy</u>:

hoose $\phi(x,y;x_i,y_i) = f\left((x-x_i)^2+(y-y_i)^2\right)$

(discuss choices later)

iterpolate is

$$\sum_j a_j \varphi(x,y;x_j,y_j)$$

$$z_i = \sum_i a_i \varphi(x_i,y_i;x_j y_j)$$

$$\underline{z} = \underline{M}\,\underline{a}$$

light conditions on φ, M has full

(Micchelli)

-sider some choices of φ.

$$;x_i,y_i) = f((x-x_i)^2+(y-y_i)^2)$$

$$= f(d^2)$$

$$(d^2) = \frac{1}{d^2+\varepsilon} \longleftarrow$$

- <u>not</u> finite support
- ε has important control properties

$$^2) = \max\left(1-\left(\frac{d^2}{\sigma^2}\right), 0\right) \longleftarrow$$

- finite support
- σ has control properties

$$= -\log(d^2+\varepsilon) \longleftarrow$$

- not finite support
- rather odd far away from data
- minimizes a form of bending cost

$$(\nabla^4 f = 0)$$

?

...ote each of these basis fn's has a
...meter, which is essentially a scale
...m.

...hoose (x_u, y_u) ← random subset of points
or random points
base points

$$\| z_i - \sum_{j \in \text{basepoints}} a_j \phi(x_i, y_i; x_j, y_j) \|^2$$

$$\| \underline{z} - M_b \underline{a} \|^2$$

$M_b^T M_b a = M_b^T z$ — solve for a

...ing scale param: plot err vs scale for pt set, choose best

...ber of base points:

- application logic
- MDL / AIC style reasoning

at choices of basis, scale
ffect linear algebra.

$\,^{2}_{2} \vdots\, 0)$ $\longleftarrow$ many zeros in M_6

$\longleftarrow$ can often solve w/ iterative method,

<u>precondition</u>

is often a good preconditioner.

imates Laplacian on some triangulation of
oints

point, pass to Shape from Shading

l form

Given shaded image of a surface, with domain D, viewed orthographically, with KNOWN RADIOMETRIC CALIBRATION, known albedo, known ... se, RECOVER SURFACE GEOMETRY

...971).

Traditional Strategy:

odel $$I(x,y) = \big(N(x,y) \cdot S\big) \cdot \rho(x,y)$$

source vector

unit normal

image intensity, in radiometric units (hence calibration)

Known albedo

assume WLOG, $\rho = 1$

$$N(x,y) = \frac{(-h_x, -h_y, 1)}{(1 + h_x^2 + h_y^2)^{1/2}}$$

ace $(x, y, h(x,y))$

PDE

$$\overline{\quad + h_x^2 + h_y^2} + S_0 h_x + S_1 h_y - S_2 = 0$$

an instance of an eikonal eqn

. No soln when $I^2 > S_0^2 + S_1^2 + S_2^2$

can be shown that existence of
olutions is a serious problem

nerally, Solving this PDE does not
yield approaches that
- make sense mathematically
- make sense practically
- yield good looking soln's

tric model is <u>WRONG</u>

correct for

- diffuse surfaces
- isolated patches
- distant sources

but these conditions don't apply.

radiometric model is, <u>at least</u>

$$\underline{(x)} = \underbrace{B_0(x)}_{\text{radiosity at } x \text{ due to source alone (eg, when patch at } x \text{ is isolated)}} + \int \underbrace{K(x,y)}_{\text{geometric, radiometric gain terms}} \underbrace{B(y)}_{\text{radiosity at } y} \, dy$$

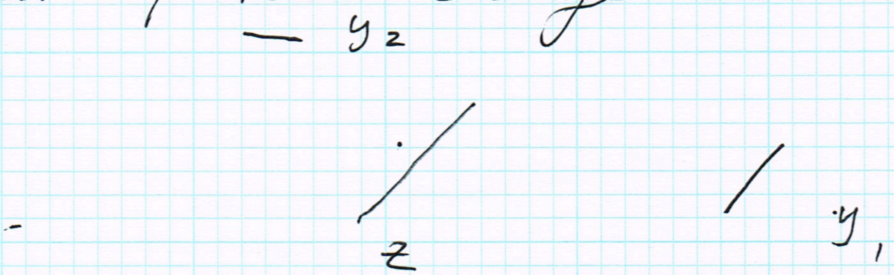
ct

(brightness)

el is <u>wildly</u> unpromising

ll pairs of patches interact

her patches change interaction



→ x light transfer occurs

→ x doesn't, z is in the way

a complicated fn of geometry

e are claims in literature that

can work ~~the~~ interrefln's into shape

ence — I discount them.

[M]odify Shading model to

$$I(x,y) = G(N;\ S)$$

some fn of the unit normal

natural G

$$G(N;\ S) = \sum_i a_i\ S_i\ (N)$$

spherical harmonics

encode source properties

yields another PDE

. Still have existence problems

[Attem]pts to duck existence problems

[usin]g variational methods ~~fagl~~ haven't

[succeed]ed.

t Malik

imize $\left[\text{Cost}(\text{Surface, albedo, Illum}) \right]$

ect to

$$I - \rho G(N; a) = 0$$

does not have existence problems,
I is badly mishandled.

hat is Cost(Surface, albedo, Illum) ?

t should it be)

ies :

- illum field is "smooth"
  except at shadows

- albedo field is >0, <1,
  has few slow changes,
  has few distinct values

Surface is "smooth"

) - turns away from eye at outline

) - is biased toward front

) - ~~is~~ tends to be locally "flat"

). $n_x^2 + n_y^2 \geq$ thresh (at boundary)