Report on my Sabbatical Leave during 2012-2013:

Submitted by Ravi Shankar, Professor, CEECS, COECS, FAU

The following lists the goals that I had presented when I went on sabbatical leave:

- Leverage our success with Android phones and Robotics to obtain major NSF /DoEd funding for K-16 STEM education
- Increase collaborations with other colleges to obtain research grants from NSF
- Build an environment of social entrepreneurship and help students obtain small business federal grants
- Document and publish on our flow to radically increase engineering design productivity.

Much has been accomplished with focus on these objectives as I will list below. The resume attached provides all the details. My collaborations (in teaching, publications and proposal submissions) involve the following faculty members from various colleges within FAU and elsewhere: F. McAfee, SCMS, Arts and Letters; M. Harris, Anthropology, Arts and Letters; D. Mitsova-Boneva, Urban and Regional Planning; D. Ploger, Education; A. Nemeth, Henderson School; O. Masory, OME, Engineering; R. Behara, ITOM, Business; R. Voss, Mathematics, Science; and S. Hecht, Psychology, Nova.

- **Multi-college collaborative teaching publications**: (a) Two papers were presented at the CIEC (*Conf. on Industry and Education Collaboration)* Conference in Phoenix, AZ; (b) Three papers were reviewed and accepted to the ASEE (*American Society of Engineering Educators)* national conference for presentation in Atlanta, GA in June 2013, and (c) One conference paper was submitted to EEE'13 (*The 2013 International Conf. on e-Learning, e-Business, … and e-Government, Las Vegas, NV),* to be presented in July 2013. All these papers document our work over the past 3 years in smart phone, robotics and eLearning.
- **Multi-college collaborative grant proposals**: We submitted 2 proposals one to NSF (for $1.35 M) and one to FAU (for $21K) to further our collaborations in both teaching and research, as related to smart phone, robotics and eLearning. I am the PI for both. A third one, with Dr. Mitsova-Boneva as the PI, to FAU's QEP program is scheduled to be submitted this month. This will integrate research on climate change and urban planning with our smart phone App development course.
- **Teaching Infrastructure**: We have built up several good websites which I improved substantially last year. Here are those sites: http://android.fau.edu/ , http://robotics.fau.edu/ and http://semanticweb.fau.edu/ . My professional faculty site acts as the bridge among these various fields. Here is the link: http://faculty.eng.fau.edu/shankar/ . I am also now certified as an eLearning Designer/Facilitator at FAU and have undergone further training at the Sloan-C center on Web 2.0 in eLearning. All this should help develop truly collaborative multi-college

teaching collaborations. My goal here is to automate many of the processes and enhance productivity. A tool related to ABET accreditation was prototyped recently with this goal in mind. It will be presented at the ASEE conference in Atlanta, GA. All the three proposals listed above will help us integrate teaching and research (on automation, productivity enhancement and semantic web support).

- **Research collaborations**: Two PhD candidates are working with me on their doctoral dissertation. Frank Wissinger's focus is on using mixed level and signal EDA (engineering design automation) tools to urban planning. A journal paper has been accepted on a related topic. Sifat Islam's focus is on using semantic and intelligent web technologies to address a health care need (diabetes care). He presented a conference poster paper at the IEEE SysCon conference being held now in Orlando, FL.
- **Areas for research focus**: My two areas of research focus are on the semantic web and health informatics. I presented a tutorial (with Sifat Islam) on the semantic web at the recent IEEE Syscon conference in Orlando, FL. I attended a conference of AMIA (American Medical Informatics Association) in Chicago in November 2012, to get up to speed on the health informatics. I have good background in medicine (I am a Fellow of the American Heart Association), automation and productivity, the three of the four backgrounds that are needed to achieve success in health informatics. The fourth background pertains to the clinical setting, which requires collaboration with practicing medical doctors. Coupling with semantic web and intelligent web techniques should lead to very useful and beneficial research and community tools. I also received two more US patents during 2012 in related areas. Here is our research site that was substantially enhanced last year: http://csi.fau.edu/ . I am also now CITI certified to conduct studies with human subjects in both biomedical and behavioral and social research.
- **Entrepreneurship**: One of the three papers at the ASEE conference, on smart phone Apps, is being presented in their Entrepreneurship session. We had to document proof that three of our teams have established themselves well and are viable. Our future collaborations will seamlessly integrate the team work in our jointly taught course with entry to the FAU Business Competition. Our eTeams site documents our progress so far: http://eteams.pbworks.com/w/page/61784805/FrontPage . We have also established a site for MTC (Mobile Technology Consortium) to post their semi-annual conference presentations: http://mtc.fau.edu/ Mr. Borras, President, MTC, has been a judge for our student teams and will be hosting poster presentations by our student teams at their conferences, to connect entrepreneurs and business people with our student teams.

My overall objective is to build multi-college collaborations in teaching and research and use my backgrounds in automation, productivity, entrepreneurship, medicine, eLearning and several application domains (smart phones, robotics and the semantic web) to develop open source tools to facilitate teaching, research and community needs, and to create opportunities for our graduates.

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Team course sites: http://android.fau.edu/ , http://robotics.fau.edu/, http://semanticweb.fau.edu/
eLearning Faculty Team Site: http://eteams.pbworks.com/
Online Tool for the Open Data Initiative: click here (or http://csi.fau.edu/?page_id=99)

Objective:

Contribute to progress on issues of national importance by leveraging my various strengths in

- Technology (systems, engineering, medicine, algorithms, semantic web, and automation),
- Education (STEM education, eLearning and interdisciplinary collaboration), and
- Management (innovation, management, leadership, industry experience, and grantsmanship)

Experience:

Education: MBA, College of Business, Florida Atlantic University, Boca Raton, FL, May 2000
PhD, Electrical and Computer Engineering, University of Wisconsin, Madison, 1982
M.S, Electrical and Computer Engineering, University of Wisconsin, Madison, 1977

Employment and Professional Experience:

- **2012-2013,** *Sabbatical*, On building a consortium for smart phone and mobile Apps (CUSP)
- **1993-Present,** *Director*, *CSI*, a center for multi-college university-industry collaboration
- **1982-Present,** *Promoted and Tenured, Assistant to Full Professor*, CEECS disciplines, FAU
- **2009-Present,** On multi-college teaching coordination to help student teams develop Apps
- **2003-2008,** *Research Director*, Motorola Grant ($1 M). Increased design productivity six fold
- **2001-2002,** *Senior Consultant,* Cadence Design Systems, leading maker of chip design software
- **1998-1999,** *Sabbatical*, On rapid and low cost prototyping for STEM hands-on experience.
- **1991-2002,** *Consultant*, Vasocor, on clinical studies for early prediction of atherosclerosis
- **1992-1993,** *Research Director*, Vasocor Grant ($750K), on medical imaging for atherosclerosis.
- **1986-2008,** *Consultant*, IBM, APTEK, Harris, and Motorola, on engineering design automation.
- **1977-1982,** *Teaching & Research Assistant*, Elec. and Comp. Eng., U of Wisconsin, Madison, WI

Teaching Experience:

- **2008- Present,** *Mobile Applications***,** based on open source tools for Google's Android, Arduino for robotics, Jena and Protégé for the semantic web, and EMF for auto code generation.
- **2000-2007,** *System on a chip (SoC)***,** with courses on Network on Chip, Concurrency, SystemC for mixed-signal systems, Design and Verification, and Biologically Inspired Architectures.
- **1999-2000,** *Innovation***,** with course on new product development, College of Business
- **1986-1999**, *VLSI***,** with courses on Microelectromechanical Systems (MEMS), Neural VLSI; Low Power Design, Silicon-on-Insulator (SOI), Structured VLSI Design; Introduction to VLSI
- **1982-1992,** *Computer Architecture*, with courses on Embedded System Design, Concurrent Processing, Neural Networks, Microcomputers, Digital Computer Architecture
- **1985-2000,** *Engineering Design Automation*, with courses on CAD-Based Computer Design , Structured Digital Design; Computer Hardware Design, Semi-custom VLSI Design in DSP

- **1982-1985,** *Data Acquisition*, Data Acquisition and Measurement Systems and Biomedical Instrumentation Lab (at the Univ. of Wisconsin-Madison)

Scholarly Achievements

Statement of Professional Interests: Mobile Systems, System Complexity, Semantic and Intelligent web, Engineering Design Productivity, Systems Integration, Concurrency Modeling, SoC (System-on-a-chip) Design, VLSI (analog, digital and neural) Design, Computer Architecture, Distributed Parallel Processing, MEMS, and Biomedical Engineering.

Theses and Dissertations Supervised: 26 MS theses and 9 PhD dissertations (two on-going) in the following domains (current to earlier): Semantic Web, System Modeling, Productivity, Computer Architecture,Concurrency, Artificial Neural Networks, Design Automation, VLSI Design, Instrumentation, and Biomedical Engineering.

Patents (in Computer and Biomedical Engineering): Click here for details.

- Two patents on highly scaleable multiplier architecture for low power mobile systems. US patents numbers: 7,873,823 (issued in January 2011 and 7080114 (issued in January 2005)
- Five patents on early and/or noninvasive diagnostic methods for atherosclerosis and diabetes. US patent numbers: 8,197,416 (issued in June 2012), 8,185,182 (issued in June 2012), 5,343,867 (issued in September 1994), 5,297,556 (issued in March 1994), and 5,241,963 (issued in September 1993).

Journal Publications (in Technology and Education):

- Mitsova, D., Wissinger, F., Esnard, A-M, Shankar, R., and Giles, P., A Collaborative Geospatial Shoreline Inventory Tool to Guide Coastal Development and Habitat Conservation, revised manuscript submitted, ISPRS International Journal of Geo-Information, 2013.
- Fonoage, M., Cardei, I., and Shankar, R., Mechanisms for Requirements Driven Component Selection and Design Automation, *IEEE Systems Journal*, Vol. 4, No. 3, Sept 2010, pp. 396-403
- Shankar, R., Gopinathan, M., and Webster, J.G., Digital Signal Processing in clinical validation studies with impedance plethysmography, Paper draft, CSI Technical Report, *csi.fau.edu*.
- Shankar, R., Shao, S.Y., and Webster, J.G., A Fully Automated Multi-Channel Digital Electrical Impedance Plethysmograph, Paper Draft, CSI Technical Report, *csi.fau.edu*.
- Shankar, R., Webster, J.G., Object-Process Modeling of Glucose Metabolism in Health and Disease, Paper Draft, CSI Technical Report, *csi.fau.edu*.
- Agarwal, A., Shankar, R., and Iskander, C.,Survey of NoC Architectures and Contributions, *Scientific International Journal of Engineering Computing and Architectures*, Vol. 3, Issue 1, 2009
- Agarwal, A., Shankar, R., A Concurrency Model for Network on Chip Design Methodology, *Journal of Modeling and Simulation*, Vol. 29, Issue 3, pp. 238-247, 2009
- Agarwal, A., Mustafa, M., Shankar, R., Pandya, A.S., and Lho, Y., A Deadlock Free Router Design for Network on Chip Architecture, *Journal of Korea Institute of Maritime Information and Communication Sciences*, Vol. 11, No. 4, pp. 696 - 706, April 2007
- Shankar, R., Freytag, L., and Alon, D., "A CAE-based Course for Design of Digital Systems," *Computers in Education Journal*, ASEE, Vol. 1, No. 3, pp. 76-85, July-September 1991.
- Zhongkai, Z., and Shankar, R, "A Tutorial on CMOS VLSI Design for an Introductory Course," *Computers in Education Journal*, ASEE, Vol. 1, No. 3, pp. 22-30, July-September 1991.
- Shankar, R., and Webster, J.G., "Noninvasive Measurement of Compliance of Human Leg Arteries," *IEEE Trans. Biomed Eng.*, Vol. 38, No. 1, pp. 62-67, January 1991.

- Shankar, R., & Bond, M.G., "Correlation of Noninvasive Arterial Compliance with Anatomic Pathology of Atherosclerotic Nonhuman Primates, " *Atherosclerosis*, Vol. 85, pp. 37-46, Dec 1990
- Pajunen, G., Steinmetz, M., and Shankar, R., "Model Reference Adaptive Control with Constraints for Postoperative Blood Pressure Management," *IEEE Trans. Biomed. Eng.*, Vol. 37, No. 7, pp. 679-687, July 1990.

Books:

- Agarwal, A., Shankar, R., and Pandya, A.S., Embedding Intelligence into EDA Tools to Meet the Future Technology Trends, in *Integrated Intelligent Systems for Engineering Design*, X. F. Zha and R. J. Howlett (Eds), IOS Press, Amsterdam, Netherlands, 2006, pp. 389-408
- Shankar, R., and Fernandez, E., *VLSI and Computer Architecture*, 490 pages, Academic Press, Inc., August 1989.

Refereed Conference Proceedings (recent ones):

- Shankar, R., McAfee, F., Harris, M., Behara, R., and Fowlkes, J., Android Exchange (AEx) - A Virtual Community for Students on eTeams, submitted to *EEE'13* - Las Vegas, NV, July 2013.
- Shankar, R., McAfee, F., and Harris, M., Smart Phone App Development: A Multi-College Approach, *2013 Annual Conference, ASEE*, June 2013, Final Paper accepted.
- Shankar, R., Dickson, J., and Mazoleny, C., A Tool for ABET Accreditation, *2013 Annual Conference, ASEE*, June 2013, Final Paper accepted.
- Shankar, R., Ploger, D., Nemeth, A. and Hecht, S.A., , Robotics: Enhancing Pre-College Mathematics Learning with Real-world Examples, *2013 Annual Conf., ASEE*, June 2013, Final Paper accepted.
- Islam, S., Shankar, R., and Freytag, G., Leveraging Semantic Web to Retrieve Customized Medical Information, *IEEE Syscon Conference*, April 2013, paper presented.
- Ploger, D., Shankar, R., Nemeth, A., and Hecht, S.A., Exporting Engineering Technology Practice to Enhance Pre-College Mathematics Learning, Practice Brought Into the Engineering Technology Classroom, *2012 ASEE Gulf Southwest Annual Conf.*, April 2012 El Paso, Texas.
- Borras, J., Shankar, R., and Furht, B., Mobile Technology Consortium (MTC): An Industry-University Alliance, *Conf. on Industry and Education Collaboration*, Phoenix, AZ, Feb. 2013.
- Shankar, R., Borras, J., McAfee, F.X., Harris, M., Ploger, D., Masory, O., Behara, R., Impact of Motorola's Vision on FAU's Engineering Curriculum, *Conf. on Industry and Education Collaboration*, Phoenix, AZ, February 2013.
- Islam, S., Freytag, G., and Shankar, R., Intelligent Health Information System to Empower Patient with Chronic Diseases, *IEEE IRI Workshop on Health Informatics*, Las Vegas, 2012.
- Mitsova, D., Esnard, A-M., Shankar, R., Wissinger, F. Viciedo, M., Holding Back the Sea: Approaches toward Shoreline Management and Planning to Reduce Erosion Hazards, Risk and Response: *Sea Level Rise Summit*, Ft. Lauderdale, FL, June 2012
- Shankar, R., Gundel, J., Nemeth, A., Ploger, D., and Hecht, S.A., Robotic Art for STEM, *FCRAR2012*, Boca Raton, FL, May 2012.
- Shankar, R., Ploger, D., Masory, O., and McAfee, F.X., Robotic Games for STEM Education, *ASEE Mid-Atlantic Regional conference*, Temple University, Philadelphia, PA, October 2011
- Shankar, R., McAfee, F., Carvalho, G., Silva, N., and Harris, M., STEM Education with Innovation and Entrepreneurship, *ASEE MidAtlantic Conference*, Temple University, Philadelphia, PA, October 2011
- Shankar, R., Preparing System Engineers of Tomorrow, *ASEE Southeastern Section Annual Conference*, Marietta, GA, April 2009
- Shankar, R.,, and Agarwal, A., KISMET: An Open Source Process for Faculty Participation in ABET Accreditation, *ASEE Southeastern Section Annual Conference*, Marietta, GA, April 2009

- Castellanos, R., Kalva, H., and Shankar, R., Low Power DCT using Highly Scalable Multipliers, *ICIP 2009*, Feb 2009.
- Fonoage, M., Cardei, I., and Shankar, R., *IEEE Systems Conference*, 2009
- Jayadevappa, S., and Shankar, R., The Changing Ways of Computer Science & Engineering Education – A Suitable Pedagogy to Adapt Better, *2009 ASEE Annual Conf. and Exposition*, Austin, TX, June 2009
- Shankar, R., and Islam, S., A Reference Model Based Patient Management System: Opportunities and Challenges, *25th Southern Biomedical Engineering Conference*, May 2009
- Mozelny, C., and Shankar, R., The Health Advisor: Application for Parkinson's Disease, *25th Southern Biomedical Engineering Conference*, May 2009

Sponsored Research Cash Grants : $ 4.3 M (Systems: $ 2.3 M, Biomed: $ 1M. Royalties: $1M)

- FAU QEP: Research component for Android Team Projects, to be submitted $6 K ('13)
- FAU Tech Grant: Integrating Mobile Apps and Robotics into STEM Education, submitted $21K ('13)
- NSF DIP: Android Exchange - A Virtual Community for Students on eTeams, submitted $1350 K ('13)
- A Shore Characterization Tool to extend ARCGIS (PI: Mitsova), FAU, 2012 $10 K
- Android App Development, FAU, 2010 $8 K
- Accelerated Mobile Product Development Co-PI: Agarwal), SBA, 2009-2010 $123 K
- Highly Scaleable Multiplier, GAP Funding from Tech Transfer/FAU, 2007 $15 K
- One Pass to Production (Co-PI: Furht et al), Motorola/iDEN, 2003-2008 $1000 K
- EDA Undergrad Curriculum, Cadence Design Systems, Inc, 2001-2002 $20 K
- Low Power Optimization, SABA Grant, Motorola, 2000 –2001 $22 K
- Advanced System Control (Co-PI: Pajunen), Motorola, 1999 $72 K
- Integration of RF and Digital Design Flow, Harris SemiConductors, 1997 $25 K
- Modularly Expandable Mixed Signal IC Tester, NSF and Motorola 1994 - 1997 $260 K
- A Seamless Env. for Productivity, PI/Co-PI, NSF and Motorola, 1994-1995 $85 K
- Early and Noninvasive Detection of Atherosclerosis, Vasocor, 1991-1993 $750 K
- Character Recognition with Neural Networks (PI: Pandya), IBM, 1990-92 $86 K
- Layout Topology Optimization for DCVS Logic (Co-PI: Barrett), IBM, 1990-91 $77 K
- Wafer Scale Integration for Image Perception, DARPA/SUS, 1989-1990 $78 K
- VLSI Implementation issues for neural networks, FHTIC, 1989-1992 $109 K
- Early Detection of Atherosclerosis, FAU, 1989-1990 $27 K
- Patterned Functional Electrical Stimulation for Hemiplegics, FHTIC, 1989-1990 $35 K
- Design of Analog VLSI Cell Library, USF, Tampa, 1986-1988 $40 K
- VLSI Design of Communication Systems (Co-PI: Szabo), APTEK, 1986-1987 $75 K
- Early Noninvasive Detection of Atherosclerosis, FHTIC, 1985-1987 $133 K
- Distributed Computing and VLSI Design (Co-PI: Raskin), IBM 1984-1986 $125 K

Synergistic (and Large Team) Activities:

- **Consortium for Smart Phone, Mobile and Web Applications (CUSP) (2011 to Present):** Multi-disciplinary efforts that combines my various backgrounds in biomedical, electrical, computer engineering, computer science, innovation, and management. Multi-college joint courses have evolved on smart phones, robotics and the semantic web. These span high school to graduate school, across a number of colleges. This has facilitated communication across colleges which can be leveraged to evolve a university infrastructure of research enhancement, social entrepreneurism and STEM.
- **Android Smart Phone Apps (2009- Present):** SBA funded us in 2009 to develop courses on Android Mobile phone App development. Since then, we have offered courses for high school to graduate level and beyond, and have involved students and faculty members from arts, anthropology, and engineering to develop marketable Apps. During the last year, we expanded the course to include business students in a

face-to-face course; and later offered it as an eLearning course. Our Android site is well visited by developers around the world (220 K visits).

- **Multi-Disciplinary Engineering Collaborations (2003-2008):** I led groups of 20+ computer science, computer and electrical engineering faculty members and students on a major 6 year Motorola project on radically increasing engineering design productivity. The group changed year-to-year with new goals. This was entitled "One Pass to Production" (OPP)
- **Industry Research and Development (2001-2002):** I worked as a senior consultant and technical account manager at Cadence supporting all system and chip design activities at Motorola. This allowed me to meet engineers and managers in all the disciplines and understand their design and product development flow. Citations of the OPP publication are at the CSI site.
- **Technology Transfer (1991-2001):** My biomed patents resulting from pilot studies on human and monkey subjects were licensed to Vasocor Inc. I led a 30+ technical group (5/92-5/93) in developing Vasogram I. Vasogram II was used in a multi-center clinical validation study. (Herrington et al., Circulation, 2004). My noninvasive measure for atherosclerosis was successfully correlated with abdominal aortic measurements with MRI.

Professional Recognition:

- Presented a 4 hour tutorial on the semantic web, in collaboration with Sifat Islam (PhD candidate), at the IEEE Syscon Conference, in Orlando, FL, April 2013.
- Panel Member, Education Alternatives for Combining Engineering and Management, IEMC, Newfoundland, CA, September 2005
- Outstanding Faculty Award, Annual Award, College of Engineering, FAU, December 2003.
- Plaque of Appreciation, for leadership in implementing 'One Pass to Production' and 'Digital Six Sigma' programs, Motorola's iDEN Cell Phone Division, September 2003.
- Leadership award, for leading the department in establishing collaborative relationship with Motorola, CSE Dept., FAU, March 2003.
- Panel Member, Education Alternatives in Biomedical Eng., Biocomplexity Conf., Dartmouth, 2002
- Team of the Year award, to our Motorola Enterprise Team at Cadence Design Systems, 2002.

Other Information

Research Commercialization: FAU's first licensing contract based upon my research on early and non-invasive detection of atherosclerosis, signed March 1991. Royalty payments of $1 Million have been received by the FAU Research Corporation through 2004.

Continuing Education:

- Certification of Achievement. Web 2.20 Tools You can Use to Improve Learning, The Sloan Consortium, December 2012.
- Became a member and attended the conference of AMIA (American Medical Informatics Association), held in Chicago, November 2012. I intend to contribute strongly to the field of health informatics.
- eLearning Designer/Facilitator Certification at FAU, passed with honors, May 2012
- CITI (Collaborative Institutional Training Initiative) Certification obtained for both Biomedical Research Investigators and Social & Behavioral Research investigators, September 2011
- NIH, UMLS (Unified Medical Language System) One-day Training, Fall 2007
- Rhapsody, UML Tool for Real-Time, Motorola Funding, FAU, April 2004
- NSF Sponsored Workshop on Biocomplexity, at Dartmouth College, Hanover, NH, July 2002.
- Leadership Training, Three-day course, The Client Partner, Aspen Consulting Inc., April 2002.
- Senior Consultant at Cadence, with focus in the complex and challenging area of SFV (Systems and Functional Verification), during January 2001 to July 2002.
- Active support of Cadence tools and design flow, during January 2001 – 2003 at Motorola.

- Design experience with UML, MLD, SystemC, Verilog, SPW, Cascade, Analogy, PSPICE, HSPICE, Matlab, HP Tester, Xilinx, and several microcontrollers
- Executive MBA – to enhance and expand our college wide center and our product engineering consortium (comprised of centers at four universities).

Collaborators and Other Affiliations:

- Industrial: Jaime Borras, ex-VP and CTO, iDEN, Motorola, Plantation, FL, now President, MTC (mobile Technology Consortium), FL; Jerry Merckel, ex-Senior Manager, IBM, Boca Raton, FL.
- Academic: Fran McAfee, Michael Harris, and Don Ploger, Faculty members at FAU
- Biomedical: John G Webster, Professor Emeritus, University of Wisconsin, Madison, WI, and M. G. Bond, Professor Emeritus, Bowman Gray School of Medicine, Winston-Salem, NC