Foreward

Paul Butzer reaches his seventy-fifth year

Paul Butzer's seventy-fifth birthday fell on April 15 this year, and it is fitting that the present issue of *Sampling Theory in Signal and Image Processing* honours him as an eminent scholar and prodigious writer on many mathematical topics. This is fitting because, although an approximation theorist by nature and by training, Paul's interests broadened in the middle 1970s to include various aspects of signal theory, topics that are in harmony with *STSIP*. Paul's professional career and mathematical interests will be outlined very briefly in this short prologue to the issue.[1]

Paul Leo Butzer was born at Mülheim an der Ruhr in 1928. When Paul was nine, Europe was already in the turmoil that, two years later, was to become the Second World War. The Butzer family left Germany and after a spell in England settled in Montreal in 1941. And so it was in Canada that Paul found his education; first at Loyola College, Montreal, and then at the University of Toronto. Here he heard lectures by H.S.M. Coxeter, W.J. Tutte, W.J. Webber, and the approximation theorist G.G. Lorentz, the latter becoming his mathematical mentor in 1951. Paul was the youngest student to obtain a Ph. D. in Canada up to that time.

After graduating with a thesis on the Bernstein polynomials, he quickly established an international reputation in approximation theory. He took up the problem of polynomial approximation in L^p and the associated rates of convergence; the idea of using linear combinations of Bernstein polynomials to improve the approximation process is one of his most frequently cited works.

In 1955 he spent some time conferring with J. Favard in Paris; at this time he became interested in saturation theory and semi-groups of operators. Here he pioneered the use of integral transform methods which provided an important unifying principle in the subject.

[1]Much information was gleaned from R.J. Nessel's biographical survey: Towards a Survey of Paul Butzer's Contributions to Approximation Theory, *Contemporary Mathematics*, Vol. 190, Amer. Math. Soc., Providence, R.I., 1995, 31–65, and from material available at the Lehrstuhl A, RWTH Aachen, where the help of Prof. R.L. Stens was much appreciated.

The Butzer family returned to Germany soon after this, settling in Aachen where in 1958 Paul joined the Rheinisch–Westfälische Technische Hochschule (the Aachen University of Technology) as *Dozent*, and has remained there ever since. His rise was rapid, and by 1962 he was *Ordinarius* with a chair of his own, the Lehrstuhl A für Mathematik. Paul always stressed collaboration and teamwork at the Lehrstuhl A, much to the benefit of the many talented students that he attracted there. Indeed, most of his work is written in collaboration with others, and most of his collaborators are his students.

By 1971 Paul's school of approximation theory was well established in Aachen, and in that year the very well-known book *Fourier Analysis and Approximation*, written jointly by Paul and former student R.J. Nessel, appeared. This ground-breaking project was the first book to emphasize the connections between Fourier analysis and approximation theory.

Work in approximation theory continued, with topics such as best trigonometric approximation (extending the Jackson–Bernstein theory), and best approximation by algebraic plynomials, an area where some of Paul's finest results are to be found.

Paul's interest in probability theory led him in another direction, beginning in about 1975, to study the central limit theorem and the rates associated with its basic convergence theorem. This problem was, of course, well-suited to Paul's expertise in approximation theory and Fourier analysis.

Let us turn to Paul's involvement with signal theory, which began in about 1970 when he became interested in dyadic analysis, particularly the problem of defining a satisfactory derivative in that setting. A few years later, Paul's interests in the sampling theory of band-limited, and of not-necessarily band-limited, functions were awakened by a group of engineers at Aachen; applications of the theory have never been far from his thinking in this area. Sampling theory now became a major activity at the Lehrstuhl A and prompted a wide ranging programme of research involving colleagues, students and their doctoral dissertations, and conferences large and small. A landmark was the international Kolloquium *Mathematische Methoden in der Signalverarbeitung* held at Aachen in 1984 under Paul's scientific leadership .

Just to mention a few of the main lines of this research, in many of which the presence of approximation theory is, not surprisingly, detectable: approximation by sampling sums of non band limited functions;

sampling for duration limited functions; sampling in the stochastic setting; theory of prediction from past samples; derivation of sampling series using convolution operators and their discretisation; error theories; sampling theories where the Fourier transform is replaced by some other transform; general sampling formulae that are designed to enhance the rate of convergence; sampling theories generated from differential operators; sampling expansions for special functions; and the equivalence of sampling theorems with other results in analysis.

Paul has published widely in the history of mathematics, but his interests here are not easy to summarize in a few phrases. Sometimes he studies the works of an individual mathematician; one could single out his very comprehensive study of E.B. Christoffel as an example. Sometimes the studies are based in a particular period or region, especially the Carolingian period and the region surrounding Aachen.

Some fifty papers bearing his name have appeared since his retirement in 1993, and six volumes have appeared of which he has been a joint editor. Many of these publications are on topics that have been mentioned already; some of the newer topics are: fractional calculus; applications of sampling in combinatorics and number theory; continuous analogues of polynomial sets, for example, the Bernoulli and Euler polynomials; Mellin transforms; ergodic theorems for semigroups; and wavelets.

There is rather little space here to mention all the honours that have been conferred on Paul, honorary degrees and honorary membership of scientific societies; or the other academic activities that he has pursued so assiduously over the years, such as duty on the editorial boards of several journals, conducting conferences and acting on their scientific committees. These activities still have an important place in his life and he pursues them today just as vigourously as he ever did.

I am sure that my colleagues on the editorial board of *STSIP*, indeed, all who know Paul Butzer, will join me in wishing him a long, happy, and productive continuation of his retirement.

His works are there for us to admire, his dedication to the education and nurturing of his students is a model to which everyone can aspire, and the spirit of determination that enriches all his undertakings is an inspiration to us all.

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