Cooking up new MEMS

Microelectromechanical systems (MEMS) are tiny components etched from silicon. Production is extremely complex, sometimes with hundreds of steps, each with dozens of parameters. One European project has developed software that can test, simulate, track and share new manufacturing processes. It could slash development times and pave the way for innovative MEMS designs.

If you could shrink yourself smaller than a dust mite and explore the innards of a modern car you would discover some amazing microscopic machines. Carefully etched out of silicon wafers are microscale accelerometers to trigger airbags, gyroscopes to detect and correct dangerous yaw and pressure sensors to monitor tyre inflation.

The automotive industry is one of the biggest consumers of microelectromechanical systems (MEMS). These tiny components marry the worlds of electronics and mechanics. Using the same manufacturing principles employed to produce microchips, it is possible to etch silicon into electrical devices with moving parts.

MEMS manufacturing is extremely complex, involving sometimes hundreds of different steps. Each step may be controlled by a dozen or more parameters, including temperatures, pressures and chemical compositions.

“Trying to come up with a manufacturing recipe for a new MEMS component is so complicated it would be impossible without ICT support. You just couldn't keep up with all the variables and their impact on the final outcome,” explains Dirk Ortloff, co-originator of the EU-funded Promenade project.

A difference of five degrees Celsius may have little effect on the production of silicon chips because they only depend on the electrical properties of the material. MEMS, however, also have mechanical properties. A small variation in any manufacturing parameter at any step could alter the performance of the final product.

Promenade brings together some of the foremost experts in process development for MEMS devices. The project consisted of seven partners, including industry, research institutes, universities and software vendors, from Belgium, the UK, the Netherlands, Germany and Austria.

Virtual manufacturing

The aim of the project was to build software that could support the design of MEMS manufacturing sequences.

Working closely with Bosch and the centre IMEC research centre as potential end users, the research partners focused on three modules. The design module lets manufacturers input and edit the sequence of manufacturing steps using a graphical interface. The module can really cut down development time by

performing consistency checks on the assembled process flow. These checks help to avoid common errors like wrong or forgotten pre- or post-processing.

Each step and its related parameters and other data are stored in a database in a standardised format. Ortloff says this is an important breakthrough for the MEMS industry. “Currently it is not possible to transfer complex MEMS recipes together with their support data electronically. By making this information available in a standard format it will be much quicker for manufacturers to transfer the information and to set up fabrication in different units.”

The second module allows designers to simulate the manufacturing sequence. This module is based on a commercially available simulation package by Silvaco, one of the project partners. Development work within the project has adapted Silvaco's software to account for the physical structure of MEMS. Reliable simulations are essential for MEMS designs so that as many problems can be ironed out prior to expensive experimental and prototype production.

The final module developed by the Promenade consortium is a tracking component that documents the entire manufacturing process – every parameter of every step, along with images and scans of the device.

“Capturing experimental data is routine in the industry,” says Ortloff, “but there is no system that captures all of it, then organises the data in a way that finds the relations between the data. We help to turn all the data into knowledge and, again, speed up the development process because you don't need to gather all the knowledge again every time you design a new MEMS.”

Etching out new markets

The project’s results have been welcomed by MEMS manufacturers and several commercial products will be made available. Silvaco will offer a tool for full three-dimensional process flow simulation analysis, incorporating models for MEMS processing.

Furthermore a spin-off company, Process Relations GmbH, has been founded jointly by Cavendish Kinetics in the Netherlands and the University of Siegen. The start-up has already completed its first round of funding and is approaching a second round as it prepares the worldwide launch of Promenade's commercial successor, named XperiDesk.

XperiDesk will provide the first-ever process development and execution system (PDES) in the area of microelectronics and MEMS, and later also for other high-tech industries like solar and bio-medical equipment manufacturers. Ortloff estimates the market for PDE-systems at €100 million per year.

“XperiDesk will really speed up process development and the transfer of the processes, perhaps by two or more weeks for any one transfer,” says Ortloff. “It also will allow novel devices and ideas to be tested and taken into development, whereas previously they would have been cancelled because no one could work out how to make them. For high-tech companies with their fast product lifecycles, this can be a real competitive advantage.”

Who knows what magnificent machines you might soon discover exploring the insides of that automobile?

Source: ICT Results