References

[1] Catmull, E., and Clark, J. Recursively generated B-spline surfaces on arbitrary topological meshes. *Computer Aided Des. 10* (1978), 350 – 355.

[2] Cattani, C., and Paoluzzi, A. Boundary integration over linear polyhedra. *Computer Aided Des. 22,2* (March 1990), 130 – 135.

[3] de Boor, C. B-form basics. In *Geometric Modeling: Algorithms and New Trends*, G. Farin, Ed. SIAM, Philadelphia, 1987, pp. 131–148.

[4] DeRose, T. D., and Loop, C. T. S-patches: A class of representations for multi-sided surface patches. Tech. rep., University of Washington, Department of Computer Science, Seattle, 98195, 1988.

[5] Doo, D., and Sabin, M. Behaviour of recursive subdivision surfaces near extraordinary points. *Computer Aided Des. 10*, 6 (Nov 1978), 356–360.

[6] Eck, M., and Hoppe, H. Automatic reconstruction of B-spline surfaces of arbitrary topological type. *Computer Graphics – Proceedings of Siggraph 95* (1995), 359–368.

[7] Farin, G. *Curves and Surfaces for Computer Aided Geometric Design*, 3 ed. Academic Press Inc. (London) Ltd., 1993.

[8] Fong, P., and Seidel, H.-P. An implementation of triangular B-spline surface over arbitrary triangulations. *Computer-Aided Geometric Design 10* (1993), 267–275.

[9] Grimm, C. M., and Hughes, J. F. Modeling surfaces of arbitrary topology using manifolds. *Computer Graphics – Proceedings of Siggraph 95* (1995), 359–368.

[10] Kobbelt, L. Robust and efficient evaluation of functional on parametric surfaces. In *Proceedings of the 13th annual symposium on Computational Geometry* (June 4-6 1997), ACM press, pp. 376–381.

[11] Lee, Y. T., and Requicha, A. A. G. Algorithms for computing the volume and other integral properties of solids. II a family of algorithms based on representation conversion and cellular approximation. *Commun. ACM (USA) 25* (Sept. 1982), 642–650.

[12] Lien, S., and Kajiya, J. A symbolic method for calculating the integral properties of arbitrary nonconvex polyhedra. *IEEE Computer Graphics and Applications 4(9)* (Oct 1984), 35–41.

[13] Messner, A., and Taylor, G. Algorithm 550: Solid polyhedron measures. *ACM Transactions on Mathematical Software 6(1)* (March 1980), 121–130.

[14] Miles, R. G., and Tough, J. G. A method for computation of inertia properties for general areas. *Computer-Aided Design (GB) 15* (1983), 196–200.

[15] Peters, J. C^1-surface splines. *SIAM Journal on Numerical Analysis 32*, 2 (1995), 645–666.

[16] Peters, J. Pcp2nurb: smooth free-form surfacing with linearly-trimmed bicubic B-splines. *ACM Transactions on Mathematical Software x* (1997). to appear.

[17] Peters, J., and Nasri, A. Computing volumes of solids enclosed by recursive subdivision surfaces. *Computer Graphics Forum 16,3* (Sept 1997).

[18] Prautzsch, H. Free-form splines. *Computer-Aided Geometric Design 14* (1997), 421–447.

[19] Prokop, R. J., and Reeves, A. P. A survey of moment-based techniques for unoccluded object representation and recognition. *CVGIP: Graphical Models and Image Processing 54*, 5 (Sept. 1992), 438–460.

[20] Reif, U. Turbs - topologically unrestricted b-splines. *Constructive Approximation xx* (19xx), xx–xx. to appear.

[21] Rudin, W. *Real and complex analysis.* Series in Higher Mathematics. McGraw-Hill, 1987.

[22] Schroder, Sweldens, and Zorin. Interpolating subdivision for meshes with arbitrary topology. *Computer Graphics – Proceedings of Siggraph 96* (1996), 189–192.

[23] Shirman, L., and Séquin, C. Local surface interpolation with bézier patches. *j-CAGD 6(2)* (1987), 167–172.

[24] Timmer, H., and Stern, J. Computation of global geometric properties of solid objects. *Computer-Aided Design 12, 6* (1980), 301–304.

[25] Yang, L., Albregtsen, F., and Taxt, T. Fast computation of three-dimaensional geometric moments using a discrete divergence theorem and a generalization to higher dimensions. *Graphics Models and Image Processing 59,2* (March 1997), 97–108.

Appendix: Surface spline synopsis

C^1-surface splines [15] define a piecewise cubic manifold capable of modeling smooth and non-smooth surfaces of arbitrary patch layout and topological genus. The embedding of the smooth manifold into R^3 is locally governed by so-called blend ratios. These numbers allow for local distribution of curvature and fine-tuning of shape; where they are set to zero sharp edges and vertices result so that also purely polyhedral objects can be modeled in this frame work. Surface splines come in three flavors, with an underlying representation of exclusively 4-sided, exclusively 3-sided and a mixture of 3-and 4-sided patches, respectively. Exclusively 4-sided patches have recently been used for reconstruction [6]. However, the exclusively 3-sided and the mixed representation have better shape properties, satisfy the strong local convex hull property and have lower algebraic and parametric degree. Moreover, they too can be represented as standard linearly-trimmed NURBS quilts and hence stored, transmitted and rendered in standard form [16].

Surfacing with surface splines consists of two stages. In the first, illustrated in Figure 9, an arbitrarily connected input polyhedron is transformed into a planar-cut polyhedron by (edge and) corner cutting (cf [15] pp 649–650). A planar-cut polyhedron is a polyhedron with every interior vertex surrounded by four facets. The first and third facet are four-sided, the other two must be the affine image of an n-gon if they have more than four edges. – Zero depth cuts, corresponding to a non-smooth embedding of the C^1 manifold into R^3, are permitted so that also purely polyhedral approximations can be modeled and measured in this frame work. – In the second step, the Bézier coefficients of the cubic patches are computed as simple convex combinations of the planar-cut polyhedron (cf [15] p 652).

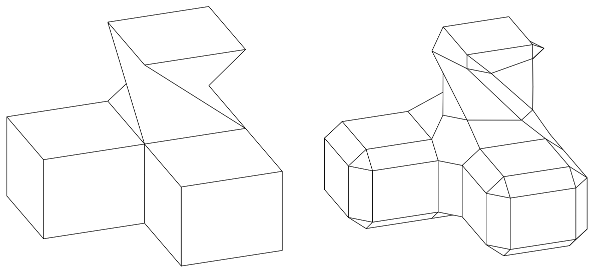

Figure 9: Input polyhedron and planar-cut polyhedron.

Corresponding author:
Jörg Peters, Dept of Computer Sciences
Purdue University, W-Lafayette IN 47907-1398
jorg@cs.purdue.edu, (317) 494-6183
http://www.cs.purdue.edu/people/jorg