# Christoph Witzgall

We are dedicating this Special Issue of the *Journal of Research of the National Institute of Standards and Technology* to Christoph Witzgall. It honors his many contributions to Operations Research, Geometric Design, and Optimization.

Christoph Johann Witzgall (Chris to his friends and colleagues) was born in 1929 in a resort town in the Bavarian Alps. He is fond of recounting that his education was paid for by the broken bones and torn tendons of the skiers tended to by his doctor parents.

Chris studied mathematics at the Universität München, where the faculty included Constantin Caratheodory, Oskar Perron, and Wilhelm Maack, who supervised his 1958 Ph.D. thesis on subgroups of modular functions. He then moved to the Technische Hochschule, München, where another defector from the university, Friedrich Bauer, was assembling a team around the first fully electronic computer in Germany to engage in the esoteric art of "programming". He shared an office with Klaus Samelson, who together with Bauer designed ALGOL, the algorithmic language at the time intended to ensure portability across all hardware lines. An assignment to program the simplex method of linear programming turned out to set the tone for his subsequent professional development: the numerical analysis of optimization.

In 1959, Chris was recruited by the Swiss physicist and mathematician Hans Maehly to come to the Institute for Advanced Study in Princeton, which then housed the electronic computer—now at the Smithsonian—designed by John von Neumann. Maehly had an Office of Naval Research (ONR) project to develop rational approximations to the elementary transcendental functions, a project soon after moved to Princeton University. As fate would have it, the group around Al Tucker and Harold Kuhn at Princeton was in the forefront of providing theoretical foundations to linear and nonlinear optimization. Chris deeply appreciated being invited into this group as part of an ONR project which had previously support-

ed key researchers Alan Goldman and Ralph Gomory. Back in Germany after two years, Chris rejoined Friedrich Bauer's team, now at the Universität Mainz, working on numerical properties of norms, work that also involved a young colleague, Josef Stoer. Having started a manuscript on optimization during his stay at Princeton, Chris persuaded Stoer to coauthor the ensuing book, "Convexity and Optimization in Finite Dimensional Spaces", which was to appear in 1971 as Volume 163 in the Springer "Grundlehren" Series.

In 1961, Chris spent the summer with the Rand Corporation in Santa Monica, CA, where George Dantzig had convened a workshop on optimization. There Chris shared an office with Jack Edmonds from Alan Goldman's Operations Research Section at the National Bureau of Standards (NBS), now the National Institute of Standards and Technology (NIST). In particular, he was to witness the breakthrough by Edmonds as he found an algorithm of only polynomial complexity for optimal matching in a graph, a major combinatorial problem. Edmonds recruited Chris to join NBS, which he did in October 1962 during the Cuban Missile Crisis. That summer he had spent at Argonne National Laboratory, editing papers of Maehly, who had died there of a heart attack. He also extended Gomory's linear integer programming algorithm to quadratic programming. At NBS, he worked on facility location problems of the Postal Service, matching algorithms following Edmonds' work, and a comparison of shortest path algorithms in connection with the Northeast Corridor Transportation Project. Both his comprehensive report on approaches to facility location and his work with Judith Gilsinn on shortest paths are still quoted in the literature. Married to Elizabeth Bingham, an attorney at the Justice Department, he moved his family to Seattle, where he joined the Boeing Scientific Research Laboratories (BSRL). Their Mathematics Laboratory was headed by Burt Colvin, who later on was to join NBS as head of its Center of Applied Mathematics. There Chris worked on airline scheduling, transportation polytopes with Victor Klee, and simulating the Morgantown "People Mover" with Fred Johnson. He also saw the publication of the book with Stoer.

In 1973, Chris rejoined NBS, preceded by Burt Colvin, who took the helm of the Center for Applied Mathematics, and by Fred Johnson. He solved challenging problems for other Government agencies. Together with other staff of the Operations Research Division, he designed and implemented transportation analysis algorithms for the Urban Mass Transportation Administration (UMTA), developed a parametric integer programming model to assess an electronic mail system then under consideration by the Postal Service, and joined a major effort by the Division, involving also Carl Harris and Saul Gass, in conjunction with the Energy Information Administration (EIA) aimed at energy modeling and forecasting. Working, in particular, with Patsy Saunders (now Hindman) and Ric Jackson (now director of FIATECH), he designed and implemented the major component of a model of the natural gas market that was used for 10 years to forecast natural gas supply and demand. There were NIST interactions such as with Larry Bennett on phase diagrams, and with Bill Stone on calculating the potential drag on external fuel tanks of space shuttles. He also found time for theoretical research such as when he joined Paul Boggs and Paul Domich on designing and evaluating interior point algorithms for linear programming. He also taught a course at Johns Hopkins University emphasizing this then new development. After Alan Goldman left NIST in 1979, he served for 3 years as acting division chief.

In 1986, Chris began a long and fruitful collaboration with the Topographical Engineering Center (TEC) of the Army Corps of Engineers, involving also Douglas Shier, Majorie McClain, and Javier Bernal. Together with TEC staff, he authored the Engineering Technical Letter instructing the Corps' Districts to use TIN (Triangulated Irregular Networks) for dredge volume determinations, work that continued under DARPA sponsorship for the purposes of distributed simulations of military activities. This work forms the basis for recent work with the Building and Fire Research Laboratory (BFRL) on construction automation. He was also invited with Isabel Beichl, Javier Bernal, and Francis Sullivan to contribute articles on computational geometry to the Encyclopedia of Operations Research. Most of all, however, Chris wants to be remembered as never having shirked getting his hands dirty with messy data and real life problems.

**David E. Gilsinn**
Special Issue Editor