THE CENTER FOR SUSTAINABLE ENGINEERING, ART & ARCHITECTURE - MATERIALS, MANUFACTURING AND MINIMALISM

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Engineers as Teachers: The Cooper Union – Spring 2011

Introduction

Iridescent (http://iridescentlearning.org) is the brainchild of Ms. Tara Chklovski. Started in 2006 in Los Angeles, the mission of *Iridescent* is to bring STEM (Science, Technology, Engineering and Mathematics) to children and their parents in the underserved sections of our society. Inclusion of the parents as an integral constituent of the audience for *Family Science Night* lessons encourages engagement of the *family* in the learning and enlightenment processes so providing future support for the nascent scientist/engineer in their quest for knowledge.

Engaging a *family* in a conceptual topic – about which they may know nothing – presents a significant and unique challenge. The obvious hurdles presented to children in underserved communities may be compounded by their limited acquaintance with the English language and limited background education – both potentially astride poverty, unemployment and poor housing.

Ongoing support within the school environment continues through a partnership that *Iridescent* forms with the school in which the *Engineers as Teachers* students become mentors and teachers for those interested in STEM. Support outside these environments comes from the *Iridescent Science Studio*, an informal physical space situated in the Bronx providing further opportunity for ongoing engagement with these families.

This structure provides a unique and powerful framework within which to engage interested children and provides continued support for them and their families as they progress through the K–12 education sequence. For the current rollout in New York City, grades 3-6 are targeted with the span gradually increasing until grades K–12 are covered – at which point the high school students themselves become the *Engineers as Teachers* for kindergarten, first grade and so on.

Spring 2011

This is the second semester in which the *Engineers as Teachers* class is to be offered as an Independent Study (3 credits) at The Cooper Union. After the Fall 2010 semester, we have made **significant** changes to the course content and to your teaching load. **The number of schools at which you teach has been reduced from two to one** with the addition of two *taster* lessons prior to the four lesson unit sequence. Through this change, we are able to increase significantly our overall impact on the school by being better acquainted with the school culture and better prepared for the lesson unit. For the first *taster* class you will speak at a recruiting assembly during the school day, meet the school staff, and sit in on a regular class. For the second *taster* class, you will present a

self-contained *Family Science Night*, identical in structure to those in the unit sequence, but on a different topic to recruit children and their families for the succeeding *Family Science Nights*.

The *taster lessons* provide an opportunity for you to get to know the school administration and the teachers – and, perhaps most importantly, for you to gain a *feel* for the school atmosphere – in terms of school culture, classroom behavior and etiquette, teacher participation and administrative commitment to the program. Not unsurprisingly, we have found that the most successful *Family Science Nights* are those for which there is strong commitment to the program from the families *and* the teachers *and* the administration. We hope that the *taster* lessons will initiate and nurture this three-way relationship.

Credibility

The Office of Naval Research has awarded Ms. Chklovski $7,800,000 over a three year period to support this program in Los Angeles, San Francisco and New York. Further substantial awards from the National Science Foundation and other organizations support assessment of the program and the development of low-cost teaching modules for dissemination within the USA and ultimately the rural areas of the less industrialized world.

You are about to become part of a highly esteemed program – one in which The Cooper Union is privileged to be a participant. From several perspectives, we are still in the development stage of this program – the changes being instituted this semester part of an ongoing evolution of the course, the outreach activities, and the teaching materials and methods. Erika Allison (Iridescent) and I believe that we have everything well planned – and that the structure and content of the classes is to your maximum benefit. However, we may initiate further changes if we believe this to be in the best interests of you and the program as a whole and it is our intention to engage other Cooper faculty in capacities that suit their interests and schedules.

Do not be daunted by these responsibilities but do realize that by signing up for this course, you are making a commitment to complete the program. You are committing to a class time of at least three hours/week (to be front loaded[1] in the first five weeks), to completing a sequence of assignments – and, working in pairs, to designing and presenting a sequence of five two-hour lessons on mutually agreeable topics at a mutually convenient time for both you and your school. Most importantly you are committing to exposing these students and their families to the empowering confidence that accompanies an understanding of a new concept or idea, or an appreciation of how something works.

The Challenge

How do you present a complex scientific topic to an audience with the composition described in the introduction? Answer – you are unbelievably familiar, completely understand and are completely at ease with the concepts and material you are going to teach. This is probably where the bulk of your energies will go – asking yourselves question, after question, after question – to enable you to reach

[1] Front-loading the course work (4 hrs/week for the first 5 weeks) ensures that when you start your teaching, you will have all your coursework prepared. Our class time can then be used for analysis and reflection of your teaching and classroom activities, and for fine-tuning your varied classroom demonstrations and experiments.

the core of your topic. From there you will work upwards – building the story in a way that enables you to carry your audience into your framing of the in-class engineering activity they are going to undertake.

Implementation

Hands-on experience is at the heart of Iridescent's teaching philosophy for the *Family Science Nights*. Each family works on an open-ended project with sufficient instruction to enable them to learn by exploring different routes to their solution for the problem presented. The engineering investigation must be extremely carefully designed so that the participants are able to complete it within the allotted time with minimal input from the 'teachers'. It must be framed such that *design and redesign* are implicit to the activity. You are there to facilitate questions, to encourage those with not quite enough confidence and generally enliven the session.

The duration of your direct instruction is 20 – 30 minutes – the investigation lasts 40 minutes to an hour – and the class finishes with a 5 to 10 minute reflection followed by 5 to 10 minutes during which the participants complete an exit questionnaire. The lesson runs for about two hours and usually includes dinner or a snack.

It is not possible to predict actual class sizes until much closer to the event. In New York City we have had attendances of between 5 and 85 families – yes, *you* and your partner could have an audience with close to 200 people as we had in the Fall 2010 semester. I am telling you all this because I want you to walk into this class with your eyes wide open. If the thought of 200 people hanging upon your every word is terrifying – you are not alone. Firstly, you will be there with your partner and at least one person from Iridescent – and – one of the outcomes of this class is that we will teach you how to 'control' your fear.

It is not our intention to frighten you by acquainting you with these numbers – but it is our intention to make you *really* appreciate how good your preparation must be. Your lesson plan must be unambiguous, perspicuous, lean and enlightening. Your directions and guidelines for the engineering activity must be crystal clear – you must anticipate everything that can go wrong and be in a position such that, should something unexpected occur, the change is easily accommodated.

We will help you learn how to make a subject your own such that you can walk into class *without* the *crutch* of a PowerPoint presentation – although your direct instruction may include some carefully selected or constructed images or animations and possibly a short video to better communicate the concept you are teaching. We will work with you to help you prepare lessons that comprise a dialog of unparalleled clarity; straightforward, creative classroom demonstrations undertaken by you; straightforward, creative classroom activities undertaken by the class participants; a scavenger hunt subtly incorporated into your direct instruction; an engineering investigation through which the participants learn about the concept you are teaching; a reflection which ties together what you have done; and an exit slip that measures how effectively you communicated your material.

The program requires commitment and application from each of you. We expect, and will accept, nothing less than your full participation in the class as we critique and circulate your different ideas and discuss some of the foundations of teaching methods, learning styles and assessment techniques.

Outcomes

From this activities, you will learn how to present complex concepts through approaches that are accessible by all – you will learn how to translate the jargon of textbooks and engineers into clear and concise language, instruction and direction – so enabling the families who attend your classes the opportunity for true comprehension of fundamental scientific and engineering concepts and ideas.

Through this process you will learn how to approach generic conceptual material and problems – how to disassemble the seemingly impossible into the feasible and the workable, and how to communicate and transfer an understanding of science to the public – both of which will be of direct benefit to you now and in the future as you move forwards in your scientific career.

Last but not least, the satisfaction derived from this intellectual activity will pale into insignificance when you see a room full of children and their parents *get it* as they embrace the material and ideas you place in front of them. You will carry the smiles on their faces with you for the rest of your life knowing you have made a real difference. The families with whom you interact have been given the opportunity to engage 'real' (nascent) engineers in free and open discussion – and you will have given them the insight to 'see into' a phenomenon, concept or machine and understand it – you will open their eyes to science and engineering and the opportunities therein – from all this will emerge future STEM students.

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