Nuclear, Landmarker for a Waste Isolation Site: International Architecture Competition – 18240

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ABSTRACT

The design and construction of a nuclear waste marker must include many architectural considerations. Very little research has been conducted by architects to address this issue to date. Historically, the task of designating a nuclear waste site has been a discussion predominantly contained within the scientific and engineering communities. In an effort to engage architects within this dialogue, **arch out loud** hosted the NUCLEAR competition as an international, architectural investigation into the design of a nuclear waste site marker. The NUCLEAR competition asks participants to design a marker to designate the site of the Waste Isolation Pilot Plant (WIPP) located near Carlsbad, New Mexico. The marker will be meant to be a means of passive institutional controls (PICs) to deter inadvertent human intrusion upon the site and should last 10,000 years.

The NUCLEAR competition defined the purpose of the nuclear waste site marker as a means to communicate the danger of inadvertent intrusion from future generations. The competition requires that entries must be both legible in communication and durable in their construction. The competition brief challenged participants to consider how customs and languages will evolve over time and to predict what motivations future generations might have for digging at the site. Other background information was provided about the site such as how waste was stored and how the unique geology of the site seals the waste. The 1993 Sandia National Laboratories report titled Expert Judgment on Markers to Deter Inadvertent Human Intrusion into the Waste Isolation Pilot Plant [1] was referenced along with the 1992 WIPP Land Withdrawal Act [2], interviews with WIPP scientists [3] involved with the WIPP PICs program and the Nuclear Energy Agency Records Knowledge and Memory working group. Competition participants were given digital 3-D Computer-Aided Design models for reference that included the underground storage portion of the site, existing buildings and the 16-square-mile site boundary identified in the 1992 WIPP Land Withdrawal Act [2].

This paper will:

- Provide a detailed description of the submitted proposals including graphic analysis of the visualizations, diagrams, technical drawings, jury comments and statements.
- Catalogue and identify the consistent themes within all submissions with possible categories including:
  1) overall architectural form and language,
  2) integration of written language and symbols within architecture,
  3) use of technology and robotics,
  4) construction methods and materials.

INTRODUCTION

arch out loud is a research initiative, publisher and design competition host but, more important, it is a platform that gives designers, architects, urban planners, engineers and creatives of all backgrounds a place to critically think.

Among the many formative forces in society today, geopolitical, spatial and cultural issues demand the constant rethinking of former ideologies. **arch out loud** was created to offer opportunities to examine the relationship between the oddities of culture and processes of the built environment.

Recently, **arch out loud** has explored how dense urban areas facilitate the constrained need for cemetery space and how architecture can influence the political and physical borders at the heart of global conflict. Currently, **arch out loud** asks: How can design transcend thousands of years to effectively communicate and educate future generations about the dangers of a nuclear waste site?

Hosting open idea competitions allows **arch out loud** to explore some of today's most-pressing issues and ignite dialogue between designers on a global scale. **arch out loud** intends to search for innovative solutions and test the limits and capability of design to influence the impending issues of the ever-changing society.

Show Nuclear Introduction Video (1:08) [5]

As the U.S. produces nuclear weapons,
Waste must be transported to the Waste Isolation Pilot Plant.
One-half mile under the WIPP waste is buried to remain for thousands of years.

The surface of the site should be marked,
With signs, symbols and structures,
That will last 10,000 years.

Architecture has endured for centuries.
But with time its meaning can be lost.
Could you build something to last 10,000 years?

What does 10,000 years look like in history?
What would you build?



Fig. 1 Arch Out Loud, NUCLEAR: international open ideas competition, digital video, 1:08, August 3, 2017, https://vimeo.com/228298374.

DESCRIPTION

Introduction to Competition

Since the Cold War, one of the most challenging and urgent tasks facing governments around the world has been the disposal of transuranic nuclear waste. As a byproduct from nuclear weaponry production, transuranic waste is not only harmful, but also boasts a formidable decay process lasting thousands of years. To address this issue, millions of barrels of highly radioactive waste have been buried in repositories deep beneath the Earth's surface. To ensure public safety, it is imperative that sites with this waste remain undisturbed for the duration of the decay process.

The WIPP Site

After coming across a documentary titled “Into Eternity” [6] that discussed the longevity of nuclear waste decay, **arch out loud** began looking at architecture’s role and potential within this process. During research **arch out loud** discovered one such disposal site in New Mexico called the Waste Isolation Pilot Plant, or for short, WIPP.

Until 250 Million years ago, this site was completely covered by seawater. It has since left behind a stable salt bed where transuranic nuclear waste can be safely and permanently stored. Over time, it is expected that the residual salt will gradually seep into the cracks of the rooms where barrels are stored and permanently seal the chambers of waste.

The extents of the site are dictated by U.S. Environmental Protection Agency standards that require a minimum boundary encircle the site separating the accessible area from the WIPP control area. In 1992, U.S. Congress designated 16 square miles within the control area as part of the WIPP Land Withdrawal Act. This surface and the subsurface below has been dedicated for all disposal operations performed at the WIPP.

Why arch out loud Hosted a Competition

In 1993, a report issued by Sandia National Laboratories [1] described architectural and semiotic proposals for markers designed to discourage human intrusion upon the WIPP site after the day-to-day facilities are no longer in operation. These markers were not barriers of force but signs, meant to signal that the place was dangerous and should remain undisturbed. Besides the designs put forth by the report, very few alternative proposals have addressed these concerns.

Because of these concerns, **arch out loud** became interested in what designers would propose today, 25 years after the report was conducted, and created an open ideas architecture competition for the WIPP site. **arch out loud** asked competition entrants to design a marker or marker system to deter inadvertent human intrusion into the Waste Isolation Pilot Plant. Proposed markers needed to exist as a means of passive institutional control of the site for the duration of 10,000 years, following the closure and deactivation of the WIPP. The purpose of the marker is to communicate with future generations that transuranic waste is buried within a repository at the facility, located 2,150 feet beneath its surface, and should remain isolated until the risks posed by its release have been sufficiently diminished. In the interest of public safety, the competition was created to understand how other architectural proposals for markers could serve to warn future societies of the dangers of such a place with messages that could endure for millennia.

How arch out loud Set Up the Competition

To make sure the competition explored as many solutions as possible, the programmatic requirements were left vague and open-ended. There was no required scale so long as participants were in the 16-square-mile site boundary. Instead of definitive measures, **arch out loud** asked that designers consider two important variables in their proposals. The first— durability—in the construction techniques, materials and placement of the marker(s) on the site and how the markers will react to natural forces and human vandalism for a duration of 10,000 years. The second—communication—which gestures, symbols, signs and expressions will be a legible and enduring means of conveyance. In addition to the two variables, it was encouraged, but not required, that designers explore the potential of supplementary activity for the marker.

Future generations, 10,000 years from now, may be more, less or equally developed as present-day people. Since political or natural forces may shift the demographic of the site, the customs and languages of future inhabitants will likely be different from today.

What changes to language, infographics and nomenclature should **arch out loud** anticipate in the years to come? Future generations might be motivated to excavate the site in search of resources or wish to reopen the site to store additional waste. Excavation for archaeological purposes, explosive testing and infrastructural projects could also pose potential threats to the site's intended isolation.

Purpose

Why is it important to include architects in the dialogue about the designation of nuclear waste sites? What can architects offer in their expertise and background that could help scientists and engineers design effective and lasting markers or marker systems?

Defining the Program

A building or structure is not just an object in the landscape, but something which contributes to placemaking. Is the marker a memorial or a barrier? Is it didactic, what activities do you do when you confront the marker? Are their amenities in the vicinity? All these questions relate to the subject of programming. Defining the program is usually the first step to any architectural project, in which the design team works to establish the primary and secondary functions of the project. There is an entire architectural licensing exam dedicated to the topic of programming because it carries such weight in establishing the trajectory of the project.

Communicating Ideas

Sometimes it is most effective to communicate project ideas through graphics and visual representation, in addition to written and verbal language. This is particularly effective when sharing ideas with non-experts, like the public. Architects are equipped with the knowledge and skill to produce accurate, technical drawings for construction as well as compelling rendered visualizations at all phases of design. Not only do they have experience with two-dimensional forms of communication but 3-Dd model-making, animations and fly-throughs, as well as virtual and augmented reality are increasingly becoming common means for both designers and clients to experience projects before they are even built.

Familiarity with Construction

In many construction projects, architects can be at the center of project coordination. Architecture project managers consult with material suppliers, fabricators, contractors, and communicate directly with the client. Once the design is approved by the client, the architect must continue to coordinate with all other parties to ensure the building is documented and constructed accurately and with quality.

DISCUSSION

Analysis of Competition Proposals and Strategies

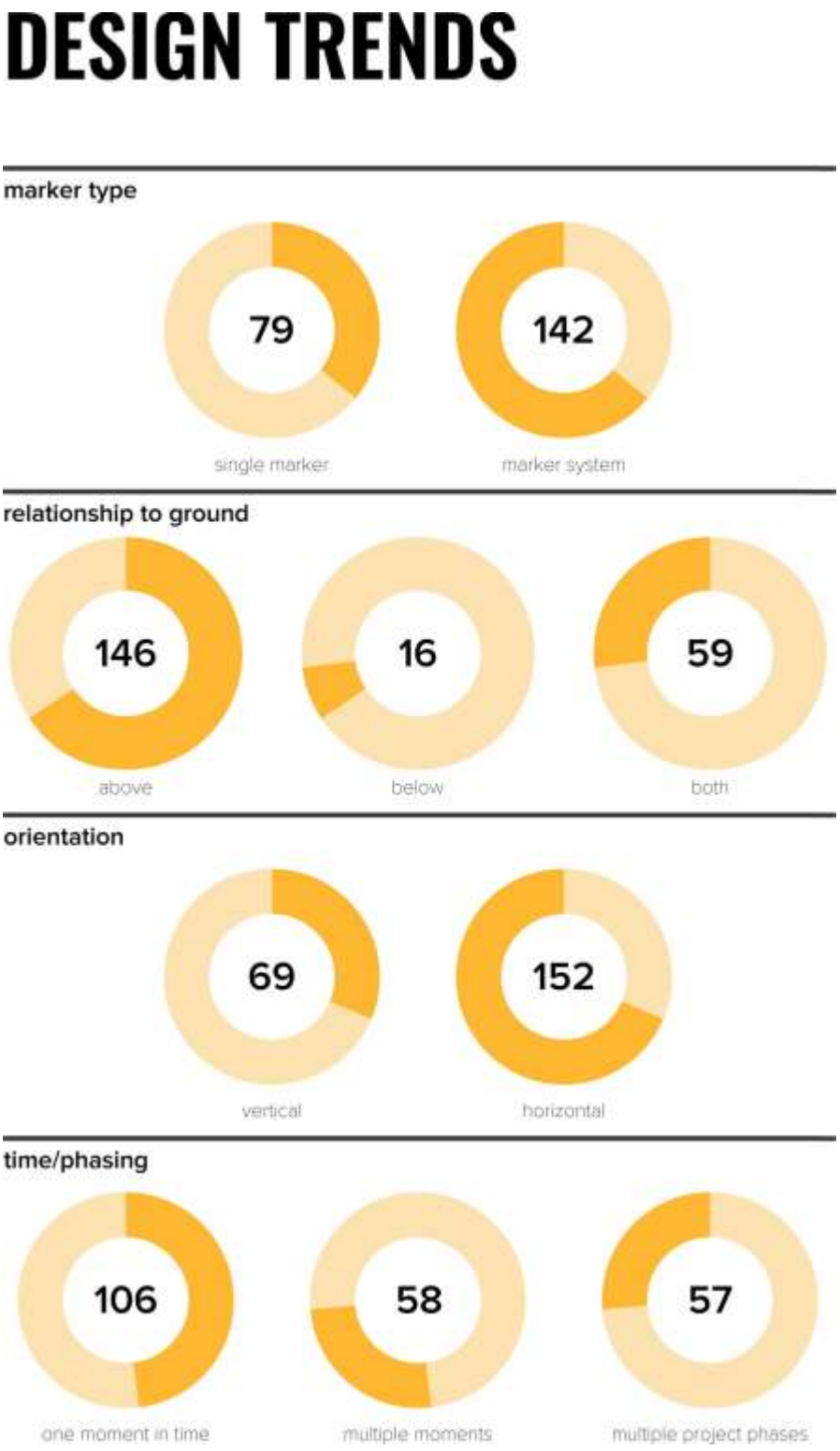


Fig. 2 Arch Out Loud, NUCLEAR: international open ideas competition, graphic analysis, January 11, 2017.

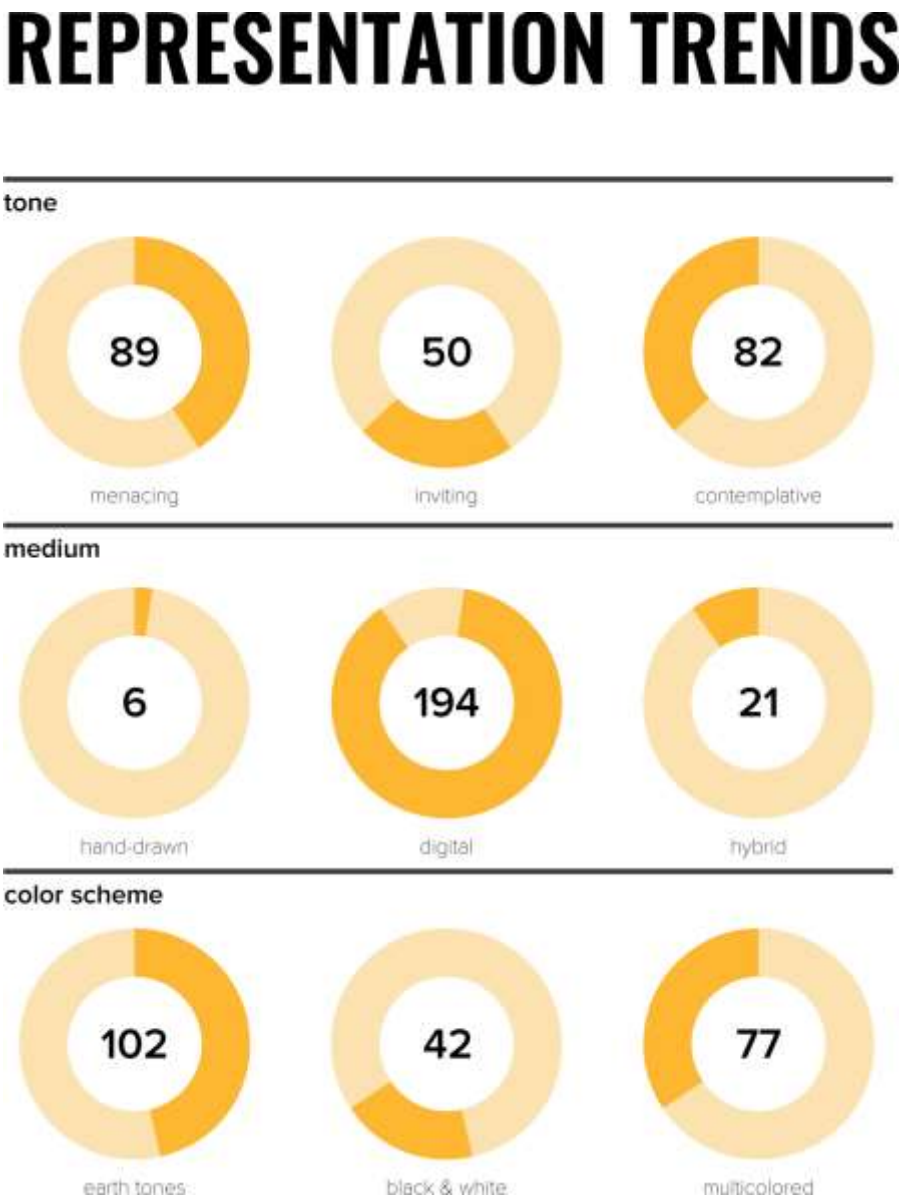


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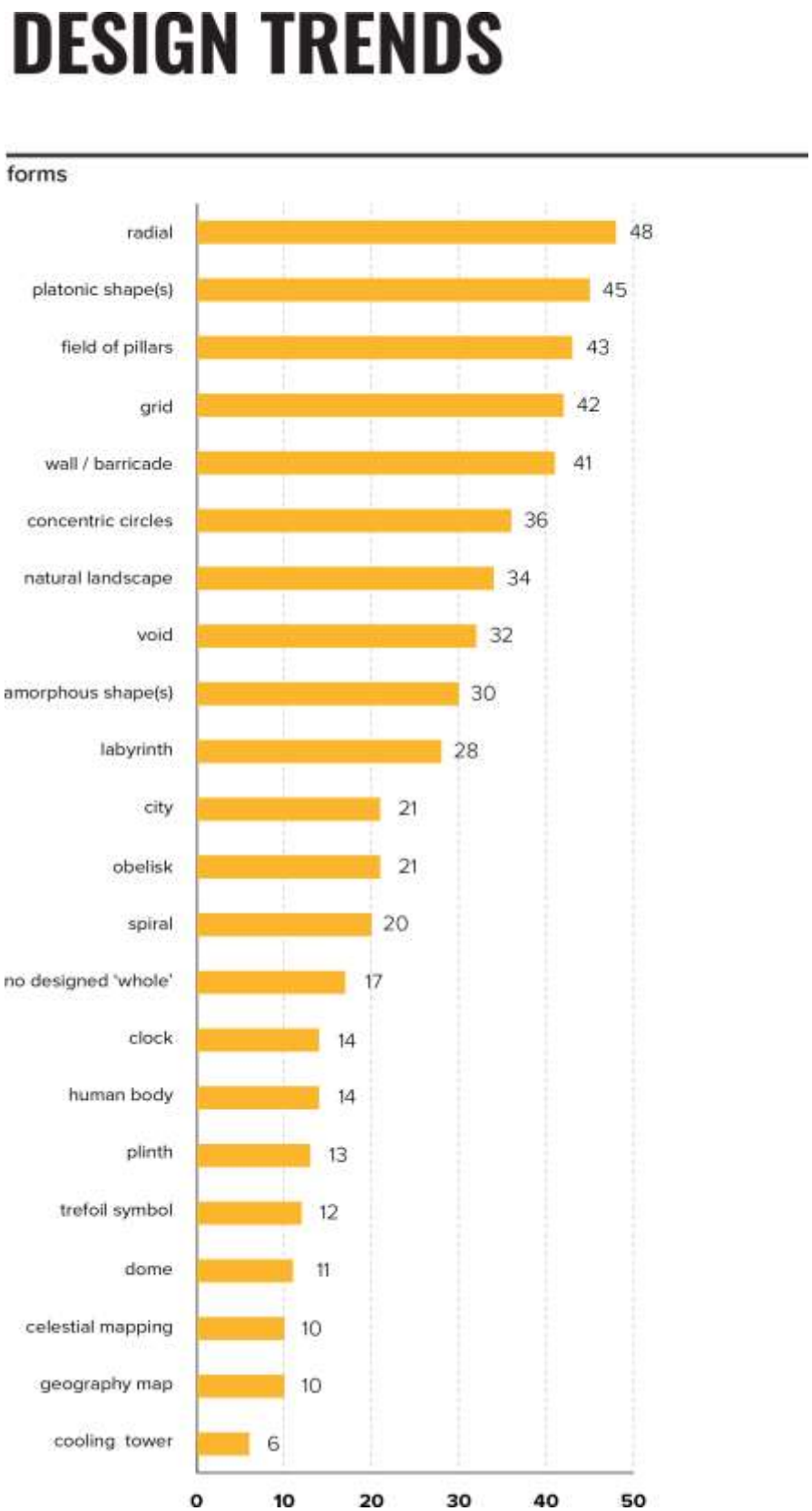


Fig. 3 Arch Out Loud, NUCLEAR: international open ideas competition, graphic analysis, January 11, 2017.

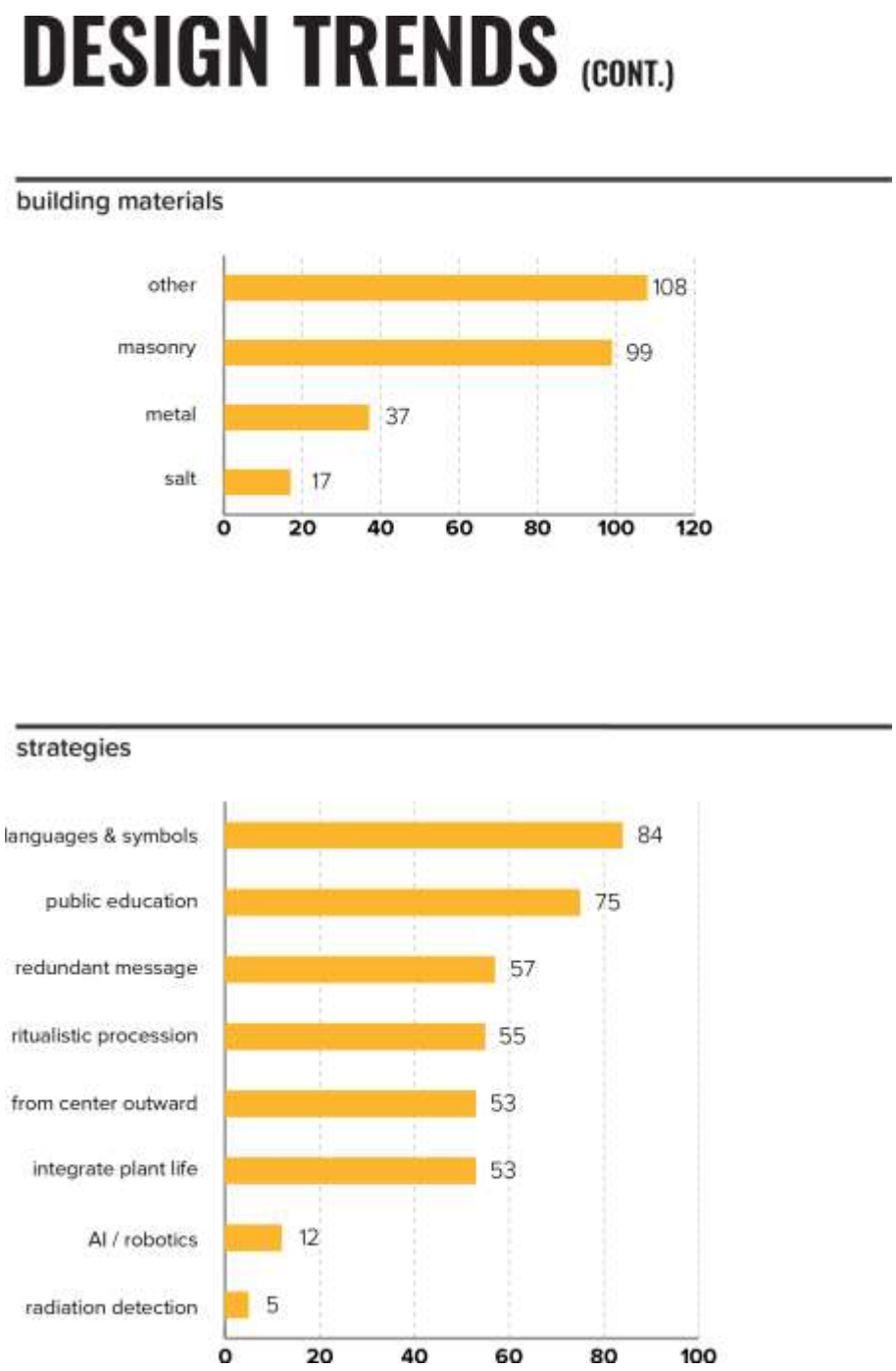


Fig. 4 Arch Out Loud, NUCLEAR: international open ideas competition, graphic analysis, January 11, 2017.

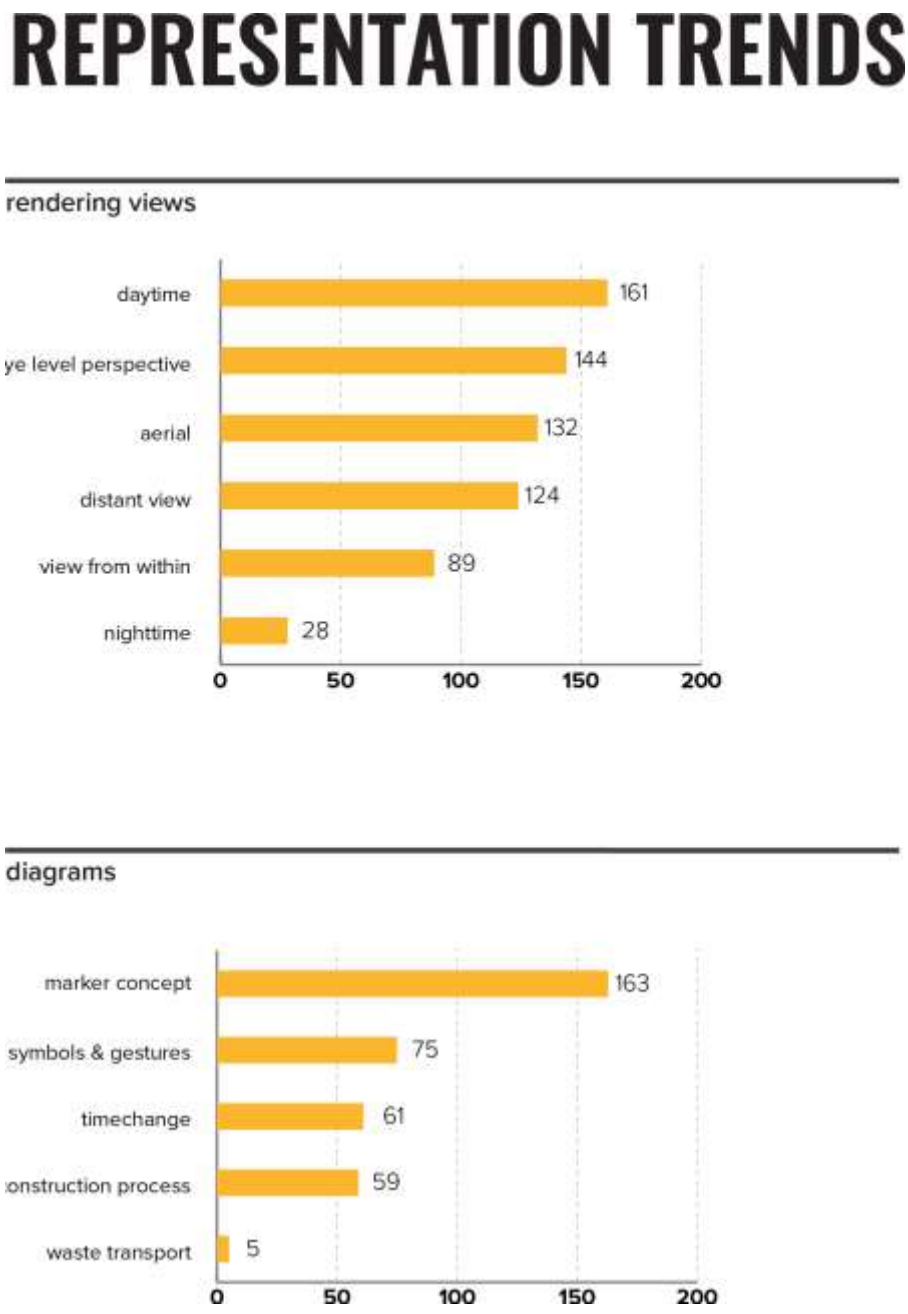


Fig. 5 Arch Out Loud, NUCLEAR: international open ideas competition, graphic analysis, January 11, 2017.

A marker's location was determined by its **position** either above, below, or both above and below ground. Most entries sited markers above ground. This above-ground positioning contributed to greater visibility than subterranean markers when views of the site are clear. Conversely, entries with subterranean markers often proposed dangerously linking the buried storage with the surface above. For example, some entries featured shallow trenches or passageways just beneath the surface with most of the marker visible from above.

Most entries featured markers with a dominant horizontal **orientation**. These entries were expansive and sometimes occupied the entire extents of the site. Other vertically oriented markers functioned as beacons with more slender proportions. Though a marker with a predominantly vertical orientation could have greater visibility from further distances at ground level, horizontally oriented markers may better resist natural and human destruction given the entropic considerations of the markers long lifespan. A horizontal marker could have greater visibility in aerial and satellite views as well.

Markers were further classified by **type**, either as single markers or marker systems. Marker systems were much more common than single markers. While single markers were more symbolic and synthetic in their message, marker systems offered variety in storytelling and significantly greater redundancy in construction and communication.

The markers were designed to be constructed from a number of building **materials**. Masonry construction dominated and exceeded the number of markers composed of metal or salt. The most permanent manmade structures, like the Giza Pyramids and Stonehenge are long-lasting for the same reason. A variety of other materials including glass and rammed earth were also considered as part of a category designated as "other" material. A couple of entries proposed using tungsten carbide, a material stronger than steel. Material research in the 21st century is something that should not be overlooked in the consideration of durable construction of the marker. For example, scientists and designers are currently exploring 3-D printing with algae, metal, wood and other materials over more conventional plastic filament.

Since the marker could have an inherently symbolic meaning, the building's **form** became one of the most important elements in the design. Some of the most common building shapes were compositions of Platonic Shapes, Fields of Pillars, and Radial Compositions. There were also some very literally shaped markers configured like nuclear cooling towers and trefoil symbols. Given that the transuranic waste buried beneath the site is a byproduct of nuclear weapons production rather than energy, nuclear cooling towers are probably not an appropriate symbol to incorporate into the marker(s).

The markers also utilized many architectural and communicative **strategies**. Some of the most common components included a programmatic feature for public education, direct integration of languages and symbols within the structure, as well as redundancy in the message. Projects also included circulation strategies such as ritualistic processions and radial movement from the center of the project outward.

It was also important to note the representation techniques and **tone** of the presentations. Projects were described as either menacing, inviting or contemplative. Though most projects were represented as menacing, there were also others that satisfied the other two descriptions. The tone of the marker very much reflected the position that the entrant made regarding the relationship between the public and the site. Visitors were either encouraged to fear, be welcomed or pause and reflect at the place.

The NUCLEAR competition was held in 2017, and it is interesting to note which **mediums** the entrants used to communicate their designs. The competition stipulated an electronic submission of a single 24x36 inch board. Almost all entries had a digital component to the graphic representation and visualization of the project, its concepts and views on the site. Very few entrants had any hand-drawn designs. This preferred representation method varies greatly from the 1991 Sandia Laboratories:

Expert Judgment on Markers to Deter Inadvertent Human Intrusion proposals where diagrams and sketches were almost exclusively hand-drawn images, more conventional of architectural production at the time.

The **color scheme** of the competition submissions was also a critical element of the visual representation. Most entries featured earth-toned color schemes, few were black and white only, while many were multicolored. Since the project was sited in the desert, it was naturally fitting that many of the presentation images showed markers either integrated or contrasted against this earth-toned context.

The competition asked participants to consider markers that should last 10,000 years, which was a challenging consideration not only for the marker design but also in the representation of **time and phasing** of the project. Most projects showed the marker in one moment in time. Many projects showed how a marker might look in different moments in time. Other projects showed how the marker would be constructed or physically evolve in different phases.

The presentations featured **views** of the marker from many angles. Some views and angles like daytime views, eye-level perspectives, aerial views, and distant views were popular vantage points. Very few projects included images of markers at night and some showed views from within the marker. This is significant because it suggests an expectation that the marker will not have artificial lighting and probably not require occupation to be communicative.

Other than rendered visualizations of the project, many entries featured **diagrams** that helped describe elements of the project in an abstract way. Many projects featured diagrams explaining the marker concept. Some showed how the marker might change over time, described the construction process and elaborated on the meanings and uses of symbols or gestures.

CONCLUSION

Is a marker system best located above the surface or within it? Is educating the public more important than instilling fear in future intruders? Based on the opinions of the architects, researchers, artists, directors and scientists that served as the jury for the **arch out loud** NUCLEAR competition, this group has selected *Test Field* by Agency-Agency as the best project addressing the challenges posed by the competition. These challenges include addressing issues of durability and effective communication and addressing objectives like redundancy in message and considering potential threats of the site.

The jury has selected one winner, but **arch out loud** believes the diversity of the competition—with entries hailing from 40 countries—and the problem of designing a marker to deter inadvertent human intrusion on the site is a complex issue that can yield a variety of solutions. Given the range of submissions from the profession, the academy and range of countries, **arch out loud** proposes that extrapolating trends from the submissions is a useful exercise to consider the design for a nuclear marker system.

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