

## MEMS NOTES: From inner to outer space

### Greetings from Convergence Central!

By Dr. Ken Gilleo,  
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MEMS are a clever extension of semiconductor technology where modified fab processes can create mechanical and macro-world structures on silicon along with integrated circuitry.

MEMS builds upon the huge semiconductor industry, tapping that massive knowledge base and synergistically adopts solid-state electronics. > **Page 2**

**MicroConnections™**  
The international newsletter for electronics interconnection

Special  
MEMS  
Test Edition

### SMI will streamline MEMS test with Centipede Systems' unit

SAN JOSE—Centipede Systems, an emerging supplier of advanced connectors for electronics, announced



Centipede Systems' MEMS test unit

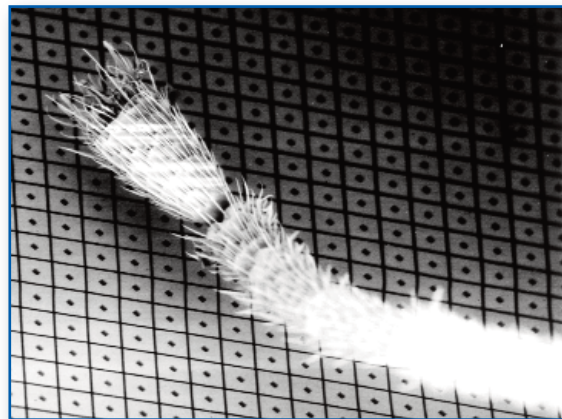
recently that Silicon Microstructures Inc. (SMI), has ordered a Centipede tester to speed MEMS pressure sensor testing and improve quality at SMI's Milpitas, Calif., fabrication facility.

SMI is the acknowledged leader in low-pressure, ultra-small and harsh environment pressure sensing.

A member of the ELMOS Group, SMI is an ISO 9001 and ISO/TS 16949-certified developer and manufacturer of MEMS-based pressure sensors used in critical automotive, medical and industrial applications, from tire pressure sensing to medical respiration monitoring.

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### NAME THAT MEMS!



At the time of publication, this was—at least according to Dr. Ken Gilleo—the world's most complex machine, Texas Instruments' DLP 1.4-million mirror optical MEMS (MOEM). That's an ant's leg over the mirrors! (Courtesy of Texas Instruments)

#### Most Tire Pressure Systems Controlled by MEMS

About 99 percent of direct TPM systems use MEMS pressure sensors

If there are no substantial changes in European or Asian legislation, the current market for TPMS pressure sensors will reach \$183M in 2012 from \$168M in 2007, according to Yole Développement.

While that will represent an increase in volume of 12 percent, it will only account for a CAGR of 2 percent. (yole.fr)

**MEMS NOTES:**

**From inner to outer space**

But MEMS takes us beyond electronics with chips that handle multiple energy forms; mechanical forces, light waves, sound waves, and radio waves, as well as conventional electrical energy.

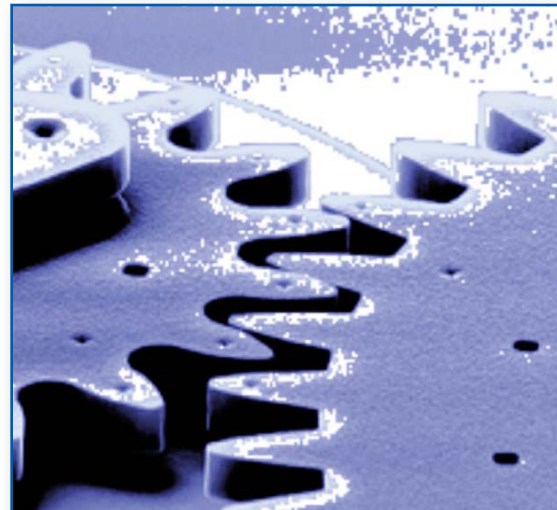
**MEMS technology can provide the highest level of micro-integration and functionality yet devised; motion, light, sound, heat, radio waves, reactive molecules and electrons can all converge on these unusual chips.**

**‘CONVERGENCE CENTRAL’**

MEMS is “convergence central” for all science and technology—electronics, mechanics, physics, chemistry, biology, medicine, optics, sensory, micromanipulation, digital computation, and multiple control, into a single, tiny monolithic universe.

The key is extreme integration of dissimilar systems in a miniature form factor to deliver unique, valuable and practical functionality.

Most remarkably, MEMS technology can place motors, gears, chains, wheels, pumps, turbines, reactors, sensors and computers all on a tiny piece of substrate using the massively parallel productivity of wafer-level manufacturing.



**SIMPLY DEFINED**

Micro-Electro-Mechanical Systems says it all. “Micro” fits more than 99 percent of MEMS devices since there’s no present need for shrinking to nanoscale. When MEMS drops below the 100nm feature size, Nano-MEMS will be called “NEMS.”

**The “Electro” term defines the type of energy used to run these tiny machines, perform sensing, and handle data. MEMS runs on electrons! “Mechanical” is the key term and the all-important addition to electronic chips. A MEMS device must have mechanical motion, or impart motion to matter. If nothing moves, it’s not MEMS.**

Inkjet chips that use simple heaters to propel ink are a popular example of MEMS with no moving chips. “System” is also a critical descriptor for some, but

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## MEMS NOTES (continued)

not all, MEMS chips. When electronics is integrated into the MEMS chip, it's clearly a system. Some MEMS, like most microphones, use off-MEMS electronics (a separate amplifier chip), but the trend is toward integration.

**If IC logic is the brain, MEMS adds the eyes, nose, ears, taste buds, and super-human sensing ability. But MEMS also brings control and manipulation—the hands and fingers that let chips operate on matter.**

MEMS can also be tiny factories—small enough to fit inside the human body. MEMS reactors can make products and perform biochemical synthesis, e.g., “pharma-on-chip.”

**The merging of mechanics, sensing, molecular transformation, and computation represents a leap in technology and its unification. MEMS is one of the top technologies for the 21st century and it's just getting started.**

MEMS miniaturization of so many functions makes it today's most versatile technology cluster. Sensors are the top product with no end in sight.

**Now in use for more than a decade, MEMS accelerometers make the life-and-death call on when to deploy air bags.**

Chips sense sudden changes in velocity to “decide” when to “fire” your airbag. Newer MEMS gyroscopes will prevent rollovers.

**These motion sensors are moving rapidly into consumer applications including cell-phone pedometers, game controllers and even the new iPhone for scrolling and motion functions.**

### FUTURE MEMS

An intriguing, and ultimately the most

important area for MEMS, is probably the biomedical sector.

Clinics are testing implanted blood pressure sensors, wellness monitors, and even autonomous drug dispensers.

**The day will come when MEMS “Medibots” continuously monitor and repair the human body, powered by bloodstream nutrients. These machines will offer better capability than the miniaturized submarine in *Fantastic Journey*, the 1960's sci-fi classic.**

*Notes: (1) Not all MEMS are made with silicon. (2) Not all MEMS have an integrated IC. (3) Some disagree and include inanimate micro-parts, but this writer says, “nonsense!”*

*Dr. Gilleo is the author of five McGraw-Hill technical publications, including a 2005 book on MEMS and MOEMS. He is also a widely known lecturer and trainer in IC packaging, MEMS and nanotechnology. Contact Dr. Gilleo at gilleo@ieee.org.*

### Editorial Advisory Board

**Dr. Tom Di Stefano.** Dr. Di Stefano is founder and president/CEO of Centipede Systems, San Jose, a developer and builder of special MEMS test and handling equipment. He was also the founder of Tessera, an industry pioneer in chip-scale packaging. [tom@centipedesystems.com](mailto:tom@centipedesystems.com).

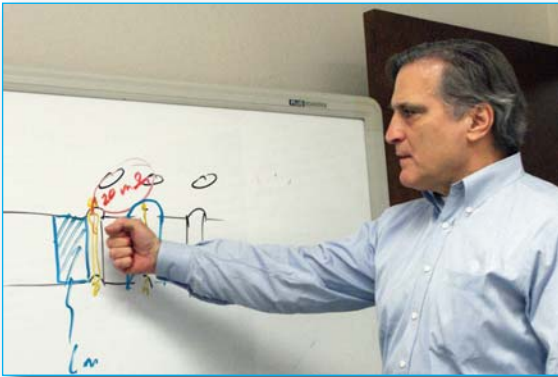
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## SMI will streamline MEMS test

from page 1

“The Centipede system will enable rapid thermal cycling from  $-65^{\circ}\text{C}$  to  $+160^{\circ}\text{C}$ ,” said Dr. Thomas H. Di Stefano, Centipede founder and president. “Additionally, this new system offers MEMS developers economies-of-scale that have not been achieved in earlier test systems.”



Dr. Tom Di Stefano

“As a supplier of high quality, high-volume parts to both Fortune 500 and smaller customers, SMI is committed to the continuous improvement of its



product quality,” said Dr. Nicole Kerness, vice president of product engineering for Silicon Microstructures Inc.

“We expect the Dr. Nicole Kerness Centipede Thermal Forcing Unit to enable us to test parts rapidly through extremes of temperature cycling, saving valuable time and extending the temperature test range,” Dr. Kerness added.

Testing MEMS has been an arduous, expensive and mostly manual operation in the past, Dr. Di Stefano observed.

In the future, the Centipede MEMS tester will be configured to allow for fully automated production test with automatic load and unload via test-in-tray or strip test.

(centipedesystems.com)  
(si-micro.com)

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# Forget everything you learned about testing MEMS!

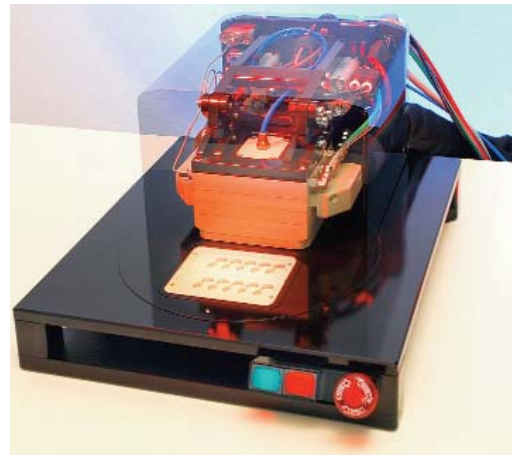
The Centipede tester speeds MEMS production test,  
hikes efficiency and extends the  
temperature range for thermal cycling.

It's the dawn of a new  
day in MEMS test



**U**ntil now, MEMS production testing has been a slow, complicated, often hit-and-miss process. With the introduction of the Centipede Systems test unit, production-line test is fast and efficient.

The unit permits rapid thermal cycling at temperatures ranging from -65°C to 160°C, which enables test economies-of-scale that will positively impact your bottom line!



The tester is ideal for most types of MEMS and MOEMS, including pressure sensors, accelerometers, gyroscopes and many others.

Testers are now under development at Centipede Systems that will permit fully automated production test with automated load/unload via test-in-tray or strip test.

For more information or to arrange a demonstration, please contact Centipede Systems today.



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## NEWS & PRODUCTS

### STMicro packs gyroscope for GPS in 16-pin LGA

GENEVA—European MEMS maker STMicro has unveiled a MEMS gyroscope with a choice of analog or digital absolute angular-rate outputs.

The device, LY530AL, packaged in a 5 x 5 x 1.5mm, 16-pin LGA, measures fast angular displacements for intuitive man-machine interfaces or enhanced GPS for car navigation.

The LY530AL is a single-axis sensor with “high survivability” against shock and vibration for industrial and consumer uses.

Furnished in RoHS-compliant packaging, full production is slated for this quarter.

(stmicro.com)

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### SEMI forecasts 17% MEMS growth over the next 5 years

SAN JOSE—SEMI predicts that MEMS will continue their 17 percent average growth rate for the next five years.

The prediction is found in the report *2008 Global MEMS/Microsystems Markets and Opportunities* compiled by SEMI and Yole Développement.

**The report says MEMS device production hit two billion units last year and will jump 25 percent this year to 2.5 billion units.**

However, the report notes, “These consumer market volumes bring consumer price pressures, as well, holding total MEMS revenue growth to 14 percent this year.”

**Even with this price pressure, however, revenue growth is expected to jump to 18-19 percent by 2010-2012.**

By 2012, MEMS producers will ship 8.1 billion units/year, worth about \$15.5 billion. Nearly half of those MEMS, according to the report, will be used in consumer products.

**Key market drivers include silicon microphones, micro displays, RF MEMS and microfluidics for biomedical applications.**

RF MEMS and silicon microphones will represent more than 45 percent of unit demand from 2011. ([semi.org](http://semi.org))



Consumer products like this iPhone 3G, are among the forces propelling the MEMS market. (Apple Inc.)

## A MATTER OF OPINION™ WHY ANOTHER NEWSLETTER?

BY RON ISCOFF, EDITOR/PUBLISHER

First, let's get the introductions out of the way: Yes, I am the same guy that's been reporting on the semiconductor packaging industry for more than 25 years. To prove it, here's my photo.



Second, I am no longer affiliated with the other publication that I co-founded in 1997 and which recently experienced a management change.

Now, let's get to the business at hand.

Why another newsletter in the semiconductor area? Aren't there enough already?

Yes, there are enough. There are, certainly, too many. However, like a nicotine addict, I need my fix. My fix is ink, paper and words.

*MicroConnections* is brought to you by the same team that started the magazine I recently left: myself and Dr. Tom Di Stefano.

Tom, who does not particularly relish the title, is none-the-less a pioneer in wafer-level and chip-scale packaging. As the co-founder of Tesser, he brought chip-scale packaging into the mainstream.

Although this, our first issue, is about all things MEMS, we will explore the world of electronics interconnection. After all, no interconnects, no functionality, period. So that's mainly what we're about.

We're pleased to carry an exclusive article in this issue by the *King of MEMS*, Dr. Ken Gilleo. He knows enough about the subject to fill several books.

One of Ken's books is the 2005 McGraw-Hill publication *MEMS/MOEMS Packaging*, a resource I shall frequently need to borrow from!

As we go along from issue to issue, we'll be covering every important aspect of interconnection. We'll even get into solar, which nearly everyone fiercely believes is the *Next Big Thing*.

Another important area is that of standards, particularly for MEMS.

Remember when Sony's BETAMAX was king of the VCRs? And then Sony fell to Japanese Victor Corp. Standards battles are won and lost everyday, but some are more important—and costly—than others.

A year ago, I got a great deal on a Toshiba HD DVD player. Seen on a big HD screen, the images it produces are incomparable.

Unfortunately, Toshiba "pulled a Sony," and failed to standardize its technology. Sony, apparently having learned the painful BETAMAX lesson, won the whole HD DVD ball game with its *Blu-ray HD system*.

Please let me know how we can meet or exceed your expectations. E-mail me at [roniscoff@gmail.com](mailto:roniscoff@gmail.com), or phone 209/824-1289.

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**LYON, France—French MEMS analyst Yole Développement says the cell phone industry offers the largest growth potential for MEMS in the next five years.**

In its report on MEMS for cell phone applications, Yole explores how cell phone suppliers

Knowles Acoustics and Avago Technologies have increased sales from \$1 million to \$50 million.

**“Few MEMS-based sensor and actuator companies have found the right business case to penetrate the wireless handset market,” Yole says.**



Twelve MEMS devices have potential applications in this market, including silicon microphones and FBAR/BAW filters which have experienced “incredible growth” since their introduction in 2003 and are entering the mature stage.

**Many other products, adds Yole, are at the emerging stage, including gyroscopes, microdisplays, micro autofocus and micro-zoom components. (yole.fr)**

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