Designing for Chaos
Turning Digital Complexity into a Quantum Science Learning Center
“Traditional religions emphasize constancy, the Modernists with their mechanistic models emphasize predictability, but the cosmos is much more dynamic than either a predesigned world or a dead machine”

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Complex Systems
Dynamic Complex Systems
Complex Systems

Dynamic

Ubiquitous
Dynamic Ubiquitous Unpredictable Complex Systems
Dynamic Ubiquitous Unpredictable Self Organizing
Dynamic Ubiquitous Unpredictable Self Organizing

Emergence

Complex Systems
Complex Systems

Physics

Architecture

Emergence

Dynamic

Ubiquitous

Unpredictable

Self Organizing
Architecture
THE SHIFT FROM DETERMINATE TO INDETERMINATE ARCHITECTURE
THE SHIFT FROM DETERMINATE TO INDETERMINATE

Parametric Design Software
Complex Forms

= 

Increasing unpredictability in design methods
The Shift from Determinate to Indeterminate

Quantum Mechanics

Architecture
The Shift from Determinate to Indeterminate

Quantum Mechanics

Rethinking of the Classical Science

The building blocks of our universe are in Chaotic Flux until observed.

The way in which these phenomenon are observed affects how they manifest.

The understanding of a quantum event requires two distinct frameworks of interpretation.
What is a Quantum Science Learning Center?
Case Studies
Case Studies

Rose Center for Earth and Space

Polshek Partnership
Case Studies

Rose Center for Earth and Space
Polshek Partnership

Weisman Art and Teaching Museum
Frank Gehry
Case Studies

Rose Center for Earth and Space
Polshek Partnership

Weisman Art and Teaching Museum
Frank Gehry

Church of Colònia Güell
Antoni Gaudí
Case Studies:

Rose Center for Earth and Space (1999) at the American Museum of Natural History

**Type:** Museum of Astrophysics and Natural History

**Location:** New York, New York

**Programmatic Elements:** Space Theater, Big Bang Theater, Galleries, Offices/Administration, Storage, Gift shop.
Rose Center for Earth and Space: at the American Museum of Natural History

This project is one of the most recent and iconic science museums in the United States. Its design represents not only the missions of the Hayden Planetarium and the American Natural History Museum, but our concept of the universe. The Hayden Planetarium, who’s director is astrophysicist Neil deGrasse Tyson, has as its mission to “conduct, interpret, and bring frontier astrophysics research into the educational offerings of the American Museum of Natural History” and to serve “as the premier conduit between the frontier of cosmic discovery and the public’s appreciation of it.” To facilitate this mission, the architects, Polshek Partnership, have used simple plactic forms to express the idea of cosmic understanding and awareness contained within an earthly, manmade container. The celestial forms within the Rose Center are contrasted by the glass cube which contains them. While the forms within the rose center are sleek simple and clean, reminiscent of the order of the cosmos, their glass container expresses the engineering and technical sophistication of its construction, reminiscent of the telescopes and satellites with which we measure the cosmos. In this way the Hayden Planetarium has brought together the celestial bodies and the manmade instruments which we use to understand them, but more importantly it represents our concept of the celestial universe as a composition of simple, almost elemental geometries (Lyall, 2002).
Case Studies:

Weisman Art and Teaching Museum (1993)

**Type:** Art Museum

**Location:** Minneapolis, Minnesota

**Programmatic Elements:** Lobby, Galleries, Offices/Administration, Auditorium, Kitchen, Offices, Carpentry Shop, Loading Dock, Storage, Parking, Gift Shop.

*Weisman Art Museum (Mathews, 2011)*
Weisman Art and Teaching Museum:

This Weisman Art and Teaching Museum, designed by Frank Gehry, was inserted into a site on the east bank of the University of Minnesota. It overlooks the Mississippi River and the Minneapolis skyline at the east end of the Washington Avenue Bridge. The Weisman Art Museum is significant because it demonstrates the precedent for form-based architecture integrating itself within the University of Minnesota and Minneapolis at a highly visible location. Perched on the high banks of the river, it can be clearly seen by the drivers and pedestrians from the Washington Avenue Bridge as well as from many other vantage points along that section of the river. The aim of the project was to increase awareness of the Art and Teaching Museum's collection and academic resources. The building accomplishes this through its strategic location which makes use of the high traffic surrounding the site, and the original design which stands out from the rectilinear buildings around the museum. The originality of the form comes from Frank Gehry's sculptural based method of form finding. The stainless steel cladding undulates on the west façade in a chaotic unpredictable way. The stainless steel is continued through the awning over the entry and then again acting as a railing along the museums undulating walkways. The museum's walkways connect the pedestrian level of the Washington Avenue Bridge with the campus and the museum, and the parking below connects with the lower roadways (Steele, 1994, p. 75). In this way the museum negotiates many intersecting modes of transportation, and with the addition of a light rail station at the doorstep of the museum, the museum continues to act as an anchor for various levels of infrastructure.
Case Studies:

Church of Colònia Güell (1898)

**Type:** Church (Unfinished)

**Location:** Santa Coloma de Cervelló, Barcelona

**Programmatic Elements:** Sanctuary, Entrance Gallery, Basement, Crypt, Baptistery, Library, Choir Gallery.
Church of Colònia Güell:

The Church of Colònia Güell is one of Antoni Gaudí’s unfinished works in Santa Coloma de Cervelló, near Barcelona. Only the basement and crypt of the church were built. The significance of this church comes from Gaudí’s design method. The structure of the church came from the use of a hanging model, a method Gaudí pioneered as a tool for generating structural forms. After the hanging model created the iconic structural geometry of catenary curves, Gaudí took a photograph of the hanging model, flipped it, and drew over it to create the profile of the church (Crippa, 2007, p.43). The form of Gaudí’s church was derived from of the geometry his model created. Although Gaudí’s suspended model predates any computer modeling software by a century, this was one of the first dynamic models to be used, not only as a medium for depicting geometry, but as a tool for generating it. Since this design process is geometrically driven, the form of the Church of Colònia Güell is derived, not from conventional methods of construction, but from an abstracted representation of gravitational forces. The result of this new method of form generation was the first ever architectural use of the hyperbolic paraboloid in a building (Tomlows, 1989, p.21). Even though the Church of Colònia Güell was never completed, the method of hanging wires was used to test structural ideas Gaudí would later use in his masterpiece Sagrada Familia.
Completed crypt of the Church of Colònia Güell (Tomilow, 1969)

Church of Colònia Güell hanging model in silhouette (Tomilow, 1969)

Reconstruction of Antoni Gaudí's hanging model for the Church of Colònia Güell (Tomilow, 1969)
Why A Quantum Science Learning Center?
Why A Quantum Science Learning Center?

More and more of our world is becoming quantum

Provides a scientific and academic outreach center for the community

Makes complex scientific concepts accessible to the public

Serves as an educational tool to the local school districts

Furthers research and computer modeling for theoretical and particle physics

Illustrates the dynamic and complex nature of the world
“A world that is open to continuous change and to becoming different, requires an ars accidentalis.

The creativity and the productivity of the Accident, the break and the fall, have to be understood as the potential to achieve new forms of heterogeneity and of the disjunctive synthesis”

(Burry, 1999)
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“We like to look for patterns, forms, for an underlying structure. And even if we don’t quite understand all of the equations, we grasp at the beauty of the answers”

(Wise, 2004)
Designing Chaos
Designing Chaos

Algorithms – Iterations – Complexity + Grasshopper
SITE: CEDAR RIVERSIDE
Site Information

My site is located within Minneapolis by the University of Minnesota’s West Bank.
Notable site features include:

- The University of Minnesota
- The Cedar Riverside Apartments
- A nearby light-rail stop
- A Highway
- A Small Urban District
Charts and Diagrams:
Current Development

- Building Site - City Owned
- Vehicular Transit
- Light Rail Transit
- University of Minnesota
- Augsburg College
- Fairview Hospital
- Mixed Use Development
- Medium to High Density Residential

(Department of Community Planning, 2008)
Charts and Diagrams:
Current Problem Areas

- Building Site - City Owned
- Vehicular Transit
- Light Rail Transit
- Problem Areas Identified by the Community

(Department of Community Planning, 2008)
Charts and Diagrams:

Future Activity Center

- Building Site - City Owned
- Vehicular Transit
- Light Rail Transit
- Future Activity Center

(Department of Community Planning, 2008)
“Bohr considered the two pictures — particle picture and wave picture — as two complimentary descriptions of the same reality.

Any of these descriptions can only be partially true.

There must be limitations to the use of the particle concept as well as of the wave concept, else one could not avoid contradictions.

If one take into account those limitations which can be expressed by the uncertainty relations, the contradictions disappear.”

(Heisenberg, 1958)
The Problem Of Visibility
THE PROBLEM OF VISIBILITY
“The observation itself changes the probability function discontinuously; it selects from all the possible events the actual one that has taken place. […]”

Therefore, the transition from the ‘possible’ to the ‘actual’ takes place during the act of observation.

[...] and we may say that the transition from the ‘possible’ to the ‘actual’ takes place as soon as the interaction of the object with the measuring device, and thereby with the rest of the world, has come into play.”

(Heisenberg, 1958)
THE CHALLENGE OF RECONSTRUCTION
The Challenge of Reconstruction
“So far, the emerging technologist has to limit the output of the process to an object rather than a project.

A project has a definite purpose.

A project has a site.

A project interacts with people.

It interacts with climate. It interacts with time. And unlike a computer process it is made up of imperfect materials and things that change according to this interaction.

In short, the project lives. And in part in having life, it enriches the lives of those involved in putting together the project and the next one. Somehow the algorithm and the wax modeler don’t quite do this for me. Yet”

Emergence
**Floor Plans**

**Sub Floor**
1. Parking
2. Utilities and Storage
3. Loading Dock

**1st Floor**
1. Entrance
2. Café
3. Ticketing
4. Emergency Ramp
5. Offices and Administration
6. Classrooms
7. Auditorium
8. Study Lounge
9. Computer Room
10. Bathrooms
11. Utilities
12. Courtyard

**2nd Floor**
1. Main Gallery
2. Auditorium
3. Study Lounge
4. Thinking Labs
5. Library
6. Bathrooms

**3rd Floor**
1. Upper Gallery
2. Moving Gallery
3. Bathrooms
4. Green Roof
“...we have to remember that what we observe is not nature in itself but nature exposed to our method of questioning. [...] In this way quantum theory reminds us, as Bohr has put it, of the wisdom that when searching for harmony in life one must never forget that in the drama of existence we are ourselves both players and spectators”

Heisenberg, 1958
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