Designing Inclusive Makerspaces

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The Maker Movement

• Global, collective learning + doing
• DIY, reinvent, recycle
• Open, shared solutions
• Community hackerspaces, makerspaces
• All ages
• Next industrial revolution
A Movement Gathers Mass and Momentum

Number of attendees at Maker Faire
- 2013: 120K (San Francisco Bay Area 64K, New York 56K)
- 2012: 110K (San Francisco Bay Area 50K, New York 60K)
- 2011: 97K (San Francisco Bay Area 71K, New York 26K)
- 2010: 83K (San Francisco Bay Area 62K, New York 21K)
- 2009: Did not exist!

Revenue from maker-driven businesses

Kickstarter project hits
<table>
<thead>
<tr>
<th>Project</th>
<th>Goal</th>
<th>Funded</th>
<th># of backers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pebble</td>
<td>$100K</td>
<td>$10.3M</td>
<td>69,000</td>
</tr>
<tr>
<td>Oculus rift</td>
<td>$250K</td>
<td>$2.4M</td>
<td>9,522</td>
</tr>
<tr>
<td>Goldieblox</td>
<td>$150K</td>
<td>$286K</td>
<td>5,519</td>
</tr>
<tr>
<td>Safecast</td>
<td>$4K</td>
<td>$104K</td>
<td>290</td>
</tr>
</tbody>
</table>

>1,000 hackerspaces around the world
Find details at: http://hackerspaces.org/wiki/list_of_hacker_spaces

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Invent To Learn:
Making, Tinkering, and Engineering in the Classroom
www.InventToLearn.com

- Maker tools, materials, & tech
- Tinkering mindset
- Engineering design
- How to make the case for “making” in the classroom

robotics  e-textiles  3D printing  Arduino  Scratch  Raspberry Pi  programming  electronics  sensors  laser cutters  STEM/STEAM
Invent To Learn
Making, Tinkering, and Engineering in the Classroom

By Sylvia Libow Martinez & Gary Stager

Using technology to make, repair, or customize the things we need brings engineering, design, and computer science to the masses. Fortunately for educators, this maker movement overlaps with the natural inclinations of children and the power of learning by doing.

Buy now!

From the World of DIY
- Trash For Teaching
- Kid Inspiration - All for the Boys - SCIENCE FUN
- Hon Weng Chong: Paging Dr. Smartphone
- The Burgeoning Craft of 3D Printing
- The STEM Crisis is a Myth: An Ongoing Discussion - IEEE Spectrum

Upcoming Events
Leadership 3.0 Symposium 2014 – Sylvia (keynote)
April 10 - 12

Learning & the Brain Conference
May 8 - 10
Coming Soon

Making Science
Reimagining STEM Education in Middle School and Beyond
Christa Flores

Meaningful MAKING
Projects and Inspirations for Fab Labs and Makerspaces

Making in the K-3 Classroom
Why, How, and Wow!
Alice Baggett

from the publishers of Invent To Learn
Top Tools of the Maker Movement for Education

Computer controlled fabrication
1. Additive (3D printer)
2. Subtractive (mill, cutter)

Physical computing
3. Robotics
4. Microcontrollers (Arduino)
5. Microcomputers (Raspberry Pi)
6. Wearable computing (Lilypad, Flora)

Programming
7. Block-based (Scratch, SNAP, good for robotics)
8. Text-based (C, Arduino, Python, Processing - good for computing, design)

New conductive materials
9. Conductive paint, glue, tape, thread
10. Graphite pencils

Inventive interface elements/kits
11. MaKey MaKey
12. Hummingbird

Electronics components
13. Displays & LEDs
14. Sensors (light, heat, motion)
15. Motors
16. Special purpose batteries

Traditional/hybrid materials
17. Squishy Circuits
18. Cardboard
19. LEGO

Shared content & community
20. Design warehouses (Thingiverse, MAKE, Sparkfun)
21. Community websites
Materials and Spaces That Invite...

- Flexibility & serendipity
- Low threshold, high ceiling
- Artistic expression
- Sense-making (not making stuff)
- Agency
“The role of the teacher is to create the conditions for invention rather than provide ready-made knowledge.”

- Seymour Papert
Newest outposts of maker movement

Hacking biology - rapid prototyping a *Euglena gracilis* environment
“Bio is the new digital”
- Nicholas Negroponte

Programmable Behavior in Biology
Newest outposts of maker movement

Global health and education
Making is not a shopping list or a special place...

It’s a stance toward learning.
“When our schools become more gender-fair, education will improve for all our students—boys as well as girls—because excellence in education cannot be achieved without equity in education. By studying what happens to girls in school, we can gain valuable insights about what has to change in order for each student, every girl and every boy, to do as well as she or he can.”

– How Schools Shortchange Girls
(American Association of University Women Educational Foundation)
NEW RESEARCH FINDINGS

The road from Maker to computer science and engineering for girls and women

Making is a great way to interest girls and women in computer science and engineering activities.

Research suggests that girls involved with making, designing, and creating things with electronic tools may build a stronger interest—and greater skills—in computer science and engineering.

MakeHers: Engaging Girls and Women in Technology through Making, Creating, and Inventing intel.com/girlsintech
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Leah Buechley’s Critique of Make: Magazine
Leah Buechley’s Critique of Make: Magazine

9 YEARS
39 COVERS
PROJECTS

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronics</td>
<td>56%</td>
</tr>
<tr>
<td>Vehicles</td>
<td>31%</td>
</tr>
<tr>
<td>Robots</td>
<td>26%</td>
</tr>
<tr>
<td>Rockets</td>
<td>8%</td>
</tr>
<tr>
<td>Music</td>
<td>5%</td>
</tr>
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Leah Buechley’s Critique of Make: Magazine

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MEN</td>
<td>80 %</td>
</tr>
<tr>
<td>WOMEN</td>
<td>20 %</td>
</tr>
<tr>
<td>MEDIAN AGE</td>
<td>44</td>
</tr>
<tr>
<td>COLLEGE DEGREE</td>
<td>97 %</td>
</tr>
<tr>
<td>MEDIAN INCOME OF</td>
<td>$106,000</td>
</tr>
</tbody>
</table>
Resources

Maker
Invent To Learn
MakeHers: Engaging Girls and Women in Technology through Making, Creating, and Inventing (Intel infographic)
Power, Access, Status: The Discourse of Race, Gender, and Class in the Maker Movement

Virtual Handout
sylviamartinez.com/handout

Associations
National Girls Collaborative Project
National Council of Women and Informational Technology (NCWIT)
American Association of University Women (AAUW)
WISE (UK) - campaign to promote women in science, technology, and engineering

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Girls more likely to:

• Collaborate & strive for consensus
• Let others take credit / Take the blame
• Girls are more likely to look to the teacher for clues on how to behave or what to choose
• Decline to compete (including for scarce materials)
• Take on organizational roles
• Be compliant / adapt
Maker Mindset

* DIY
* Open
* Shared solutions
* Recycle, reuse
* Future-looking
* Artistic
* Get it done
* Self-reliant
* Positive
* Collaborative
* Smart
* Global citizen

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Makerspace

- Space design (space, tools, materials)
- What happens in the space (activities, lessons, free time)

Culture

- Framework
- Ongoing search for group identity
- Roles
- “The way we do things around here”
What are attributes of a gender-inclusive makerspace*?

*Can be a classroom, library, lab, or other learning space.

Write on post-it notes
Most important attribute on pink
Elements of School Culture

- Vision
- Rituals
- Ceremonies
- Values & Beliefs
- Climate
- Tools & Materials
- Mission
- Language
- Symbols
- Heroes
- Norms
- Stories

from School Culture Rewired: How to Define, Assess, and Transform It. Steve Gruenert & Todd Whitaker (ASCD)
What is important?

- Will be different for different groups
- Can point out strengths to build on
- Can point out what might be missing
- Provides a place to start
- Not a checklist
What can we do?
K - 12
Key Findings

The Maker Lab has been wildly popular with patrons.
Making has strong potential for building patrons' digital literacy.
The Maker Lab engages female patrons to participate in STEAM learning.
Making facilitates collaboration between learners and supports the library's role as a community convener.
Key Findings

- The Maker Lab has been wildly popular with patrons.
- Making has strong potential for building patrons’ digital literacy.
- The Maker Lab engages female patrons to participate in STEAM learning.
- Making facilitates collaboration between learners and supports the library’s role as a community convener.
Learn2Teach Teach2Learn

- Listening – Create a participatory culture that speedily responds to feedback and ideas.

- Collaboration, not competition – Knowledge is collective and responsibility is shared.

- Personal expression – Allow style, identity, and artistic expression to flourish.

- Making the world a better place – Technology is a way to help people and build relationships.

- Susan Klimczak, L2TT2L Education Organizer
In Recontextualizing the Makerspace: Culturally Responsive Education, she argues, “…for a redefinition of technology and technological processes that include engagements by groups underrepresented in the DIY/makerspace/hacker culture movement.”

Hip-hop artists Grandmaster Flash and Afrika Bambaataa, along with a few others, pioneered what we now know to be hip-hop music and culture. Grandmaster Flash is credited with the invention of the first cross-fader or audio mixer by reclaiming parts from a junkyard in the Bronx. Flash also advanced the technique of scratching, which is a DJ and turntablist technique used to produce distinctive sounds. Scratch programming was inspired by this method of music production.
Visitors from Boston's Office for Jobs & Community Services came to our Fab Lounge and worked with Fab Steward Naeem to make etched wood keychains on our lasercutter! They were exploring the possibilities for training at SETC!
GOAL: Transcending Black Lives Matter & Making Liberation

Creating a space to explore using technology to achieve liberation and catalyze (r)evolution.

Pair learning activities through vlogging and peer sharing.

Using new technologies to explore possibilities and express participation.

Workshop at Hope.

What is the big idea we want to address?

To express & elicit participation.

How can technology of the heart serve that purpose?
THE HARVEY MUDD MODEL

1. Update introductory course
2. Expose students to early research opportunities
3. Introduce students to the community of female computer scientists
Full steam ahead

- Flexible, open spaces, owned by the inhabitants
- Honor culture, community
- Model the maker mindset - “I don’t know, let’s find out!”
- Real problems, real research, real tools
- Value all kinds of making, tools, materials (craft vs. tech)
- Reduce risk, reduce stakes, reduce barriers to entry - open doors, transparency
- Peer mentors, leaders, experts
- Constant reflection and course correction
Proceed with caution

• Role models - work with, not talk at
• Gender differentiated experiences - supportive or enshrining segregation?
• Student-led, student voice - is it the voice of a mono-culture?
• Embrace differences, don’t enshrine them. Young people try on new identities.
Question

• Activities that differentiate boys from girls (stereotype threat)

• Adding “school” frameworks (grades, pre-requisites)

• What is popular

• Everything being a competition. Can the same quality of experience be had without a prize?
• Micro-inequalities (actions and words)
• Cheerleading - “Girls can be anything!”… Reinforces the unsaid stereotype.
• A deficit frame - we aren’t “fixing” girls or improving their self-confidence
• Unconscious bias - difficult to see your own bias.
Two more...

• How we teach STEM subjects needs to change

• Figure out how to fix teacher math and science anxiety
Problem Solving

• Dr. Seymour Papert defined two styles of problem solving: analytical and bricolage

• Bricolage - French for tinkering, using found objects, playfulness in creation

• Higher grades = more analytical

• Real world is both
Mastery Styles
Sherry Turkle

Hard Mastery    Academic & rigorous
linear, rigid, abstract, solitary

Soft Mastery    Naive & lazy
non-linear, messy, concrete, collaborative
"The bricoleur resembles the painter who stands back between brushstrokes, looks at the canvas, and only after this contemplation, decides what to do next." - Sherry Turkle
Teacher Math Anxiety

- Elementary education majors have some of the highest levels of mathematics anxiety
- Math anxiety impacts student learning
- Female teachers’ math anxiety disproportionally affects girls’ math achievement
- 90% of elementary teachers are female


Math is hard!
How do teachers learn to teach this way?

http://www.inventtolearn.com/workshops/
http://constructingmodernknowledge.com
A MINDS-ON INSTITUTE FOR EDUCATORS

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Guest Speakers include:
Reggio Children's Carla Rinaldi
TV's Paul DiMeo
MIT's Mitchel Resnick

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Let’s make it happen!

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