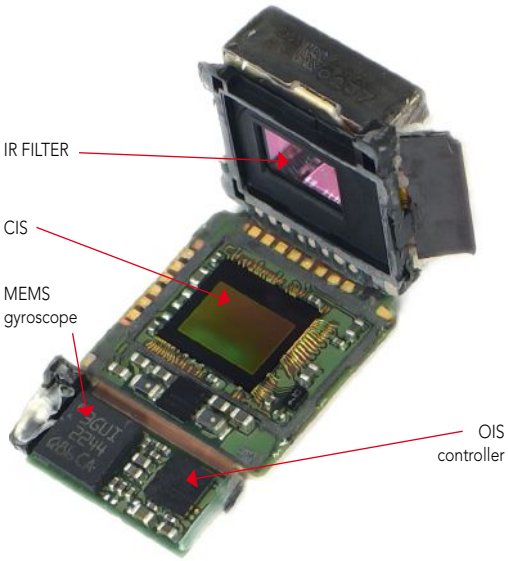
Adding value to MEMS with bigger die

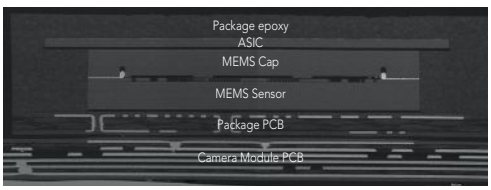
While most MEMS devices have been steadily driving down to smaller sizes to reduce cost and footprint, there are also applications where the distinguishing feature is increased functionality, even if that means a larger device.

Both STMicroelectronics and Analog Devices Inc. have recently drawn upon their ASIC design expertise to make more complex controller die that add value to standard inertial sensors even as they add more costly silicon area. ST adds the processing power to its existing gyroscope to make a dual purpose version, while ADI adds extreme power management to a standard accelerometer to make an ultra low power device. While gyros for optical image stabilization are commonly included in digital cameras, the Nokia Lumia 920 is one of the first smart phones to add the feature, using ST's L3G4IS 3-axis gyro.



Nokia Lumia 920 camera module (Courtesy of System Plus Consulting)

The device is in a 4mm x 4mm LGA package, though it uses the exact same MEMS die as the company's standard 3-axis gyro which comes in a smaller package. The difference, as can be seen in the cross-section SEM image below, is the larger



L3G4IS cross-section (Courtesy of System Plus Consulting)

ASIC on top. This more complex processor allows the single MEMS die to be used both for the very precise, high sensitivity motion sensing needed for the optical image stabilization and also for the coarser motion sensing needed for gaming and other gesture controls. Even with this larger and more expensive ASIC, which we estimate accounts for >50% of the total cost of this device, this single dual-purpose gyro will likely still be cheaper, and take up less space, than two separate gyros with their own separate ASICs and packages. And it suggests how economics pushing MEMS towards combination sensor solutions, as there may not be much room left to reduce costs by continuing to simply reduce die size, now that the typical 2-axis gyro package is down to a 2mm x 2mm package.
It's not yet clear how widely smart phone makers will adopt image stabilization, or if they will use a single gyro or two separate ones. Rival gyro maker InvenSense argues that integrating two separate gryos for the two separate applications will be the simpler and preferred approach.

We found two version of the dual-purpose MEMS device in our teardowns. The one in the Nokia phone, used traditional glass-frit wafer bonding, while one sourced as a component used gold-gold thermocompression wafer bonding to shrink the MEMS die size by ~30%. The smaller version also replaced the usual buried polysilicon interconnect layer with a stack of three materials.

ADI, meanwhile, makes its ultra-low power ADXL362 3-axis accelerometer by adding smarter power management, by similarly adding a larger ASIC to the same MEMS die used in its more standard 3-axis accelerometer. The device is currently being tested to extent battery life in the always-on Blast Gauges used by the US military to continuously monitor soldiers for exposure to concussive forces. ADI also targets other monitoring applications where batteries are hard to replace for the device, with its 1.8µmA operation at a 100Hz output data rate, 270nA in motion sensing wake-up mode, and 10-nA in deep-sleep mode.

Here the ASIC is 3X larger, and likely costs ~3X more, to account for roughly half the total cost of the device. Instead of packaging the MEMS and ASIC dies side by side, ADI stacks the MEMS on top of the larger ASIC, which enables it to keep the package to the same 3mm x 3.25mm footprint.

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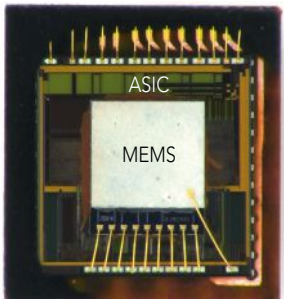

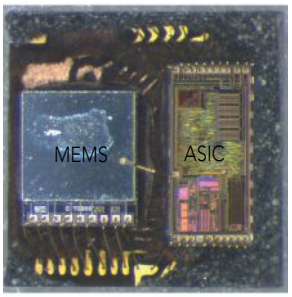

Top: ADXL362 Bottom: ADXL342. (Courtesy of System Plus Consulting)

Romain Fraux, Electronics Cost Engineer, System Plus Consulting
Romain Fraux is Project Manager for Reverse Costing analyses at System Plus Consulting. Since 2006, Romain is in charge of costing analyses of MEMS devices, Integrated Circuit and electronics boards. He has significant experience in the modeling of the manufacturing costs of electronics components.
Romain has a BEng from Heriot-Watt University of Edinburgh, Scotland and a master's degree in Microelectronics from the University of Nantes, France.