Geometric and Computational Aspects of Injection Molding*

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> During injection, the mold is tilted into a favorable position that will eliminate surface defects such as bubbles and insure a complete fill. Mold orientation during fill is a cut-and-try process to find the most favorable position. (Wayne Pribble, p610 [8])

Our motive in studying injection molding is to understand the geometric and computational aspects that will allow us to remove the 'cut-and-try' referred to in the above quotation from the process of finding a favorable mold position.

Given a mold represented by a polyhedron in 3-space, establishing whether there exists an orientation that allows the filling of the mold using only one pin gate (the pin gate is the point from which the the liquid is injected into the mold) as well as determining an orientation that allows the most complete fill are two of the major problems in the field of injection molding.

These problems seem difficult, and to date, only heuristic solutions have been proposed [2], [5], [10], [8]. A thorough study of the two-dimensional case may shed some light on the difficulties involved in three dimensions. To this end, we study some problems of injection molding in the plane.

References

[1] D. Avis and G. Toussaint. An Optimal Algorithm for Determining the visibility of a Polygon from an Edge. *IEEE Transactions on Computers,* C-30-12: 910-914, 1981.

[2] John Bown. *Injection Moulding of Plastic Components.* McGraw-Hill, England, 1979.

[3] H. ElGindy and D. Avis. A Linear Algorithm for Computing the visiblity Polygon from a point. *Journal of Algorithms,* 2:186-197, 1981.

[4] A. Horn and F.A. Valentine. Some Properties of L-Sets in the plane, *Duke Mathematics Journal*, 16:131-140, 1949

[5] K.C. Hui and S.T. Tan. Mould design with sweep operations - a heuristic search approach. *C.A.D.*, 24-2: 81-90, 1992.

[6] D.T. Lee and F.P. Preparata. An optimal algorithm for finding the kernel of a polygon. *SIAM Journal of Computing*, 6-3: 594-606, 1979.

[7] N. Megiddo. Linear time algorithms for linear programming in R^3 and related problems . *SIAM Journal of Computing*, 12-4: 759-776, 1983.

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[8] Wayne I. Pribble. Molds for Reaction Injection, Structural Foam and Expandable Styrene Molding. *Plastics Mold Engineering Handbook, Fourth Edition.* J. Harry DuBois and Wayne I. Pribble (eds.), Van Nostrand Reinhold Company Inc., New York, 1987.

[9] C.C. Lee and D.T. Lee. On a Circle-Cover Minimization Problem. *Information Processing Letters*, 18:109-115, 1984.

[10] Christopher W. Macosko. *RIM Fundamentals of Reaction Injection Molding.* Hanser Publishers, New York, 1989.

[11] *Developments in Injection Moulding - 3.* A. Whelan and J.P. Goff (eds.), Elsevier Applied Science Publishers, New York, 1985.

[12] *Molding of Plastics.* Norbert M. Bikales (ed.), Wiley-Interscience, Toronto, 1971.

[13] A. Rosenbloom and D. Rappaport. Moldable and Castable Polygons. *Proc. of the Fourth Canadian Conference on Computational Geometry*, St. John's, Newfoundland, 1992.