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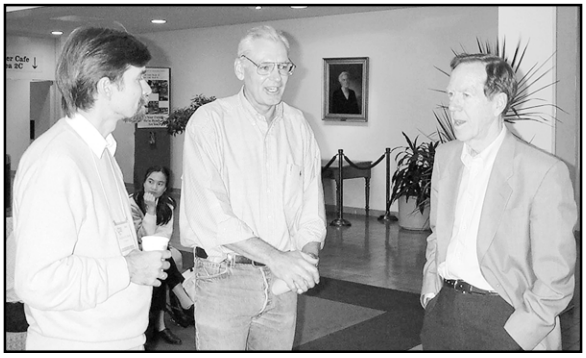
SIAG/LA and ILAS Mark Twenty Years of Progress At Joint Applied Linear Algebra Meeting

By Ilse C.F. Ipsen and Volker Mehrmann



Top, Conference co-organizer Ilse Ipsen of NC State with Paul Van Dooren of l'Université Catholique de Louvain, Belgium. Van Dooren, one of nine invited concurrent speakers at the conference, gave a talk titled "Convex Optimization over Positive Polynomials and Polynomial Matrices." Middle, Conference co-organizer Carl Meyer (center) of NC State, with Siegfried Rump of Technische Universität Hamburg–Harburg (left) and invited speaker Gilbert Strang, whose invited talk was titled "Random Perturbations of Familiar Matrices."
Bottom, Jack Dongarra of the University of Tennessee (left), who discussed the impact of computer architectures on linear algebra algorithms in an invited concurrent talk, and Cleve Moler, whose insights into the ways in which Matlab is used in a variety of application areas enlivened the "Linear Algebra: What's it Worth?" discussion.

The Seventh SIAM Conference on Applied Linear Algebra was a special occasion—held October 23–25, 2000, it followed by just about 20 years SIAM's first meeting on applied linear algebra, and it marked the occasion by returning to Raleigh, North Carolina, the site of the earlier meeting. To help commemorate the milestone, the International Linear Algebra Society (ILAS) had agreed to hold its annual meeting in 2000 jointly with SIAM.

The conference, held at North Carolina State University, was a grand combined meeting in celebration of accomplishments in linear algebra and its applications. Speakers discussed such "classic" topics as eigenvalue problems (including recent developments in Lanczos-type algorithms), direct and iterative methods for the solution of systems of equations, and preconditioning for iterative methods. Other speakers considered the computation of invariant subspaces, totally nonnegative matrices, matrix completions and pseudo-inverses, and matrix calculations in image processing, among many other current research areas. The program featured eight invited plenary talks, with topics including random perturbations of special matrices, the ubiquitous Kronecker product, interior-point methods for optimization, and displacement structure. Dan Pierce of The Boeing Company moderated a panel discussion, "Linear Algebra: What's it Worth?" (see sidebar).

More than 300 people attended the conference, which was preceded by the first Workshop on Computational Information Retrieval, CIR '00, organized by Michael Berry of the University of Tennessee (see article on this page). The conference was sponsored jointly by the SIAM Activity Group on Linear Algebra (SIAG/LA) and ILAS, and organized by Carl Meyer and Ilse Ipsen of North Carolina State University.

On the last day of the conference, SIAG/LA chair Jim Demmel presented the activity group's prize, given for the best paper in linear algebra published during the three years preceding the meeting. Sharing the prize, which consists of a calligraphed certificate and a plaque, were Olga Holtz from the University of Wisconsin, Madison, and the team of Alan Edelman from MIT and Erik Elmroth and Bo Kågström from the University of Umeå in Sweden.

In her prize-winning paper, "Not All GKK Tau-Matrices are Stable" (*Linear Algebra and its Applications*, Vol. 291, No. 1–3, pages 235–244, 1999), Olga Holtz solves a long-standing open problem concerning the location of spectra for two important classes of matrices that arise frequently in applications. The history of this problem dates back to 1958, when Olga Taussky proposed to unify the theory (regarding such issues as stability, eigenvalue bounds, convergence of iterative methods) for three classes of matrices: positive semidefinite, element-wise non-negative, and totally nonnegative. In 1976, Engel and Schneider introduced two classes of matrices—named Omega and Tau matrices after Olga Taussky—that combine those three classes. Omega and Tau matrices are characterized by eigenvalue inequalities for principal submatrices or, alternatively, by Hadamard Fischer-type determinantal inequalities. In 1967 Carlson had introduced yet another matrix class, GKK matrices (named for Gantmacher, Krein, and Kotelyanskii); this class is defined by different determinantal inequalities and does not contain totally nonnegative matrices.

Positive stability was conjectured for the class of Tau matrices by Engel and Schneider, and for GKK matrices by Carlson. In 1978, using an analogy to incidence matrices of graphs, Varga showed that the eigenvalues of Tau matrices of order 3 are located in a cone in the right

half-plane whose opening angle is $\pi/6$. He conjectured that, in general, the eigenvalues of a Tau matrix of order n are located in a cone in the right half-plane with opening angle $\pi\ (n\ -\ 2)/2n$.

Hershkowitz and Mehrmann extended Varga's results to matrices of order 4. In the early 1980s, seeking a counter-example to Varga's conjecture, Mehr-mann performed an extensive (but unsuccessful) numerical search for matrices of orders up to 9. Subsequently, no progress was made toward either a positive or a negative solution to the problem until Olga Holtz constructed an upper Hessenberg Toeplitz matrix of order 44 with a large band of zeros above the diagonal that represents a counter-example to the conjectures of Carlson, Engel and Schneider, and Varga.

SIAG/LA opted to award two prizes for best paper in linear algebra, one to the team of Erik Elmroth (left), Bo Kågström (second from left) and Alan Edelman, and the other to Olga Holtz.

In their prize-winning paper "A Geometric Approach to Perturbation Theory of Matrices and Matrix Pencils. Part I: Versal Deformations" (*SIAM Journal on Matrix Analysis and Applications*, Vol. 18, No. 3, pages 653–692, 1997), Alan Edelman, Erik Elmroth, and Bo Kågström introduce the geometric theory of versal deformations to derive metrical information for the perturbation theory of the Kronecker canonical form of a matrix pencil. The importance of efficient and reliable numerical software for the computation of the Jordan structure of a matrix, or the Kronecker structure of a matrix pencil, is evident in numerous applications in numerical linear algebra, control, and ordinary differential equations. The geometric theory developed by Edelman, Elmroth, and Kågström provides the insight necessary for an understanding of the perturbation directions. This in turn leads to a numerical tool that, even in finite-precision arithmetic, gives a very good picture of the Jordan and Kronecker structures.

Holtz gave a 30-minute presentation about her work, while Edelman, Elmroth, and Kågström gave a truly joint talk, with each author taking ten minutes to present a particular aspect of their paper. The members of prize committee were Volker Mehrmann (chair), Uwe Helmke, Danny Hershkowitz, Nick Higham, and Zdenek Strakos.

Although the conference featured almost non-stop talks, starting at 8:30 in the morning and ending as late as 10:00 at night, participants still had time to socialize over the breakfasts and lunches provided by SIAM in NCSU's McKimmon Center and at night on Hillsborough Street, the main thoroughfare of the NCSU campus.

At the SIAG/LA business meeting on Monday night, everyone agreed that the cooperation with ILAS was successful and should be continued—in future SIAM linear algebra meetings as well as in ILAS meetings. The Eighth SIAM Conference on Applied Linear Algebra, organized by Roy Mathias and Hugo Woerdemann of the College of William and Mary, will be held in Williamsburg in 2003.

The names of all the speakers at both the Seventh SIAM Conference on Applied Linear Algebra and the information retrieval workshop will appear in the Web versions of these articles. Nick Higham has posted photos of the conference at http://www.ma.man.ac.uk/~higham/photos/la00/.

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Soul Searching for Linear Algebra

A challenging topic for discussion at any conference is the status of the field in the scientific community at large. Such a self-examination was the goal of the panel discussion "Linear Algebra: What's it Worth?" held at the Seventh SIAM Conference on Applied Linear Algebra.

Daniel Pierce of The Boeing Company moderated the discussion. The panelists were Al Erisman (The Boeing Company), Roland Freund (Bell Labs), John Gilbert (Xerox Corp.), Bruce Hendrickson (Sandia National Laboratories), Cleve Moler (The MathWorks, Inc.), and Esmond Ng (Lawrence Berkeley National Laboratory).

The truth is that although linear algebra is at the heart of most problems in computational science, many of us feel that it does not receive adequate credit. The difficulty, one panelist pointed out, is that linear algebra is at the base of the pyramid (the bottom of the "food chain"), almost always arising in another context, such as optimization. Does this explain why scientists are sometimes reluctant to tell their funding agencies about the importance of research on linear algebra?

Another panelist recalled that in the past, companies would often hire numerical linear algebraists to tackle common problems, whereas nowadays they tend to hire experts in the application areas, hoping that they will know enough linear algebra. Cleve Moler pointed out that the MathWorks' Matlab is used in many different real applications, from finance to car and cell phone design; nevertheless, the trend is for Matlab to hide matrix computations from the users.

In any case, the time from research in linear algebra to implementation and then simulation or business calculations is usually very long, which makes it tough to assess the value of the initial research.

The panel did not come up with definitive answers (which was not its goal). It did produce some useful suggestions, however. One is that people working in applied linear algebra do not seem to be good at public relations. In addition, the field may have a communication problem. One remedy: People working in linear algebra could try to master other groups' languages and then talk to them in their own terms. One panelist suggested that the resulting lists of synonyms should be widely disseminated in the linear algebra community.

The panel may not have answered the question posed in the session's title, but some of the real applications discussed at the conference certainly speak for themselves. How about "Cruising at (approximately) 41,000 Feet—Iterative Methods at Boeing" or "Linear Algebra or Nuclear Testing: The Lesser of Two Devils" (talks given by John Lewis, The Boeing Company, and Bruce Hendrickson, respectively)? Convincing enough? Three cheers for applied linear algebra!—*Osni Marques, National Energy Scientific Computing Center Division, Lawrence Berkeley National Laboratory.*