

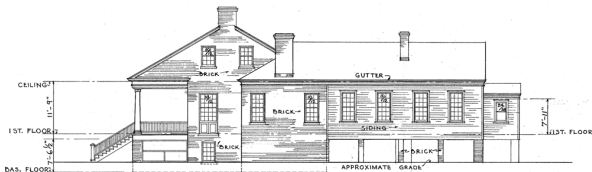
# Computational Design + Fabrication

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EECS UC Berkeley

August 27, 2015

- introduction
- thing compiler
- demos
- course info



RIGHT SIDE ELEVATION  
SCALE  $\frac{1}{8}'' = 1'-0''$



REAR ELEVATION  
SCALE  $\frac{1}{8}'' = 1'-0''$

J.L. GATLING JR., DEL.

WORKS PROGRESS ADMINISTRATION  
OFFICIAL PROJECT NO. 245-6707  
UNIVERSITY OF SOUTHERN CALIFORNIA, DIVISION OF THE HISTORIC  
SOUTHERN PARK SERVICE, DIVISION OF PLANS AND DESIGN

NAME OF STRUCTURE  
**"UMBRIA" — THE GOV. SAMUEL PICKENS' HOME**  
NEAR SAWYERVILLE, HALE COUNTY, ALABAMA

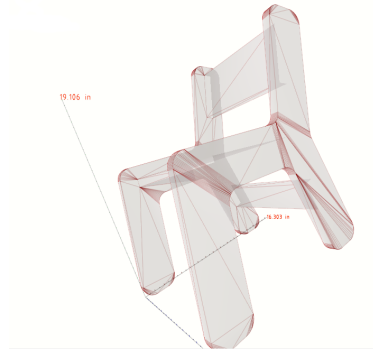
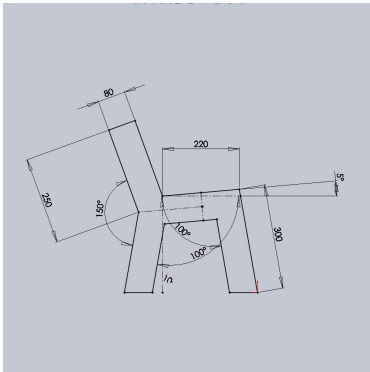


SCALE  $\frac{1}{8}'' = 1'-0''$  IN 0 5 10 15 20 FT.  
DM 0 1 2 3 4 5 6 METERS  
METRIC SCALE

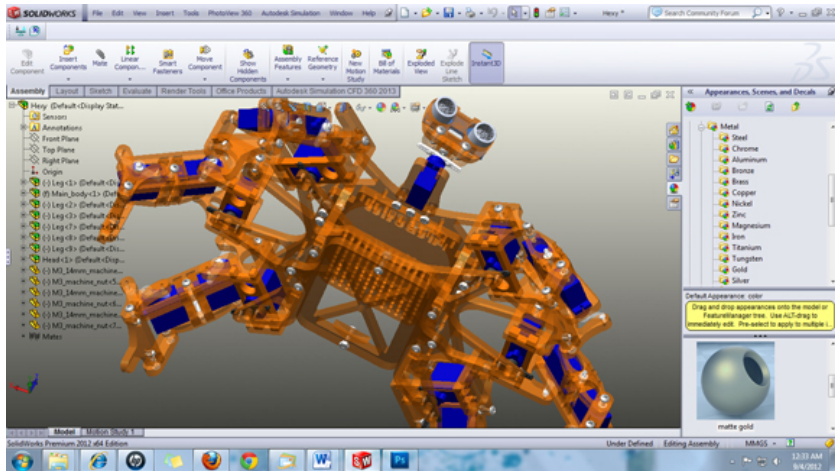
SURVEY NO.  
ALA  
236

HISTORIC AMERICAN  
BUILDINGS SURVEY  
SHEET 5 OF 8 SHEETS

DATE OF SURVEY  
1968



- parameters
- constraints



- manually intensive
- hard to keep in sync
- difficult to learn
- brittle – hard to parameterize
- disconnected from fabrication



- is manually intensive
- is difficult/dangerous/slow to tools
- has a distribution bottleneck

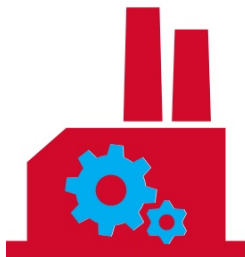






- make hardware more like software?
- automating design + fabrication
- new computer based fabrication machines
- using software techniques

- 1/4 economy based on manufacturing of physical goods
- many people do repetitive / dull jobs
- tremendous latent creativity



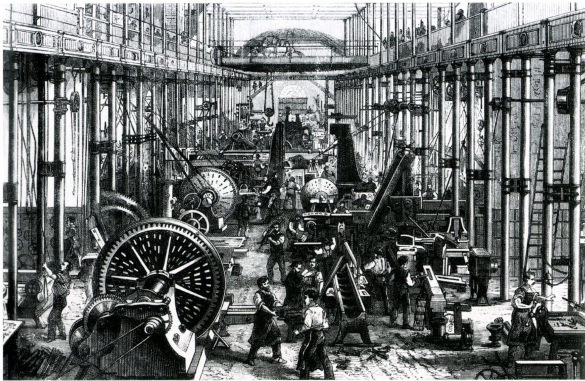
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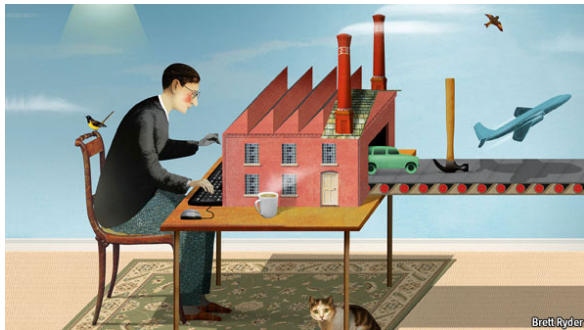
- set of technologies that vastly amplify productivity of people
- fewer people in society needed for bare essentials:
  - food, clothing, shelter
- more time spent on
  - ideas, invention, learning, politics, the arts, and creativity



- 1 1700s – textiles – invention of invention
- 2 1850s – steel + transportation + assembly line



- hardware as software
- just in time manufacturing



The Economist

- affordable JIT manufacturing
- rise of the artisan
- increases entrepreneurship
- mass customization

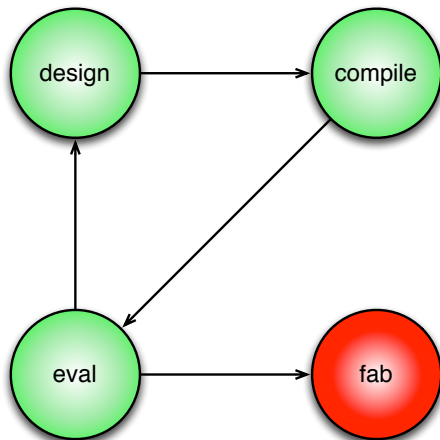


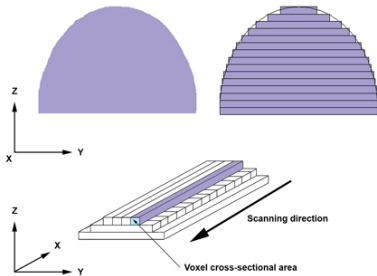
- designs as information – file formats
- network effect – sharing
- remix culture – rip, mod, fab
- manufacture local or global



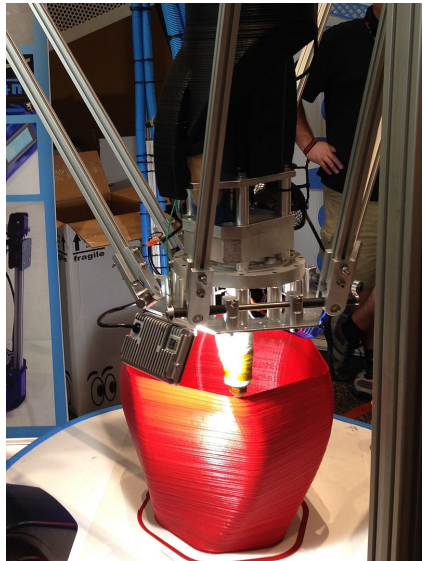


- design
- compilation
- evaluation
- fabrication





additive manufacturing



many different kinds

- 1 complexity is free
- 2 variety is free
- 3 no assembly required
- 4 zero lead time
- 5 unlimited design space
- 6 zero skill manufacturing
- 7 compact, portable manufacturing
- 8 less waste by-product
- 9 infinite shades of materials
- 10 precise physical replication

- 3d design
- limited materials, scale
- multi-material
- big data
- simulation + evaluation
- inadmissible inputs

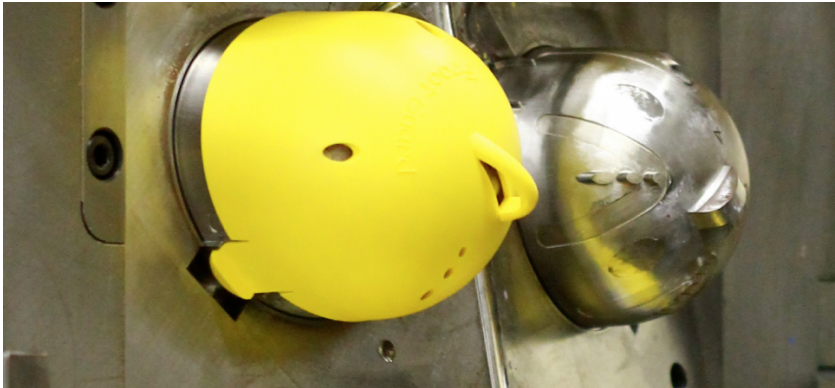


- cutters
  - laser
  - vinyl
  - water jet
- mills
  - 3 axis
  - 5 axis
- miscellaneous
  - wire bender



- software
  - clunky
  - ambiguous input
  - sometimes manual
  - not WYSIWYG
  - no nesting
- assembly
  - still manual





- design twice
- labor intensive

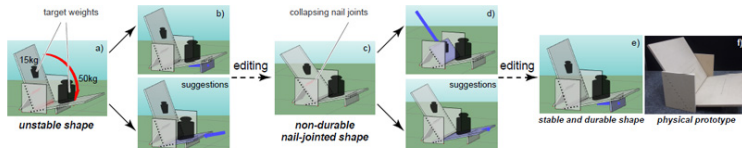
- design once
  - all design manufacturable
  - all problems shown up front in design
- human out of the loop

## Guided Exploration of Physically Valid Shapes for Furniture Design

ACM SIGGRAPH 2012

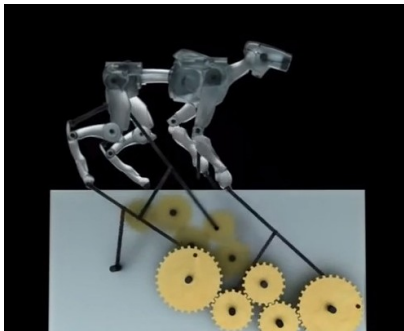
Nobuyuki Umetani Takeo Igarashi Niloy J. Mitra

The University of Tokyo JST ERATO University College London



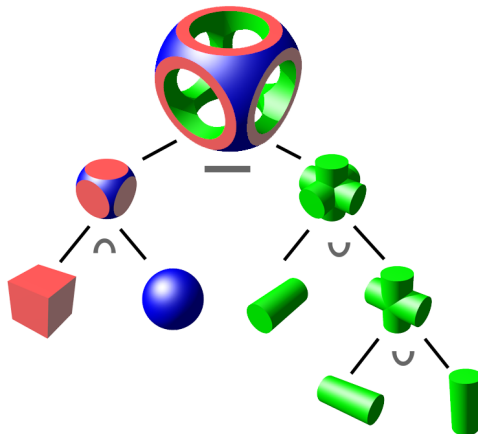


- what not how
- goals + constraints
- optimization

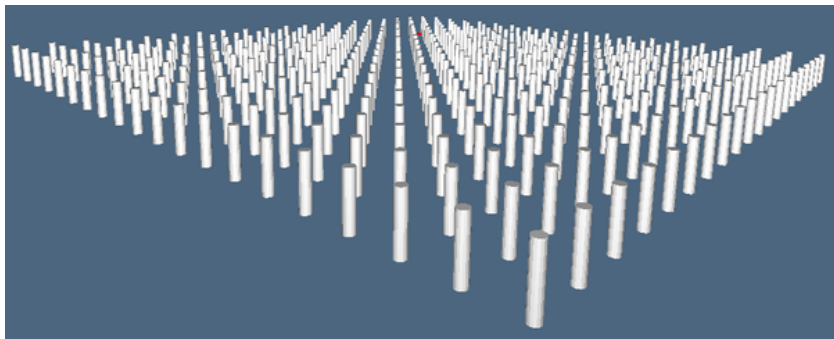


Computational Design of Mechanical Characters – Disney Research

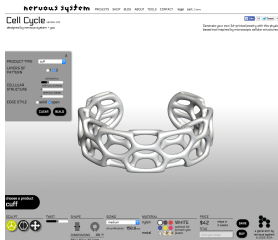
- primitives + operations + transformations



- abstraction -> reuse
- replication etc



- thing functions
- parameters sweep space
- what are parameters?



=>



## Community Developed Shape Generators

Built using the Autodesk Creative Platform



Limpet

by [Dr Who Joh...](#)



D 2

by [Dr Who Joh...](#)



Broken Heart

by [Dr Who Joh...](#)



Butterfly

by [Marrisa](#)



Cute Heart

by [Dr Who Joh...](#)



eyes

by [Dr Who Joh...](#)



Telstar

by [Dr Who Joh...](#)



Pin

by [Dr Who Joh...](#)



Icosa-diamond

by [Dr Who Joh...](#)



puzzle 2

by [Dr Who Joh...](#)



crystal

by [Dr Who Joh...](#)



Half Paraboloid

by [Dr Who Joh...](#)



d

by [Dr Who Joh...](#)



Roller Cylinder

by [Anthony](#)



Semi Buttress T...

by [Anthony Gra...](#)



Voronoi

by [Tinkercad](#)



Angular Ring

by [Henrik W Nl...](#)



Twisted polygon

by [Eliza Byrne](#)



Rounded Cube

by [Tony](#)



Delta

by [Peter Qian](#)



Custom Gear

by [Android78](#)



QR Code

by [bosgood](#)



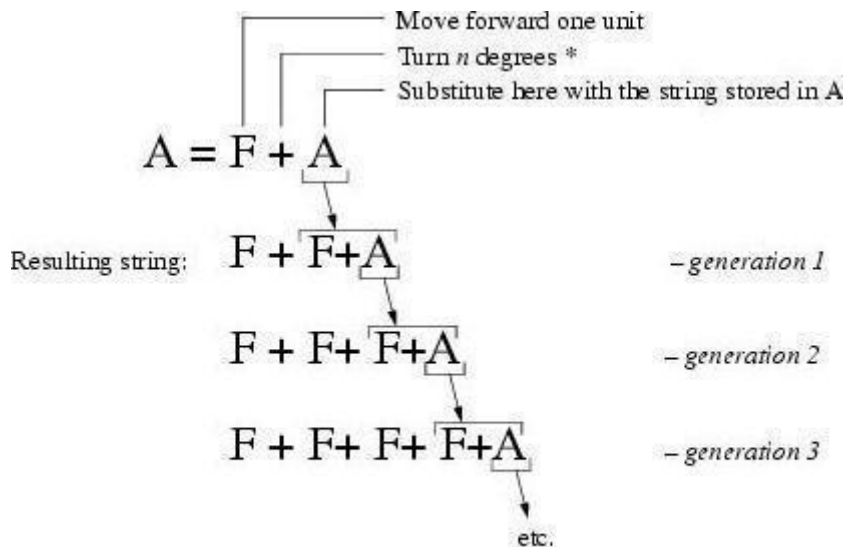
SoftBox

by [john sadler](#)

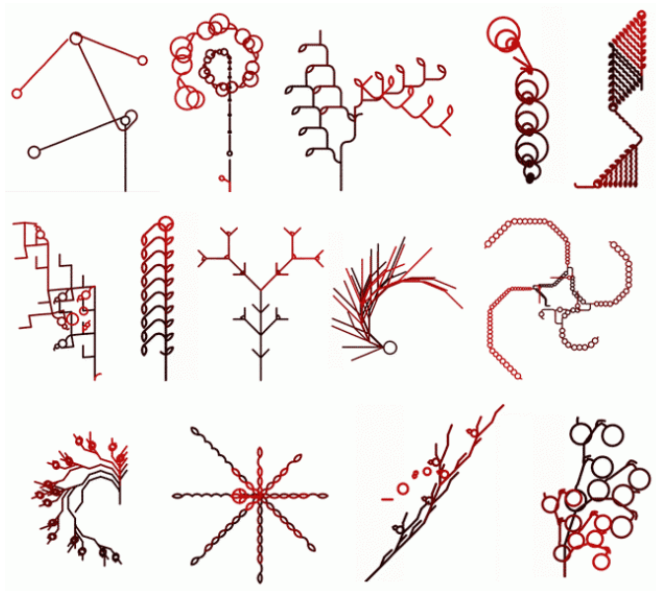


Hi-Res Sphere II

by [klaas](#)



\* The value of  $n$  can be set via the L-system SOP's Value/Angle parameter.



## ***Bending and Folding Structures 1***

*Arch 259 – Prof. Simon Schleicher*

UC  
**BERKELEY**  
ENVIRONMENTAL  
DESIGN



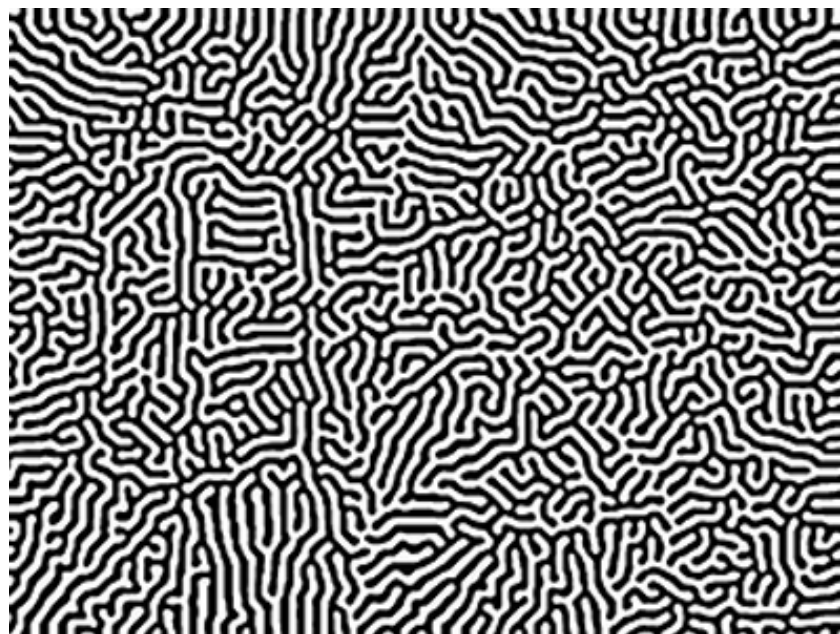
photo: Nicola Haberbosch and Andreas Schönbrunner

in collaboration with

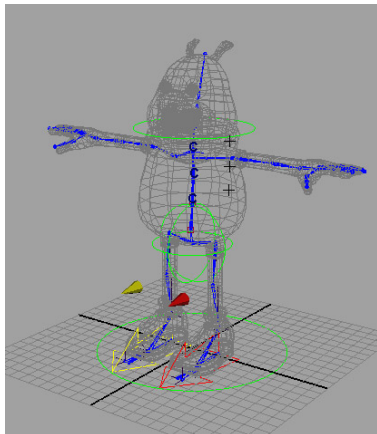


**SOFISTIK**

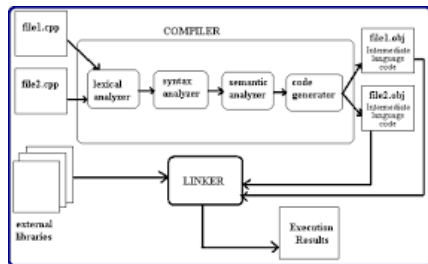


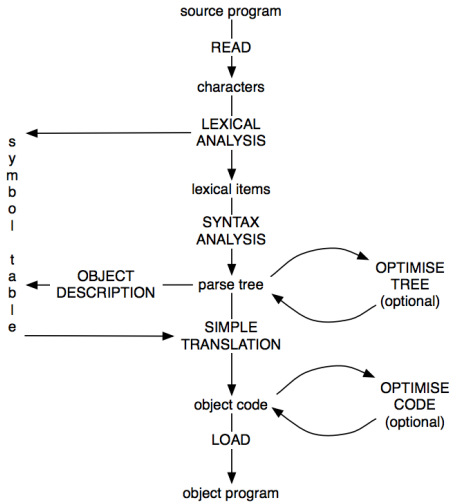


- specification
- transformation
- example skeleton + skinning

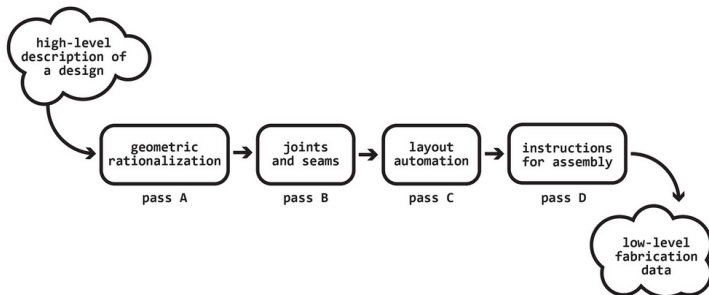


- human-readable source into machine-executable object code
- intermediate representation + passes
- front-end, optimizer, back-end

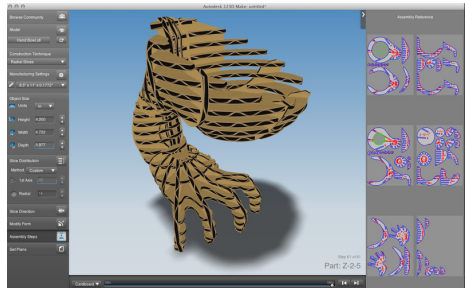




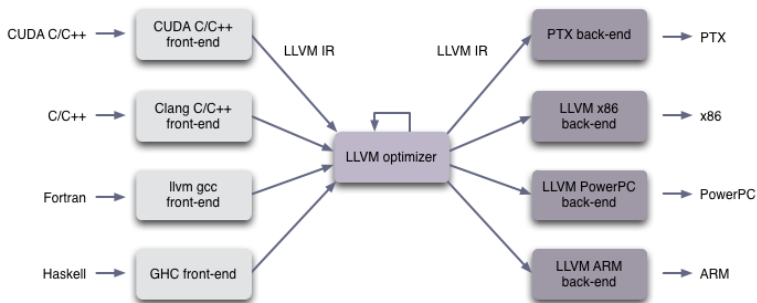
- high-level conceptual design text input
- fabrication machine code output
- towards an architecture compiler



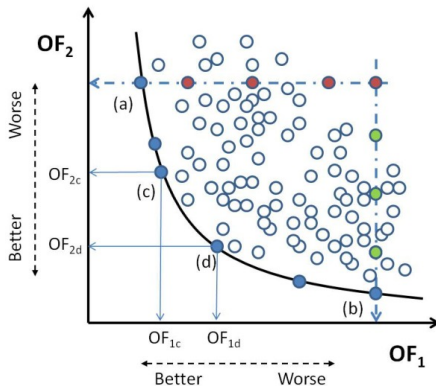
- 3d mesh into slices
- slots
- labels
- layout
- instructions



- modularize compiler into library
- compiler is set of passes
- can write new passes
- explosion in languages and backends



- combination of DSE + compilers
- optimization technique
- visualization





- healing
- growing
- programmable shapes



- robotic construction
- feedback loop with materials



ETH University + Gramazio Kohler Research

- Fabricated: The New World of 3D Printing, by Hod Lipson, Melba Kurman
- Makers: The New Industrial Revolution, by Chris Anderson
- Makers, by Cory Doctorow
- The Third Industrial Revolution, The Economist