Costumed, first-person interpreters blend historical context with hands-on STEM interactives.

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Create.Connect

A History and STEM Mash-up

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It is nothing new for history museums to present stories of science and technology. But the *Create. Connect* exhibition at Conner Prairie—an 800-acre history park in Fishers, Indiana—integrates history and science, technology, engineering and math (STEM) content to an unprecedented degree.

Create.Connect gives visitors opportunities to practice science skills within exhibit environments that link STEM to place- and time-specific stories, and fosters learning in two domains as it offers visitors varied paths through the exhibition and a richer understanding of some key moments in Indiana's past. But perhaps more importantly, it shows the possibility for new ways of thinking and working in museums—between, through, and around our often-confining disciplinary boundaries.

Why History and STEM Together and Why at Conner Prairie?

Conner Prairie's mission embraces informal learning of all sorts as it encourages visitor involvement in Indiana's past. History sits at Conner Prairie's core, but it does not serve as a strict barrier delineating the types of experiences for our visitors. Time and time again, we have sought to create immersive experiences by folding in techniques from other kinds of institutions.

Conner Prairie serves a sizable population drawn from suburban Indianapolis and northern Indiana, an area not served by an easily accessed science center. With the need for improved STEM education articulated by the National Science Board and others,[1] Conner Prairie set a course toward integrating STEM content across a range of visitor experiences. Our goal was to broaden our offerings, provide access to more informal STEM opportunities, and increase the relevance of a visit by enhancing our core experiences with new content.

Starting in 2006, then-CEO Ellen Rosenthal kicked off a series of STEM-focused programs, including *Science Saturdays*, *Science Lab*, *Mini Maker Faire*, and the *STEAM Innovation Festival*. To expand our offerings beyond programming to exhibitions, we submitted a grant proposal to the Institute of Museum and Library Services (IMLS) to develop and evaluate three STEM activities that would later be incorporated into *Create. Connect*, a new, permanent exhibition in our 2,500-square-foot visitor center atrium, through which all visitors would pass.[2]

In 2010, we reached out to colleagues at the Science Museum of Minnesota (SMM) to ask them to lend their expertise to the project. SMM has a mission to increase STEM literacy through informal learning experiences, an interest in new ideas and techniques that move work forward, and a long history of planning STEM exhibitions using a tried-and-true development process that includes testing multiple iterations of exhibits with visitors on the museum floor.

In 2013, Conner Prairie and SMM, along with four participating museums, received a $2.3 million grant from the National Science Foundation (NSF). The grant money

1 See National Science Board, *A National Action Plan for Addressing the Critical Needs of the U.S. Science, Technology, Engineering, and Mathematics Education System*, NSB-07-114, accessed March 2016, http://www.nsf.gov/ nsb/edu_com/draft_stem_report.pdf; Business-Higher Education Forum, *A Commitment to America's Future: Responding to the Crisis in Mathematics and Science Education* (Washington, DC: Business-Higher Education Forum, January 2005), accessed March 2016, http://www.bhef.com/solutions/MathEduPamphlet_press.pdf.

2 *Test Lab: Indiana Inventions* award abstract, https://www.imls.gov/grants/awarded/ma-04-11-0179-11, accessed March 2016.

supported a multipronged project that included extensive evaluation.[3] The core would be the 2,500-square-foot history/STEM exhibition at Conner Prairie, but there would also be smaller installations at the four participating history museums (California State Railroad Museum in Sacramento; Wabash County Historical Museum in Indiana; Mystic Seaport in Connecticut; and Oliver H. Kelley Farm in Elk River, Minnesota). These institutions were selected by project leaders for their geographic and size diversity, as well as their ability to incorporate STEM activities into their historical content. Each partner institution would receive a small exhibition (approximately 500 square feet) developed using the *Create.Connect* model tailored to their local, historical narrative. These institutions became part of the development process as we entered into the schematic design phase.

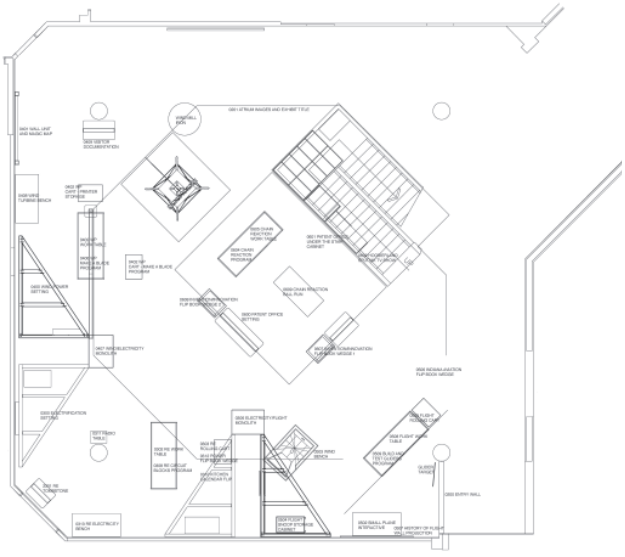

fig. 1. Floor plan, *Create.Connect*.

Formative evaluation allayed an early concern: would visitors think it made sense to have STEM content at a history museum?

First Step: Creating a Strong Team With a Shared Vision

Fostered through frequent face-to-face meetings and workshops, strong, positive relationships between Conner Prairie and SMM—at the institutional and individual levels—benefitted our team process and, consequently, the resulting exhibition. Familiarity and trust built over time, aided by work sessions at key project stages, weekly phone meetings that nearly always included a short discussion of a journal article relevant to the project, and three workshops that included the core project team and representatives of the four partner museums.

It also helped that from the start, the project's principle investigators, Cathy Ferree at Conner Prairie and Mark Dahlager at SMM, established clearly defined roles for team members based on the contributions expected of each institution. Conner Prairie exhibit development staff identified Indiana history stories that would afford opportunities for both history and STEM learning. They took the lead in researching images and media, and in the sourcing, acquisition, and preparation of objects. Planning for interpretive staff, based on "Opening Doors" (a conversation-based engagement and facilitation approach), was exclusively in the hands of Conner Prairie.[4] Team members at the Science Museum of Minnesota identified successful interactives they had developed for exhibitions at SMM or for other museums, adapting them as necessary to help convey the STEM content embedded in each story. SMM took the lead in exhibition and graphic design, media and graphic production, and exhibition production. Evaluation staff from Conner Prairie and SMM together planned and implemented several rounds of testing. Throughout the project, we all served as sounding boards for each other's work.

3 *Prairie Science: Integrating Informal Science and History Learning through Family Dialogue*, award abstract, accessed March 2016, http://www.nsf.gov/awardsearch/showAward?AWD_ID=1223770.

4 For more on Opening Doors, a facilitation approach developed and utilized at Conner Prairie, see http://www.connerprairie.org/About-Conner-Prairie/Driven-by-Our-Mission/Our-Mission-at-Work, accessed March 2016.

Iteration and Evaluation Built Confidence in Our Approach

Create.Connect went through three distinct iterations. The initial iteration of the exhibition was located in our visitor center atrium space (fig. 1). It featured three history/STEM groupings, each focusing on a historical Indiana narrative: REA (Rural Electrification Act) comes to Indiana (1930s); Flint & Walling windmills (1900s); and Purdue's Rube Goldberg Machine Competition (1950s). Each section included the same types of elements: an IMLS-funded, STEM make-and-test activity (assemble electrical circuits, design windmill blades, or engineer a chain-reaction contraption); large artifacts behind clear acrylic barriers; and an introductory panel. We displayed images, reproduced ephemera, and interpretive labels informally, on large, cork-covered columns. And we staffed the areas both with modern facilitators and costumed, first-person facilitators (composite characters Vera Zimmerman—a 1930s rural homemaker—and Jimmy Riggs, a Flint & Walling windmill salesman). These front-line interpreters were on hand to engage visitors in discussions about the exhibition (intro image). Conner Prairie is known, in the field and by the public, for first-person, costumed composite historical characters. We felt it was important to include them in *Create.Connect* in order to firmly establish the historical narrative. It would be the first time we used historical characters in the visitor center.

Formative evaluation allayed an early concern: would visitors think it made sense to have STEM content at a history museum? Testing showed that for 94 percent of the visitors interviewed, it did. Evaluators found that visitors spent most of their time with the make-and-test activities and these encouraged—especially in children—the iterative behaviors of making and testing with the STEM activities that we wanted to see. These findings were encouraging but, on the other hand, evaluation also showed that visitors weren't necessarily exploring the STEM and history domains simultaneously, nor were they making connections between the two. There was great visitor engagement at the STEM activity tables (helped by the costumed interpreters).[5] But aside from admiring the 30-foot-tall, fully restored Flint & Walling Windmill (fig. 2), visitors weren't spending much time examining artifacts, looking at images, or reading label copy in the history areas.

5 Allison Cosbey, Marjorie Bequette, Catherine Hughes, Molly Phipps, and Gretchen Haupt, *Test Lab: Indiana Inventions Formative Evaluation Report* (unpublished report, Conner Prairie, 2013).

fig. 2. The Flint and Walling Windmill sets the tone for the space with both a history-exhibit and science-center feel. All of the groupings in *Create.Connect* lack compartmentalizing barriers, creating an open floor plan that invites family groups to explore independently.

Armed with the evaluation findings, the team made changes aimed at bumping up visitor engagement with the history content in the exhibition. We concentrated our efforts on the Rural Electrification section, where the exhibit asked visitors to think about how electricity impacts lives. We created a more immersive environment: we added walls to suggest a 1930s farm kitchen; embedded a monitor in a window to show slides of rural electrification activities in Boone County, Indiana; juxtaposed a wood-burning stove with a "new" electric refrigerator; and tacked up a calendar with delivery dates for electrical appliances on the wall. We also added artifacts related to rural domestic life before and after electrification, and provided facilitators with touchable props (fig. 3). We edited the narrative of the farmwife character in this area to emphasize the positive changes that might result from electrification of her home (rather than her fear of what she didn't understand about electricity). This shift occurred because we did not want people in the past to appear afraid of science or ignorant. The historical characters were intended to be curious alongside our visitors, modeling questioning and learning. We also added an additional STEM interactive to each area. For example, in the REA area we added an electricity bench with an oscilloscope, meters, electrical components, and a digital guide to multiple experiments. These allowed more formal observation and measurement of phenomena than what was supported by the make-and-test activities.

In October 2013, we conducted a second round of formative evaluation. Family interviews confirmed that by enhancing the physical setting, we had helped visitors make connections between history and STEM content. Engagement with facilitators increased in this iteration, as did dwell times. For instance, in the area focusing on the Rural Electrification Act—the most developed of the groupings—dwell times nearly doubled between the first and second formative evaluations.[6] Informed by the apparent success of the changes we'd made in REA, we set about planning for the final iteration of *Create.Connect*.

6 Amanda Svantesson-DeGidio, Gretchen Haupt, and Al Onkka, *Create.Connect Formative Evaluation Report* (unpublished report, Science Museum of Minnesota, 2013).

fig. 3. In the 1930s kitchen, visitors build simple circuits—in the guise of wiring their homes for newly installed electricity. They are asked to think about how their new electric appliances will change their lives.

fig. 4. The historical period and story is further communicated through physical setting and media. Each grouping has a media piece appropriate to the setting: this TV plays an original episode of the popular science show *Mr. Wizard* (1951–1965) and CBS's coverage of Sputnik's launch on October 4, 1957.

A Third Round of Changes Further Enhances the History/STEM Connections

Using what we had learned over the months by watching, interacting, and talking with visitors in the REA area, our team was able to confidently make other adjustments and additions throughout the entire exhibition.
To encourage active engagement with the historic settings and narratives, we made them more immersive and interactive.
We displayed photos and ephemera in ways appropriate to the period depicted.
We added media to convey history content, using technologies of the era—such as vintage television and radio sets (fig. 4).
We incorporated more touchable objects—vintage-looking light bulbs, electric cooking appliances, early airplane parts—to provoke observation, curiosity, and discussion.
We constructed doors, drawers, and cabinets so that visitors could open them up and "snoop" (contents included an illustrated windmill sales catalog and a scrapbook), and made props and documents that could be picked up and examined.

To tighten ties between history and STEM components, we made a number of changes. For instance, early on in developing the Flint & Walling area, visitors designed and made windmill blades, testing them to see if they would generate enough electricity to power lights in a village of tiny houses. But Flint & Walling mills, rather than generating electricity, generally provided direct power to agricultural implements like corn grinders, sawmills and water pumps. In order to better align the STEM and history content, SMM created models of some of those machines. Visitors can drive these with the windmills—which makes the correlation more accurate.

The final iteration of *Create.Connect* also included two significant changes. The first was to refocus the Rube Goldberg Machine section. Goldberg himself had no Indiana connection aside from the famous annual competition held at Purdue University, and visitors were making false connections between the STEM activity and history.
We designed a different setting, based on a patent agency that could have existed in

fig. 5. At the popular Chain Reaction activity table, visitors apply creative problem solving to a simple challenge, opening up connections between the activity and the history of innovation and invention in Indiana.

the late 1950s. The new context allowed us to feature a group of Indiana inventors and innovators, a story that better complements the area's STEM focus on engineering and innovation (fig. 5).

The second major change was to add another grouping. Because the team had identified research that suggested that girls are more engaged with STEM when a narrative is introduced, we decided to develop a new, first-person female character for *Create. Connect*, one that would model women taking an active role in engineering. Since Indiana was a hotbed of early aviation innovation, we decided to create a setting in which visitors could join a young aviator in her workshop (fig. 6). They can look through her scrapbook (created with reproductions of primary source documents), snoop in a cabinet full of her tools and materials, explore lift at the wind table, operate controls to fly a model airplane, and make, launch, and revise their designs to create a paper airplane.

fig. 6. Visitors are invited to snoop through an aviation tool cabinet, where they find such contextualized objects as a wing spar, a scrapbook, a leather helmet, and a stopwatch. These items enhance the historic setting and provide easy-to-access, touchable objects and props for interpreters.

In the summer of 2014, after *Create.Connect* had been open to the public for several months, we conducted a summative evaluation of the final iteration. We collected and analyzed several types of data, including a tracking and timing study, exit surveys, lobby surveys, and recorded family conversations. A majority of the families observed exhibited the target behaviors we were looking for: multigenerational collaboration, interaction with a facilitator, reaching the endpoint of an activity, and iterating—trying different approaches to an activity. When compared to both of our earlier formative evaluations, we saw improved measures in both dwell times and questions of fit for STEM activities at Conner Prairie.[7]

7 Alice Anderson, Marjorie Bequette, Gretchen Haupt, and Catherine Hughes, *Create.Connect Summative Evaluation Report* (unpublished report, Science Museum of Minnesota, 2016).

Sharing *Create.Connect*

One of the key findings in *Create.Connect* is that evaluation—and open-mindedness to its results—is key. Iterative prototyping and ongoing attention to visitor responses led to a richer and more successful exhibition. It also helped us to articulate a history/STEM integration framework, which we used to help our partner institutions in their work—and can now apply to other projects. Our framework calls for three essentials: a **setting** that evokes a specific time and place where visitors engage in self-guided **activities** that lead to discovery of history and STEM content related to a **historic narrative**.

Made confident by the positive findings of our evaluation findings, and equipped with our new framework, after opening *Create. Connect* in spring 2014, we worked with our colleagues at our four participating museums to finalize plans for their history/STEM exhibitions, which three of the four installed in late spring 2015. Through workshops with the team and concentrated work with one of the project leaders, Jim Roe, the partners created *Create.Connect*-style experiences that both fit their individual needs and the project framework. The California State Railroad Museum uses a 1950s setting and electricity interactives in presenting the transition from steam-powered to electric-powered engines. Mystic Seaport has incorporated wind-based interactives and narrative elements into a larger exhibition, *The Search for Speed*. Wabash County Historical Museum has focused their installation on the moment in 1880 when Wabash became the first electrically lighted city in the world. Oliver H. Kelley Farm will install their setting pieces and wind power interactives in a new visitor center opening in late 2016.

Final Thoughts

This collaborative project began with conversations between Conner Prairie and the Science Museum of Minnesota about how exhibitions and programs could integrate STEM and history learning. The team's overarching goal was to see visitors engaged in creative approaches to solving problems that would incorporate both. Our analysis of visitor behaviors, attitudes, and conversations in *Create.Connect* suggests that visitors easily see STEM and history as complementary, and that this interdisciplinary approach may deepen engagement and learning. Visitor conversations and interactions with exhibit components indicate that family groups found multiple ways to engage with both STEM and history topics. Roughly half of the visitor groups in the study verbalized instances in which they engaged in STEM and history-thinking strategies at the same time.[8]

This project has some broader implications for how we think of ourselves as a field. We tend to think of history and STEM as separate or even at odds, with different collections, constituencies, and funding streams. But, as so often happens, our visitors—unencumbered by these assumptions—see things more clearly. This project shows the possibility for new ways of thinking and working. By blurring the lines between domains, between science and history museums, and between traditional and nontraditional exhibit techniques, we can create engaging and unique experiences for our visitors.

8 Ibid.

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