November 20, 2007

2008 Ohio Research Scholars Program  
Ohio Department of Development  
Technology Division  
77 South High Street, 25th Floor  
Columbus OH 43215

Subject: 2008 ORSP Letter of Interest

Dear ORSP Committee:

I am pleased to submit this Letter of Interest for the Ohio Research Scholars Program on behalf of Kent State University.

Lead Applicant: Kent State University  
Contact: Dmitry Ryabogin  
Department of Mathematical Sciences  
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Title: Industrial Applications of Mathematical Analysis in Medical and Information Technology

Collaborators:  
- Volodymyr Andriyevskyy, Andrew Tonge, and Artem Zvavitch (Department of Mathematical Sciences, Kent State University);  
- Stanislaw Szarek and Elisabeth Werner (Department of Mathematics, Case Western Reserve University);  
- Philips Medical Systems, Cleveland, Ohio;  
- Alexander Koldobsky and Mark Rudelson (University of Missouri, Columbia);  
- Roman Vershynin (University of California-Davis);  
- Société de Calcul Mathématique, Paris, France.

Estimated budget dollars: (types and amounts) total: $3,500,000  
Endowment $3,000,000; Operating $500,000

A summary of the proposed technology/research focus area, research cluster Growth Plan, and positions to be requested appears on the pages following.

Sincerely,

[Lester A. Leeton  
President]

Office of the President  
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**Industrial Applications of Mathematical Analysis in Medical and Information Technology**  
**Ohio Research Scholars, Track 2 Projects**

**Research Focus:** Mathematical Analysis provides powerful tools in Science and Technology. In addition to many traditional, profound applications across the full spectrum of theoretical and applied mathematics, analytical methods have recently been used successfully to make breakthroughs in applications in medical science (for example, in questions related to tomography and artificial organs), computer science (for example, in the theory of algorithms and learning theory), and information technology (for example, in signal processing, including audio and video recognition and compression problems).

These are fresh developments whose impact is yet to be fully understood or exploited. A window of opportunity is opening for the development of exciting new industrial collaborations, building on established excellence in Kent State University's Banach Center and its academic partners, using developments in applied analysis where our faculty is at the forefront of some of the most striking recent progress. The time is extremely right to enrich existing links between Kent State University and Case Western Reserve University in support of opportunistic industrial collaborations that have the potential to create niche powerhouses in northeast Ohio.

The existing group of collaborators has already been recognized by multiple awards of significant federal funding, detailed at the end of this letter. The core proposal is to add an outstanding researcher to the faculty at Kent State University to lead the Banach Center to an internationally prominent academic level and to innovative industrial interactions consistent with Ohio's Third Frontier initiatives. This distinguished researcher would engage federally supported postdoctoral fellows and graduate assistants at Case Western Reserve and Kent State Universities, as well as with industrial partners. The joint enterprise would have great potential for attracting further external funding from both national and international sources, while expanding the industrial base of northeast Ohio.

**Impact on Undergraduate and Graduate Education and Professional Development:** Rapid growth in knowledge in the area of mathematical analysis and recent realizations of its previously unanticipated wealth of applications make it an ideal topic of study for graduate students and young researchers. Pipeline initiatives are under way to promote the flow of students to this area to serve increasing industrial demand. For example, both Kent State University and Case Western Reserve University are participants in a Choose Ohio First proposal that promises to provide scholarships for 200 students annually in northeast Ohio to develop their mathematical expertise to enhance STEM fields. New courses in applied mathematics are being created to excite high school students and lower division college students in areas consistent with this proposal. The Department of Mathematical Sciences at Kent State University has submitted a Research Experience for Undergraduates proposal to the NSF, which promises to attract new blood from across the United States. In addition, new Kent State's instigation of the new COURAGE consortium will bring valuable externally supported international talent at the doctoral and postdoctoral levels.

Further, the energy of this area makes it very attractive for mature mathematicians interested in expanding their horizons. Since there is a significant number of mathematicians in the region surrounding northeast Ohio who would benefit from an opportunity to deepen their knowledge of recent advances stemming from applied analysis, this is an opportune moment to create more synergies with industry.
Subject Recognition: Participants in this proposal work in a number of general areas of analysis, including Functional Analysis, Probability, Harmonic Analysis, Geometric Tomography, Approximation Theory, and their applications. These fields have recently entered a period of explosive growth. In particular, at the most recent International Congress of Mathematicians all three Fields medals (the mathematical equivalent of the Nobel Prize) were awarded to mathematicians working in the area of applied analysis.

Although the areas of mathematics cited above have evolved in relative isolation from the external world for much of the last half century, important industrial applications are now emerging at a startling rate. Significant steps to industrial development and implementation have been made internationally. Several prestigious conferences in applied and pure analysis have been organized in the last few years where an industrial presence has been crucial. These include "Educational Workshop on Probabilistic Methods in High Dimension Phenomena" (Université Paul Sabatier, Toulouse, France; Centre Emile Borel at IHP, Paris, France), "Educational Workshop on Geometric Inequalities" (Università degli Studi di Firenze, Italy), "Workshop on Asymptotic Theory of the Geometry of Finite Dimensional Spaces" (Erwin Schrödinger Institute, Vienna, Austria). In addition, the Hebrew University of Jerusalem, Israel, highly reputed for its contributions to hi-tech industries, has hosted a number of conferences of this type.

However, the United States has lagged behind these international developments. Some of the first moves to turn this situation around were in Ohio. Extremely exciting and important events have been already organized at Kent State University (see www.math.kent.edu for more information).

- The NSF-CBMS conference at Kent State University, August 2006, organized by Per Enflo, Andrew Tonge, and Artem Zvavitch (NSF supported Regional Conference in the Mathematical Sciences Grant - "Probabilistic and combinatorial approach in analysis".Grant number DMS-0532494).

- Informal Analysis Seminar, December 2-3, 2006 (supported by NSF Grant in Classical Analysis; grant number DMS-0504049).

Moreover, steps to create links between Ohio universities have been already made: Kent State University and Case Western Reserve University have been awarded a prestigious NSF Focused Research Grant. Two more states are collaborators: California - University of California, Davis - and Missouri - University of Missouri, Columbia. In this framework, the Department of Mathematical Sciences at Kent State University has already held a successful conference:

- Informal Analysis Seminar, October 27-28, 2007 (supported by NSF Collaborative Research grant: Fourier analytic and probabilistic methods in geometric functional analysis and convexity; grant number DMS-0652684).

These meetings attracted attention of many people to northeastern Ohio. Numerous graduate students and young researchers benefited a lot from the events. In their letters to National Science Foundation participants expressed their gratitude to Kent State University.

- In August 2008 the Department of Mathematical Sciences at Kent State University and Department of Mathematics at Case Western Reserve University organize a big international conference and summer school on applied analysis. Leading experts from
MIT and Princeton will deliver the series of lectures. (The event is supported by a joint Focused Research Groups NSF grant.)

**Collaboration with Industry:** The proposal is to build a bridge between and within higher education and industry that will develop new opportunities for the Ohio economy, placing it on an international cutting edge. In collaboration with the Société de Calcul Mathématique, whose director, Bernard Beauzamy, has long standing interactions with Kent State University, colloquia showcasing the work of industry, are a component of the regular colloquium series, and have led to collaborations with faculty in mathematical analysis. Recently, two of the applicants, D. Ryabogin and A. Zvavitch organized an international conference at the American Institute of Mathematics in Palo Alto (supported by NSF and Fry Electronics), where a number of interesting tomography questions were raised and solved. The practical overlap with medical technology, especially with questions related to recognition of objects from X-ray data, was very apparent. As a point of entry to more extensive industrial collaboration, researchers at Kent State University and at Philips Medical Systems are exploring a mutual interest in tomography and video processing. Representatives from Philips Medical Systems will visit Kent this November. We see the new hire as playing a key role in directing collaboration between Kent State University, Case Western Reserve University, and Philips Medical Systems, and in developing further industrial partnerships.

**Existing External Funding (Kent State and Case Western Reserve participants):**

Each of the senior researchers participating in this proposal is and has been supported by NSF grants. The following awards are closely related to the current proposal. (We list only current awards).

- S. Szarek: “Topics in Asymptotic Geometric Analysis and its Applications” (NSF, DMS-0503642, $240,000); NSF “Collaborative Research: Fourier analytic and probabilistic methods in geometric functional analysis and convexity” (joint with E. Werner) (NSF DMS-0652722, $300,000).
- E. Werner “Convexity and Applications” (NSF, DMS-0305191, $120,000).
- A. Zvavitch: “Fourier Analytic Approach to the Geometric Tomography” (NSF DMS-0504049, $92,626); NSF “Collaborative Research: Fourier analytic and probabilistic methods in geometric functional analysis and convexity” (NSF DMS-0652684, $150,000).

Notice that Ryabogin, Zvavitch, Szarek, and Werner are collaborating through NSF “Collaborative Research: Fourier analytic and probabilistic methods in geometric functional analysis and convexity,” which is a grant supporting collaboration between Case Western Reserve University and Kent State University.

**Budget Request:** We request funds for a Track 2 position to enhance the Banach Center at Kent State University by hiring an Ohio Research Scholar ($3 million) to lead academic and industrial collaborations. In addition, we request operating research funds, including administrative support and support for additional graduate students and postdoctoral fellows ($5 million).
**Growth Plan:** Announced retirements at Kent State University create the opportunity to further enhance the Banach Center through an additional tenure track faculty hire, coupled with a postdoctoral faculty hire, within two years. Following the successful model of the Société de Calcul Mathématique in Paris, France, it is anticipated that emerging industrial collaborations, in combination with increased federal funding and international funding (through consortium agreements with overseas universities), will allow the addition of a further two or three postdoctoral faculty and a similar number of graduate students within 4 to 5 years. Industrial partnerships will provide internships for undergraduates intending to work in these industries after appropriate academic training.