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INSIDE: ADDING VALUE BY CELEBRATING SCIENCE

ALSO, A NEW PARTNERSHIP BETWEEN TRAVELING EXHIBITIONS AND GIANT SCREEN FILMS,
RESULTS FROM THE INTERNATIONAL SCIENCE CENTER IMPACT STUDY, AND MORE.

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STAR LIBRARY EDUCATION NETWORK

By P.B. Dusenbery

“
A LIBRARY OUTRANKS
ANY OTHER THING A
COMMUNITY CAN DO TO
BENEFIT ITS PEOPLE
~ANDREW CARNEGIE
”

Introduction

From climate change to decreasing biodiversity to threats to human health and access to clean water, the majority of challenges facing society today – and their solutions – are rooted in science, technology, engineering, and math (STEM) (c.f., NAE, 2008; Climate Literacy, 2009). The STEM workforce of tomorrow requires highly competent STEM professionals and a public that is sufficiently STEM literate to assess the choices before them (NSB, 2010). It is not too surprising that many jobs today require what the Institute of Museums and Library Services (IMLS) calls 21st Century Skills such as critical thinking, creativity and innovation, collaboration and communication (IMLS, 2009). The fastest growing occupations in our nation require high levels of proficiency in STEM (NAS, 2006; NSB, 2010); unfortunately, less than 20% of our high school students are ranked as proficient in these disciplines (Nation’s Report Card, 2010). Beyond addressing the challenges of today, STEM achievement is an investment in tomorrow’s innovators and innovations.

Falk and Dierking (2013) observed that “Average Americans spend less than 5 percent of their life in classrooms, and an ever-growing body of evidence demonstrates that most science is learned outside of school.” They argue that it would be more effective for the nation to direct its education reform focus away from a school-centric approach to exploring the role that free-choice experiences play in the public understanding of STEM. Research shows that family attitudes about the joy and love of learning and their willingness to support their children’s learning in and out of school is the single most important predictor of student success (Henderson and Mapp, 2002; Harackiewicz et al., 2012). The role of families and the educational impact that community organizations and free-choice programs can

have is therefore critical to success in school. In this equation for success, public libraries can provide the community involvement that can be so critical to a child’s evolving identity as a learner.

In 2010, American libraries received about 1.6 billion visits from patrons (IMLS, 2013). Libraries are natural venues for engaging and educating the public about science and technology (both content and process knowledge). Over 16,000 public library outlets exist nationwide, often at the heart of rural and urban under-served and low-income populations. The public library of today is very different from that of 10 years ago. Recognizing that they are the only public institutions to offer free access to information, technology, and services to educationally at-risk populations, libraries are evolving from storing books to offering continuing education, academic assistance, parenting classes and children’s programs in accordance with the cultures and needs of their local audiences. Attuned to the need to support academic achievement, libraries are seeking innovative methods for engaging their audiences such as interactive exhibits and STEM programming for their children’s and youth programs (Shipp et al., 2008; Smith et al., 2012; Dusenbery, 2014). Designed spaces, like libraries, allow lifelong, life-wide, and life-deep learning to take place (Bell et al., 2009).

The essential mission of most public libraries is to serve their communities with lifelong learning opportunities. With thousands of libraries, there is an enormous potential for engaging under-served youth and their families in fostering an appreciation and deeper understanding of science and technology topics (Dusenbery, 2014). To utilize this largely untapped resource, the Space Science Institute’s National Center for Interactive Learning (NCIL), in partnership with the American Library Association (ALA), the Lunar and Planetary Institute (LPI), and the National Girls Collaborative Project (NGCP), received funding from the National Science Foundation (NSF) to create a new national education project for libraries that focuses on building STEM skills through developing “science-technology activities and resources” (STAR). This project, known as the STAR Library Education Network (STAR_Net), is a hands-on learning program for libraries and their communities across the country. Other key partners included Evaluation & Research Associates (ERA) who conducted the summative evaluation, University of Colorado, Engineers Without

Borders-USA, and the National Renewable Energy Lab.

STAR_Net Goals and Deliverables

The three primary project goals for STAR_Net are to

1. Increase youth and adult patrons' interest, knowledge, and engagement in STEM topics,
2. Increase STEM program participation at libraries in communities with populations under-served and underrepresented in STEM, and
3. Build the capacity of libraries and library staff nationwide to deliver inspirational and effective STEM learning experiences for their communities.

In order to achieve these goals, the project's deliverables were:

1. Design, fabricate and tour 2 STEM-based, interactive exhibits (*Discover Earth* and *Discover Tech*).
2. Develop inquiry-based activities and resources (for host and non-host libraries) in collaboration with professional STEM organizations.
3. Develop and implement a library staff training program (online and in-person).
4. Create an online Community of Practice (CoP) that includes project team members, librarians, and professionals in relevant STEM disciplines.
5. Conduct education research and evaluation and disseminate results to the informal STEM education and library communities through presentations at professional education meetings and publications.
6. Design and launch a STAR_Net project website (www.starnetlibraries.org).

As part of the STAR_Net project, John Baek (2013a) developed a foundational research model for exploring STEM learning in libraries that used the set of informal science learning characteristics identified by Bell et al. (2009). The six strands that were identified articulate science specific capabilities supported by informal environments. He found that the following three Strands fit best in a public library setting: *Strand 1* (Supporting Excitement, Interest, and Motivation); *Strand 5* (Engaging in Scientific Practices); and *Strand 6* (Development of a Science Learning Identity). He also used the concept of a Third Place (Oldenburg, 1999; Pastore, 2009) to define the modern public library. The first place is home and the second place is the workplace (for adults) and school (for students). Third spaces are the informal meeting places (e.g., pubs, barbershops, cafes) that are anchors of community life that foster creative interactions and community building. Public libraries can be considered an ideal third place because they are free, accessible, welcoming, and have many regulars (especially parents).

Baek (2013b) also examined the impact of STEM programming on library staff using the concept of an *accidental STEM librarian* (i.e., a librarian who does not have professional training in STEM programming). This can be a useful approach to inform the design and planning for professional development of librarians in STEM education. It may be that accidental STEM librarians will be the majority within a library. As a target audience, they will require training that addresses their concerns and perceived gaps in competency.



Figure 1 (above): Library patrons participate in a Discover Earth program. Courtesy NCIL

Figure 2 (below): Discover Earth and Discover Tech tour locations



STAR_Net education programs have been designed with the goal to inspire lifelong learning through inquiry and play (Dusenbery, 2013). They include museum-quality, interactive exhibits, along with a rich variety of programming developed by library staff or external partners. Over 140 libraries applied to ALA to host the project's two interactive traveling exhibits: *Discover Earth: A Century of Change* and *Discover Tech: Engineers Make a World of Difference*. Only 19 libraries were able to be selected. The project team is

currently planning a short extended tour to 5-6 libraries in 2014/2015. This overwhelming demand is consistent with the results of the NCIL and ALA survey in 2008 (Dusenbery, 2014).

Discover Earth: A Century of Change

Our view of Earth from space has deepened our understanding of the planet as a global, dynamic system. Instruments on satellites and spacecraft, coupled with advances in ground-based research, have provided us with astonishing new perspectives of our planet. The project development team agreed upon the following Big Idea statement (Serrell, 1996) for the exhibition: My Changing World: The global environment changes—and is changed by—our community’s local environment.



Figure 3: The Magic Planet component in Discover Earth. Courtesy NCIL

Discover Earth features interactive, multimedia displays that allow library visitors to explore local and global earth system topics—such as weather, water cycle, and ecosystem changes. This approach allows patrons to make personal connections through a local perspective, and then place it in a larger context. Each host library creates a photo archive of local environmental changes (within the last 100 years) and displays their photos as part of the exhibit. This reinforces the “century of change” concept. Library patrons can also contribute photos for this exhibit element and participate in discussions about how the environment

impacts people and how people impact the environment.

The exhibition featured a 16-inch-diameter Magic Planet™ globe and a 42-inch multi-touch table computer. Discover Earth integrated personal narratives, robust graphics, video, museum-quality animations, weather artifacts, animal specimens, and simulation-based educational games. Each host library received their own real-time digital weather station (from Davis Instruments) that collects data and shows how local temperature, pressure, and precipitation change during the time the exhibition stayed at the library and after the exhibit leaves.

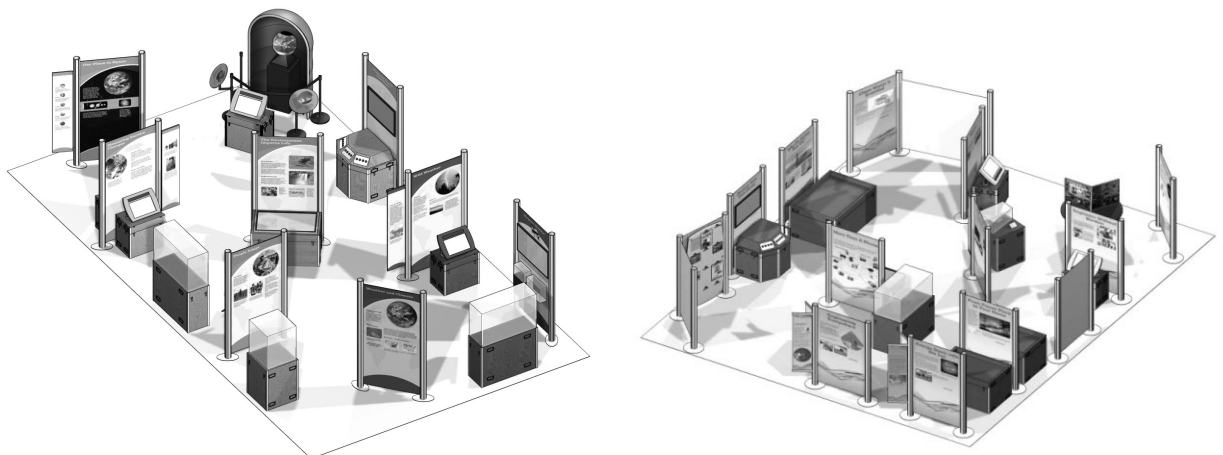
Discover Tech: Engineers Make a World of Difference

Technology has been an integral part of the human experience since the invention of stone tools and the mastery of fire. Now it is a driving force of civilization. Technology and engineering influence every facet of human life. Clean water, reliable sources of energy, safe shelter and food, modern health care, diverse transportation options and global mass communication —things we take for granted daily—all depend on technology and an understanding of the engineering design process.

Discover Tech shows how engineering provides solutions to better meet human needs and explores how engineers create new technologies to solve problems. The exhibition was designed to help host libraries and their communities understand the global issues affecting our planet, such as the National Academy of Engineering’s 14 Grand Challenges for Engineering (NAE, 2008). The Big Idea statement for this exhibition was chosen to be *Change the world for the better, one problem at a time.*

Discover Tech features a number of hands-on activities that engage people of all ages. These include a three-person quiz game that allows visitors to explore the engineering process while addressing misconceptions about what engineers really do and a hands-on challenge in which visitors cooperate to build their own arch structure. At the Inventors Lab station, visitors can build 300 different electrical

Figure 4 (left): The Discover Earth exhibit floorplan; Figure 5 (right): Discover Tech exhibit floorplan. Courtesy NCIL



circuits. A state-of-the-art, 42" interactive touch table includes an activity called Game Changers that presents the 14 Grand Challenges for Engineering.

Visitors can choose from several inspirational videos showing members of Engineers Without Borders (EWB) using their skills to profoundly improve the quality of life for communities in Central America, South America, Africa, and Asia. Exhibits also address the importance of energy in modern society. For example, using a hand-crank generator, visitors can produce electrical energy that can be used to power various types of light bulbs and learn which one uses the least energy to operate. Nearby, the *Solar Power* station demonstrates the basic functioning of solar energy by allowing visitors to experiment with a light source and a large solar panel.



Figure 6: A Visitor builds an arch and then takes it down.
Courtesy NCIL.

STAR_Net's Community of Practice

The *STAR_Net* CoP currently has about 500 members from all 50 states, Canada, Mexico and the Philippines. Approximately 50 members of the community are STEM professionals who are working with their local libraries to provide STEM programming. CoPs are "groups of people who share a common concern or passion for something they do and learn how to do it better as they interact regularly," (Wenger et al., 2002).

To help with *STAR_Net's* CoP efforts, the project has created a web-based infrastructure for communications and resource sharing, which provides its members with professional development, resources, and opportunities for facilitating various STEM programs in libraries.

The project team has been guided by the extensive body of research on communities of practice (e.g., Wenger et al., 2002) such as (1) identifying gaps in knowledge and developing a learning agenda; (2) measuring the value of the community; (3) maintaining a cutting-edge focus; and (4) continuing to build and organize a knowledge repository. CoP goals include (1) continuing to grow the community; (2) improving and further developing the infrastructure that supports the online community; and (3) providing professional development opportunities for the communi-

ty (e.g. webinars) by supporting the learning that occurs by exchanging information and best practices. The *STAR_Net* project has conducted several webinars addressing topics such as collaboration and how to implement standards-based activities that were developed for *Discover Earth* and *Discover Tech*. All informal STEM educators are welcome to join this emerging CoP. Go to www.community.starnetlibraries.org for more information.

Project Impacts

The project team conducted both front-end and formative evaluation internally (led by Kate Haley Goldman). Evaluation & Research Associates (ERA) conducted the summative evaluation (led by Ginger Fitzhugh, Vicky Ragan Coulon, and Julie Elworth). The evaluation team developed a detailed logic model in collaboration with the project leadership, co-crafted evaluation questions, and drafted a detailed plan to measure the impact of *STAR_Net* on participating librarians and library patrons. They also administered a planning survey to the *Discover Earth* librarians in May 2012 to determine the feasibility of collecting data from library staff and patrons, and used the results to inform development of nine different evaluation instruments. Institutional Review Board approval for the summative evaluation design and instruments was obtained in July 2012 and data collection began.

The summative evaluation utilized mixed methods to investigate project implementation and its outcomes. Methods included pre- and post-exhibit surveys administered to staff from each library that hosted the exhibits; interviews with staff from host libraries; patron surveys; exhibit-related circulation records; web metrics regarding the online *STAR_Net* CoP; and site visits to five *Discover Earth* and *Discover Tech* libraries, during which patrons and library staff were observed and interviewed.

An online exhibit report form that libraries complete shortly after the exhibits leave their libraries asks staff to estimate the total number and demographics of visitors to the exhibit, and to describe exhibit-related programming conducted while the exhibit was at their library. The ERA team provided the *STAR_Net* leadership with access to

“ WE’RE GETTING MORE FAMILIES HERE THAN WE NORMALLY WOULD. WE’LL SEE THEM ENGAGING AND PLAYING AND HAVING A LOT OF FUN. ~STAR_NET LIBRARY STAFF MEMBER ”

the report data to aid in project planning and reporting. Key findings from the evaluation (ERA, 2013) included the following: 1) STAR_Net professional development helped *Discover Earth* and *Discover Tech* librarians host the exhibits and deliver informal science education programming; 2) The redesigned STAR_Net CoP website has increased reach, but has not yet reached its potential; 3) All of the libraries implemented informal science activities while they hosted the *Discover Earth* or *Discover Tech* exhibit, and at least two thirds of the libraries reported that they had offered additional STEM programming after the exhibit had left their libraries; 4) STAR_Net succeeded in reaching the targeted library participants and audiences at the host libraries; and 5) Many library patrons at the host libraries became more interested, knowledgeable, and engaged in the STEM topics presented in the exhibits and related

That is, over the course of an exhibition, a large percentage of visitors will have stopped at more than half of the exhibits and many will have stopped at all of the interactive components.

Like library staff, patrons from the host libraries were beginning to see the library as a place for STEM learning. All patrons who were interviewed during site visits said they were supportive of libraries hosting STEM exhibits. Several librarians said that patrons continued to talk or ask about the exhibit, even months after it left their facility. About half of the librarians (47%) who completed the Six Month Post-Exhibit Survey said that patrons had asked for more activities or programs. Many librarians also said they believe that patrons now see the library as more than just a repository for books.

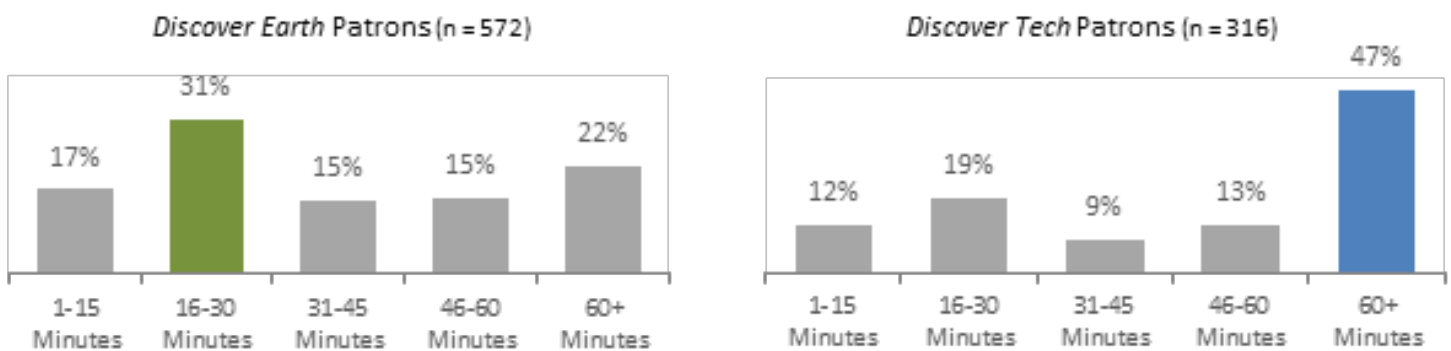


Figure 7: Average engagement times for both STAR_Net exhibits (ERA, 2013)

programming.

A majority of visitors to *Discover Earth* spent more than 30 minutes in the exhibit and for *Discover Tech* it was more than 60 minutes (see Figure 7). One can compare these engagement times to a similarly sized museum exhibit (800 sq. ft.) by using Serrell's (1998) Sweep Rate Index (SRI). Sweep rates of less than 300 square feet per minute indicate that visitors are moving slowly, stopping often, or spending more than a few seconds at each stop (Serrell, 1998). The more time visitors spend, the more engaged they seem to be with exhibits, and time and engagement are related to learning (Borun, 1998).

The SRI for *Discover Earth* is 27 and for *Discover Tech*, an astonishingly low 13.5. Another commonly used method to assess visitor engagement is Serrell's "Percentage Diligent Visitor Index" (%DV). The %DV is obtained by calculating the percentage of visitors that stopped at more than one-half of the exhibits. The higher the %DV, the more thoroughly the exhibition was used. While this method is often used for exhibitions in science museums, it may not be very relevant for public library exhibitions because public libraries have such a large number of repeat visitors.

The exhibits supported free-choice learning. Adults and children could look at the exhibits whenever they chose for as little or as long as they liked, and could easily return to interact with different parts of the exhibit again. Several teachers and parents reported that the exhibits supported what students were learning during the school day in traditional classrooms or through home schooling. The exhibits also supported intergenerational learning. Parents, children and even grandparents were frequently observed learning together.

Conclusions and Discussion

The majority of participating librarians, library staff, and library patrons were enthusiastic about the STAR_Net exhibits and programs. Librarians and library staff reported that the resources the project provided were helpful, and increased their knowledge, interest, and confidence in offering STEM programming in their libraries. Many libraries reached out and developed connections with STEM organizations and individuals they had not worked with previously. The project reached patron audiences with STEM exhibits and programming that patrons in many

of the STAR_Net communities would otherwise have not had access to. The exhibits appeared to spark the interest of many patrons to learn more about science, technology, and engineering. Most of the libraries that had hosted a STAR_Net exhibit implemented additional STEM programming after the exhibit left their library and planned to implement more programming in the future.

A growing number of libraries and library staff understand that they have an important role to play in helping the U.S. to improve its lagging STEM education standings by providing out-of-school-time (OST) experiences for young people and their families, working with schools on joint STEM projects, and exposing children to career possibilities in science and technology (IMLS, 2009). Almost all the nation's public libraries now offer programs tailored to the needs and interests of young adults. Computers, on-line games, and tinkering labs (e.g., Maker Spaces) have also become part of the mix at many public libraries (Good, 2012), and some use gaming to attract new patrons (e.g., the MacArthur/IMLS-funded Learning Labs).

It's clear that interactive STEM experiences in libraries can be an effective way to reach under-served audiences and increase STEM content knowledge and interest in STEM careers. Broader participation success will come from libraries offering relevant STEM programming and forging strategic partnerships with community institutions that reach under-served populations. OST programs are especially well-positioned to help close the opportunity gap that many children and youth from under-served and underrepresented communities face (Afterschool Alliance, 2011). Of the 8.4 million children in OST programs, ethnic minority children are more likely than others to participate (Afterschool Alliance, 2011). Libraries are an ideal OST setting to reach the populations the country needs to widen the STEM-pipeline through engaging, interactive



Figure 8: A young engineer at work in the Discover Tech exhibit. Courtesy NCIL.

technology (Dusenbery, 2014). The change in programming will come with increased STEM anxiety (Baek, 2013b). These concerns can sometimes slow down or derail efforts to offer such programming system-wide. The role of librarian staff will need to change from a focus on information gathering to facilitating real STEM learning. They will need help from the informal STEM education community in developing new skills and knowledge (Baek, 2013b).

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“ HAVING THE OPPORTUNITY TO INTERACT AND PLAY WITH SOMETHING NEW, REALLY GIVES THE BOOKS MORE MEANING.

~STAR_NET LIBRARY STAFF MEMBER

”

experiences.

The demand in libraries for STEM programs and training is higher than it has ever been and will continue to increase in the years ahead. STEM programs in libraries give audiences of all ages more opportunities to learn, to experiment, and to follow individual interests in science and

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