The Council on Electronic Design Automation: Creation, Growth, and Future

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Editor's notes:
This article outlines the establishment of the IEEE Council on Electronic Design Automation (CEDA) in 2005 and reflects on the leadership and vision behind IEEE CEDA's creation, emphasizing its role as a central hub for EDA professionals worldwide.
—Jörg Henkel, Vice-President of Publications, IEEE CEDA
—L. Miguel Silveira, President, IEEE CEDA

The IEEE Council on Electronic Design Automation (IEEE CEDA) is an operational unit (OU) within the Technical Activities Board (TAB) of IEEE, which comprises other councils and societies. In layman's terms, a society is a group of IEEE members interested in a specific topic. A council is also a group within a broader context and draws members from affiliated societies. At present, IEEE comprises 39 societies and eight councils (altogether called OUs), and the total number has not changed much during the last 20 years, whereas bylaws and organizational structures are different for societies and councils; in essence, they provide services to the community such as publications, conferences, workshops, educational materials, and recognitions. The sense of belonging to a group is very important to most engineers, no matter whether they perform research or development, and whether they work in academia or industry. A focal point is useful for driving the community to new scientific heights, and such a focus is represented by flagship conferences, well-cited publications, and awards. The logo and banner of IEEE CEDA are shown in Figure 1.

With this spirit, IEEE CEDA was founded in early 2005. Al Dunlop and I, with the support of other volunteers cited in Figure 2, took the leadership to create a unit for the Electronic Design Automation (EDA) community. The rationale was just to form the focal point, as EDA activities were scattered among various IEEE Societies. The IEEE TAB welcomed and approved this initiative, with the objective of harmonizing EDA work under a single roof. Al Dunlop became the founding President of IEEE CEDA, while I was selected to follow him. Eventually, I did not, as I was elected IEEE Division 1 Director, managing five societies and IEEE CEDA itself. It was a step up, but I did not lose sight of the council.

First steps

The baby was born in 2005, but it had to grow in stature. This required a tremendous effort from volunteers to take over leadership in publications and conferences. We were fortunate that a group of distinguished

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individuals took pride and devoted time to grow the council. The historical text shown in Figure 3 highlights the pioneering steps and goals. We acknowledge also the collaborative support of the Special Interest Group on Design Automation (SIGDA) of Association for Computing Machinery (ACM), with whom we have shared many initiatives. We acknowledge also the support of the original sponsoring societies in transferring activities and revenue streams to IEEE CEDA. The original group of societies (mentioned in Figure 3) was enhanced later by the addition of the IEEE Electronics Packaging Society and the IEEE Microwave Theory and Technology Society.

Figure 1. IEEE CEDA logo was designed at EPFL in 2005.

Twenty years of achievements

Financial constraints of viability of the council acted as signposts for a wise growth in activities that paralleled the growth of the EDA industry. As all IEEE CEDA activities are published online (see https://ieee-ceda.org/), it is pointless to list them all. Suffices to say that IEEE CEDA added to the seminal Design Automation Conference (DAC) 17


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Dylan McGrath
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SAN FRANCISCO — The IEEE's new Council for Electronic Design Automation (CEDA) has named design consultant Alfred Dunlop president, IEEE said Wednesday (Aug. 24).

Giovanni (Nanni) De Micheli, director of the Integrated Systems Centre at EPF Lausanne in Switzerland, was named president-elect.

The officer elections, which took place last week, also resulted in the naming of vice presidents Wayne Wolf of Princeton University, Andreas Kuehlmann of Cadence Berkeley Labs, EDA consultant Richard Smith and Rajesh Gupta of the University of California at San Diego. A runoff election for the position of secretary will be held within the next month, according to IEEE.

All officers are scheduled to serve two-year terms that end December 31, 2007.

Dunlop was instrumental in IEEE's creation of the CEDA in April.

"CEDA recognizes the strong contribution to the technology from industry and academia," Dunlop said in a statement. "Creating a tighter coupling between

Figure 2. EE Times announces IEEE CEDA formation in 2005.

other conferences and symposia worldwide. IEEE Transactions on Computer-Aided Design (TCAD) is now accompanied by the *IEEE Design&Test* magazine, IEEE Embedded Systems Letters, and five other cosponsored publications. IEEE CEDA sponsors the Ernest Kuh Early Career Award and the Richard Newton Technical Award, and cosponsors [with the Electronic System Design Alliance (ESDA)] the prestigious Phil Kaufman Award. IEEE CEDA also supports several best publication awards. Outreach activities include promoting Chapters (i.e., 13 local units throughout the world), student and young professional travel support, and inclusion activities to reduce gender and ethnical imbalances.

The importance of IEEE CEDA has grown along with the impact of the EDA industry, with a worldwide business of US$11 billion (and up to 16 billion when services are included). First, IEEE CEDA is the face of EDA, which is the means by which new results/tools are communicated. Second, IEEE CEDA sets a roadmap for future achievements by supporting the dialog among major actors in the field and promoting the best research. Third, IEEE CEDA pursues an educational mission by training in EDA the new generation of engineers in EDA, who will sustain the growth of the industry. It is important to stress that IEEE CEDA supports these tasks indirectly, as it is a lightweight unit consisting

IEEE Moves to Form Council on Electronic Design Automation

April 4, 2005 -- The IEEE Technical Activities Board has endorsed the formation a new IEEE Council for Electronic Design Automation (C-EDA), with final approval expected in June. The council will become the focal point for IEEE's multiple EDA disciplines, bringing increased value to its members by coordinating EDA activities and offering a way to enable new initiatives. It also will pursue an aggressive policy to recruit young talent to EDA.

"The council is a major step toward realizing that EDA is a key technology for the semiconductor and systems sector," says Giovanni (Nanni) De Micheli, former IEEE Circuits and Systems Society president and director of the Integrated Systems Centre at EPF Lausanne in Switzerland. "This technology needs to be nurtured by fostering interdisciplinary research and by exposing its results to young engineers whose presence in this field is necessary for the overall growth of the electronics industry."

Five IEEE societies have agreed to join the council: Antennas and Propagation Society; Circuits and Systems Society; Computer Society; Electron Devices Society; and Solid State Circuits Society. C-EDA's charter spans theory, implementation and use of computer aided design (CAD) tools to design integrated electronic circuits and systems. This includes tools that automate all levels of the design, analysis and verification of hardware and embedded software up to complete working systems.

C-EDA will further increase visibility for IEEE-sponsored EDA events such as the Design Automation Conference (DAC) and International Conference on Computer Aided Design (ICCAD) and its technical publications that feature EDA. Previously, EDA-related activities were spread among various IEEE societies with little coordination.

A committee of technical leaders from industry and academia initially will manage C-EDA's activities. It will be led by Al Dunlop, a design consultant and a member of the Board of Governors for the IEEE Circuits and Systems Society that unanimously endorsed the committee formation in May 2004. The IEEE Circuits and Systems Society is home of the CAD journal and the Design Automation Conference within IEEE, and many of its members are involved in CAD and are strong supporters of the C-EDA Council initiative. "The expectation is that the Circuit and Systems Society through these CAD members continues to support the EDA activities, a field that is now getting a more focused attention within IEEE through this council," remarks Georges Gielen, president of IEEE Circuits and Systems Society, and full professor of electrical engineering at Katholieke Universiteit Leuven, Belgium

Final approval by the IEEE Technical Advisory Board and its Board of Directors is expected in June. Adds Dunlop: "A council on EDA is an imperative as a broader set of disciplines becomes necessary to design future circuits. It used to be possible to design logic circuits without much attention to issues such as power or crosstalk. Now device and substrate issues must be an integral part of the design tools, while software and embedded systems play a major role in SoC."

Figure 3. Specialized press (SOCentral) reports on the IEEE CEDA formation and its goals.

of volunteers who provide the enabling mechanisms for research and education.

Next 20 years

Niels Bohr is often quoted by the sentence "Prediction is very difficult, especially about the future." Nevertheless, it is possible to envision a future of IEEE CEDA on the basis of the trajectory of EDA research and development starting from its roots. Alberto Sangiovanni-Vincentelli's 40th DAC keynote speech, "The Tides of EDA," analyzed the origins and early developments [1]. It explored the notion of progress as the repetition of spiral-like patterns, introduced by enlightenment philosopher G. Vico, and applied this methodology to EDA. Subsequently, in the 59th DAC keynote speech "Strange Loops in Design and Technology" [2], I expanded on Hofstadter's thesis [3] that an innovation leap is often caused by a *strange loop*, i.e., by a loop that does not close because of an unsolved constraint. In EDA jargon, design closure means performing optimization to achieve all desired objectives. Closure may be difficult or impossible due to the fact that designers have goals that are too ambitious, given the current state of technology. Hence, the creation of new architectures, the use of emerging technologies, and/or the introduction of new computing paradigms are required.

EDA is the enabler for reaching new goals in computing and communication circuits and systems. This goal can be roughly stated in terms of maximizing the performance delivered to users and minimizing the energy cost of computation. Thus, the future of EDA has to face the challenges of supporting the design of novel architectures, for example, by high-level synthesis of accelerators that match the computation to the design technology. When moving to the uncharted areas of emerging post-CMOS technologies, new EDA tools and flows have to be created to enable design. Furthermore, new computing paradigms, such as 3-D integration, optical, and quantum computing (QC), require new families of design tools for both the detailed layout of the processing elements and the mapping of high-level algorithms into executable functions on the technological platform of interest.

With this perspective growth of the importance of EDA for advancing computing and communication systems, IEEE CEDA faces several challenges. IEEE CEDA has to support the design of CMOS-based systems in view of the ever-increasing demands of performance. Mobile systems have to perform a variety of tasks, cooperate with a swarm of devices and sensors, and yet consume a low amount of energy to have meaningful service times. A seamless and high-bandwidth connection to the network (e.g., Wi-Fi, 5G, and 6G) is ubiquitously necessary. At the same time, cloud services are expanding and taking an important fraction of the electrical energy produced on the planet, with a corresponding high cost in heat and CO_2 release. The council has to take action toward designing, promoting, and certifying systems that employ energy wisely, i.e., toward effective computation and communication with limited environmental impact. The rising use of artificial intelligence (AI) services leads to unprecedented requests for computation to servers and edge devices with a corresponding rise in energy cost. It is obvious that the growing use of AI tools for personal and/or work-related tasks is a potential threat to the environment. It is then a task of the council to educate and promote both the wise use of AI technology and the design of effective low-energy hardware processors for AI and other applications.

The ubiquitous presence of edge devices, from mobile phones to sensing units, demands both seamless and secure communication. Security and privacy have become imperatives of modern society. Addressing them implies spending resources, in terms of higher design cost and some degradation in performance and energy efficiency. Still, security and privacy must be incorporated in all future systems, and thus, their cost has to be budgeted. It is one of IEEE CEDA's tasks to promote hardware and software security in systems and the use of advanced methods, e.g., fully homomorphic computing (FHE) [4]. In layman's terms, FHE enables the computation over encrypted data, and thus, the transmission or combination of data does not reveal its contents. An example of an application is provided by a patient transmitting his/her own medical data via a mobile terminal to a care provider, where the data are processed along with comparative data from other patients in the search for an appropriate therapy. Only the final result would be known to the patient, and the medical provider would be unable to pin down the patient's personal data. Developing and deploying FHE architectures require new EDA research both at the architectural and logic levels. Besides the research and development efforts, it is

Figure 4. Al Dunlop and Giovanni De Micheli received the distinguished service award for founding IEEE CEDA from IEEE CEDA's Past President John Darringer in 2010.

also important that the council provides an understanding of the needs for security/privacy and their solutions to the general public.

We are witnessing an increasing impact of AI/ML techniques on EDA at present. Some of these techniques improve incrementally design steps and/or facilitate design closure and design space exploration by learning from previous temporary solutions with their pros and cons. We envision already methods that can produce hardware description language (HDL) models from informal descriptions. Such models can then be compiled to hardware. Whereas this avenue will free designers from part of the creative process, it may lead to operational solutions that do not match all designers' requirements because of the inherent inexactness of the generated HDL models. Hence, the introduction of AI/ML techniques in design prompts extending the use of verification at all levels and primarily the validation of designs versus the original human-mandated specifications. I believe that the importance and computational burden of verification will increase even though AI techniques may come to the rescue by facilitating some of the steps. Again, the mission of IEEE CEDA will include the oversight of the full incorporation of AI/ML techniques in design, as well as their safe and effective use.

As our ambitions will make us desire computational systems with unprecedented performance, we will face the issue of nonclosure of designs because solutions do not exist with the current CMOS technology. Hardware accelerators provide already speedup of specific functions and enhance system performance. Yet, the potential of post-CMOS technologies is still to be tapped. A simple example is related to realizing matrix-vector multiplication, a key task in ML, with new materials or optical techniques. Prototypes already show the embedding of new materials, from phase-change [5] to monolayer [6] devices, for this objective. Optical multiplier units have been successfully designed [7]. The main question is how to rationally design a large system that uses diversity efficiently (i.e., heterogeneity) in the implementation of computation. This problem has its roots in synthesis, where high-level decisions have to be made on the computational fabric for each unit. Diversity complicates high-level decisions because of the need for abstractions and models that let tools foresee the implications of realizing that a unit is a specific fabric. IEEE CEDA has a unique opportunity to promote research in this area, as it acts as a bridge over different IEEE societies from computing (COMPUTER) to circuits (CAS and SCCS) and from devices (EDS and MTT-S) to packaging (EPS and AP-S). The combined expertise of scientists and engineers in these areas will surely be a tremendous asset to propose technological solutions that will enable faster, leaner, and smarter computational engines and transfer this knowledge to industry.

QC and engineering are much debated these days. While the fundamental principles are understood, the practical realization of useful quantum computers is still far on the horizon. There are noise-intermediate quantum computers (NIQCs) that can already provide solutions to some important problems in physics and chemistry. On the other hand, QC is inherently a noisy process. Solving discrete mathematical problems requires fault-tolerant quantum computers (FTQCs) where corrupted qubits are corrected. Current solutions to fault tolerance use a large number of quantum devices. Despite a broad research effort, FTQCs are not yet available, and it is not clear if they will eventually be economically viable. Indeed, FTQCs may be well-tuned to solve some problems, but they may not perform equally well on some others. EDA can be very instrumental in both providing advanced technical solutions for the physical design of quantum chips and the creation of quantum compilation tools. The latter maps high-level specifications to *quantum circuits* that are the analog of *assembly code* for quantum computers [8]. There is still a long learning curve in QC design and applications, also related to the fact that thinking in terms of quantum science is not germane to us. Thus, IEEE CEDA can be extremely instrumental in educating scientists and engineers, in promoting research and development in QC in academia and industry, and in creating constructive discussion communities for the understanding of the challenges of QC.

Overall, there is no lack of interesting topics for IEEE CEDA to tackle, and the ceiling is mainly defined by the available efforts of volunteers and the funding provided by private and public agencies. I can expect topics to change in terms of importance and interest over the next twenty years, but the underlying methods, based on modeling, analysis, synthesis, and verification, will still provide the pillars of future microelectronic design. Moreover, this methodology will extend to new technologies and fields and be the cornerstone of designing complex systems.

It is fair to say that IEEE CEDA has gone a long way since its inception in 2005 (Figure 4). The expansion of interests of the council is matching the evolution of electronic engineering design and its diversity, as evidenced by the cosponsored publications, ranging from *AI* to *emerging devices* and from *signal/power integrity* to *sustainable computing*. This enlargement of scope is a witness to the cooperation with other IEEE societies and their communities. At some point, IEEE CEDA may reach the size and maturity to evolve into an IEEE society. This evolution should not be an objective per se but the natural outcome of a capillary growth into many aspects of design automation. Most important is the collaboration with other sectors, such as computing and technology, which provides us with the focus to research and develop EDA. Equally important, IEEE CEDA is an international strong and vibrant community that carries the torch of promoting EDA, up and beyond differences and national boundaries. The world we all live in, where technology blends with daily life, is made possible by integrated circuits and systems designed by EDA. Contributing to IEEE CEDA is contributing to the future of mankind. ■

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