The Microflown, from die to product

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SUMMARY
This article reports on various steps to transform a concept to a product. A sound intensity probe based on a micro-machined acoustic sensor "the Microflown" is used as an example. Requirements for the micro-machined part are simplicity and uncomplicated processing to reach a high throughput. For monitoring the quality, simple and reliable characterisation tools should be designed as well. To gain credibility independent labs should test the product. The product should offer a complete solution that competes in overall costs and performance, and it must be possible to connect it into existing systems.

Keywords: Particle velocity, product, sound intensity.

INTRODUCTION
Only one year after its invention the Microflown [1] was used already as a sensing tool for measuring the acoustic impedance of a horn loudspeaker [2]. The first "product" was made. Then the desire to make a product rather than a scientific gadget was born. Some important steps to convert a micro-machined sensor into a product will be presented in this article.

The product that will be discussed is a p-u sound intensity probe. Sound intensity is defined as the time averaged product of sound pressure, p (measured with a microphone) and particle velocity, u (measured with a Microflown).

THE DIE
The most essential part of the Microflown is obviously the particle velocity sensitive part, the silicon die. In order to optimise the sensor simplicity and fast processing are essential. These intended properties always turn out to require several iterations to realise, and often promises are made that surely can’t wait another six months.

It is very important for a sensor that the properties are stable. Therefore in stead of exotic materials, platinum is used for realising the temperature sensing part of the Microflown.

Since the micro-machined sensor is the most important part of the product, one should not be struggling width the reliability of the fabrication. Therefore one should only use the standard process steps available in the lab.

Design simple and reliable characterisation tools since the price of the product increases along the way.

Don’t wait for better samples coming soon out of the cleanroom, but go on with the realisation of the product. Otherwise the product will never be realised and the better sample will still be coming soon…

THE PRODUCT
To enable to make a product, first one should know everything about the product that is competed with. Listen to the market: don’t make a good product but a product that is asked for.

The Microflown has a number of very interesting properties. It is for example the smallest microphone existing. For the sound intensity application however this is of less importance. Furthermore nobody in the real world is interested in silicon, SEM pictures and "NEW!, presented for the first time". This is only important when one want to publish a MEMS article. The only matter that is of importance is that the overall performance is better than the existing products. This must be proven, preferably by an independent research institute, see [3] (Philips Natlab). One must gain credibility: (positive) statements from leading persons or companies are essential.

Connectivity is also an important issue. The product should be easily connected to the existing equipment, so the right connectors and the right output levels are required.

The packaging should be somewhat similar to existing products. Copy as much as you can.

Fig. 1: Picture half inch probe
OFFER COMPLETE SOLUTION

The proposed product should possess better properties and offer a better solution to a problem as the competing product.

Not only the product itself, but also its use should be cost-effective. If for example the use of the sensor permits much less measuring time or much easier measuring procedures (so that lower educated personnel can do the job) the sensor itself may be very expensive.

At first a half-inch probe that complies all essential items was made. Together with a standard microphone a good sound intensity probe was created [3]. This was still too complex for the user. The microphone had to be integrated into the package. At this point, a very small and pragmatic probe is realised, sound pressure and particle velocity are measured at once, at one position.

**Fig. 2: Schematic drawing of the p-u probe**

The output signals (sound pressure and particle velocity) should be filtered, multiplied and integrated, for which purpose an analyser was designed, since these operations were not yet available.

**Fig. 3: Picture analyser**

The new probe should be calibrated which can be achieved in an anechoic room. Since this is an expensive solution, difficult to use "in the field", a practical and portable calibrator allowing a calibration on the spot had to be designed. A standing wave tube turned out to be a good alternative.

The next step is the publication of examples about already solved problems. For this the best thing to do is to lend your product to an organisation, skilled in solving acoustic problems and willing to publish about it.

In order to exploit this product, a company is needed to be dealing with prices, billing, delivery conditions, warranties and so on. For the sound intensity probe, the Microflown Technologies B.V. was founded.

MEASUREMENTS

The Microflown is the only acoustic sensor that measures particle velocity and consequently no reference particle velocity probes are present.

For the calibration of a p-u sound intensity probe, a known acoustic environment is necessary, since this permits calibrating the probe with the use of a calibrated pressure microphone only.

An anechoic chamber is a known acoustic set up in which the p-u sound intensity can be calibrated. As an alternative, a standing wave tube was (successfully) investigated: the anechoic response should have the same value of the maximums of the standing wave tube response.

**Fig. 4: Measurement and simulation results. The upper curves represent the calibration of the pressure probe and the lower curves the calibration of the Microflown. The solid lines are measurements the dashed lines simulation results.**

CONCLUSION

In this paper the various steps to make a product that where taken are presented. As an example, a sound intensity probe based on the Microflown was examined.

We found that besides the packaging problems, issues such as a stable and reliable production process of the die, calibration standards, interconnectivity and efficient entrepreneurship must be considered. For exposure, it proved to be advantageous to exploit independent companies and agencies for testing and approval.

REFERENCES