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# New effort to create green electronics, workforce

WEST LAFAYETTE, Ind. – The world's love affair with gadgets - many of which contain hazardous materials - is generating millions of tons of electronic waste annually.

Now, Purdue and Tuskegee universities are leading an international effort to replace conventional electronics with more sustainable technologies and train a workforce of specialists to make the transition possible.

"The rapid, global proliferation of smart phones, laptops, tablets and other electronic devices has connected the world in positive ways, but the electronic waste is - literally - piling up," said Carol Handwerker, Purdue's Reinhardt Schuhmann Jr. Professor of Materials Engineering. "We want to create materials that will allow computer components to be disassembled, recycled and reused. There is a growing realization that the traditional, linear model of consumption - 'design it, build it, use it, throw it away' - has long ceased being viable for electronics. That is why we proposed this innovative, integrative global education and research program to educate and train a Ph.D. workforce with an unprecedented capacity for analyzing complex dynamic systems."

The new Global Traineeship in Sustainable Electronics is funded with a five-year, $3.2 million grant from the National Science Foundation. Handwerker is leading the project with four co-principal investigators, including Mahesh Hosur, a professor of materials science and engineering at Tuskegee.

The three other co-principal investigators are Inez Hua, associate director of Purdue's Global Engineering Program and a professor of civil engineering; Karthik Ramani, the Donald W. Feddersen Professor of Mechanical Engineering; and Ananth Iyer, associate dean for graduate programs and Purdue's Susan Bulkeley Butler Chair in Operations Management at the Krannert School of Management.

Researchers are working closely with the International Electronics Manufacturing Initiative (iNEMI), a consortium of electronics manufacturers, suppliers, associations, government agencies and universities.

"This collaboration will enable doctoral students and faculty to take a global supply chain perspective that integrates engineering issues and business realities and enhances research effectiveness," Iyer said. "Being linked to industry leaders and to research experts will offer us an opportunity to understand business challenges and provide impactful research solutions."

Working with industry is vital to the program's success, said Bill Bader, CEO of iNEMI.

"At the same time, programs like these are critical to industry," he said. "Industrial research has consistently decreased over the past two decades, making it important for industry to aggressively encourage and support academic research programs such as this one that focus on innovation to meet technology needs."

The workforce should include specialists in many disciplines, from engineering and science to economics, anthropology, management, and political science.

"It's not just an engineering problem, it's not just a technology problem," Handwerker said. "It involves people's behavior, dynamics of social systems, industrial systems, legislation and regulation. We will bring together all of these disciplines and people to address the complex set of issues related to sustainable electronics."

More than 3 million tons of e-waste were generated in 2007 in the United States, with 13.6 percent collected for recycling and 86.4 percent going to landfills and incinerators. Electronic products contain hazardous materials such as heavy metals and brominated flame retardants. The materials can leach out of landfills into groundwater or be converted into "super toxins" including dioxin while being incinerated. Environmental concerns have led 25 states to pass laws mandating e-waste recycling.

"Because many states have laws prohibiting disposal of electronic waste in landfills, the waste is incinerated or shipped to developing countries," said Fu Zhao, an assistant professor in Purdue's School of Mechanical Engineering and Division of Environmental and Ecological Engineering. "Neither scenario is good from a sustainability perspective. Incineration is expensive, and materials and energy are wasted. Exporting e-waste to developing countries damages local environments, harms people's health and is against environmental justice."

Researchers will work to develop "nanocomposites" made of natural materials for structural applications in casings and circuit boards. Another thrust will be to create lignin and soy-based resins for circuit board construction to replace petroleum-based resins.

"Being naturally derived and plentiful, these materials may offer an opportunity for low-cost, non-fossil-fuel-derived materials for high performance structural applications. Whether they are more environmentally benign than alternatives will depend on their life cycle environmental costs. This is truly a case where 'the devil is in the details,' " Handwerker said.

Other goals include development of adhesives from marine organisms for the construction and disassembly of