

MEMSentry

The Exclusive Yole Bulletin on MEMS

Issue n°4, March 2006

Welcome introduction

Yole Développement is now editing an exclusive bulletin analyzing recent events and coming trends in the MEMS fields. This bulletin will be published 12 times a year and distributed electronically. You are now reading the fourth issue.

Content

The Latest News and Analysis

- RF MEMS: is it a growing business or not?
- Launch of WiSpry MEMS based Varicap
- Radant MEMS is focusing on military markets for MEMS based RF switches
- IMT get new volume production from Xponent
- Akustica has launched its first silicon microphone digital sensor
- Launch of new accelerometers at Freescale and STM
- GPS in mobile phone is gaining strong interest

Latest Financial News and Analysis

- Caliper announced 2005 sales at 87 M\$, up 9% on 2004 activities
- Memstech announced growing sales with expected growth of more than 50% in the next 2 years
- 2,6% growth of Elmos Semiconductor sales in 2005

- Semefab get benefit of 26 M\$ investment in order to develop its MEMS foundries capabilities
- INEX announced major investment
- New venture round at Perpetuum
- New venture round at SiClocks
- New venture round at Lilliputian Systems
- Miradia is searching fresh money
- MEMX has stopped its business
- Acacia acquires micro-mirror patent portfolio
- Microsens has changed its shareholders and name to Silsens

Feature: Application Analysis

- MEMS based displays: new opportunity outside TI leadership

Feature: Company Analysis

- Memscap: All you have always dreamed to know on the reality of the company business and industrial activities

Latest News and Analysis

RF MEMS: is it a growing business?

This month has been the time for announcement of several RF Mems based products from several vendors, including WiSpry, Radant MEMS ... Today, the reality of the RF MEMS market is very simple: 2 families of products are available.

FBAR (Frequency Bulk Acoustic Resonator), manufactured by **Agilent**, **Infineon**, **Epcos** and several Japanese companies, for a 2005 market of \$ 120 M, representing more than 250M units.

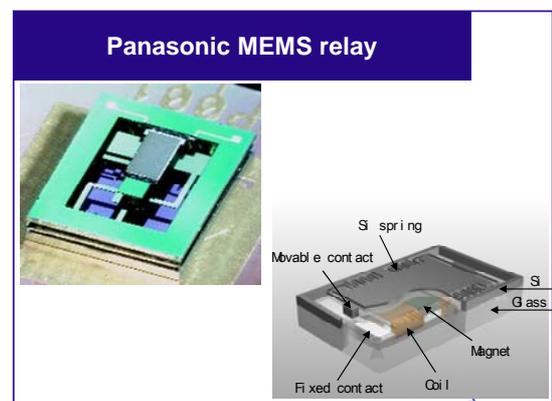


Figure 1: Panasonic Mems relay

MEMS based RF switch, manufactured by **Teravicta** and **Panasonic** are in a sampling and small volume production phase, started in September 2005 (see Figure 1).

As far as we know, none of the products announced for years are on the market at the moment. The main issues are the following: concerning passive devices, it is difficult for RF MEMS devices to compete against existing technologies which have already a low cost. Concerning active devices, MEMS components are still expensive compared to the existing products or are not reliable enough.

We estimate at YOLE that the RF MEMS applications will continue to grow in the next 5 years, but at a slow rate due to the market price pressure and the time needed to be introduced on the market.

The next devices which are of interest are clearly either for high end applications (test equipment, military applications ... where the price could be high) or focused applications like the tuneable RF front end for multi-standard and multi-mode operation. But the road to reliable and cost adapted device is long.

Launch of WiSpry MEMS based Varicap

WiSpry has announced new varicap duplexer to be available 1Q 2006. It is a low state, tunable notch filter, suitable for CDMA and W-CDMA handsets (see Figure 2).

WiSpry has also announced the availability of MEMS based RF switches and also PA (power amplifier) module, competing with existing GaAs and LD MOS technologies (which is a big challenge).

WiSpry is collaborating with **Jazz Semiconductor**, a CMOS foundry specialised in RF devices. The joint program between the two companies has successfully demonstrated the feasibility of commercially manufacturing WiSpry's digitally tunable capacitor devices into Jazz Semiconductor's 200mm wafer fab and provides commercial availability of highly integrated RF-MEMS devices, built upon Jazz's leading-edge processes.

WiSpry has been created out of the RF MEMS activities of Coventor in 2002. The company has secured \$7 M in venture

investment in 2005 (post money value of \$ 12.2 M, according to our information) after a first round of \$ 1 M in 2003).

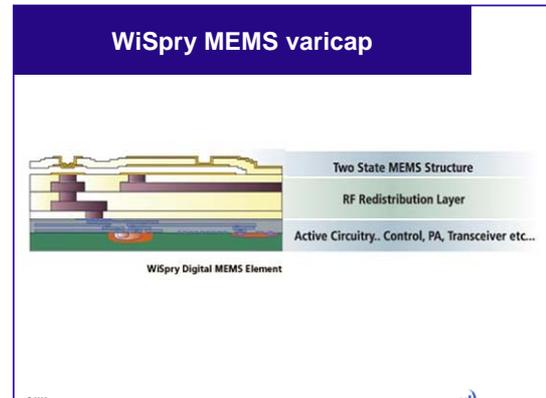


Figure 2: WiSpry varicap

WiSpry is at the moment closing a third round of financing, estimated at \$ 10 M in order to finalize R&D and enter volume production.

Radant MEMS is focusing on military markets for MEMS based RF switches

Radant MEMS has a completely different focus: the company is developing MEMS based RF switches, mainly for military applications. Radant MEMS is a fully owned subsidiary of **Radant Technologies**, specialized in the design, manufacture and testing of radomes, electronically steerable antennas which are used in high performance airborne, ground based shipboard and submarine installations.

Radant MEMS has been created in 1999 and is developing since that time MEMS technologies. According to the company (and Yole Développement agrees on that), MEMS based RF switches are far away from commercialisation, due mainly to reliability issues.

GPS in mobile phone is gaining strong interest

Several companies, including the Israeli company **Telmap Navigator** and the US company **Navteq**, are now proposing solutions for GPS in mobile phone. Several operators (Mobilcom, Saunalahti, Mirs, Celcom ...) are already proposing such service.

In the same way, **SiRF**, world leader for GPS chip, are now proposing complete chipset for mobile phone applications.

Such mobile phone GPS will induce the use of MEMS for several reasons:

- Concerning the RF module, MEMS technologies could be the technology of choice for the tuneable RF front end with multi-standard. There is still 2 to 3 years of development but we think at YOLE it could be an important business
- For the Japanese market, the Z axis is very important in order to determine at which level you are in a building (specific Japanese market where shops, restaurants ... could be from level -3 up to +10). So you need an accelerometer in order to detect if you are climbing stairs ...

New business opportunities are appearing with the diffusion of the mobile phone GPS.

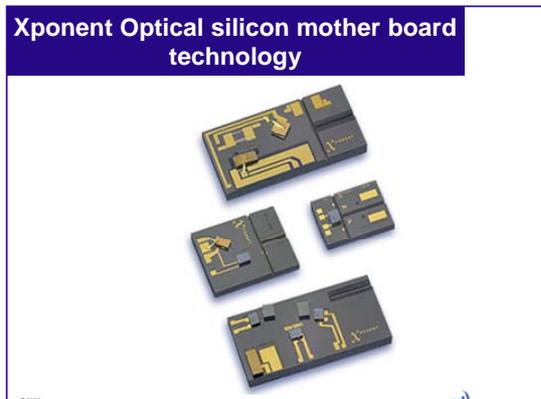


Figure 3: Xponent SMP technology

IMT get new volume production from Xponent

IMT will produce all the range of devices and modules manufactured by **Xponent**. The company has developed a technology named Surface Mount Photonics (SMP, see Figure 3): it simplifies the way optical components are built by eliminating the expense of lenses, active alignments, hermetic packages and most serial optical assembly processes. SMP chipsets are assembled with flip-chip die bonders, streamlining the assembly process for optics and converging it with electronics

assembly processes to drive cost out of the supply chain. The assembly and manufacturing of Xponent modules will be done at IMT.

The optical MEMS markets for optical telecommunication are still a small business. We estimate at YOLE (in one of our new reports) that the linked applications (VOA, SOB, OXC ...) are around \$120M in 2005, with a growth rate around 3% (almost flat). Alone, the MEMS based VOA market is evaluated at \$60M, dominated by **JDSU** with more than 45% of market shares (device manufactured by **Memscap**, see the article below). The second manufacturer is **Lightconnect**. The management of Lightconnect has recently changed, certainly to provide new directions to the company.

Akustica has launched its first silicon microphone digital sensor

Akustika has launched in March the first one chip Silicon microphone. After **Knowles Acoustics**, **SonionMEMS** and **Memstech**, a fourth company is now proposing such device on the market. Knowles Acoustics has completely dominated the 2005 market (SAM of 100M units according to YOLE report "Silicon Microphone 05") but competition in 2006 will be more important.

Akustika is proposing 2 chips (one analog and one digital device). We estimate at Yole that the market price for high end silicon based microphone is around \$ 0.65 at the moment and for low end microphone, the price is below \$ 0.30-40. Akustika has announced that the price of the digital microphone is less than \$ 4 for low volume.

Launch of new accelerometers at Freescale and STM

Freescale, Analog Devices, Kionix, STM ... all these companies have announced the introduction of a new generation of 3D accelerometers, dedicated for mobile phone and games applications.

The use of accelerometer in mobile phone is becoming more and more important, especially in Asia. Several other applications, including gaming (Magic Wand, next Nintendo game platform ...)

GPS, pedometers, cars alarms ... are more and more using silicon based accelerometers. The market is growing ... and the prices are going down ... It seems that the early companies involved in this market like **MemsIC** (creation in 1999), are able to make money but for the others, the question is still open.

Latest Financial News and Analysis

Caliper announced 2005 sales at \$ 87 M, up 9% on 2004 activities

Caliper announced a 9% increase of its sales in 2005, from \$80.1M in 2004. The last quarter, the company has been for the first time cash flow positive. The net loss for 2005 was \$14.5M, divided by 2 compared to 2004. Caliper is forecasting sales of \$120M to \$128M in 2006.

The main growth for Caliper is coming from the microfluidics products. This includes the collaboration with Affymetrix which is basically an OEM agreement on liquid handling instrument. Another important customer is Agilent. Caliper is now deeply involved in the In Vitro Diagnostic business.

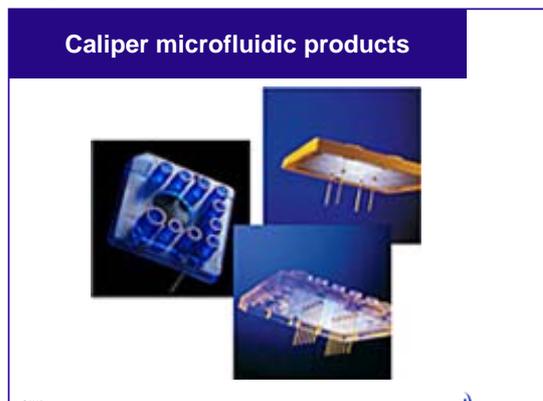


Figure 4: Caliper technology

We see a very strong momentum at the moment linked to microfluidics: life science but also chemical and energy applications are pushing the microfluidic industry to real high growth business. But the business models and the added value chain is different compared to standard MEMS activities. YOLE new report "LifesciencelC" is analysing in details the markets, applications, technology and business challenges of the use of MEMS

and IC technologies for the life science applications.

Memstech announced growing sales with expected growth of more than 50% in the next 2 years

Memstech, a Malaysian MEMS foundry, is forecasting a strong growth of its thermopile arrays, with an increase of 100% in the next 2 years. Memstech is a public company, created from the former MEMS activities of EGG Heiman. Memstech has reached sales of RM48M (\$13M) for a profit of RM13.8M (\$3.7M). Memstech is certainly at the moment the most profitable MEMS foundry worldwide. The other products manufactured by Memstech are pressure sensors and accelerometers. Silicon Microphone seems to be in a prototyping phase.

2,6% growth of Elmos Semiconductor sales in 2005

Elmos has announced sales of Euro 147M for the Year 2005, 2,6% up to the 2004 sales. **SMI**, the MEMS subsidiary of Elmos, has made sales of Euro 8.9M, down 2.2% compared to 2004 (Euro 9.1M sales). SMI is still in the transition from 4" to 6" facility and is facing a stability of its traditional activities (pressure sensor for medical applications). The activities of SMI have generated 0.8 MEuro operating income. The new growth opportunities linked to automotive and consumer applications are still to come.

SEMEFAB get benefit of 26 M\$ investment in order to develop its MEMS foundries capabilities

SEMEFAB, a Scottish ASIC and MEMS foundry, involved since more than 5 years in MEMS manufacturing, is involved in a \$ 26M investment in order to extend its MEMS manufacturing facility.

Today, SEMEFAB is mainly producing pressure sensors, barometric sensor and temperature sensor. Semefab has made more than \$ 5M sales in 2005.

The new investment will bring to the company new technical capabilities (deep RIE, wafer bonding, specific back end assembly).

This investment brings a new player in the MEMS foundry field (see MEMSentry #3 for the analysis of the MEMS foundries markets extract from our reports "MEMS Foundries").

INEX announced major investment

INEX, a MEMS manufacturing facility based at the University of Newcastle, has completed the upgrade to 6" of its facility. UK has now 2 industrial facilities able to manufacture MEMS devices. The investment at INEX is estimated \$8.5M, financed by a grant of the UK government and by the European Commission.

New venture round at Perpetuum

The UK based company **Perpetuum** has raised \$3.9M in a second VC round (for a post valuation of \$9.2M). The company, founded in March 2004, is providing solutions for self-powered sensor systems eliminating external wires or batteries. The concept is to harvest kinetic energy, usually vibration, which is then converted using micro-generators into usable electrical energy to power sensors, microprocessors and transmitters. Perpetuum was founded by a team of researchers at the University of Southampton. The team is using a novel way of using an optimised combination of coils and magnets.

Depending on the acceleration applied on the micro-generator, the system can produce several mW of energy. Today, no product is available in volume but the investment has been done in order to fasten the product development.

Several other companies are at the moment trying to re-use structures based on comb drive accelerometer in order to be able to generate energy from movement. The industrial implementation will be challenging but the industrial interest is very strong.

New venture round at SiClocks

SiClocks has secured a first \$ 11 M venture round, in order to be able to develop integrated timing solutions. SiClocks is using SiGe technologies in order to integrate MEMS based oscillator

and other timing functions in a CMOS process.

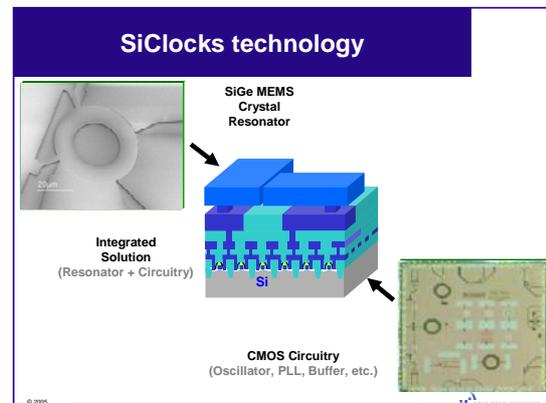


Figure 5: SiClocks technology

SiClocks is the fourth company (after **Discera**, **SiTime** and **VTI Technologies**) to develop MEMS based oscillator, which will certainly be, according to our analysis, one of the key application of MEMS in the next 5 years. A complete analysis of this application will (finally) be included in the next MEMSentry issue.

New venture round at Lilliputian Systems

The company, created in 2001 from the R&D done at MIT, get more than \$35M VC funding in last 6 months (after already \$9,6M invested since 2001) in order to develop and industrialize MEMS based micro fuel cells. By combining micro electromechanical systems (MEMS) and solid oxide fuel cell (SOFC) technologies, the company will enable power supplies providing 5-10 times more energy within the same small form-factor as today's rechargeable batteries.

The company is still in the development phase but it is another sign of the strong interest to use MEMS technologies for the next generation of micro fuel cell. STM, Hitachi, NEC, Infineon ... a large number of companies are developing such technologies, for a product introduction scheduled in 2007 for the most aggressive ones (see MEMSentry #2 for more details).

Miradia is searching fresh money

Miradia, developer of a technology competing with the DLP from **Texas**

Instruments, has announced the opening of a third venture round 2Q 2006 in order to finance the development and industrialisation of its micro-mirror arrays. The amount is not known at the moment but could be around \$40M. Up to now, the company got more than \$30M in VC funding.

MEMX has stopped its business

MEMX has announced that it is closing its activities. The IP is for sell: almost 50 patents are available, linked to the Summit process developed by Sandia Lab, with a strong focus on optical design and optical switches.

Acacia Patent Acquisition acquires miro-mirror portfolio

Acacia Research Corporation has acquired (via its subsidiaries Acacia Patent) a complete portfolio linked to MEMS based micro-mirrors for applications like displays. This fact shows the increasing importance of the display applications for MEMS producers. Acacia has not mentioned the source of the acquired IP.

Microsens has changed its shareholders and its name to Silsens

The share holders, the management and the product focus of **Microsens** (CH) have changed. Now, the new company name is **Silsens**, focusing more on industrial activities (compared to R&D projects). Microsens has been one of the first MEMS based chemical sensor company. The company was focusing on the development of new technologies and has licensed its chemical sensor technology to **Motorola** in 1998. Motorola has after 3 years stopped this activity and the humidity sensor business had been the basis for the creation of **Humirel** (F), acquired last year by **MSI**.

Application Analysis

MEMS based displays: new opportunity outside TI leadership

Except for a handful of cases in consumer electronics, most of the micro-electromechanical systems (MEMS) receiving attention today are MEMS-based

displays: they represent a thriving business sector, with products for non-entertainment use as well as for home theatre systems and handheld devices. The versatility of this technology holds strong promise for the future. The Figure 6 is presenting the applications based on optical scanners (extracted from our "MEMS4Display" report).

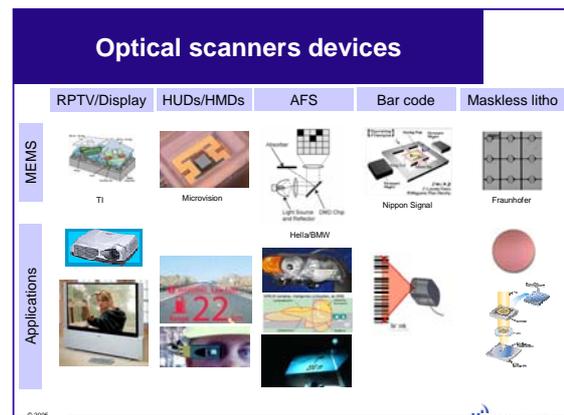


Figure 6: Optical MEMS applications

Among the many ways to use MEMS are methods to integrate them with optical functions. The resulting optical MEMS have uses:

- in infrared image sensors, mainly for night-vision systems (**Ulis**, **SCD**, **Honeywell**, **Raytheon** ... are among the major manufacturers worldwide)
- in optical scanners (**Intermec**, **Microvision** have products available for such applications while **Symbol** is very active in R&D)
- in spectrometers (like **Microparts**, **Ocean Optics**, **Polychromix** ...)
- in telecommunications
- in displays

MEMS-based infrared image sensors for night-vision systems serve the security, industrial and automotive markets. Optical scanners that use MEMS generally work in barcode readers. MEMS-based spectrometers help to perform chemical and biochemical analysis.

Between 2003 and 2008, these markets are likely to grow from US\$756 million to more than \$3 billion (Fig. 7 extracted from "MEMS4Displays" report). Most non

telecommunications optical MEMS devices relate in some way to display devices. In turn, there are two core uses for MEMS-based displays, in rear-projection systems like rear-projection TVs and projection modules, and in displays that use MEMS technologies for enhanced features.

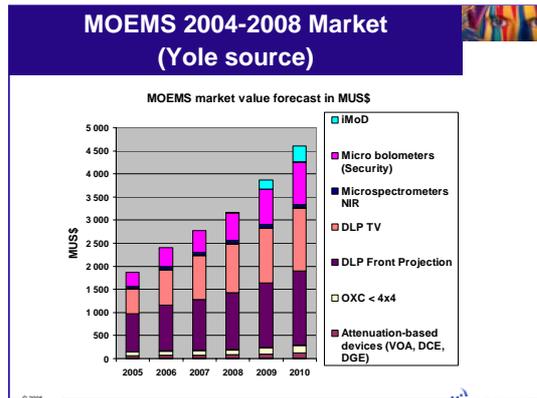


Figure 7: Optical MEMS markets

With its Digital Light-Processing (DLP) technology, **Texas Instruments**, Inc. clearly dominates the market for MEMS-based rear-projection systems. Rear-projection systems are growing, and probably will continue to do so (Fig. 7). In 2003, shipments totaled 1.2 million units, putting the market at US\$600 million. By 2008, shipment volumes will have swelled to 7 million units, and the market scale will have climbed to \$2.4 billion. Sales in 2005 decreased by 8% but the sales in Q4 2005 and in Q1 2006 are very strong, so that we can expect a very good year for 2006.

Growing uses for MEMS-based rear-projection systems will give impetus to this growth. TI's DLP technology now commands close to 45 percent of the market for projection systems. It has the potential to surge to 60 percent in 2006. Meanwhile, among TVs larger than 40 inches, DLP accounted for more than 12 percent of the North American market in 2005. The market share is much smaller in other regions. Furthermore, DLP accounts for about 5 percent in Europe, and has almost no market share in Asia. Meanwhile, other companies are working to develop products that can be able to compete with the dominant DLP chips. **Sony Corp.** has introduced a chip set

using a technology Sony licensed from Silicon Light Machine (now a wholly owned subsidiary of **Cypress Semiconductor Corp.**). Silicon Light Machine's technology, known as a Grating Light Valve, uses ribbon-like structures that permit precise variations in the amount of light that the system diffracts or reflects. However, Sony's product works only in ultra-large-screen systems, like those for stadiums and theatres.

Eastman Kodak Co. is also working on a MEMS variant called grating electro-mechanical system, which employs 1 x 1,080 arrays of diffractive elements. In some ways, this product is comparable to Sony's chip, but it is simpler and promises stronger image contrast. However, it remains under development.

Two companies in Sunnyvale, California, **Miradia Inc.** and **Reflectivity, Inc.**, are working on silicon based MEMS technologies. Miradia has developed a micro-mirror display whose mechanical structure consists of single-crystal silicon, according to its Web site, and does not require aluminium mirrors. Miradia, which has not yet announced the release of product samples, has raised more than \$22 million in venture-capital funding. **Taiwan Semiconductor Manufacturing Co. (TSMC)**, Miradia's foundry partner, considers the market attractive, and therefore is investing in process development.

Reflectivity's developments include micromirror array and micro-assembly technologies. The company says it has produced working prototypes of its display chips. Investors have given Reflectivity more than \$18 million (according to Yole). MEMS development presents its own set of challenges. It takes a long time to bring the technology to industrial-release stage. It also requires some time-consuming effort to establish the reliability and yield at sufficient levels. Keyotee, Inc. from Texas was also working in the MEMS field.

However, the company seems to have halted development, and is looking to re-

sell its intellectual property, according Yole. Others players still active in MEMS are **Micralyne** Inc. of Edmonton, Canada, and **FhG Institute** in Dresden, Germany. So far, Micralyne's is mainly working in optical switching for telecommunications applications.

The progress of MEMS based display faces some uncertainty. Undoubtedly Texas Instruments will capture additional market shares in rear-projection systems worldwide, including new shares of the rear-projection TV market in North America. Indeed, in 2006 the company is aiming at decreasing the cost of its DLP devices to less than \$300 or even below \$200. If it accomplishes this task, Texas Instruments may be able to seize additional shares of the market for TVs larger than 40 inches.

The challenge for Texas Instruments is to enter the European and Asian markets. European peoples are beginning to buy DLP-based TVs, but the growth rate for these sales is much lower than TI expected. Sales remain quite low in Asia. For strategy reasons, a number of TV manufacturers are unwilling to push DLP-based systems in Europe, Korea and Japan.

Yole Développement predicts that DLP technology will continue to be quite strong in the North American market for the next three years. It will achieve healthy growth in the European markets, but its impact in Asia will be much lower. By 2008, sales will reach 7 million units, with an average selling price of \$350. For the low-end market, Texas Instruments will probably offer devices for about \$200 each. The price pressure on TI products is very high: according to our information, the customers are asking 5% decrease on the price every quarter!

MEMS technology has other potential in the display field, including the ability to devise small, low-power displays. Qualcomm, Inc. is leading efforts in this field. Following its purchase of **Iridigm Display Corp.** in the autumn of 2004,

Qualcomm formed a new business unit, **Qualcomm MEMS Technologies (QMT)**. Qualcomm believes Iridigm's interferometric modulator device, known as iMoD, will prove far superior to the LCD technology that now forms the mainstream in mobile phones.

QMT says the main advantages of iMoD are its ability to produce extremely bright displays and its low power consumption, compared to LCDs. QMT is in the middle of technology development, and has not yet made any announcements about commercial release. Overall, MEMS-based displays will become increasingly important. If QMT is able to introduce a new display using its iMoD technology, it could reinforce the market growth from 2008 onward.

Yole Développement has published a detailed analysis of displays and optical scanners based on MEMS technologies. (MEMS4Displays report). All our products can be viewed at:

<http://yole.fr/pagesAn/products/reports.asp>

YOLE Développement has edited several reports describing the MEMS markets:

- **Gyro Markets**
- **MEMS Foundries**
- **MEMS for mobile phone**
- **Life Science IC**
- **Silicon Microphone**
- **Status of the MEMS industry**
- **Optical MEMS for non telecom applications**
- **Emerging Markets for Microfluidic Applications**
- **World MEMS Inertial Sensors**
- **MEMS on IC**
- **Microsystems for Harsh Environments**
- **World MEMS fab**
- ...

YOLE Développement is proposing the most complete collection of MEMS markets analysis worldwide.

Company Analysis

Memscap: All you have always dreamed to know on the reality of the company business and industrial activities

Memscap history

1997-2001: the Electronic Design Automation (EDA) and Intellectual Property (IP) phase

Memscap has been created in November 2007 by Jean-Michel Karam. Between 1997 and 2001, the company raised more than Euro 13M. The main investors were SPEF Venture (**Banque Populaire**), **Innovacom** and **ETF Group**.

The first activity of the company was the development of EDA tools for the design and simulation of MEMS devices. The company has in parallel developed new designs for RF and optical applications. The business model of Memscap was mainly based on IP development and licensing of design to customers. Companies like **Walsin Liwha** have licensed several RF designs from Memscap.

The sales of the company for that period are presented in Figure 8.

	1998	1999	2000	2001
Sales (M Euro)	0.55	1.75	3.1	9.8

Figure 8: Memscap sales (1997-2001)

2001: the IPO

In March 2001, Memscap went public and rose with success Euro 101.5M (out of which Euro 83.5M went to Memscap, the rest was sale of shares and cost of IPO). This introduction to the stock market was mainly to implement the following strategies:

- Build a manufacturing facility in order to produce devices for the telecommunications markets (mainly for optical cross connect): Memscap get very important contract from ADC in September 2000 (order cancelled in April 2002)
- Target key acquisitions

This period in 2001 was difficult due to the end of the Internet bubble. It is important to notice that at the same time, a US company was also registered for an IPO (Optical Micromachine, **OMM**) but failed. The timing of the IPO for Memscap was critical and has been a financial success for the early investors. In 2001, Memscap multiplied by 3 its revenue.

2001-2002: implementation of the post IPO strategy

After the IPO, the company has implemented its strategy: the building of the manufacturing facility in Bernin (France) has started in 2001 (Euro 60 M invested).

At that time the company had several business models:

- CAD tools and IP development
- RF business unit
- Opto business unit
- Foundry activities

Memscap has hired more than 250 persons and has created more than 20 different offices in Europe, North America, Africa and Asia.

The optical communications bubble then exploded and Memscap had no business to put into its manufacturing facility. Memscap ended the year with a net loss of 27.8 MEuro.

2002: the industrial acquisitions phase

Memscap used also its money and liquidity of its share to make acquisitions. Two companies have been acquired in 2002:

- **Capto**, former subsidiary of **Sensoror** (at that time, public Norwegian company manufacturing inertial sensors and pressure sensors for the automotive industry), acquired in February 2002 for Euro 9.8M in cash.
Capto (always in Memscap portfolio) was involved in the medical and avionic business, developing, manufacturing and commercialising pressure sensors. The manufacturing of the silicon sensing element was (and is still partially) manufactured at Sensoror. Memscap is making the design, packaging and sales/marketing of those devices and modules in Norway.
Capto was sold by Sensoror in order to get fresh money: Sensoror was re-investing in new devices at that time (gyro and pressure sensor for tyre pressure monitoring).
- Acquisition of **Cronos**, a company of **JDSU**, based in North Carolina, in November 2002, for Euro 5.2M in shares (Cronos has been acquired by JDSU in 2000 for \$ 750 Millions). The business of Cronos was mainly linked to the development of optical MEMS devices and also was running since more than 10 years a project allowing R&D groups (mainly universities) to have access to its processes, the MUMPS program. This MUMPS program has been financed during 10 years by DARPA.
Cronos had at that time two manufacturing facilities, a former Motorola fab and the small Research Triangle Park (RTP) facility for the production of optical cross connect, VOA and other optical devices. Memscap acquired the assets, IP and the use of the RTP facility of Cronos in the deal with JDSU.

So Memscap ended the year 2002 with 2 manufacturing facilities, with low volume activities and with very high operating expenses (see Figure XX for the financial data during these years).

2003 and 2004: the financial acquisitions phase

During 2003 and 2004, Memscap has made 3 acquisitions, mainly for financial purpose:

- Acquisition of **Galayor**, an Israeli company developing optical system on chip; the company has been acquired for \$ 3.5 Millions in paper and Memscap get \$ 1.5 Millions in cash from Galayor cash flow, concomitant to \$5 Million capital increase.
- Acquisition of **Opsitech**, a French company specialised in integrated optics; the company has been acquired for 3 MEuro in paper and Memscap get 3 MEuro from Opsitech cash flow
- Acquisition of **Optogone**, a French company developing liquid crystal switches; the company has been acquired for 3 MEuro in paper and Memscap get 3MEuro from Optogone cash flow.

Memscap get patents, knowledge and persons with these acquisitions. The majority of these activities have stopped at Memscap. The patents are still in the portfolio of Memscap but with a value difficult to estimate and several employees were integrated into the Corporate R&D group of Memscap.

The objective of these 3 acquisitions was mainly a financial objective: each time, Memscap paid with paper, with no discount (often with a premium on its stock), and get fresh money. Each time, the acquisition by Memscap was done just after a re-investment of the investors in the acquired company of an amount of money more or less equivalent to the valorisation of the company by Memscap.

In 2003, Memscap shut down the Bernin fab in order to cut its expenses. What we understood, is that Memscap was not able to close the North Carolina manufacturing facility

due to the links with existing customers and to the running cost of the Bernin manufacturing facility, which is higher than the RTP one.

2003 and after: fight for survival

Since 2003, Memscap tried to decrease its costs and raise new money. After the financial acquisitions, Memscap raised more than 11 MEuro on the stock market in 2005, in order to reduce its debt and remain in business.

The RTP manufacturing plant has been upgraded to 6" equipment format. The office building of the facility in Bernin has been sold to real state investors in October 2005, decreasing significantly the annual cost of the company and its debt.

The year 2005 ended in a more positive picture for the company. Net liabilities went from 15 MEuros to less than 0.3 MEuro within this fiscal exercise.

Memscap Facts and Figures:

The figure 9 presents the evolution of Memscap revenues.

- Headquarter location: the Bernin (France, 25 persons) site is hosting the management of the company and the corporate R&D. 2 other sites are based in Norway (40 persons) and USA (40 persons, see description below)
- Creation: November 1997, public company since 2001
- Employees: 102, including 30 persons in R&D
- Growth rate: 13,6% between 2004 and 2005,
- Sales and net earnings: see Figure 9 for the details since the creation of the company

	1998	1999	2000	2001	2002	2003	2004	2005
Sales MEuro	0.55	1.75	3.1	9.8	5.7	7.7	8.8	10
Net earnings	0.05	0.1	-2.6	-0.2	-27.8	-58	-9.9	-4.2

Figure 9: Memscap sales (1997-2005)

The 2005 sales breakdown is presented in figure 10.

Geographical breakdown is as follow: 43% of the sales are made in the USA and 40% in Europe. 17% is done in Asia and Rest of the World.

The shares of the sales between the different activities of Memscap are the following:

- Standard products (including 0.7 MEuro for IntuiSkin): 5 MEuro (up from 3.2 in 2004)
- Custom products: 5 MEuro (down from 5.6 MEuro in 2004)

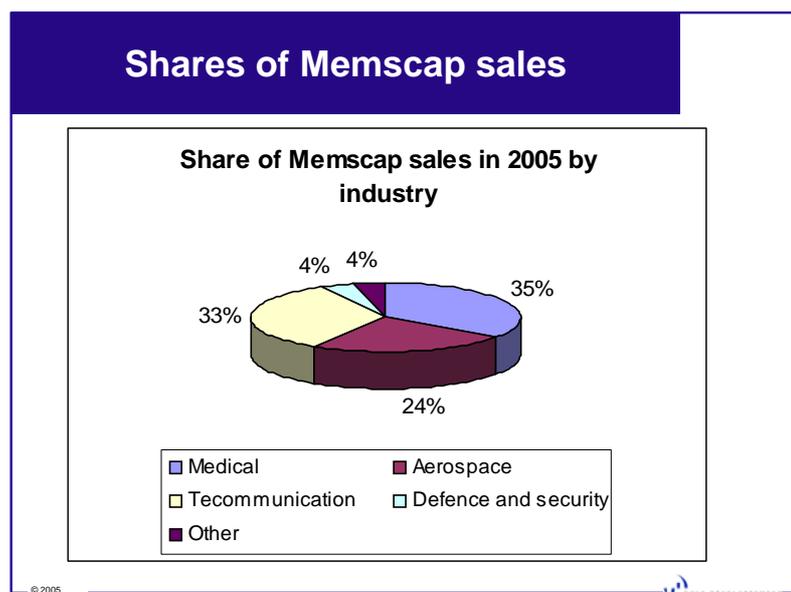


Figure 10: Shares of Memscap sales (2005)

Memscap is, with a Singaporean company named **Memstech** (foundry business model), one of the two pure MEMS companies which are public.

Production activity:

Memscap production is done in the 2 non French sites:

- North Carolina: the North Carolina plant is hosting a 320m² front end silicon clean room facility (class 10) with an upgraded 6" facility.
- Norway: the Horten plant is a back end facility (the silicon devices used in Memscap/Capto products are still largely manufactured at **Sensoror**, an **Infineon** company) equipped with a 250m² grey room (class 10,000) for the assembly and test of the medical and avionic products

The different activities, which were within Memscap (CAD, RF ...) before the disinvestment, have contributed to a creation of companies outside Memscap:

- The CAD tools business has led to the creation of a new company named **Softmems**, based in USA and France (1 MEuro deal)
- The reliability group has been closed and the staff has created a company named **Novamems**
- Several other persons from Memscap have created companies related to the MEMS business like **Adelsa Group** ...

Current products and customers:

Today, Memscap has 2 key activities, which have been inherited from the Capto and Cronos activities. Both organisations have their own marketing and commercial structures:

- Standard products, for the medical and aeronautic industry. This activity is based on the Capto business. Memscap is selling packaged pressure sensors. The major customers of Memscap are equipment manufacturers for the aerospace (Liebherr, Honeywell, Meggitt ...) and for the medical industry (Philips, Siemens Medical ...).

The targeted markets are the following:

Medical applications:

- Re-usable implantable blood pressure
- Blood purification (just starting with **Therakos** and **Sedat** as key customers)

Avionics applications:

- Air data control and altimeter
- Cabin pressure regulation
- Cabin pressure
- Engine control
- A gyroscope is under development
- Custom products: in this field, Memscap acts as a contract manufacturer, working mainly on its own IP. The North Carolina facility is producing silicon chips (non packaged chip) for Memscap customers. A very strong diversity of products is manufactured in North Carolina for telecommunication to biomedical applications.

We can notice the following products:

- VOA for several customers including **JDSU**
- Optical mirror matrix for **Glimmerglass Network**
- MEMS relay for switchboard (Memscap claims to have the basic patents for this application)
- Implantable sensors and lab on chip
- MUMPS process, generating every year in the range of \$500
- Development linked to automotive, seismic and security business, paid by customers

Knowles Acoustics was a customer of Memscap in 2004 but due to a problem in 2005 in the relationship between the companies, the production for Knowles has stopped.

A specific activity of Memscap is **Intuiskin** (subsidiary of Memscap), developing a system able to analyse the physical and chemical properties of skin. Intuiskin contributed by 0.7 MEuro to the sales of Memscap in 2005. This new activity, under development since 2003, is pushed by Memscap in order both to target a professional and consumer business.

This activity is linked to a complete different business model compared to the 2 others, with different markets, customers ... and will need a specific infrastructure if the business is really starting. Part of these developments includes a product named SensiCard (a consumer product dedicated to skin analysis). Memscap hopes that the product will be launched in volume in Q4 2006.

Excluding Intuiskin, the two activities are equivalent in the 2005 sales (see the chapter on Memscap facts and figures).

Organisation of the company:

The operational management of the company is organised in the following way:

- Jean-Michel Karam, CEO
- Aurore Foulon, VP Communication
- Yann Cousinet, New Finance Director
- Ron Wages, VP, Business Unit Custom Products
- Jan Hallenstedt, General Manager and VP Business Unit Standard Products
- Gaetan Menozzi, VP Strategy
- Nicolas Bertsch, Director R&D Corporate
- Pascal Ransch, Director, Intuiskin

Competitive situation

Depending on the business unit, Memscap has several competitors.

Concerning standard products, Memscap is competing with several companies like **Druck**, **Honeywell**, **Meggitt**, **Medex** ... which are generally bigger than Memscap and with long established customer relationship.

Concerning the custom products, Memscap is working like a contract manufacturer with a strong internal IP portfolio: the majority of the customers of the custom product division is using Memscap IP.

Due to this strong similarity with the contract manufacturers, Memscap is competing with approximately 15 companies worldwide, which are proposing MEMS manufacturing either as contract manufacturers (**Colibrys**, **Tronic's Microsystems**, **Micralyne**, **Silex** ...) with or without IP or with foundries (**IMT**, **APM**, **Xfab**, **Microfab Bremen**, **Elmos/SMI** ...) including several semiconductor companies providing such services (**Sony**, **DNP**, **STM** ...).

As an example: Memscap was producing in 2004 silicon microphone for **Knowles Acoustic**. The first source of manufacturing for Knowles was Sony (with a large majority of the volume). A competitor of Knowles, **Akustika**, is using **Xfab** for the manufacturing of the MEMS device. In term of comparison, Memscap, like Colibrys in Switzerland, has developed both a standard product and custom product activity.

In term of ranking, according to Yole analysis (report "MEMS foundries" released in March 06), Memscap is N°10 worldwide in the MEMS foundries and contract manufacturers (after **Colibrys**, **Dalsa Semiconductor**, **IMT**, **Micralyne**, **SMI**, **Silex**, **Sony**, **STM** and **Tronic's Microsystems**, alphabetical order). 2005 has seen a decrease of Memscap sales, mainly due to the shift from 4" to 6" production and to the stop of the production of Knowles Acoustics. In parallel, the MEMS contract manufacturer market grew by more than 35% in average in 2005.

In a more general way, Memscap is ranked N°40 among the MEMS manufacturers worldwide (Yole data), all business models included.

What are the next steps?

After 4 years of very important difficulties and 8 years in business, Memscap get together more than Euro 130M from the financial investors, without taking into account the budgets of the European Commission, DARPA, French financing bodies linked to specific R&D projects. The result is a Euro 10M business company, with Euro 4.2M losses in 2005 and a market value of Euro 100M approximately.

It seems that the reshaping of the company has ended for this phase. The business models of Memscap, inherited from Cronos and Capto, are clear and positioned in existing markets. Intuiskin products are still under development.

Two banks analysing Memscap (**CM CIC Securities** and **KBC Securities**) are forecasting a strong development of the company (see Figure 11, with each year the lowest estimation between the two financial analysts). They also predict that 2007 will be the year with the return to profitability for Memscap.

	2006	2007	2008	2009
Sales (MEuro)	15.6	26.6	37.2	49

Figure 11: Memscap sales forecast (source KBC Securities and CM CIC Securities)

According to our analysis of Memscap figures and our experience of the MEMS (things never happen the way you expected), these estimations are too high. We think that reasonably, Memscap can reach in 2006 a sales level of Euro 12M to 13M, depending on the implementation in production of several R&D projects. In the same way, a successful launch of Intuiskin can positively impact the sales of the company.

For 2007 and the year after, a 15% to 20% growth per year is possible, in line with the growth of the MEMS business.

The management of the company has been able up to now to keep Memscap alive, mainly with financial operations. Memscap is still burning cash (the level of sales is 12MEuro in order to generate positive cash flow). The company is now entering a phase where the operational and industrial activities will be vital to turn Memscap into a profitable company.

The first challenge is the ability of the custom product business unit to be in line with the company expectations (make every quarter at least 2 MEuro sales); it will be key for the success of Memscap in 2006 and the years after.

The second challenge is linked to the successful launch of Intuiskin products: 12 to 18 months delay is always possible in this field of the industry.

Next challenges are linked to the implementation of a real industrial business using Capto and Cronos activities as the heart of the new strategy: we will see if Memscap will be able to grow and come back into profitability.

YOLE Développement is editing a complete company profile of **Memscap**. More information is available on our web site <http://www.yole.fr/pagesAn/products/Companyprofiles.asp> or by sending me an email at: eloy@yole.fr

Company profiles also available are on **Tronic's Microsystems** and **VTI Technologies**.

Feed back on our analysis.

If you have questions, feed back on our analysis, or remarks, feel free to send us an email so that we can send you a reply.

Questions can be sent to: eloy@yole.fr.



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The next issue of MEMSentry will focus on the following topics:

Analysis of the latest news

Latest financial News and Analysis

**Application Analysis:
Mems based oscillator**

**Company Analysis:
Matsushita Electric Works**

Content of the coming issues (next issue: 14th of April 2006):

<i>MEMSentry</i>	<i>Issue #5</i>	<i>Issue #6</i>	<i>Issue #7</i>	<i>Issue #8</i>
<i>Company analysis</i>	Matsushita Electric Works	Invensense	Bosch	MemsIC
<i>Application analysis</i>	Mems based oscillator	Frequency bulk acoustic resonator	Optical scanner	Tire pressure monitoring systems
<i>Analysis of the latest news</i>	X	X	X	X
<i>What has happened and why</i>	X	X	X	X
<i>Last financial rounds</i>	X	X	X	X

Our analysis and reports are based on the **1 500 industrial interviews** we conduct each year (in average 30 interviews every week since 1998) in the MEMS industry. We are contacting sensor manufacturers to system integrators, as well as investors, equipment and materials suppliers ...

All our analyses are updated regularly (on a monthly basis) in order to provide our customers the best available data and the most accurate analysis of technology, business trends, markets and existing and emerging applications.

Micronews will report on the facts whereas MEMSentry provide analysis of these facts.

CONTENT OF THE MEMSENTRY BULLETIN

Content of MEMSentry issue

(Approximately 10 pages depending on the news)

Analysis of the latest news

Highlight the key aspects of the latest news, with a particular focus on industrial strategies, new applications, industry changes...

What has happened and why?

Presentation of the evolution of the different industrial companies, last changes and Yole analysis on the impact on the industry

Latest financial and investment rounds

Presentation of the latest investments in MEMS companies, M&A, exits, new venture rounds...

Analysis of one application

In each issue, we will analyze a specific application in order to provide market data and present the strategy of the main players involved on this market

Analysis of one company

In each issue, we will analyze a specific company in term of technologies, products, future developments, but also finance

About Yole Développement.

Yole Développement (18 consultants) is a market research and strategy consulting company, world leader in the analysis of MEMS markets.

Yole Développement offers a range of different services for companies and investors involved in the MEMS markets:

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