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MEDICAL INNOVATIONS

FlexFactor: Imagination and Innovation

Flex Talk

Feature Column by Tara Dunn, OMNI PCB

Take a minute and think back to your high school days. Now that you have thought of some of your best memories and hopefully chuckled only a little, did any of those memories involve conceptualizing a product introduction that utilized a flexible circuit or rigid-flex? I know mine didn't. I didn't give flexible circuitry much thought at all until I interviewed at a flexible circuit manufacturing company after graduating from college. Thankfully, I was hired for that job and my early years in the printed circuit board industry were focused almost exclusively on flex and rigid-flex. One of my favorite phrases to this day came from that time: "Flex is really only limited by your imagination." I am from the generation that saw flexible circuit application ideas take off outside of military and aerospace work. I remember the insulin pump being developed, and medical equipment—such as hearing aids—becoming smaller, lighter, and more portable. Flex technology and the number of flexible circuit applications is advancing at a staggering pace. With the demand for increasingly complex electronics, we see semi-additive processing, modified semi-additive processing, and flexible hybrid electronics technology (among others), advancing rapidly to meet those needs.

Imagine being back in high school and getting introduced to these advanced electronics

Figure 1: A student team from Abraham Lincoln High School in San Jose, California, pitches their product concept, driving technology, and business model to a panel of representatives. (Source: NextFlex)

Figure 2: Students visit Jabil's Blue Sky Center to learn about advanced technologies and applications. (Source: NextFlex)

manufacturing technologies. Then, imagine the opportunity to earn college credit by participating in an entrepreneurial program that challenged you to conceptualize a new product introduction using this technology to solve a human health issue or develop a performance monitoring program where you would pitch your idea in a similar way to the business show "Shark Tank." Wouldn't that be fun!

One exciting program that fosters this type of imagination and creativity in high schools is the NextFlex FlexFactor program. Over the past two years, NextFlex—America's Flexible Hybrid Electronics Institute—has built and scaled an innovative educational program designed to create a pipeline of young people excited about and prepared for the advanced manufacturing careers of tomorrow.

Emily McGrath, deputy director of workforce development at NextFlex, describes the program: "The FlexFactor platform assembles all the actors in the labor market to allow students to visualize their future and understand the educational pathways to make that future a reality. Through an amazing immersion experience, students, schools, higher education, and companies interact and bring advanced technologies and entrepreneurship into the classroom in a project-based learning approach that fits in any class, any subject, anywhere. Students leave the program convinced that they can and should be part of solving the big problems of our time and well into the future."

Through FlexFactor, students are exposed to the vast range of professional opportunities in the advanced manufacturing sector. Skills needed for a career in industry are revealed in a way that is appealing and fun where student teams address a wide range of real-world problems—from cancer treatment and head trauma, to waste management and lunch lines. The conceptualized hardware solutions developed by students often feature an incredible array of revolutionary technologies, including advanced functional fabrics, Internet of Things (IoT) devices, cloud technology, augmented reality, flexible hybrid electronics, and more.

A few fun examples of creative applications utilizing flexible hybrid electronics include Fast Asleep—a small wristband that would fit snug-

Figure 3: Students design, print, and test flexible circuits in NextFlex's cleanroom to learn what it's like to work with next-generation technologies in the advanced manufacturing sector. (Source: NextFlex)

Figure 4: Students visit Jabil's Blue Sky Center to learn about manufacturing processes and careers in the advanced manufacturing sector. (Source: NextFlex)

ly around a baby's arm while sleeping that measures movements, oxygen, and heart rate, allowing parents to rest easier. Another example is the Relieve Sleeve—a pain reliever designed to alleviate joint pain and stiffness associated with rheumatoid arthritis (RA) that administers heat sensations and applies electric pulses tailored to a user's needs. These functions are embedded in a compression sleeve for easy application around joints and muscles. Another creative application is Asthmex—a chest band with a smart patch to detect asthma symptoms and administer medication via an autoinjector, which helps everyone from student athletes to Olympic athletes with asthma to compete.

FlexFactor alumnus Tate Morillo from Willow Glen High School in San Jose, California, worked with his team to conceptualize an implantable glucose monitor for diabetes patients that would alert users in real time to take insulin by pushing notifications to a paired cellphone. The device would be powered by low-flow hydroelectric power harvested from blood flow.

Tate explained, "My impetus for creating such a concept stemmed from first-hand experience with my diabetic father's struggles. Watching him checking his glucose levels as a child scared me, and I felt that there must be a better solution to this problem. Already being a large burden on the individual, diabetes seems to consume the lives of people, controlling how they eat, their energy levels, and the way they must live their lives. As a son, I wanted to do everything in my power to make the way this problem was treated easier, more convenient, and less painful for my father. The most important lesson I learned from FlexFactor was that the youth's ideas should not be ignored, but nurtured. Without influencing the young minds of today, students may never find their passion or become the inventors of tomorrow, thus changing the path of technological development and history."

The program layers onto an existing class and requires students to work in teams to identify a real-world problem, conceptualize an advanced hardware solution, and build a business model around it. At the end of the program, students pitch their ideas "Shark-Tank style" to a panel of representatives, highlighting how they have considered both technical features and market needs to solve the problem they identified. The program's agile framework allows it to work in a wide range of subject areas, including topics like English and fashion design, allowing it to engage new populations of students with the advanced manufacturing sector instead of only students who have already self-selected STEM pathways.

NextFlex launched the pilot of FlexFactor in the fall of 2016 with eight students, and by the

end of this semester (fall 2018), they expect to have put roughly 2,100 students through the program across multiple states. FlexFactor's success at engaging young people with the careers of tomorrow has sparked a national expansion of the program, beginning with Lorain Community College in Elyria, Ohio, which launched their first pilot in spring 2018. Colleges and universities leverage the turn-key program to improve engagement with local high school students, increase enrollment in specific education pathways, and achieve regional workforce and economic development objectives.

The ultimate goal of FlexFactor is to create a generation of students who use their critical thinking, creativity, communication, and collaboration skills to create the materials and devices that will address and mitigate the biggest challenges of the future. I have personally had the opportunity to participate in one of the student "pitch days" and was completely impressed with their innovative product ideas, energy, and knowledge of the advanced manufacturing space. If NextFlex ever decides to expand this concept to an adult continuing education program, I may be the first to sign up! **PCB007**

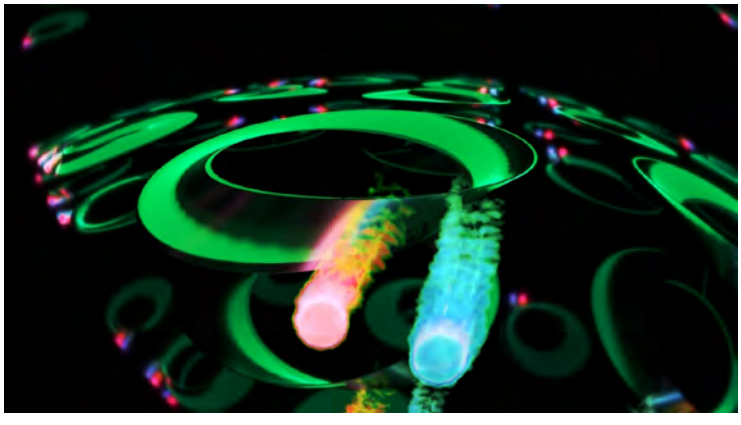
Tara Dunn is the president of Omni PCB, a manufacturer's rep firm specializing in the printed circuit board industry. To read past columns or contact Dunn, click here.

Photons Created at the Edge of a Silicon Chip

by Dina Genkina and Emily Edwards
JOINT QUANTUM INSTITUTE

Researchers at the Joint Quantum Institute (JQI) have demonstrated a new approach that enables different devices to emit nearly identical single photons repeatedly.

Led by JQI Fellow Mohammad Hafezi, the team made a silicon chip that guides light around the device's edge where it is inherently protected against disruptions. In earlier research, Hafezi and colleagues showed that this design could reduce the likelihood of optical signal degradation.



Researchers configure silicon rings on a chip to emit high-quality photons for use in quantum information processing. (Source: JQI)

Their recent paper published in the journal *Nature* explains that the same physics that protects the light along the chip's edge also ensures reliable photon production.

In the experiment, the team used silicon to convert infrared laser light into pairs of differently colored single photons. They injected light into a chip containing an array of minuscule silicon loops and arranged in a way that always allows the light to travel undisturbed around the edge of the chip even if fabrication defects were present. This design not only shields the light from disruptions, but also restricts how single photons form within those edge channels. The loop layout essentially forces each photon pair to be nearly identical to the next regardless of microscopic differences among the rings.

Using this approach, the researchers were able to produce high-quality single-color photons reliably and repeatedly compared to the unpredictable output of traditional chips. Their device also has one unique advantage: "Our chip works at room temperature," says Sunil Mittal, a JQI postdoctoral researcher and lead author of the study, "I don't have to cool it down to cryogenic temperatures, making it a comparatively very simple setup."

The team says this finding could open up a new avenue of research that unites quantum light with photonic devices having built-in protective features.