

Date: January 22, 2004

To: William H. Parker  
Vice Chancellor for Research  
Dean of Graduate Studies

From: Daniel D. Gajski  
Henry Samueli "Turing" Endowed Chair  
Director, Center for Embedded Computer Systems

Subject: CECS 2001-2003 Annual Report

The Center for Embedded Computer Center {CECS} ended the 2003 fiscal year with many significant accomplishments and a strong and innovative research program. CECS is internationally recognized as an outstanding research center in embedded systems.

The core and domain research programs were conducted by 18 UCI faculty members and 54 graduate students. A CECS Research Advisory Board was established and Dr. Gilbert F. Amelio, Senior Partner, Sienna Ventures, Sausalito, CA became our first member. Dr. Jai K. Hakhu, Vice President, Intel Corporation, Santa Clara, CA became our second member. Today, we have three distinguished industrial executives serving on the CECS Research Advisory Board. We also hosted 16 research visitors from foreign industry and universities who conducted embedded systems research for varying time periods.

As recognition of our research capabilities, we were successful in capturing \$1,100,382 in contracts and grants, and \$716,930 in research donations for a total of \$1,817,312. This level of research funding and support signifies the importance of and the recognition achieved by our core and domain research programs.

Four issues of CECS eNEWS were published each year which pictorially highlighted the research accomplishments of our faculty members, graduate students, and visitors. We also held the Southern California Embedded Systems Symposium (SCESS) which showcased our leading-edge research to the Orange County technical community. The SCESS Keynote Address was delivered by Justin Harlow III, Semiconductor Research Corporation (SRC) to 120 attendees.

Fifty eight CECS Technical reports were published and posted on the CECS web site covering a variety of research topics. Each report has a very appealing and colorful cover page which highlights the report topic. Our web site, [www.cecs.uci.edu](http://www.cecs.uci.edu), was maintained in a timely manner and the site navigation was improved.

Our core and domain research programs were extremely successful in 2003. We are striving to build on these research accomplishments in 2004 hoping to have significant societal impact through innovative research and technology transfer.

## **FACULTY MEMBERS**

Nader Bagherzadeh - Electrical & Computer Engineering, UC Irvine  
Lubomir Bic - Information & Computer Science, UC Irvine  
Pai H. Chou - Electrical & Computer Engineering, UC Irvine  
Nikil D. Dutt - Information & Computer Science, UC Irvine  
Daniel D. Gajski - Information & Computer Science, UC Irvine  
Jean-Luc Gaudiot - Electrical & Computer Engineering, UC Irvine  
Tony Givargis - Information & Computer Science, UC Irvine  
Rajesh K. Gupta - Information & Computer Science, UC Irvine  
Raymond Klefstad - Electrical & Computer Engineering, UC Irvine  
Fadi Kurdahi - Electrical & Computer Engineering, UC Irvine  
Kwei-jay Lin - Electrical & Computer Engineering, UC Irvine  
J. Michael McCarthy - Mechanical Engineering, UC Irvine  
Alex Nicolau - Information & Computer Science, UC Irvine  
Alex Orailoglu - Computer Science & Engineering, UC San Diego  
Tatsuya Suda - Information & Computer Science, UC Irvine  
Bruce J. Tromberg - Beckman Laser Institute, UC Irvine  
Frank Vahid - Computer Science & Engineering, UC Riverside  
Alexander Veidenbaum - Information & Computer Science, UC Irvine

## **RESEARCH ADVISOR**

Dr. Gilbert F. Amelio - Senior Partner, Sienna Ventures, Sausalito, California  
Dr. Jai H. Hakhu - Vice President, Intel, Santa Clara, California

## **ADMINISTRATION**

Daniel D. Gajski - Director  
Robert Larsen - Associate Director  
Juancho Banaag - Assistant Director  
Quent Cassen - Research Relations  
Christina Dinh - Financial Analyst  
Maral Melkichian - Student Assistant

## **VISITORS**

Yohei Akita - Hitachi Limited, Tokyo, Japan  
Juan Luis Aragon - University of Murcia, Murcia, Spain  
David Berner - University of Offenburg, Offenburg, Germany  
Kiyoungh Choi - Seoul National University, Seoul, South Korea  
Akira Fukuda - Kyushu University, Fukuoka, Japan  
Alexnader Gluhak - University of Offenburg, Offenburg, Germany  
Dirk Jansen - University of Offenburg, Offenburg, Germany  
Wolfgang Nebel - University of Oldenburg, Oldenburg, Germany

Chun-Myoung Park - Chungju National University, Chungju, South Korea  
 Franz Rammig - University of Paderborn, Paderbon, Germany  
 Jose L. Ayala Rodrigo - University Polytechnic of Madrid, Madrid, Spain  
 Wolfgang Rosenstiel - University of Tuebingen, Tuebingen, Germany  
 Slim Ben Saoud - National Institute of Applied Science and Technology, Tunis, Tunisia  
 Sandeep Shukla - Virginia Tech, Blacksburg Virginia, USA  
 Hiroyuki Yagi - Sony Corporation, Tokyo, Japan  
 Whanki Yong - Handong Global University, Gyoung-buk, South Korea

**GRADUATE STUDENTS**

Samar Abdi	Prabat Mishra
Yuvraj Agarwal	Mahesh Mandipaka
Carmen Badea	Chhawchhari Manjari
Sudarshan Banerjee	Ravindran Mohavavelu
Nikhil Bansal	Pinikai Mukherjee
Partha Biswas	Andre Nacul
Srinivas Bongoni	Dan Nicolascu
Marcio de Oliveira Buss	Sudeep Pasricha
Lukai Cai	Junyu Peng
Siddharth Choudhuri	Mukesh Rajan
Radu Cornea	Kiran Ramineni
Paolo D'Alberto	Mohammad Reshadi
Ambarish De	Amir Safarian
Andreas Gerstlauer	Nick Savoiu
Mohammaed Ghodrat	Eun Kyong Seo
Arijit Gosh	Dongwan Shin
Ashok Halambi	Srikanth Srinivasan
Ilya Issenin	Aviral Shrivastava
Ravindra Jejurikar	Weiyu Tang
Arun Kejariwal	Bo Tian
Jihye Kim	Jelena Trajkovic
Sung Jun Kim	Anshuman Tripathi
Kyoungwoo Lee	Shireesh Verma
Li Lihua	Ahmad Yazdi
Rafael Lopez	Haobo Yu
Manev Luthra	Ying Zhang
Atri Mandal	Shuqing Zhao

**STUDENT INTERNS**

Lukai Cai - Motorola Incorporated, Austin, Texas  
 Sumit Gupta - Intel Incorporated, Hillsboro, Oregon  
 Mahesh Mamidipaka - Motorola Incorporated, Austin, Texas  
 Prahbat Mishra - Motorola Incorporated, Austin, Texas  
 Srikanth Srinivasan – Motorola Incorporated, Austin, Texas  
 Mukesh Rajan – Emulex Corporation, Costa Mesa, California

**AWARDED CONTRACTS AND GRANTS**

Semiconductor Research Corporation	\$200,000
UC Micro State (2001)	50,000
UC Micro Intel (2001)	25,000
UCLA/Semiconductor Research Corporation	60,000
Hitachi, Ltd., Japan	20,000
STARC, Japan	22,222
National Science Foundation/INRIA, France	40,000
Lockheed Martin Corporation	90,641
National Science Foundation	80,019
Hitachi, Ltd., Japan	50,000
UC Micro State (2002)	32,500
UC Micro Intel (2002)	50,000
National Science Foundation/NSG	380,000
 Sub Total	 \$1,100,382

**RESEARCH DONATIONS**

Hitachi, Ltd., Japan	\$10,500
Motorola, Incorporated	400,000
Accellera, Incorporated	1,500
Semiconductor Research Corporation	2,000
Semiconductor Research Corporation	2,000
SpecC Technology Open Consortium, Japan	10,000
InterDesign Technology, Incorporated, Japan	7,425
Conexant Systems, Incorporated	25,000
Hitachi, Ltd., Japan	10,500
SpecC Technologfy Open Consortium, Japan	1,875
Conexant Systems, Incorporated	50,000
Motorola, Incorporated	12,135
Emulex Corporation	5,000
Emulex Corporation	4,500
Semiconductor Research Corporation	2,000
Semiconductor Research Corporation	2,000
InterDesign Technology, Incorporated, Japan	40,000
Intel Corporation	5,000
Hitachi, Ltd., Japan	24,995
Hitachi, Ltd., Japan	10,500
SpecC Technology Open Consortium	10,000
Renasas Technology Corporation	50,000
Conexant Systems, Incorporated	5,000
Sony Corporation, Japan	25,000
 Sub Total	 \$716,930

**CONTRACTS, GRANTS AND DONATIONS TOTAL      \$1,817,312**

### **PROPOSAL SUBMITTED (since 2000)**

Twenty nine proposals submitted to various Federal, Private and Industrial agencies amounting to \$9,559,139.

### **SPACE ALLOCATIONS**

CECS has space allocation in Information and Computer Science and Engineering Research Facility Building (IERF). It provides office and lab space for 5 faculty members, 54 students, 5 administrative staff and numerous visitors.

### **DISTINGUISHED LECTURES**

“Real-Time Dynamic Voltage Scaling for Low-Power Embedded Operating Systems” by Professor Kang Shin, University of Michigan, May 13, 2003, McDonnell Douglas Auditorium, University of California, Irvine

### **LECTURES**

“Tutorial on Real Time Operating Systems: Basics and Actual Trends” by Dr. Franz J. Rammig, University of Paderbon, Germany, July 25-26, 2002, University of California, Irvine

”Design Methodology for Systems-On-Chip” by Prof. Daniel Gajski, IEEE Orange County Computer Society, August 26, 2002, Wyndham Gardens Hotel, Costa, CA

### **SYMPOSIUMS**

2002 Southern California Embedded Systems Symposium, September 10, 2002, Conexant Systems, Inc., Newport Beach, California

### **RESEARCH REVIEWS**

Annual Semiconductor Research Corporation ICSS Research Review, February 27, 2001, University of California, Irvine

### **EVENTS**

CECS Design Automation Conference Open House, June 6, 2003, University of California, Irvine

## **NEWS LETTERS**

Volume 3, Issue 2, April 2003, "Amelio visits CECS"

Volume 3, Issue 1, January 2003, "CECS at ISSS'03" and "CECS at ICCAD'03"

Volume 2, Issue 4, October 2002, "Special Edition: SCESS, September 10, 2002"

Volume 2, Issue 3, July 2002, "CECS at CODES'02 and "CECS at DAC;02"

Volume 2, Issue 2, April 2002, "CECS at DATE'02" and "CECS at ASP-DAC'02"

Volume 2, Issue 1, January 2002, "CECS at ICCAD'02" and "CECS at ISSS'02"

Volume 1, Issue 3, October 2001, "CECS Interns"

Volume 1, Issue 2, July 2001, "CECS at DAC'01"

Volume 1, Issue 1, April 2001, "CECS-Past, Present, Future"

## **PRESS RELEASES**

CECS dominates International Conference in Kyoto, Japan, November 8, 2002

CECS dominates European Conference in Paris, France, April 17, 2002

CECS releases open source reference compiler for SpecC, Irvine, California, June 4, 2001

CECS chosen for development of open source reference compiler for SpecC, Irvine, California, February 1, 2001

## **COLLOQUIUMS**

"Statistical Tools and Methodologies for Delay Test and Timing Validation" by Li-C Wang, University of California, Santa Barbara, ECE Department, May 9, 2003

"Reconfigurable Systems", by Majid Sarrafzadeh, UCLA, Computer Science Department, September 19, 2002

"Worst-Case Performance Analysis of Parallel Communicating Processors" by Wolfgang Rosensteil, University of Tuebingen, Germany, August 23, 2002

"Low-Power Liquid Crystal Display Systems" by Naehyuck Chang, Seoul National University, August 6, 2002

"Embedded Systems Research at IIT Delhi" by M. Balahrishnan, IIT Delhi, India, August 2, 2002

”Design of a Hardware/Software RTOS for SoC” by Vincent John Mooney III, Georgia Institute of Technology, August 2, 2002

”Polychrony for System Design” by Dr. Jean-Pierre Talpin, INRIA project ESPRESSO, France, July 24, 2002

”Power Estimation and Optimization on Architectural Level” by Achim Rettberg, C-Lab, Paderborn, Germany, March 25, 2002

”Compiling with Code-Size Constraints” by Jens Palsberg, Purdue University, March 15, 2002

”Heterogeneous Actor-oriented Modeling in Ptolemy II” by Steven Neuendorffer, University of California, Berkeley, February 21, 2002

”Evaluation of VLSI Architectures” by Dr. Walter Stechele, Director of Research, Institute for Integrated Circuits, Munich University of Technology, Munich, Germany, August 31, 2001

”Low-Energy Intra-Task Voltage Scheduling Using Static Timing Analysis” by Prof. Jihong Kim, School of Computer Science & Engineering, Seoul National University, Korea, August 8, 2001

”Embedded System Design and Energy Optimization” by Prof. Naehyuck Chang, School of Computer Science & Engineering, Seoul National University, Korea. August 8, 2001

”FLYSIG - A Fast Re-Configurable Asynchronous Architecture for Multimedia Applications” by Achim Rettberg, Cooperative Computing & Communication Laboratory (C-LAB), Paderborn, Germany, August 2, 2001

”ORINOCO-Low Power Algorithms, Low Power Architectures” by Prof. Wolfgang Nebel, Computer Science Department, Oldenburg University, Germany, July 30, 2001

”OCAPI-xl: Uniform Design Refinement of Hardware/Software Platforms” by Patrick Schaumont, Digital Broadband Terminal Group IMEC, Belgium, July 30, 2001

### **2003 TECHNICAL REPORTS**

”On Demand Paging Using Bluetooth Radios on 802.11 Based Networks”, Y. Agarwal, R. Gupta, CECS Technical Report 03-22, 19 pages, June, 2003

”System-On-Chip Specification Style Guide”, A. Gerstlauer, K. Ramineni, R. Doemer, D. Gajski, CECS Technical Report 03-21, 18 pages, June 25, 2003

”Interface Synthesis using Memory Mapping for an FPGA Platform”, M. Luthra, S. Gupta, N. Dutt. R. Gupta, A. Nicolau, CECS Technical Report 03-20, 21 pages, June, 2003

”Integrated Power Management for Video Streaming to Mobile Handheld Devices”, R. Cornea, S. Mohapatra, N. Dutt, A. Nicolau, N. Venkatasubramanian, CECS Technical Report 03-19, 30 pages, May, 2003

“A Framework for GUI-driven Design Space Exploration of a MIPS4K-like processor”, S. Pasricha, P. Biswas, P. Mishra, A. Shrivastava, A. Mandal, N. Dutt, A. Nicolau, CECS Technical Report 03-17, 26 pages, April, 2003

“Greedy and Heuristic-based Algorithms for Synthesis of Complex Instructions in Heterogeneous-Connectivity-based DSPs”, P. Biswas, N. Dutt, CECS Technical Report 03-16, 27 pages, April, 2003

“Energy Efficient Communication for Reliability and Quality Aware Sensor Networks”, C. Pereira, S. Gupta, K. Niyogi, I. Lazaridis, S. Mehrotra, R. Gupta, CECS Technical Report 03-15, 16 pages, April 21, 2003

“Loop Shifting and Compaction for the High-Level Synthesis of Designs with Complex Control Flow”, S. Gupta, N. Dutt, R. Gupta, A. Nicolau, CECS Technical Report 03-14, 22 pages, April, 2003

“C to SpecC Conversion Style”, D. D. Gajski, K. Ramineni, CECS Technical Report 03-13, 29 pages, April 4, 2003

“RTOS Scheduling in Transaction Level Models”, D. D. Gajski, H. Yu, A. Gerstlauer, CECS Technical Report 03-12, 12 pages, March 20, 2003

“Comparison of SpecC and SystemC Languages for System Design”, D. D. Gajski, L. Cai, S. Verma, CECS Technical Report 03-11, 30 pages, May 15, 2003

“Transaction Level Modeling in System Level Design”, D. D. Gajski, L. Cai, CECS Technical Report 03-10, 14 pages, March 28, 2003

“G.729E Algorithm Optimization for ARM926EJ-S Processor”, D. D. Gajski, A. Tripathi, S. Verma, CECS Technical Report 03-09, 43 pages, March 21, 2003

“Automatic Communication Refinement for System Level Design”, D. D. Gajski, S. Abdi, CECS Technical Report 03-08, 12 pages, March 7, 2003

“Dual-Mode Frequency Inheritance Algorithm for Energy Aware Task Scheduling with Task Synchronization”, R. Gupta, R. Jejurikar, C. Periera, CECS Technical Report 03-07, 24 pages, February 28, 2003

“Formal Verification of Specification Partitioning”, D. D. Gajski, S. Abdi, CECS Technical Report 03-06, 15 pages, April 23, 2003

“ReXsim: A Retargetable Framework for Instruction-Set Architecture Simulation”, N. Dutt, M. Reshadi, P. Mishra, N. Bansal, CECS Technical Report 03-05, 16 pages, February 10, 2003

“HDLGen: Architecture Description Language driven HDL Generation for Pipelined Processors”, N. Dutt, A. Kejariwal, P. Mishra, J. Astrom, CECS Technical Report 03-04, 21 pages, February 3, 2003

“Channel Mapping in System Level Design”, D. D. Gajski, L. Cai, CECS Technical Report 03-03, 25 pages, January 7, 2003

“System Design Methodology and Tools”, D. D. Gajski, J. Peng, A. Gerstlauer, H. Yu, D. Shin, CECS Technical Report 03-02, 112 pages, January 12, 2003

“Adaptive Online Cache Reconfiguration for Low Power Systems”, T. Givargis, A. Nacul, CECS Technical Report 03-01, 12 pages, April 23, 2003

## **2002 TECHNICAL REPORTS**

“Computing Static Slowdown Factors under EDF Scheduling when Deadline less than Period”, R. Jejurikar, R. Gupta, CECS Technical Report 02-36, 22 pages, December 13, 2002

“Coordinated Parallelizing Compiler Optimizations and High-Level Synthesis”, S. Gupta, N. Dutt, R. Gupta, A. Nicolau, CECS Technical Report 02-35, 57 pages, December 2002

“Mapping Loops on Coarse-Grain Reconfigurable Architectures Using Memory Operation Sharing”, J. Leei, K. Choi, N. Dutt, CECS Technical Report 02-34, 24 pages, September 2002

“System-Level Design Flow: What is needed and what is not”, D. D. Gajski, CECS Technical Report 02-33, 30 pages, November 26, 2002

“Variable Mapping of System Level Design”, D. D. Gajski, Lukai Cai, CECS Technical Report 02-32, 35 pages, October 8, 2002

“Grouping-Based Architecture Exploration of System-Level Design”, D. D. Gajski, Lukai Cai, CECS Technical Report 02-31, 19 pages, August 16, 2002

“C/C++ Based System Design Flow Using SpecC, VCC and SystemC”, L. Cai, D. D. Gajski, CECS Technical Report 02-30, 14 pages, June 14, 2002

“Using Global Code Motions to Improve the Quality of Results for High-Level Synthesis”, S. Gupta, N. Savoiiu, N. Dutt, R. Gupta, A. Nicolau, CECS Technical Report 02-29, 36 pages, October 1, 2002

“CE Environment – Tutorial” S. Abdi, J. Peng, R. Doemer, D. Shin, A. Gerstlauer, A. Gluhak, L. Cai, Q. Xie, H. Yu, P. Zhang, D. D. Gajski, CECS Technical Report 02-28, 162 pages, September 24, 2002

“Analytical Design Space Exploration of Caches for Embedded Systems”, A. Ghosh, T. Givargis, CECS Technical Report 02-27, 18 pages, September 11, 2002

“Architecture Description Language driven Functional Test Program Generation for Microprocessors using SMV”, P. Mishra, N. Dutt, CECS Technical Report 02-26, 18 pages, September 13, 2002

“RTOS Modeling in System Level Synthesis”, CECS Technical Report 02-25, 18 pages, August 30, 2002

“Energy Aware EDF Scheduling with Task Synchronization for Embedded Real Time Systems”, R. Jejurikar, R. Gupta, CECS Technical Report 02-24, 14 pages, August 10, 2002

“Automatic Instruction Set Design Through Efficient Instruction Encoding for Application-Specific Processors”, J. Lee, K. Choi, N. Dutt, CECS Technical Report 02-23, 31 pages, August 8, 2002

“Optimal Cache Organization using an Allocation Tree”, T. Givargis, CECS Technical Report 02-22, 18 pages, September 11, 2002

- “Energy Aware Task Scheduling with Task Synchronization for Embedded Real Time Systems”, R. Jejurikar, R. Gupta, CECS Technical Report 02-21, 14 pages, June 21, 2002
- “Specification Tuning of System-Level Design”, L. Cai, D. D. Gajski, CECS Technical Report 02-20, 18 pages, June 6, 2002
- “A Framework for Memory Subsystem Exploration”, P. Mishra, M. Mamidipaka, N. Dutt, CECS Technical Report 02-19, 30 pages, May 24, 2002
- “Parallelization Optimization of System-Level Specification”, L. Cai, D. D. Gajski, CECS Technical Report 02-18, 15 pages, June 12, 2002
- “System-Level Abstraction Semantics”, A. Gerstlauer, D. D. Gajski, CECS Technical Report 02-17, 14 pages, July 12, 2002
- “SpecC Modeling Guidelines”, A. Gerstlauer, CECS Technical Report 02-16, 45 pages, April 12, 2002
- “Interactive System Design Flow”, J. Peng, L. Cai, A. Gerstlauer, D. D. Gajski, CECS Technical Report 02-15, 13 pages, April 15, 2002
- “Automatic Model Refinement for Fast Architecture Exploration”, J. Peng, S. Abdi, D. D. Gajski, CECS Technical Report 02-14, 6 pages, April 1, 2002
- “Interface Synthesis from Protocol Specification”, D. Shin, D. D. Gajski, CECS Technical Report 02-13, 19 pages, April 12, 2002
- “Queue Generation Algorithm for Interface Synthesis”, D. Shin, D. D. Gajski, CECS Technical Report 02-12, 19 pages, April 11, 2002
- “Scheduling in RTL Design Methodology”, D. Shin, D. D. Gajski, CECS Technical Report 02-11, 15 pages, April 12, 2002
- “Optimal Indexing for Cache Miss Reduction in Embedded Systems”, T. Givargis, CECS Technical Report 02-10, 16 pages, July 4, 2002
- “RTL Design and Synthesis of Sequential Matrix Multiplication”, P. Zhang, D. D. Gajski, CECS Technical Report 02-09, 13 pages, April 3, 2002
- “System Level Design Using SpecC Profiler”, L. Cai, D. D. Gajski, CECS Technical Report 02-08, 45 pages, April 1, 2002
- “Introduction of Design-Oriented Profiler of SpecC Language”, L. Cai, D. D. Gajski, CECS Technical Report 02-07, 20 pages, March 1, 2002
- “Parity Checker Implementations in SpecC”, Q. Xie, D. D. Gajski, CECS Technical Report 02-06, 39 pages, January 27, 2002
- “Datapath Synthesis for a 16-Bit Microprocessor”, H. Yu, D. D. Gajski, CECS Technical Report 02-05, 67 pages, January 22, 2002

“The Formal Execution Semantics of SpecC”, W. Mueller, R. Doemer, A. Gerstlauer, CECS Technical Report 02-04, 14 pages, January 11, 2002

“Efficiency and Optimality of Static Slowdown for Periodic Tasks in Real-Time Embedded Systems”, R. Jejurikar, R. Gupta, CECS Technical Report 02-03, 26 pages, March 19, 2002

“A Software Architecture for Building Power Aware Real Time Operating Systems”, C. Pereira, V. Raghunathan, S. Gupta, R. Gupta, M. Srivastava, CECS Technical Report 02-02, 28 pages, March 14, 2002

“Aspect + Gamma = AspectGamma: A Framework for Aspect Oriented Programming”, M. Mousavai, G. Russello, M. Chaudron, M. Reniers, T. Basten, A. Corsaro, S. Shukla, R. Gupta, D. Schmidt, CECS Technical Report 02-01, 15 pages, March 1, 2002

Note: Technical Reports for year 2001 and older were managed by Information and Computer Science.