

Semiconductor workforce development with chipshub on nanoHUB.org

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Over 200,000 nanoHUB users have run over 7 million simulations in Apps mostly focused on semiconductor devices and materials modeling. nanoHUB created nano-Apps before Apple created Apps for the iPhone and made scientific codes usable for a much larger user group. Most scientific tools strive to be comprehensive in solving “any” simulation problem in a specific problem range. That comprehensiveness limits the use to experts, who require extensive training. nanoHUB has instead focused on delivering a spectrum of Apps (over 700 now) that individually have a limited capability focused on a PN-junction, MOSFET, or nanowire while the underlying tool could of course solve a much wider set of problems. We assembled some of these Apps that are essential for specific courses into small sets such as ABACUS (crystals, bandstructure, drift-diffusion, pn-junctions, BJTs, MOScaps, MOSFETs) [1]. The usability results are stunning. Our user analytics prove that over half of the simulation users participate in structured education through homework/project assignments. We can identify classroom sizes and detailed tool usage [2,3]. We can begin to build mind-maps of design explorations and assess depth of explorations for individuals and classes. While parts of academia struggled to innovate curricula, we have measured the median first-time App insertion into a class to be less than six months. Over 180 institutions have utilized nanoHUB in their curriculum innovation in over 3,600 classes. 2 million nanoHUB visitors explore lectures and tutorials annually. With such a community presence we believe nanoHUB is the platform of choice to deliver online modeling, simulation, virtual environments, and lectures for the US initiative on workforce development and chip design [4]. We are in the process to build chipshub.org as a group inside nanoHUB. Chipshub hosts commercial and open-source chip design tools and associated apps and learning materials. It is hosted in Purdue’s hardware cloud.

[1] <https://nanohub.org/groups/abacus> ABACUS - Assembly of Basic Applications for Coordinated Understanding of Semiconductors. A one-stop-shop for teaching and learning semiconductor fundamentals.

[2] Krishna Madhavan, Michael Zentner, Gerhard Klimeck, **"Learning and research in the cloud"**, Nature Nanotechnology 8, 786–789 (2013)

[3] TEDx Talk, Klimeck, “Mythbusting Scientific Knowledge Transfer with nanoHUB.org”,
<https://www.youtube.com/watch?v=PK2GztlfJY4> .

[4] <https://nanohub.org/groups/semiconductoreducation> Semiconductor workforce development homepage on <https://nanoHUB.org> .

Dr. Gerhard Klimeck is a Professor of Electrical and Computer Engineering at Purdue University; Director of the Network for Computational Nanotechnology; Reilly Director of the Center for Predictive Materials and Devices. He helped to create nanoHUB.org, the largest virtual nanotechnology user facility serving over 2.0 million global users, annually. Dr. Klimeck is a fellow of the Institute of Physics (IOP), the American Physical Society (APS), the Institute of Electrical and Electronics Engineers (IEEE), the American Association for the Advancement of Science (AAAS), and the German Humboldt Foundation. He has published over 525 printed scientific articles; he has been recognized for his co-invention of a single-atom transistor, quantum mechanical modeling theory, and simulation tools. His NEMO5 software has been used since 2015 at Intel to design nano-scaled design transistors. The nanoHUB team was recently recognized by a top 100 by R&D award - Making simulation and data pervasive.

