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Making the Case for Making

Jane Werner, Children's Museum of Pittsburgh, Leads a Conversation with Stephanie Change, Maker, Ed; Cara Lesser, KID Museum; and Sam Dean, Amazeum

Inspired by Maker Faire, launched in the Bay Area in 2006 by *Make: magazine* founder Dale Dougherty, schools, libraries, museums, and even for-profit groups have joined the maker movement. Over the past decade, makerspaces have blossomed in museums—especially children's museums and science museums, which champion learning by doing.

The hallmarks of the movement—makerspaces, maker faires, and making activities—appeal to visitors of all ages. Projects from electronics to sewing foster a deep engagement, increase possibilities for learning, and strengthen the role of museums as centers for learning and community involvement.

In this interview, Jane Werner, executive director of the Children's Museum of Pittsburgh, where the iconic MAKESHOP flourishes, spoke with directors from two new children's museums and the making-centered nonprofit Maker Ed about about the evolution of makerspaces, their increasing popularity, and more.

Stephanie Chang is director of programs at Maker Ed, a nonprofit organization that supports and empowers educators and communities, particularly underserved ones, to facilitate meaningful making and learning experiences with youth. Drawing from her extensive background in education, she oversees Maker Ed's project offerings, including Maker Corps, Maker VISTA, Young Makers, the Open Portfolio Project, Making Spaces, and the online Resource Library.

Sam Dean is the first executive director of the Scott Family Amazeum (Bentonville, AR). He previously worked with the Exploratorium in San Francisco in providing exhibits, educational experiences, and professional development to partners around the country. He created the hands-on traveling exhibition *Tinkering,* currently touring the U.S., designed a series of tinkering studios for six museums across Arkansas, and has helped design maker-rich exhibitions for museums in Oklahoma, Arkansas, Texas, and Turkey.

Cara Lesser is founder and executive director of KID Museum, a new children's museum in Bethesda, MD. In 2011, Cara left her career in health policy to create a new kind of children's museum that cultivates the creativity and skills necessary for elementary and middle-school aged kids to become innovative, bold leaders in the 21st century. The museum's core program centers on maker experiences that integrate science, technology, and art through hands-on, project-based learning.

Jane Werner's thirty-four years of museum experience include work at the Children's Museum of Pittsburgh, the Carnegie Science Center and the Franklin Institute. The museum is widely recognized as an educational leader in the Maker movement and is currently conducting a capital campaign to create Museum Lab, a children's cultural campus.

WERNER: The maker movement is about ten years old. Aside from its explosive growth, how has it evolved in the past decade?

CHANG: When the maker movement "officially" started ten years ago with the first Maker Faire and the publication of *Make:magazine,* it centered on adults, particularly affluent males. The magazine was initially focused on science and engineering. In fact it was intentionally designed to look like a reiteration of the classic how-to publications *Popular Science* and *Popular Mechanics.* But the movement has evolved and now brings together people from all different backgrounds, communities, and cultures—and it is completely embraced by youth. Kids not only visit maker faires, but they're exhibitors and makers themselves.

LESSER: Our museum is young, but we've already seen younger kids and an increasingly diverse population drawn to making. Caregivers are looking for ways for kids to tap into their creativity and curiosity, and to experience self-directed learning by figuring things out. The maker movement creates space for that to happen for all different types of learners: accelerated learners discover new challenges, while kids who struggle in traditional academic settings find tremendous opportunities for personal growth.

DEAN: In the early 2000s, before *Make:magazine,* the playful invention and exploration work out of MIT Media Lab contained threads of the maker movement. Obviously, making has gone on throughout time. But the grassroots work that's happened over the past decade has given the movement legs. Making is not a top-down, mandated activity; it's grown naturally from people who simply like to make things. There are no requirements for participation. You self-identify and then move closer to the center of a community of practice. With the explosion of social media communication, people can share ideas and identities, which helps attract more people.

WERNER: The early maker movement was kind of a boys' club with a no-

ticeable lack of involvement of women and people of color. Is that changing?

LESSER: Our multi-session school program Invention Studio provides kids with time to use tools, gain skills, and then apply that experience to designing and creating their own inventions. Schools that are looking for leadership opportunities for minorities, in particular, are very interested in this model.

DEAN: The Exploratorium and the Children's Museum of Pittsburgh are two leaders in thinking about how to broaden participation. Pittsburgh's MAKESHOP has lots of materials and tools—including sewing machines—that signify that the space can be used by lots of different folks for lots of different reasons. The Exploratorium's Tinkering Studio brings in many different artists, folks who are considered makers. It's a model of diversity in action.

CHANG: We work with a lot of schools that, when introduced to making, recognize it as something they already do. For instance, we worked with a predominantly Hispanic school in a high-need community on their Dia de los Muertos celebration. All of the crafting skills involved in those preparations are integral to what we consider making, and all are important for learning, as well. So, yes, we want to make sure that we're inclusive, but we also want to be clear about what making is and recognize it where it's already happening.

WERNER: An ACM member survey found the typical users in children's museum makerspaces are kids ages six to twelve. But we are surprised to find that three- and four-year-olds consider themselves makers, too. Have you seen younger children engaged in maker spaces?

LESSER: We have kids as young as three or four involved in maker activities that are way more sophisticated than one might expect for that age group. When we opened our maker space, we wanted the older kids to feel welcome—and they do—but younger kids come and engage as makers in the same way the older kids do.

WERNER: In our MAKESHOP, kindergarteners, regular visitors from the school across the street, use soldering irons. Working in groups of five, with an educator, they handle it just fine.

LESSER: We have four- and five-year-olds using power drills—of course in a safe environment, in small groups. But talk about empowering!

DEAN: The best makerspaces allow kids of any age and their adults to be on equal footing. A parent might use a tool for the first time, and their child will watch the parent struggle with something. Or vice versa. We see kids involved in an activity but overlook the powerful adult-child moments that are happening.

In our workshop, a small child made a mask, and when they took it home, their parent let them try to nail it on a wall. In the process, the kid put a big hole in the wall. So what they learned was, well, here's a moment of frustration. Let's move the mask up three inches, nail it in again, and cover the hole with the mask.

WERNER: Great story. So what makes a great maker space?

LESSER: The people who animate the space and facilitate great experiences. It must be conducive to learning, but at the end of the day, it's about how tools and materials are introduced and how kids' imaginations are sparked for where they can take them. This comes down to how educators guide experiences for kids and all visitors.

CHANG: Great makerspaces are about the people who work in them—their intentions and their ideals. They set the tone and communicate that it's safe to try new things, to make mistakes, to be both a novice and an expert. They have to be able to encourage new ideas and foster collaboration with people. Those human traits are much more important than the size of the physical space or the stuff in it.

DEAN: There's a patina and a smell to a maker space that, as you walk in, you think, "Whoa, this is it." The things that happen there are real, not staged, and there's a possibility in this space for interesting things to emerge. It's all about the people. Does your team generate ideas? Are they themselves makers? You can sense when you walk in, how staff talk about ideas, how they use tools, how they hold materials, and how they talk to you about your ideas.

WERNER: Can you have a makerspace without staff?

LESSER: In theory, you can buy equipment and call it a makerspace, but it is not going to be as effective for learning. Staffing is critical.

CHANG: You can't have a makerspace without the people who run it, because they create the relationships, monitor expectations, and think about the purpose and motivation behind the space and the tools and activities in it. Funders need to understand that staff capacity and professional development opportunities are as critical as how many supplies you have.

DEAN: I think about the concentric rings of participation. In the outer ring, where folks are introduced to making, staff are the most important elements, and tools are probably the least important. As you move closer to the center, ideas develop and specialized tools become more important as folks start doing small-batch fabrication or need a more lab-type of environment. On the other hand, makerspaces also attract folks who don't need to be introduced to tools. They have their own skills, but they're looking for a community of practice—looking for their tribe. So staff people need to have flexibility to engage with people at all levels of access and participation.

WERNER: Making has made us think differently about the museum. In the MAKESHOP, it doesn't matter what people are making, it's the interactions among them that are so rich. But this new focus on experiences and people has shifted how we think about budgeting. We don't raise money for the stuff, we raise money for payroll and investing in talent. Are you seeing this happen in your museums?

DEAN: A little over a year old here, we don't have to think "differently" because we built our model around investing in the people, in a heavy staff presence on the floor. We sacrifice many traditional back-of-house positions to make sure our front-of-house has more connection with visitors.

LESSER: KID Museum is still working on models for its permanent home, but already we're very different from a traditional children's museum. Rather than invest in building out exhibit space, we're creating collaborative workspace focused on interaction among visitors and with staff planning and prototyping those experiences.

WERNER: How are museums and libraries reinventing themselves around their makerspaces?

CHANG: If a library's book circulation or visitorship is down, its leaders might re-

think what the library is for. It's an open community space. What is the best way to engage people who make up the community? How does it reflect their interests, desires, and skills? Adding making to the mix attracts a broader variety of people. People might be drawn to a library for the making activities, but then check out books because they're there. As a result, we are rethinking what literacy means. Is it just about reading? Or is it about interpreting the world? A lot of budgets are being re-edited to emphasize people, who are integral to creating the experiences and the environment itself.

WERNER: An exhibit designer commented that "maker spaces were arts and crafts rooms with bigger expectations." How do you all feel about this description?

DEAN: A lot of arts and crafts spaces are now called "maker spaces" with no depth or reason why they're called that. It misses the point of the Maker movement and trashes traditional arts and crafts spaces at the same time. When you try to merge the two kinds of spaces together, you end up with a mess that lacks intentionality and the glory that happens when you're true to the intent of either space.

LESSER: In maker learning creativity plus agency empowers kids—or adults. More than just experimenting with tools and materials, maker spaces build a sense of self-efficacy and increase the ability to apply skills in ways that go beyond a single creative project. Making can lead to the development of social and emotional skills in the process of pursuing creative expression.

WERNER: How is making different from arts and crafts?

CHANG: When we talk about arts and crafts, we often stereotypically think about very young learners with cardboard and pipe cleaners, which is not a bad thing at all. But that perspective diminishes arts and crafts. The arts and crafts movements—both at the turn of the 20th century and later in the 1960s—are much bigger than that, and include architecture, woodworking, and glassblowing, to name a few immense areas of creativity and innovation. There are gender issues here, too. "Crafts" are often identified as female, and STEM as male. Response to these types of questions can reflect some of those underlying biases.

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WERNER: Recently, a provost from Carnegie Mellon visiting MAKESHOP said, "This is brilliant. You're really getting kids ready to think about how technology's going to be completely embedded in the physical world." Do you agree that maker spaces encourage kids to think about the integration between technology and physical objects?

LESSER: Kids feel the separation between technology and "other" as much as we do. I think they enjoy having a space where they can play with both technology and tactile materials that's not bifurcated.

DEAN: Maker activities also prepare kids to talk to their parents about getting ready for the future. It's like recycling: the biggest motivation that got parents to recycle was getting their kids excited about it because they made their parents do it. Making introduces kids to a fusion of high tech/low tech concepts, and allows them to understand these concepts in a visceral, hands-on way. Children have so few opportunities to do this in other realms of their life unless their parent is involved in that domain.

CHANG: There's less of a separation these days between high tech/low tech. Maybe today's kids won't see arts and crafts as separate from making either. Technology is often thought of being what perfectly, immediately, and mysteriously goes on in a beautiful white box, but it's more than that. Making allows kids to open up the box and look inside so they understand how it does or doesn't work and what the possibilities are. With the prevalence of immediate gratification these days, setting the stage for people to tinker, uncover, unpack, and take apart is really important.

WERNER: How effective are makerspaces? What does maker education really do?

CHANG: There's a lot of research going on to address questions from a wide variety of perspectives and entry points. How does this work advance overall learning? Is this investment in people and tools better than what we did before making was "invented"? There's also specific research around maker-centered learning—trying to understand what engagement looks like, what flow looks like, what indicators show that engaging in making correlates with a child having more confidence in their abilities. There's an unusually rich, open line of conversation between researchers and practitioners. Research into both practical and theoretical sides goes back and forth, each informing the other to understand the effects and the consequences of it all.

The Framework Project, supported by the Institute of Museum and Library Services (IMLS), is designed to help folks think about how museums and libraries can use making to enable learning. It focuses on three simple areas: purpose, people, and pieces and parts. Thinking about makerspaces in that order results in effective, engaging, conducive learning environments that are purposeful and have intention and goals behind them. People often start backwards: focusing on tools and equipment and forgetting that people and purpose are more important.

DEAN: One of the maker movement's greatest strengths is also its greatest research challenge: it runs cross-sector. There are implications in formal and informal education, but there are also as many implications in the entrepreneurial system and workforce development. All of these pieces bundle together to produce a larger possible societal impact, beyond the formal and informal education system.

WERNER: Why do you think the maker movement has taken root and blossomed in all sectors of life now?

LESSER: Based on what kids experience both in and out of school, there's a demand for more opportunities for creative expression as well as greater accessibility to technologies like Raspberry Pi or an Arduino. There are no borders between digital and physical worlds for this generation of digital natives. Everyone has seen the cost of the narrow focus of trying to respond to the need for academic rigor. So now, how do we create more space for kids to learn by figuring things out, by playing around with things? How can creative expression really flourish?

CHANG: Making in formal learning settings is a reaction to the standardized testing environments in schools. It's spurred by what's often termed the "democratization of technology": increased competition has made tech items cheaper and more accessible. Even access to the internet is better these days.

Finally, in global discussions about preparing individuals for the workforce and thinking about college and career opportunities, people are beginning to realize we can't predict what the exact jobs of the future will be. The best way to prepare students is to help them develop problem-solving, creative, critical-thinking skills. And one of the best ways to do that might be through making.

DEAN: I live in a community that has a fairly large international retailer. They just launched a $250 billion movement to bring manufacturing back to the U.S. for fiscal reasons. The ability to work in a trade is becoming more of an acceptable career again, not a fallback career. There's a lot of local discussion about trades and alternate pathways of education—legitimate pathways for learning—that we weren't hearing about fifteen, twenty years ago. There are good jobs in those areas. It suddenly feels more acceptable to work with tools and with your hands in ways that people avoided in the '80s and '90s.

WERNER: My dad was a steelworker. We had a great life, but we thought the good jobs were the ones where you sat behind a desk in an office and made a lot of money. There's a different feeling about honoring work now. Here in Pittsburgh, a manufacturing town, people are honest, hardworking. There's an ethos here about keeping it real…and making things. The maker movement honors work—a belief we've lost along the way.

LESSER: My experience in the Washington, DC, policy world is a big part of what motivated me to start the KID Museum: we need more creative, bold leadership in policy making as well as in manufacturing and making things with our hands. Kids need to develop an ability to believe in themselves and be creative leaders across a wide range of sectors.

WERNER: A lot of making activities have been focused on STEM and STEAM. But what about the social and emotional impact of making on kids?

LESSER: In making, there's space for trial and error, something that has been squeezed out of schools. Hands-on learning can result in profound personal growth. We've implemented a mentorship program in which eighth graders mentor seventh graders working in our space, pushing us to articulate more of the social/emotional development components linked to the maker experience. For example, we hear kids saying, "I'm smarter than I thought I was. When I put my mind to it I could do it." Kids don't use buzzwords like "resilience" and "grit." They're having authentic experiences of working through problems that they're motivated to solve, and coming through it feeling stronger, with a greater sense of self-confidence, self-efficacy, and self-worth.

DEAN: The least important dimension of learning is domain-specific content (even if it's talked about the most when you're trying to secure support from corporations or funders). Making is often spoken about this way ("We're learning STEM in here" or "We're learning arts in here."), but that's reductionist.

Physical, cognitive, and social/emotional skillset learning is an important dimension of learning in makerspaces. This includes attitudes or habits of mind like perseverance, learning how to have a curious nature, or learning how to respect tools and respect other people. These attitudes are probably the most important things that come out of makerspaces, along with identity, particularly among kids who might not think of themselves as makers.

We hold annual Tinkering Festivals in which every experience is participatory for families. One activity involves taking apart a vehicle piece by piece under the guidance of a real mechanic. One girl, dressed in a princess dress, put on goggles, gloves, and started going to town taking apart this minivan. Her parents were amazed: "I can't believe she's spending so much time in there. We didn't think she liked to work with tools." And our next question was, "Well, have you ever given her a tool to work with?" "Well, no."

That was an "ah-ha" moment. Consciously or unconsciously, they had limited her exposure, but the makerspace broadened it. Her parents now identify her as someone with previously unidentified capabilities and interests. I get frustrated when people call it a "STEM space" because making is at an intersection of many interesting ideas. You need space for possibilities to bloss

CHANG: Making is a vehicle for growth, development, and learning, from choosing a career to realizing the importance of working with tools. When we limit our talk to STEM and STEAM, we forget that there's so much more to it. Without the confidence that comes from knowing you have the skills to contribute to any project, environment, or community, a STEM career doesn't mean much.

WERNER: How do funders respond to requests for funding makerspaces?

DEAN: The language around the maker movement and tinkering spaces is tricky and can be hard to explain to funders. Instead of writing a letter or talking about it on the phone, you want to say, "Hey, can you just drive over here and stand and watch our makerspace for half an hour. You will want to fund us." As soon as people have a personal experience, they get it really fast. Makerspaces are interesting and very fundable, but it's hard to write a proposal without that firsthand experience.

LESSER: I learned that the hard way when I sat in on an open grant review panel of one of our museum's maker proposals. We had a line item for "consumables," which is a term used frequently in the maker community to refer to program materials that cannot be reused for future projects. A handful of funders understood it, but others didn't, and we didn't have the opportunity to clarify. It is really hard to capture the power of making concisely if you haven't witnessed it first-hand.

WERNER: What do the funders who "get it" like about it? Pretty much everything!

DEAN: 3M sponsors our Tinkering Hub, and their representatives visited our space with the company's "innovation platforms" in mind. They walked in and immediately said, "This is what we want. We want to hire these kids in twenty years." Later, IBM employees, in town for a big tech conference, visited the Tinkering Hub. It was one of the first times I've seen guests use some of our experiences to depths that are built into the interactive. They rapidly used the same exhibit in different ways in the span of minutes, from giggling, exploratory play to rotational dynamics in one case. Often, at a parent's behest, kids may start and stop at a point that still leaves lots of grist to explore.

One of the maker movement's greatest strengths is also its greatest research challenge: it runs cross-sector. There are implications in formal and informal education, but there are also as many implications in the entrepreneurial system and workforce development. All of these pieces bundle together to produce a larger possible societal impact, beyond the formal and informal education system.

CHANG: Funders have their own goals. So our broad use of buzzwords or phrases like STEM, STEAM, workforce development, or creative confidence is fine as long as we don't drift from the goal of understanding what making enables (problem-solving skills, interest in learning, agency). If a funder is really interested in STEAM, we can potentially show how this connects. But can we absolutely say that there is a causal relationship between making activities and later STEAM proficiency? Not yet. But that's ultimately where the research must go, which will further help define and clarify a case for support.

WERNER: Funders are people, and all people have some kind of experience with making something. You can talk with funders about STEM, STEAM and all the educational objectives of making, but when you talk about their childhood or what they make now, if you can reach them at the human level, then they start seeing the importance of it. There's an emotional case to be made. Here in Pittsburgh people walk into the MAKESHOP, or they hear about it, or see a picture of something that a kid has made, and they immediately want to fund it. Because it's real, and it shows what children can do to change the world. If you have a good idea, and pitch it at the emotional level, you can always find the funding.

DEAN: Jane, does this broaden the pathway to participation for some smaller, perhaps trades-based businesses that might normally be harder to recruit to join as museum funders?

WERNER: Absolutely. It broadens the audience—our funding base—in so many ways. Our Make Nights, aimed at young adults, sell out every time. Twenty-three-year-olds are participating. (Power tools and alcohol, what could go wrong?) We have started a fundraising group called the New Friends Committee, and they all came through Make Night. Making introduces new audiences to the museum, and frankly, they're our funding base for the future.

Final question: if you want to start a maker space, what would you do first?

DEAN: First, know why you want to build a maker space. And secondly, visit ones that you hear are really awesome. Don't just go buy a 3D printer.

LESSER: Before you buy any equipment, think about the needs, interests, desires, and intentions from your community. What is going to make your space their space?

CHANG: That framework is perfect: the purpose, the people, and then finally the parts and pieces.

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