An approach to seminar based MEMS training.

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ABSTRACT

We present the training method employed in the microBUILDER project, a project aiming to further increase developments in integrated micro fluidic systems, integrate micro intelligent systems with micro fluidic systems and generate interest in micro fluidics in general. In the project, a significant effort is made to develop training materials and perform training events. The syllabus addresses participants with a broad range of backgrounds, spanning from master level students, via PhD students and researchers to technical managers. In addition, the participants have a range of experience within biotechnology and semiconductor areas. To meet the challenges of addressing such a diverse audience, a modular approach is adopted. The courses have so far been given to more than 1100 participants.

1. INTRODUCTION

The EU-funded project microBUILDER includes an extensive training program. The training is organized as a series of events around Europe, spanning one to three days depending on the participant's background and particular interest. The participants background span from bioengineers to MEMS professionals, this combined with the limited time and the broad range of technologies in the project presents a challenge compared to regular training. To meet the different needs and desires of the participants, a modular approach is adopted. The course syllabus is divided into three modules: 'Awareness', 'Technology' and 'Hands-On'. Each module is based on the previous module and has an increasing level of detail and complexity. In this paper we present a novel approach to teaching MEMS/microfluidics within the limitations mentioned above, used in one of the 'Hands-On' modules developed in the microBUILDER project.

2. MODULES OUTLINE

The three modules developed are

A. Awareness

The awareness module addresses all participants, and aim to give an introduction and qualitative description of the services offered by the project. For trained professionals, this module will give insight into the technologies sufficient to highlight their possibilities and limitations. For professionals with a non-microtechnology background, this module will illustrate some of the capabilities of microfluidic systems, and hopefully spawn ideas for new and improved products/devices. For students, it will give an introduction to industrial processes and, particularly for Ph.D candidates, present an offer for having something made even if their local institution has no laboratory fur such.

B. Technology

The technology module address those who plan to use any of the services provided. The participants will gain detailed insight into the technologies, the processes used. For students, this module will give an introduction to considerations taken in industrial processes, a topic not often covered by the syllabus at universities. The module provides the basis knowledge for participating in the various versions of the 'Hands-On' module.

C. Hands-On

The hands-on module aim to give an introduction to designing for any of the technologies offered and introduces relevant tools and methods. Different sessions have been designed for the different technologies. The module described in Section '3 The Demonstrator Hands-On module', is one of totally four sessions available, which of two are based on booklet tutorials and two are based on assignment based tutorials.

3. ASSIGNMENT BASED TUTORIALS

The broad range of backgrounds and levels of the participants, make the hands-on training a challenge. To be able to offer all participants an interesting hands-on session, an assignment based approach has been developed. The idea is to give a partially finished design, and let the participants redesign key components through a series of assignments, each illustrating a key aspect of the technology featured. To adjust to the individual level of the participants, little details on exactly how to do the assignment is given, and the instructor will, after giving an introduction, advice each participant individually. After a given time, a suggestion for solution will be shown on a video projector, and depending on the level of the participants, this will be preferably done by one of the participants. This makes it easier to get plenum discussions and hence interactivity throughout the session. Given below is an outline for one of the hands-on sessions developed.

4. THE DEMONSTRATOR HANDS-ON MODULE

The session described here is based on a demonstrator developed in the project by the coordinating partner SINTEF, combining two of the core technologies of the project, to form a flow rate sensor. The session starts by giving an outline of the session and describe the functionality of the demonstrator. The participants are then given a layout similar to what seen in Figure 1, where key cells have been emptied. The assignments are to redesign these cells. As the emptied cells are still present and correctly positioned in the distributed file, each finished assignment leads to a rapid increasingly finished design, allowing focus on the key features on the technology rather than the layout itself. As the participants are not necessarily familiar with the software tools used, the first assignment is to design a simple geometry, a piezoresistor, which is used as a component in a Wheatstone bridge designed in a later assignment. The participants can then learn the software while still designing something useful. The following are

then to design a pressure sensor, featuring anisotropic etching of silicon, before a Venturi channel is designed before the final assignment of designing the isotropically etched glass. When all the assignments are finished, the layout equals that which was used for the demonstrator, as seen in Figure 2. At the end of the session the participants can immediately have a look at the finished device (See Figure 3) using a-bring-along USB microscope with 20 to 200 times magnification.

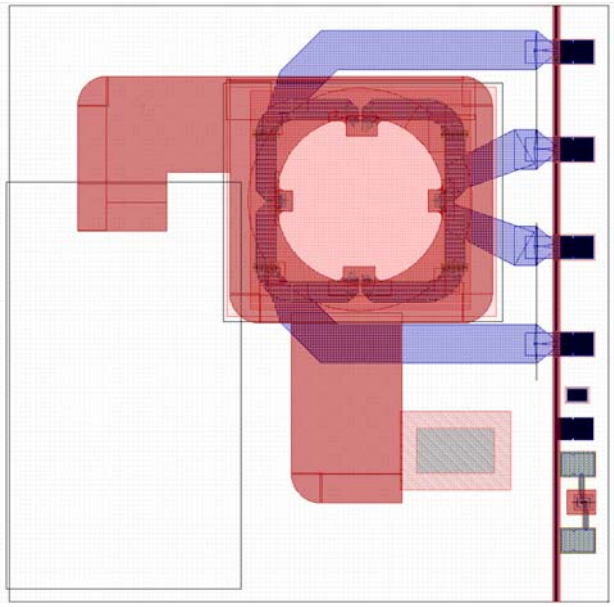

Figure 1 The layout provided to the participants in the 'Hands-On ' module based on the project demonstrator.

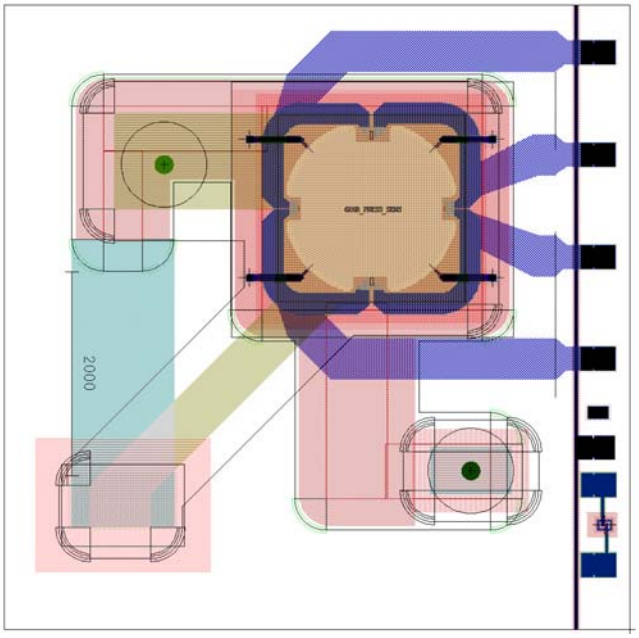

Figure 2 The finished layout after the emptied cells have been redesigned.

Figure 3 Top and bottom view of manufactured flow rate sensor. Image by SINTEF.

Because not all the features of the demonstrator can easily be seen even using the microscope, a scale model of the sensor part of the demonstrator has been made using a 3D polymer printer. The scale model is useful to illustrate how the masks drawn correspond to the features of the sensor. The same approach was used when the cell counting structure seen in Figure 4, was adopted as a design example by the project.

5. RESULTS

As of today (April 2008), 21 Awareness-, 9 Technology- and 14 Hands-On courses have been conducted. A total of 1138 person-modules have been registered. Feedback has been collected at a subset of the courses. On a scale from 1 to 10 with 10 being the best, the average score when asked for 'Overall impression', is 7.9, 8.0 and 7.9 for the 'Hands-On', 'Technology' and 'Awareness' modules respectively. Participants at the courses have submitted designs to the MPW services

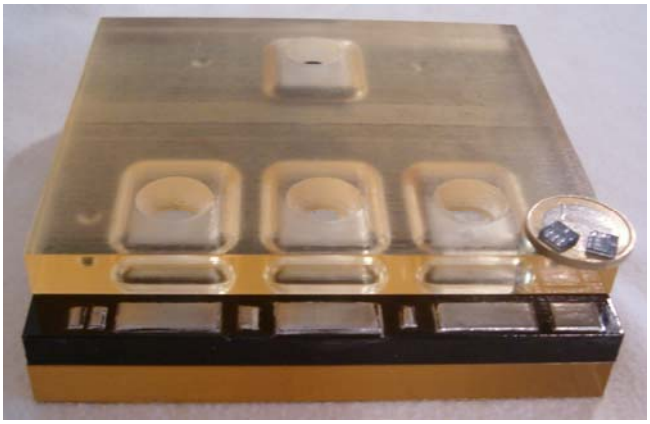

Figure 4 A scale model of a cell counting structure made using a microBUILDER service. The designer participated at a microBUILDER course before designing the device. The device has later been adopted as a design example by the project. On top of the scale model is a 1 Euro coin with two devices on.

REFERENCES

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