POSITION STATEMENT

FEDERAL SUPPORT FOR BASIC RESEARCH

Adopted by the IEEE-USA
Board of Directors, 18 Feb. 2011

The Institute of Electrical and Electronics Engineers-United States of America (IEEE-USA) strongly recommends sustained support for basic research in science, technology, engineering and mathematics (STEM). Basic research provides the foundation for scientific discovery, and is vital to advancing technological progress. In the civilian sector, basic research is the critical component to ensure technological competitiveness and innovation. In national security, technological superiority continues to be the cornerstone of our national military strategy. Federal investment in long-term, high-risk, high-payoff, basic research is particularly important today to maintain the United States' competitive edge in the increasingly competitive global arena.

IEEE-USA recommends that Congress and the executive branch of the federal government work with private industry and universities to:

- Maintain healthy and stable basic research investment in STEM
- Continue to encourage rapid transfer from basic research to prototyping and development, through programs such as the Small Business Innovative Research and Small Business Technology Transfer
- Continue to support graduate students with fellowships and research assistantships, while at the same time providing innovative programs in post-graduate engineering education, to better meet U.S. competitive needs in the global economy
- Assure support for maintaining and updating infrastructure, including facilities, instrumentation and equipment
- Incentivize private-sector investment in U.S. STEM research and innovation

This statement was developed by IEEE-USA's Research and Development Policy Committee, and represents the considered judgment of a group of U.S. IEEE members with expertise in the subject field. IEEE-USA advances the public good and promotes the careers and public policy interests of the more than 210,000 engineers, scientists and allied professionals who are U.S. members of the IEEE. The positions taken by IEEE-USA do not necessarily reflect the views of the IEEE or its other organizational units.

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BACKGROUND

The importance of science and technology in U.S. society is visible and undeniable. The impact of recent developments in physical, biological and engineering sciences on our daily lives and in the defense of our nation is evident, even to members of our society not trained in these areas. The erosion of this critical asset, and the extent of this erosion in our nation over recent decades, is less visible.

Serious decline is evident in the elimination and re-direction of the major citadels of science and technology. Neither Bell Laboratories nor IBM's Watson research laboratory run the far reaching, cross-disciplinary, basic research programs that they did when they produced their Nobel Prize winning research. It would be hard to imagine today's Bell labs (run by Alcatel, a French firm) supporting a program studying the 4K-background radiation of the universe. In the late '80s, Watson transitioned to product-oriented research, requiring its scientists to seek extramural funding for "basic" projects.

On the surface, it appears that we are still "winning the prize." Last year's Nobel Prize did go to U.S. scientists from Bell Labs working on solid-state imagers. The CCD was invented in 1969. The United States still leads the world in patent output. But China, one of the least "patent productive" of the technologically-oriented nations exports more high technology to the world. As the National Science Foundation (NSF) reports in its *2010 Science and Engineering Indicators Report*, "The global expansion of high-technology trade has made China the largest single high-technology exporter, and has changed the relative positions of the developed and developing countries. China's share of world high-technology exports increased from six percent in 1995 to 20 percent in 2008, while the Asia-9 maintained a 26–29 percent share. Japan's export share eroded from 18 to eight percent; the U.S. share dropped from 21 to 14 percent; and the EU maintained a 16–18 percent share."

Most dramatic is the decline in U.S. representation in the high impact journals of our own society. For example, out of 26 articles in the last issue of the prestigious *Circuits and Systems Journal*, only eight originated in the United States. In the Transactions of the Electron Device Society, only 10 out of 39 articles (26 percent) were of U.S. origin. Twenty years ago, U.S. representation in this journal was over 50 percent.

These facts are by no means of benign import for our country. They are not the positive results of globalization. In fact, they represent a threat to our economic and physical security.
The reason for these stunning reversals is complex. Mowrey and Rosenberg summarized the most evident of these reasons in their book *Technology and the Pursuit of Economic Growth* (University of Cambridge Press, 1989). U.S. industry is "risk adverse." Becoming a "fast second" makes more business sense than expending major resources becoming a technological first. Control of the supply chain and dominance of the equipment markets through size and volume orders has been more effective in gaining presence and longevity than maintaining advanced development capabilities. This emphasis on business strategy over product development is driven by the speed that technology can be imitated or reverse engineered. In addition, "road mapping" exercises, like those routinely performed by agencies like SEMATECH, have "institutionalized" development into well-defined pathways, minimizing cost but excluding potentially game-changing alternatives.

Decline of interest by student populations in physical science and in engineering is a symptom of these factors, and not a cause. Drug discovery, public health, the traditional “professions” are, perhaps, more interesting and certainly more lucrative given the current industrial situation. This decline of interest combines with the fact that many of our most highly educated graduates are placed in positions that do not fully utilize their skill. Complex tooling and the maintenance of sophisticated process technology require intelligence and training. But they do not require a research-oriented degree. And yet, a considerable amount of industries’ perceived demand for Ph.D.-level personnel is in these areas.

Our recommendations here are not simply for increased fiscal expenditure in the science and technology arena. Simply increasing spending for science will only reinforce the current trends in our technological economy: declining participation in the world’s research agenda, declining innovation, and a general evaporation of our technological skill base. But it is an undeniable fact that the federal government has been a great nurturing force in U.S. science and technology. This nurturing has been evident from the invention of radar, to the invention of the microchip and even in the development of the Internet.

We applaud the federal government’s stewardship of basic science and we urge the government to take a more aggressive role in protecting our technological base. The suggestions provided in our position statement represent only a start in the undertaking that confronts us. IEEE-USA respectfully requests a serious, unbiased evaluation of the factors leading to the current decline in our capabilities in the physical, mathematical and engineering sciences. And further, we offer our cooperation in helping to devise methods to reverse this decline.