

Broader Impact of Jorgensen's Research: Past, Present, and Future

Impact of Research. The purpose of my research is the completion and continuation of mathematics which is well under way. Much of it is joint research between myself and other researchers (see the bibliography) in the United States, Europe and Asia. I was recently invited as a main speaker at an international wavelet conference in Texas and one in Hong Kong. It is the second time that I have been an invited senior researcher to visit Hong Kong to give lectures on my ongoing research. Both my joint work with other researchers, as well as my solo papers, fall on the interface of wavelets, signal processing, harmonic analysis, representation theory, and operator theory. My mathematics research has been applied in quantum theory, engineering, and in the study of self-similar processes. The latter concerns the art of utilizing observed self-similarity in some given data in the analysis, storage, and synthesis. Areas of application within mathematics include the theory of partial differential equations and dynamics, and several of my current projects address these last mentioned applications.

My research has been used in all of the graduate courses and most of the undergraduate courses I have taught as well as in my direction of Ph.D. theses (see Section). I have taught overload courses and have had many recent Ph.D. students finish, two of them women and a third working on her thesis. I need the support afforded by a grant in order for me to finish my research and to keep up with advances in my field and in applications. The benefits derived from that go directly into the classroom (including undergraduate classes) and into my work directing Ph.D. thesis and advising postdocs. In particular, I have worked for the past two years on a wavelet-signal processing course for engineers.

The results from the research benefit teaching at all levels: undergraduate, service teaching for engineers (the engineers are the major users of wavelets and signal processing), graduate courses, Ph.D. thesis direction, and postdoc research direction on my part. My research is directly linked to applications: wavelet theory is an "abstract" harmonic analysis made easy to engineers and programmers. Signals are functions, and wavelets represent the most successful algorithm so far for the approximation (in digitized form) of an arbitrary function with just a few simple basis functions and two operations: *translation* by discrete amounts and *scaling* in large and small directions, which are easily written into filter-bank algorithms. The latter depend directly on the harmonic analysis which is the focus of my research. This research has also led to new, and perhaps unexpected, connections between commutative and non-commutative harmonic analysis and hopefully helped to enrich both subjects. The references which bear this out are [Bor92], [DaPi98a], [DaPi99], [BoSp94], [Spe93], [Wor96], [DoPa89], [GKT92], [Ola91], [Ola93], [Ols82], to mention only a few.

A concrete benefit (aside from the publication of research papers in internationally recognized journals) which derives from the project is the completion of preparation of new course materials and a textbook needed for projected service courses for engineering students. I frequently help graduate students in Computer & Electrical Engineering with their research projects on high/low pass filter constructions. Several textbook publishers (Wiley, Birkhäuser) have invited me to complete my textbook project. I have received many invitations from around the world to speak at conferences on wavelets and signal processing.

The renewal and vitality of the courses we offer resulting from the research directly affect the quality *and* the quantity of students we produce at the University of Iowa. Since much

of my research is interdisciplinary, it affects the community as a whole. More specifically, Jorgensen is a co-organizer of two student-faculty seminars at the University of Iowa, Operator Theory and Mathematical Physics. Both are well attended and have a long history (more than 15 years). Moreover, the same faculty group (including Curto, Muhly, et al.) organizes a local semiannual conference with neighboring universities. This is in addition to the annual GPOTS event (attendance in excess of 100) in which we are also involved.

Ph.D. Students during Jorgensen's University of Iowa Period. Humberto Prado, 1989; Xiu Chi Quan, 1992; Anna Paolucci, 1992; Martin Olesen, 1994; Yuan-Ching Huang, finished Spring 1997; Eui-Chai Jeong, finished Spring 1997; Beth Peterson, finished Summer 1998; and Ilona Svidersky, now working on her thesis with me. (I had several Ph.D. students before coming to Iowa.) During the recent period, seven of my Ph.D. students (of the seven, one hispanic and two women) have completed their degrees and graduated: Humberto Prado, X.-C. Quan, Anna Paolucci, Martin Olesen, Y.-C. Huang, E. Jeong, and Beth Peterson. H. Prado wrote a thesis on analytic continuation of representations of Lie groups, X.-C. Quan on harmonic analysis of compact quantum groups, A. Paolucci on deformations of the symplectic quantum groups, and M. Olesen on von Neumann algebras in local quantum field theory. My more recent students have worked on a duality theory for spectral pairs. Specifically, Y.-C. Huang's thesis was on representations of Cuntz algebras, and E. Jeong's was on wavelet theory. Prado (now professor in Santiago, Chile) and Quan (now assistant professor in Florida) have published several papers since their theses, Paolucci holds a postdoc in Leeds, England, Olesen now holds a position in a Danish bank, Huang is an assistant professor in Taiwan, and Jeong is an assistant professor in Korea. I also have one current Ph.D. student now in the course of her thesis work, Ilona Svidersky, and another one finished Summer 1998, Beth Peterson (now Asst. Prof. in Texas). I thus had 3 recent women graduate students, with two already finished with their PhD. I myself have several projects in preparation with former students, most notable, the one with Steen Pedersen (now professor at Wright State, Ohio). I have ongoing collaborations with younger colleagues L. Schmitt (Japan), R.F. Werner (Germany), and Gestur Ólafsson (Germany, Denmark, and Louisiana State University now). Recently, I have also resumed collaboration with O. Bratteli (Norway). Some of the collaborations are supported in part also by local grants from the host countries or the host institutions. While Jorgensen collaborated with European colleagues, and Derek W. Robinson in Australia, he also received partial support from the Research Councils of the respective countries: Norway, Denmark, Germany, and Australia. Jorgensen also has a recent research collaboration with his University of Iowa colleague Florin Radulescu.

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