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ASSOCIATE PROFESSOR JAN BRANDTS, EDITOR-IN-CHIEF OF APPLICATIONS OF MATHEMATICS, IS FIFTY

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Only those who can see the invisible can accomplish the impossible!

Patrick Snow

Mathematics became renowned as the queen of sciences. So how to call a mathematician—perhaps a king among scientists? Not every mathematician is a king, but Jan Brandts undoubtedly is a king. At present we can barely imagine how many weird sisters were standing around his cradle. But they surely awarded him generously by the ability of mathematical abstraction, precision, and longing to discover new scientific facts. Mathematics is a proud lady who does not want to give up her secrets easily. However, she has a capable rival in Jan Brandts who does not hesitate to calculate ad infinitum to find a mathematical truth. This is confirmed by the number of Jan's excellent results.

The first time I met Jan was in July 1996 at the international conference on Finite Element Methods: Superconvergence, Post-processing and A Posteriori Estimates

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held at the University of Jyväskylä in Finland. His outstanding lecture on superconvergence similarities in standard and mixed finite element methods really impressed me. That was the reason I discussed with him many problems from numerical analysis, in particular those connected with superconvergence phenomena of the finite element method for solving boundary value problems of elliptic type. Then in 1997 I invited him to the Institute of Mathematics in Prague, where he spent one year as a visiting scholar. From that time we co-authored over 30 scientific papers on numerical analysis, discrete and computational geometry, theory of matrices, combinatorics, and even cosmology (see e.g. [5]).

Johannes Hendrikus Brandts was born on January 16, 1968 in Ede, Netherlands. He has been fascinated by solving various mathematical problems since his youth. He studied mathematics at the University of Utrecht and got a Master degree in mathematics in 1990. On January 16, 1995, he received his PhD degree from the same university. The title of his doctoral dissertation was: *Superconvergence Phenomena in Finite Element Method.* His supervisors were Henk A. van der Vorst and Gerard L. G. Sleijpen who became famous due to the invention and development of methods like Bi-CGStab [7] and Jacobi-Davidson [6].

During the period 1995–1999 Jan Brandts was employed at many academic institutions outside the Netherlands: University of Bristol (England), University of Jyväskylä (Finland), University of Kiel (Germany), Institute of Mathematics (Czech Republic), University of New South Wales (Australia), and Institute of Computer Science (Czech Republic). Then he finally got a Research Fellowship of the Royal Netherlands Academy of Sciences. At present, Jan Brandts is Associate Professor at the Korteweg-de Vries Institute for Mathematics at the Faculty of Science of the University of Amsterdam. He was the supervisor of two PhD students there: Ricardo Reis da Silva and Abdullah Cihangir. He also guided over 30 BSc and MSc student theses and projects.

Jan Brandts has a long-term collaboration with the Czech mathematical community. We participated together and had several common lectures at international conferences in Europe, Asia, America, and Australia. Our primary interest lies in the numerical solution of partial differential equations by the finite element method. We wrote a number of papers on this topic that appeared in renowned mathematical journals such as SIAM Rev., Linear Algebra Appl. (2×), IMA J. Numer. Anal., and Comput. Geom. Our further interests are the superconvergence of the finite element method, the discrete maximum principle, and generation of nonobtuse triangulations in n-dimensional Euclidean space. The research on the last topic was, in fact, initiated by Professor Miroslav Fiedler. Jan Brandts wrote altogether almost 100 scientific and popularization papers (50 of them are recorded in the database of Mathematical Reviews).

Now let us take a closer look at some of his mathematical results. During the development of the finite element method it has been found that the rate of convergence of finite element approximations at some exceptional points of a domain exceeds the possible global rate. This phenomenon has come to be known as *superconvergence*. In 1994 Jan Brandts published in Numerische Mathematik a paper on superconvergence and a posteriori error estimation for triangular mixed finite elements.

Superconvergence of the gradient for the linear finite element method applied to elliptic equations was a well-known feature in one, two, and three space dimensions. Surprisingly, the corresponding proofs were all quite different in nature. In 2003 Jan found that there exists an elegant proof of this superconvergence phenomenon independent of the space dimension. It is based on a supercloseness property of the linear interpolant and the finite element solution over a simplicial face-to-face mesh. Later Jan also came with a proof of a superconvergence phenomenon for tetrahedral quadratic elements.

I was always looking at an n-simplex as a geometrical object in $\mathbb{R}^n$, whereas Jan treated an n-simplex as an $n \times n$-matrix. This enabled him to achieve several fundamental discoveries, in particular, the strengthened Cauchy-Bunyakowski-Schwarz inequality for n-simplicial linear finite elements. He also invented some equivalent inscribed and circumscribed ball conditions guaranteeing a mesh regularity. Such conditions prevent that simplices degenerate. This was a natural generalization of the well-known minimum angle condition introduced in 1968 by Miloš Zlámal for triangular elements. Several of Jan's results are connected with properties of nonobtuse simplicial partitions, which enable us to derive the discrete maximum principle for a reaction-diffusion problem. Moreover, he constructed a triangulation with only one obtuse triangle, which violates the discrete maximum principle for the Poisson problem. He also proved that any path-simplex (a natural generalization of a right triangle) in $\mathbb{R}^n$ can be dissected into n path-subsimplices.

Together with Jan's students we proved that there exist only two nonobtuse binary simplicial triangulations of the unit n-cube. We have also established tight bounds on angle sums of nonobtuse simplices, which are valid for dihedral and also for solid angles. Some of the above-mentioned Jan's results are contained in The On-Line Encyclopedia of Integer Sequences by N. J. A. Sloane, see e.g. A000453, A000712, A000793, A001146, A002620, A003432, A028243, A039754, and A179290. These integer sequences were often obtained by MATLAB programs developed by Jan Brandts. This shows that he is really very good at programming. His dream is to resolve the famous Hadamard conjecture from the end of the 19th century, which states that there exists a subset of $n + 1$ vertices of the n-cube whose convex hull is a regular n-simplex if and only if $n \equiv 3 \pmod 4$.

As a numerical analyst, Jan is fond of collecting and inventing various numerical paradoxes. Recently he presented a trivial example showing that in finite precision arithmetic the standard Gram-Schmidt orthogonalization process may easily fail even in three-dimensional space. This hobby of his helped me to understand better the local Hubble expansion of the Solar system. He inspired me by the idea that this effect can be due only to the long-term accumulation of small errors coming from the considered Newtonian model.

Jan Brandts was a member of the editorial boards of SIAM Journal on Matrix Analysis and Applications until 2009 and Applied Numerical Analysis until 2007. He is also a member of the Editorial Board of Applications of Mathematics since 2002 and from April 1, 2013 he is its Editor-in-Chief. Under his leadership the impact factor of Applications of Mathematics has steadily increased from 0.210 to 0.618. Furthermore, he edited four conference proceedings [1]–[4] together with several Czech mathematicians.

Further, I would like to emphasize his excellent style of giving lectures. He has taught undergraduate courses on Numerical Analysis, Linear Algebra, Iterative Methods, Simulation and Modelling, Numerical Methods for Eigenvalue Problems, etc., and he was shortlisted several times by his students to be selected the best lecturer at the Faculty of Science at the University of Amsterdam. His long-term pedagogical activities are not only at Dutch universities, but also in Czech academic institutions. Since 1997 he gives every year several lectures in our seminar Current Problems in Numerical Mathematics at the Institute of Mathematics of the Czech Academy of Sciences. Over twenty years he has presented in the middle of December a Christmas Lecture on various numerical analysis topics. In 1998, he received the Babuška Prize awarded by the Czech Society for Mechanics and in 2017, the medal of the Czech Mathematical Society. Jan Brandts is a member of the Netherlands Scientific Computing Community, the Royal Netherlands Mathematical Society, the European Mathematical Society, the American Mathematical Society, the International Linear Algebra Society, and the Society of Industrial and Applied Mathematics (SIAM).

Jan Brandts is a researcher with broad further interests connected mainly with classical music, piano playing, and reading. He has a deep knowledge of the Czech language and culture. He also likes swimming, long distance trekking on the bicycle, and particularly marathon running. His best time is 3 hours and 32 minutes. In 2010 Jan was running the Prague Half Marathon together with the top Czech football star and Ballon d'or winner 2003 for the best football player in Europe Pavel Nedvěd. Although Jan is more than 4 years older than Nedvěd, Jan's running time was more than 10 minutes shorter, which is very good, indeed!

Felicitations: It is my privilege and honor to congratulate Jan Brandts sincerely on his 50th birthday. I wish him good health and happiness for many years to come. Meeting him was my great life luck.

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