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The First (of a Long Series) Nano Student Design Competition

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***Abstract*—The IEEE Nanotechnology Council (NTC) has marked its 25th anniversary by fostering educational initiatives for students and young professionals. Among these efforts, the Nano Student Design Competition (Nano SDC) was introduced during the 24th IEEE International Conference on Nanotechnology (IEEE NANO 2024) in Gijon, Spain. Nano SDC is a platform for student teams to design practical solutions to challenges in nanoscience and nanotechnology, guided by NTC Technical Committees. Participants showcase their prototypes, software, or methodologies at the conference, fostering innovation and collaboration. The inaugural competition included awarded projects ranging from flexible graphene-based infrared photodetectors to software for graphene fabrication, with winners gaining opportunities to publish their work in the IEEE Nanotechnology Magazine. Building on its success, Nano SDC is set to become a recurring highlight of IEEE NANO conferences, aiming to enhance student participation and create a sustainable, dynamic network within the nanotechnology community. The next edition will take place at IEEE NANO 2025 in Washington, D.C., continuing its mission to inspire and engage the next generation of nanotechnologists.**

***Index Terms*—Educational Activities, Student Design Competition, Young Professionals**

I. INTRODUCTION

THE Nanotechnology Council (NTC) has reached its 25th anniversary. In its history the NTC has always aimed to involve and engage students and young professionals (YPs) by offering interesting activities and creating valuable initiatives. The NTC offers to its community several technical activities coordinated by 18 technical committees (TCs), covering topics from nanorobotics and nanomanufacturing, nano-biomedicine, nanofabrication, nanooptics, nanophotonics, nanooptoelectronics, spintronics, nanoelectronics, nanosensors, nano-metrology, modeling and simulation, nanopackaging, nanomagnetics, nanoenergy, nanoscale communications, nanoacoustic devices, quantum and neuromorphic computing, emerging plasma technologies, soft electronics. Furthermore, NTC foster the development and sharing of knowledge in nanotechnology and nanoscience by publishing articles in its journals, e.g., the IEEE Transaction on Nanotechnology, the IEEE Open Journal of Nanotechnology, the IEEE Transaction on NanoBioscience, and, of course, the IEEE Nanotechnology Magazine. In a complementary way to the technical activities, NTC focuses also on educational activities by providing "TryNano.org", i.e., a resource for anyone interested in learning about Nanoscience and Nanotechnology, but also support for organizing seasonal schools and a distinguished lecturers program. Therefore, to prepare the next generation of nanotechnologists and nanoscientists in the evolving landscape shaped by the Covid-19 pandemic, the crucial challenge of transforming the teaching and learning paradigms for nanotechnology was tackled by the NTC YPs by adopting innovative strategies powered by digital and inclusive tools, resulting in the first edition of the World Nanotechnology Marathon [1]. Over the course of 24 hours, 24 renowned experts in nanotechnology shared their insights and expertise, inspiring both emerging talents and seasoned professionals while fostering a sustainable and dynamic global network of young nanotechnology professionals. More recently, the NTC promoted a specific mentoring program called MENED (MENtoring program – from Effectiveness to Durability). [2] MENED aims to involve more YPs in NTC activities, while training and mentoring YPs of how to contribute to the NTC through its TCs, while helping in the development of future generations of NTC leaders [2].

To keep up the pace with the everchanging and evolving needs of youngers NTC participants, the NTC Vice President (VP) for Educational Activities (EA) and the YPs committee have launched a permanent initiative to be held during the NTC flagship conference: the IEEE International Conference on Nanotechnology (i.e., IEEE NANO). This new initiative has been named the NANO student design competition (Nano SDC). The SDCs are planned to be unique events that challenge the creativity, competitive spirit, and enthusiasm of the students, thus being a great opportunity for students to show their finest design and innovation skills. In general, SDCs are known to offer tough problems that are designed to exercise students' creativity [3]-[5]. Participation in the Nano SDC within the IEEE NANO Conference is optional and wholly separate from the Best Student Paper and the Best Poster competitions. It provides an additional opportunity for highly motivated students to be engaged in the activities of the conference.

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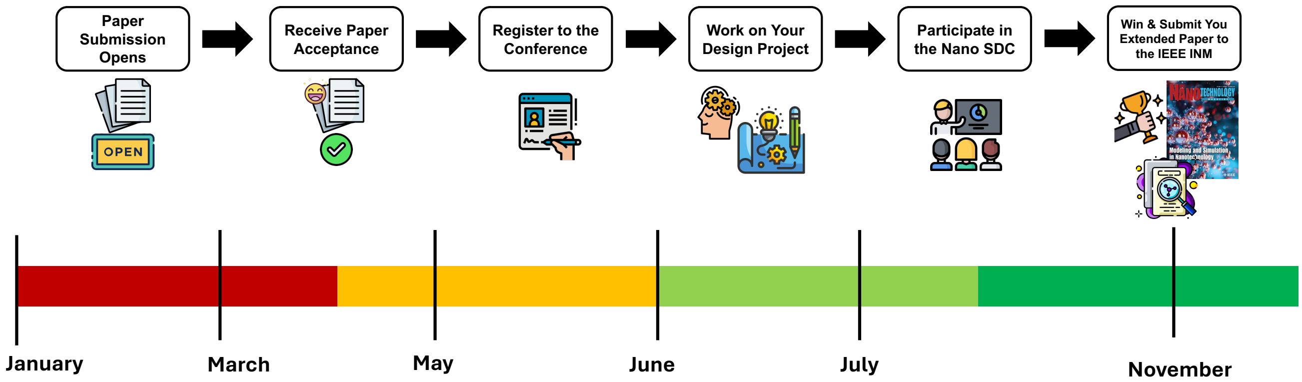

Fig. 1. Sketch of the main steps of the Nano Student Design Competition.

Other IEEE Societies and Councils are known to have a long history and tradition of SDCs. For instance, to cite some, the over twenty-year SDC organized by the Microwave Theory and Technology (MTT) society at the International Microwave Symposium (IMS) [6], or the SDC organized by the Circuit and System (CAS) Society [7]. However, the NTC had not have ever organized such an activity. Therefore, the NANO SDC should be regarded as an encouraging sign of the future health of the NTC as well as that of the nanoscience and nanotechnology industry in general. Indeed, the NTC will benefit from the NANO SDC in different ways. The Nano SDC can create a new bottom-up enthusiastic and proactive participation from the students, so that they can feed and bring new ideas to the NTC, creating a sustainable environment. Furthermore, the NANO SDC has the potential to bring more student attendees to participate in IEEE NANO, augmenting the number of participants and enhancing the quality of the presentations, while, also, leading to a more vibrant and active network of NTC participants.

In this short spotlight article, we will present the general idea and implementation of Nano SDC and report about the first edition held at the 24th IEEE International Conference on Nanotechnology (IEEE NANO 2024) Conference in Gijon (Spain) from 8th to 11th July 2024. Then, a conclusion and future perspectives for the new editions will be given.

II. The Nano Student design Competition

The Nano SDC allows small student teams (one to four members) to develop simple but effective technical solutions to practical problems provided by the organizers, supervised by the NTC TCs, that are relevant to the fields of nanoscience and nanotechnology. The Nano SDC encourages students to employ creative problem solving and gain practical design experience by manufacturing small samples, developing synthesis and characterization methodologies, as well as novel software, simple prototypes or systems to address a problem stated in the competition rules while following specified constraints.

A. Nano SDC Explanation and Implementation

The general coordination and development of this initiative is on behalf of the YPs and the VP for EA, supported by IEEE NANO Conference organizers. The general steps and a generic timeline are sketched in Fig. 1. We will summarize and clearly describe these steps.

Before releasing any calls, the eighteen NTC TCs are asked to submit proposals for some hot, cutting-edge topics. Among these proposals, one or more topics will be selected and a call for students will be released (i.e., around January-February) on the conference website and social media.

All full-time undergraduate (B.Sc.) and graduate students (M.Sc. & PhD) worldwide are invited to take part in the Nano SDC. However, some mandatory requirements need to be fulfilled to participate in the Nano SDC. Indeed, students must submit a paper to the conference and receive the acceptance decision for it (see Fig. 1). Then, at least one team member must register for the NANO Conference and attend the Nano SDC in person to assist with presentation, showcase, and measurements. As the student(s) register for the conference, to participate in the competition, the students will be asked to provide contact information for all team members and the academic advisor. In addition, the academic advisor must certify that the work is completely performed by the students. This application to the Nano SDC is essential for the participation. The application deadline is usually coincident with the final paper submission deadline (i.e., around May or June). Students are advised to contact the individual competition organizers as early as possible to ensure a full understanding of the design specifications and judging criteria before beginning their projects. Therefore, from the time of paper acceptance, students can fully work on their project for the Nano SDC. It is worthwhile highlighting that, depending on the Nano SDC topics, the students' project may or may not be directly related to the submitted paper. In other words, if a student submits a paper to IEEE NANO, he/she can participate in any topics of the Nano SDC if such a paper is accepted and registered, independently from the manuscript subject. The students must notify the Nano SDC organizers at least one week before the date of the competitions if they plan to withdraw or will not be able to participate in person.

When the IEEE NANO conference takes place (i.e., July – see Fig. 1), a specific session is organized during the conference to allow students to present their work. The time for each presentation is 10-15 minutes roughly. Depending on the Nano SDC topic, each presentation will consist of a software demonstration or a sample/prototype showcase. The participants are responsible for the specific equipment (e.g., laptop, measurement devices, etc.). Furthermore, travel visas and any project equipment are the students' responsibility, so it is recommended to arrange these as early as possible. During the Nano SDC session, a proper committee composed by the proposers of this initiatives, IEEE NANO organizers and the involved TCs Chairs will evaluates the demonstration.

Based on the evaluations, awardees are selected, and the Nano SDC winners are announced at the IEEE NANO social dinner and closing ceremony. The winners are awarded with a certificate, and they will have the unique opportunity to submit an extended paper to the IEEE Nanotechnology Magazine for a special issue. This chance may be a perfect starting point for young researchers to enter the exciting world of scientific publishing and present their work to a broader audience.

B. *The First NANO SDC at IEEE NANO 2024*

During the 24th IEEE International Conference on Nanotechnology (IEEE NANO 2024) Conference in Gijon (Spain) from 8th to 11th July 2024, the first Nano SDC was held. In a vibrant and exciting atmosphere, during a crowded coffee-break, students had their moment to shine and present their work. A series of photos that capture part of this moment are given in Fig. 2. The curiosity and engagement of the conference participants was high. For the first edition of the Nano SDC, three awards were given, and the list of the winners are reported in Table 1. From Table 1, it can be seen that the awardees' affiliations and geographical origins are different as well as the topics of their projects are different. In particular, the winning projects ranges from a flexible graphene/pedot:pss infrared photodector, the use of first-principle simulations for the calculation of the elastic constants of β-$(AL_XGA_{1-X})_2O_3$ for heterogeneous interface applications, to a software for predicting and understanding the rapid and low-cost fabrication of graphene from pencil lead. Two out of three awardees of the first Nano SDC have submitted an extended version of their work to the IEEE Nanotechnology Magazine and they have been published in this issue.

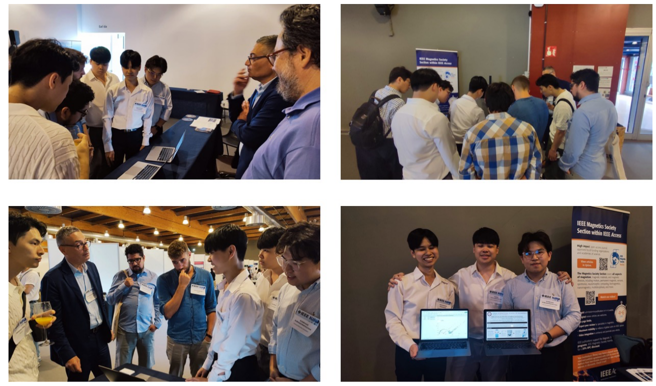

Fig. 2. Some photos of different moments of the first Nano Student Design Competition (Nano SDC). From top left to bottom right: evaluation, presentation and discussion, awardees photo.

TABLE I
FIRST NANO SDC AWARDEES

Awardees	**Affiliation**	**Paper Title**
Guanxuan Lu, Rui Zhou, Jiaqi Wang, Zhemiao Xie, Yifei Yuan, John T.W. Yeow	University of Waterloo, Canada	FLEXIBLE GRAPHENE/PEDOT: PSS FREE-STANDING INFRARED PHOTODETECTOR
Hyokung Lim	Pohang University of Science and Technology, Korea	FIRST-PRINCIPLE ANALYSIS OF ELASTIC CONSTANTS OF β-$(AL_XGA_{1-X})_2O_3$ FOR HETEROGENEOUS INTERFACE APPLICATIONS
Natchanon Jiwarawat, Thapan Leuklwatanachai, Kunbhass Subhakornpichnan	Chulalongkorn University, Thailand	RAPID AND LOW-COST FABRICATION OF GRAPHENE FROM PENCIL LEAD

III. CONCLUSION & FUTURE PERSPECTIVES

To offer new educational and career opportunities to students and young professionals, the NTC has established the Nano SDC as a permanent initiative within the flagship IEEE International Conference on Nanotechnology (IEEE NANO). The Nano SDC enables small student teams (1-4 members) to create practical technical solutions to some problems and topics guided by NTC TCs in a competition focused on challenges in nanoscience and nanotechnology. Participants enhance their skills in creative problem-solving, design, and manufacturing by developing small samples, synthesis and characterization methods, innovative software, prototypes, or systems. During the IEEE NANO conference the SDC participants will present and showcase their designs, prototypes or software. The awardees are announced at the social dinner and will receive a certificate for their project. They will also will be given the opportunity to submit an extended version of their work to the IEEE Nanotechnology Magazine. The first edition of the Nano SDC was held at the 24th IEEE International Conference on Nanotechnology (IEEE NANO 2024) in Gijon (Spain) from 8th

to 11th July 2024, where three groups of students, ranging from B.Sc. students to PhD, coming from Canada, Korea and Thailand, won awards. Given the warm welcome and great enthusiasm after the first edition, the Nano SDCs promise to be one of the most interactive and exciting activities of the next IEEE NANO 2025 Conference that will be held in Washington D.C. from 13th to 16th July 2025. All students worldwide are invited and welcome to participate!

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