References

- [AGL87] William Armstrong, Mark Green, and Robert Lake. Near-real time control of human figure models. *IEEE Computer Graphics and Applications*, pages 52–61, June 1987.
- [Ald88] B. Aldefeld. Variation of geometries based on a geometric-reasoning method. *Computer Aided Design*, 20(3):117–126, April 1988.
- [Ald92] Aldus Corporation. Intellidraw. Computer Program, 1992.
- [Alp93] Sherman R. Alpert. Graceful interaction with graphical constraints. *IEEE Computer Graphics and Applications*, pages 82–91, March 1993.
- [AS85] Harold Abelson and Gerald Sussman. *Structure and Interpretation of Computer Programs*. MIT Press, 1985.
- [Bar86] Paul S. Barth. An object-oriented approach to graphical interfaces. *ACM Transactions on Graphics*, 5(2):142–172, April 1986.
- [Bar89] David Baraff. Analytical methods for dynamic simulation of non-penetrating rigid bodies. In *Computer Graphics (Proc. SIGGRAPH*), volume 23, pages 223–232. ACM, July 1989.
- [Bar90] David Baraff. Curved surfaces and coherence for non-penetrating rigid body simulation. In *Computer Graphics (Proc. SIGGRAPH)*, volume 24, pages 19– 28. ACM, August 1990.
- [Bar91a] David Baraff. Coping with friction for non-penetrating rigid body simulation. In *Computer Graphics (Proc. SIGGRAPH)*, volume 25, pages 31–40. ACM, July 1991.
- [Bar91b] Joel Bartlett. Don't fidget with widgets, draw! Technical report, DEC Western Research Laboratory, May 1991.
- [Bar92a] David Baraff. *Dynamic Simulation of Non-Penetrating Rigid Bodies*. PhD thesis, Department of Computer Science, Cornell University, March 1992. Appears as technical report 92-1275.
- [Bar92b] David Baraff. *Dynamic Simulation of Non-Penetrating Rigid Bodies*. PhD thesis, Cornell University, March 1992. Appears as Department of Computer Science Technical Report 92-1275.
- [Bar92c] Ronen Barzel. *Physically-Based Modeling for Computer Graphics*. Academic Press, 1992.
- [Bar94] David Baraff. Fast contact force computation for nonpenetrating rigid bodies. In *Computer Graphics (SIGGRAPH '94 Proceedings)*, pages 23–34, July 1994.

- [Bau72] J. Baumgarte. Stabilization of constraints and integrals of motion in dynamical systems. *Computer Methods in Applied Mechanics and Engineering*, 1:1–16, 1972.
- [BB88] Ronen Barzel and Alan H. Barr. A modeling system based on dynamic constaints. *Computer Graphics*, 22:179–188, 1988. Proceedings SIGGRAPH '88.
- [BD86] Alan Borning and Robert Duisberg. Constraint-based tools for building user interfaces. *ACM Transactions on Graphics*, 5(4):345–374, October 1986.
- [BDFB⁺87] Alan Borning, Robert Duisberg, Bjorn Freeman-Benson, Axel Kramer, and Michael Woolf. Constraint hierarchies. In *Proceedings OOPSLA*, pages 48–60, October 1987.
- [Ben89] M. Benyon. Evaluating definative principles for interaction in graphics. In R. A. Earnshaw and B. Wyvill, editors, *New Advances in Computer Graphics: Proceedings of CG International '89.* Springer Verlag, 1989.
- [BFBW92] Alan Borning, Bjorn Freeman-Benson, and Molly Wilson. Constraint hierarchies. *Lisp and Functional Programming*, 5:223–270, 1992.
- [BG88] Nathaniel Borenstein and James Gosling. UNIX Emacs: A retrospective. In *Proceedings of the ACM SIGGRAPH Symposium on User Interface Software and Technology*, pages 95–101, 1988.
- [BGK93] Christian Bischoff, Andreas Griewank, and Peyvand Khademi. Workshop report on first theory institute on computational differentiation. Technical Report ANL/MCS-TM-183, Argonne National Laboratory, December 1993. Abstracts from the workshop held at Argonne May 24-26,1993.
- [Bie86] Eric Bier. Skitters and jacks: Interactive 3d positioning tools. In *Proceedings of the 1986 Workshop on Interactive 3d Graphics*, pages 237–249, October 1986.
- [Bie89] Eric Bier. Snap-dragging: Interactive geometric design in two and three dimensions. Technical Report EDL-89-2, Xerox Palo Alto Research Center, 1989.
- [Bie90] Eric Bier. Snap-dragging in three dimensions. *Computer Graphics*, 24(2):193–204, March 1990. Proceedings 1990 Symposium on Interactive 3D Graphics.
- [Bli88a] James Blinn. Me and my (fake) shadow. *IEEE Computer Graphics and Applications*, pages 82–86, January 1988.
- [Bli88b] Jim Blinn. Where am I? What am I looking at? *IEEE Computer Graphics and Applications*, pages 76–81, July 1988.
- [BMB86] Norman Badler, Kamran Manoocherhri, and David Baraff. Multi-dimentional input techniques and articulated figure positioning by multiple constraints. In *Proceedings of the 1986 Workshop on Interactive 3d Graphics*, pages 151–170, October 1986.

References

- [BMW87] Norman Badler, Kamran Manoocherhri, and Graham Walters. Articulated figure positioning by multiple constraints. *IEEE Computer Graphics and Applications*, pages 28–38, June 1987.
- [Bor81] Alan Borning. The programming language aspects of ThingLab, a constraintoriented simulation laboratory. *ACM Transactions on Programming Languages and Systems*, 3(4):353–387, 1981.
- [Bor86] Alan Borning. Defining constraints graphically. In *Proceedings CHI* 86, pages 137–143, April 1986.
- [Bro86] Frederick Brooks. Walkthough a dynamic graphics environment for simulating virtual buildings. In *Proceedings of the 1986 Workshop on Interactive 3d Graphics*, pages 9–22, October 1986.
- [Bru86] Beat Brudelin. Constructing three-dimensional geometric objects defined by constraints. In *Proceedings of the 1986 Workshop on Interactive 3d Graphics*, pages 111–129, October 1986.
- [BS86] Eric Bier and Maureen Stone. Snap-dragging. *Computer Graphics*, 20(4):233–240, 1986. Proceedings SIGGRAPH '86.
- [BW92] David Baraff and Andrew Witkin. Dynamic simulation of non-penetrating flexible bodies. *Computer Graphics*, 26(2):303–308, July 1992. Proceedings Siggraph '92.
- [CFV88] U. Cugini, F. Folini, and I Vicini. A procedural system for the definition and storage of technical drawings in parametric form. In D. A. Duce and P. Jancene, editors, *Eurographics* '88, pages 183–196. Elsevier Science Publishers, 1988.
- [CG91] George Celniker and David Gossard. Deformable curve and surface finiteelements for free-form shape design. In *Computer Graphics (Proceedings SIG-GRAPH 91)*, pages 257–266, 1991.
- [CMS88] Michael Chen, S. Joy Mountford, and Abigail Sellen. A study in interactive 3D rotation using 2D input devices. *Computer Graphics*, 22(4):121–130, August 1988. Proceedings SIGGRAPH '88.
- [Com88] PHIGS+ Committee. Phigs+ functional description, revision 3.0. *Computer Graphics*, 22(3):125–215, 1988.
- [Com92] Computervision Corporation. DesignView. Computer Program, 1992.
- [Cor89] Thomas H. Cormen. Introduction to Algorithms. MIT Press, 1989.
- [Cra86] John Craig. *Robotics: Mechanics and Control*. Addison-Wesley, 1986.
- [CSH⁺92] D. Brookshire Conner, Scott Snibbe, Kenneth Herndon, Daniel Robbins, Robert Zeleznik, and Andries van Dam. Three-dimensional widgets. In *Proceedings of the 1992 Workshop on Interactive 3D Graphics*, pages 183–188, March 1992.

- [CW92] George Celniker and William Welch. Linear constraints for deformable b-spline surfaces. In *Proceedings of the 1992 Symposium on Interactive 3D Graphics*, pages 165–170, March 1992.
- [DER86] J. S. Duff, A. M. Erisman, and J.K. Reid. *Direct Methods for Sparse Matrices*. Oxford University Press, Oxford, UK, 1986.
- [DGZ92] Steven Drucker, Tinsley Gaylean, and David Zeltzer. CINEMA: a system for procedural camera movements. In *Proceedings of the 1992 Symposium on Interactive Computer Graphics*, pages 67–70, 1992.
- [DNN⁺93] Roger B. Dannenberg, Tom Neuendorffer, Joseph M. Newcomer, Dean Rubine, and David B. Anderson. Tactus: toolkit-level support for synchronized interactive multimedia. *Multimedia Systems*, 1:77–86, 1993.
- [End90] Eric Enderton. Interactive type synthesis of mechanisms. Master's thesis, University of California, Berkeley, April 1990. Also appears as Report No. UCB/CSD 90/570.
- [Eng86] Douglas Englebart. The augmented knowledge workshop. In ACM Conference on the History of Personal Workstations, pages 73–83, January 1986.
- [ETW81] Kenneth B. Evans, Peter P. Tanner, and Marceli Wein. Tablet-based valuators that provide one, two, or three degrees of freedom. *Computer Graphics*, 15(3):91–97, August 1981.
- [FB93] Bjorn Freeman-Benson. Converting an existing user interface to use constraints. In Randy Pausch, editor, *Proceedings of the ACM SIGGRAPH Symposium on User Interface Software and Technology*, pages 207–215, 1993.
- [FBB92] Bjorn Freeman-Benson and Alan Borning. Integrating constraints with an object oriented language. In *Proceedings ECOOP* '92, 1992.
- [FBMB90] Bjorn Freeman-Benson, John Maloney, and Alan Borning. An incremental constraint hierarchy solver. *Communications of the ACM*, 33(1):54–63, January 1990.
- [Fei93] Steven Feiner. Knowledge-based design of 3D graphics and virtual worlds. In *Proceedings Graphics Interface*, pages 51–52, 1993.
- [FF87] Daniel Friedman and Matthias Felleisen. *The Little Lisper*. MIT Press, 1987.
- [FFD93] Mingxian Fa, Terrence Fernando, and Peter Dew. Direct 3D manipulation techniques for interactive solid modelling. In *Proceedings Eurographics*, pages 237– 248, 1993.
- [Fle87] Roger Fletcher. *Practical Methods of Optimization*. John Wiley and Sons, 1987.

- [Fow92] Barry Fowler. Geometric manipulation of tensor-product surfaces. In *Proceed*ings, Interactive 3D Workshop, 1992.
- [FP88] N. Fuller and D. Prusinkiewicz. Geometric modelling with euclidean constructions. In M. Magnenant-Thalmann and D. Thalmann, editors, *New Trends in Computer Graphics: Proceedings of CG International '88*. Springer-Verlag, 1988.
- [FvDFH90] James D. Foley, Andries van Dam, Steven K. Feiner, and John Hughes. Computer Graphics: Principles and Practice. Addison Wesley, second edition edition, 1990.
- [FW88] Kurt Fleischer and Andrew Witkin. A modeling testbed. In *Proc .Graphics Interface*, pages 127–137, 1988.
- [Gan84] Sundaram Ganapathy. Decomposition of transformation matrices for robot vision. In *International Conference on Robotics*, pages 130–139, March 1984.
- [Gas93] Marie-Paule Gascuel. An implicit formulation for precise contact modeling between flexible solids. *Computer Graphics*, 27:313–320, August 1993. Proceedings Siggraph '93.
- [GBT93] Enrico Gobberti, Jean-Francis Balaguer, and Daniel Thalmann. VB2: An architecture for interaction in synthetic worlds. In Randy Pausch, editor, *Proceedings UIST '93*, pages 167–178, 1993.
- [Gen79] Donald Gennery. Stereo-camera calibration. In *Proc. DARPA Image Under*standing Workshop, pages 101–107, 1979.
- [GL89] Gene Golub and Charles Van Loan. *Matrix Computations*. The Johns Hopkins University Press, 1989.
- [Gle92a] Michael Gleicher. Briar a constraint-based drawing program. In *SIGGRAPH Video Review*, volume 77, 1992. CHI '92 Formal Video Program.
- [Gle92b] Michael Gleicher. Through-the-lens camera control. In *SIGGRAPH video review* 86, 1992.
- [GMW81] Phillip Gill, Walter Murray, and Margret Wright. *Practical Optimization*. Academic Press, New York, NY, 1981.
- [Gol80] Herbert Goldstein. *Classical Mechanics*. Addison Wesley, 1980.
- [Gos83] James Gosling. *Algebraic Constraints*. PhD thesis, Carnegie Mellon University, May 1983.
- [Gri89] Andreas Griewank. On automatic differentiation. In M. Iri and K. Tanabe, editors, *Mathematical Programming: Recent Developments and Applications*, pages 83–108. Kluwer Academic, 1989.

- [Gro89] Mark Gross. Relational modeling: A basis for computer-assisted design. In Maclcolm McCullough, William J. Mitchell, and Patrick Purcell, editors, *The Electronic Design Studio (Proc. CAAD Futrues '89)*, pages 123–146. MIT Press, 1989.
- [GW91a] Michael Gleicher and Andrew Witkin. Differential manipulation. *Graphics Interface*, pages 61–67, June 1991.
- [GW91b] Michael Gleicher and Andrew Witkin. Snap together mathematics. In Edwin Blake and Peter Weisskirchen, editors, Advances in Object Oriented Graphics 1: Proceedings of the 1990 Eurographics Workshop on Object Oriented Graphics. Springer Verlag, 1991. Also appears as CMU School of Computer Science Technical Report CMU-CS-90-164.
- [GW92] Michael Gleicher and Andrew Witkin. Through-the-lens camera control. *Computer Graphics*, 26(2):331–340, July 1992. Proceedings Siggraph '92.
- [GW93] Michael Gleicher and Andrew Witkin. Supporting numerical computations in interactive contexts. In Tom Calvert, editor, *Graphics Interface*, pages 138–145, May 1993.
- [GW94] Michael Gleicher and Andrew Witkin. Drawing with constraints. *The Visual Computer*, 11(1), November 1994. to appear.
- [Hah88] James Hahn. Realistic animation of rigid bodies. Computer Graphics, 22:299– 308, 1988. Proceedings SIGGRAPH '88.
- [Hal89] Roy Hall. *Illumination and Color in Computer Generated Imagaery*. Springer-Verlag, New York, 1989.
- [HBP+93] Ralph Hill, Tom Brinck, John Patterson, Steven Rohall, and Wayne Wilner. The Rendezvous language and architecture. *Comminications of the ACM*, 36(1):62– 67, January 1993.
- [Hei93] Jeff Heisserman. Boeing computer services. Personal Communication, 1993.
- [HH88] Tyson Henry and Scott Hudson. Using active data in a UIMS. In *Proceedings of the ACM SIGGRAPH Symposium on User Interface Software and Technology*, pages 167–178, 1988.
- [HH90] Pat Hanrahan and Paul Haeberli. Direct WYSIWYG painting and texturing on 3D shapes. In Forest Baskett, editor, *Computer Graphics (SIGGRAPH '90 Proceedings)*, volume 24, pages 215–223, August 1990.
- [HHK92] Willaim M. Hsu, John F. Hughes, and Henry Kaufman. Direct manipulation of free-form deformations. *Computer Graphics*, 26(2):177–182, July 1992. Proceedings Siggraph '92.

- [HHN90] Tyson R. Henry, Scott E. Hudson, and Gary L. Newell. Integrating gesture and snapping into a user interface toolkit. In *Proceedings of the ACM SIGGRAPH Symposium on User Interface Software and Technology*, pages 112–121, October 1990.
- [Hil91] Ralph D. Hill. A 2-d graphics system for multi-user interactive graphics based on objects and constraints. In E. Blake and P. Weisskirchen, editors, Advances in Object Oriented Graphics 1: Proceedings of the 1990 Eurographics Workshop on Object Oriented Graphics, pages 67–92. Springer Verlag, 1991.
- [Hor91] Bruce Horn. Siri: a symbolic reduction interpreter for object oriented constraint programming. Technical Report CMU-CS-91-152, CMU School of Computer Science, June 1991.
- [Hor92] Bruce Horn. Constraint patterns as a basis for object oriented programming. In *Proceedings OOPSLA '92*, pages 218–233, October 1992.
- [Hor93] Bruce Horn. *Constrained Objects*. PhD thesis, School of Computer Science, Carnegie Mellon University, 1993. Appears as CMU SCS technical report CMU-CS-93-154.
- [Hou92] Stephanie Houde. Iterative design of an interface for easy 3D direct manipulation. In *Proceedings CHI* '92, pages 135–142, May 1992.
- [HtM93] Chris Hanson and the MIT Scheme Team. Mit Scheme. online reference manual, October 1993.
- [Hud90] Scott E. Hudson. Adaptive semantic snapping a technique for semantic feedback at the lexical level. In *Proceedings CHI '90*, pages 65–70, April 1990.
- [Hud91] Scott Hudson. Incremental attribute evaluation: A flexible algorithm for lazy update. *ACM Transactions on Programming Languages and Systems*, 13(3):315–341, 1991.
- [Hud92] Scott Hudson. Adding shadows to a 3D cursor. *ACM Transactions on Graphics*, 11(2):193–199, April 1992.
- [HY91] Scott E. Hudson and Andrey K. Yeatts. Smoothly integrating rule-based techniques into a direct manipulation user interface builder. In *Proceedings of the* ACM SIGGRAPH Symposium on User Interface Software and Technology, pages 145–153, November 1991.
- [HZR⁺92] Kenneth Herndon, Robert Zeleznik, Daniel Robbins, D. Brookshire Conner, Scott Snibbe, and Andries van Dam. Interactive shadows. In Proceedings of the 1992 ACM SIGGRAPH Symposium on User Interface Software and Technology, pages 1–6, November 1992.

- [IC87] Paul Issacs and Michael Cohen. Controlling dynamics simulation with kinematic constraints, behavior functions and inverse dynamics. *Computer Graphics*, 21(4):215–224, 1987. Proceedings SIGGRAPH '87.
- [Iri91] Masao Iri. History of automatic differentiation and rounding error estimation. In Andreas Griewank and George Corliss, editors, Automatic Differentiation of Algorithms: Theory, Implementation and Application, pages 3–16. SIAM, January 1991.
- [Joh63] Timothy E. Johnson. Sketchpad III: A computer program for drawing in three dimensions. In *Conference Proceedings, Spring Joint Computer Conference*. IEEE Computer Society, 1963. Reprinted in Herbert Freeman, ed, Tutorial and Selected Readings in Interactive Computer Graphics, 1980, pp20–26.
- [Jue91] David W. Juedes. A taxonomy of automatic differentiation tools. In Andreas Griewank and George Corliss, editors, *Automatic Differentiation of Algorithms: Theory, Implementation and Application*, pages 315–329. SIAM, January 1991.
- [Kas92] Michael Kass. CONDOR: constraint-based data flow. *Computer Graphics*, 26:321–330, July 1992. Proceedings SIGGRAPH '92.
- [Kau91] Henry Kaufman. Constraint techniques for interactive physically-based modeling. Master's thesis, Brown Unversity, July 1991.
- [KF93] David Kurlander and Steven Feiner. Inferring constraints from multiple snapshots. *ACM Transactions on Computer Graphics*, 12(4), October 1993.
- [KLW92] Solange Karsenty, James A. Landay, and Chris Weikart. Inferring graphical constraints with Rockit. In *HCI'92 Conference on People and Computers VII*, pages 137–153. British Computer Society, September 1992.
- [KNK89] Nami Kim, Tsukasa Noma, and Tosiyasu L. Kunii. PictureEditor: A 2D picture editing system based on geometric constructions and constraints. In R. A. Earnshaw and B. Wyvill, editors, *New Advances in Computer Graphics: Proceedings* of CG International '89, pages 193–207. Springer Verlag, 1989.
- [Kol91] Craig Kolb. Rayshade. Computer Program, 1991.
- [KP88] Glenn Krasner and Stephen Pope. A cookbook for using the Model–View– Controller user interface paradigm in smalltalk-80. *The Journal of Object Oriented Programming*, pages 26–49, August/September 1988.
- [KPC93] John Kawai, James Painter, and Michael Cohen. Radioptimization goal based rendering. In Computer Graphics (SIGGRAPH '93 Proceedings), pages 147– 154, 1993.
- [Kra90] Glenn A. Kramer. Solving geometric constraint systems. In *Proceedings AAAI-*90, pages 708–714, 1990.

[Kur93]	David Kurlander. <i>Graphical Editing by Example</i> . PhD thesis, Columbia University, 1993.
[KW93]	Larry Koved and Wayne Wooten. GROOP: an object-oriented toolkit for ani- mated 3D graphics. In Andreas Paepcke, editor, <i>OOPSLA '93 Conference Pro-</i> <i>ceedings</i> , pages 309–325, October 1993.
[KWT88]	Michael Kass, Andrew Witkin, and Demetri Terzopoulis. Snakes: Active contour models. <i>International Journal of Computer Vision</i> , 321–331, 1988.
[Lel88]	Wm. Leler. Constraint Programming Languages: Their Specification and Generation. Addison-Weseley, 1988.
[LGL81]	V. C. Lin, D. C. Gossard, and R. A. Light. Variational geometry in C.A.D. <i>Computer Graphics</i> , 15(3):171–177, 1981. Proceedings SIGGRAPH '81.
[Low80]	David Lowe. Solving for the parameters of object models from image descriptions. In <i>Proc. DARPA Image Understanding Workshop</i> , pages 121–127, 1980.
[Mac90]	Anthony Maciejewski. Dealing with the ill-conditioned equations of motion for articulated figures. <i>IEEE Computer Graphics and Applications</i> , May 1990.
[Mal91]	John Harold Maloney. <i>Using Constraints for User Interface Construction</i> . PhD thesis, University of Washington, 1991. Appears as Computer Science Technical Report 91-08-12.
[MB86]	Brad A. Myers and William Buxton. Creating highly-interactive and graphical user interfaces by demonstration. <i>Computer Graphics</i> , 20(4):249–258, 1986. Proceedings SIGGRAPH '86.
[McG89]	Chris McGlone. Automated image-map registration using active contour models and photogrammetric techniques. In <i>Proceedings of the SPIE, Volume 1070</i> , January 1989.
[MCR90]	Jock Mackinlay, Stuart Card, and George Robertson. Rapid controlled movement through a virtual 3d workspace. <i>Computer Graphics</i> , 24(4):171–176, August 1990.
[Mer50]	Mildred P. Merryman. <i>Children's Stories</i> , chapter "Quack!" said Jerusha, pages 117–136. Whitman Publishing Co., Racine, WI, 1950.
[MGD+90]	Brad A. Myers, Dario Guise, Roger B. Dannenberg, Brad Vander Zanden, David Kosbie, Ed Pervin, Andrew Mickish, and Phillipe Marchal. Comprehensive support for graphical, highly-interactive user interfaces: The Garnet user interface development environment. <i>IEEE Computer</i> , November 1990.
[MKW89]	D. L. Maulsby, K. A. Kittlinz, and I. H. Witten. Metamouse: Specifying graph- ical procedures by example. <i>Computer Graphics</i> , 23(3):127–136, July 1989. Proceedings SIGGRAPH '89.

- [Mof59] Francis H. Moffitt. *Photogrammetry*. International Textbook Company, 1959.
- [MW88] P.M. Moore and J. Wilhelms. Collision detection and reponse for computer animation. In *Computer Graphics (Proc. SIGGRAPH)*, volume 22, pages 289–298. ACM, August 1988.
- [Mye90] Brad Myers. A new model for handling input. *ACM Transactions on Information Systems*, 8(3):289–320, July 1990.
- [Mye93] Brad Myers. State of the art in user interface software tools. In H. Rex Hartson and Deborah Hix, editors, *Advances in Human-Computer Interaction*, volume 4, pages 110–150. Ablex Publishing, 1993. Appears as CMU School of Computer Science technical report CMU-CS-92-114.
- [Mye94] Brad Myers. Challenges of HCI design and implementation. *Interactions*, pages 73–83, January 1994.
- [Nak91] Yoshiko Nakamura. *Advanced Robotics: Redundancy and Optimization*. Addison-Wesley, 1991.
- [Nel85] Greg Nelson. Juno, a constraint based graphics system. *Computer Graphics*, 19(3):235–243, 1985. Proceedings SIGGRAPH '85.
- [NKK⁺88] T. Noma, T. L. Kunii, N. Kin, H. Enomoto, E. Aso, and T. Yamamoto. Drawing input through geometrical constructions: Specification and applications. In M. Magnenant-Thalmann and D. Thalmann, editors, *New Trends in Computer Graphics: Proceedings of CG International* '88. Springer-Verlag, 1988.
- [NO86] Gregory M. Nielson and Dan R. Olsen. Direct manipulation techniques for 3d objects using 2d locator devices. In *Proceedings of the 1986 Workshop on Interactive 3d Graphics*, pages 175–182, 1986.
- [Nor90] Donald Norman. *The Design of Everyday Things*. Doubleday, 1990.
- [OA90] Dan R. Olsen and Kirk Allan. Creating interactive techniques by symbolically solving geometric constraints. In *Proceedings of the ACM SIGGRAPH Sympo*sium on User Interface Software and Technology, pages 102–107, 1990.
- [OA92] James R. Osborn and Alice M. Agogino. An interface for interactive spatial reasoning and visualization. In *Proceedings CHI* '92, pages 75–82, May 1992.
- [Ous91] John K. Ousterhout. An X11 toolkit based on the Tcl language. In 1991 Winter Usenix Conference Proceedings, 1991.
- [Pau81] Richard Paul. Robot Manipulators: Mathematics, Programming, and Control. MIT Press, Cambridge, MA, 1981.
- [PB88a] Cary Phillips and Norman Badler. Jack: A toolkit for manipulating articulated figures. In *Proceedings of the ACM SIGGRAPH Symposium on User Interface Software and Technology*, pages 221–229, 1988.

- [PB88b] John Platt and Alan Barr. Constraint methods for flexible models. *Computer Graphics*, 22:279–288, 1988. Proceedings SIGGRAPH '88.
- [PB91] Cary Phillips and Norman Badler. Interactive behaviors for bipedal articulated figures. In *Computer Graphics (Proceedings SIGGRAPH 91)*, pages 359–362, 1991.
- [PF92] Pierre Poulin and Alain Fournier. Light from highlights and shadows. In Proceedings of the 1992 Symposium on Interactive Computer Graphics, pages 31– 38, 1992.
- [PFTV86] William Press, Brian Flannery, Saul Teukolsky, and William Vetterling. *Numer-ical Recipes in C*. Cambridge University Press, Cambridge, England, 1986.
- [Pla92] John Platt. A generalization of dynamic constraints. *CGVIP: Graphical Models* and Image Processing, 54(6):516–525, November 1992.
- [PS82] Christopher Paige and Michael Saunders. LSQR: an algorithm for sparse linear equations and sparse least squares. ACM Transactions on Mathematical Software, 8(1):43–71, March 1982.
- [PT94] Randy Pausch and The University of Virginia User Interface Group. Personal communication, 1994.
- [Pug92] David Pugh. Designing solid objects with interactive sketch interpretation. In Proceedings of the 1992 Symposium on Interactive Computer Graphics, pages 117–126, March 1992.
- [PW85] Theo Pavlidis and Christopher Van Wyk. An automatic beautifier for drawings and illustrations. *Computer Graphics*, 19(3):225–234, 1985. Proceedings SIG-GRAPH '85.
- [RK77] A. J. Rubel and R. E. Kaufman. Kinsyn III: A new human-engineered systems for interactive computer aided design of planar linkages. *Transactions of the ASME: Journal of Engineering for Industry*, pages 440–448, May 1977.
- [Ros86] Jarek Rossignac. Constraints in constructive solid geometry. In *Proceedings of the 1986 Workshop on Interactive 3d Graphics*, pages 93–110, October 1986.
- [Rub91] Dean Rubine. The Automatic Recognition of Gestures. PhD thesis, School of Computer Science, Carnegie Mellon University, 1991. Appears as CMU SCS technical report CMU-CS-91-202.
- [San94] Michael Sannella. The SkyBlue constraint solver and its applications. In Pascal Van Hentenryck and Vijay Saraswat, editors, *Principles and Practice of Constraint Programming*. MIT Press, 1994. to appear.
- [Sap93] Mark Sapossnek. Virtual Prototyping: An Interactive Approach to Geometric Tolerance Design and Analysis. PhD thesis, Carnegie Mellon University, 1993.

[SB91]	Wolfgang Sohr and Beat Bruderlin. Interaction with constraints in 3D model-
	ing. In Symposium on Solid Modeling Foundations and CAD/CAM Applications,
	pages 387–396, June 1991.

- [SB92] Michael Sannella and Alan Borning. Multi-Garnet: Integrating multi-way constraints with garnet. Technical Report 92-07-01, Department of Computer Science, University of Washington, 1992.
- [SC92] Paul S. Strauss and Rikk Carey. An object-oriented 3d graphics toolkit. *Computer Graphics*, 26(2):341–349, July 1992. Proceedings SIGGRAPH '92.
- [Sch59] K. Schwidefsky. *An Outline of Photogrammetry*. Pitman Publishing Corporation, first english edition, 1959.
- [Sch83] Ben Schneiderman. Direct manipulation: A step beyond programming languages. *IEEE Computer*, pages 57–69, August 1983.
- [SDS⁺93] Chris Schoeneman, Julie Dorsey, Brian Smits, James Arvo, and Donald Greenberg. Painting with light. In *Computer Graphics (SIGGRAPH '93 Proceedings)*, pages 143–146, 1993.
- [SG86] Robert W. Scheifler and Jim Gettys. The X window system. ACM Transactions on Graphics, 5(2):79–109, April 1986.
- [Sha93] Shapeware Inc. Visio. Computer Program, 1993.
- [She94] Jonathan Shewchuck. An introduction to the conjugate gradient method without the agonizing pain. Technical Report CMU-CS-94-125, School of Computer Science, Carnegie Mellon University, 1994.
- [Sho85] Ken Shoemake. Animating rotations with quaternion curves. *Computer Graphics*, 19(3):245–254, July 1985. Proceedings SIGGRAPH '85.
- [Sho92] Ken Shoemake. ARCBALL: a user interface for specifying three-dimensional orientation using a mouse. In *Proceedings Graphics Interface* '92, pages 151–156, May 1992.
- [Sil91] Silicon Graphics Inc. *Graphics Library Programming Guide*, 1991.
- [Sis90] Steven Sistare. A Graphical Editor for Three-Dimensional Constraint-Based Geometric Modelling. PhD thesis, Harvard University, 1990.
- [Sis91] Steven Sistare. Interaction techniques in constraint-based geometric modeling. In *Proceedings Graphics Interface '91*, pages 85–92, June 1991.
- [SKN90] Gurminder Singh, Chun Hong Kok, and Teng Ye Ngan. Druid: A system for demonstrational rapid user interface development. In *Proceedings of the ACM Symposium on User Interface Software and Technology*, pages 167–177, October 1990.

- [SKvW⁺92] Mark Segal, Carl Korobkin, Rolf van Widenfelt, Jim Foran, and Paul Haeberli. Fast shadows and lighting effects using texture mapping. *Computer Graphics*, 26(2):249–252, July 1992. Proceedings Siggraph '92.
- [SLGS92] Chris Shaw, Jiadong Liang, Mark Green, and Yunqi Sun. The decoupled simulation model for virtual reality systems. In *Proceedings CHI '92*, pages 321–328, May 1992.
- [SM88] Pedro A. Szekely and Brad A. Myers. A user interface toolkit based on graphical objects and constraints. In OOPSLA '88 Proceedings, pages 36–45, September 1988.
- [SMFBB93] Michael Sannella, John Maloney, Bjorn Freeman-Benson, and Alan Borning. Multi-way versus one-way constraints in user interfaces: Experience with the DeltaBlue algorithm. Software—Practice and Experience, 23(5):529–566, May 1993.
- [Sof93] Softimage Inc. Softimage creative environment. Computer Program, 1993.
- [Sur92a] Mark Surles. Interactive modeling enhanced with constraints and physics with applications in molecular modeling. In *Proceedings of the 1992 Symposium on Interactive Computer Graphics*, pages 175–182, March 1992.
- [Sur92b] Mark C. Surles. An algorithm for linear complexity for interactive, physicallybased modelling of large proteins. *Computer Graphics*, 26(2):221–230, 1992. Proceedings SIGGRAPH '92.
- [Sur92c] Mark C. Surles. Techniques for Interactive Manipulation of Graphical Protein Molecules. PhD thesis, University of North Carolina at Chapel Hill, 1992. Appears as TR93-016.
- [Sut63] Ivan Sutherland. *Sketchpad: A Man Machine Graphical Communication System*. PhD thesis, Massachusetts Institute of Technology, January 1963.
- [SZ90] Peter Schroeder and David Zeltzer. The virtual erector set: Dynamic simulation with linear recursive constraint propagation. *Computer Graphics*, 24(2):23–31, March 1990. Proceedings 1990 Symposium on Interactive 3D Graphics.
- [TBGT91] Russell Turner, Francis Balaguer, Enrico Gobbetti, and Daniel Thalmann. Physically-based interactive camera motion using 3d input devices. In N. M. Patrikalakis, editor, *Scientific Visualiztion of Physical Phenomena: Proceedings* of CG International 1991, pages 135–145, Tokyo, 1991. Springer-Verlag.
- [TTA91] Konstantinos Tarabamis, Roger Tsai, and Peter Allen. Automated senor planning for robotic vision tasks. In *Proceedings of th 1991 IEEE International Conference on Robotics and Automation*, pages 76–82, April 1991.
- [Ups89] Steve Upstill. *The Renderman Companion*. Addison-Wesley, 1989.

- [Ven93] Dan Venolia. Facile 3D manipulation. In *Proceedings INTERCHI '93*, pages 31–36, 1993.
- [VL89] John M. Vlissides and Mark A. Linton. Unidraw: A framework for building domain specific graphical editors. In *Proceedings of the 1989 ACM SIGGRAPH Symposium on User Interface Software and Technology*, November 1989.
- [VW82] Christopher J. Van Wyk. A high level language for specifying pictures. *ACM Transactions on Graphics*, 1(2):163–182, April 1982.
- [vWJB85] J. J. van Wijk, F. W. Jansen, and W. F. Bronsvoort. Some issues in designing user interfaces to 3d raster graphics. *Computer Graphics Forum*, 4:5–10, 1985.
- [VZ88] Bradley T. Vander Zanden. Constaint grammars in user interface management systems. In *Proc. Graphics Interface*, pages 176–184, 1988.
- [VZ89] Bradley T. Vander Zanden. Constraint grammars a new model for specifying graphical applications. In *Proceedings CHI* '89, pages 325–330, April 1989.
- [VZMGS91] Brad Vander Zanden, Brad A. Myers, Dario Guise, and Pedro Szekeley. The importance of pointer variables in constraint models. In *Proceedings of the ACM SIGGRAPH Symposium on User Interface Software and Technology*, pages 155– 164, November 1991.
- [VZMGS94] Brad Vander Zanden, Brad Myers, Dario Guise, and Pedro Szekely. Integrating pointer variables into one-way constraint methods. *ACM Transactions on Computer Human Interaction*, 1(2), June 1994.
- [Wam86] Charles W. Wampler. Manipulator inverse kinematic solutions based on vector formulations and damped least-squares method. *IEEE Transactions on Systems, Man, and Cybernetics*, 16(1):93–101, January 1986.
- [Wan92] Leonard Wanger. The effect of shadow quality on the perception of spatial relationships in computer generated imagery. In David Zeltzer, editor, *Computer Graphics (1992 Symposium on Interactive 3D Graphics)*, volume 25, pages 39– 42, March 1992.
- [Wav94] Wavefront Inc. Kinemation and dynamation. Computer Programs, 1994.
- [Wel93] Chris Welman. Inverse kinematics and geometric constraints for articulated figure manipulation. Master's thesis, Simon Fraser University, September 1993.
- [Wer94] Josie Wernecke. *The Inventor Mentor*. Addison-Wesley Publishing Company, 1994.
- [WFB87] Andrew Witkin, Kurt Fleischer, and Alan Barr. Energy constraints on parameterized models. *Computer Graphics*, 21(4):225–232, July 1987.

References

- [WG87] Dennis Wixon and Michael Good. Interface style and eclecticism: Moving beyond categorical approaches. In *Proceedings of the Human Factors Society – 31st Annual Meeting*, pages 571–575, 1987.
- [WGW90] Andrew Witkin, Michael Gleicher, and William Welch. Interactive dynamics. Computer Graphics, 24(2):11–21, March 1990. Proceedings 1990 Symposium on Interactive 3D Graphics.
- [WGW91] William Welch, Michael Gleicher, and Andrew Witkin. Manipulating surfaces differentially. In *Proceedings, Compugraphics '91*, September 1991.
- [Whi88] R. M. White. Applying direct manipulation to geometric construction systems. In M. Magnenant-Thalmann and D. Thalmann, editors, *New Trends in Computer Graphics: Proceedings of CG International* '88. Springer-Verlag, 1988.
- [Wil87] Jane Wilhelms. Using dynamic analysis for realistic animation of articulated bodies. *IEEE Computer Graphics and Applications*, pages 12–27, June 1987.
- [Wit89a] Andrew Witkin. Personal Communication, 1989.
- [Wit89b] Andrew Witkin. Physcially-based modeling: Past, present future. In *SIGGRAPH Panel Proceedings*, pages 203–205, 1989. Part of panel chaired by Demetri Terzopoulis and John Platt.
- [WK88] Andrew Witkin and Michael Kass. Spacetime constraints. *Computer Graphics*, 22:159–168, 1988. Proceedings SIGGRAPH '88.
- [WKTF88] Andrew Witkin, Michael Kass, Demetri Terzopoulos, and Kurt Fleischer. Physically based modeling for vision and graphics. In *Proc. DARPA Image Understanding Workshop*, pages 254–278, 1988.
- [WO90] Colin Ware and Steven Osborne. Exploration of virtual camera control in virtual three dimensional environments. *Computer Graphics*, 24(2):175–184, March 1990. Proceedings 1990 Symposium on Interactive 3D Graphics.
- [Wol88] Stephen Wolfram. *Mathematica*. Addison Wesley, 1988.
- [WR87] Catherine G. Wolf and James R. Rhyne. A taxonomic approach to understanding direct manipulation. In *Proceedings of the Human Factors Society 31st Annual Meeting*, pages 576–580, 1987.
- [WW90] Andrew Witkin and William Welch. Fast animation and control of non-rigid structures. *Computer Graphics*, 24(4):243–252, August 1990. Proceedings SIG-GRAPH '90.
- [WW92] William C. Welch and Andrew Witkin. Variational surface modelling. *Computer Graphics*, 26(2):157–166, July 1992. Proceedings SIGGRAPH '92.

- [WW94] Will Welch and Andrew Witkin. Free form shape design using triangulated surfaces. In *Computer Graphics (SIGGRAPH '94 Proceedings)*, pages 247–256, July 1994.
- [ZCW⁺91] Robert C. Zeleznik, D. Brookshire Conner, Matthias M. Wloka, Daniel G. Aliaga, Nathan T. Huang, Philip M. Hubbard, Brian Knep, Henry Kaufman, John F. Hughes, and Andries van Dam. An object-oriented framework for the integration of interactive animation techniques. In Thomas W. Sederberg, editor, *Computer Graphics (SIGGRAPH '91 Proceedings)*, volume 25, pages 105–112, July 1991.
- [ZHR⁺93] Robert Zeleznik, Kenneth Herndon, Daniel Robbins, Nate Huang, Tom Meyer, Noah Parker, and John Hughes. An interactive 3d toolkit for constructing 3d widgets. *Computer Graphics*, 27:81–84, August 1993. SIGGRAPH '93 video paper.