

**Nanotechnology Forum: A Call to Action for California Community Colleges
City College of San Francisco – School of Math and Science and Center for
Applied Competitive Technologies
Friday March 24, 2006**

Panel Discussion with Industry

Dr. Brian Sullivan (Kumetrix)

Dr. Phillip A. Williams (NASA Langley Research Center)

Dr. Dhaval Brahmabhatt (PHYchip Corp)

Dr. Alex Roth (Fluidigm Corp)

Please describe the industry sector your company represents, e.g., MEMS, semiconductors, biotechnology and types of job titles that work with nano- or microtechnology at your company

Dr. Brian Sullivan (Kumetrix, Inc.)

- Employ physical chemists, MEMS engineering; most employees have Bachelors, Masters, Ph.D.
- Utilize a bootstrap method of training engineers and scientists because are not coming to the company with the necessary training; critical to have speaking same language
- Seeking students now with a nanotech, microtech background

Dr. Dhaval Brahmabhatt (PHYchip Corp)

- Started out as a regular chip house; got involved w/ nanotech couple years ago
- Work w/ NASA license technologies; developing sensors with super high density memories; avenues for converting solar energy into electricity
- Work closely w/ NSF and get exposure to first-class research occurring in country; exposed to many creative minds working on advanced applications of nanotechnology

Dr. Phillip A. Williams (NASA Langley Research Center)

- Participate in the NIA—a consortium of NPOs and universities; formed to reach goals of education institutions/systems, to support NASAs overall mission/goals and as an avenue to gather funding through venues NASA could not pursue (on its own)
- Work with computational material scientists; nanosensors...advanced materials processing branch [?]
- Have an educational component at NASA Langley; goal to develop and educate on aerospace technology
- Include number of job titles—research scientists; poly, aero engineers, computer scientists, engineering technicians, work in MEMS
- Maintain 3 NASA research centers—Ames, Langley and Glenn

Dr. Alex Roth (Fluidigm Corp)

- Deal with microfluidic devices; pre-IPO
- Using micro concepts to do what's been done at large scale down to small scale
- Have ability w/ chips to take what normally done by one person over longer period of time down to less than one person in a couple hours

- Feels technology is so advanced that scientists have ability to do DNA, blood sampling analysis
- Employ 75 people in SSF and recently opened a new facility in Singapore
- Employ research development, engineers, material scientists—wide range of opportunities
- Communications is most critical need other than technical skills
- Interpersonal skills; particularly in small group highly educated, small team w/ time sensitive projects
- Anything dealing w/ bioMEMs, MEMs
- Clear knowledge of working biological [?]. . . how placed inside a microchip

Describe the typical knowledge and skills required of the nanotechnology or technical staff at your company?

What are the key activities that nanotechnology employees perform?

Dr. Roth

- Seeking people who are interested in furthering career but need further training
- Need individuals who perform routine basic intro level research, e.g., taking existing processes to see if stable
- Understand that these skills are things community colleges provide students but need graduates with more structure in how to use and apply data; will help them to advance much more quickly

Dr. Williams

- Need students to get the foundation courses—physics, chemistry, biology, computer science
- Seek graduates who can interact with a variety of departments and disciplines, in addition to communication skills; important graduates can understand and speak different “languages” across disciplines

Dr. Brahmabhatt

- Seeking students training with an atomic force microscope (AFM); important that community colleges teach how to work with instrumentation for small scale work
- Suggest that colleges prepare technicians with AFM

Dr. Sullivan

- Think the trial and error process is important
- Need employees to be wary of not getting caught in [data discovery] loop
- Seek those with knowledge of looking at data in critical manner and knowing when to stop and realize a discovery or a problem—knowing the decision point and when to proceed

Dr. Williams

- Learned AFM as one of first instruments; used by chemists, physicists, biologists; allows researchers in different disciplines to communicate through fundamentals of AFM
- AFM, STM—those two alone have various modes; compliance issues, friction,

- Microspectrometry, electrospectrometry, lithography (optical, electron)—can all be done by technicians
- Need constant communication, writing, analyzing data, collaborating w/ theorists

Dr. Roth

- Deal with a wide range of equip, processes; geometries of range—50-100 micron
- Believe that the ability to take and learn any tool is central element of any position; engineer, scientists, tech all know how to run equipment—microscopes
- [Densities of yielding product]
- Observe a big gap in understanding that we contaminate the “clean room;” need student to practice in this environment
- Need people to run spin coders, exposed pattern waivers, do tasks w/ solvents
- Need individuals who know how to read MSDS

What do you think the most critical skill needs will be for your employees in the next 5 to 10 years?

Dr. Brahmabhatt

- Focus on commercialization, so looking out 5 years, need will be in marketing new products to public that might not understand the potential
- Consider it difficult to predict where the field will be; one area that could provide huge opportunities is energy efficiency...automotive industry

On clean energy, how will NT be used to produce some form of fuel?

Dr. Brahmabhatt

- See huge opportunity for energy storage and conversion from chemical to electrical energy
- Look at trees, have tremendous surface area to collect and transmit energy

Dr. Williams

- Think about carbon nanotube used for hydrogen storage; carbon nanotube used as sources of light; probably brightest around; photovoltaic cells using nanotech; photoconductive property to use light or sun to generate current

What gaps do you see in training that we should know about as CC educators that you'd like to bring to our attention?

Dr. Roth

- Observe that students are not able to gather and apply data
- Encourage educators to work with students to find a way to transfer and apply learning, exercising/doing simple tasks of gathering data and applying
- Would like employees who can get to where don't need to be directed but can lead

Dr. Sullivan

- Observe that many students lack basic laboratory skills—org chemistry, chemistry, basic handling of lab equipment

- Realize many universities stretched for time to offer in depth lab skills necessary for engineer to come into workforce
- Think it would be beneficial for community colleges to have students get in and get hands dirty with equipment before transferring

Dr. Brahmbhatt

- Encourage students to take statistics as they are an important element for collecting and communicating data
- Encourage educators to prepare students to understand the environmental impact of products

Dr. Sullivan

- Think its important to train students for when statistics are useful and the boundary for their use; not just to plug in numbers; want them to think about, understand the accuracy, be critical of numbers; programs do have mistakes and have to be careful to pick up where those mistakes are

What recommendations do you have for CCs in developing programs to serve your needs in the nano, microtechnology industry?

Dr. Brahmbhatt

- Think CCs can address the retraining of engineers—those who want a new career or who've been laid off in previous years; when started working in semiconductors, would regularly take courses at Mission College

Dr. Roth

- Rely on versatility; even techs are coming in with 4-year degrees
- See the level of tasks expecting from employees and complexity of work growing for all in chain (2-yr, 4-yr, etc.)
- Recommend fundamental skills in Excel, Access, Words—basic computers, basic math, basic use of microscopes and difference between tools
- Seek people who are able to interact in environments that are different from what used to on a day to day basis
- Consider working with industry to supply equipment to create mini-environments of what will encounter in the field

How can CCs partner with industry to obtain internships, work-study, equipment?

Dr. Williams

- Solicit companies that sell microscopes specifically for education; could acquire an AFM so grads have seen one and know what to do with it
- Develop clean rooms—clean rooms are not just clean but meticulous; when dealing with a nanoscale and expose to “macro” dirt, not going to get nano results
- Drive home the importance of being careful w/ process, analysis (even without a clean room)

Dr. Sullivan

- Use Web for interactive learning and teaching such as Olympic Microscope University—a multi-staged activity
- Look into Wikipedia—marvelous online encyclopedia with very good resources
- Can have online simulations or interactive experiences if can't have a clean room

Dr. Brahmbhatt

- Suggest emphasizing design of experiments in curriculum

Dr. Roth

- Know many companies already have work study programs as they provide a great way to get their technologies into universities

What experience, education would a CC student need to enter industry; is it realistic to expect a 2-yr degree will prepare graduates for the industry?

Dr. Brahmbhatt

- Can definitely contribute handling of materials; definitely something that can be taught in 2 years

Phillip

- Second Dr. Brahmbhatt; even in 4-year college, this is one of the first things have to learn; handling materials

How should nanotechnology modify physics instruction?

Dr. Brahmbhatt

- Think about big focus on molecular level interactions
- Combine with lab time on AFMs

Dr. Williams

- Jumping into nano technology without macrotechnology tech is problematic
- To become good at anything new, must have solid foundation
- Recommend a solid foundation of scientific thought
- As teaching fundamentals, use examples relevant to nanotechnology to explain; e.g. how friction on nano and macro levels are different
- Replace some classic examples with those more appropriate to nano

Do you know of teacher training programs for field?

Dr. Brahmbhatt

- Suggest train the trainer opportunities; need to prepare 1200 teachers annually

Dr. Sullivan

- Suggest journals like *Micronano*, *Small Times*, *Nanotech*, *Nanoletters*—all trade journals that are freebies, industry journals that are not research papers but that give overviews

Dr. Roth?

- Keep in mind that many small start-ups are under time constraints and pressure to get funding; need to be more established to have teachers come in and out

***What if any resources are available for teachers, counselors, parents to make aware of field?
Any professional association that can take on?***

Dr. Brahmhatt

- Recommended traveling exhibit through BRTF

Dr. Cormia

- Need to change paradigm; nanotech will not be something you will find
- Need to start with big problems—energy, water, food, medicine—think about what are problems and needs
- Shift paradigm in how educating to think about how can both know and do as related to solving these big problems
- Work backwards to what technologies are; begin modeling

American River College

- Offer many resources at www.arc.losrios.edu/~electron, *Nanotech links*

What entry level salaries and graduated based on experience?

- Entry-level: \$14-\$18/hr
- 5-yrs: high \$28-29/hr