TIES
Teaching Institute
for Excellence in STEM

Maker Faire and Fab Lab Roundtable

At the Bay Area Maker Faire
San Mateo Event Center
2495 South Delaware Street
San Mateo, CA

May 21, 2011

Maker Faire®

The Center for Bits and Atoms
Massachusetts Institute of Technology

Maker Faire and Fab Lab Roundtable

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At the Bay Area Maker Faire

San Mateo Event Center
2495 South Delaware Street • San Mateo, CA

Agenda

8:30 - 8:45 a.m. Breakfast/Introduction with Jan Morrison of TIES and Dale Dougherty of MAKE

8:45 - 10:45 a.m. Roundtable Discussion Moderated by Tom Kalil OSTP

Questions to be answered today:

Why are we gathered here?

Why are the Maker Movement and Fab Lab Community vitally important to our economic future?

How can we leverage our assets globally and provide:

- **Easy points of entry into the PreK-20 pre-engineering pipeline for interested funders, companies and organizations?**
- **Concrete programs that are scalable and measurable?**

How do we entice more companies and funders into the Maker/ Fab Lab Movement?

How do we inspire collaboration among existing programs and new-comers to nurture growth?

What programs already exist that can be easily scaled with available funds?

How do we integrate the burgeoning "merit badge" system into our efforts

How do we keep the momentum going after today and measure our progress?

10:45 a.m. - Noon Tour of Maker Faire with Dennis Bartels of Exploratorium

Attendees

Dennis Bartels, *Exploratorium*
Paulo Blikstein, *Stanford University*
Emily Brizendine, *Gateways Partnership, Cal State East Bay*
Willow Brugh, *Jigsaw Renaissance*
James Carlson, *School Factory*
Muhammed Chaudry, *SVE Foundation*
Linda Christopher, *LEED*
Tony DeRose, *Pixar*
Dale Dougherty, *MAKE Magazine*
Stuart Gannes, *Fab Foundation*
Neil Gershenfeld, *Center for Bits and Atoms, MIT*
Mark Greenlaw, *Cognizant*
Saul Griffith, *Other Lab & Instructables*
Susan Harvey, *S.D. Bechtel Foundation*
Mark Hatch, *TechShop*
Michelle Hlubinka, *MAKE Magazine*
Jennifer Hoachlander, *Connected California*
Gary Hoachlander, *Connected California*
Tom Kalil, *OSTP*
Lucinda Lee Katz, *Marin Country Day School*
Julie Kidd, *S.D. Bechtel, Jr. Foundation*
Michelle Kim, *Tiger Woods Foundation*
Michele Korb, *CSU East Bay*
Sherry Lassiter, *Center for Bits and Atoms, MIT & Fab Foundation*
Alexander Michel, *Forest City Enterprises*
Amon Millner, *Center for Bits and Atoms, MIT*
Melita Morales, *Marin Country Day School*
Jan Morrison, *TIES*
Debra Mustain, *San Bernadino County Schools*
Barbara Nagle, *UC Berkeley*
Matt Pearson, *Marin Country Day School*
Oscar Porter, *MESA*
Katie Rast, *Fab Lab San Diego*
Chris Roe, *CSLNet*
Bob Rosenberg, *Nueva School*
Diane Rosenberg, *Nueva School*
Kim Saxe, *Nueva School*
Gerald Solomon, *Samueli Foundation*
Soo Venkatesan, *S.D. Bechtel, Jr. Foundation*
Amy Wong, *SVE Foundation*

March 2, 2010

Prepared Remarks

***by* Jeff Raikes,** *Chief Executive Officer, Bill and Melinda Gates Foundation*

Thank you for a very nice introduction. I am grateful to the Pacific Science Center for inviting me to speak to you this morning.

One of the reasons I like coming to Seattle Center is to keep an eye on the construction across the street. We are very excited to move into our new campus next Spring. Bill, Melinda, and Bill Sr. always say that even though their work takes them to the furthest corners of the earth, it starts with the values they learned at home. That's why they insisted on building a headquarters in the heart of Seattle.

The Gates Foundation has committed more than $3 billion to organizations located in Washington state. More than $530 million of that has gone to help people right here in our community.

People are almost always surprised by that last figure. We get a lot of attention for our work in global health and development, and I think it sometimes overshadows the investments we make at home.

Every single one of our projects—no matter where it's located—originates from the same idea: that everyone deserves the chance at a healthy and productive life. The least prepared first grader deserves it just as much as the most prepared. The poorest children in the poorest countries deserve is just as much as your children, or mine. Bill and Melinda created the foundation because they wanted to do their part to make these principles a reality.

In the United States, we invest in education because we believe it is the key to opportunity. A good education paves the way for a rewarding career and a more rewarding life. A mediocre education stands in the way.

And one of the most powerful reform movements in education today is the STEM movement, which stands for Science, Technology, Engineering, and Math. At the Gates Foundation, STEM is an important complement to our College Ready strategy that stresses teacher effectiveness.

The STEM movement is an urgent priority for two reasons: First, it can resurrect the democratic promise of our school system—that it prepares all young people to succeed. And second, STEM can resurrect the spirit of innovation and economic vitality that has been so important to our prosperity for more than a century.

First, resurrecting our democratic promise.

We project that—every single year—there will be 1 million openings for high-paying STEM jobs that require some college. The STEM fields are where the opportunities of the future will lie.

But today, our education system simply isn't giving students the skills they need to seize those opportunities.

Let's take a close look at the numbers.

In a typical year, more than 4 million students start the ninth grade. Four years later, fewer than 3 million graduate.

Of those 3 million high school graduates, fewer than 1.5 million are prepared for college.

So, to review, we started with 4 million, and we're down to 1.5 million by the time college starts.

Out of that group, less than a quarter declares a major in a STEM field, so that takes us to about 300,000.

And just over half of the 300,000 get a degree on time.

What started as more than 4 million 14-year-olds ends up as fewer than 200,000 STEM graduates. Fewer than 10 percent of those are black or Latino students, which tells me that instead of making social divisions better, our schools are part of a system that is making them worse. A vigorous STEM movement can reverse that trend.

The second reason we're interested in STEM is that can resurrect our spirit of innovation and economic vitality.

Remember that we project 1 million STEM job openings annually, so we're looking at a shortfall of 800,000. And the negative economic impact of those unfilled jobs is immeasurable. That's because those are the jobs responsible for innovation, and innovation has always been the key to our economic fortunes.

And it's not just the number of degrees. It's the skills of the students getting the degrees. A few years ago, students in 30

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Prepared Remarks

by* Jeff Raikes,** *Chief Executive Officer, Bill and Melinda Gates Foundation* ***continued

nations participated in something called the Program for International Assessment. We finished 16 out of 30 in science literacy and 23 out of 30 in math literacy.

Those numbers are scary.

The raw material of American excellence—that relentless drive for innovation—is running low. Our schools are no longer producing it. We need the STEM movement if we hope to write a different story about our future.

The problem is especially stark here in Washington state. Demand for innovation is high: we rank fourth among states in the number of high-tech companies. But supply is, frankly, abysmal: we rank forty-sixth in the number of STEM graduates.

Right now, in the midst of a historic recession, there is a gap of at least 12,000 jobs in STEM fields in Washington. Double-digit unemployment, yet STEM industries have to look overseas for workers.

The state of Washington's response to this crisis has been shockingly inadequate. You may have heard about some of the things the Obama Administration is doing to encourage innovation in education. This state is well behind on every measure. I'm talking about basic things like putting rigorous standards in place and using the data we have to measure how teachers are performing.

The STEM movement is an important part of the solution. STEM does a lot more than provide a little extra help to students in science and math courses. It's much broader than making sure everyone stays on top of stoichiometry and the FOIL method.

STEM brings new players into the education sector, and it brings a new kind of pedagogy into the classroom.

Let me give you one of my favorite examples. MC-Squared, a high school in Cleveland, Ohio, is located at the headquarters of General Electric's Lighting Division. Just like the GE employees, the students at MC-Squared work year-round, and until 5 o'clock in the evening. You can't tell who's a research scientist and who's a teacher. You can't distinguish between a student and an intern. That's because the scientists are the teachers, and the students are the interns.

MC-Squared is home to one of the fewer-than-50 fabrication labs, or fab labs, in the entire world. A fab lab's computers run design software connected to cutting-edge production machinery—things like laser-powered etchers and robotic routers. One person called fab labs "technological sandboxes."

Students at MC-Squared have used the fab lab to make their own solar-powered phone chargers. And that process is coupled with social science and humanities lessons about global energy policy and the history of energy consumption.

It's the epitome of a hands-on curriculum. Students learn by doing. They learn that they can be bold about their talent—and audacious about what they plan to do with it. They learn to be the innovators this country needs. In short, the STEM movement resurrects a more ambitious concept of what public schooling is supposed to be about.

I've been using the word resurrect intentionally. Because the connection between STEM education and resurrection is personal for me.

I've loved science for as long as I can remember. My dad was trained as a chemical engineer, and he brought a STEM outlook to running our family farm in Nebraska. He always said that his training in engineering helped save our family farm during the Great Depression. My mother was a high school chemistry teacher and, later in her career, a junior high science teacher.

Alice Raikes was tough as nails. She insisted that her students, including me, write up professional-quality lab reports, starting with our hypotheses. One of my best friends from home, Clay Anderson, is an astronaut now. He's going back to the space station in two weeks, and he gives my mom a great deal of the credit for his success.

So, you see, I was pretty good in STEM. I was pretty hopeful about my future.

Then I went to Stanford. Naturally, given my career goals, I took engineering calculus my first quarter. Everything was fine until the midterm. Before Professor Peter Winkler handed it back, I remember him announcing that the median was an 85.

So when I saw that my grade was a 47, I decided I had to drop out.

Try to imagine where I was coming from. I aced advanced math at Ashland High School in Nebraska. I won the science fair. If those things translated into being doubled up by everyone else in my first class at Stanford, then I figured it was time to go back home.

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Prepared Remarks

by* Jeff Raikes,** *Chief Executive Officer, Bill and Melinda Gates Foundation* ***continued

Luckily, Professor Winkler intervened. He told me that most of my classmates had gone to fancy private schools and learned everything on the midterm the year before. He promised that we'd burned though the stuff they knew, and that they'd get theirs on the final. He also taught me how to study. I thought I only needed to read the text book. He introduced me to problem sets. Lots of problem sets.

So I stuck around, I did my problems, and I proved Professor Winkler right. I got a 92 on the final exam; that time, the median was 67.

I remember those numbers so clearly because they mark what I now think of as my own personal resurrection. I ended up getting a degree in engineering economic systems and building a satisfying career in software—and now another one in philanthropy, which, I might add, is heavily science- and math-based.

I sometimes reflect on how close I came to giving up. And I was lucky. I had support from wonderful teachers and from my parents.

How many talented students don't have those advantages? How many never make it? The evidence indicates that my resurrection was the exception, not the rule. We are wasting lots and lots of talent.

But I am hopeful that all that's about to change. Because the STEM movement in this state is about to take off.

Just last year, with support from Microsoft, Boeing, and Battelle—as well as the Allen Foundation and the Gates Foundation—a group called the Partnership for Learning launched the Washington STEM Initiative. Over the next few months, it will launch a multi-million dollar STEM Center.

The Center is the big bet on STEM in Washington state.

For years, local businesses and nonprofit organizations like the Science Center have been working in the education sector. The STEM Center will unify that work, and add to it, so that the people in Washington who have an interest in education will also have a powerful vehicle for reforming it. The Center will test cutting-edge ideas in pilot sites throughout the state, and it will work with key players in Washington to make sure the best ideas get scaled up.

Let me repeat, the Center is opening right now. We are about to see if STEM's potential to deliver a much better education to many more students gets realized in Washington.

So I have to ask, What are you going to do about it? I don't mean the rhetorical you. I mean you who have come to the Foundations of Science breakfast because you care about this community and believe in the importance of STEM in society.

The Center needs your support. It needs money. It needs political muscle in Olympia. Most of all, it needs your ideas. The same processes you use to solve problems in your area of expertise can solve our schools' problems. Using data creatively. Innovating on demand. These are things you can do, and they are things our schools need.

If you want to get in on the ground floor, I urge you to talk to Dean Allen, Brad Smith, or Elson Floyd, all of whom serve on the board. Dean Allen is here this morning.

You can also get in touch with the Partnership for Learning, which has been working on behalf of the Washington Roundtable to get the Center started.

If you care about the issues we've been talking about this morning, then nothing is more important than the success of the Washington STEM Center.

Every child should have an Alice Raikes, that tough as nails junior high teacher who makes them believe they can be an astronaut. Every young adult should have a Professor Winkler, who gives them the confidence and the skills they need to beat the curve. With a thriving STEM movement, we will all have our chance at resurrection. We can resurrect our students' capacity for innovation and our country's competitiveness in the 21st century global economy.

It's about our kids; it's about their education.

Thank you.

MIT Fab Labs

The current generation of digital natives flows seamlessly between being creators and consumers of content, having fun while building critical technical, creative, cognitive, and social literacies that will prepare them to shape their current and future world. While much of this work is happening outside of school, based on new media tools and content in online and virtual worlds, there is a growing population developing the ability to shape the physical world as well. A solar sunflower power charger for public parks, an electronic kiosk for disseminating information about teen pregnancy, a Green Wheel battery-powered bicycle focused on youth enterprise, an "iBed" comforter that serves as a smart alarm clock that won't stop ringing until the user gets out of bed, a game of Scrabble to help teach Haitian children how to read and write. These are a few of the projects that young people across the country have imagined and made using the MIT Fab Lab.

Fab Lab (short for fabrication laboratory) is the educational outreach component of MIT's Center for Bits and Atoms (CBA), an extension of our research into digital fabrication and computation. A Fab Lab is a technical prototyping platform for innovation and invention, providing stimulus for local entrepreneurship. A Fab Lab is also a platform for learning and innovation: a place to play, to create, to learn, to mentor, to invent. While originally designed for communities as prototyping platforms for local entrepreneurship, Fab Labs are increasingly being adopted by schools as platforms for project-based, hands-on STEM education. Users learn by designing and creating objects of personal interest or import. Empowered by the experience of making something themselves, they both learn and mentor each other, gaining deep knowledge about the machines, the materials, the design process, and the engineering that goes into invention and innovation. In educational settings, rather than relying on a fixed curriculum, learning happens in an authentic, engaging, personal context, one in which students go through a cycle of imagination, design, prototyping, reflection, and iteration as they find solutions to challenges or bring their ideas to life. In the US Fab Labs have been adopted by a number of Community Colleges in Illinois, Maryland, Michigan, Minnesota, Ohio, and Wisconsin with many more in development. Additionally Middle and High Schools are turning to the Fab Lab model as a new approach to applied, cross disciplinary STEM education. High schools in Michigan, New York, Ohio, and Oklahoma have already established Fab Labs which are showing promising student outcomes, and new school Fab Labs are planned in California, Washington, D.C., North Carolina, and Ohio.

A Fab Lab is comprised of off-the-shelf, industrial-grade fabrication and electronics tools, wrapped in open source software and programs written by researchers at MIT's Center for Bits & Atoms. Currently Fab Labs include a laser cutter that makes 2D and 3D structures, a sign cutter that plots in copper to make antennas and flex circuits, a high-resolution NC milling machine that makes circuit boards and precision parts, a large wood router for building furniture and housing, and a suite of electronic components and programming tools for low-cost, high-speed microcontrollers for on-site rapid circuit prototyping.

To be a Fab Lab means connecting to a global community of learners, educators, technologists, researchers, makers and innovators--a knowledge sharing network that spans 16 countries and 24 time zones. Because all Fab Labs share common tools and processes, the program is building a global network, a distributed laboratory for research, education and invention.

As support for advanced technical education, and to provide for professional development for teachers and lab managers, Fab Academy, an internationally distributed campus for technical education has emerged from the Fab Lab program. The Fab Academy provides instruction and supervises investigation of mechanisms, applications, and implications of digital fabrication.

For more information regarding the MIT Fab Lab Program, please contact:

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TIES
Teaching Institute for Excellence in STEM

TIES is the country's foremost innovator bringing STEM School design, STEM curriculum development, and STEM instructional support to schools, districts, states and the federal government. TIES works with all students in all kinds of communities to ensure that they are prepared for all post-secondary options especially those that lead to STEM fields and STEM teaching.

The Catalyst to Reinvigorate Our Public Schools and Erase the Achievement Gap

Cutting Edge School Design & Curriculum Development Customized to Address Local Workforce Development Needs

TIES design teams create and build the finest STEM schools throughout the country and recognize the importance of professional development for all teachers as the basis to improve and advance the character of science, technology, engineering and mathematics teaching for students regardless of grade level. Student performance is improved as the teaching of STEM education is shifted away from the traditional model which focuses on fragmented and isolated bits of discrete information towards the more practical model which focuses on scientific inquiry, understanding and reasoning. STEM education is trans-disciplinary in nature offering students the ability to use project-based learning to address real-world issues that affect their family, their community and their world.

TIES advisors establish a formal set of core design principles of STEM schools include intentional leadership, equity and democracy, project-based learning, innovation and dynamic systems, performance optimization, professional learning communities, student centered learning, real-world experiences, and collaborative networking.

TIES works with regional and state economic development organizations to fuel STEM education curriculum and instructional program development for the benefit of all. Our students are digital natives and TIES works to ensure that the "Technology and Engineering" in STEM drive the relevance of the "Science and Mathematics."

TIES STEM Advisors Provide Support to Individual Schools, Districts, States and The U.S. Department of Education

The TIES team consists of the most successful STEM principals in our nation, business leaders who have worked hard to design and implement STEM pipelines in their own economic cluster, and engineers and scientists who have turned their focus from their own research to the problems that face the next generation of scientists, engineers and explorers.

TIES advisors are expert in helping school systems assess their current assets and leverage valuable resources, organizations, and people to develop and then advance teaching and learning in the STEM disciplines. They utilize a proven network based education innovation infrastructure strategically designed to impact the local and national public education and economic systems.

TIES Offers the Only STEM School Model Specifically Designed to Turn Around Low-Achieving Schools

TIES has coordinated a team of national innovative design experts focused solely on turning low-achieving school systems into effective models of STEM school design. The team uses a STEM School Design Model based on proven network systems and processes that can be replicated, modified, and sustained in any school district regardless of geographic location or student demographics. Assuming a core set of design principles are met, this model will provide more students with access to quality real-world learning environments to achieve and perform at their maximum potential. The goal of this model is to build a community of critical thinkers that use creativity, scientific inquiry and technology to achieve academic excellence by exploring the world around them.

This innovative TIES model will help district/state leaders and instructional staff grapples with implementing a STEM school design model as a turn-around strategy and provide technical assistance to work through the complexities and change this innovation brings to a school system and its relationships to other systems.

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SF Bay Area
May 21–22, 2011
100,000 attendees

Detroit
July 30-31, 2011
30,000 attendees

New York
September 24–25, 2011
45,000 attendees

There is simply nothing else like it.

Emerging from a passionate, innovative and diverse DIY culture, the award-winning Maker Faire unites, inspires, informs and entertains a growing community of highly imaginative and curious people who come together in an energetic, family-focused environment to learn, participate, and imagine their world in new ways.

Maker Faire displays projects that cover a wide range of interests from technology, robots, sustainability, art, education, science and food. We celebrate the intrepid individuals who use unconventional, unexpected and even renegade techniques, materials and tools to experiment, invent, build, hack, play... and connect.

We proudly call these people "Makers."

The real story here is the curiosity, vibrancy, and passion of the Makers themselves, the people who comprise the rapidly emerging DIY category. Scientists, homemakers, students, automotive enthusiasts, software developers, musicians, crafters of all stripes: individuals and communities of people drawn together by a common delight in the magic of tinkering, hacking, creating, and reusing materials and technologies.

- Maker Faire has reached over 250,000 people in three years. Attendance at the flagship Bay Area event has grown from 22,000 attendees in 2006 to 95,000 in 2010.
- Average time spent at Maker Faire: 7.3 hours
- Builds on the success of Make Magazine, which has an enthusiastic readership of over 300,000.
- Our companion website, Makezine.com, is ranked in the top 50 of all blogs on the Internet. It reaches over 3 million unique visitors and over 5 million page views per month.
- MAKE's video series consistently ranks in the top 25 shows on the Internet with over 2 million views per month.
- The Craftzine.com site reaches over 1 million unique visitors a month – attracting crafty, community driven, tech-savvy females.

Recommended Reading

1. The New York Times; Published: May 13, 2011 The Kitchen-Table Industrialists By ANAND GIRIDHARADAS
   http://www.nytimes.com/2011/05/15/magazine/the-kitchen-table-industrialists.html

2. Carnegie-IAS Commission on Mathematics and Science Education. (2009). Opportunity Equation: Transforming Mathematics and Science Education for Citizenship and the Global Economy. Retrieved March 3, 2011 from http://opportunityequation.org/report <http://opportunityequation.org/report>

   Committee on Science Engineering and Public Policy. (2007). Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future Engineering in K-12. Retrieved March 3, 2011 from http://books.nap.edu/openbook.php?record_id=11463&page=R1 <http://books.nap.edu/openbook.php?record_id=11463&page=R1>

3. Do, E. & Gross, M. (2007). Environments for Creativity—A Lab for Making Things. In B. Shneiderman (Chair), Proceedings of the Creativity and Cognition Conference. Seeding Creativity: Tools, Media and Environments. (pp. 27-36). New York: The Association for Computing Machinery. Resnick, M. (2007). All I really need to now (about creative thinking) I learned (by studying how children learn) in kindergarten <http://www.media.mit.edu/%7Emres/papers/kindergarten-learning-approach.pdf> . Proceedings of the 6th ACM SIGCHI conference on Creativity and Cognition. Seeding Creativity: Tools, Media and Environments. (pp. 1-6). New York: The Association for Computing Machinery.

4. Frank Wilson's excellent book, The Hand: How Its Use Shapes the Brain, Language, and Human Culture <http://www.amazon.com/gp/product/0679740473/ref=pd_lpo_k2_dp_sr_1?pf_rd_p=486539851&pf_rd_s=lpo-top-stripe-1&pf_rd_t=201&pf_rd_i=0679412492&pf_rd_m=ATVPDKIKX0DER&pf_rd_r=18X7RMDSF95GEWW04D92> .

5. Make: Television, created by Richard Hudson at Twin Cities Public Television: http://makezine.tv/ <http://makezine.tv/>

6. http://www.nysci.org/learn/research/maker_faire_workshop

7. Pathways_to_Prosperity_Feb2011.pdf

8. young-makers[1].pdf

9. 1991Bamberger_LMT[1].pdf

10. Bay Area Maker Faire 2011 brochure is available at http://dl.dropbox.com/u/2977907/MF11BA_Insert.pdf

Making Their Way: Creating a Generation of "Thinkerers"

Elliot Washor, *Co-Founder of Big Picture Learning*

"Rise above oneself and grasp the world." -Archimedes (engraved on the Fields Medal)

Making is making a comeback. A cornucopia of fabrication and tech labs public and private are sprouting throughout the country. Maker Faires – sprawling outdoor extravaganzas that combine the atmosphere of a medieval fair with old low-tech and new high-tech garages – are bringing makers of all ages together to share their work and their learning. These new expressions of "thinkering" bring the wizened tinkerer and the tech-savvy youth together in playful competitions that range from the serious and sublime to the deliberately frivolous and outrageous. Fab labs provide makers with easy access to powerful and expensive technology tools in a community of like-minded minds.

Making provides opportunities for young people to use their hands and their minds together. Untold numbers of youth are messing around with all manner of tools to create, in tangible form, what's on their minds. Equally important, the maker movement nurtures communities of practice that bring adults and young people together around common interests. Thus, to visit the Maker Faire or a community-based fab lab is to see an aspect of our young people that we seldom witness in schools.

Sadly, however, to observe these young "thinkerers" is to be at least temporarily deluded into believing that this is what many of our young people are all about. Not so. Unfortunately, most young people do not experience making in their schools or in their lives. Literally and figuratively, most of our young people are not at the Faire. Research reveals that the vast majority of them are not into making at all and instead are frittering away their time in a variety of wasteful and unproductive learning activities.

Making is a celebration of an alternative and powerful way of knowing and of thinking things through. Consequently, making is typically antithetical to what traditional schools are all about. That is why the communities of practice that come together at Maker Faires and fabrication labs usually – some would say thankfully--flourish outside of schools.

A few educators, however, are circling these making places to determine where and how they fit in schools, if at all. Educational historian Larry Cremin once wryly noted, that educators respond to a new area of learning by creating a course in it. Recall how schools responded to technology by creating a course "down the hall at fifth period" without ever thinking about changing every course because technology existed. Similarly, educators run the risk of demeaning hand and mind work by creating separate courses for making rather than bringing making into all aspects of the school curriculum and thereby thoroughly reconstituting it.

It was this dissonance between actuality and potentiality that prompted Big Picture Learning to conduct at the end of July a symposium focused on young people "making their way in the world." Big Picture assembled a broad cross-section of individuals experienced with making and hand-mind learning – artists, craftspeople, neurologists, engineers, students and educators. We met in Dearborn, Michigan at The Henry Ford museum and used as our inspiration the Maker Faire that ran at The Henry Ford during the BPL (Big Picture Learning) symposium. That inveterate tinkerer Henry Ford was our muse and the Ford Motor Company Fund was our benefactor.

By using the Maker Faire as our source of inspiration, we observed, investigated, played, and analyzed how the aspects of making, inventing, and creating combine and fit in innovative ways into science, technology, engineering, and mathematics (STEM), career and technical education (CTE), and the arts. By looking across generations of makers at the vast assembly of fabricators, we gathered information on the practice, motivation, skill and determination of the Faire contributors.

Big Picture's purpose was to determine how making can be an integral part of how young people figure out who they are in the world and to show schools how to capitalize on the fact that people of all ages are natural fabricators and makers. People, as one symposium participant observed, "use their hands to figure things out," not just to solve a problem related to

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Making Their Way: Creating a Generation of "Thinkerers"

continued

what they are making, but to figure themselves out as well. Making provides us all a means of validating who we are, what we know and what we can do.

We centered our symposium conversations on several young people from our Big Picture Learning schools who had stories to tell about how making opened them up as learners and as individuals. We created images and examined data to develop additional insights. We harnessed this interplay between stories, images and data to gain perspective on the design of programs that might establish making as an important part of the school curriculum.

We reviewed disturbing data on how young people spend their time. We learned, for example, that they use the Internet about 12 hours a week, more time than they spend watching television (about 10 hours per week), talking on a cell phone (13 hours per week), and doing homework (9 hours per week).

The research reveals that the U.S. is becoming a nation of "non-tinkerers." In a poll of 1,000 U.S. adults, nearly six in 10 (58%) said they never have made or built a toy. More than a quarter (27%) have not made or built even one item from a list of eight common projects ranging from a dollhouse or piece of furniture to a fence or flower box.

As Frank Wilson, symposium participant, neurologist, and author of "The Hand" reminded us, the hand has "a mind of its own," as well as being at one with our minds. To engage the hand is to engage the mind. Thus, schools must provide for all students a hand-mind approach to the essential "academics." The hand-to-mind pathway is a way to engage all students and deepen their learning, to understand what quality looks like, and through practice and tinkering to apply discipline-based skills. Working the mind without the hands, and without a practice community of adults and young people, produces abstract learners who have difficulty applying what they know to the world around them. Making with hands and minds stimulates young people to develop their imaginative, creative, entrepreneurial, and scientific chops.

Schools can reap the rewards of making if they can resist the "curse of the course;" loosen rigid time structures to promote exploration and smart failures; and, in the evening and on weekends, open their labs, sheds and garages to the community and to makers of all ages and levels of expertise. They will need as well to bring the traditional academic disciplines – including the increasingly essential arts and design -- into those fab labs and to the making itself. By employing people, objects, places and situations (POPS) to support making, schools will prepare a whole generation of young people to succeed in the challenging careers out there now – and the ones that will be.