

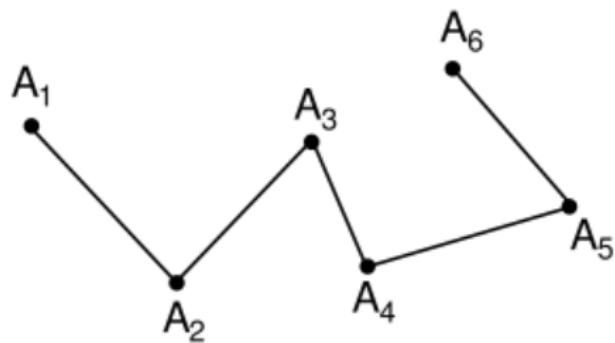
# Computational Design + Fabrication: 1D Design

Jonathan Bachrach

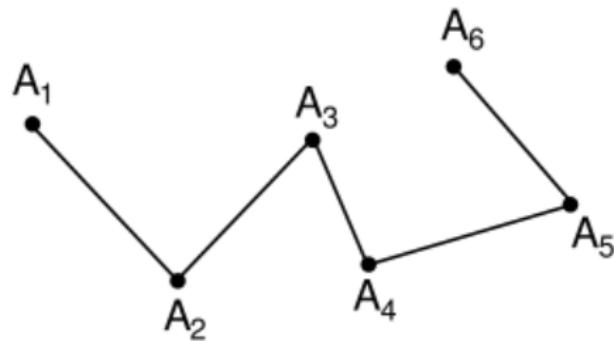
EECS UC Berkeley

September 10, 2015

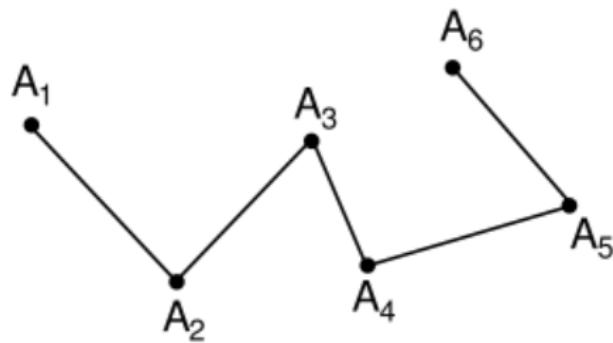
- News
- 1D Design
- DIWire



- lab 0 due thursday
- section tomorrow 2-3p in soda 380
- please do invention lab safety training
- review paper comments on thursday
- teaming
- questions for austin right now?



- polylines
- line drawings
- rods
- straws

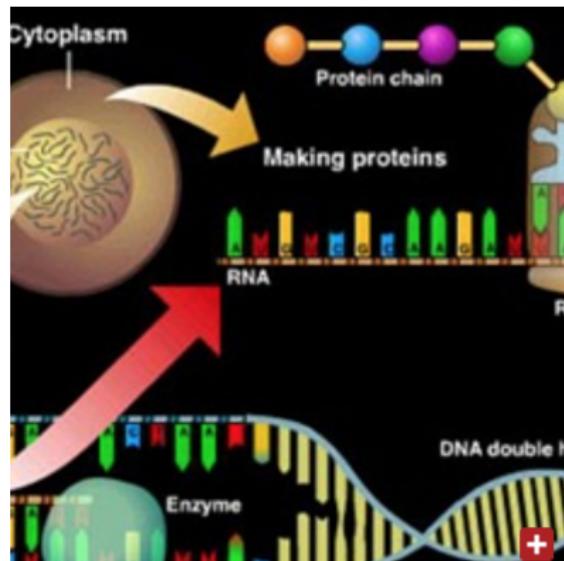


- simplification
- compact material
- strength to weight
- self-assembly

- biology
- craft
- art
- engineering

- what's the design algorithm?
- how would you want to design it?
- how do you break it down into bite sized chunks?
- what sort of machine could build it?
- how would you write assembly instructions?

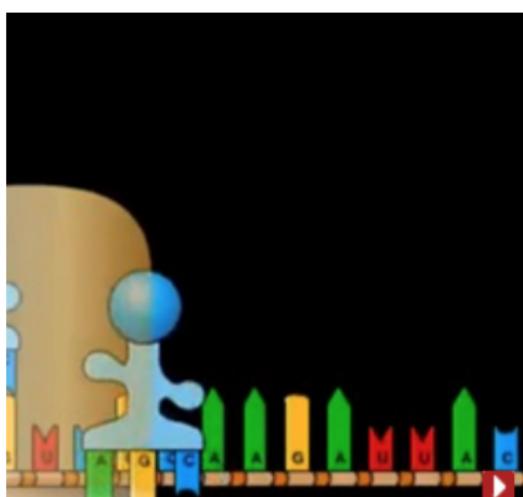
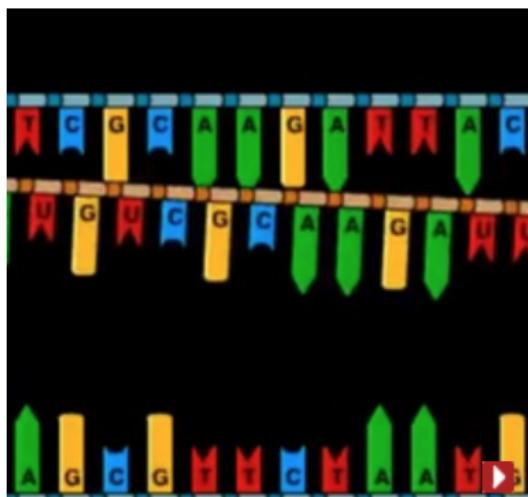
- builds organisms by forming 1D bent proteins
- long chains of 20 different amino acids
- wide range of all possible biological functions



# Protein Formation

8

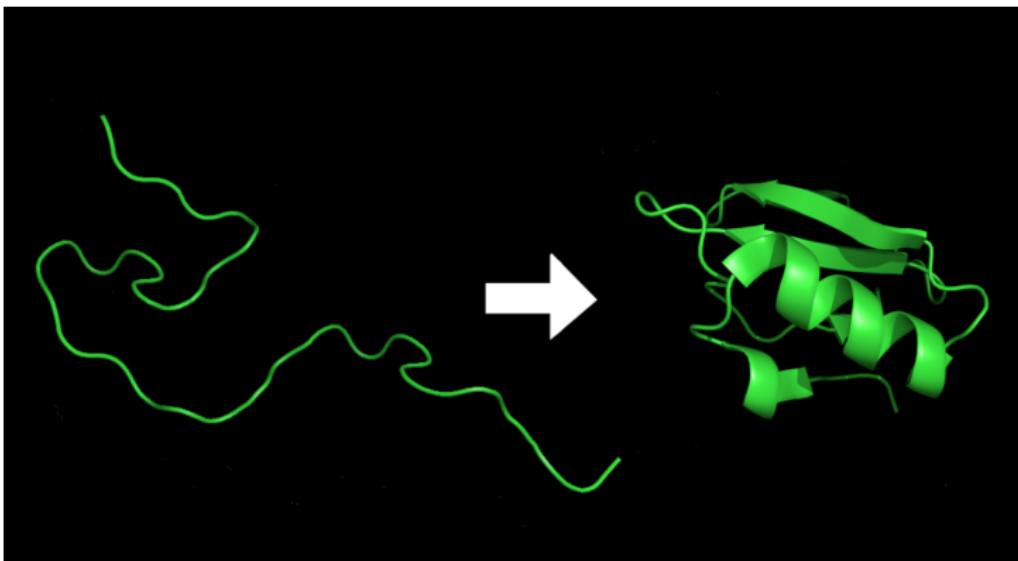
- DNA contains linear blueprint
- converts DNA into single stranded RNA
- ribosome copies RNA into proteins



# Protein Folding

9

- once protein chains are formed
- they fold into a compact blob into specific shape
- folds based on energy function



# Spiders Spin Webs

10

- build structures from extruded threads
- often have radial structure



# Spiders Cover Structures with Web Blanket

11



# Robot Arm Spins Web

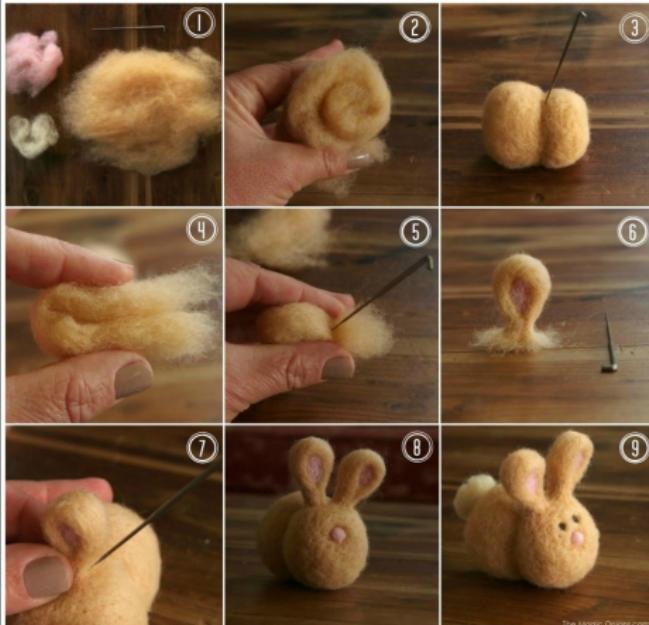
12



University of Stuttgart

- felting
- weaving
- knitting
- crochet

## Tutorial : Needle Felted Bunny



by the magic onions

TheMagicOnions.com

# Felt Alive Pixies

15



by felt alive



Figure 1. A 3D Printed Teddy Bear. Solid model (top left), printing in progress (top right) and result (bottom).

## Printing Teddy Bears: A Technique for 3D Printing of Soft Interactive Objects

Scott E. Hudson

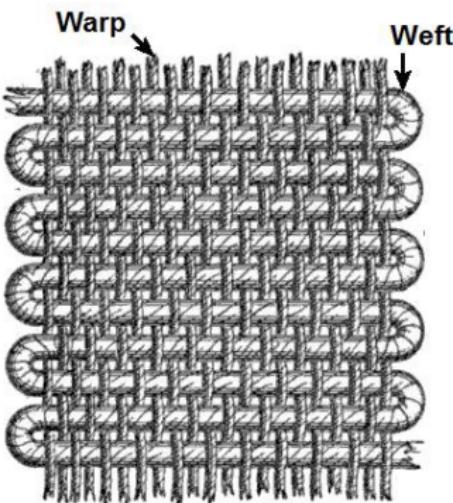
Human-Computer Interaction Institute, Carnegie Mellon University and Disney Research Pittsburgh  
5000/4720 Forbes Ave., Pittsburgh, PA15213

scott.hudson@cs.cmu.edu

<https://youtu.be/YhXIWyfI7Cw>

https:

- interlocking threads
- how clothing is made
- earliest CNC machines



# Jacquard Loom

18



Jacquard Loom and Punch Cards with Laszlo Zonger



DORNIER rapier weaving machine

# Basket Weaving

20

- fibrous or pliable materials
- woven strands



# Step 1

21



by design sponge

## Step 2

22



by design sponge

# Step 3

23



by design sponge

## Step 4

24



by design sponge

## Step 5

25



by design sponge

## Step 6

26



by design sponge

## Step 7

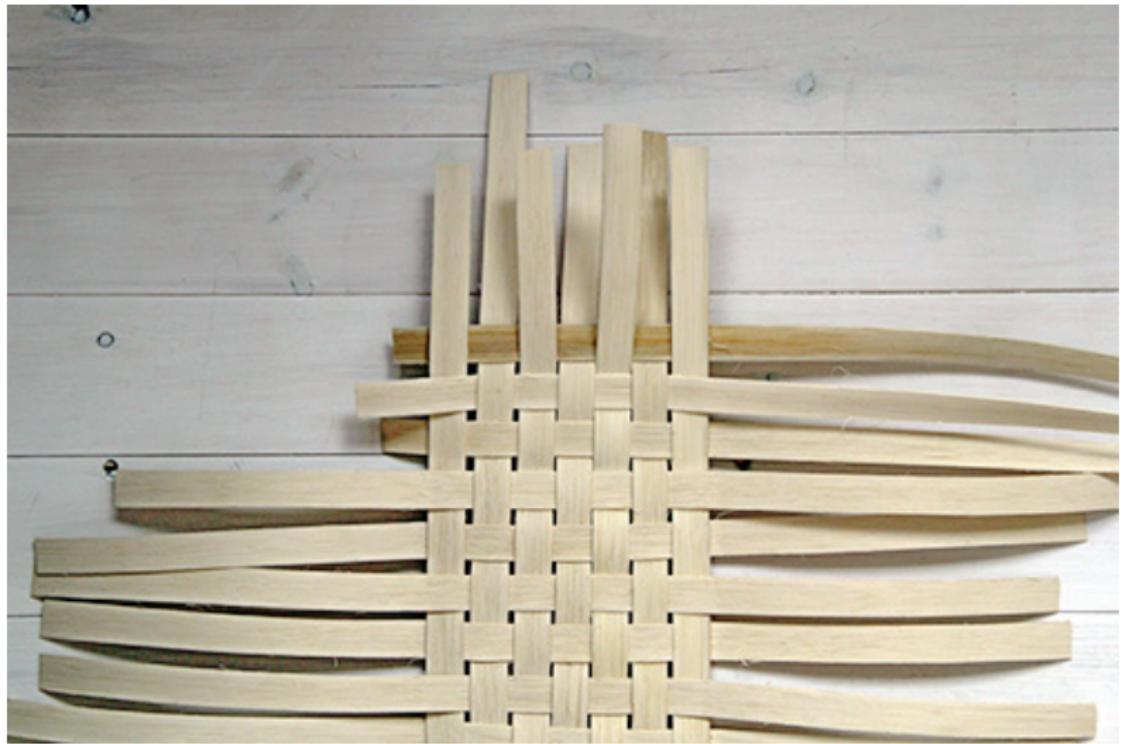
27



by design sponge

## Step 8

28



by design sponge

## Step 9

29



by design sponge

## Step 10

30



by design sponge

## Step 11

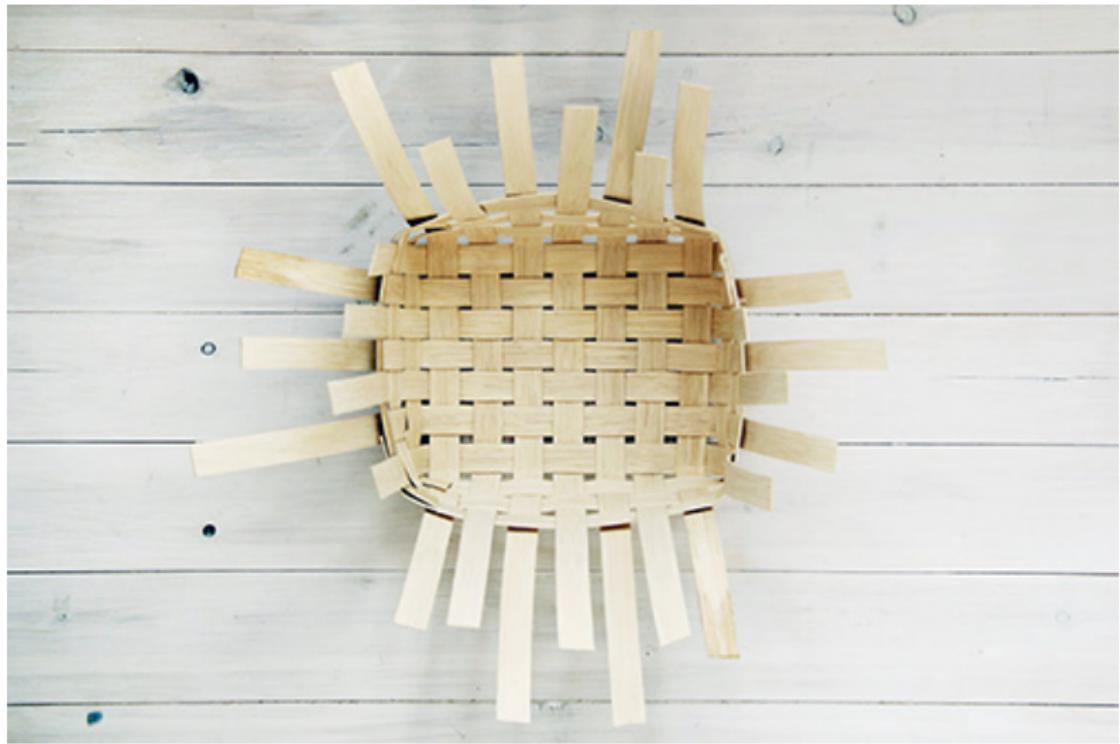
31



by design sponge

## Step 12

32



by design sponge

## Step 13

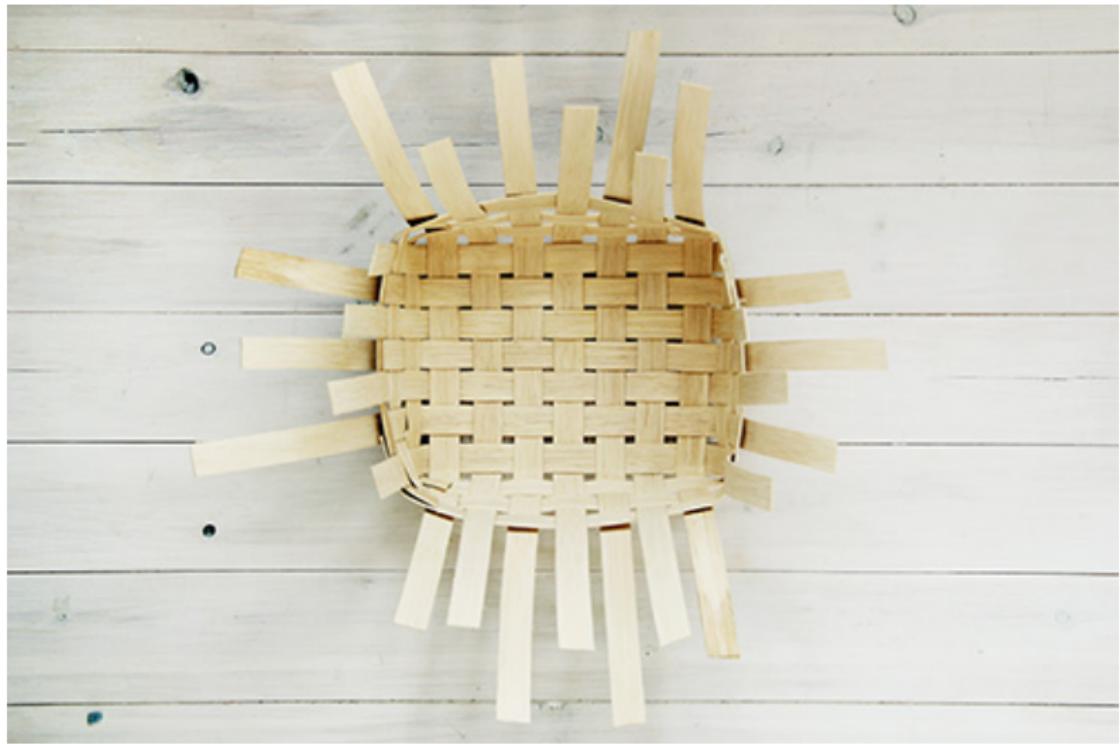
33



by design sponge

## Step 14

34



by design sponge

# Step 15

35



by design sponge

## Step 16

36



by design sponge

## Step 17

37



by design sponge

## Step 18

38



by design sponge

# Step 19

39



by design sponge

- yarn and two needles
- meandering path – stretchy – adjust length
- form stitch rows
- universal
- patterns

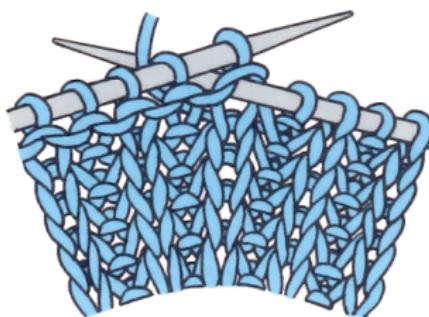


Fig 43

by learn2knit

# Spinning Yarn

41



sergiyev posad

- multiple active stitches on the needle at one time,
- form consecutive rows of interlocking loops,
- transfer loops between needles

# Knitting Pattern

43



susie rogers

# Knitting Pattern 1

44

## Susie Rogers' Reading Mitts

Designer: Susie Rogers

### Size

Women's Small (Medium, Large)

### Finished Measurements

DK yarn (200 yards)  
Yarns Used: Cascade Cloud 9 (White)  
Berroco Ultra Alpaca Light (Red)  
US size 5 double point needles  
Waste yarn  
Stitch markers  
Tapestry needle

### Gauge

5 1/2 stitches=1inch in Stockinette Stitch  
worked in the round

### Lace Pattern Stitch

Round 1: Purl.  
Round 2: Knit.  
Round 3: Purl.  
Rounds 4 and 5: Knit.  
Round 6: [Yo, k2tog] around.  
Rounds 7 and 8: Knit.  
Round 9: Purl.  
Round 10: Knit.  
Round 11: Purl.



### Pattern

Cast on 42 (48, 54) stitches with double pointed needles. Divide stitches evenly among the needles, place a marker and join for working in the round. Be careful not to twist your stitches.  
Knit 4 rounds.

Next round (turning round for hem): \*Yo, k2tog; repeat from \*around.  
Knit 4 rounds.

Decrease Round: (K4, k2tog) repeat around. 35 (40, 45) stitches remain.

Work Rounds 1-11 of Lace Stitch pattern once, then continue in St st until work measures 5 inches from turning round or desired length.

### Thumb Gusset

Round 1: Knit to 1 st from end of round marker. Place a second marker, M1, k1, M1.  
Rounds 2 and 3: Knit.

Round 4: Knit to first marker, slip marker, M1, knit to end of round marker, M1, slip marker.

and matching yarn. Weave in ends.  
Block gently if desired.

Repeat Rounds 2-4 three (four, five) more times. 11 (13, 15) thumb stitches between markers. Rearrange stitches on double pointed needles as necessary, keeping markers in place.

### Hand

Knit to first marker, remove marker, place 11 (13, 15) thumb stitches onto a piece of waste yarn. Cast on 1 stitch over gap and rejoin in the round, keeping the end of round marker in place. 35 (40, 45) stitches.

Continue in St st until work measures 1/2 inch from the top of the thumb gusset.

Repeat Rounds 1-11 of Lace Stitch pattern.

Knit 4 rounds.  
Rep turning round.  
Knit 4 rounds.  
Bind off all stitches.

### Thumb

Place 11 (13, 15) held thumb stitches onto 3 double pointed needles. Pick up and knit 1 st in the gap where the thumb joins the palm of the hand. 12 (14, 16) stitches.

Place a marker and join to work into the round.

Work in St st for 1/2 inch.

Round 1: Purl.  
Round 2: Knit.  
Round 3: Purl.  
Round 4: Knit.  
Bind off all stitches.

### Finishing

Turn under hem at top and bottom of mitts along turning rounds and stitch in place on wrong side with tapestry needle



- type of stitch
- number of stitches
- tightness of stitches
- pieces connected together

# Sweater Knitting Machine

46



by flying tiger technology

# Express Knitting Machine

47



by addi

# Knitted Nike Shoes

48



[Save to Wish List](#)

by nike

- single hook
- always complete
- patterns



# Crochet Throw

50



by the green dragonfly

# Crochet Penguin

51

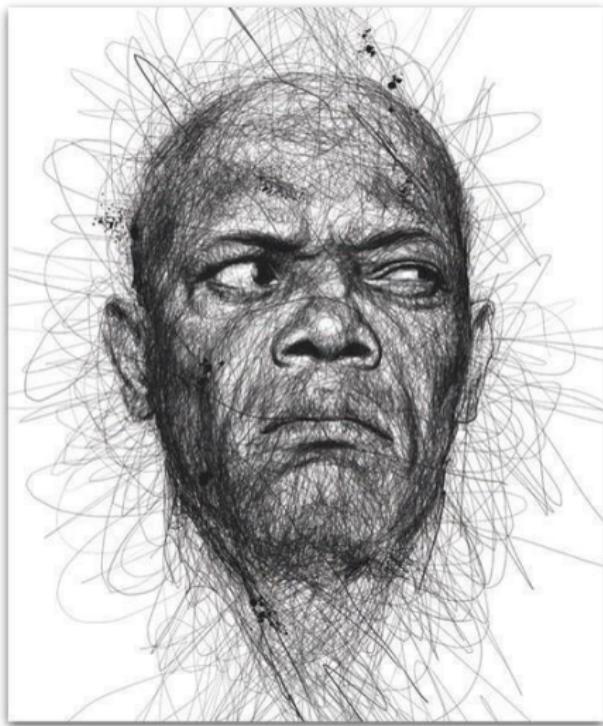


by amy gaines

- drawings
- static sculptures
- mobiles
- kinematic sculptures

# Scribble Drawing

53



by paris palmer



by stitch by wire

# Wire Formed Bike

55



by ace wire

# Wire Shoes

56



by Harriet Wharton

# Wire Typewriter

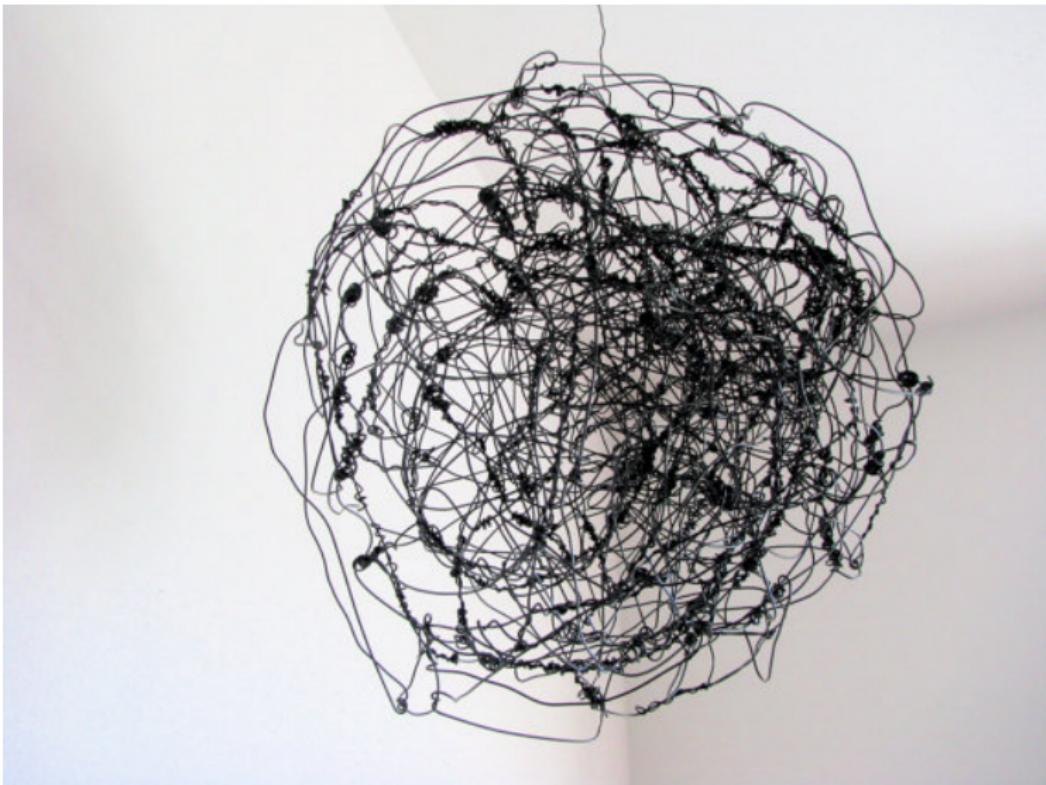
57



by martin senn

# Wire Chaos Contained

58

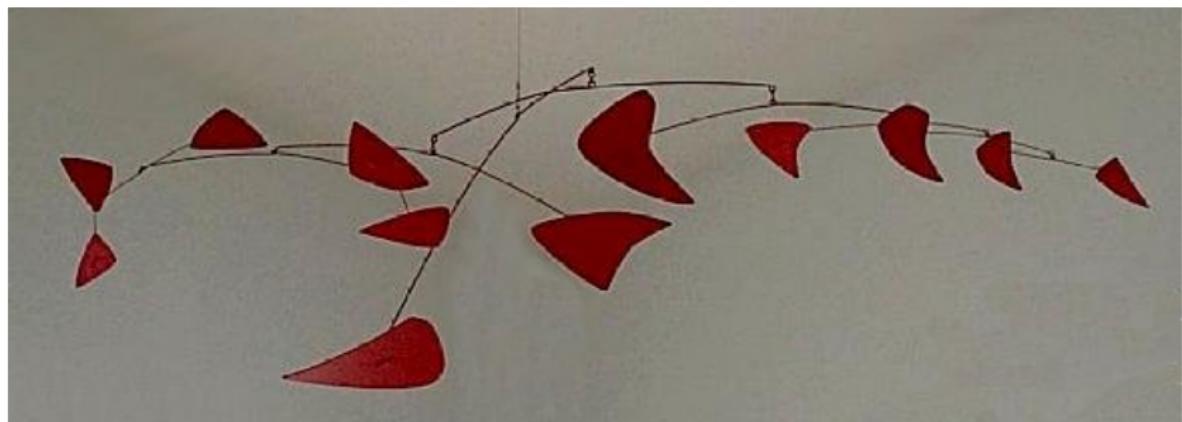


by lula + hasil



by anonymous african artist

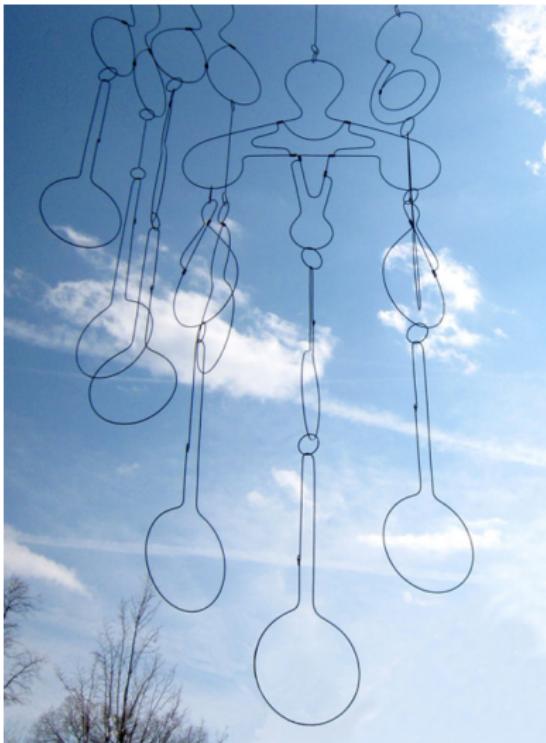
- balanced
- passive



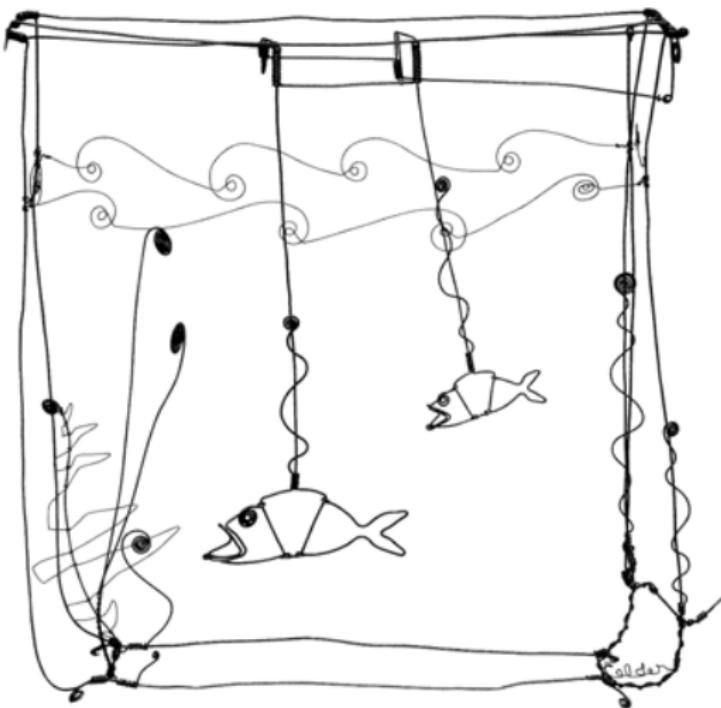
by red mobile

# Wire Mobiles

61

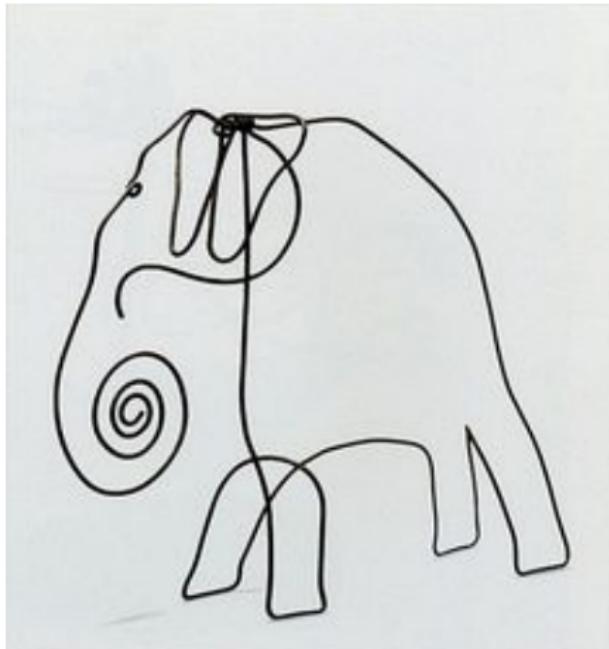


by rodger stevens



Aquarium by Calder

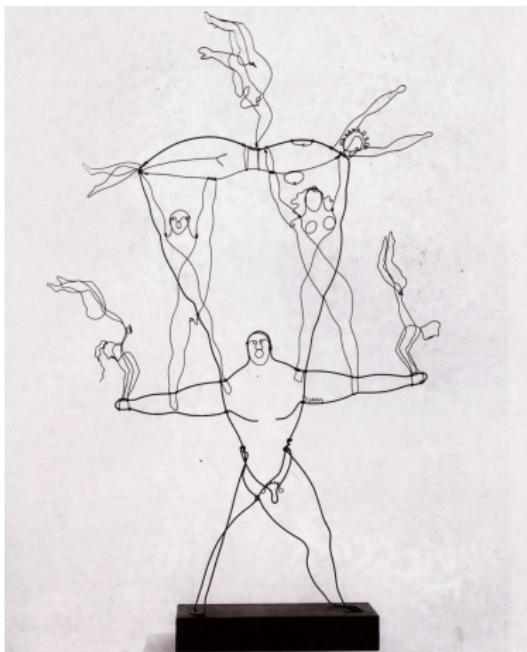
- calder circus performance



Elephant by Calder

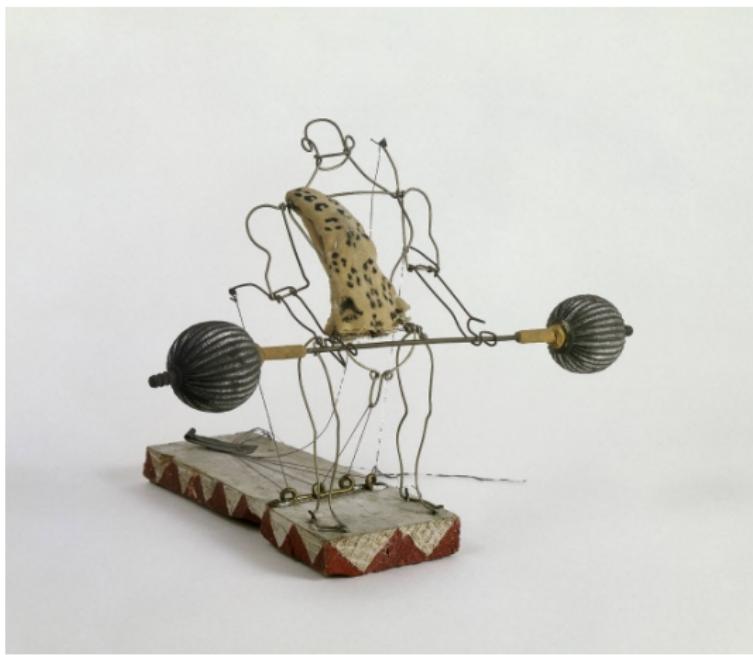
# Calder Strong Man

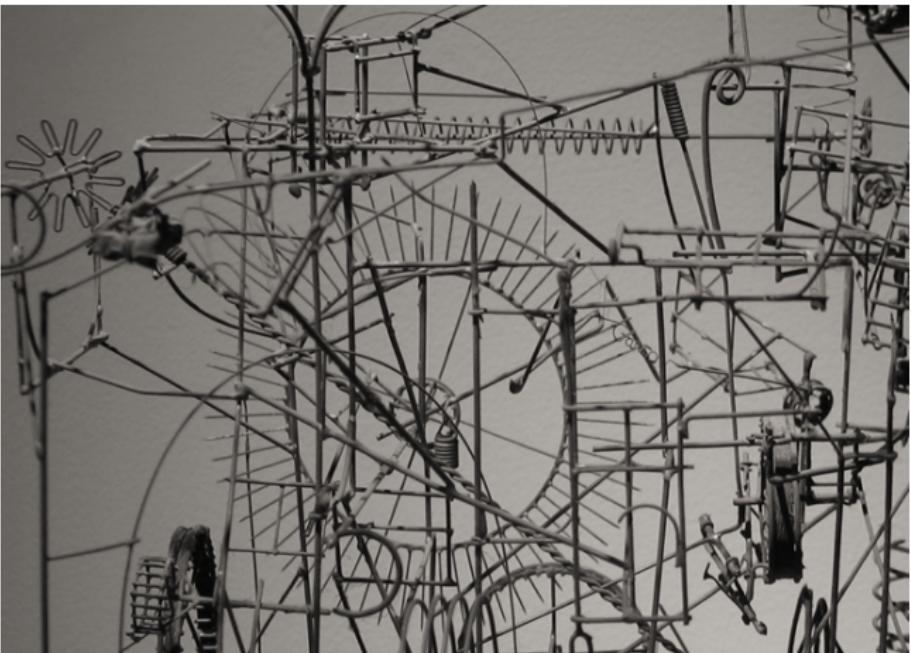
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# Calder Weight Lifter

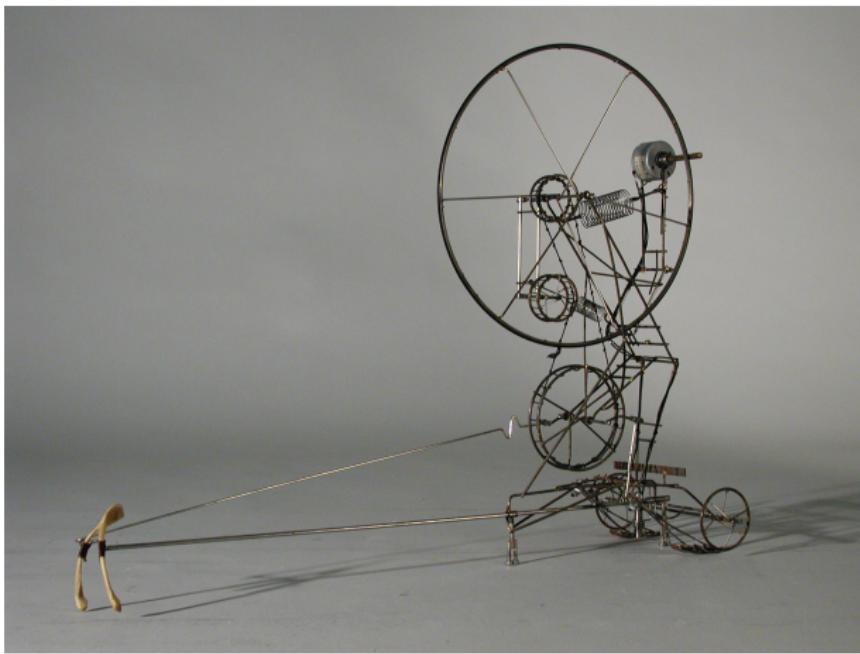
65





# Ganson Walking Wishbone

67





1:48

**The First Noble Truth - Arthur Ganson**

13,490 views • 3 years ago



3:12

**My Little Violin - Arthur Ganson**

29,232 views • 5 years ago



1:37

**Machine with Wishbone - Arthur Ganson**

44,312 views • 6 years ago

<https://www.youtube.com/profile?user=dreamingmachines&view=videos>

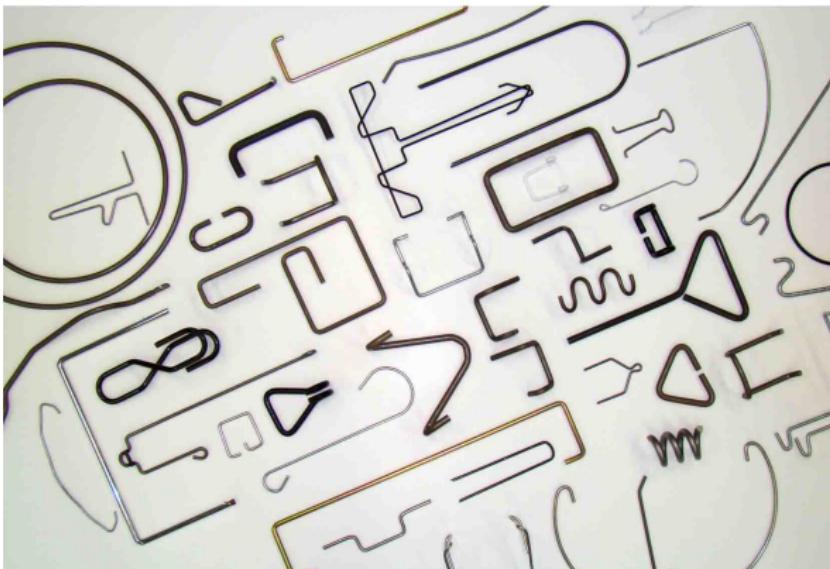
- wire forming
- trusses and space frames
- digital materials

- wire bending machine
- manual with pliers
- 3d CNC machine

- wire basket
- paper clip
- hangeers
- fasteners
- marlinwire

# Wire Bending Examples

72



by ace wire

# Springs

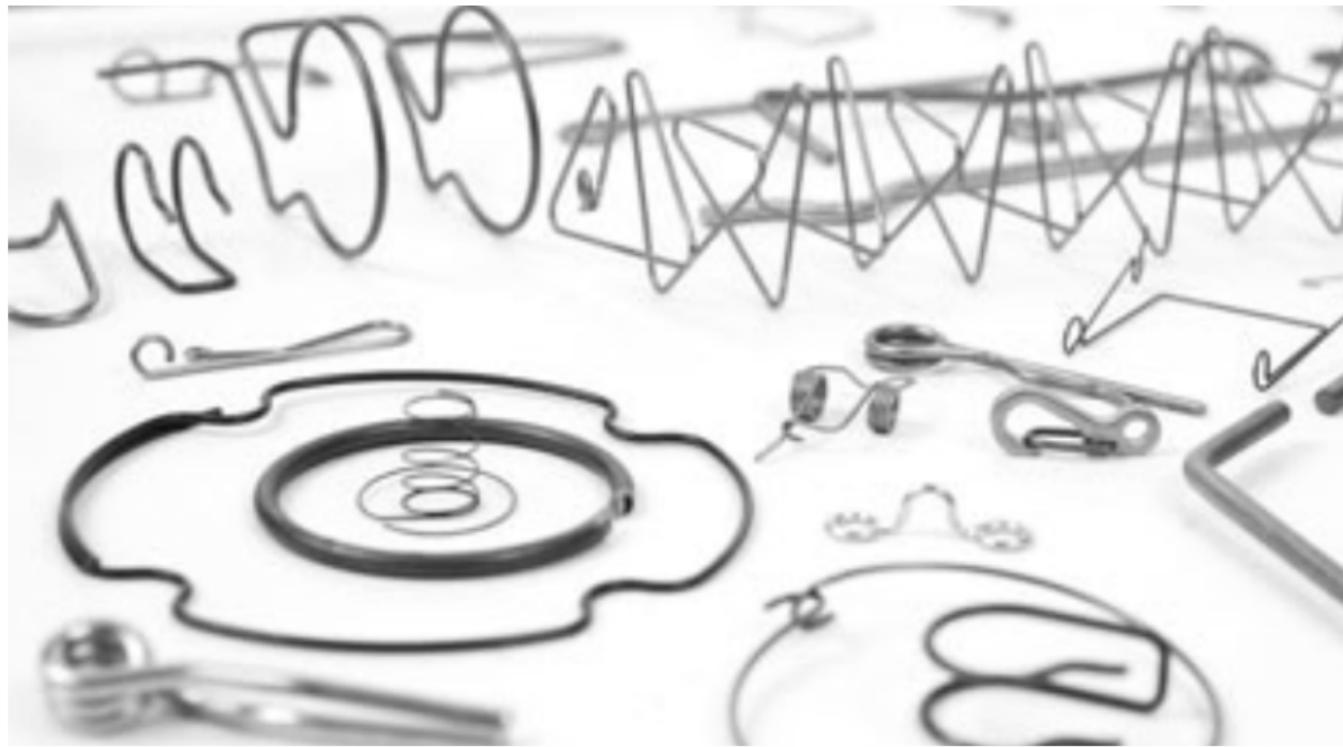
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by ace wire

# Precision Wire Forms

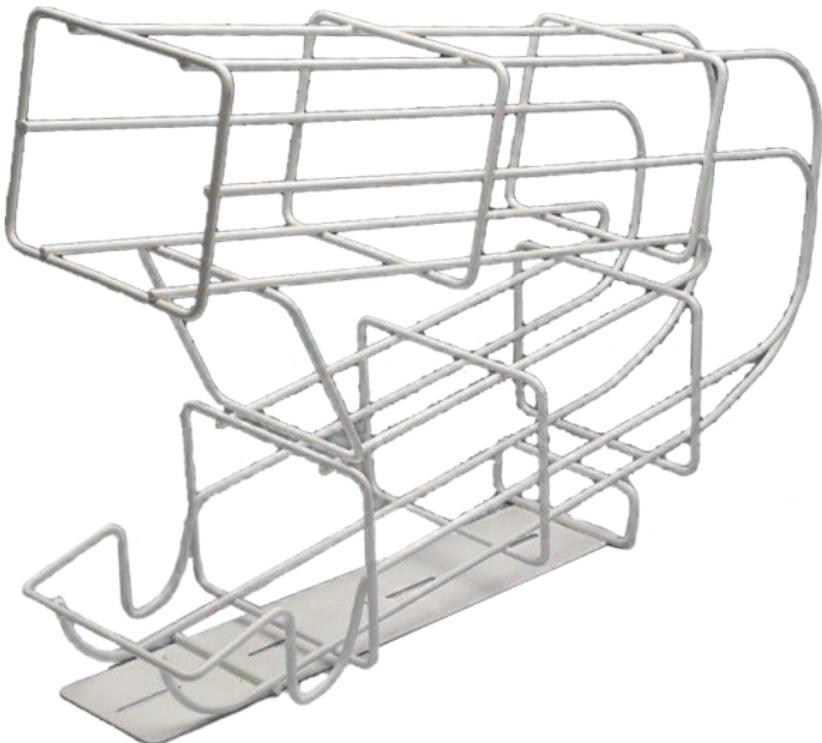
74



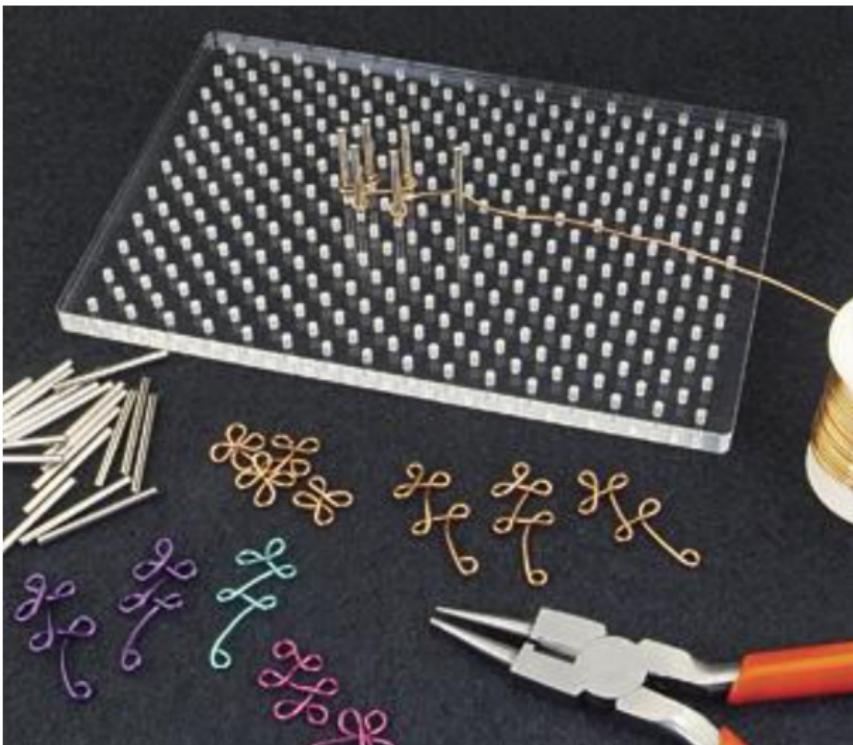
by orlando spring

# Wire Basket Tunnel

75



by acme wire



by micro-mark

# 3D Wire Bending Machine

77



Spring Machine CMM-5-800R

# 3D Wire Bending Machine

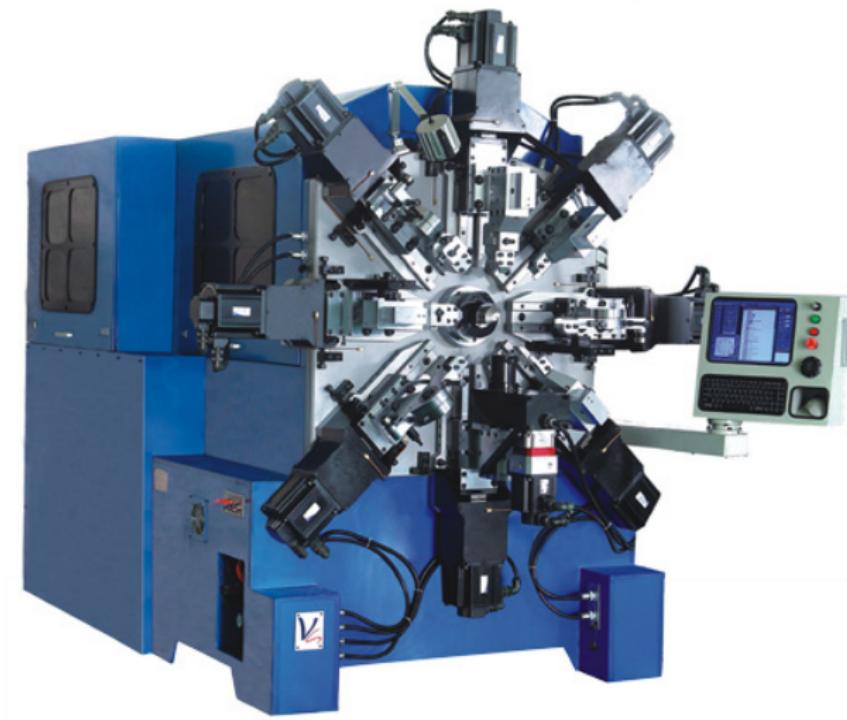
78



Spring Machine CMM-5-800R

# Massive 3D Wire Bending Machine

79



Spring Machine CMM-12-600R



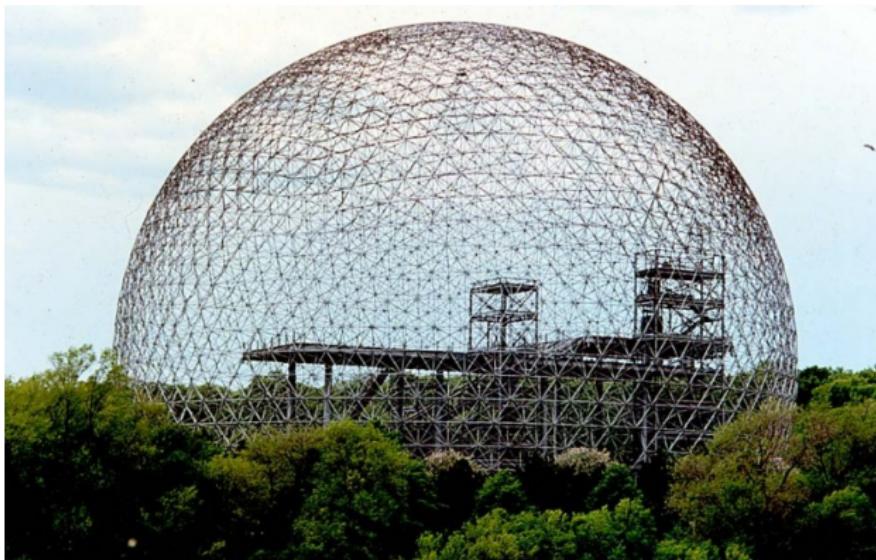
<https://www.youtube.com/watch?v=D13KfrGSMC0>  
<https://www.youtube.com/watch?v=dykosw63QV8>

- patented in 1800s
- strong and light using compression and tension of triangles
- used in bicycles etc



Pratt Truss

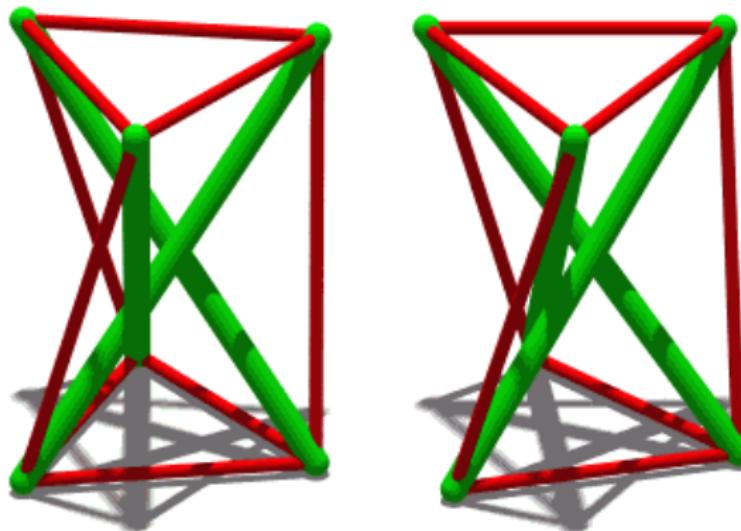
- invented by walther bauersfeld after WWI
- named, popularized, and patented by buckminster fuller in 1943
- series of intersecting great circles forming triangles



- invented by alexander bell and developed by buckminster fuller
- based on repeated pyramids – 3D truss
- lots of variations



- compression members isolated by tensioned members
- explored by buckminster fuller
- pure tension or pure compression – no bending
- exceptional rigid
- biological connection

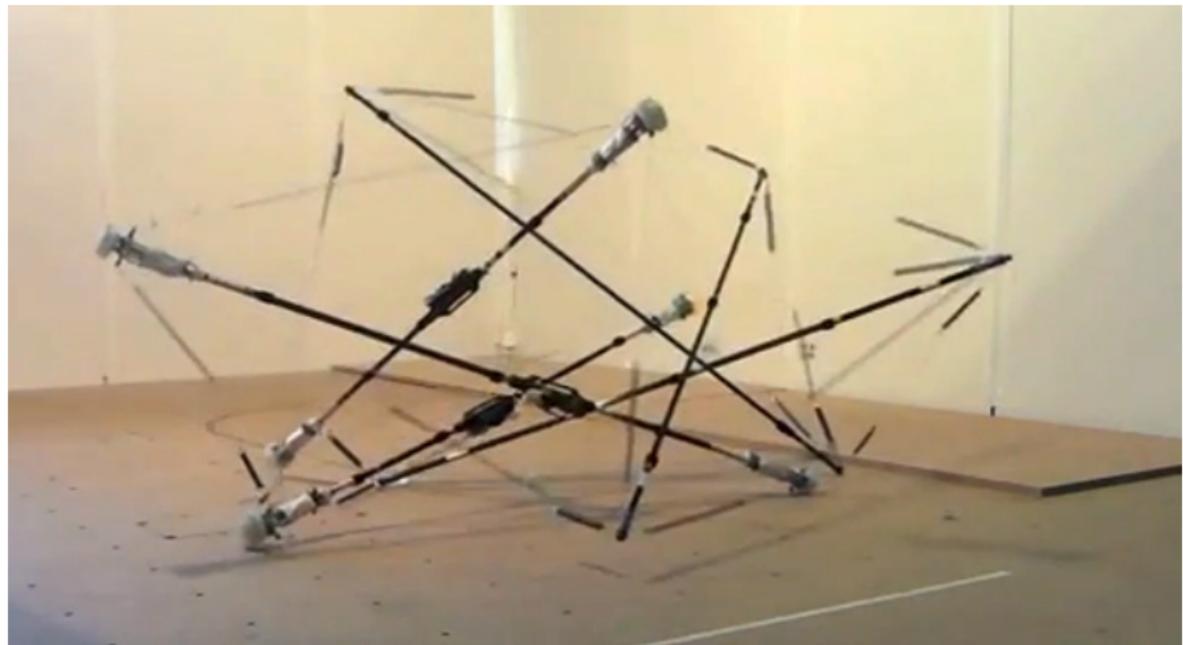


# Tensegrity Bridge

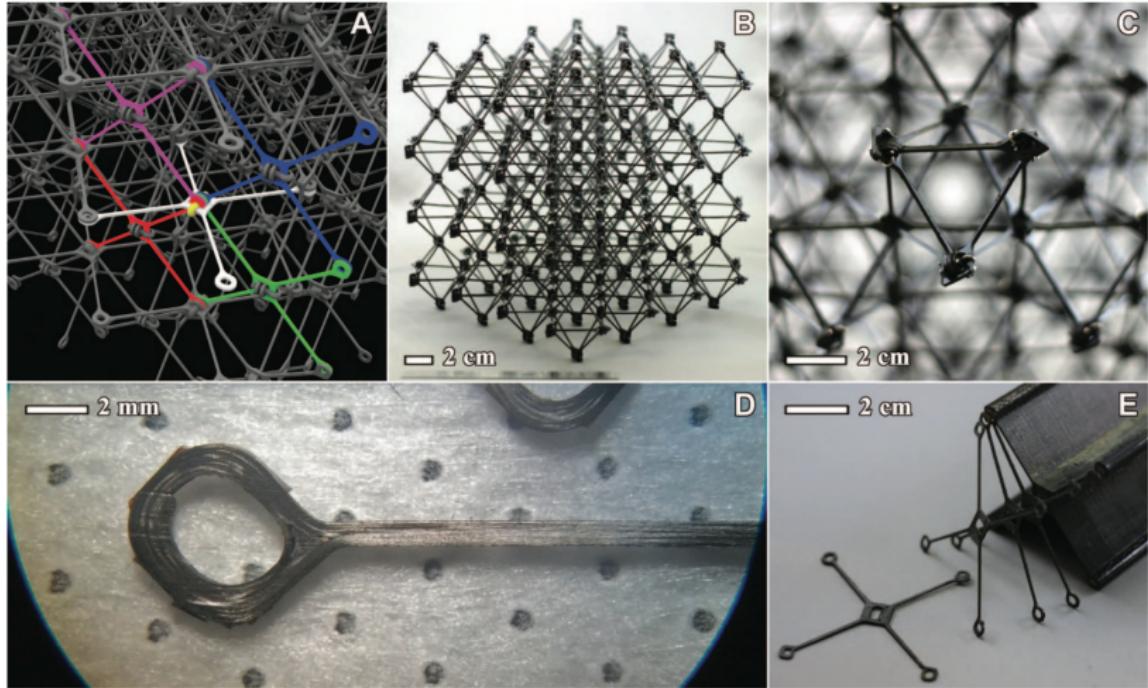
85



kurilpa bridge in brisbane australia



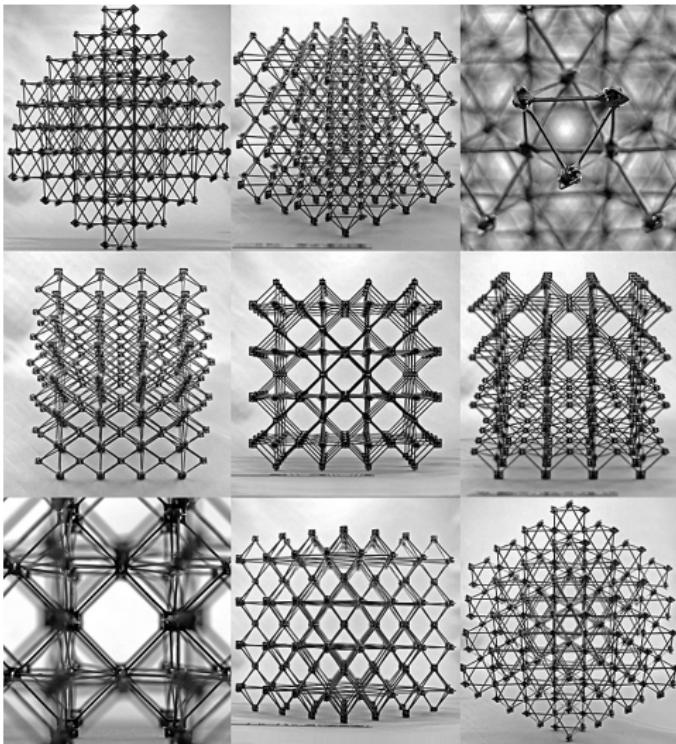
by NASA



by cheung + gershenfeld

# Big Things Out of Small Things

88

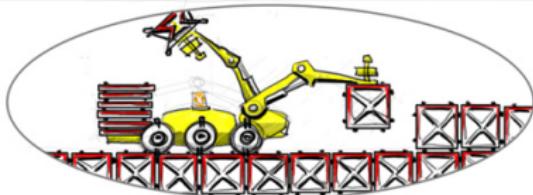
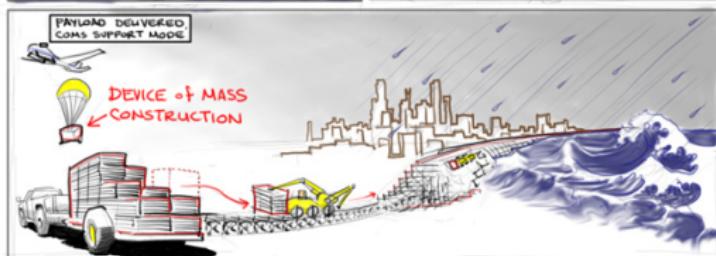
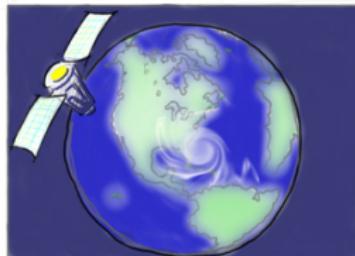


by cheung + gershenfeld

# Space Frame Construction

89

PROGRAMMABLE MATTERS



by kenny cheung

kenny@cba 2012

- Space Filling Curves
- Review Paper
- 1D Geometry
- Lab 0 Solutions
- Lab 1 Released