

Valuation of Jyve from Fairchild acquisition reveals strong need for innovative consumer gyroscope technology



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While Fairchild Semiconductor never issued a press release or made a dedicated announcement, we have finally been able to piece together the information regarding its acquisition of Jyve Inc., a startup founded by Janusz Bryzek (the veteran of several MEMS startups in Silicon Valley) who was also its CEO at the time.

Deep within its Annual Report for 2010 and in the conference call transcript for its Q4:10 and 2010 year-end numbers, Fairchild discussed the acquisition of a MEMS start-up in November of that year. At the same time, Janusz repeatedly revealed in descriptions of his professional experience on several public webpages that his new MEMS venture was acquired by Fairchild in November 2010, where he is now VP Development, MEMS and Sensor Solutions. We can thus deduce from this information and these events that the inertial MEMS start-up mentioned by Fairchild was in fact Jyve, Inc.

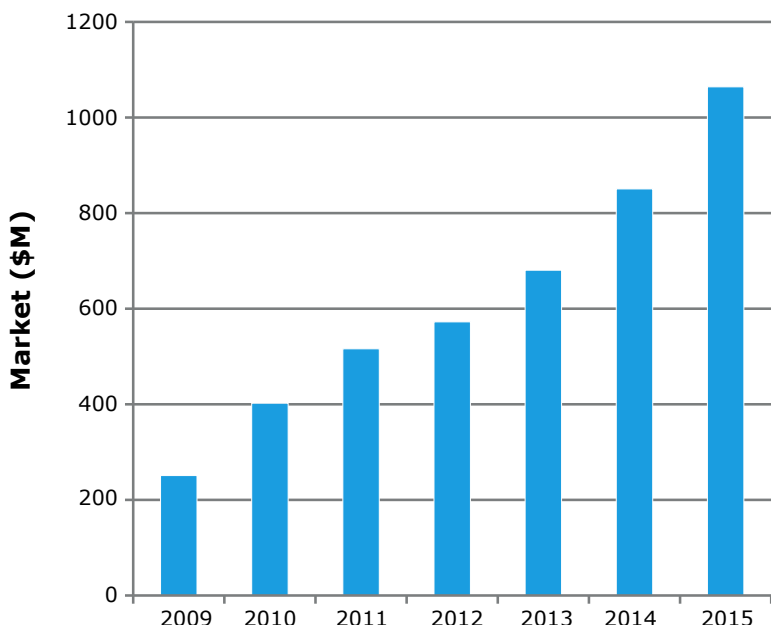
Some of the details of the terms and conditions of the acquisition highlighted in the Fairchild 2010 annual report certainly put the deal in the upper quartile valuation range for inertial sensors as tracked by Yole Finance, especially since Jyve was probably a pre-revenue company. The details disclosed in

the report indicate that it consisted of an upfront payment of \$11.0 million in cash, combined with some contingent consideration (likely stock) to be earned over the next five years (now four) and dependent on the success of the technology. At the time, Jyve was developing inertial MEMS with a very disruptive technology that would significantly lower manufacturing cost and possibly offer higher performance than today's consumer sensors. We expect to learn more in the next few months, including more details on Fairchild's growth plans for this business unit. There are indications in the market that a product introduction is expected in 2012, and so this looks like another success story for Janusz Bryzek and an attractive acquisition for Fairchild.

As motion sensing becomes part of more and more smartphones and tablets, the hype surrounding MEMS gyroscopes companies has never been higher. InvenSense's IPO was very successful: announced mid-November 2011 at \$8.25, the shares were priced at \$11.30 by the end of November (see the next article, which is dedicated to InvenSense's IPO). Also, two inertial MEMS companies were acquired this year because of the technology's potential in the consumer market: SensorDynamics was acquired by Maxim in July 2011 for \$130 million in cash, and VTI was acquired by Murata in October 2011 for \$265 million.

As the inertial business on the consumer side becomes more and more competitive, prices for 3-axis gyroscopes are dropping quickly. Most companies are trying to find disruptive design and sensing principles that will reduce manufacturing costs even further, since the traditional comb-drive design has reached its limit in terms of miniaturization and cost reduction. This is why disruptive developments coming from start-ups such as Jyve are raising so much interest.

Market for MEMS gyroscopes in consumer electronics (\$M)
(Inertial Combo Sensors for Consumer & Automotive report, Yole Développement, 2011)



InvenSense now listed on the stock exchange: what does it mean?

InvenSense is one of the few successful MEMS start-ups, having generated \$100 million-plus in annual business in only a couple of years. This success has put InvenSense in a very good position in terms of creating value for its shareholders, and more than likely it has attracted the attention of other potential strategic investors who want to strike while the iron is hot.

What drove InvenSense's IPO?

After Kionix's acquisition for a very nice multiple in late '08, a similar step seemed like an attractive option for InvenSense -- and one that would provide it with the necessary global footprint for future growth. Instead, InvenSense decided to remain an independent company and moved toward an IPO in order to generate the capital necessary to increase its product offering both organically and through acquisitions in the short and medium-term -- understanding well that building a global organization and infrastructure to support a growing number of demanding customers requires a significant amount of capital and other important resources. It is worth noting that most of the proceeds from the IPO went to VCs -- none of the money went to InvenSense, as it has \$48 million cash in the bank right now. We thus expect it will stage a follow-up offering soon in order to raise more cash. The most important challenge for this U.S. start-up will be to stay ahead of its competition, which is particularly aggressive in the gyroscope market space. ST Microelectronics is InvenSense's primary competitor -- the two companies are today the only two companies in the world that have 3-axis gyroscopes massively integrated into cellphones and tablets. Their competition began in 2009, when ST entered the market with a large, aggressively-priced portfolio of single and dual-axis gyroscopes (more than 30 models released!).

In the consumer accelerometer market, only a few companies are really doing well, while most are struggling to turn a profit. In fact, only ST Microelectronics and Bosch Sensortec are succeeding, while others like Freescale and Kionix try to keep up, and many, such as ADI, have failed to stay competitive. As such, there is a very little room in the consumer gyroscope market and consumer motion sensing business and so InvenSense needs to continue investing in order to maintain its position in the market.

Over the last couple of years, the gyro business has become a hotbed for competition. According to Yole's analysis, InvenSense was number one in the consumer gyroscope business in 2010 with 23.6% market share, finishing ahead of Epson Toyocom and ST Microelectronics. Epson was strong thanks

to key contracts in the gaming and high-end DSC market -- however, its prospects in the booming mobile phone market are not as bright, since it still relies on single-axis devices. InvenSense's position became very unstable by the end of 2010 because the company was strongly dependent on one customer, Nintendo, which accounted for 85% of InvenSense's business in fiscal year 2010. Also, InvenSense missed out on two key contracts in 2010: first, ST was chosen for the iPhone contract, which was bad news for InvenSense but good news for the gyroscope business in general because it meant that the handset business was about to boom. The second missed opportunity was the iPad: the first generation of the Apple tablet featured an accelerometer and a compass, but it

"InvenSense has raised the bar for the next generation of early-stage MEMS device companies,"
says Laurent Robin, Yole Développement.

was probably designed to also feature a gyroscope -- indeed, there is an empty slot on the board just beside ST's accelerometer, with a number of pins which fits with InvenSense's 3-axis gyro. So it is likely that InvenSense's 3-axis gyro was very close to being included in the iPad, but at the last minute Apple decided not to integrate it for some reason. It is important to note that the second generation iPad did integrate a gyroscope that enabled users to benefit from applications which had been developed for the iPhone 4 gyroscope, and from brand-new applications as well, but this gyroscope was sourced to ST. Indeed, Apple uses ST's gyroscope in its iPhone, and the two companies have enjoyed a long-term collaboration.

Due to its "slow" start in the 3-axis gyro market, InvenSense eventually lost its number one position to ST, but 2011 was a different story. Despite a decrease in Nintendo orders, InvenSense was able to penetrate new markets and diversify its customer base with many design wins related to Android products. InvenSense now supplies Samsung, LG, HTC, RIM, Acer and other large OEMs for smartphone and tablet applications. InvenSense also successfully introduced new products to the

market (including the first 6DOF accelero-gyro combo solution), and developed a significant software offering. They now look like a very solid company which is positioned to play a major role in the booming motion sensing business over the next couple of years.

InvenSense is the opposite of ST in nearly every respect. Contrary to ST, InvenSense is fabless and thus depends on external foundries to produce its sensors. Since optimization of production costs is one of its biggest key success factors, InvenSense will need to work hard with TSMC and other foundry partners in order to really get its costs lower, and produce on 8 inch wafer lines at a reasonable yield. The reverse costing study of InvenSense's 3-axis gyro performed by System Plus Consulting shows a component manufacturing cost ranging from \$1.10 to \$0.81 according to yield variations. A similar analysis of ST's 3-axis gyro shows a production cost in the same range.

In addition to InvenSense and ST Micro, many other companies are eyeing the gyroscope market, and competition is intensifying as the market becomes increasingly attractive. Established players are pushing hard to introduce 3-axis gyroscopes to more markets, while large accelerometer suppliers such as Kionix are entering the market too. Panasonic recently launched its own 3-axis gyroscope, which it is actively promoting to the gaming and mobile phone industries. Competition will further intensify now that Murata (VTI acquisition), Maxim (SensorDynamics acquisition) and Fairchild (Jyve acquisition – see previous article) have also made the strategic decision to get into the game. In total, Yole Development has screened more than 50 companies involved in motion sensors for mobile applications.

Is the motion sensing business really this hot?

According to Yole's forecasts, the market for MEMS gyroscopes is expected to be one of the most dynamic in the coming years for all motion sensing devices used in consumer and mobile applications. Indeed, an annual growth of 19.8% is expected, versus 9.9% for MEMS accelerometers and 10.9% for magnetometers – in fact, the gyroscope market is expected to grow from \$516M in 2011 to \$1.27B in 2016! Given that mobile phones, tablets and gaming applications alone will represent more than two-thirds of this market, it's no surprise that competition is so tough!

The MEMS accelerometer market will also offer some very nice business opportunities in the coming years, with a projected growth from \$622M in 2011 to \$998M in 2016. This market will be especially strategic because many applications are expected to rely on a 3-axis accelerometer + 3-axis gyroscope in a single package: early reports are that the market for such motion sensor combos will reach \$659M in 2016, a gigantic leap from a miniscule \$5M in 2011. A strong synergy between accelerometer and gyroscope players has developed, and it would not be surprising to see gyroscope companies buy accelerometer technologies if they don't choose to develop their own internally like InvenSense did.

Magnetometers are also positively affected by such market traction. From 2011 to 2016, it is expected that this market will grow from \$386M to \$646M, and will find growth opportunities outside of the mobile phone area. Already, new functions using low-cost motion sensors are being realized: one example is the successful integration of a compass in Sony's DSC-HX5V, released in 2010. In this product, a GPS receiver associated with a compass is used for advanced geo-tagging, with proprietary Sony software -- the exact

position and heading can then be indicated on a map. Social networks are the main driver for this type of function – for example, it lets your Facebook contacts know where you've been.

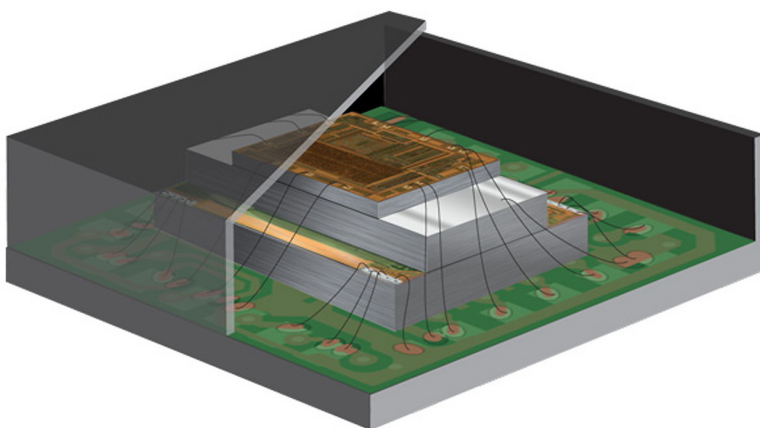
Who'll be the next InvenSense?

InvenSense's success story is clearly unique, and many people are now wondering: "Who's next?" InvenSense has raised the bar for the next generation of early-stage MEMS device companies, and due to market attraction and fierce competition we are now seeing a race to achieve lower-cost versions of inertial sensors. Market leaders are working hard on reducing production costs, and new companies like Baolab in Spain are emerging, with a focus on developing ultra-low cost devices for current markets.

To the question of what the next technology revolution in motion sensing will be, we see a strong demand for more precise and longer-term navigation solutions (tens of minutes with an accuracy of a few meters) in markets such as indoor pedestrian navigation. Such solutions will require the sensor fusion of data from A-GPS (if available), Wi-Fi and of course motion sensors or a combination of motion sensors. However, the required precision is far from what can currently be achieved today – the one exception being the expensive MEMS sensors used in the aerospace and defense industries. Perhaps the next InvenSense will come from one of a handful of promising start-up projects, such as Qualtre, MCube and Jyve -- each of these ventures has developed revolutionary motion sensing technologies by using a different sensing principle or a different way of combining motion sensors, while residing within a low cost production infrastructure. Also, companies like Movea have started to impact the traditional supply chain model by bringing a novel expertise in software and sensor fusion.

The MEMS market is still very fragmented, and motion sensors are just one part of many. We've seen an increase in M&A activity, driven by some large companies that are interested in broadening their portfolio of products and integrating new functions in their existing devices. Recent examples of this are Qualcomm's acquisition of Pixtronix (MEMS displays) and Sony's acquisition of Micronics (point of care diagnostics), both of which occurred in 2011.

Indeed, Yole Development sees many other potential high-volume device businesses operating outside of the "hot" inertial area: in oscillators (Sand 9, IDT), RF MEMS switches (Wispry, DelfMEMS), microdisplays (Qualcomm MEMS), and MEMS speakers (Audiopixels).



InvenSense MPU 9150 scratch (Courtesy of InvenSense)

Tables below are depicting October, November and December latest M&A & new investments in MEMS

Several very important financial transactions in the MEMS & Microfluidics industries: InvenSense IPO and acquisition of QuantaLife, VTI & Pixtronix.

M&A

Company	Type of product	Type of investment	Value of the transaction (USD)	Acquirer	Yole Développement comment
<i>Oct. 2011</i>					
QuantaLife (US)	Digital PCR technology	Acquisition	\$162M	Bio-Rad Laboratories	QuantaLife has developed a disruptive PCR technology with a very high sensitivity compared to traditional techniques. Thousands of micro drops can be produced in a few seconds, which can be used to generate ADN or ARN. The corresponding instrumentation was planned to be commercialized in 2011. With this acquisition, BioRad strengthens its position in the PCR market
VTI (FI)	Low g accelerometers, inertial combos, pressure sensors, oscillators & resonators	Acquisition	\$265M	Murata	Few months after SensorDynamics acquisition, this is another very large M&A that happens in the MEMS inertial industry. We see several motivations that explain this move from Murata: <ul style="list-style-type: none"> - Murata is traditionally involved in consumer gyroscopes with piezoceramic technology (tuning forks) but its market shares are decreasing since 2 years. Indeed the silicon technology is now preferred for many applications because of higher integration (3 axis), thin sensors, and now low pricing. Murata get access to a disruptive Silicon technology with VTI: both 3-axis gyros and 3-axis accelerometers, with business expected to start in high end consumer applications such as remote controls - Murata has already a silicon MEMS gyroscope that is sold to the automotive market. This is for navigation. Murata competes with Epson Toyocom and Panasonic in this market, which is declining. With VTI, Murata get access to a strong position in the inertial automotive market. Indeed VTI is leading the low g accelerometer market and has a large success on ESC combo sensor. A significant growth of this business is expected for VTI in 2011. Murata thus gets a larger footprint in the automotive market, in applications which are dynamic and with a competitive technology - Another strong driver for this acquisition is the willingness to remain a key player in the timing market. Murata is traditionally a strong player in ceramic resonators, a segment which is declining. Murata decided to invest in newer technologies. In May Murata announced a cooperation agreement with Tokyo Denpa on quartz resonators. VTI is developing silicon MEMS timing technology which is expected to be disruptive in many market segments: resonators for MCUs, oscillators, and potentially TCXO-grade products within a few years. First products are expected to be released end 2011
<i>Nov. 2011</i>					
InterSense (US)	MEMS-based inertial measurement units	Acquisition	NA	Gentex	With close to 50 employees, InterSense is a specialist of ultra-miniature, low-power motion sensors and flexible software. InterSense recently launched the world smallest high-performance IMU: 6DOF on a chip (in a 24.0 x 13.5 x 9.1mm3 package), based on MEMS technology, which achieve 10°/h bias instability. Gentex is the world's largest supplier of automotive auto-dimming mirror, by far, but also has activities in the aircraft and protection industry. We expect that InterSense motion tracking technology will be deployed in diverse commercial and military high-performance tracking, navigation, visualization and stabilization applications in the future
<i>Dec. 2011</i>					
Pixtronix (US)	MEMS displays	Acquisition	NA (sources indicate \$175M to \$200M)	Qualcomm	Pixtronix and Qualcomm are the leading MEMS display companies. Founded in 2005, Pixtronix has raised \$59M in total. The technology is focused on MEMS shutters, in order to achieve very low power displays. TFT lines can be used and only 3 mask steps are necessary, resulting in a cheap manufacturing cost. The hype around low-power MEMS display is currently high: Pixtronix recently announced joint development and licensing to Hitachi display and to CMI, while Qualcomm announced in November the high-volume commercialization of its color Mirasol display in Korea (Kyobo e-reader). Purchase of Pixtronix has not been announced officially, thus it is difficult to comment on the motivations behind this transaction. According to some sources, price of the acquisition would be significant: between \$175 million and \$200 million

New investments (VC rounds, IPOs)

Company	Type of product	Type of investment	Level of new investment (USD)	Investors	Yole Développement Comment
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Oct. 2011

Calient Technologies (US)	Photonic switching products based on internal MEMS mirror technology	13rd round	\$19.4M	Cayuga Venture Fund, Intuitive Venture Partners, TeleSoft Partners	The first part of this transaction was announced in the last issue of MEMS trends as a \$4.38M transaction was already closed. The demand for high-speed high bandwidth switching systems is currently soaring, driven by data centers and cloud computing networks
Sand 9 (US)	Silicon MEMS timing devices	4th round	\$1.3M	NA	Sand 9 is seeking to raise \$6.2M in total. Production of MEMS oscillators for RF transceivers and A-GPS is expected to start in 2012. Silicon MEMS timing had continuous market adoption in 2011: SiTime and Discera 2011 revenue was about 2 times more than in 2010

Nov. 2011

Microvision (US)	Picoprojector based on scanning MEMS mirror	Public offering	\$9.8M	NA	This financial operation bring cash to Microvision which had a disappointing 2011 year as the picoprojector sales are not yet booming and as the company is still making large loss. TI DLP and LCOS solutions still dominate the picoprojector market by far
InvenSense (US)	MEMS gyroscopes, motion sensor combos	IPO	\$75M	NA	For many reasons, InvenSense IPO is the most exciting event that happened in the MEMS industry since years! See analysis article

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