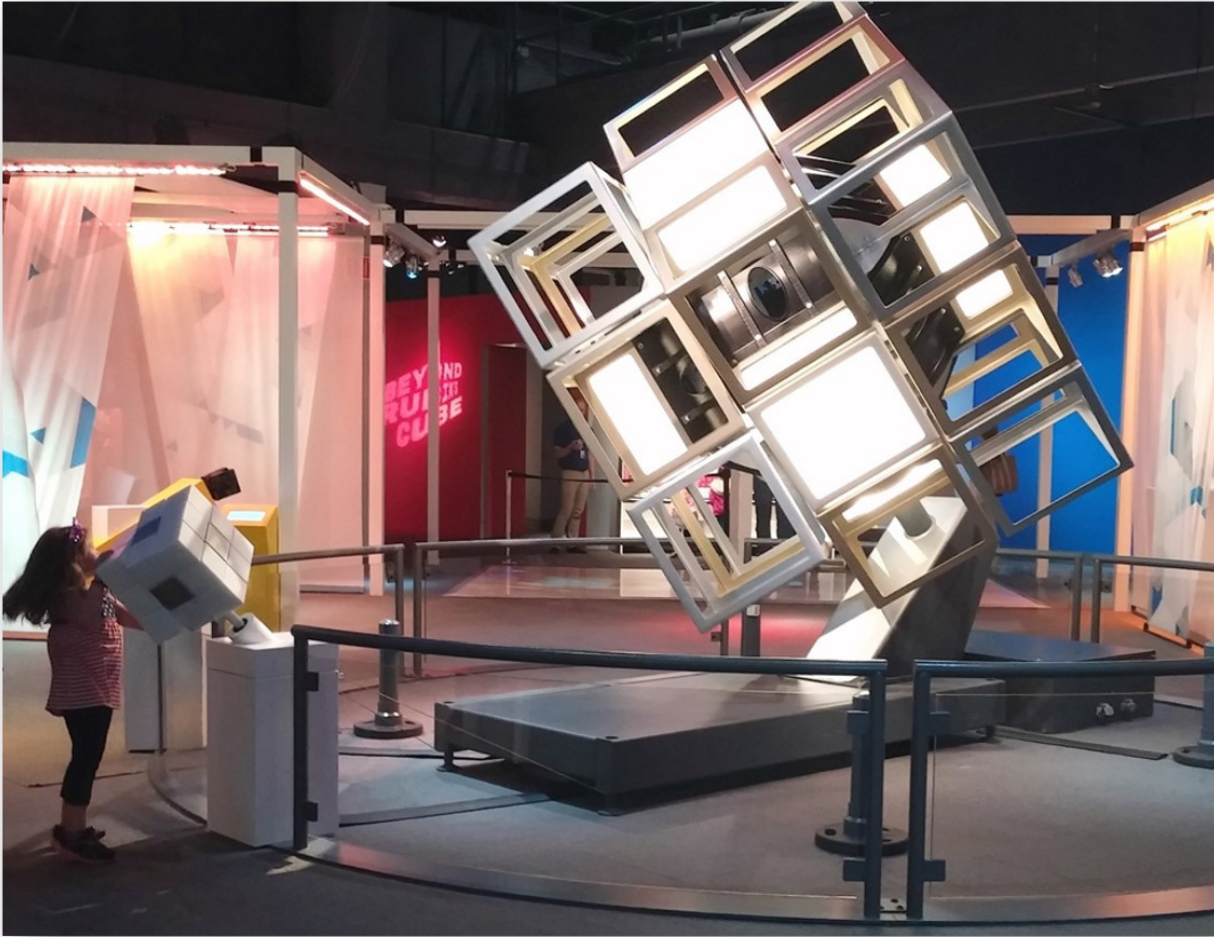


The main centerpiece of Liberty Science Center's travelling exhibit, "Beyond Rubik's Cube", will get a new home at STEAMPowerForKids.org



STEAMPowerForKids.org is excited to announce that the centerpiece of the travelling Rubik's Cube museum exhibit, titled "Beyond Rubik's Cube", will make its final trip and then be installed next to our Makerspace in Rockledge. The Liberty Science Center (www.lsc.org) of Jersey City, NJ has graciously donated the giant cube. Entech Innovative (www.entechinnovative.com) will donate the space and assemble the cube where it will be used for educational purposes by STEAMPowerForKids.org. Our students will be able to learn about the science of the cube, understand the algorithms required to solve it and discover the mechanical and control programs, which operate the cube. The original story about the cube is below.

Watch a Video

https://www.youtube.com/channel/UCC3zKHjlt1sEuaRysAI58FA?feature=emb_ch_name_ex

[Original Story](#)

Rubik's Cube is a 3D combination puzzle invented in 1974 by Hungarian sculptor and professor of architecture Ernő Rubik. This invention caused widespread interest in the world owing to its unique characteristics and became listed as one of the 100 most influential inventions during the 20th century. Additionally, it is widely considered to be the world's best-selling toy.

Liberty Science Center in New Jersey commissioned the 11.5-foot-tall Giant Working Cube (GWC) as an iconic educational interactive in their "Beyond Rubik's Cube" traveling exhibit featuring the science of Rubik's Cube, they wanted visitors to see how the internal mechanism of a Rubik's Cube functioned on a large scale. The science center chose Entech Innovative Engineering to design, engineer, fabricate, program controls, test and install the cube while also making it able to disassemble sufficiently to tour and be able to fit through standard exhibit doors.

By operating a one-foot-square working "control" cube, guests are able to move the corresponding face of the Giant Working Cube. This project required several mechanical, automation and electrical engineers to complete the custom original engineering and design that Entech Innovative performed.

Fun fact – the inventor of the cube himself, Professor Rubik (pictured right), was reported to have expressed doubt that a large-scale model, such as was being attempted, was even possible to build! But as usual, Entech Innovative's proven skill, experience and prowess delivered the crown jewel of the exhibition.



Entech Innovative President John Marhoeffer with Ernő Rubik

The execution of the GWC was challenging from a technical aspect in many

respects.

The Rubik's Cube design is unique inasmuch it is comprised of

- (8) Corner Elements
- (12) Edge Elements
- (6) Center Elements

Of these, only the six center elements are fully connected to the internal mechanism. All of the remaining 20 elements are constrained in block simply by the interlocked nature of the geometry for the construction of each. In this way, all of the elements are essentially "locked in" and capable of being pushed around but not able to be removed from the surface. Removing a single element, either intentionally as was part of the GWC design or with a screwdriver on a small Rubik's cube, will permit all but the six center elements to become loose from each other.

One of the characteristics of this design was the fact that each element was required to be a bearing surface for each other element. This required bearing surfaces to be like-on-like which in standard bearing design is bad practice.

There is no way around it for building a Rubik's Cube. In the small toy, this isn't an issue for two as the loads are low and consequences of difficulties are trivial. However, in the large scale this is not accurate and one of the early decisions was which surface to run on itself.

After testing and optimization, the decision came down to UHMW or Delrin (acetal homopolymer). Eventually UHMW was chosen for the larger cube while Delrin was utilized for the smaller control cube and both of these materials have performed well over time as predicted.

In the toy, the object is manipulated manually from the "outside in." In other words, one holds the toy and rotates the faces from the outside and the center mechanism is driven, not driving. Such was not the case in the GWC which required just the opposite - that the center mechanism drive the elements.

Furthermore in manipulating the toy, if the faces "don't line up" properly, a bit more manipulation with the control cube will see that they do. In the GWC, positioning in real time properly was critical. Inasmuch as this machine had not been built before, there was no metric for how close "close" should be or would need to be. Accordingly, decisions regarding machining and positioning tolerances were made from analytical models which were testable only after a significant commitment to fabrication.

Some decisions were made very conservatively against the potential difficulty

of correcting problems if they manifested. One was the decision to utilize zero backlash Harmonic drive servo-gear motors and to demand very close tolerances on the machined UHMW parts for the GWC.

Another challenge was the fact that the entire GWC needed to be able to “knock down” for shipping and transport. Furthermore, the GWC is considerable in weight when fully assembled, so imagination and care in detailing was required to make this possible.

The small controller was a feat in itself. Heavy duty parts are required for interactives and please-touch exhibits in museums. This device is a servo-control input device and is required to provide sensitive signal information while being nearly indestructible.

The control system for the GWC is designed so that trouble-shooting the system can be done over WIFI on the rare occasions for which it might be necessary.

Entech Innovative engineered, designed, fabricated, assembled and shop tested the entire exhibit before sending into service. It proved to be the lynchpin exhibit, the centerpiece for the well-received exhibition. While it is unlikely that another one will ever be built, the experience is simply another achievement for Entech Innovative in building the unique and one-of-a-kind.