can't do with plastic. Sure, some people make plastic screws, but they just don't measure up in terms of serviceability.

MICRO: How has the fabrication and application of microfasteners advanced over the last 5 years?

Hrinak: A lot of people are doing more with cutting now, using Swiss-machined parts. There are a few companies around the country that specialize in that and have advanced the microscrew industry through mastering that process. Some manufacturers work with 000 and 0000 screws and even smaller. I can't imagine working with something that small.

—Evan Jones Thorne

Developing effective micropart cleaning strategies

Manufactured parts are a challenge to clean. And, as is the case with designing and manufacturing them, cleaning parts becomes more challenging as they get progressively smaller and more complex.

For more than 20 years, the "Cleaning Lady," Barbara Kanegsberg, and the "Rocket Scientist," Ed Kanegsberg, have worked with manufacturers to evaluate and improve their cleaning processes. Through their independent consulting company, BFK Solutions, Pacific Palisades, Calif., the pair have helped companies turn cleaning efforts into a value-added endeavor that increases yields and improves quality. They can, for example, aid with process optimization and validation, cleaning product and equipment selection, cleanroom usage and worker education.

BFK Solutions

As electronic circuit boards become more functional, the cleaning of electronics assemblies has become a critical process.

One of BFK's services is developing cleaning solutions for manufacturers of small components used in microelectronics, medical devices, military and aerospace applications, and an assortment of miniature and nano devices.

"Ed (Kanegsberg) often points out [that] as parts become smaller, the surface-to-volume ratio increases, so that, for nanosized parts, the surface is the product," explained Barbara Kanegsberg. "The cleanliness and attributes of the surface become increasinglyimportant to product performance."

SMALLstuff

University researchers develop microscale windmill technology

Researchers at the University of Texas at Arlington have developed a power-generating micro windmill. Research associate Smitha Rao and electrical engineering professor J.-C. Chiao designed and built the device, which at its widest point is about 0.07" (1.8 mm).

The windmill was tested successfully in September 2013 in Chiao's lab. It operates without fracturing because of its aerodynamic design and durable nickel-alloy construction. The fabrication cost of making one windmill is the same as making hundreds or thousands on a single silicon wafer, meaning the devices could be mass-produced very inexpensively.

"Imagine that they can be cheaply made on the surfaces of portable electronics," Chiao said, "so you can place them on a sleeve for your smartphone. When the phone is out of battery power, all you need to do is to put on the sleeve, wave the phone in the air for a few minutes and you can use the phone again."

UTA

A micro windmill developed at the University of Texas at Arlington.

Chiao said because of their small size, thousands of the micro windmills could be affixed to flat panels that are mounted on building walls to harvest energy to power lighting, security devices, environmental sensors and wireless devices.

The researchers' work attracted the attention of Taiwanese fabrication company WinMEMS Technologies Co., which approached Rao and Chiao to brainstorm novel device designs and fabrication applications.

Rao's design for the windmill blends origami concepts and conventional wafer-scale semiconductor fabrication. WinMEMS is currently exploring the commercialization of the micro windmills.

"It's very gratifying to, first, be noticed by an international company, and, second, to work on something like this where you can see immediately how it might be used," said Rao. "However, I think we've only scratched the surface on how these micro windmills might be used."

Cleaning smaller parts requires addressing unique considerations such as shape, spacing and wettability. For example, cleaning agents must penetrate blind holes and tight spaces to contact the soil to be removed, she said. "Perhaps as important, [the] residual cleaning agent has to be displaced, because the cleaning agent can itself become a residue and adversely interact with the surface."

Critical cleaning is the cornerstone of the Kanegsbergs' approach, an idea that may run counter to preconceived notions. "Historically," she said, "we think of precision cleaning as being conducted in a controlled environment using a well-documented, tightly controlled set of processes. However, we can do things precisely, but they still may not be correct or optimal."

In critical cleaning, the concept is to perform the correct quantity and quality of cleaning at the right point in the process and to clean in a timely manner. Critical cleaning can occur at any stage of a manufacturing process, including initial fabrication in an environment that "looks more like a repair station than a cleanroom," she said. It is about picking the appropriate process for the application instead of relying on previous successes, restricting the process to a particular method or always choosing the same cleaning agent. The Kanegsbergs usually devise at least two ideas for a manufacturer to consider.

Factors in choosing a cleaning process include determining the required level of cleanliness; avoiding material compatibility problems; minimizing initial capital outlay and ongoing process costs; addressing regulatory requirements; and considering the skill levels of workers.

Preferably, the process will include a site visit so the Kanegsbergs can talk to key workers and observe the cleaning practices in place. Prior to the visit, they look at written processes; view any photos and video clips; and review the cleaning agents in use, the company's current cleaning processes and its cleaning equipment. In addition, they attempt to learn as much as possible about supply-chain partners and their part-cleaning processes.

Barbara Kanegsberg said that they sometimes find differences between a company's written procedures for cleaning and a company's actual practices, and other times they find the processes are not being adhered to at all.

"I try to find out why," she said. "There may be a lack of education about the cleaning process or the cleaning process is ineffective or impractical. If so, I coordinate with the engineers and designers to achieve more effective critical cleaning."

—Larry Adams

Robotic control in micropart manufacturing, assembly

Robotic part assembly and the ability to remove excess material from small parts are strengths of a new motion-control method that relies on force sensing, not position. ABB Robotics' Integrated Force Control (IFC) relies on discrete