Work in Progress - A Multidisciplinary Introduction to Microfabrication

Weili Cui, Wayne Jones, David Klotzkin, Greta Myers, Bruce White
Binghamton University
klotzkin@binghamton.edu, wcui@ binghamton.edu, wjones@binghamton.edu, gmyers@binghamton.edu, bwhite@binghamton.edu

***Abstract* - Microfabrication is a critical area to many branches of science and engineering. In this work-in-progress paper, we describe our plan to introduce microfabrication technology in a comprehensive, cross-curricular way through lectures, demonstrations and experiments from freshman through junior classes across four disciplines (Electrical and Mechanical Engineering, Chemistry, and Physics). Immediately following, in the senior year, will be an opportunity for students in these disciplines to take a multidisciplinary microfabrication capstone course that will serve as a complete introduction to clean room theory and practice. This approach will fundamentally show microfabrication as being based on many disciplines and vital to most modern technologies. Assessment will be done for each level of the project, and assessment results will be used to continuously improve the course over time and gauge the success of attracting students into this area.**

Index Terms – microfabrication, nanofabrication, engineering education

INTRODUCTION

Microfabrication, the processes for fabricating miniature structures of micrometer sizes and smaller, is a critical area to many branches of science and engineering. It is heavily used to make both electronic devices like integrated circuits and semiconductor chips, and other sorts of devices like accelerometers, lasers, and miniature microphones. Since microfabrication is such a broad and multidisciplinary activity, the conventional approach of presenting this topic in a single course in one department seems inappropriate. Many approaches have been presented to develop appropriate educational material in microelectronics [1]-[4]. In this work-in-progress paper, we describe our plan to *comprehensively integrate microfabrication education into the engineering and science curriculum.*

Binghamton University has recently made the substantial investment in tools and architecture to create a clean room. With the introduction of these new facilities,

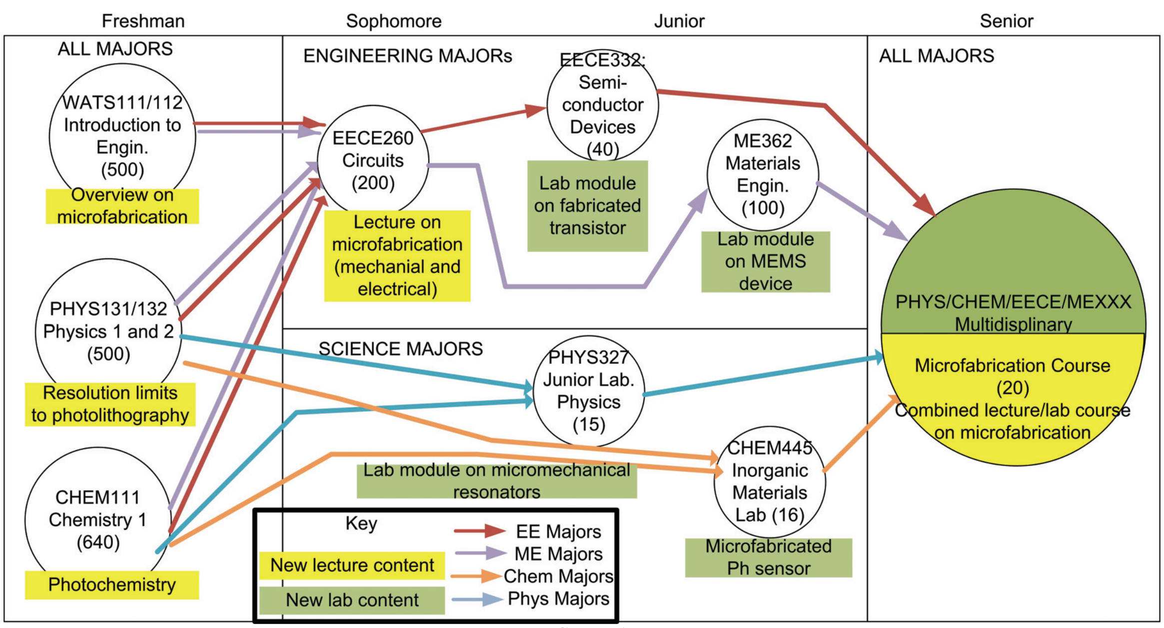

FIGURE 1
A MAP OF OUR ADJUSTMENTST TO THE CURRICULUM; THE COLOR-KEYED ARROWS REPRESENT FLOW THROUGH THE CURRICULUM BY MAJORS; NUMBERS ARE THE ESTIMATED ENROLLMENT IN EACH COURSE; YELLOW AND GREEN SQUARES INDICATE NEW LECTURE AND LAB CONTENT, RESPECTIVELY.

we have the opportunity and challenge of introducing them to the student body and integrating these facilities into the educational fabric of the institution.

PROCEDURE

Our approach is pictured in Figure 1. Lectures, demonstrations and even experiments in freshman through junior classes across four disciplines (Electrical Engineering, Mechanical Engineering, Physics and Chemistry) will be integrated into current courses. Junior level courses from four departments will integrate a 'microfabrication experimental module' into the existing syllabi. This module will expose the students to what a clean room is, what microfabrication is, and attract and interest them in the microfabrication side of their discipline. Some example modules are characterizing a thin film transistor or fabricating an organic light emitting device. In the senior year there will be an opportunity for students to take a multidisciplinary microfabrication capstone course that will serve as a complete introduction to clean room theory and practice.

Both general knowledge and attitudinal surveys will be conducted at various levels to refine the course activities and measure the effectiveness of this broad microfabrication approach. A detailed knowledge inventory is planned before and after the capstone course to refine its effectiveness and teaching methods and activities. In addition, a longitudinal survey of graduates who take the capstone class is planned to track the level of involvement of these students in careers involved with microfabrication.

PRELIMINARY RESULTS

The current activity (in the first half-year of the project) is in development of the course materials and in assessing the current level of knowledge of the students at all levels on microfabrication. These results will establish a baseline by which the effectiveness of this educational plan can be measured when the educational activities are implemented. A general knowledge assessment device has been developed and is being administered to the freshman through junior classes currently. A sample question along with responses is given in Fig. 2; the survey spans questions of size, scale, as well as materials and methods for microfabrication, and materials characterization. The advanced survey for senior students will be a detailed knowledge inventory of the material in the class and the specifics of microfabrication.

Rank these in order of size, from largest to smallest:

1) Diameter of a human hair
2) Influenza virus
3) State of the art memory transistor
4) Width of a strand of DNA

A) 1, 2, 3, 4 46%
B) 4, 3, 2, 1 10%
C) 2, 3, 1, 4 8%
D) 3, 1, 2, 4 35%

FIGURE 2
SAMPLE QUESTION AND RESPONSES FROM MICROFABRICATION ASSESMENT INSTRUMENT; CORRECT ANSWER IS A)

SUMMARY

A plan for a comprehensive approach for integration of microfabricaiton activities into an engineering and science curriculum is outlined. Assessments will be used to continuously monitor its effectiveness and improve the approach. It is our hope that this multidisciplinary activity will not only expose students to the art of microfabrication, but will also enhance their appreciation for the need of interdisciplinary research early in their engineering and scientific careers.

ACKNOWLEDGMENT

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AUTHOR INFORMATION

Weili Cui, Research Professor, Mechanical Engineering Department, Binghamton University, wcui@ binghamton.edu

Wayne Jones, Professor and Chair, Chemistry Department, Binghamton University, wjones@binghamton.edu

David Klotzkin, Associate Professor, Electrical Engineering and Computer Engineering Department, Binghamton University, klotzkin@binghamton.edu

Greta Myers, External Evaluator, Center for Learning and Teaching, Binghamton University, gmyers@binghamton.edu

Bruce White, Associate Professor, Department of Physics , Binghamton University, bwhite@binghamton.edu