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Finding Our Way Through Environmental Communication

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Mike Zender Editor
University of Cincinnati, School of Design Publisher
Oscar Fernández Guest Editor
Shelby Murphy Designer
Sheri Cottingim Circulation Manager
Merald Wrolstad Founder

Website
visiblelanguagejournal.com

Postmaster
Send address changes to:
Sheri Cottingim
Office of Business Affairs
College of Design, Architecture, Art, and Planning
University of Cincinnati
PO Box 210016
Cincinnati, OH 45221-0016
sheri.cottingim@uc.edu

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Before there was reading there was seeing. Visible Language has been concerned with ideas that help define the unique role and properties of visual communication. A basic premise of the journal has been that created visual form is an autonomous system of expression that must be defined and explored on its own terms. Today more than ever people navigate the world and probe life's meaning through visual language. This journal is devoted to enhancing people's experience through the advancement of research and practice of visual communication.

If you are involved in creating or understanding visual communication in any field, we invite your participation in *Visible Language*. While our scope is broad, our disciplinary application is primarily design. Because sensory experience is foundational in design, research in design is often research in the experience of visual form: how it is made, why it is beautiful, how it functions to help people form meaning. Research from many disciplines sheds light on this experience: neuroscience, cognition, perception, psychology, education, communication, informatics, computer science, library science, linguistics. We welcome articles from these disciplines and more.

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Learning Design Thinking by Designing Learning Experiences:

A Case Study in the Development of Strategic Thinking Skills through the Design of Interactive Museum Exhibitions

Lisa Fontaine

Realities of contemporary graphic design seem to mandate the development of broad thinking skills since graphic designers are increasingly asked to design innovative solutions that go beyond the boundaries of print and web-based media. This emphasis on ideas rather than objects suggests a move toward what is often referred to as design thinking, an approach that is seen as a response to the needs of the 21st Century innovation economy. Design thinking is said to be the creative process that focuses on user needs and motivations as the major impetus for creative solutions. It is vital for graphic design educators to prepare students to view themselves as design thinkers: problem-solvers first, image-makers second. A popular curricular response to this paradigm shift has been the inclusion of user-centered design projects that involve the design of experiences rather than of objects. The design thinking process requires students to develop an understanding of the user by listening, watching and learning about their preferences, needs, and limitations.

Throughout education, there is widespread belief that all students should be better prepared with relevant skills to enter the evolving workplace, regardless of their chosen discipline. Commonly referred to as 21st Century skills, these include important abilities that are not currently emphasized in the K-12 curriculum, such as critical thinking, problem solving, collaboration, creativity, and innovation (Goldman 2010). It is easy to see direct correlations between these widely desired skills and those developed in the practice of design thinking.

photography: Emily Nizzi

In the Graphic Design Department at Iowa State University, the curriculum is continually evaluated for opportunities to figure graphic design as a problem-solving discipline rather than one of form-making or self-expression. As we begin to make this transition, it has become clear that our design students are ill prepared for these new expectations, having been educated in a system that prioritizes standardized test scores. Graphic design educators are now struggling to devise new pedagogy that efficiently incorporates design thinking in the classroom. Experience design, with its open-ended challenges, is seen as an ideal setting for this and is now integrated into our curriculum through courses in mobile and time-based media, as well as through increasingly complex project briefs for brand identity and other design problems. Similar initiatives are being effectively implemented in many other graphic design programs, especially as the profession has begun identifying the design of experiences as being within our expertise. Unique to Iowa State University's graphic design program, however, is the integration of an interactive museum exhibition as a curricular opportunity to teach experience design and practice lateral thinking. By designing the visitor's learning experiences, it is believed that the design students become skilled in user-centered design and gain a deep understanding of how to create environments where people learn.

DESIGNING INTERACTIVE EXPERIENCES

The design of interactive museum experiences is extremely challenging for students as they are presented with unique requirements not encountered before. This makes it effective pedagogy and is an efficient way to introduce new skills.

Museums have an incredibly diverse audience, ranging across ages and education levels, so they require a multiplicity of approaches to allow each visitor to have a unique experience with meaning making (Rawson 2010). It can be especially challenging to identify communication and participation strategies that will resonate with a variety of user groups. Interactive exhibits need to relate to the visitors' interests as well as their current knowledge (Jacob, 2011), a task that is made even more difficult for design students when one considers in the limited attention span of a child visitor. The challenges of communicating to diverse audiences make interactive experience design an especially good vehicle to cultivate design thinking skills since consideration of user needs is a significant criteria.

The design of interactive exhibits is an example of an ill-defined problem: we know something about what needs to be communicated, but how this should occur is open-ended (King, 1994). This is quite different from many of the well-defined problems typically included in a graphic design curriculum,

where the solution is prescribed (i.e. it's either a website, a magazine, or a logo). Ill-defined problems are ideal for broadening students' thinking skills, which will be fundamentally useful as students enter an evolving profession. The skills learned here can be utilized later in other visual communication work, from print to web and mobile media.

For the past 23 years, the author has incorporated museum exhibition design into the graphic design curriculum in order to introduce students to critical thinking and problem solving. In 2008, this evolved into an ongoing collaboration with the Field Museum of Chicago, which has included the design of exhibitions about conservation, ants, Egypt, biomechanics, and paleontology. Each semester the museum's Exhibit Design Director, Alvaro Amat, challenges the students with a different exhibit theme and presents them with the museum's content outline, learning objectives, and relevant artifacts. Students design and propose several exhibits that include experiential learning components to help visitors learn about the scientific subtopics. While designing these exhibits, the students are learning to apply their design thinking skills since the Field Museum has very specific intentions regarding their themes and sub-themes but has intentionally offered no suggestions about possible outcomes. Students quickly realize that design solutions focusing primarily on graphic form or self-expression cannot succeed in this user-centered arena. Working with a real client also demands accountability, as one cannot simply avoid difficult obstacles in the design problem but must design a way around them. Although the Field Museum does not expect to implement the students' designs, both sides of the collaboration treat the project as realistically as possible.

Design studio projects are, by their nature, examples of experiential learning, a method of learning by doing, so there is nothing new about incorporating project-based learning in design studio. For this assignment, however, the students are learning to facilitate experiential learning for the museum visitors. So they are learning design thinking by designing learning experiences.

MUSEUMS & EXPERIENTIAL LEARNING

Exhibits that engage the museum visitor through interactive experiences build interest and help with comprehension and retention of the information. Interactive museum exhibitions, where an individual can directly encounter a phenomenon, are productive environments for experiential learning. Through personal contact, information that was once abstract can be translated into concrete realities. An exhibit can encourage the visitor to understand scientific phenomena through interactive engagement that allows for choice and initiative (Caulton, 1998). By allowing for human individuality, experiential learning encourages creativity and invention.

Experiential learning has been long understood in the education field, as far back as John Dewey who identified the importance of learning through experience in 1925 (Dewey, 1937). Museum educators adopted his theories; Dewey's influence on them is immeasurable (Shaffer, 2010). Constructivist theory in education built upon Dewey's work. This theory focuses on how the prior experiences of the learner influence how s/he learns. By engaging with information through the lens of their existing knowledge, "…learners are active agents, constructing knowledge rather than passively receiving it" (p. 38). Constructivist theory has also been enthusiastically adopted by museums, so they can better respond to the diversity of their audience by offering a multitude of ways to access the exhibit content. Museums no longer attempt to create a single, consistent visitor experience; instead they view themselves as facilitators of co-produced experiences (Simon, 2010).

Contemporary museums embrace their role as a source of informal learning. This term is used to define learning that occurs outside the formal classroom (Bitgood, 2013). It is considered to be a lifelong process that allows for learning in a variety of environments. Museums provide an informal setting that can allow learners to become immersed in a particular time or place and can offer simulated experiences through activities and games. This is, in fact, what brings visitors to museums: they come with the intention of engaging in alternative educational experiences (Anway, 2010). The methods of delivering educational content in museums now include immersive and multi-media environments, but can also include low-tech engagements through physical exploration and play (Jacob, 2011). Informal learning also allows for social experiences; families can learn together even though they have different levels of experience and attention (Bitgood, 2013).

Gardner's theory of Multiple Intelligences has also played a significant role in museum education. Gardner proposed that there are several different components to a person's intelligence; it is not a single entity. He proposed eight (and later nine) different types of intelligences, including linguistic/verbal, logical/mathematical, visual/spatial, bodily/kinesthetic, musical/rhythmic, interpersonal, intrapersonal, naturalist, and existential (Gardner 1993). According to Gardner, the first two are the ones highly valued in formal education, yet each of us has a unique blend of abilities involving many or all of them. He recommended a more holistic approach to learning that empowers learners by providing multiple access points into information to allow each person to devise his/her own path. His ideas about the many ways that people learn have been widely accepted in the museum world since they support the intentions of informal learning environments, where learners construct knowledge through non-traditional learning environments (Caulton, 1998).

Approximately twenty graphic design students per year have participated in the Exhibition Design Studio and its collaboration with the Field Museum since 2008. The course meets six hours per week; it is a required class for students pursuing the MA degree in Environmental Graphic Design, and is an option class for other graphic design students in the BFA or MFA degree programs. Most students enrolled in the course have little or no prior coursework in 3-dimensional design; some have had exposure to experience design through web or mobile media courses. The Interactive Exhibit assignment is a 10-week project.

The students work through several steps in the process of designing interactive visitor experiences for the museum's exhibits. These steps align directly with those typically described in the Design Thinking Process Guide (2014). Table 1 shows the specific steps and learning outcomes of this assignment as they relate to the design thinking phases, critical thinking phases, and 21st Century skills outlined in the literature.

	design thinking skills	critical thinking skills	21st century skills	The Interactive Museum Exhibit Assignment	intended learning outcomes
Phase 1	empathize			**1.1** learning styles and education theory	Students understand that people learn in different ways.
				1.2 universal design	Students become responsive to the different needs + abilities of users.
				1.3 ethnographic observations of museum visitors	Students are able to use observations to inform their design solutions.
Phase 2	define, develop strategies	critical thinking + collaboration		**2.1** collaboration with museum experts	Students learn to value the contributions of other disciplines.
		collect information		**2.2** investigation of visitor interaction types	Students understand how to choose and implement interactive methods.
		define the problem		**2.3** research on scientific topic	Students are able to synthesize topic research to establish parameters.
Phase 3	ideate	invent creative solutions	creativity, problem solving	**3.1** ideation	Students are able to define the problem + freely explore diverse ideas.
				3.2 establish and develop exhibit narrative	Students are able to develop a compelling + relevant story.
Phase 4	prototype and test	construct prototypes	critical thinking, innovation	**4.1** design of the interactive learning experiences	Students are able to test ideas quickly and evaluate results.
				4.2 exhibition design components	Students are able to apply principles of universal design to 3-d structures.
	defend and evaluate	evaluate		**4.3** graphic and information design	Students are able to use information hierarchy to enhance clarity.
Phase 5			communication	**5.1** present design proposal	Students are able to articulate about their creative solutions.
				5.2 self assessment	Student is able to reflect on personal process + evaluate its effectiveness.

Table 1
Intended Learning Outcomes

Brown (2009) considers the first phase of design thinking to be empathy; the designer must become concerned with the needs, abilities, and interests of the user (Brown 2009). This is where the students need to define the museum's wide-ranging audience members and understand their varied learning styles. In this project, audience definition and analysis are addressed in steps 1.1, 1.2, and 1.3.

Step 1.1: Learning Styles & Education Theory

Students receive a basic introduction to Dewey's theory on experiential learning, and learn how it is being applied in museum education. They learn about the many different learning styles articulated in Gardner's Multiple Intelligences theory. They explore these multiple intelligences to determine how particular interaction methods can appeal to different kinds of learners. They study examples of constructivist theory as it applies to visitor interactions. If each visitor constructs meaning based on their own knowledge and experiences, then it's also important to think about how a child's way of understanding an exhibit will differ from that of an adult due to basic developmental milestones (Rawson 2011).

Step 1.2: Universal Design

As students of graphic design, most have not yet been introduced to the principles of universal design and have not needed to consider safety issues in their design work. All aspects of accessibility need to be understood in order to design museum exhibits. As a basic introduction, students are exposed to principles such as perceptibility, operability, simplicity, forgiveness, and constraint (Lidwell, 2003). These general guidelines are supplemented with the more specific mandates in the Smithsonian's Guidelines for Accessible Exhibition Design (Majewsky, 2013).

Step 1.3: On-site Visitor Observation in Museums

Students conduct ethnographic observation at several museums in Chicago: the Children's Museum, the Nature Museum, the Museum of Science and Industry, and the Field Museum. They observe the ways that interactive experiences succeed or fail with users, and the effectiveness of various interaction types for different kinds of knowledge transfer. Students locate examples of each of the interaction types they have studied and observe the examples' effectiveness at engaging the visitors with the exhibit theme. Students are able to personally experience immersive environments. While on the site visit, students are able to observe how well the principles of universal design are being implemented and what happens when a museum overlooks these principles. While examining the displays, they are able to observe that "… the final exhibit will live or die based on the interface…"(Beale, 2011, p. 215.)

This observation phase is vital, as it provides an understanding of visitor behavior. Upon returning from the field trip, students document their observations in writing and photos, analyzing what methods worked well to engage different kinds of learners and how visitors really interacted with exhibits. They also analyze and document unresolved visitor interactions: did they fail due to perceptibility, operability, simplicity, forgiveness, or constraint?

PHASE 2: **PROBLEM DEFINITION & STRATEGY DEVELOPMENT**

Problem definition and strategies for solving them are addressed in steps 2.1 – 2.3. This is typically a period of analysis and investigation.

Step 2.1: Collaboration with Museum Experts
The class then meets with the design director and exhibit curator to discuss the exhibit theme and how it fits into the museum's broad educational goals. The design director invites each student to define their own specific goals and to determine the most engaging aspects of their subtopic. This collaboration continues throughout the phases of the project.

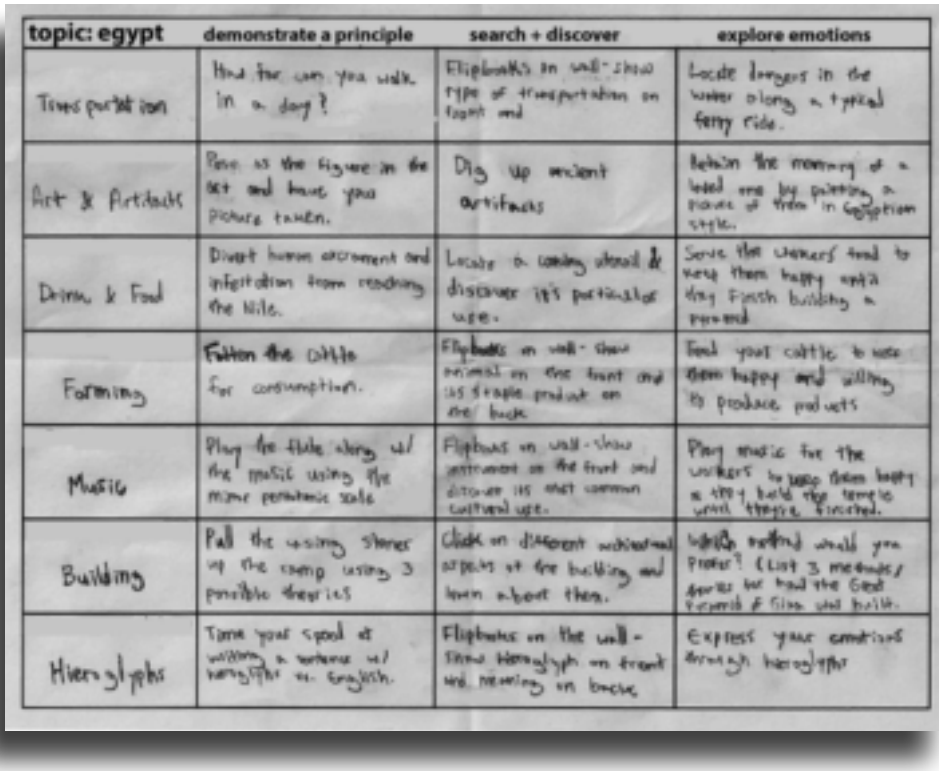
Step 2.2: Investigation of Visitor Interaction Types
Students are introduced to a taxonomy of interaction types, devised by the author, which include role-play, create and build, search and discover, demonstrate a principle, test your abilities, and explore emotions. As they begin to define their own exhibit goals, they study these interaction types to determine their usefulness for engaging visitors with different learning challenges.

Step 2.3: Research on Scientific topic
Students research the overall theme of the exhibit, with special focus on the subtopic they've been assigned. Within the Biomechanics exhibit, for example, students are given subtopics that contribute to the overall understanding of how animals adapt to their environment; these include locomotion, generating forces, temperature regulation, and staying in one piece. From this broadly defined subcategory, the students need to determine what part of that 'story' to tell and how to tell it.

A strategic plan is submitted by each student that defines the parameters of the learning experience; key facts or 'take-aways' are identified that align with the museum's exhibit goals.

Step 3.1: Ideation

Ideas are generated using an ideation matrix, which cross-references several potential subtopics with the interaction types to encourage multiple ideas for discovery-based interactions (*table 2*).



topic: egypt	demonstrate a principle	search + discover	explore emotions
Transportation	How far can you walk in a day?	Flipbooks on wall- show type of transportation on front and	Locate dangers in the water along a typical ferry ride.
Art & Artifacts	Pose as the figure in the art and have your picture taken.	Dig up ancient artifacts	Retain the memory of a loved one by painting a picture of them in Egyptian style.
Drink & Food	Divert human excrement and infestation from reaching the Nile.	Locate a cooking utensil & discover it's particular use.	Serve the workers food to keep them happy until they finish building a pyramid
Farming	~~Fatten the cattle~~ for consumption.	Flipbooks on wall- show animal on the front and its staple product on the back	Feed your cattle to make them happy and willing to produce products
Music	Play the flute along w/ the music using the same pentatonic scale	Flipbooks on wall- show instrument on the front and discover its most common cultural use.	Play music for the workers to keep them happy & stay build the temple until theyre finished.
Building	Pull the missing stones up the ramp using 3 possible theories	Click on different architectural aspects of the building and learn about them.	Which method would you prefer? (List 3 methods/ theories for how the Great Pyramid & Sphinx was built.
Hieroglyphs	Time your speed at writing a sentence w/ hieroglyphs vs. English.	Flipbooks on the wall - Show Hieroglyph on front and meaning on back	Express your emotions through hieroglyphs

Table 2
Ideation Matrix
student: Kyle Holcombe

Once a promising idea has been found, the student is asked to prepare three interactive exhibit proposals for visitor engagement that identify specific learning outcomes (Beale, 2011) and tasks the visitor will do in each engagement. The student also needs to describe why this is the best possible way to teach this information. Many of the interactive methods can be accomplished through either a physical or virtual experience. There are situations where a virtual simulation is not sufficient, but others where technology is critical to the experience (Jacob, 2011). Students must consider the advantages and disadvantages of each approach.

One proposal is selected out of three by the museum staff. The selection is based on how well the proposed interaction teaches the topic, how well it engages the visitor, how wide the audience could be, and how aligned it is to the museum's content outline.

Step 3.2: Establish Exhibit Narrative
Within each of the three proposals, students must establish a narrative for the proposed interaction. Skilled as they are with visual storytelling, this is often one of the least challenging aspects of the assignment for graphic designers. Included within their ideation they must propose possible headlines, explanatory text, and invitational text. This helps them establish the narrative within which the interactive learning will occur. Considerable testing and revising is needed to best align the narrative with the learning outcome, and ensure access for the widest audience.

PHASE 4: **PROTOTYPE**

Prototyping has been defined as a willingness to try something out and is thought to be the most effective way to create new ideas (Brown, 2009).

Step 4.1: Design of the Interactive Learning Experiences
At this point, students design quick prototypes of the interactive learning components and explore several different options for each interaction. For example, what do visitors do? How do they know what to do? If there's a guessing game, how will they know if they got it right? How might they misinterpret what you want them to do? In these refinements of the interactions, they also question the 'reward for learning. How does this teach the intended learning objective? Students experiment with affordances—physical characteristics that influence the user's understanding of how something gets used. What kinds of affordances (buttons, levers or devices) are most effective for meaningful engagement (Lidwell, 2003)? The students' prototypes are presented in class, tested, and reviewed with museum staff.

Whether designing an interaction about soil erosion, green buildings, endangered species, or coral reefs, the student's focus needed to always be on the ways that these complex topics can be made engaging and understandable through interactive experiences.

Step 4.2: Design of the Interactive Component
Students design the structure of the interactive component to house their visitor interactions, whether physical or touch screen. To facilitate family or group gatherings, the exhibit workstations must remain approachable from at least three sides. This ensures that children are not isolated from their parents within the exhibit space (Falk and Deering 1995). The interactive component should allow for more than one visitor to interact with it at the

same time. The placement of images, typography, artifacts and interactive elements should be carefully determined so that they enhance the information hierarchy and are located at appropriate heights for visitors; instructions and invitational text "…should go where the visitors' hands and eyes go when they use it" (Rand, 2010, p. 278.)

Step 4.3: Graphic and Information Design

At this final stage of refinement, there is a focus on how information hierarchy can be best used to simplify and clarify the message. Students become aware of the important role of information design in museum interaction; graphic design cannot be brought in merely as decoration or personal expression here. According to Roberts, "… the manner of presentation affects not just the effectiveness of the communication but also the particular meaning it bears" (2008, p. 74.) Graphic design students are most familiar with this step as this has been the focus of much of their prior coursework. As a result, they already know that attention to hierarchy can greatly influence the comprehension of text and images.

Typically within the design process, there is a testing phase, where the selected design is implemented and evaluated. Given the hypothetical nature of the assignment and the expense and time involved in testing, this phase is not included in the assignment.

PHASE 5: **PRESENTING & REFLECTING**

Upon completion of the design revisions, students must present a comprehensive proposal to the museum's Exhibition Design Director. This proposal includes all aspects of the functionality and learning intentions of the visitor interaction, including visual prototypes of each step the visitor takes and its result. Students document the design process to review their decisions and reflect on the effectiveness and innovation of their solutions.

Assessment of Outcomes

As with any project-based studio assignment, the Interactive Exhibit Project cannot be assessed with the objectivity of a multiple-choice exam but rather is measured with a reflective rubric tool that includes the intended learning outcomes listed in Figure 1.

Sample Outcomes of the Interactive Exhibit Assignment

The following outcomes vary widely in interaction method and learning intentions; the samples show the range of solutions that can be developed by following the design phases of this assignment. In order to be effective, each interactive exhibit must avoid confusing messages, teach the intended lesson, and reward the visitor's participation.

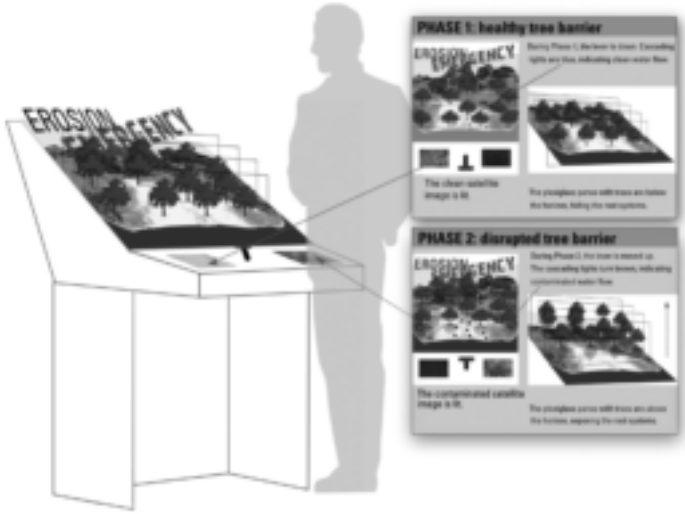
Leafy Truth Exhibit
Justin Rumpza

In the Conservation project, students were assigned a wide range of subtopics identified by the museum staff. These included soil erosion, green buildings, endangered species, coral reefs, and urban ecology. In the Leafy Truth exhibit, the student has created an interactive experience that demonstrates a principle about the cooling factor of trees within a city. In the physical simulation of urban pavement, he invites visitors to compare the area shaded by trees to the area not shaded. The visitor can feel the difference in heat on the pavement; this sensory involvement engages bodily/kinesthetic learning. While this could have been simulated in a virtual exhibit, the sensation of heat seems critically important to the learning.

Below: Overhead view of the simulated pavement (not shaded vs. shaded) for visitors to compare.

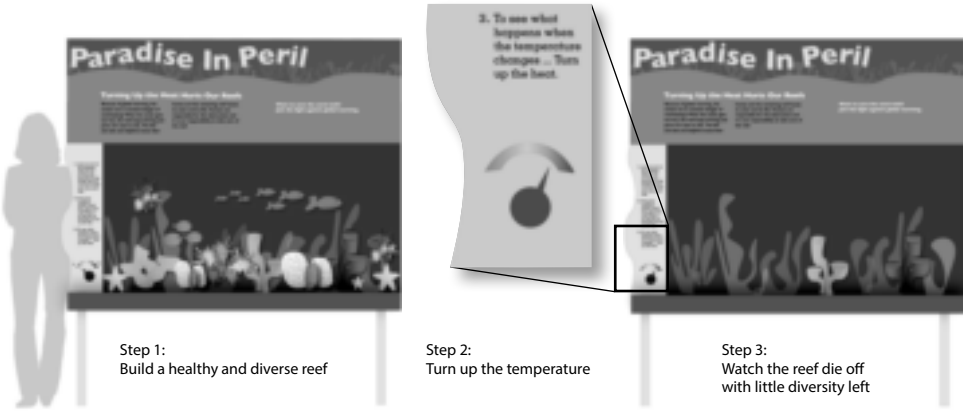
Erosion Emergency Exhibit
Emily Graves

In this exhibit, the student's intention was for visitors to learn how important trees are in preventing soil runoff. The interaction she designed demonstrates a principle by showing the different pathways rainwater will take to a river, depending on whether there are trees to impede its journey. By lifting the lever, visitors uproot the rows of trees which causes rushing rainwater to become contaminated with soil. This simulation compresses time to quickly show a process that likely takes weeks or months. A clear cause and effect relationship is evident through this narrative, so visitors of varying ages and abilities can easily learn the lesson.



Paradise in Peril Exhibit
Kelsy Postelthwait

In this conservation exhibit, the student wants to teach the visitor that global warming is destroying the coral reefs; many of the diverse species in a reef cannot tolerate the increased water temperatures. First the reef is presented in all its healthy diversity; then the visitor is invited to see what happens if the temperature rises. This action de-magnetizes many of the flora and fauna, resulting in one sorry looking coral reef. The act of turning up the dial is a metaphor that puts visitors in the position of the cause agents, and shows them the consequences of their actions. This simulation allows us to travel across oceans and to compress years of time into a few moments (Beale, 2011). This could have been accomplished with a virtual interaction, but the student has opted to reach a younger audience through the loose manipulation of physical components.



Step 1:
Build a healthy and diverse reef

Step 2:
Turn up the temperature

Step 3:
Watch the reef die off
with little diversity left

The Ant Hill Exhibit
Nick Riha

Another student designed a create/build interaction, where the visitor learns about the chambers of the anthill by constructing a cross-section model. This design demonstrates a principle so that the visitor understands how the interconnecting chambers work in relation to the anthill's construction. Children will be especially drawn to the loose manipulation of simple shapes, and the message seems age appropriate for this user group. This interaction especially appeals to visual/spatial learners.

Above: Anthill puzzle pieces showing cross-section of tunnels and chambers.

Egypt Timeline Exhibit
Taylar Jacobson

In the Egypt Timeline exhibit, the student has designed an interactive timeline showing seven time periods in Egypt's history, and featuring changes in territorial size over time, as well as the different religions, population, and art of each of the periods. While the information is presented on a video screen, the student has decided to provide a large sliding knob to activate the chronological shifts from ancient to contemporary Egypt. She feels that the strong left to right movement helps make a reference to chronology, and the physical engagement strengthens this understanding and incorporates bodily/kinesthetic learning.

Right: Video screen shows changes of territory, religion, and art over time.

Trade by Barter Exhibit
Kegeng Liu

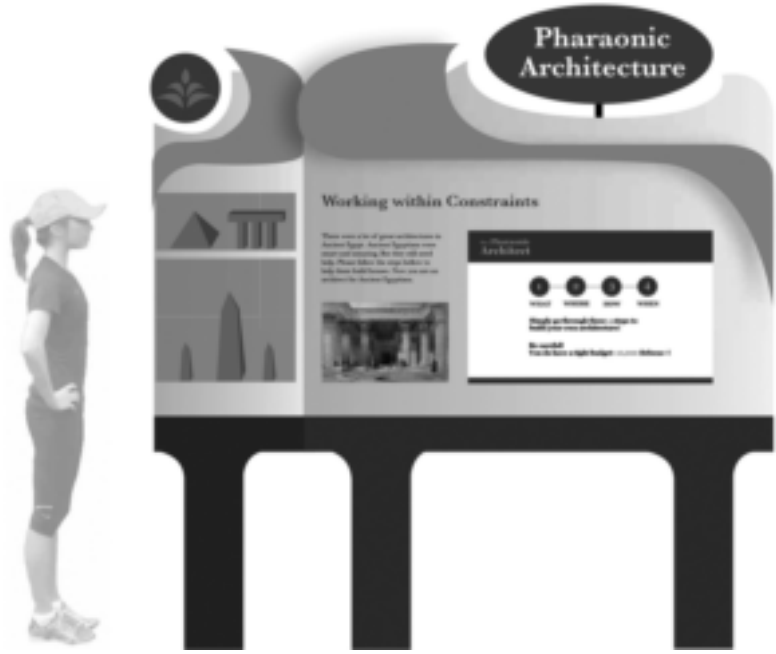
Ancient Egyptians used bartering in the marketplace, so this student invites the visitor to role play by engaging them in a simulation game with physical props that are coded by value. Visitors select a prop of unknown value and attempt to trade it for a different item; players place their items on the scale. The scale reads RFID labels to know the value of each prop, which enables the nearby screen to indicate if the items are a fair trade or not. The game requires two players; this allows for social learning that is often a key component of informal learning. By inviting visitors to engage in a negotiated experience, she has created a condition where "… the dialogue improves the learning" (Bekerman, 2006, p. 3.) This interaction will appeal to many visitors but works especially well for interpersonal learners.

Visitors engage in social learning while playing the 'trade by barter' game.

Pharaonic Architecture Exhibit
Yun Wang

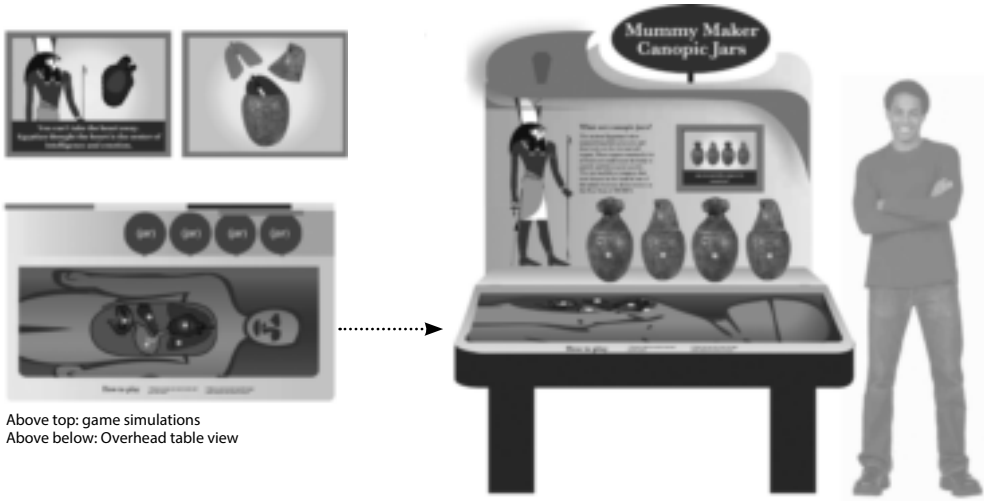
This student noticed that Egyptian architects dealt with the same constraints as contemporary ones: limitations of time, money, materials, and location. She designed a role play game that lets the visitor become a pharaonic architect and make decisions about the design of a building in ancient Egypt. As the visitor makes decisions for the project, costs rise and compromises must be made. Visitors will likely be familiar with this type of negotiation game, used in computer games as far back as The Oregon Trail. The visitor learns that little has changed in project management for thousands of years, creating a bond that connects the visitor to the people of ancient Egypt. Through design iterations the student determined that this is best done as a virtual experience. Applying the principles of accessible design (Lidwell, 2003) she allows for forgiveness of errors and employs meaningful constraints that motivate and focus the learning experience (Simon, 2010).

Right: Excerpted interactive game simulations that offer choices to the visitor at each stage of the building process



Mummy Maker Exhibit
I-yun Liu

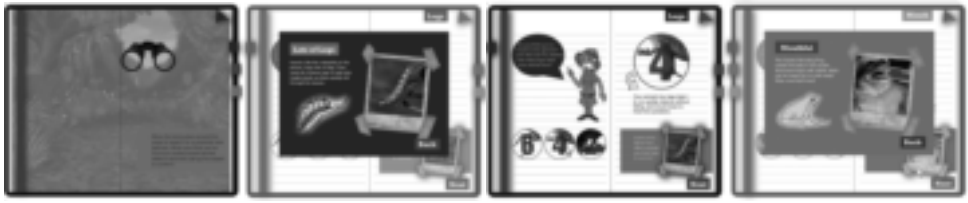
In the Egypt project, topics ranged from cultural history to archeology and agricultural history. In the Mummy Maker Exhibit, the student has devised an interaction based on the popular game Operation, where the visitor learns about the process of preserving human organs in canopic jars. Museum experts suggest the use of familiar games as a method for making exhibit topics approachable to visitors (Goldowsky and McConnell, 2011). For each organ there is a god that guards its particular jar. On a table in front of the canopic jars, a body with exposed organs allows the visitor to guess which canopic jar is intended for each of the organs and which Egyptian god is designated as its guardian. Through a series of iterative prototypes and feedback from museum staff, the student determined that a purely physical simulation game was functionally impractical. Her final solution incorporates both physical and virtual, with the three-dimensional body and jars connected to a video simulation of the organs dropping into the jars.



Above top: game simulations
Above below: Overhead table view

Discover a New Species Exhibit
Megan Fynaardt

In the Biomechanics project, students developed interactive experiences that explained some of the ways that animals and humans have adapted to their environments. In the Discover a New Species exhibit, the student has designed a touch screen game that teaches visitors how scientists categorize and identify species based on characteristics such as the quantity and type of legs, type of skin, and type of mouth. The visitor gets to play the role of the field scientist, and to fill out a field journal with wildlife discoveries. This seems to work best as a virtual experience since the sizes of the species and their habitats are too varied to effectively use physical simulation. Through this carefully constrained narrative, the student introduces the visitor to the fascination of being a field scientist (one of the museum's broad goals).



Above: Excerpted game simulations.

Built for Speed Exhibit
Holly Kayser

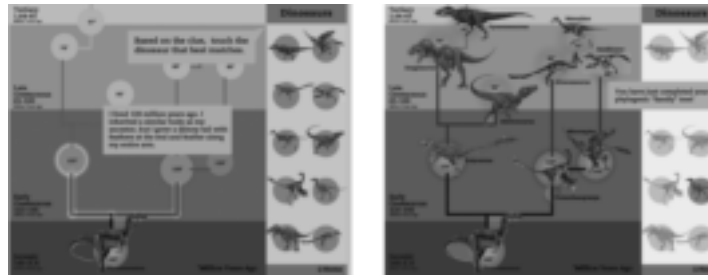
This student chose to teach about biomechanics by showing how each creature has adapted according to its needs. Cheetahs are really fast, but they don't need endurance. That's where humans are superior. In the Built for Speed exhibit, visitors run in place on a responsive floor pad (similar to that of the Dance Dance Revolution game), which reads their pace and compares it to that of the cheetah. While pretending to be the world's fastest sprint runner, or the world's best endurance runner, visitors will always have consistent race results: the cheetah will always win on speed alone, but the human will always win if the race is long enough. The comparison could be made simply by watching the human and cheetah race each other, but by including the floor pad, the student has added a feature that is especially inviting for bodily/kinesthetic learners.

Right: Excerpted interactive game simulations comparing speed racing to endurance racing.

Phylogeny Exhibit
Kayla Brown

Phylogeny is the study of the evolutionary development and history of a species. In this exhibit about dinosaur evolution, the student uses the metaphor of a family tree to help visitors understand relationships between phyla across eras that span millions of years. The interaction uses a test your ability method, which allows visitors to make increasingly informed guesses as they progress through the game. The student has determined that this works best as a virtual experience, where millions of years and a multitude of dinosaur species can be viewed on one frame. This interaction will be particularly inviting to logical/mathematical learners.

Right: Excerpted interactive game simulations showing progressive construction of a phylogenic tree



It is not known whether the skills developed during this assignment will become a permanent addition to a student's skill set. While an assessment rubric has been previously shown to be a useful tool to assess student ability in completing the project, Goldman et al point to the difficulty of using this type of reflective tool to assess the long-term shifts in a student's thinking. For this they suggest a performance assessment task after the project is completed, to see if the student has become more human-centered in his/her approach to new design problems (Goldman et al, 2010). Future offerings of this collaboration with the Field Museum could be assessed with a pre/post test, which would help to determine if the student is more likely to approach subsequent projects with empathy for the user than before this project began. Goldman describes this phenomenon as mindshift: the development of new viewpoints and instincts that can be seen through changes in the student's actions as a design thinker. The pre/post test could also determine the successful carryover of other design thinking skills; for example, if a student is better able to define a problem, to determine a strategy, and to develop rapid prototypes and test them.

CONCLUSION

There are several pedagogical advantages to incorporating interactive exhibition design into the curriculum. As a method for emphasizing strategic/design thinking, this challenge is well suited, since it is only possible to achieve the museum's learning objectives with a focus on user needs. Visually appealing graphic solutions cannot be the primary goal of the students. By learning to prioritize the visitor's learning challenge, the students become more versed in user-centered design. By defining the problem, structuring the narrative, devising and testing their own solutions, and documenting their process, they are practicing the higher order thinking that will be expected of them as 21st Century design professionals. These skills will, of course, be translatable to other areas of their graphic design careers, whether they be in print, web, or physical space.

Alvaro Amat, the Exhibit Design Director of the Field Museum and collaborator on the assignment, recognizes these expanded student skills as an indication of what new designers will be bringing to the profession:

"Some of the ways in which the students approach the creative process guided by Professor Fontaine, and the inherent talent of this new generation of designers, have had an impact on the way I see exhibition design management. One concrete aspect that has been affected is that in our institution graphic design, media and interactive development tend to be all independent divisions, separate from each other and from exhibition design which we call 3D Design. Through this collaboration in ISU's projects, I've

witnessed how students integrate all aspects of the exhibition experience, providing an insight into how our professional process could make more sense, in accordance with the kind of tools and skills that these new designers bring along with them. As these new professionals begin to participate in the profession, we will see a turn towards more integral design practices that are beneficial for the expansion of the field."

AUTHOR BIO

Lisa Fontaine is an Associate Professor of Graphic Design at Iowa State University, where she has taught since 1987. Professor Fontaine recently helped to develop ISU'S new MA degree program in Environmental Graphic Design, the first of its kind in the nation. She was a member of the 'Hablamos Juntos,' design consortium, a national initiative for healthcare symbols, and was its national research director; the project was awarded 'Best in Healthcare Design 2011' by the International Institute for Information Design (IIID). Through the Institute for Design Research and Outreach, she has supervised the student design of over 180 identity projects, sign systems, placemaking, exhibition design, wayfinding and downtown revitalization projects for Midwestern communities and clients. She has presented research at the American Institute of Graphic Arts (AIGA), Society of Experiential Graphic Design (SEGD), IIID, Icograda, and other national and international design conferences.

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Overview:
Visual theorist and design historian Johanna Drucker, in *SpecLab: Digital Aesthetics and Projects in Speculative Computing*, defines the digital humanities as "the study of ways of thinking differently about how we know what we know and how the interpretative task of the humanist is redefined in these changed conditions"[1]. Design and the digital humanities connect through critical making practices, centering on human experience and advancing the prevailing expectations of their respective disciplines.

At the convergence of conceptual and material practices[2], the ongoing development of a framework for critical making offers a means to understand complex relationships between research, scholarship and production. In design, emphasis is placed on innovative notions of what criticism or authorship can be within the context of design-making; in the digital humanities, focus is on innovative notions of what "making" can be as a form of interpretation within the context of conventional scholarly dissemination. The intersection of these two areas presents opportunities to bring form and content together in ways that are practical and theoretical, rhetorical and physical.

Critical making in design is aligned with practices that facilitate innovation and exploration related to technology, materiality and communities. In graphic design — a discipline, a medium, a practice and a tool[3] — "critical practice" has been used to describe a range of activities that position the designer as author, producer, scholar, curator or programmer[4]. These endeavors, whether individual or collaborative, may involve humanistic or scientific inquiry, and move beyond the traditional structure of client-based relationships. From a pedagogical perspective, key components of critical making include "hands-on practice, the processing of enhanced seeing and perception, and contextualized understanding"[5].

In the digital humanities, critical making distinguishes its practices from traditional forms of humanities scholarship. With an emphasis on tool building, information visualization and digital archiving, the digital humanities merge two seemingly opposing modes of scholarship: reading and making. Critical making dichotomies of thinking/making, knowing/doing and cognition/embodiment permeate current digital humanities discourse[6] and projects demonstrate a desired interest in building through existing design and development processes. *The Critical Making Zine*[7] uses physical production to publish and distribute a series of essays on technology, society and DIY culture. *Speaking in Code*, an NEH-funded symposium hosted at the Scholar's Lab in 2013, addressed questions related to "DH code-craft": tacit knowledge as it relates to the design and development of digital humanities projects[8].

Perspectives:
This special issue of Visible Language investigates critical making at the intersection of design and the digital humanities, which is a site for expanding the role(s) of divergent scholarly and creative work. We invite submissions that address one or more of the following questions:

- What are the theoretical or pragmatic ways to frame critical making in design and/or the digital humanities? Where are the similarities, differences and challenges? How are these advantageous?
- In what ways might design authors and producers connect with the digital humanities? Where or how are digital humanists' experiences of critical making intersecting with designers? How do these crossover 'ways of seeing' impact our scholarly and creative work — and future hybrid practices?
- How might forms of understanding such as speculative design, prototyping or hacking play a role in critical making, and in what ways are these influencing the scope of work in both areas?
- In what ways might design and the digital humanities collaboration be fostered in the studio or classroom? What are some examples of pedagogical approaches to teaching critical making?
- What are the forms these arguments might take as part of this special issue?

Visible Language is a journal that invites evidence-based research. For this issue, we encourage exploratory, creative works that incorporate evidence-based research through critical commentary, traditional analysis, audience responses or participant feedback.

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Proposal due: January 15, 2015
Abstract **acceptance/rejection:** March 15, 2015
Full papers / works due: June 15, 2015
Review period: June 15 – August 1, 2015
Review feedback: August 1, 2015
Final paper submission: September 15, 2015
Anticipated publication: October 2015

Submissions:
In keeping with the theme of merging form and content, the traditional printed journal will be expanded to include a corresponding online space for interactive and digital work. We invite dialogue on what defines scholarly works in regard to non-traditional forms of writing and disciplinary crossovers. Submissions may include, but are not limited to, case studies, interactive reading experiences, audial and visual works.

Proposals should include a 300-word written abstract and a brief outline to show the structure of your argument. A corresponding visual abstract is strongly encouraged. For digital work, please include a URL or screenshots. Final articles can range from approximately 3–5,000 words.

Please send proposals through January 15, 2015 to Jessica Barness, jbarness@kent.edu

Open Peer-Review Process:
Submissions will be reviewed through an open peer-review process. An open peer-review process makes available the submission author's name to the peer-reviewer. Reviewer names and reviews will be published on the Visible Language journal website. Proposals will undergo review; a selection will be shortlisted for development into full-length papers / works and these will also be peer-reviewed prior to publication.

Interested in serving as a peer-reviewer?

Peer-reviewers will be responsible for providing feedback about abstracts and/ or final submissions between January – August 2015. If you are interested in serving as a peer-reviewer, please get in touch.

Guest Editors:
Jessica Barness is an Assistant Professor in the School of Visual Communication Design at Kent State University, where she teaches graphic and interaction design. She holds an MFA in Design from the University of Minnesota with a minor in Writing Studies, and an MA and a BA in Art from the University of Northern Iowa. Barness' research through design investigates theories in social issues, language and interactive technologies. Her work has been exhibited at venues such as Hebei Normal Museum, China and FILE Electronic Language Festival, Brazil, and published in Communication & Place and Currents in Electronic Literacy. She has also presented research at the International Committee for Design History and Design Studies Conference (2014), SEGD Academic Summit (2014), AIGA Design Educators Conference (2013) and HASTAC (2013), among others.

Amy Papaelias is an Assistant Professor in the Graphic Design program at SUNY New Paltz, teaching courses in web and interaction design, as well as 2D design and visual communication. She holds an MFA in Intermedia Design from SUNY New Paltz and a BA in Cultural Studies from McGill University. Her creative research lies at the intersection of design, culture and technology with specific interests in interactive typography and the digital humanities. She has presented her design work and pedagogy at Theorizing the Web 2014, AIGA Design Educators Conference (2007, 2013), TypeCon (2005, 2007, 2012), UCDA Education Summit (2011) among others. In 2013, she was selected to participate in One Week One Tool, an NEH-funded Institute for Advanced Topics in the Digital Humanities, hosted at the Center for History and New Media at George Mason University and co-authored a long paper on the experience that was presented at Digital Humanities 2014.

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Design for Information: An Introduction to the Histories, Theories, & Best Practices Behind Effective Information Visualizations

Isabel Meirelles

Beverly, MA: Rockport Publishers, 2013.

For a complementary perspective of this book, please refer to the review written by Aaron Marcus in the *Information Design Journal* 20(3), 296–297

The book is a thorough representation of both the field of information visualization and the research interests of the author, whose focus is on "the theoretical and experimental examination of the fundamentals underlying how information is structured, represented and communicated in different media."

Beginning by the "big picture," the book includes an amazing collection of examples, the most thorough I have seen to date in a volume. The author organizes the content according to several categories represented by the titles of the chapters: 1) Hierarchical structures: trees; 2) Relational structures: networks; 3) Temporal structures: timelines and flows; 4) Spatial structures: maps; 5) Spatio-temporal structures; and 6) Textual structures. An appendix, notes, bibliography, contributors list, and index, complete the apparatus of the book.

Design for information is an extensive taxonomy of data visualization types, and is "a must" for anybody interested in the work done in the area. Each one of the hundreds of examples is explained and discussed, forming a kind of encyclopedia on the subject. It seems that nothing escaped from the through gathering of examples that Meirelles got involved in. The discussions and explanations normally focus on what information is represented and how it is represented.

It is interesting to see as well how many different professional fields use today diagrams to organize and represent information: basic science, applied science, education, engineering, medicine, technologies, etc. The value of the book is centered on the inclusion of examples of how many different problems are today being confronted by data visualizations, how many historical efforts preceded whatsoever is done today, and how the advent of the computers have allowed the field to explode, handling large data sets as well as dynamic representations.

At the end of the examination of the 224-page volume one becomes curious as to how might these diagrams have performed with the users they were intended for in terms of ease of comprehension; what conclusions could one arrive at from an evaluation of the examples included regarding perceptual and cognitive human factors; or how could a complementary book contribute to the development of best practices. I would not expect that one volume could be so extensive as this one and also cover the field critically. One, however, has to wonder how the super-complex visualizations permitted by computer programs today would perform regarding comprehension, memorization, and use of the information presented. The discussion on perception and cognition is very brief, and it might leave some readers wondering about the assertions made: they are proposed as principles without them being discussed. This topic, as well as Gestalt theory, are not considered during the description of examples. The size of some reproductions is too small to assess their quality as data visualizations, they appear as samples of problems dealt with but not as information in themselves. To compensate for this, the book includes valuable URLs for people interested in seeing in better detail many of the diagrams shown.

While the above could be perceived as a weakness, the strength of the book is its truly amazing array of examples and the rare historical diagrams it offers. It also displays an uncommon erudition, and includes an extensive and useful bibliography. One does not know how long Meirelles took to complete the manuscript, but it feels like a life-time project. These assets, coupled by an excellent production, make it an indispensable publication for whoever can be interested in information visualization.

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Editorial correspondence should be addressed to:

Mike Zender
Editor, Visible Language
College of Design, Architecture, Art, and Planning
School of Design
University of Cincinnati
PO Box 210016
Cincinnati, OH 45221-0016

Email: mike.zender@uc.edu

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