Comparison of Surface Modeling Schemes

METHOD	SHAPES	MATH	EDITING	RENDERING	HISTORY
polygon mesh	curved surfaces require many polygons; no tangent continuity; (but can do display hacks like Gouraud & Phong shading)	trivial	cumbersome – too many points to move; best for rigid shapes; awkward for flexible shapes; bulky to store	trivial, but typically not view-adaptive, so sometimes excessive detail	probably the most widely used method
implicit surface (quadrics, CSG, blobs, algebraic)	CSG good for mechanical CAD; blobs good for organic shapes; poor for free form surfaces	easy: need only $f(x, y, z)$ and ∇f	difficult to control shape with the more general implicit surface classes, such as blobs	if ray tracing, do root finding; if z-buffer, do marching cubes to convert to polygons; hard to texture	not nearly as common as parametrics; CSG has been around since 60's, blobs only popular since late 80's; few books
parametric surface (Bezier, B-spline, NURBS, others)	good for free form surfaces; NURBS can represent sphere exactly, others can only approximate them	moderate at first; things get complex with continuity constraints and triangular patches; NURBS are hairy	easy, except for continuity constraints	Z-buffer: easy, either compute points on surface directly from parameters (s, t), or use subdivision. Ray tracing: harder.	widely used; popular for CAGD since 60's, supported by OpenGL, Renderman; many books
subdivision surface	good for free form surfaces; can represent a sphere exactly	easy at first; matrix analysis required for advanced work	easy	harder than parametrics, but easier than implicits: in general, there's no parametrization, only way to generate points on surface is by subdivision; hard to texture	not used much (yet); quite new (revived in '93), soon to be supported in Renderman and OpenGL, a hot research topic

Glossary

CAGD: computer-aided geometric design (e.g. designing cars, airplanes, boats)

CSG: constructive solid geometry – modeling solid objects as the union, intersection, and difference of solids

free form surface: arbitrary shape that one might design, (e.g. car body, teapot). A somewhat nebulous term.

hairy: nontrivial, or perhaps even abstruse & impenetrable

NURBS: non-uniform rational B-spline – ratios of polynomials, with non-uniform knot sequence

solid modeling: modeling objects out of solids, as opposed to modeling out of (possibly disconnected) surfaces – this is more important for engineering simulation than for most computer graphics

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