Spring 2013

Shapes of Gray: Concepts in Concrete

Ford Bostwick
Syracuse University

SHAPES OF GRAY: CONCEPTS IN CONCRETE

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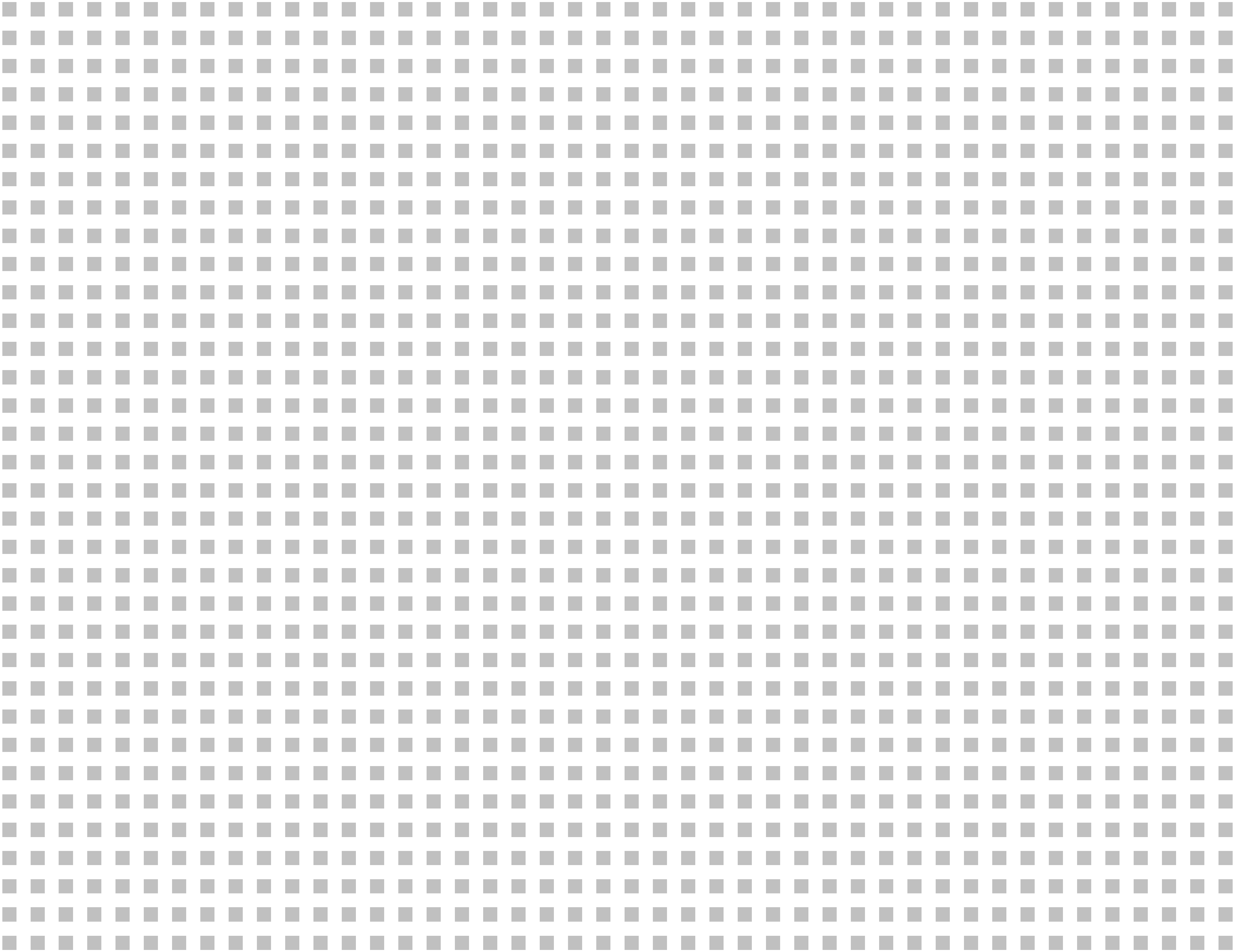

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Concrete is plastic and highly manipulatable. Its characteristics and the forms it takes are vastly diverse and its history as a building material is broken and nonlinear. By charting the trajectory of its manifestations and uses over time, as well as the trajectories of constituent things (chairs, pneumatic structures, blocks, and relevant artwork), I've reached an understanding of what some possible valuable futures for concrete might look like. I have proposed three of these possible futures in doodle form. The doodles appear later in this book.

W H A T C O N C R E T E I S

Concrete is the most abundant man-made substance on earth and is the most widely used building material. It is the definition of material and physical form as well as the definition of real. However, it remains a highly elusive building material with properties so varied that it is difficult to classify or describe its real architectural character. Its rapid and radical evolution, especially in contemporary practice, has broadened its horizons, giving each architect who uses it the power to define what it really is.[1]


FIGURE 1


FIGURE 2


FIGURE 3


FIGURE 4


FIGURE 5


FIGURE 6


FIGURE 7


FIGURE 8


FIGURE 9


FIGURE 10


FIGURE 11


FIGURE 12


FIGURE 13


FIGURE 14


FIGURE 15

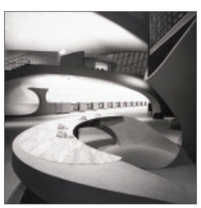


FIGURE 16


FIGURE 17


FIGURE 18


FIGURE 19


FIGURE 20

FIGURE 1

MORSE AND EZRA STILES COLLEGES

EERO SAARINEN

1962

FIGURE 2

FUNDAÇÃO IBERÊ

ALVARO SIZA

1998

FIGURE 3

ERIE CANAL

CANVASS WHITE

1817

FIGURE 4

HOUSE

RACHEL WHITEREAD

1993

FIGURE 5

VILLA SAVOYE

LE CORBUSIER

1931

FIGURE 6

DEITINGEN SERVICE STATION

HEINZ ISLER

1968

FIGURE 7

A CAST OF THE SPACE UNDER MY CHAIR

BRUCE NAUMAN

1965

FIGURE 8

TRUFA HOUSE

ANTON GARCIA-ABRIL

2006

FIGURE 9

INGALLS BUILDING

ELZNER & ANDERSON

1903

FIGURE 10

EBERSWALDE LIBRARY

HERZOG & DE MEURON

1998

FIGURE 11

TRANSLUCENT CONCRETE

LICATRON

2005

FIGURE 12

ROWBOAT

JOSEPH-LOUIS LAMBOT

1848

FIGURE 13

RICOLA BUILDING

HERZOG & DE MEURON

1998

FIGURE 14

CAST HOUSE

THOMAS EDISON

1908

FIGURE 15

TENERIFE CONCERT HALL

SANTIAGO CALATRAVA

2003

FIGURE 16

TWA TERMINAL

EERO SAARINEN

1962

FIGURE 17

CHANDIGARH

LE CORBUSIER

1962

FIGURE 18

WARD HOUSE

ROBERT MOOK

1875

FIGURE 19

40 BOND

HERZOG & DE MEURON

2005

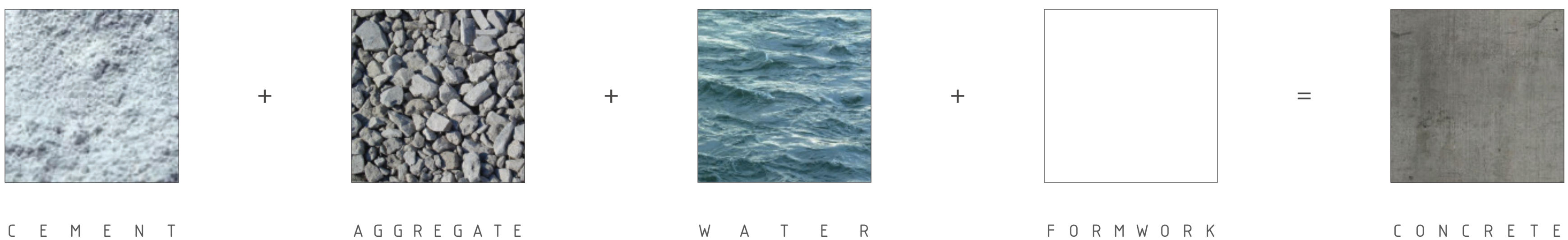
FIGURE 20

COLUMNS

MARK WEST

2008

Concrete's basic ingredients are water, aggregate, and cement. Aggregate is usually sand and gravel, but can be any inert material with compressive strength. Cement is a combination of lime, ash, and small amounts of many other chemicals. When water is added to the mixture of cement and aggregate, it triggers a chemical reaction that causes the cement to bond the aggregate together. The final, essential, and often overlooked ingredient to concrete is its formwork. Concrete has no inherent formal qualities. It takes on the form of whatever vessel it is poured into and adopts the surface treatment of its mold. This directly opposes Adolf Loos' statement in The Principle of Cladding that "Every material possesses a formal language which belongs to it alone and no material can take on the forms proper to another."[2] Concrete has no formal language and depends completely on the formal logic of the materials of its formwork.[3]


CEMENT + AGGREGATE + WATER + FORMWORK = CONCRETE

All building materials require some level of processing before they can be used. Lumber has to be cut from trees, stones are cut from larger rocks, and steel has to be made from iron ore and forged into desired shapes.[4] Concrete requires more processing than other building materials as each element of its mixture has to be processed and then added together in precise proportions to yield a desired concrete. Also, though aggregate is usually sand and gravel, nearly anything can be added to the cement and water mixture to create many diverse forms of concrete.[5]

ROCK

1. CUT

STONES

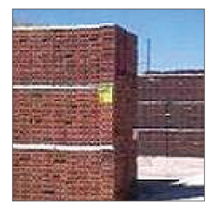
TREES

1. CUT
2. DRY
3. CUT

LUMBER

CLAY

1. CRUSH
2. MIX
3. CAST
4. CUT

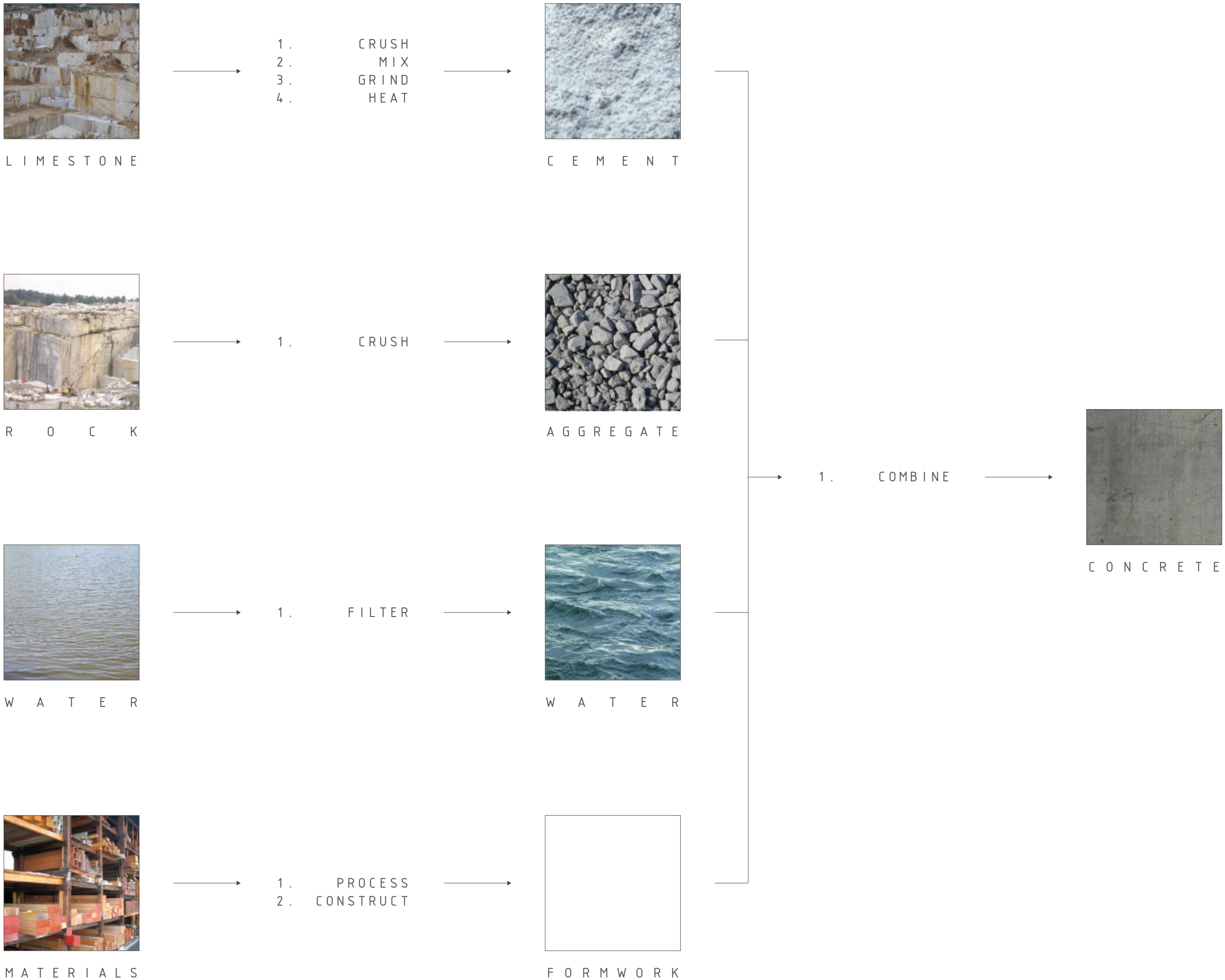


BRICKS

IRON ORE

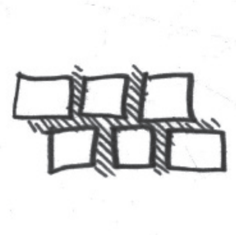
1 INJECT
2. HEAT
3. REDUCE
4. HEAT
5. REFINE
6. CAST

STEEL


LIMESTONE
1. CRUSH
2. MIX
3. GRIND
4. HEAT
CEMENT
ROCK
1. CRUSH
AGGREGATE
WATER
1. FILTER
WATER
MATERIALS
1. PROCESS
2. CONSTRUCT
FORMWORK
1. COMBINE
CONCRETE

A HISTORY OF CONCRETE

Adding to its enigmatic quality, concrete has a broken and nonlinear history. The ancient Egyptians used crude forms of it to build the pyramids, and it was an essential part of Ancient Roman architecture. When the Roman Empire fell, their recipe for concrete was lost, and it disappeared from building practice until around the early 19th century. Upon resurfacing as a building material, concrete was used to form canals, sewer systems, and boats. During the latter half of the 19th century, engineers and architects began to reinforce concrete with steel rebar. The tensile strength of the steel complimented the compressive strength of the concrete to create a more structurally sound and versatile material. In the 20th century, modern architects generally praised concrete for its neutrality and ability to make "abstract," un-ornamented surfaces, complicated curves, and uniform floor slabs. In the 1930's, German architects were able to achieve wafer thin shell structures by reinforcing concrete with fiberglass.[6] In contemporary architecture, concrete's properties are even more widely varied. By impregnating the mix with steel fibers, concrete can be made incredibly strong without the need for reinforcing rods. Architects and engineers are now experimenting with processes to make concrete lighter, change its color, and even change its opacity.[7]



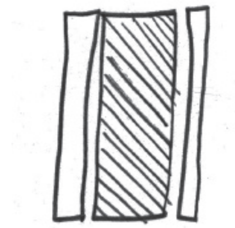


FIGURE 21

2500 BC

EGYPTIANS USE CONCRETE AS MORTAR FOR BRICKS

FIGURE 22

600 BC

GREEKS DEVELOP NEW CONCRETE MIXTURES

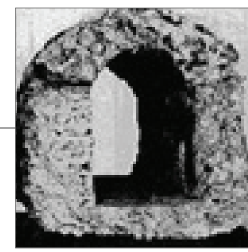


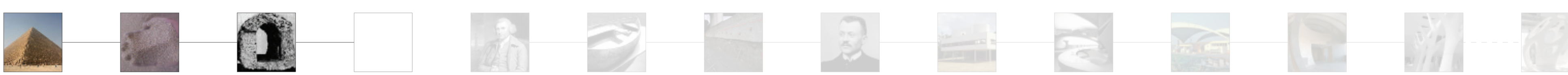
FIGURE 23

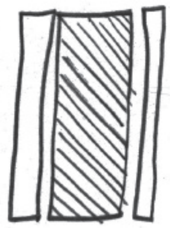
75 BC

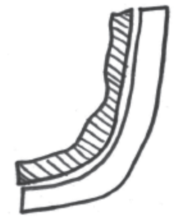
ROMANS USE CONCRETE TO CREATE FORMS

475 AD

THE ROMAN EMPIRE FALLS, AND THE RECIPE FOR CONCRETE IS LOST







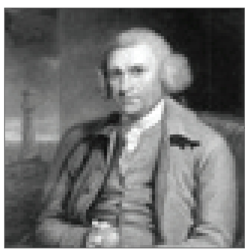


FIGURE 24

1756 AD

JOHN SMEATON REDISCOVERS CONCRETE

FIGURE 25

1848 AD

JOSEPH-LOUIS LAMBOT DEVELOPS STEEL-REINFORCED CONCRETE

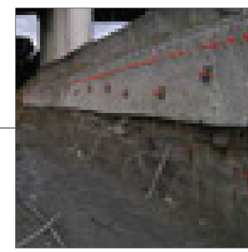


FIGURE 26

1911 AD

CARL AKELEY DEVELOPS SHOTCRETE

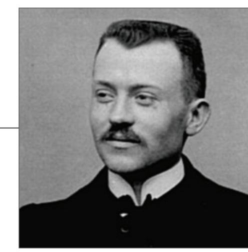


FIGURE 27

1927 AD

EUGENE FREYSSINET DEVELOPS PRE-STRESSSED CONCRETE

FIGURE 28

1931 AD

LE CORBUSIER DEVELOPS A NEW ARCHITECTURE USING CONCRETE

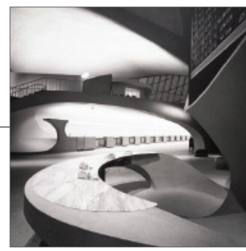


FIGURE 29

1962 AD

EERO SAARINEN DEVELOPS NEW FORMS IN CONCRETE

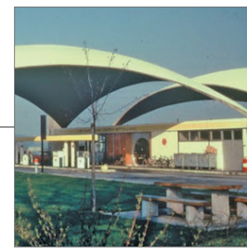


FIGURE 30

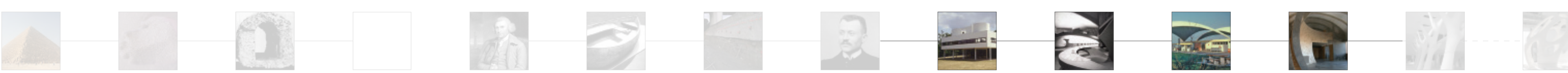
1968 AD

HEINZ ISLER DESIGNS THIN CONCRETE SHELLS

FIGURE 31

2001 AD

MASSIE ARCHITECTURE USES JIGSAW-PUZZLE PIECES AS FORMWORK



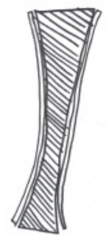


FIGURE 32

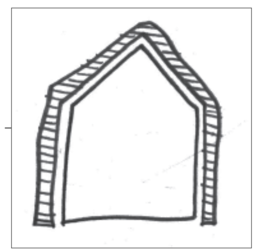
2008 AD

MARK WEST DEVELOPS FABRIC-FORMED CONCRETE

FIGURE 33

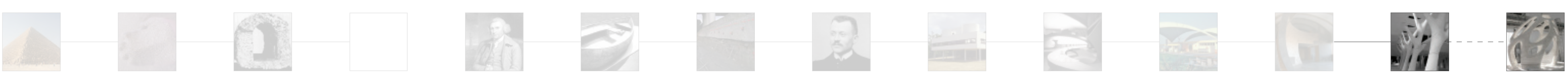
FUTURE

BUILDINGS ARE PRINTED BY ROBOTS



FUTURE

EXISTING FORMS SERVE AS FORMWORK FOR NEW CONCRETE ARCHITECTURE



A HISTORY OF CHAIR DESIGN

Chairs, besides them being seating objects, often serve as microcosms of architecture. They can express architectural ideas on a small and intimate scale. Early man most likely sat on rocks and logs, and later, these materials were processed to better serve the function of seating. In the 19th century, some chair designs were standardized and mass-produced. In the 20th century, chairs became lighter and their structures became more efficient. At the Bauhaus, Marcel Breuer predicted that the structure of the chair would be reduced so much so that in the future, we would be sitting on columns of air. Though this hasn't happened, there are inflatable chairs that are very light with minimal structure. Concrete chairs have also been made that are very light and strong.[8]

FIGURE 34

120,000 BC

EARLY MAN SITS ON STONES

FIGURE 35

2500 BC

EGYPTIANS CREATE ORNATE CHAIRS

FIGURE 36

1000 BC

ROMANS BEDS WERE ALL PURPOSE SEATING

FIGURE 37

1859 AD

MICHAEL THONET CREATES THE FIRST MASS PRODUCED CHAIR

FIGURE 38

1926 AD

MART STAM CREATES THE FIRST CANTILEVER CHAIR

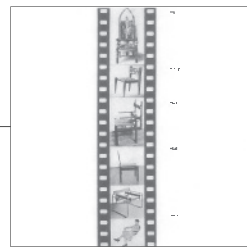


FIGURE 39

1928 AD

MARCEL BREUER CHARTS THE EVOLUTION OF THE CHAIR

FIGURE 40

1960 AD

VERNER PANTON INVENTS THE FIRST INFLATABLE CHAIR

FIGURE 41

1967 AD

VICO MAGISTRETTI DESIGNS THE MOST UBIQUITOUS CHAIR EVER

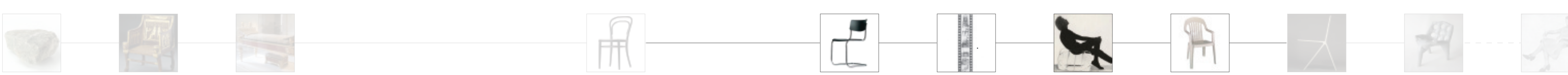


FIGURE 42

2009 AD

OMER ARBEL DESIGNS A LIGHT-WEIGHT CONCRETE CHAIR

FIGURE 43

2010 AD

TEJO REMY MAKES CONCRETE LOOK INFLATABLE

FIGURE 44

FUTURE

AS PREDICTED BY MARCEL BREUER, CHAIRS ARE COLUMNS OF AIR

FUTURE

PNEUMATIC STRUCTURES SERVE AS NEW FORMWORK FOR CONCRETE CHAIRS

A HISTORY OF PNEUMATIC STRUCTURES

Using air as the structure for a membranous wrapper is a lightweight and efficient way to create forms. The ancient Chinese began developing small hot air balloons made of paper for military purposes. Later, these hot air balloons were scaled up, and made big enough to transport people in. In the mid-20th century, Walter Bird began experimenting with using pneumatic structures as enclosures ranging in scale from houses to airplane hangars. This idea sparked much interest in the 1960's.[9] Buckminster Fuller experimented a lot with pneumatic structures not only as enclosures, but as lightweight structural supports too, with the membrane made of aluminum alloys. NASA was also interested in the efficiency of these structures, and began making Mylar balloons for satellites. The difficulty was that the membranes of these balloons could not be made strong enough to hold up against impacts from small meteorites. In the 1970's, pneumatic structures were used often as enclosures for pavilions and temporary exposition spaces. Though pneumatic structures are still used today, the craze that surrounded them in the 60's and 70's eventually died away.[10]

FIGURE 45

220 AD

CHINESE DEVELOP HOT AIR BALLOONS

FIGURE 46

1783 AD

THE MONTGOLFIER BROTHERS FLY A PASSENGER IN A HOT AIR BALLOON

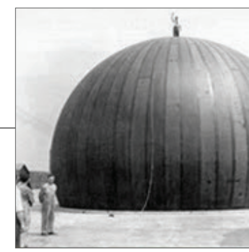


FIGURE 47

1941 AD

WALTER BIRD DEVELOPS PNEU-MATIC STRUCTURES

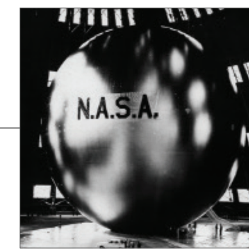


FIGURE 48

1960 AD

NASA DEVELOPS NEW PNEUMATIC STRUCTURES

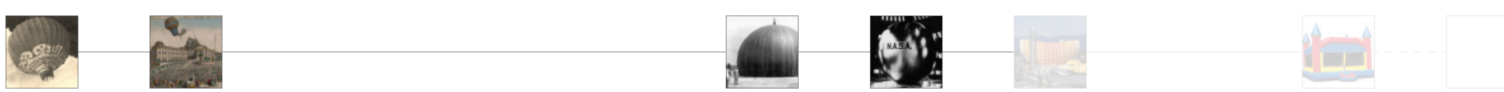


FIGURE 49

1970 AD

PNEUMATIC STRUCTURES ARE FOR PAVILIONS

FIGURE 50

2000 AD

PNEUMATIC STRUCTURES BECOME A NOVELTY

FUTURE

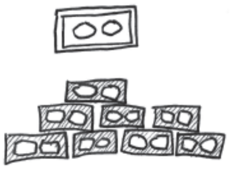
PNEUMATIC STRUCTURE SERVE AS ARMATURE FOR CONCRETE BLOCK CONSTRUCTION

FUTURE

PNEUMATIC STRUCTURES SERVE AS NEW FORMWORK FOR CONCRETE

A HISTORY OF CONCRETE BLOCKS

The ancient Egyptians used a crude form of concrete to adhere clay bricks together. Then the romans perfected a concrete recipe, and began building forms with concrete alone. It wasn't until the 1830's, however, that blocks of concrete were cast and used in building construction. In the early 20th century, Frank Lloyd Wright made his own custom concrete blocks for use in several houses he designed. Recently, 3-d printing with concrete has become possible, and custom concrete bricks can be printed that, when aggregated, can create a diverse array of forms.[11]



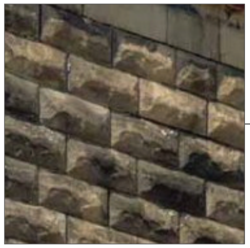


FIGURE 51

1830 AD

FIRST CONCRETE BLOCKS ARE USED

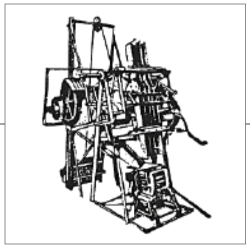


FIGURE 52

1900 AD

HARMON S. PALMER DEVELOPS A NEW BLOCK-MAKING MACHINE

FIGURE 53

1923 AD

FRANK LLOYD WRIGHT DESIGNS CUSTOM CONCRETE BLOCKS

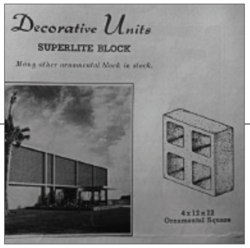


FIGURE 54

1955 AD

SUPERLITE MASS-PRODUCES CONCRETE BLOCKS

FIGURE 55

1965 AD

CONCRETE BLOCKS ACCOUNT FOR 80% OF WALL CONSTRUCTION

FIGURE 56

2011 AD

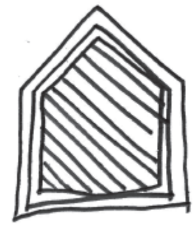
RAEL SAN FRATELLO USES 3D-PRINTED CONCRETE BLOCKS

FUTURE

PNEUMATIC STRUCTURE SERVE AS ARMATURE FOR CONCRETE BLOCK CONSTRUCTION

A HISTORY OF RELEVANT ARTWORK

In the 20th century, art began to overlap with and directly comment on architecture in thought-provoking ways. In 1965, Bruce Nauman cast the space under a chair to demonstrate the possibility of solidifying a perceived volume.[12] In the 1970's, Gordon Matta Clark began directly affecting and altering architecture by splitting and cutting holes through buildings, revealing new and unique spatial connections.[13] Rachel Whiteread, launching off of Bruce Nauman's piece, began casting the interior volumes enclosed by cabinets and houses. One of her most famous works, House, was made by filling the interior of a condemned house with concrete and then removing the house, revealing an exact cast of its interior volume.[14]



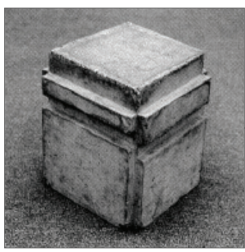


FIGURE 57

1965 AD

BRUCE NAUMAN SOLIDIFIES THE SPACE UNDER A CHAIR

FIGURE 58

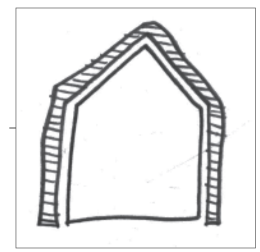
1974 AD

GORDON MATTA CLARK SPLITS A HOUSE

FIGURE 59

1993 AD

RACHEL WHITEREAD SOLIDIFIES THE ENCLOSED VOLUME OF A HOUSE



FUTURE

THE EXTERIOR VOLUME OF A HOUSE IS SOLIDI-FIED IN A CON-CRETE SHELL

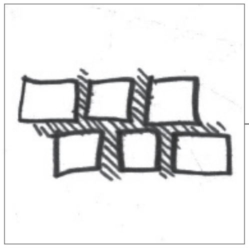
PROPOSITIONS FOR FUTURE CONCRETE

With such a rich and diverse history, the future of concrete is broad. In understanding where concrete fits into the histories of constituent things (chairs, pneumatic structures, artwork), I contend that three valuable and very plausible futures of concrete are:

I. Pneumatic-formed concrete, using new concrete with added tensile strength so as to enable more diverse form making

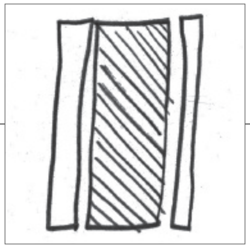
II. Lo-tech, fabric-formed, pneumatically supported concrete modules that can aggregate into different shell structures

III. Cast-in-place concrete shells over forms that no longer serve their function and can be removed from the cast to yield useful architectural void spaces



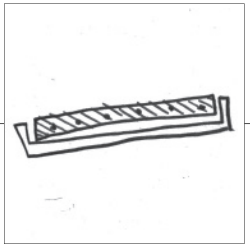
2500 BC

CONCRETE AS MORTAR FOR BRICKS



1756 BC

CONCRETE AS FORM WITH FORMWORK



1848 AD

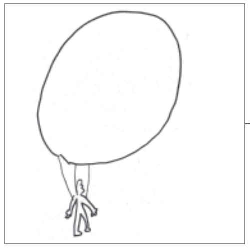
REINFORCED CONCRETE AS FORM WITH FORMWORK

120,000 AD

STONE AS SEAT

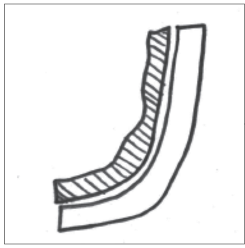
1926 AD

OPTIMIZED STRUCTURE AS SEAT



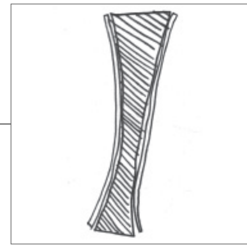
1783 AD

PNEUMATIC STRUCTURE AS CARRIER



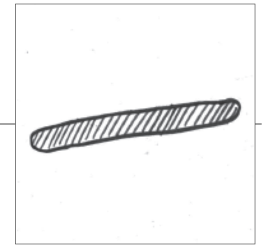
1911 AD

SHOTCRETE AS FORM WITH 1-SIDED FORMWORK



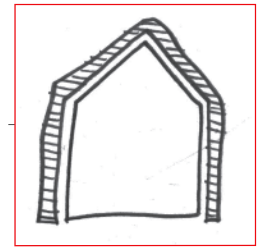
2008 AD

CONCRETE AS FORM WITH FABRIC AS FORMWORK



FUTURE

PRINTED CONCRETE REQUIRES NO FORMWORK

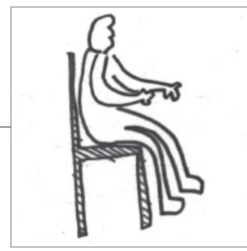


FUTURE

PROPOSITION I: SHOTCRETE WITH EXISTING FORM AS FORMWORK

1960 AD

PNEUMATIC STRUCTURE AS SEAT

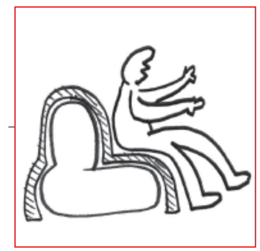


2009 AD

LIGHTWEIGHT CONCRETE AS SEAT

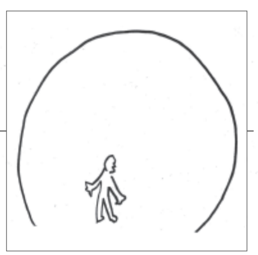
FUTURE

AIR AS SEAT



FUTURE

PROPOSITION II: CONCRETE WITH PNEUMATIC FORMWORK AS SEAT



1941 AD

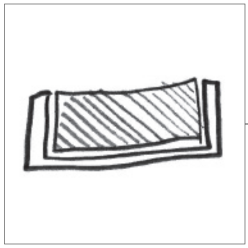
PNEUMATIC STRUCTURE AS ENCLOSURE

FUTURE

PROPOSITION II: CONCRETE WITH PNEUMATIC FORMWORK AS SEAT

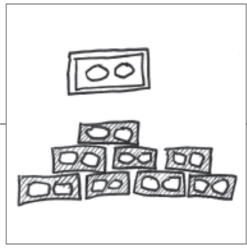
FUTURE

PNEUMATIC STRUCTURE AS TEMPORARY STRUCTURE FOR CONCRETE BLOCKS



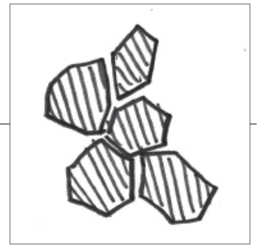
1830 AD

CAST CONCRETE BRICKS



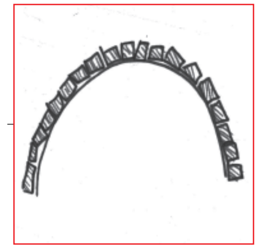
1955 AD

MASS-PRODUCED CAST CONCRETE BRICKS



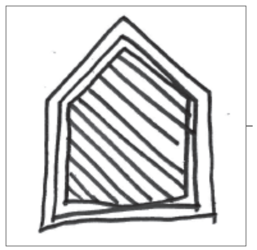
2011 AD

PRINTED CONCRETE BRICKS



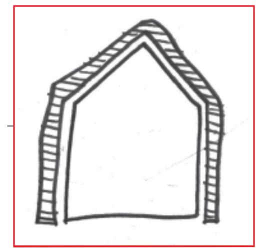
FUTURE

PROPOSITION III: PNEUMATIC STRUCTURE AS TEMPORARY STRUCTURE FOR CONCRETE BLOCKS



1993 AD

HOUSE AS FORMWORK FOR VOLUME OF INTERIOR



FUTURE

HOUSE AS FORMWORK FOR CONCRETE SHELL

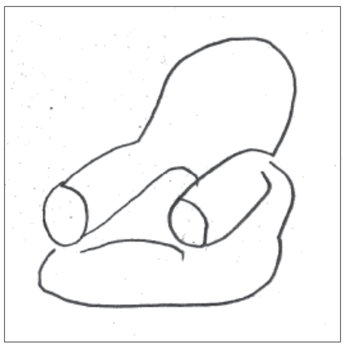
SCALE- 1:1

SITE- UNDER YOUR ASS

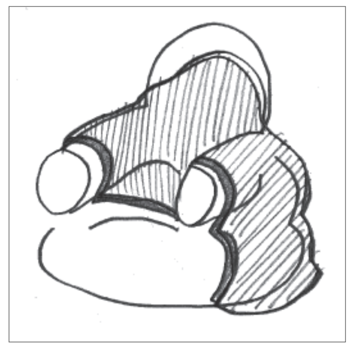
PROGRAM- SEAT

Pneumatic-formed concrete chair:

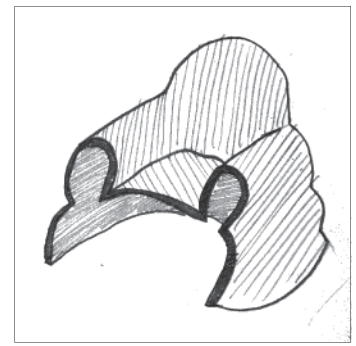
Air is the structure of an inflatable chair. I will demonstrate the ability to use pneumatic structures as formwork for cast-in-place concrete architecture by casting fiberglass-reinforced concrete over an inflatable chair and then deflating the chair, leaving a concrete shell bearing the form of the chair.



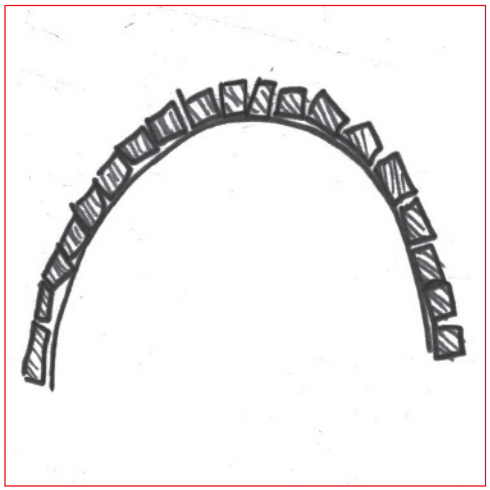
PNEUMATIC FORMWORK



CAST-IN-PLACE



FIBERGLASS REINFORCED CONCRETE



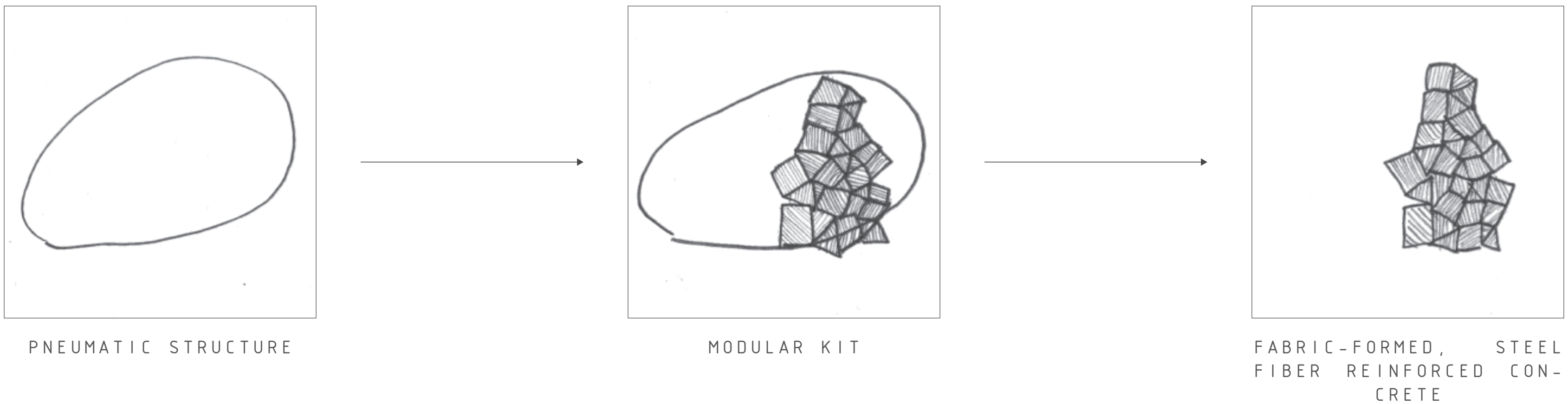
SCALE- 1:1

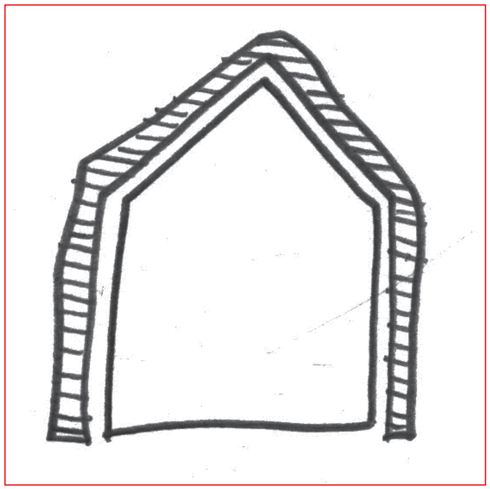
SITE- SLOCUM 4TH FLOOR

PROGRAM- PRESENTATION SPACE

fabric-formed concrete modules:

Since concrete is highly manipulatable, it can be very expressive. By handcrafting concrete modules that key together and aggregate into various shell forms, I can create a façade system that shows its handedness, and can be implemented architecturally on a large scale. Pneumatic structures can be used as temporary structure for this cladding system.


PNEUMATIC STRUCTURE
MODULAR KIT
FABRIC-FORMED, STEEL FIBER REINFORCED CONCRETE



SCALE- 3/4"=1' REPRESENTATIONAL

SITE- HUDSON RIVER VALLEY

PROGRAM- LIVE/WORK DWELLING

lost-house shotcrete shell cast:

Things that no longer serve their function, but still have valuable architectural forms can be used as formwork for concrete shell casts. A condemned house can be covered in concrete, and the house could be removed from the inside after the concrete sets. This will yield a concrete shell with an interior volume that is the exact form of a house.

EXISTING HOUSE AS FORMWORK

LOST-HOUSE, CAST-IN-PLACE

FIBERGLASS REINFORCED GUNITE

NORTH AMERICA

NEW ENGLAND

NEW YORK

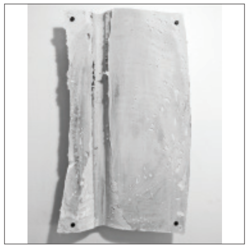
HUDSON RIVER VALLEY

I propose designing a house in the Hudson River Valley that can support a self-sufficient, pastoral/artisanal lifestyle for a contemporary couple. William is a writer and editor, as well as a beekeeper, whisky distiller, and cheese maker. Jessi designs graphics, websites, and apps, and is an avid home-brewer, pickler, and reader.

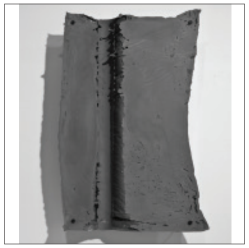
Their house will include facilities for farming, beekeeping, cheese making, beer brewing, whisky distilling, and bread making, and will have studios for writing and design. The house's character will be derived from serving these food and drink production functions. Situated in the Hudson River Valley, William and Jessi will be close enough to New York City to support their careers as a writer and designer, but will still be able to live autonomously and lightly off of the land.

RESEARCH AND DEVELOPMENT

Most of the research I've done has been in the form of directly testing concrete's properties and characteristics. From the beginning of the semester, I've been exploring the relationship between concrete and its formwork. In addition to experimenting with different concrete mixtures, I started by painting with concrete (page 51) and making concrete forms that express concrete's uniformity and homogeneous makeup (pages 52-53). I tried casting concrete without using external formwork (page 49), and started experimenting with using pneumatic structures as the formwork for concrete (pages 56-58). Through researching by doing, I got a good, hands-on grasp on what concrete is capable of.



I MADE THESE WORKS BY SATURATING FABRIC WITH CONCRETE AND HANGING IT TO DRY



THEY DEMONSTRATE A WAY TO CONSTRUCT CONCRETE FORMS WITHOUT USING EXTERNAL PHYSICAL FORMWORK

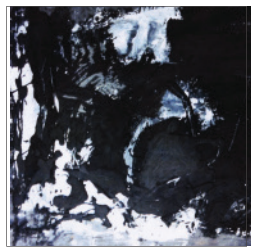
I ADDED GRAPHITE TO A CONCRETE MOLD AND IT IMPRINTED ON THE CONCRETE WHEN IT SET

I USED FABRIC DYE TO COLOR THE SAND IN CONCRETE TO MAKE IT PINK

I USED SAWDUST AS AN AGGREGATE TO YIELD A CONCRETE PANEL 20% LIGHTER THAN TYPICAL CONCRETE

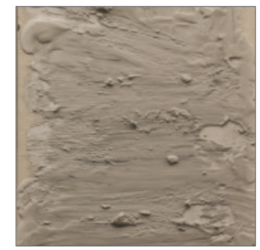
I USED FOAM BLOCKS AS AN AGGREGATE TO YIELD A CONCRETE PANEL 30% LIGHTER THAN TYPICAL CONCRETE

THIS PAINTING IS BLACK UNTITLED (1948) BY WILLEM DE KOONING

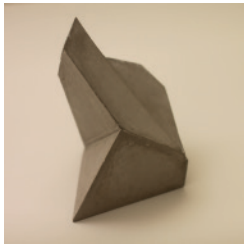


THIS IS A REPLICATION OF WILLEM DE KOONING'S PAINTING THAT I MADE USING BLACK AND WHITE QUICK-SETTING CONCRETE

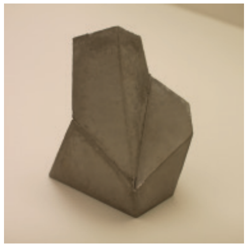
I APPLIED PINK CONCRETE TO THIS CANVAS USING A PAINT ROLLER. THE FORM OF THE CONCRETE WAS DETERMINED BY THE PROPERTIES OF THE ROLLER



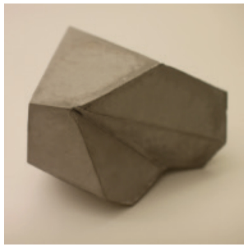
I APPLIED CONCRETE TO THIS CANVAS USING A PAINTBRUSH. THE FORM OF THE CONCRETE WAS DETERMINED BY THE BRUSHSTROKES USED



THING 1



THING 2



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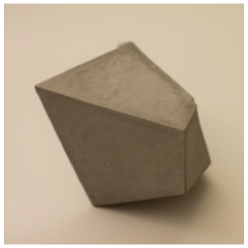
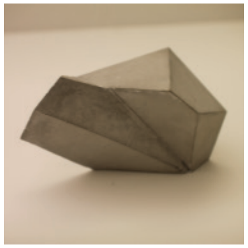


THING 4

THING 5



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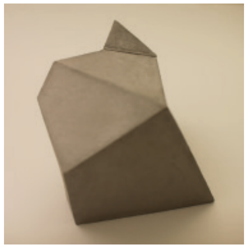

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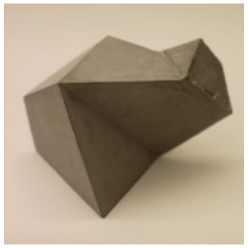

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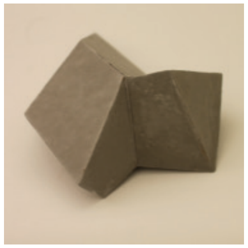
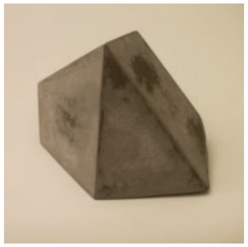


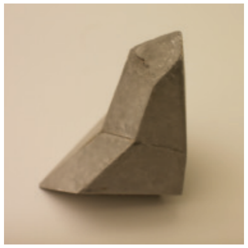
THING 9

THING 10

THING 11

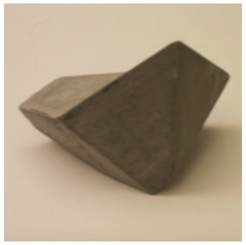


THING 12

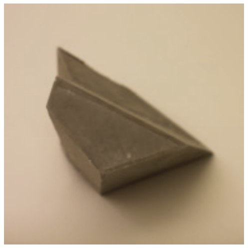


THING 13

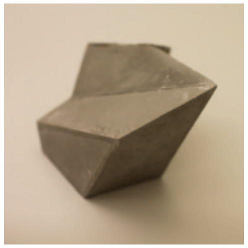
THING 14



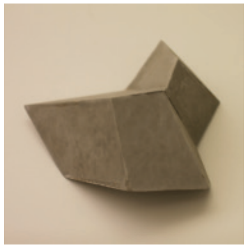
THING 15



THING 16



THING 17



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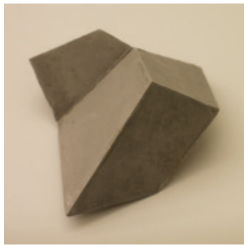

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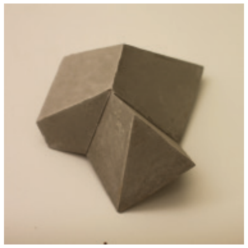
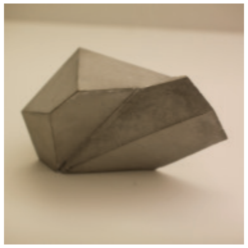


THING 20

THING 21

THING 22



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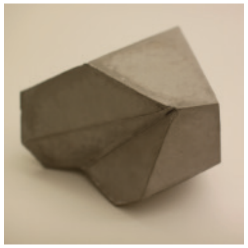
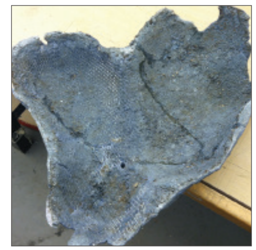


THING 24

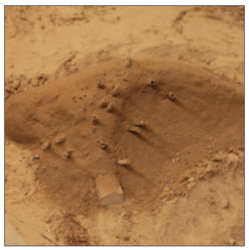
REBAR MESH IS ADDED OVER THE CONTOURS OF EXISTING DIRT MOUNDS

A MIX OF SAND, GRAVEL, CEMENT, WATER, AND BLUE DYE IS POURED OVER THE DIRT



THE DIRT IS EXCAVATED FROM WITHIN THE SHELL

A HABITABLE CONCRETE SHELL BEARING THE FORM OF THE DIRT MOUND REMAINS



LIGHT TUBES AND DOOR FRAMES ARE ADDED TO AN EXISTING SAND DUNE

A MIX OF SAND, CEMENT, WATER, AND RED DYE IS POURED OVER TOP OF THE SAND DUNE

THE SAND IS EXCAVATED FROM WITHIN THE SHELL

A HABITABLE CONCRETE SHELL BEARING THE FORM OF A NATURALLY EXISTING SAND DUNE REMAINS

A PNEUMATIC STRUCTURE IS INFLATED

A MIX OF CEMENT, SAND, AND DYE IS POURED OVER TOP

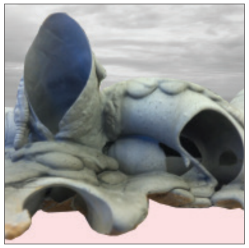
THE PNEUMATIC STRUCTURE IS DEFLATED YIELDING A HABITABLE INTERIOR

A PNEUMATIC STRUCTURE IS INFLATED

A MIX OF CEMENT, SAND, AND DYE IS POURED OVER TOP

THE PNEUMATIC STRUCTURE IS DEFLATED YIELDING A HABITABLE INTERIOR

A PNEUMATIC STRUCTURE IS INFLATED



A MIX OF CEMENT, SAND, AND DYE IS POURED OVER TOP

THE PNEUMATIC STRUCTURE IS DEFLATED YIELDING A HABITABLE INTERIOR

[1] Courland, Robert. *Concrete Planet: The Strange and Fascinating Story of the World's Most Common Man-made Material.* Amherst, NY: Prometheus, 2011. Print.
[2] Loos, Adolf. *Spoken into the Void: Collected Essays, 1897-1900.* Cambridge, MA: Published for the Graham Foundation for Advanced Studies in the Fine Arts, Chicago, Ill., and the Institute for Architecture and Urban Studies, New York, N.Y., by MIT, 1982. Print.
[3] Cohen, Jean-Louis, and Gerard Martin. Moeller. *Liquid Stone: New Architecture in Concrete.* New York: Princeton Architectural, 2006. Print.
[4] "How Products Are Made." *How Lumber Is Made.* N.p., n.d. Web. 29 Nov. 2012. <http://www.madehow.com/Volume-3/Lumber.html>.
[5] Koren, Leonard, and William Hall. *Concrete.* London: Phaidon, 2012. Print.
[6] Hein, Michael. "Historical Timeline of Concrete." *Historical Timeline of Concrete.* Auburn University Department of Building Science, 25 Oct. 2007. Web. 28 Oct. 2012. <https://fp.auburn.edu/heinmic/ConcreteHistory/Pages/timeline.htm>.
[7] Cohen, Jean-Louis, and Gerard Martin. Moeller. *Liquid Stone: New Architecture in Concrete.* New York: Princeton Architectural, 2006. Print.
[8] Dampierre, Florence De. *Chairs: A History.* New York: Abrams, 2006. Print.
[9] "History - Pneumaticstructures." *History - Pneumaticstructures.* N.p., n.d. Web. 12 Oct. 2012. <https://sites.google.com/site/pneumaticstructures/history>.
[10] Herzog, Thomas, Gernot Minke, and Hans Eggers. *Pneumatic Structures: A Handbook of Inflatable Architecture.* New York: Oxford UP, 1976. Print.
[11] "Pennington Block Company - History of Concrete Block." *Pennington Block Company - History of Concrete Block.* N.p., n.d. Web. 29 Nov. 2012. <http://www.penningtonblockco.com/history.html>.
[12] Nauman, Bruce. *Bruce Nauman: Raw Materials.* London: Tate, 2004. Print.
[13] Matta-Clark, Gordon, Corinne Diserens, Thomas E. Crow, Judith Russi. Kirshner, and Christian Kravagna. *Gordon Matta-Clark.* London: Phaidon, 2003. Print.
[14] Lingwood, James. *Rachel Whiteread: House.* London: Phaidon, 1995. Print.

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Figure 4 retrieved from: http://machinepaper.blogspot.com/
Figure 5 retrieved from: http://www.archdaily.com/84524/ad-classics-villa-savoye-le-corbusier/
Figure 6 retrieved from: http://www.architonic.com/ntsht/concrete-in-architecture-1-a-material-both-stigmatised-and-celebrated/7000525
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Figure 11 retrieved from: http://asia.cnet.com/litracon-translucent-concrete-62102658.htm
Figure 12 retrieved from: https://fp.auburn.edu/heinmic/ConcreteHistory/Pages/timeline.htm
Figure 13 retrieved from: http://udis-tmc.blogspot.com/2012/01/skin-of-architecture-pattern-2.html
Figure 14 retrieved from: http://exhibits.mannlib.cornell.edu/prefabhousing/prefab.phcontent=two_a
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Figure 18 retrieved from: http://www.auburn.edu/academic/architecture/bsc/classes/bsc314/timeline/timeline.htm
Figure 19 retrieved from: http://coolboom.net/products/40-bond-gate-by-herzog-and-de-meuron/
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Figure 21 retrieved from: https://fp.auburn.edu/heinmic/ConcreteHistory/Pages/timeline.htm
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Figure 26 retrieved from: https://fp.auburn.edu/heinmic/ConcreteHistory/Pages/timeline.htm
Figure 27 retrieved from: https://fp.auburn.edu/heinmic/ConcreteHistory/Pages/timeline.htm
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Figure 29 retrieved from: http://pinterest.com/pin/176062666653272490/
Figure 30 retrieved from: http://www.architonic.com/ntsht/concrete-in-architecture-1-a-material-both-stigmatised-and-celebrated/7000525
Figure 31 retrieved from: http://www.grunblau.com/BBHBMO.htm
Figure 32 retrieved from: http://aap.cornell.edu/arch/events/events_details.cfm?customel_datapageid_2742=75929
Figure 33 retrieved from: http://inhabitat.com/3-d-printer-creates-entire-buildings-from-solid-rock/
Figure 34 retrieved from: http://www.rallyrace.com/turning-over-the-stone-event-production-basics/
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