

# beyond the GRID

**GRAZ  
MASTER  
LECTURES  
#15**

30/06/10\_19:00  
HS1  
Alte Technik  
Rechbauerstraße 12  
8010 Graz



*Ludger Hovestadt*



# CAAD

**10 years**

*100 experiments  
6 spin offs*

**the next LEVEL**

*institute for applied virtuality*

serious

story telling

Ludger Hovestadt

*ETH Zürich*

*Departement Architecture DARCH*

*Institute for Technology in Architecture ITA*

*Computer Aided Architectural Design CAAD*

*digitalSTROM alliance*

*laboratory for applied virtuality*

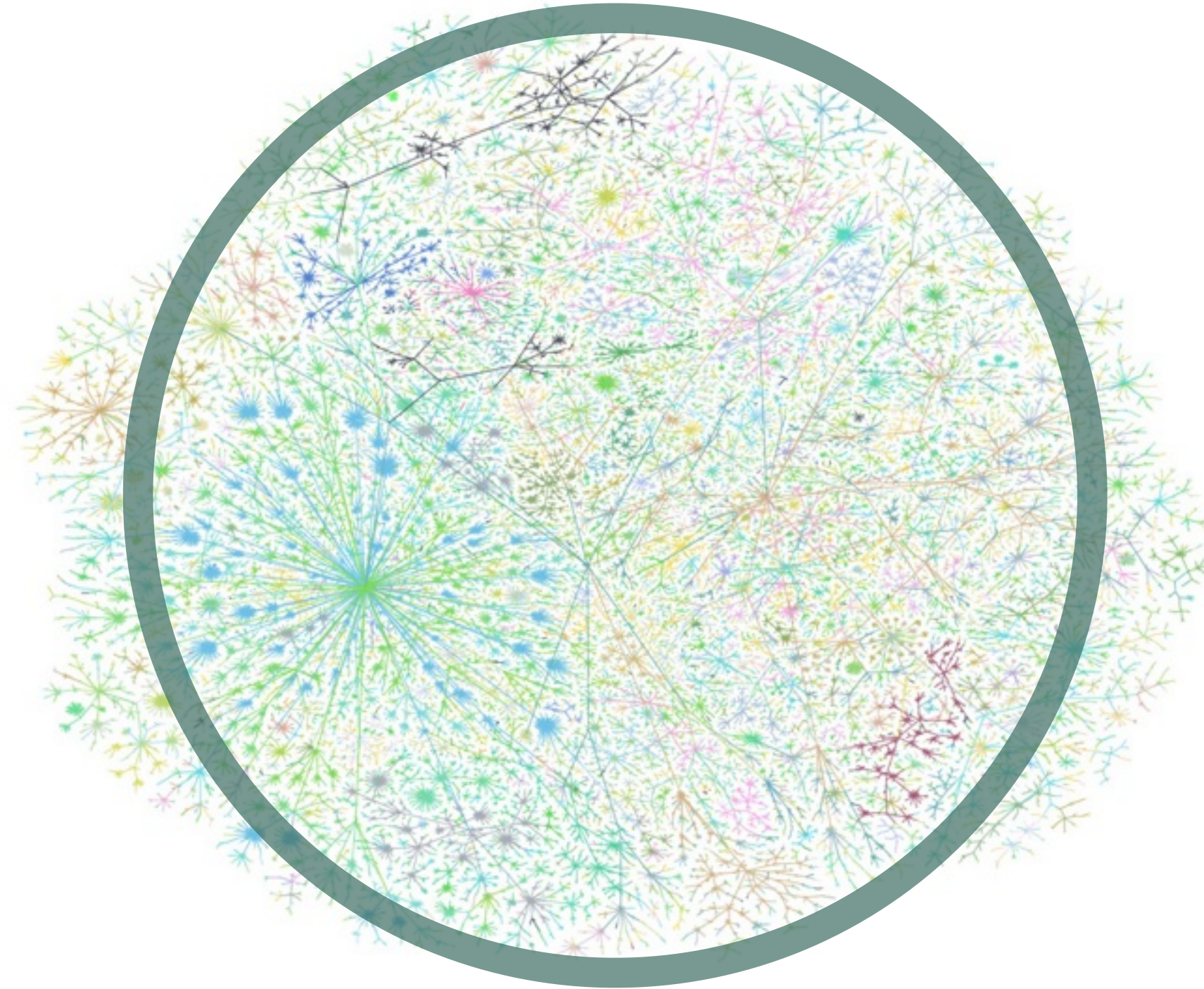
# the APOLLO story 1969

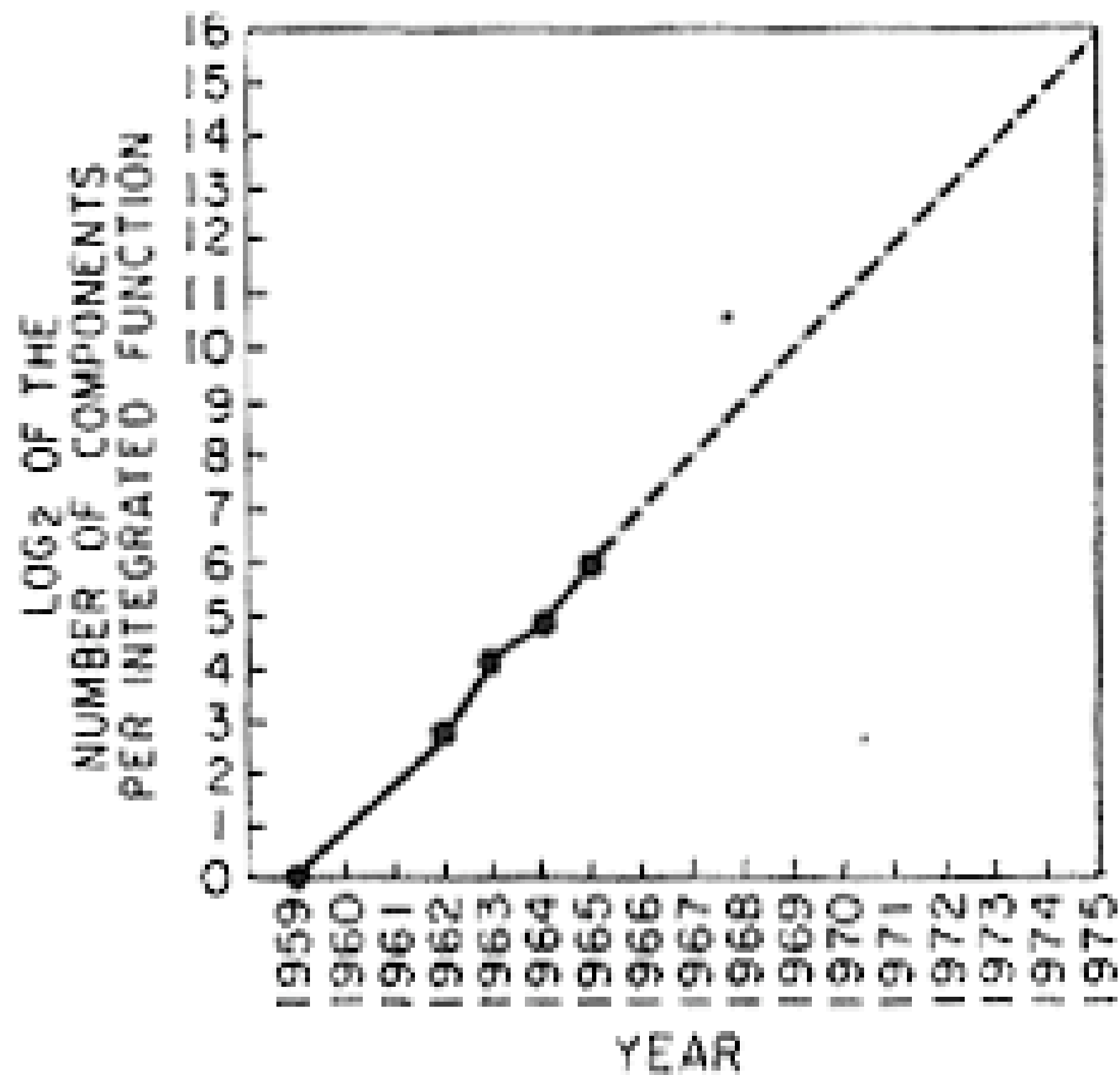


# the GOOGLE story 2009



# the GOOGLE story 2009





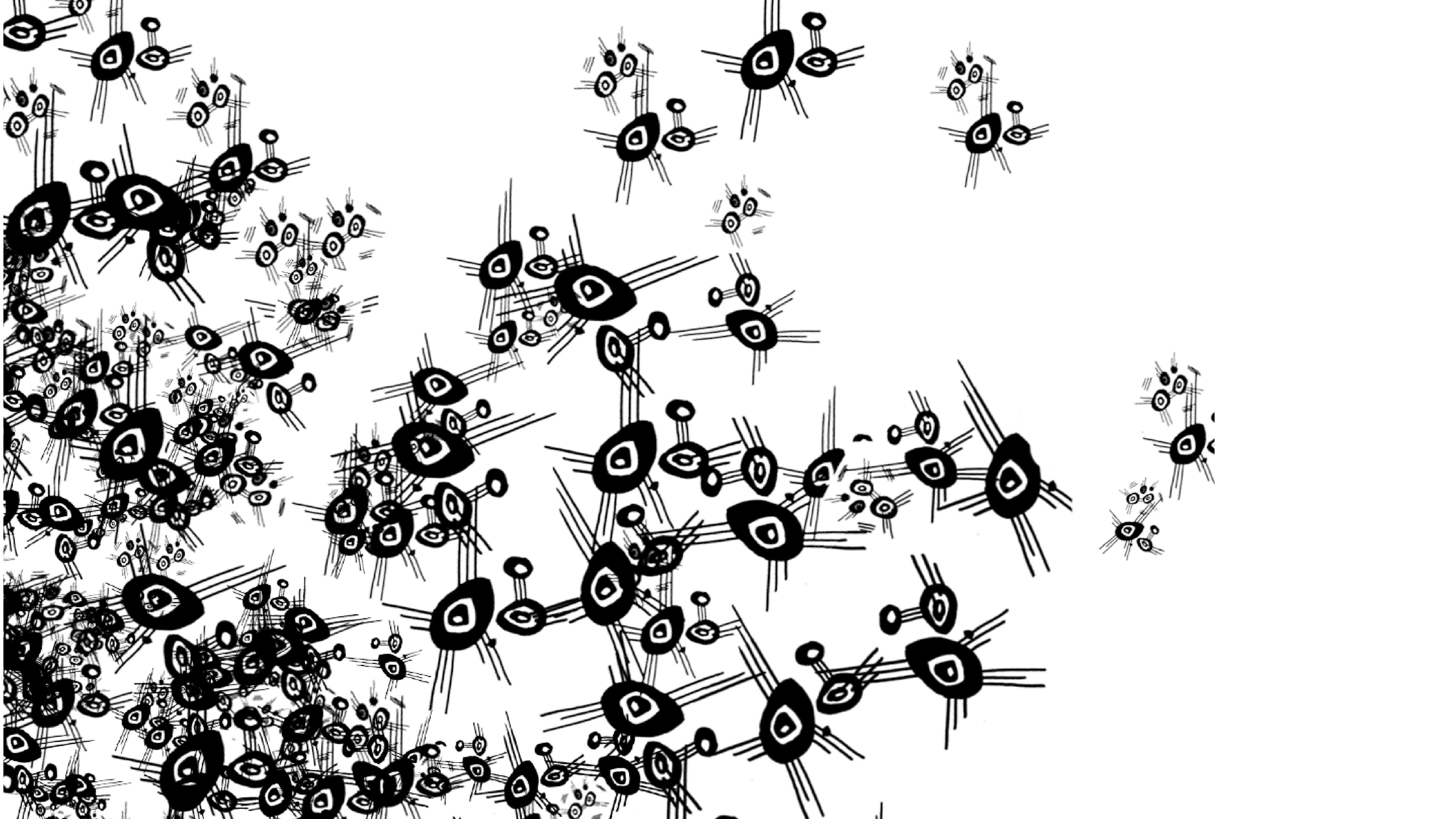
# moore's story 1965

G.E.M re

Cramming more components  
onto integrated circuits

Electronics, Volume 38, Number 8, April 19, 1965

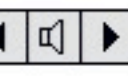




# fritz haller



⌘ i ⏪ ⏩ □ □ text



vor

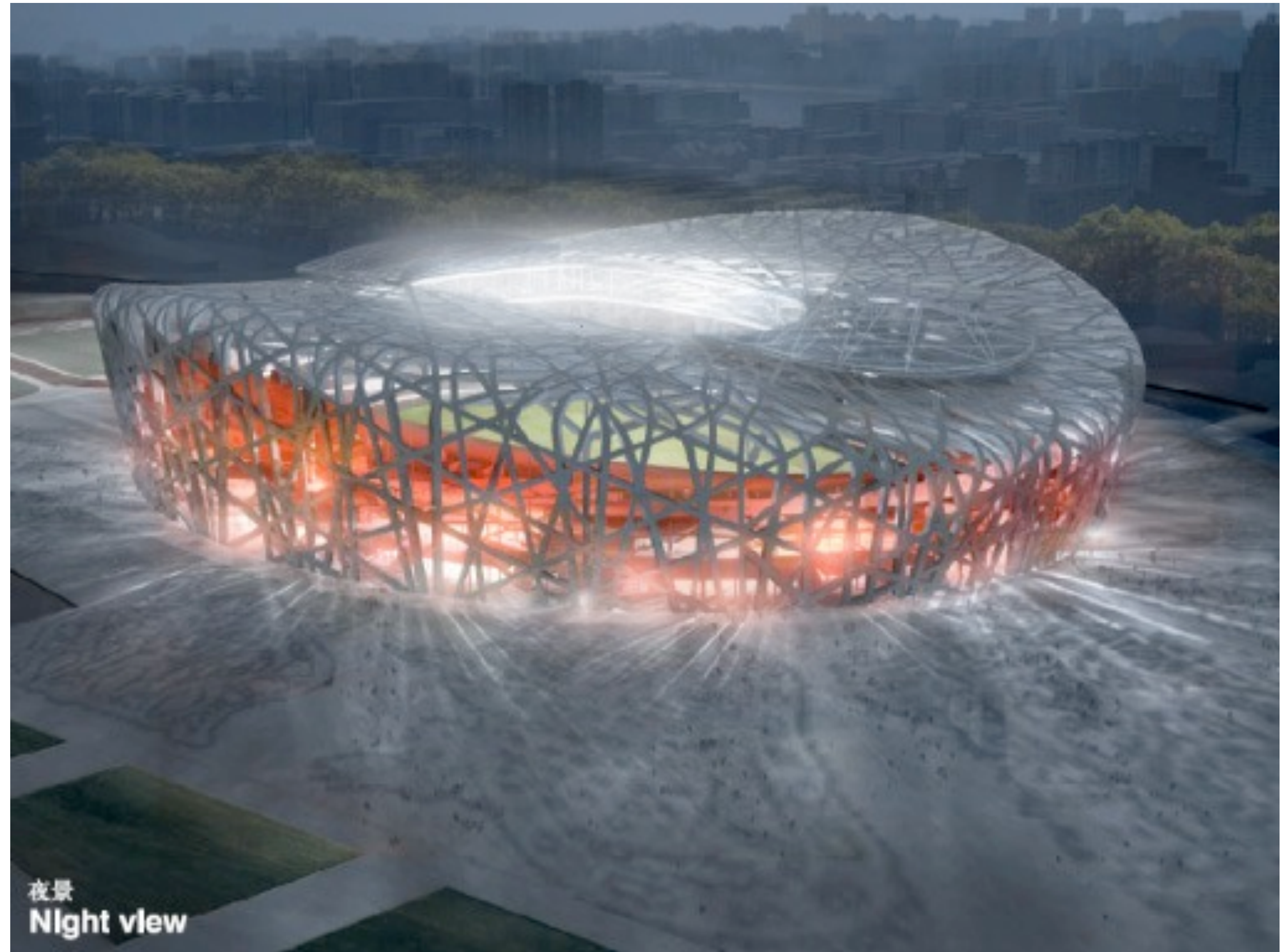
# manier & manie

bruno schindler

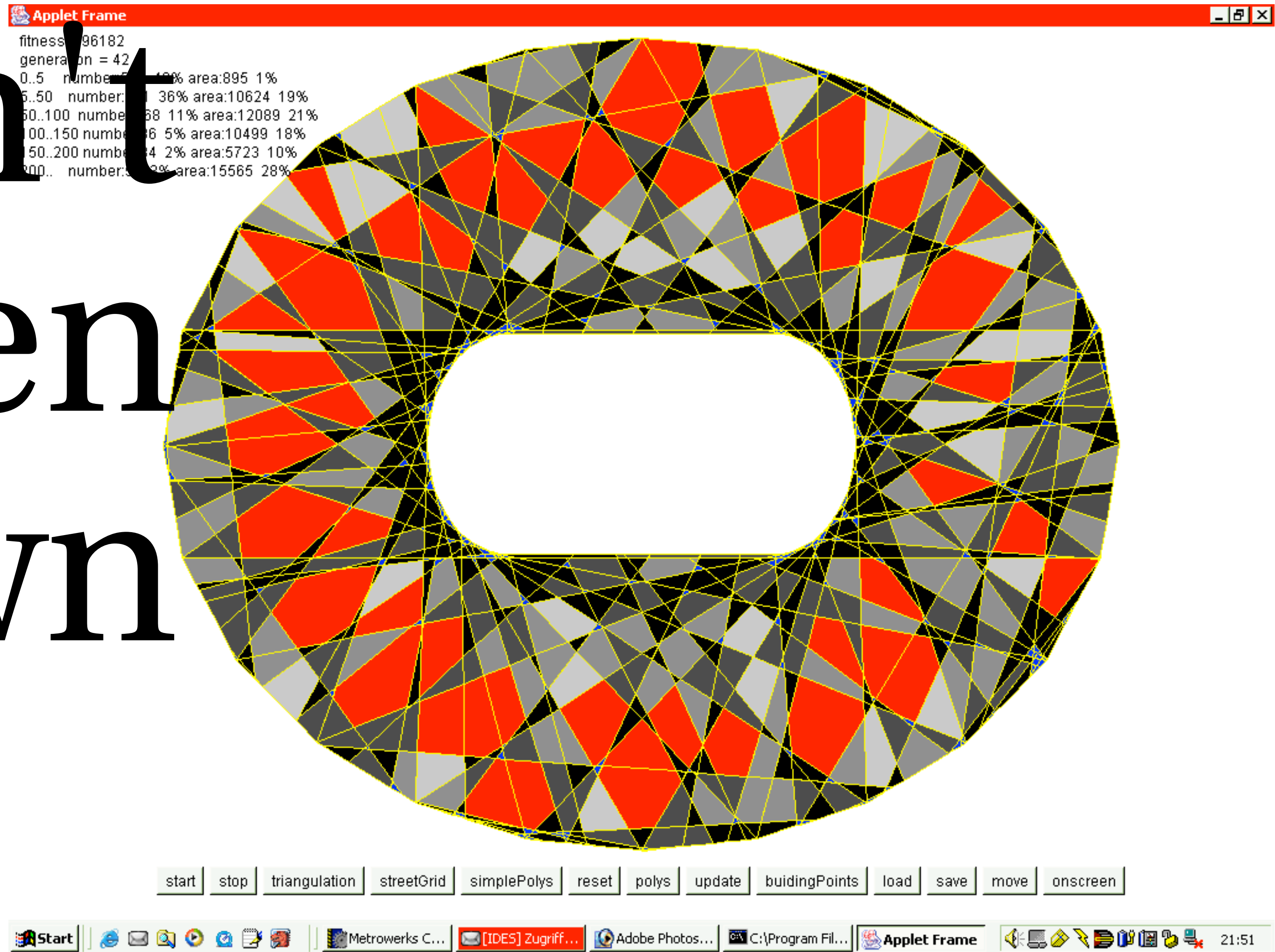
*Gustav René Hocke : Die  
Welt als Labyrinth, Manier  
und Manie in der  
europäischen Kunst, 1957*



what can't  
been  
drawn

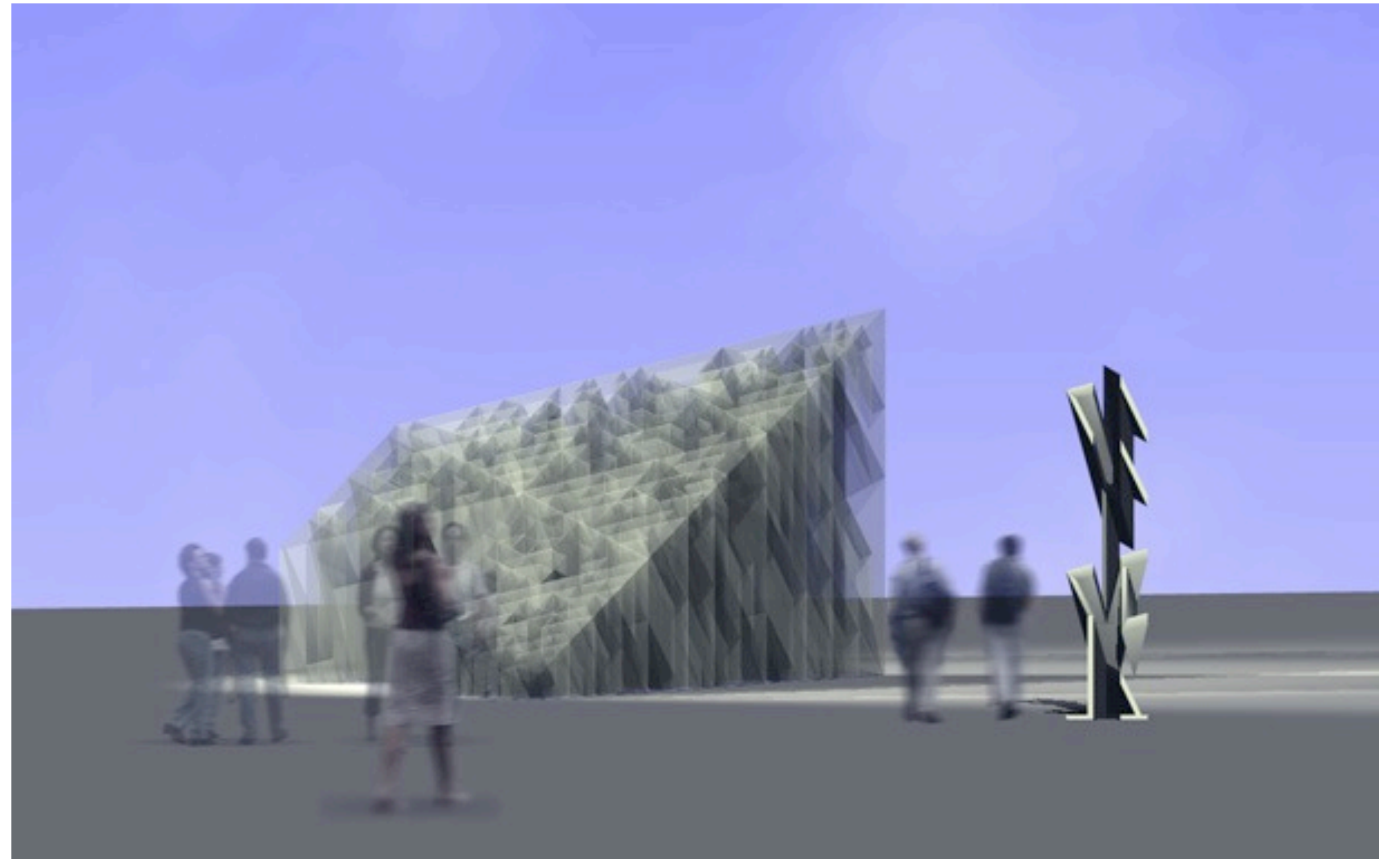


# what can't been drawn

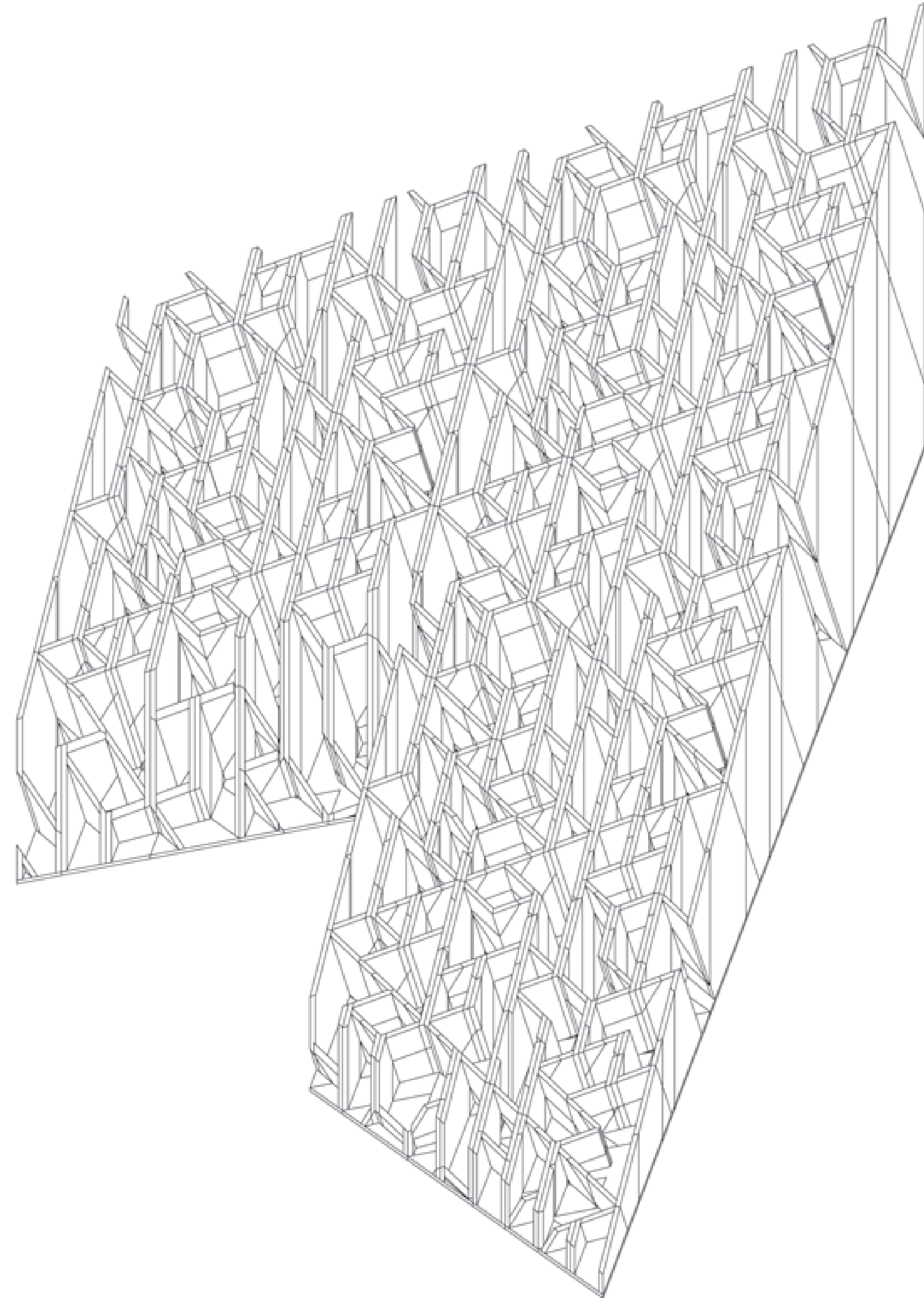




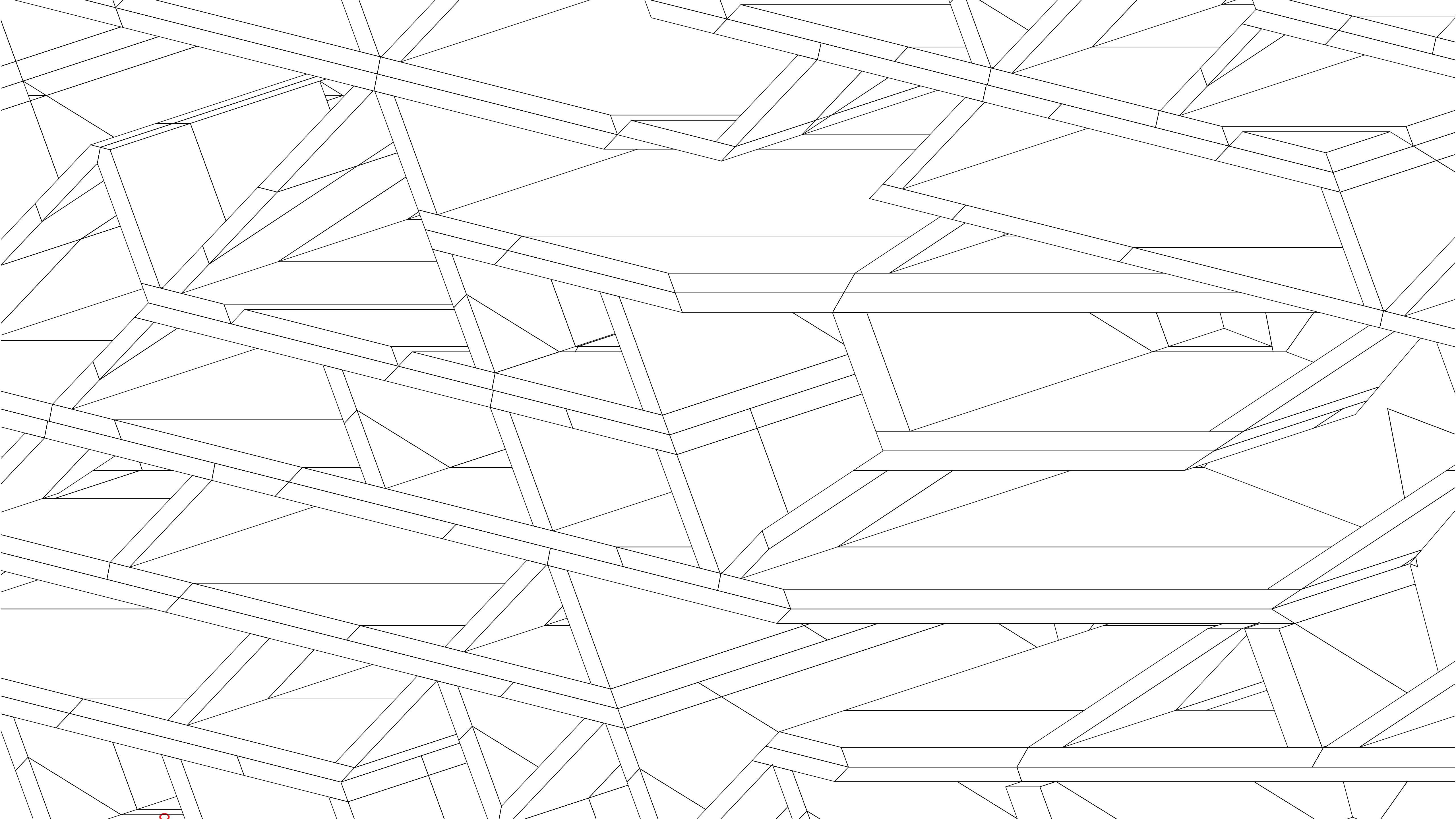
# what can't been drawn



d. libeskind, st. gallen, 2005





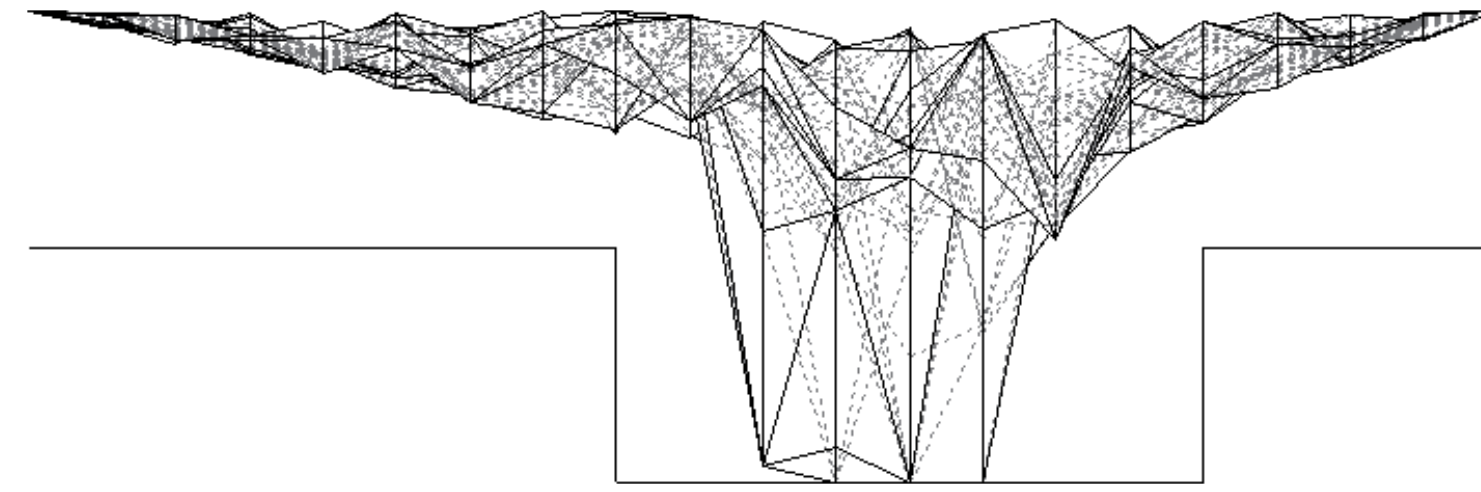








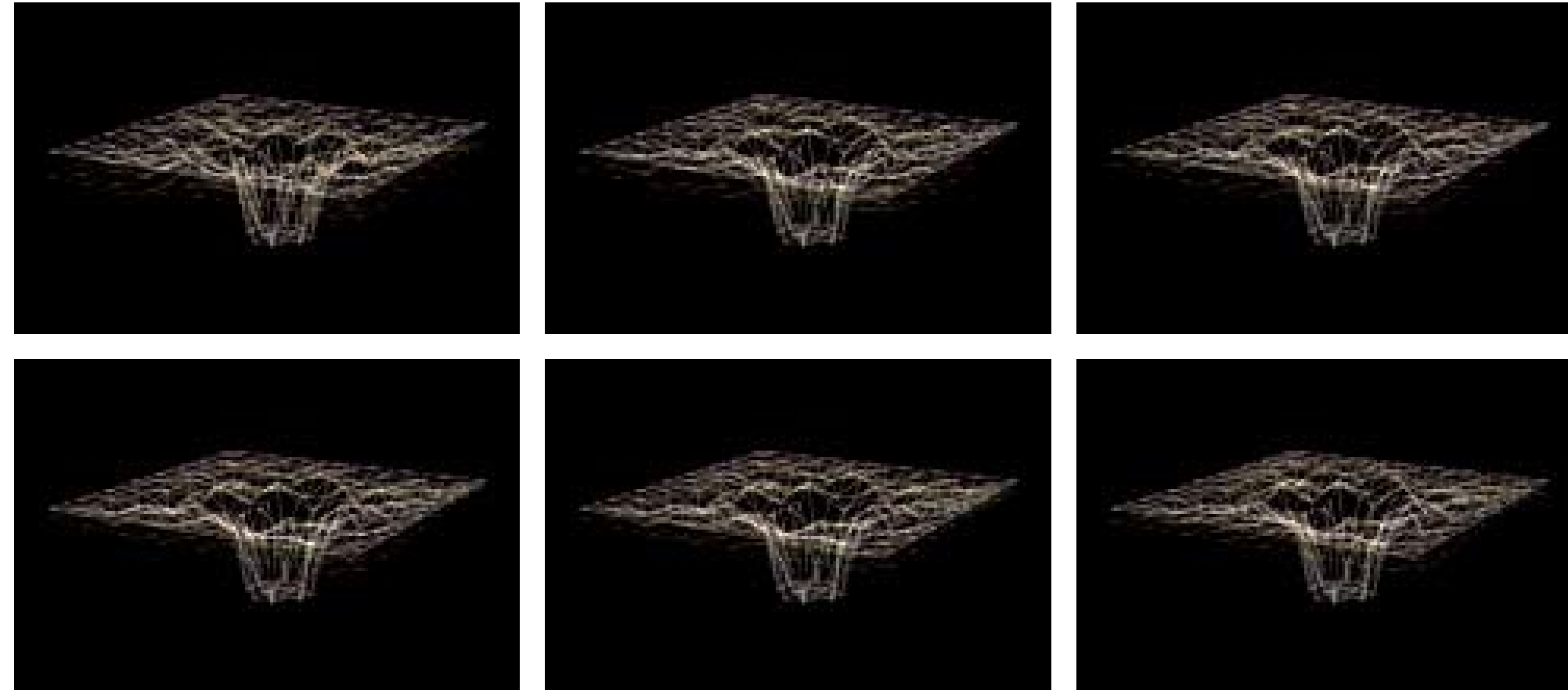
#72



Diese baumartige Tragstruktur des Architekten Dominique Perrault für eine Metrostation in Neapel ist mit manuellen Methoden nicht zu stabilisieren.

This tree-like supporting structure by the architect Dominique Perrault for a metrostation in Naples could not be stabilized using manual methods.

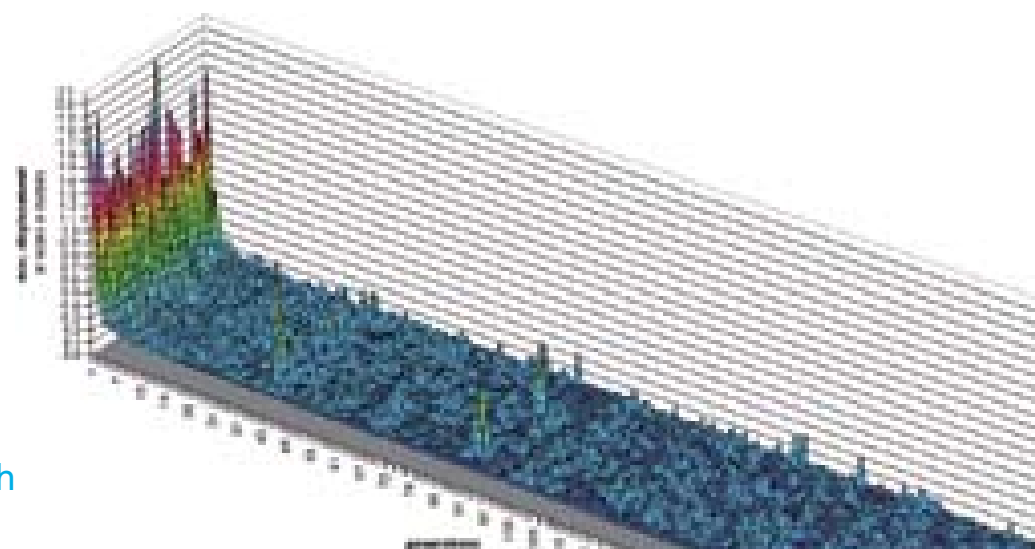
#73

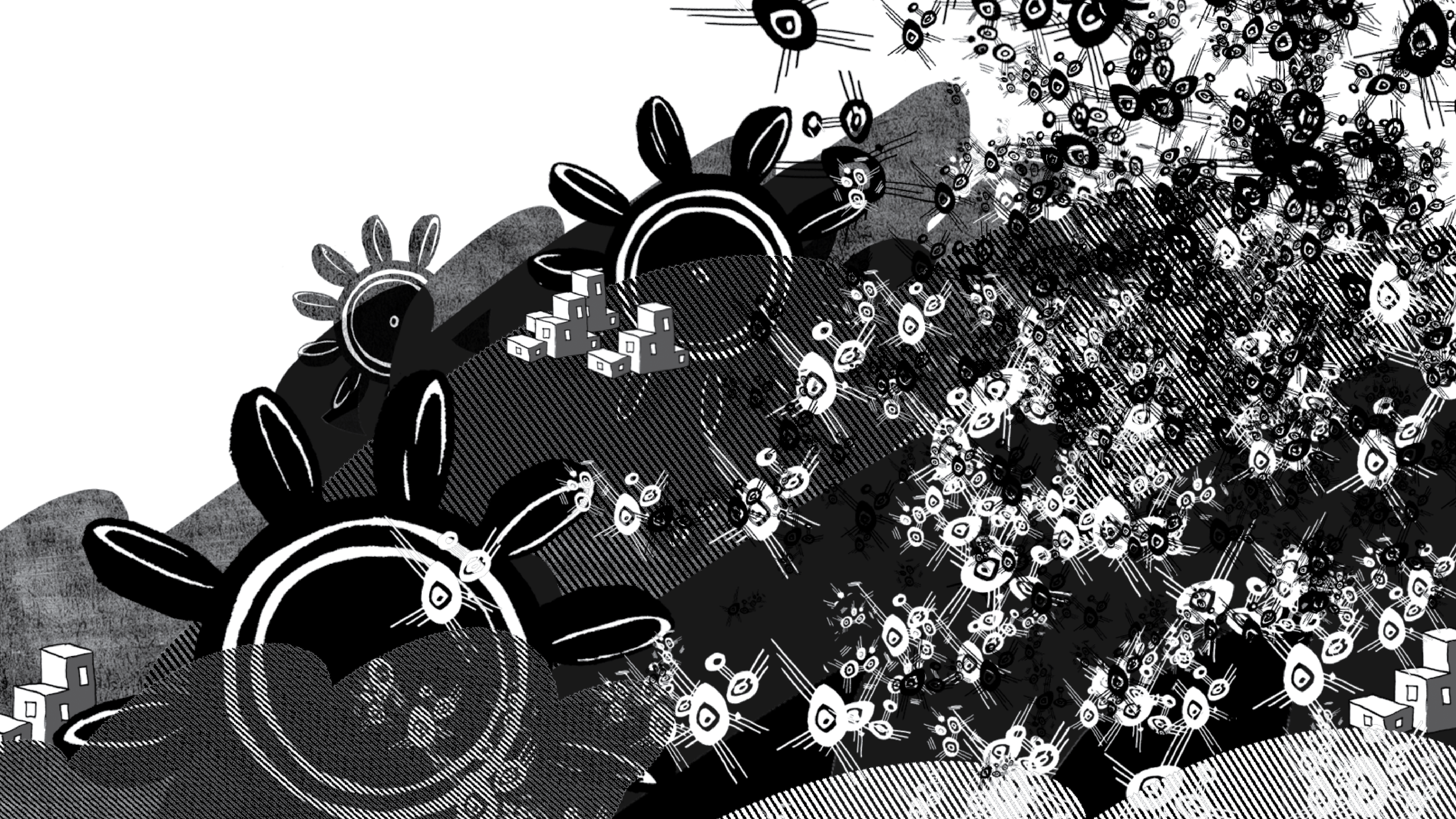


Die Sequenz zeigt die Verbesserung der Stabilität einer baumartigen Tragstruktur durch einen evolutionären Algorithmus. Beim ursprünglichen Design (oben links) bewegten sich die Elemente des Knoten-Stab-Tragwerkes (weiß dargestellt) am Rand unter Last (gelb dargestellt) unzulässig stark. Das Ergebnis (unten rechts) zeigt, dass nur durch das minimale Verschieben der Knoten, d.h. bei fast gleichem Design (weiß), die Bewegung unter Last bei einer Spannweite von 50 Metern unter das erforderliche Maß reduziert werden konnte.

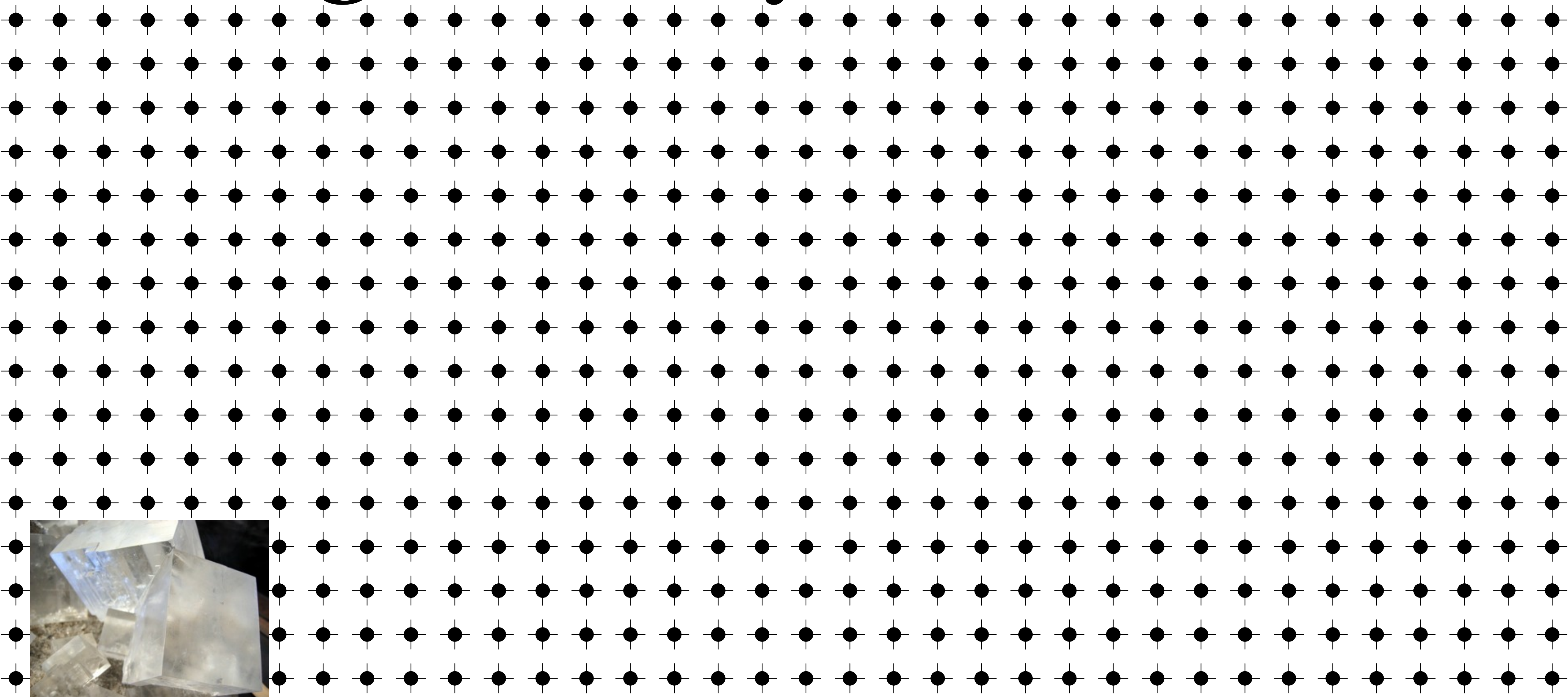
The sequence shows the improving stability of a tree-like supporting structure using a genetic algorithm. In the original design (top left), elements at the edge of the node-column supporting structure (shown in white) deflected unacceptably under load (shown in yellow). The result (below right) shows that with only a minimum displacement of the nodes (in other words, by hardly changing the design) deflection over a span of 50 meters was lowered to acceptable limits.

#74





# ONE-geometry



# ONE-geometry





Jan. 29, 1946.

R. B. FULLER

2,393,676

CARTOGRAPHY

Filed Feb. 25, 1944

5 Sheets-Sheet 2

Jan. 29, 1946.

R. B. FULLER

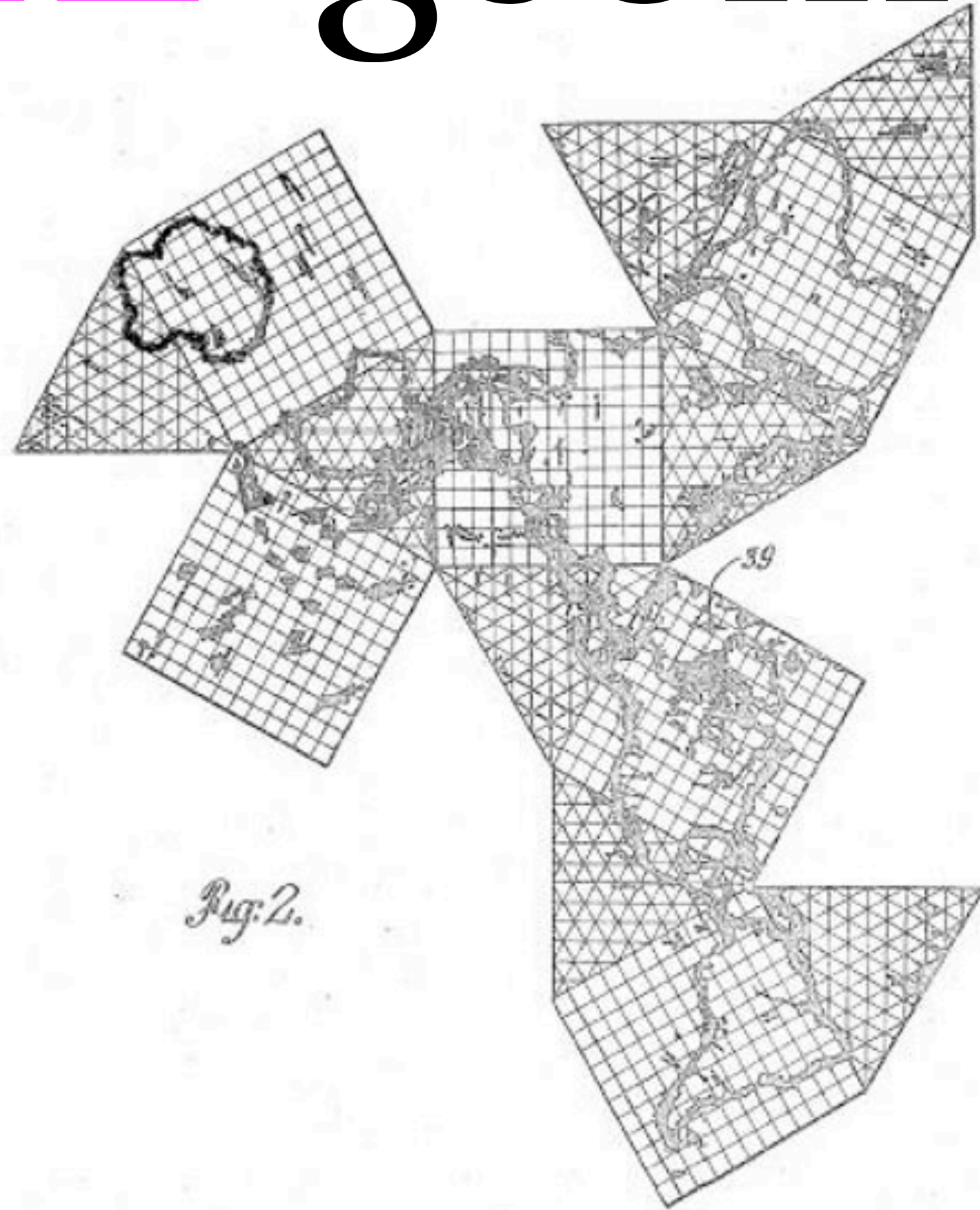
2,393,676

CARTOGRAPHY

Filed Feb. 25, 1944

5 Sheets-Sheet 1

# ONE-geometry today

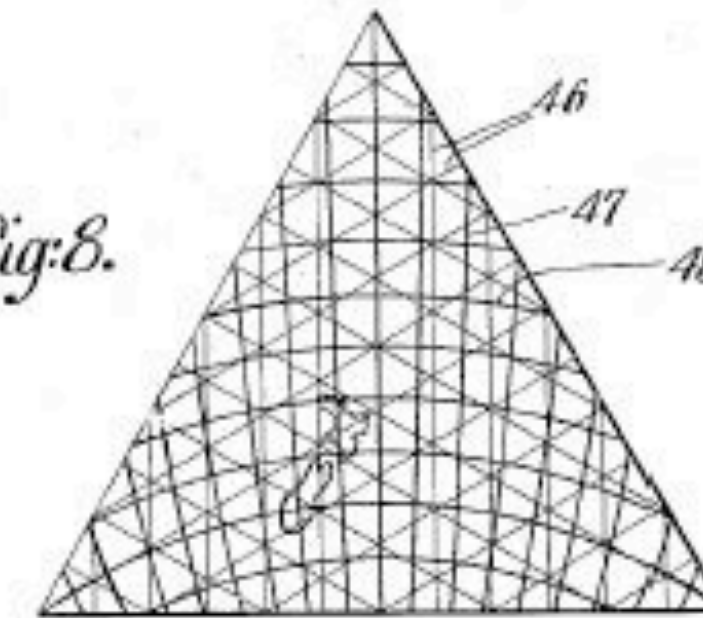


INVENTOR  
 RICHARD BUCKMINSTER FULLER  
 BY  
*Donald W. Robertson*  
 ATTORNEY

Fig. 1.



Fig. 8.



INVENTOR  
 RICHARD BUCKMINSTER FULLER  
 BY  
*Donald W. Robertson*

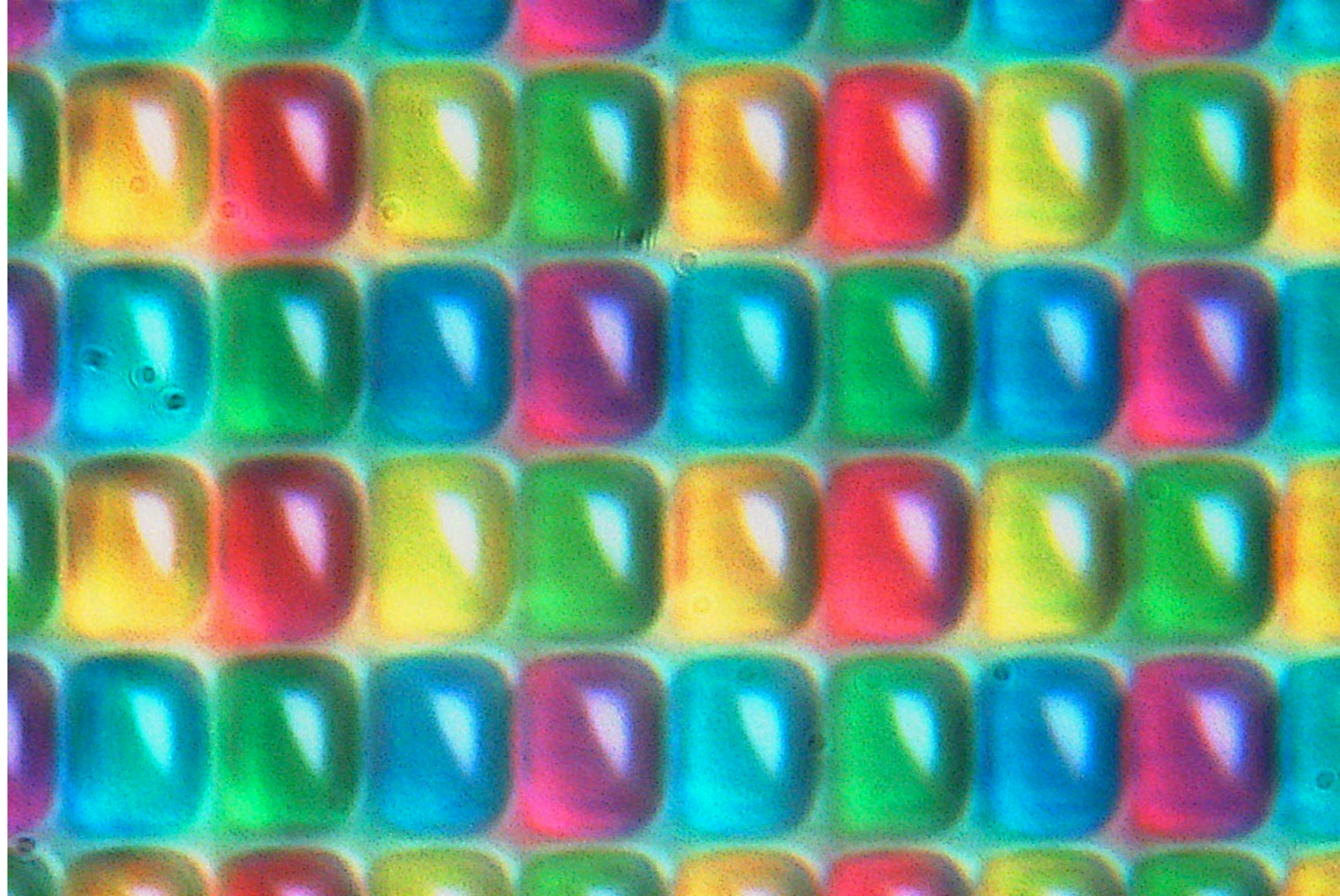
# ONE-geometry today



# ONE-geometry today

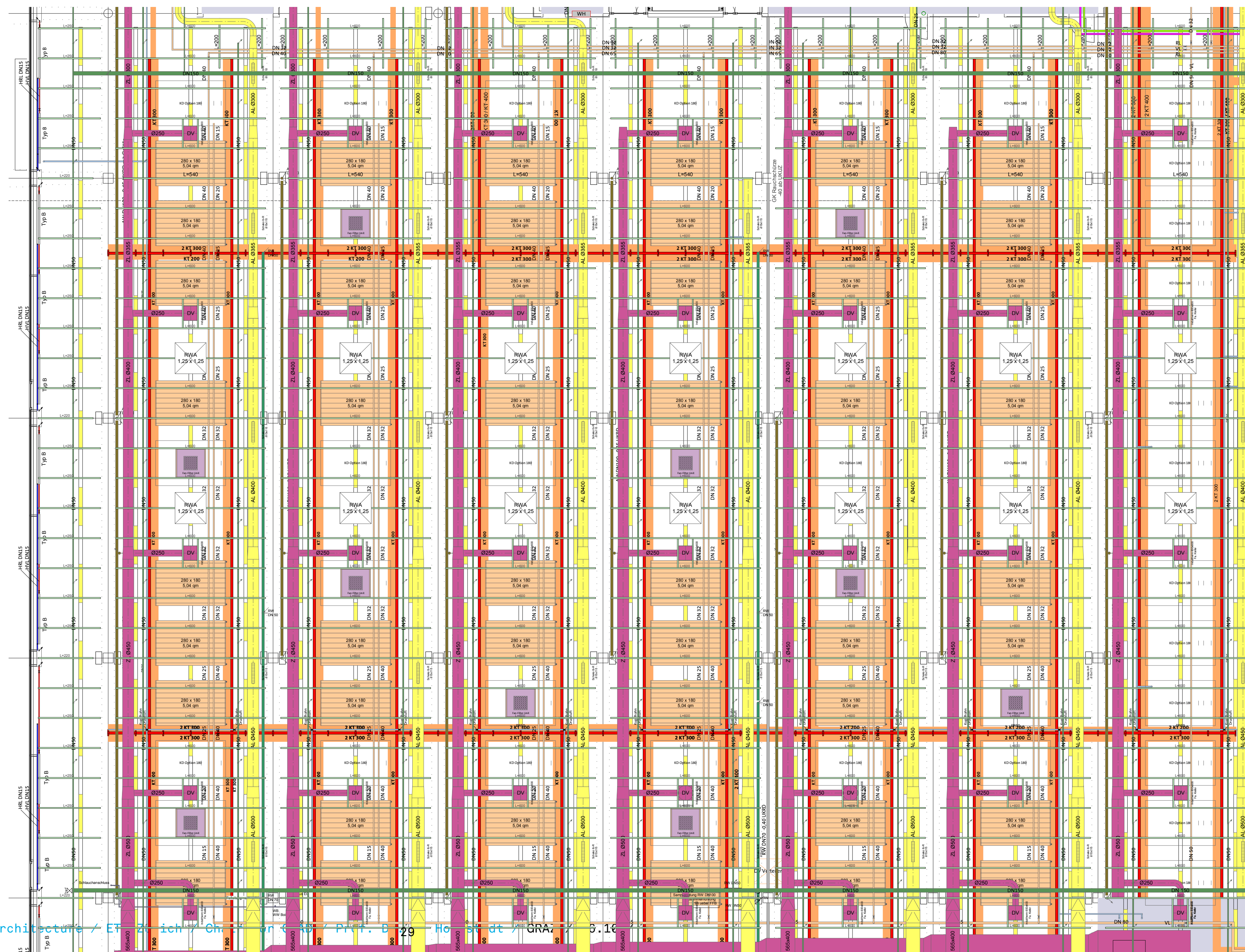


# ONE-geometry today



# spin off

## digitales bauen



# ONE-geometry today



1999



2002

*increase productivity by 60%*

**BUT :**

**50°**

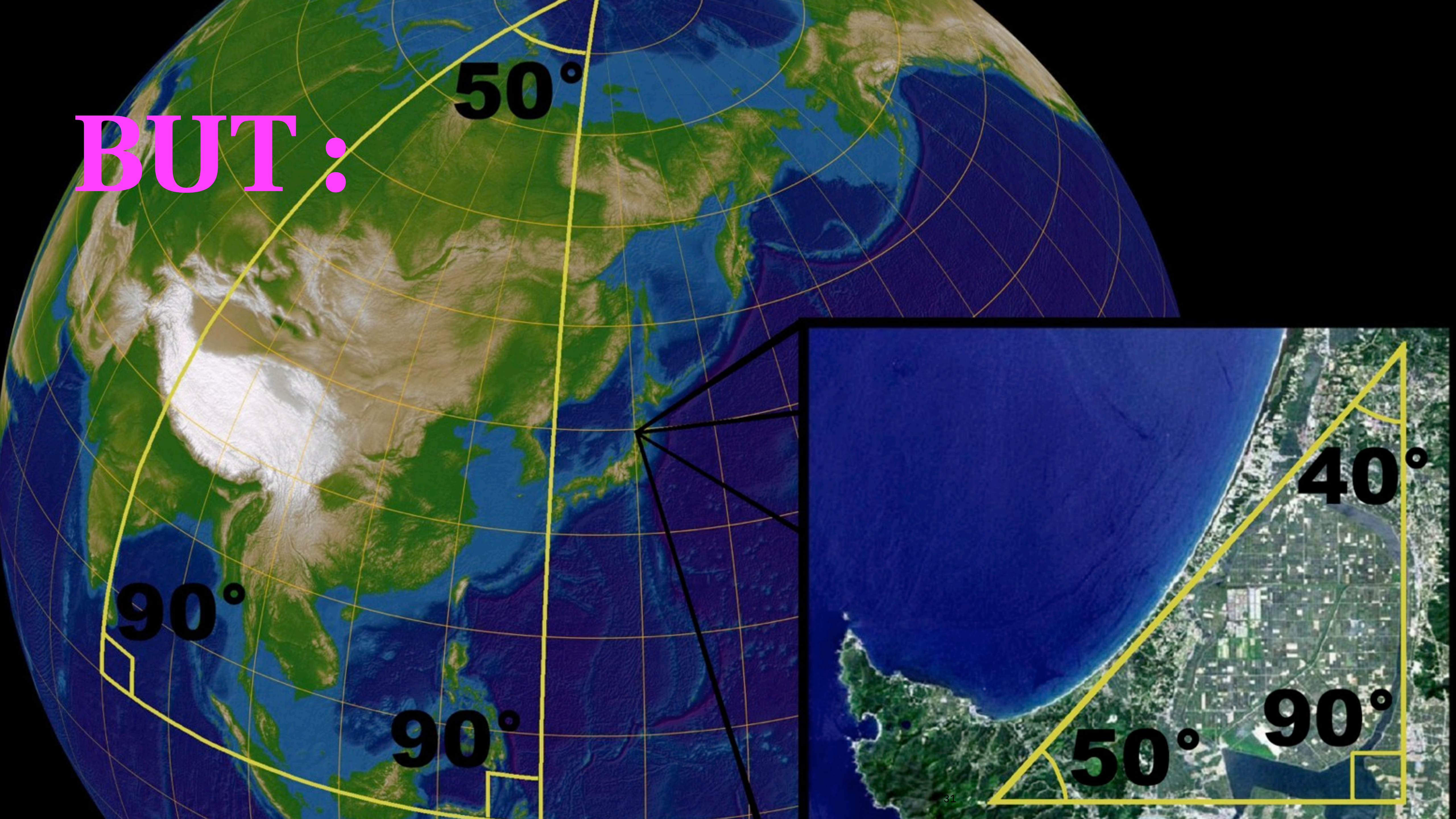
**90°**

**90°**

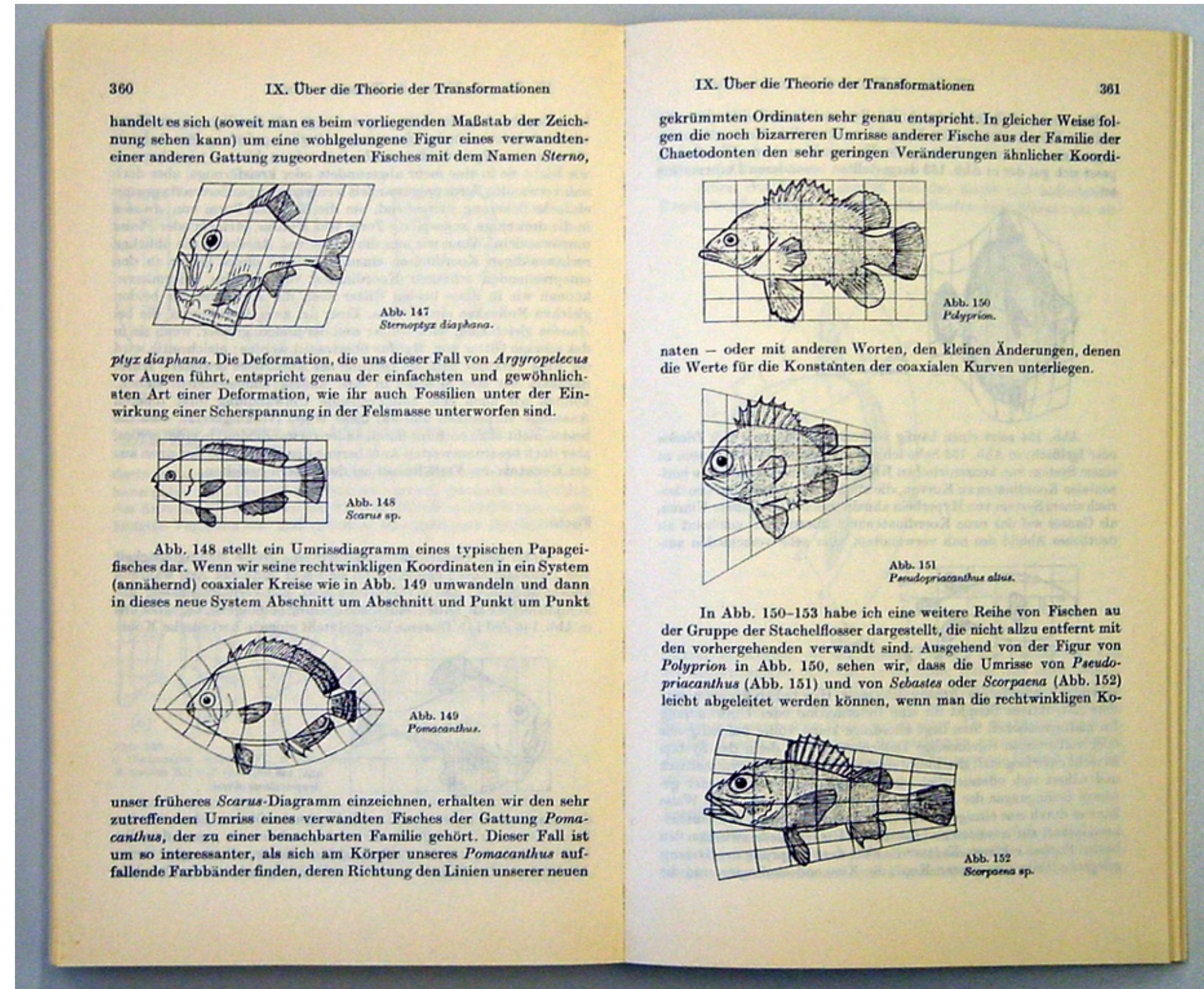
**40°**

**50°**

**90°**



# EVERY-geometry



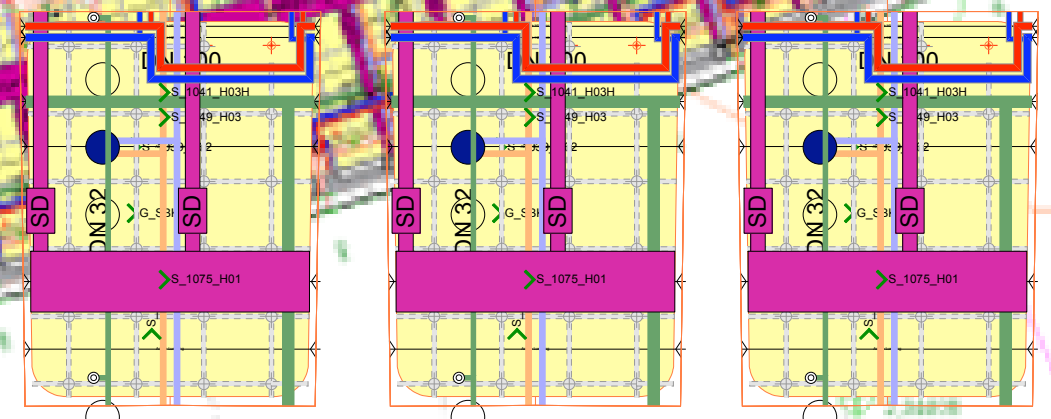
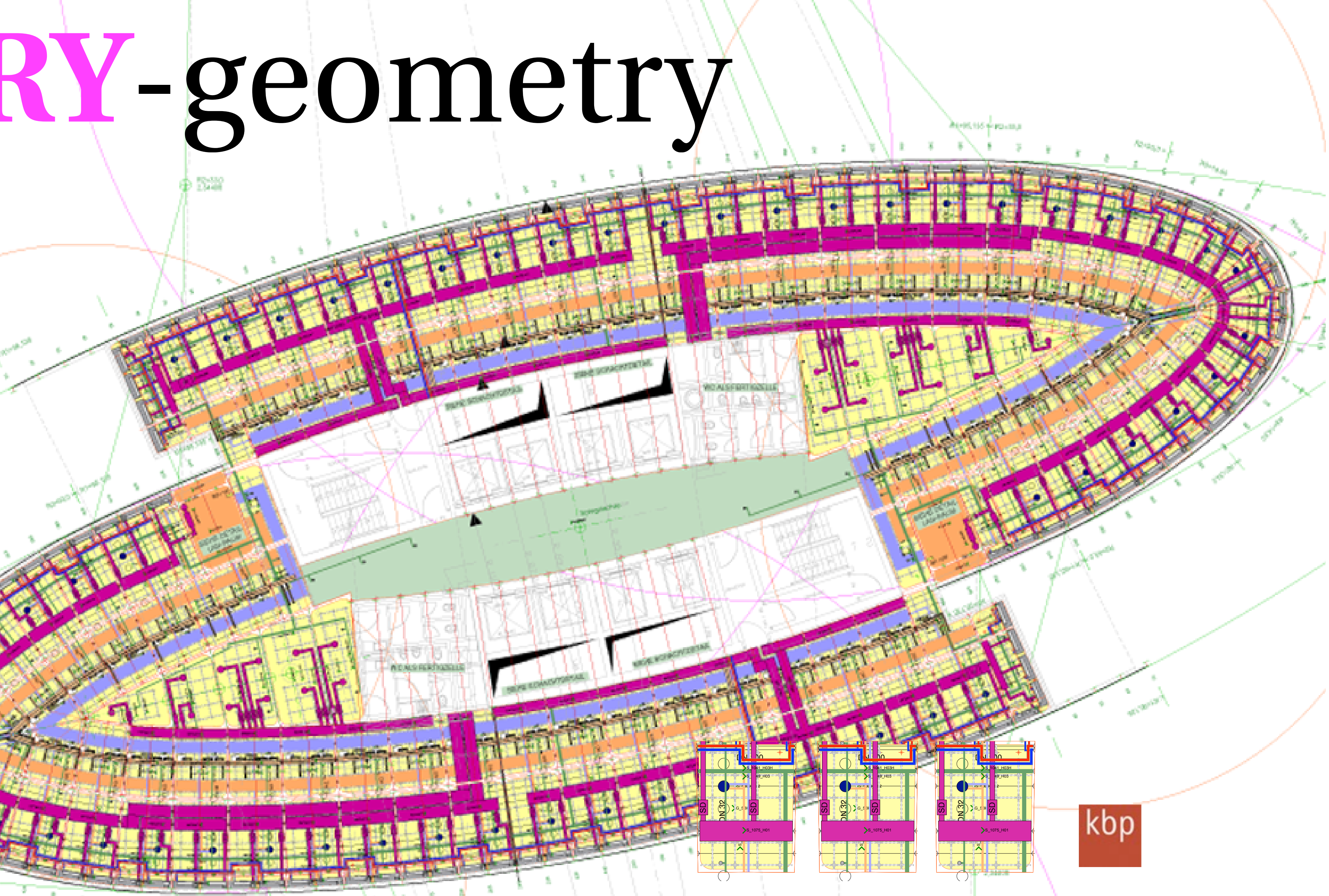
d'archy wentworth thompson  
über wachstum und form, 1917



# EVERY-geometry



# EVERY-geometry



© *digitales bauen*

# EVERY-geometry



# spin-off



HOME

SERVICES

COMPANY

History

Team

Awards

Publications

Media

Lectures & Conferences

News

PROJECTS

## 08.07.07 - NZZ am Sonntag

NZZ am Sonntag - 8. Juli 2007

Immobilien

35

### Unikate aus Serienfertigung

Architekten lieben komplexe Formen. Das erfordert neue Ansätze in der Herstellung von Bauteilen, die ohne digitale Unterstützung kaum möglich wären. Von David Strohm

Moderne Architektur will, sie muss erfüllen und ist dies nicht durch eine ganz spezielle Formensprache. In von ihnen. Diese entstehen. Zwischen zwei Kisten, die senkrecht zueinander stehen, am Rand von Beton, sind es die wellenförmig geschwungenen Flächen. Im «Werkstattbau» in Kloten, im Auftrag der Bauabteilung des Bundes & Drogenberg überließ von Platz anzuweisen, die doppelt gebogenen Stahl-Bauteile aus Glas und Stahl.

Im Auftrag des Architekten Büro Mawar, einem Projekt des Schweizer UN-Studios, haben die Gebäudeverwalter aus drei schalenartigen geschwungenen Schichten und eine auf Edige Aluminium-Glas-Fassade. Die Bauteile sind bereits in den Prozess. Die sind Libanon sind vor zwei Jahren an der Hochschule St. Gallen mit einem Wettbewerb aus mehr als zwei Einzelteilen einer spektakulären Holzkonstruktion. Und Schweizerin Julia Studli realisierte im letzten Jahr im Bereich der Regeneration der Hungerberg-Bühnen, mit



NZZ am Sonntag, weekend title of Zurich's international newspaper, describes the attitude and work of designtoproduction on their real estate pages.

- article as pdf (download 644 KB)
- article at [www.nzz.ch](http://www.nzz.ch)

### LATEST NEWS

- 10.10.07 - «Metalworks» Book published
- 06.09.07 - Back to Norway: Teaching in Trondheim
- 08.07.07 - NZZ am Sonntag
- 15.06.07 - ZipShape wins Holz21-Prize
- 15.02.07 - FutureWood

### UPCOMING EVENTS

- 27.09.07 – holz21 Exhibition Kornhaus Bern
- 01.10.07 - Columbia NY
- 04.10.07 - ACADIA 2007
- 07/08.11.07 - SAH Fortbildungskurs

**EVERY**

geometry



# EVERY geometry



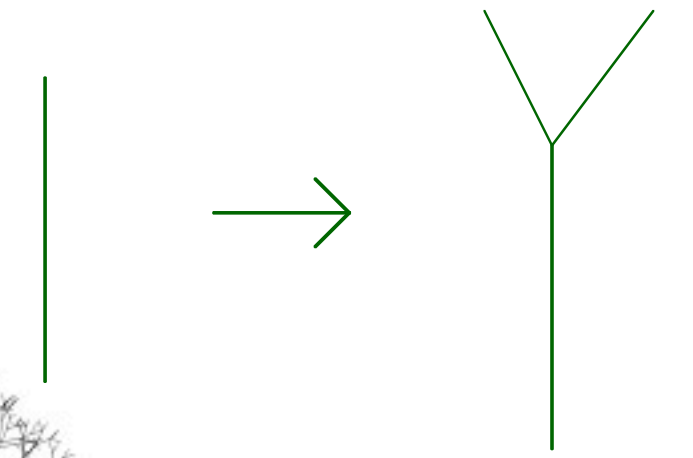
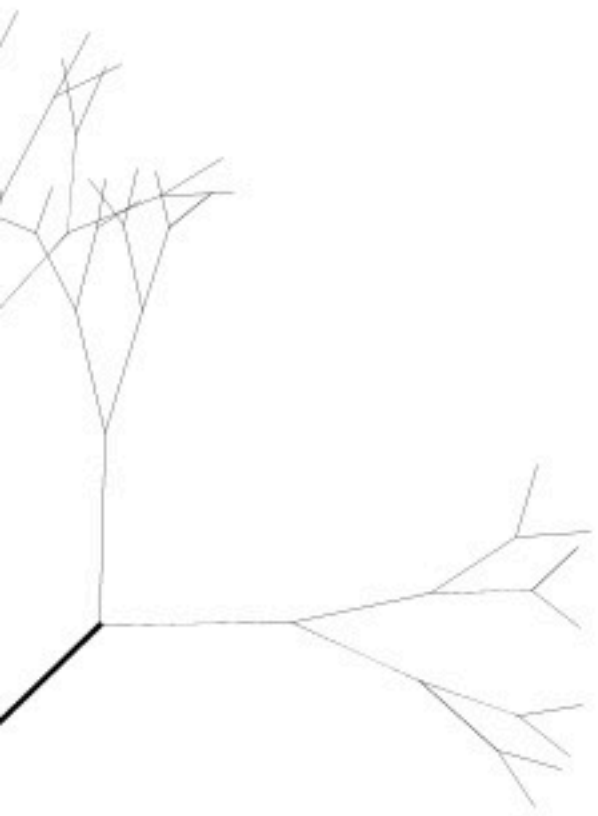
d. libeskind, st. gallen, 2005



Blätter des Manns Waldfern.  
*(Polystichum Filix mas, Roth.)*

*quantitative*  
**FLORAL** growth

# EVERY geometry



```
void setup () {  
  //kontext  
  size (800, 800);  
  background(240);  
  smooth ();  
  
  int d = 4;  
  color c = color (0, 0, 0);  
  scale(2);  
  translate (200, 350);  
  rotate (-PI/2);  
  hLine (100, 8, d, c);  
  translate (0, 50);  
  hLine (80, 7, d, c);  
  translate (0, -100);  
  hLine (60, 6, d, c);  
  redraw();  
}  
  
void hLine (float l, int i, int d, color c) {  
  pushMatrix();  
  strokeWeight(d);  
  l=l;  
  run (l);  
  translate (l, 0);  
  pushMatrix();  
  float verzweig = 1.3 + random(.4);  
  rotate (random(PI/4));  
  if (i > 0) hLine (l/verzweig, i-1, d/2, c);  
  popMatrix();  
  rotate (-random(PI/4));  
  if (i > 0) hLine (l/verzweig, i-1, d/2, c);  
  popMatrix();  
}  
  
void run (float x) {  
  line (0, 0, x, 0);  
}
```



# EVERY geometry



EVERY

geometry



# EVERY geometry



**Der wachsenden gesellschaftlichen Komplexität entspricht eine reiche Palette von parametrischen Entwurfstechniken ...**

In der jüngeren Avantgarde-Architektur hat sich mit dem „Parametrismus“ eine global wirksame Tendenz herausgebildet, die in Anlehnung an Philip Johnsons Branding der architektonischen Moderne als der neue „International Style“ der zeitgenössischen Architektur begriffen werden könnte.

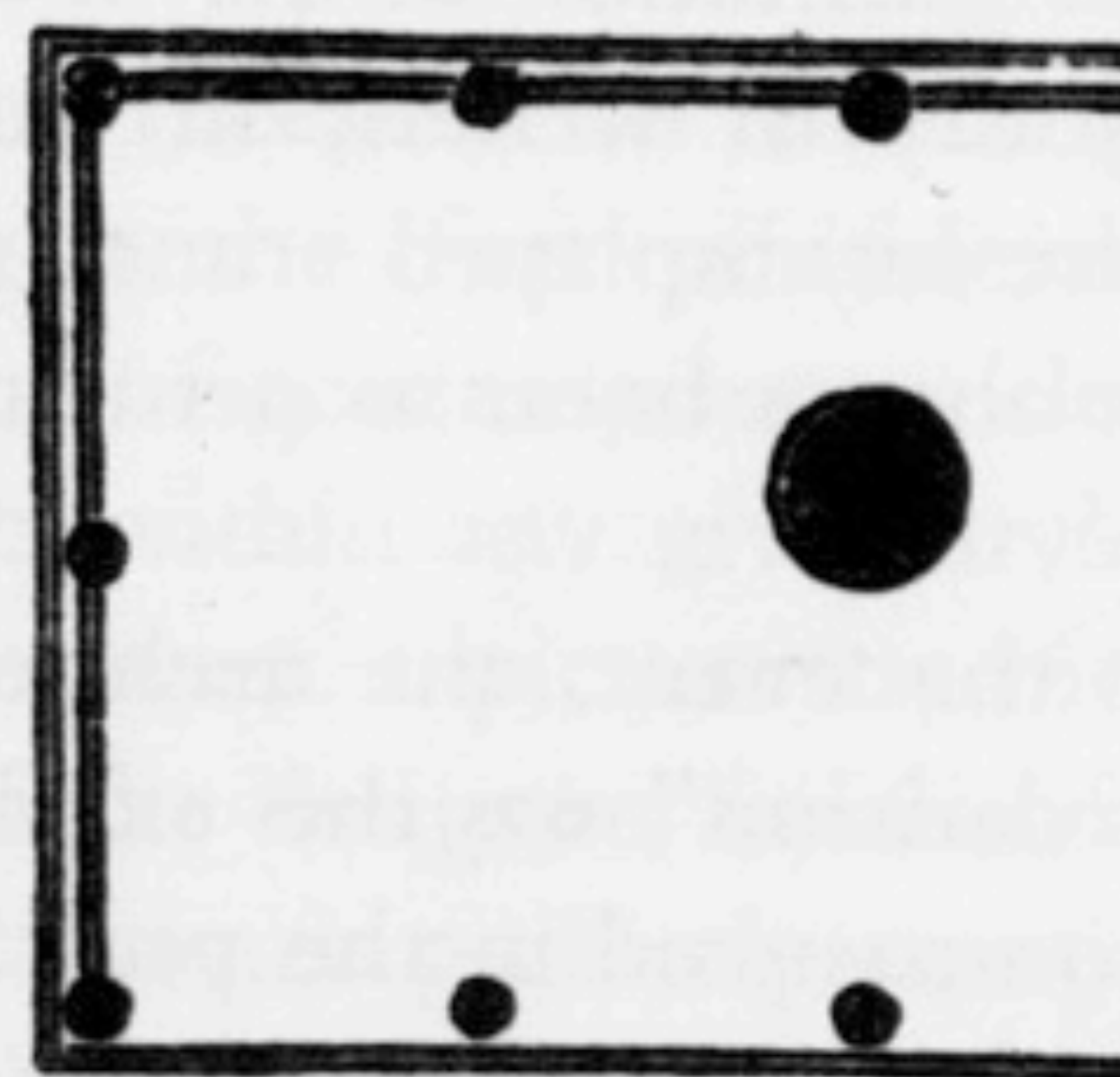
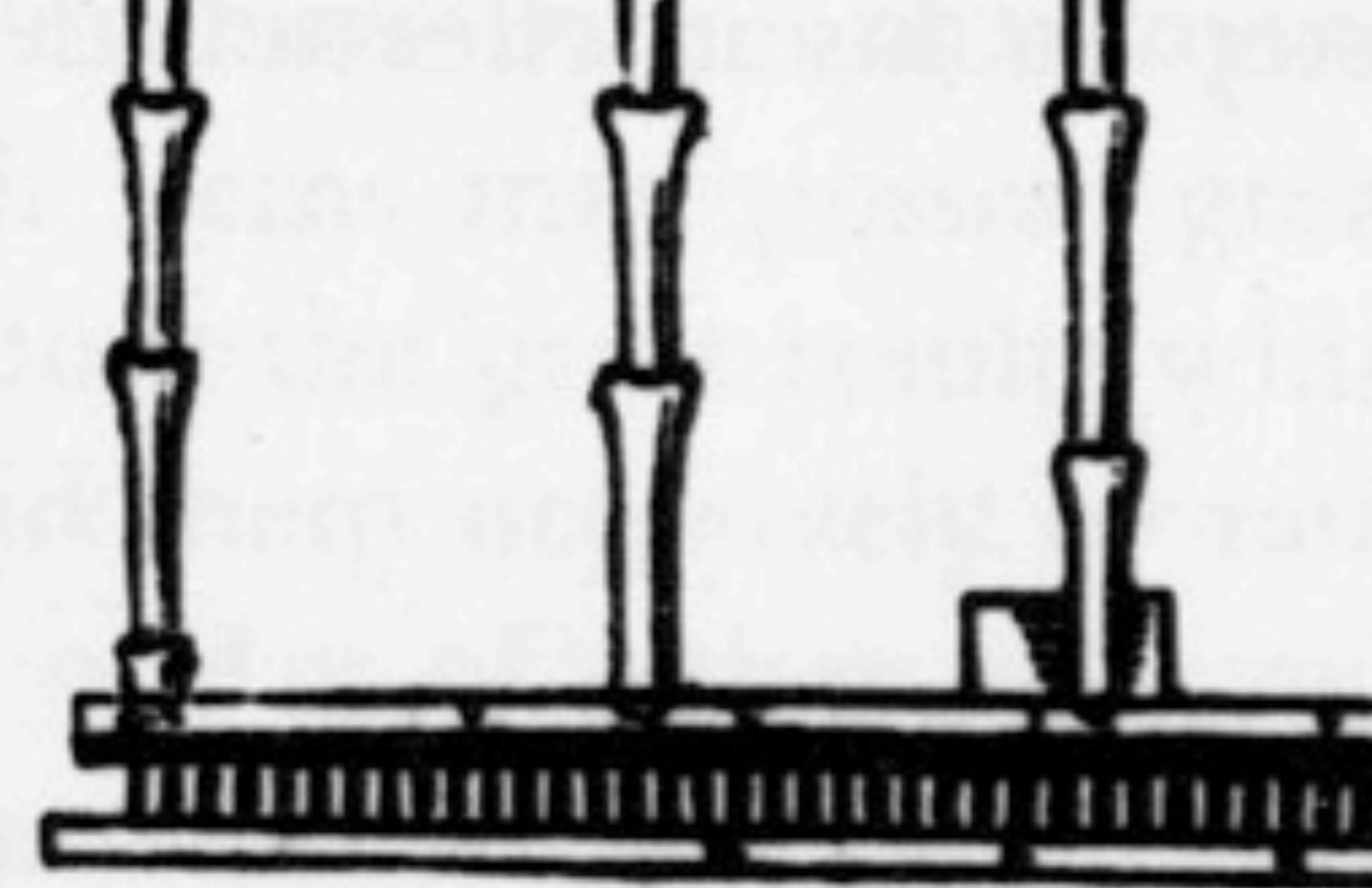
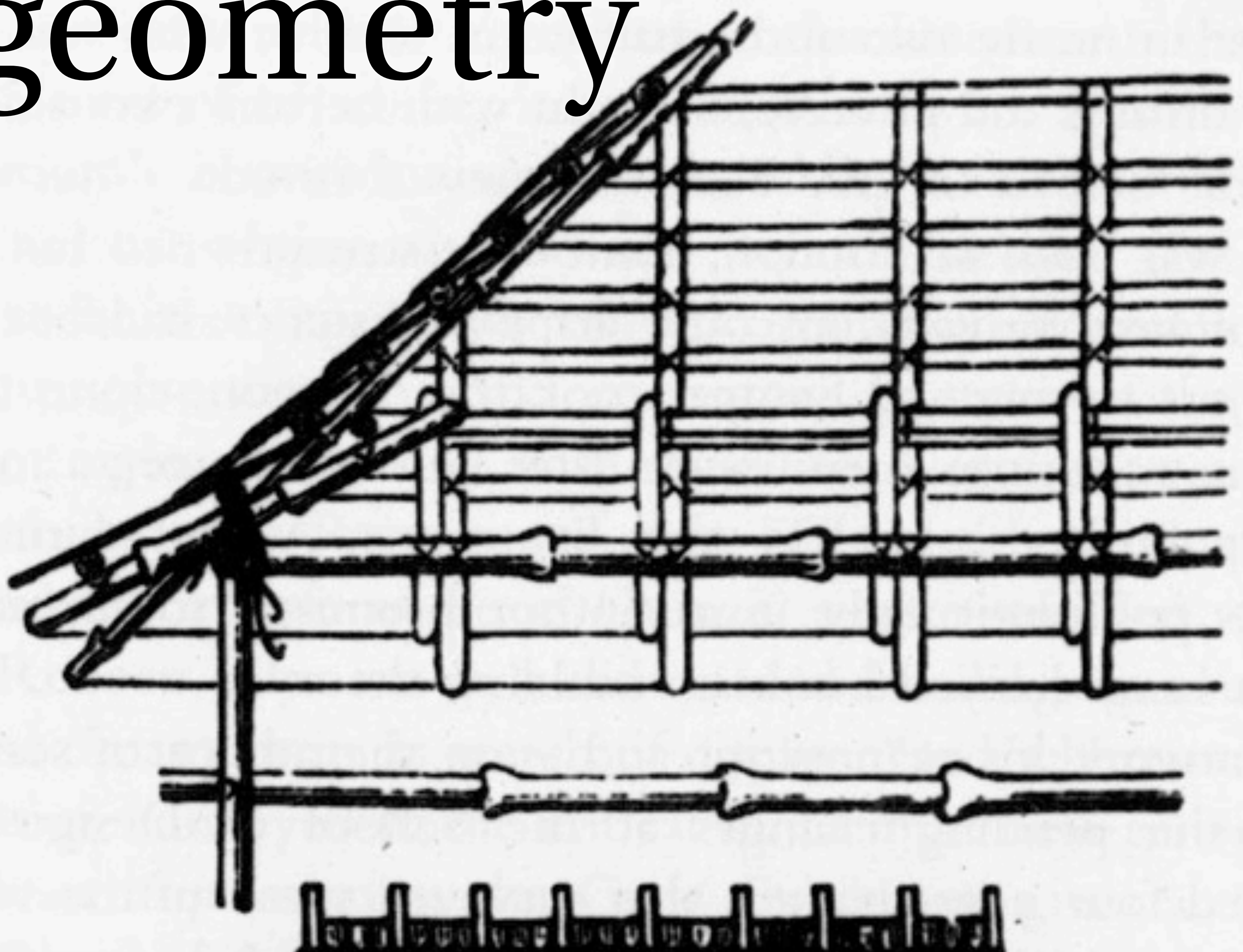
**Seine Protagonisten sehen mit der neuen Hochphase systematischer Innovationen eine wirkliche Nach-Moderne heraufziehen.** Der Stil wurzelt in digitalen Animationstechniken; seine neuesten Verfeinerungen basieren auf hochentwickelten parametrischen Entwurfssystemen und Scripting-Techniken. Nach einer fünfzehnjährigen Inkubationszeit wird nun der **Hegemonialanspruch** des Parametrismus sichtbar. **Der neue Stil beansprucht Anwendbarkeit auf allen Entwurfsebenen, von der Innenarchitektur bis hin zur groß angelegten Stadtplanung ...**

Die Ästhetik des Parametrismus ist gekennzeichnet durch die Eleganz geordneter Komplexität und den Eindruck nahtloser Fluidität – **Eigenschaften, die auch in natürlichen Systemen vorkommen.** [Patrik Schumacher (AA London, Zaha Hadid Architects) *Parametricism - A New Global Style for Architecture and Urban Design*, 2009]



EVERY

geometry





300

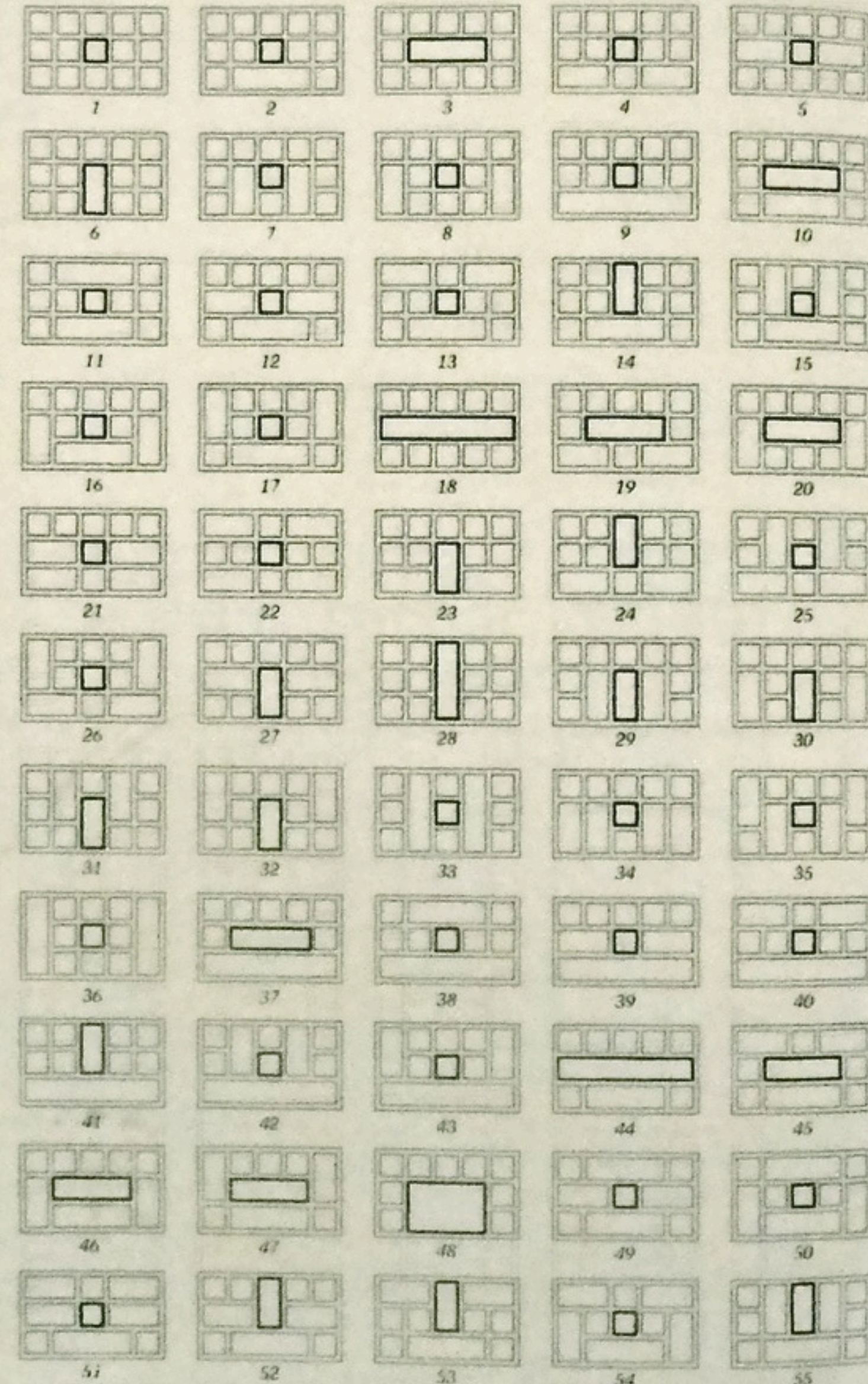




# palladio & mitchell



8.51  
All the 5 by 3 schematic plan layouts  
with rectangular central rooms in the  
Palladian language



William J. Mitchell, «schematic plan layouts with rectangular central rooms in the Palladian language», in: William J. Mitchell, *The Logic of Architecture. Design, Computation, and Cognition*, Cambridge/Mass. 1990, S. 175

*another simple story about*

EVERY

geometry



```
p1: facade(orientation)
  ↔ orientation == front
  ↳ [(z,9,2,6,1,6,1r,1,9,2) floor(0) | ledge | ||(3)
    floor(1) | ledge | ||(3) floor(1) | ledge | ||(3)
    floor(2) | ledge ]

p2: floor(ft)
  ↔ ft == 2
  ↳ [(x,0.7,1r,2.5,3.6,2.5,1r,0.7) wall | ||(3) tile(3) |
    tile(1) | tile(2) | tile(1) | ||(3) tile(3) | wall ]

p3: floor(ft)
  ↔ ft == 1
  ↳ [(x,0.7,1r,2.5,3.6,2.5,1r,0.7) wall | ||(3) tile(3) |
    tile(1) | tile(1) | tile(1) | ||(3) tile(3) | wall ]

p4: floor(ft)
  ↔ ft == 0
  ↳ [(x,0.7,1r,2.5,3.6,2.5,1r,0.7) wall | ||(3) entry |
    entry | entry | entry | ||(3) entry | wall ]

p5: tile(n)
  ↳ [(y,0.8,2,1r) | wall | win(n) | wall ]

p6: win(n)
  ↔ n == 1
  ↳ S(1r,0.4,1r) [(x,0.7,1r,0.7) wall | I("window") | wall ]

p7: win(n)
  ↔ n == 2
  ↳ S(1r,0.4,1r) [(x,0.9,1r,0.9) wall | ||(1.3) I("window")
    | wall ]

p8: win(n)
  ↔ n == 3
  ↳ S(1r,0.4,1r) [(x,0.7,1r,0.7) wall | ||(0.8) I("window")
    | wall ]

p9: entry
  ↳ S(1r,1,1r) T(0,-0.5,0) [(x,0.9,1r,0.9) | wall |
    I("door") | wall ]

p10: ledge
  ↳ S(1r,1,1r) T(0,-1,0) I("ledge")

p11: wall
  ↳ I("quad")
```

Grammar 6.1: Excerpt of the Candler Building Grammar.



# EVERY

# geometry



Pascal Müller et. al. / ETH Zürich

# EVERY geometry



# EVERY geometry

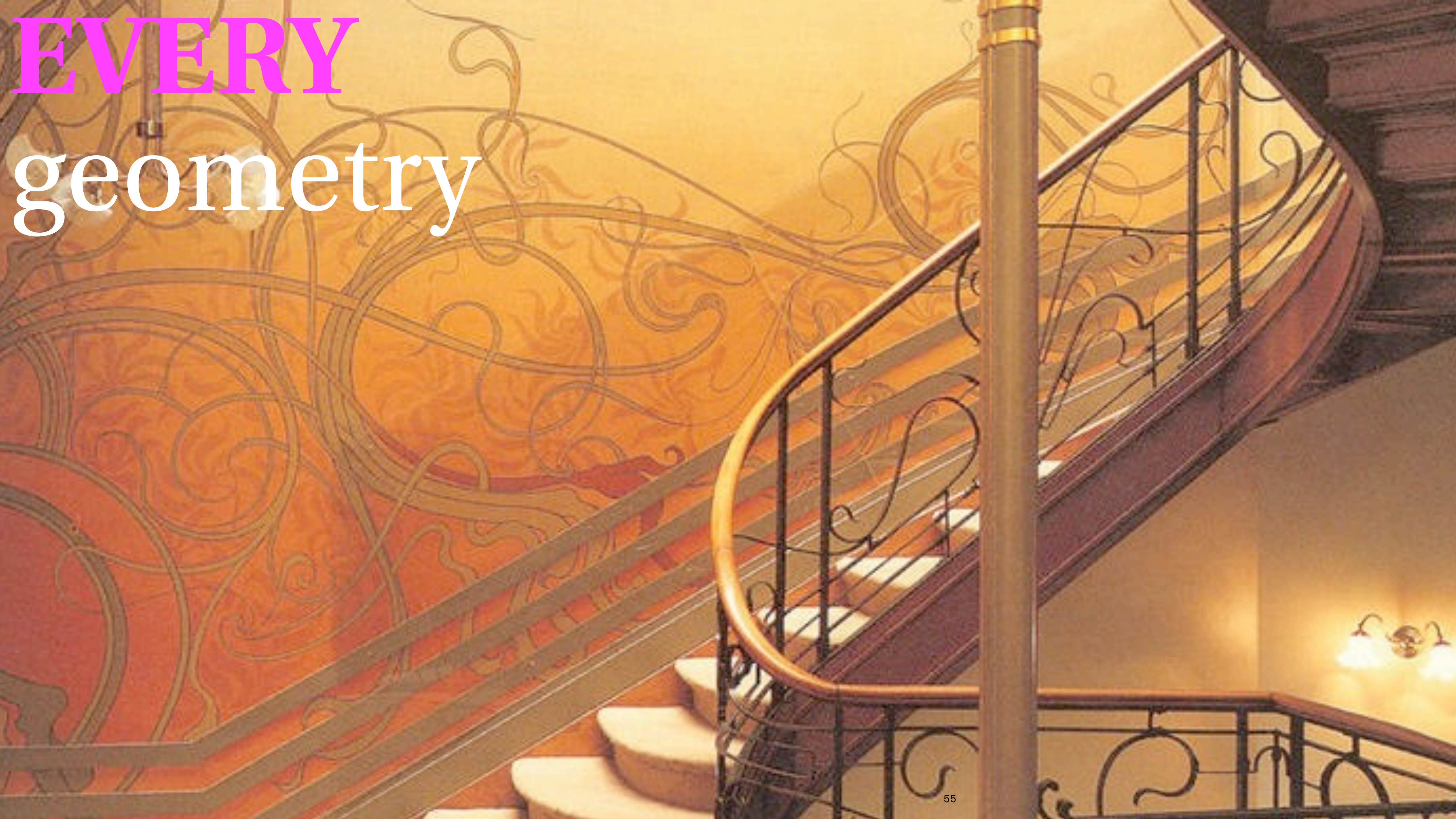
City Engine / String Grammar / Pascal Müller et.al.

# manimal

*daniel lee*



# EVERY geometry

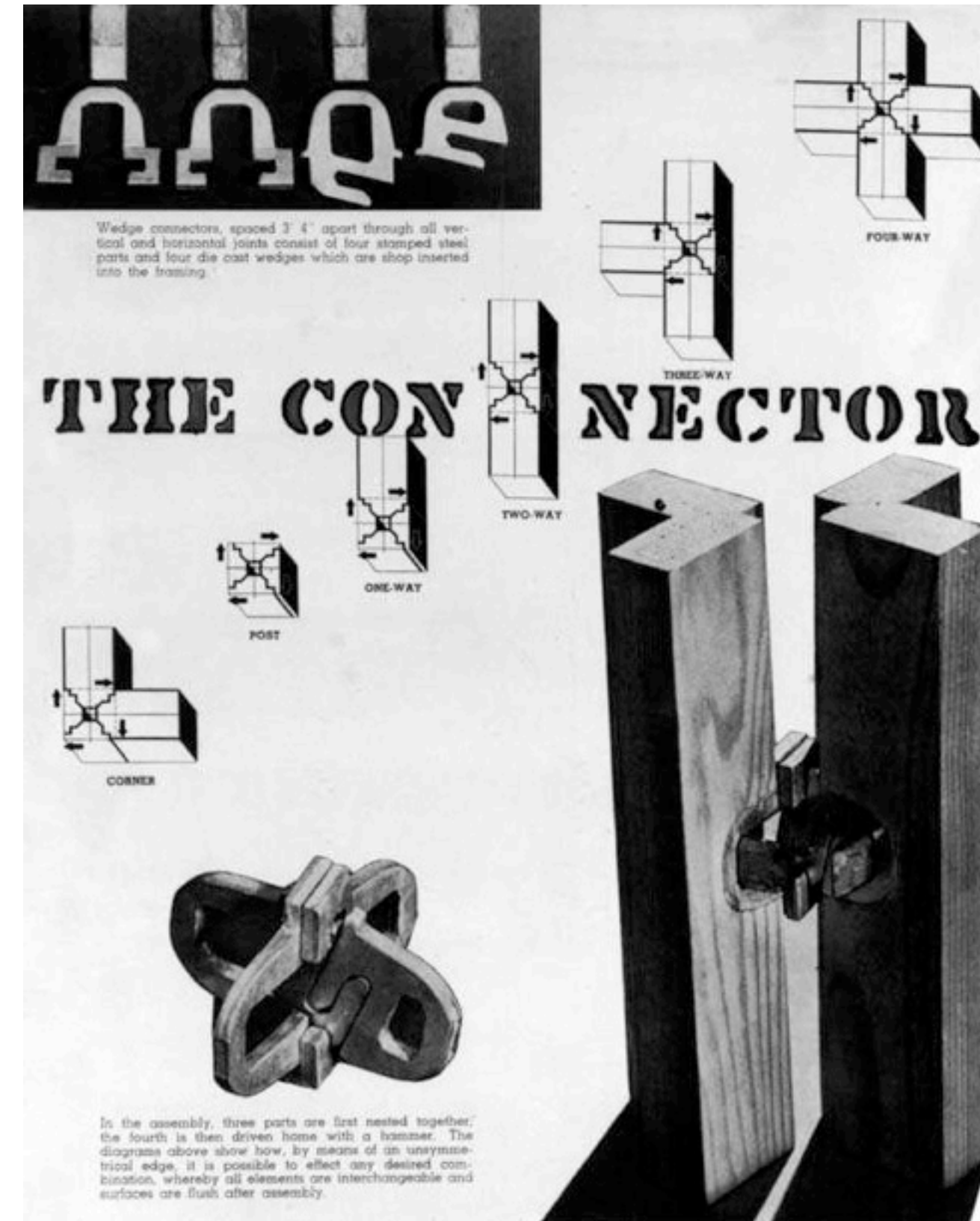


# EVERY geometry





# allgemeine knoten



*konrad wachsmann*  
*fritz haller*



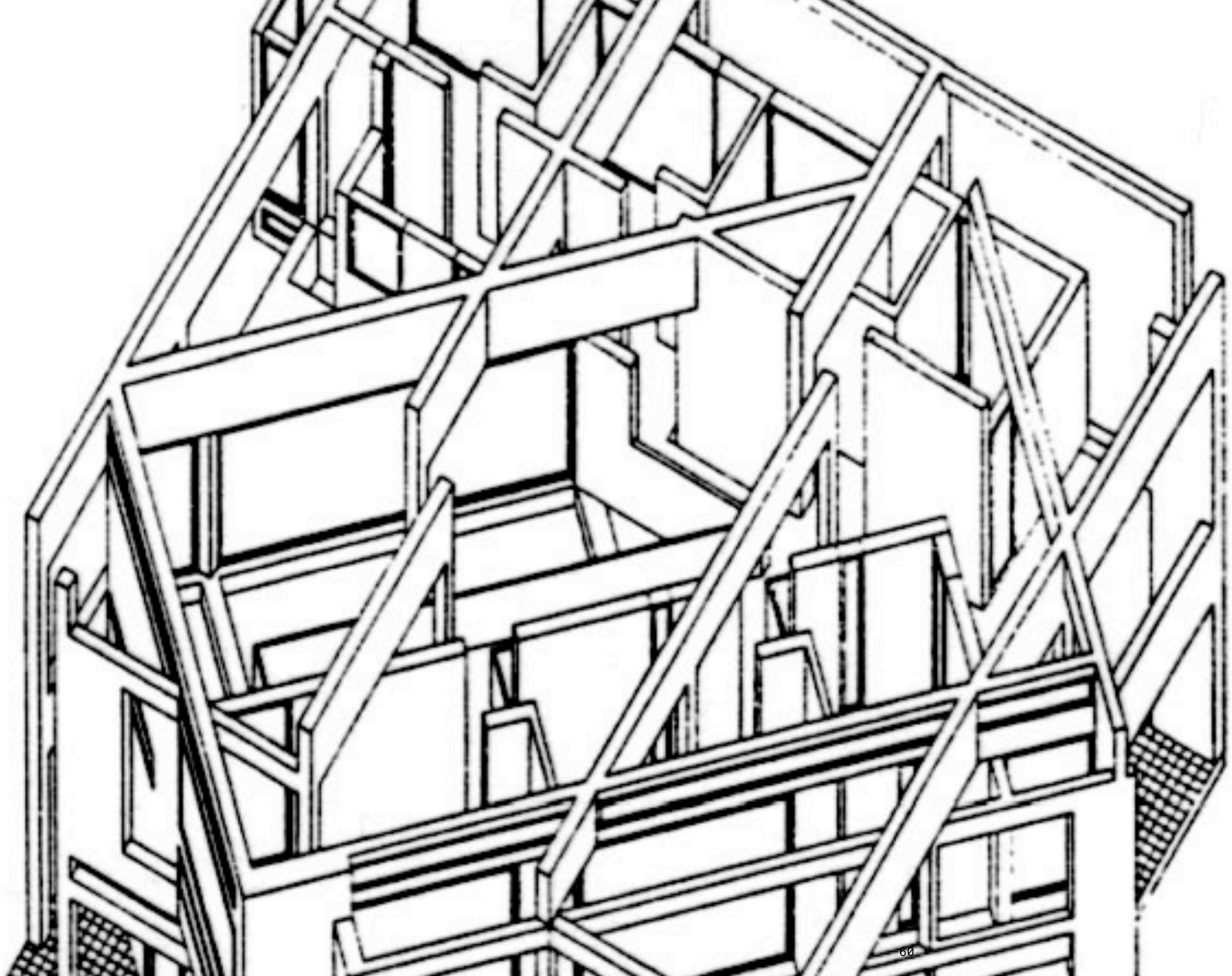


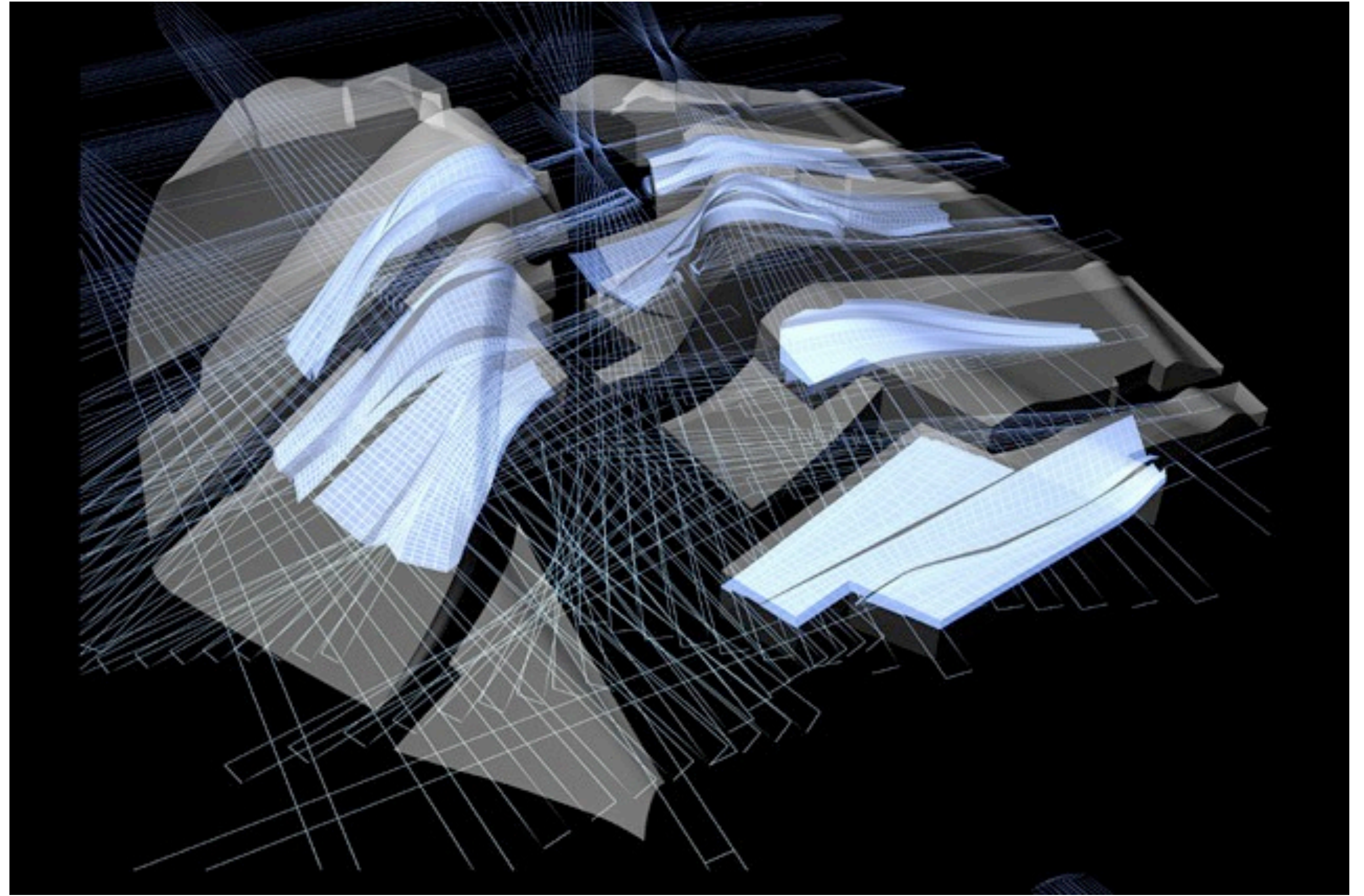
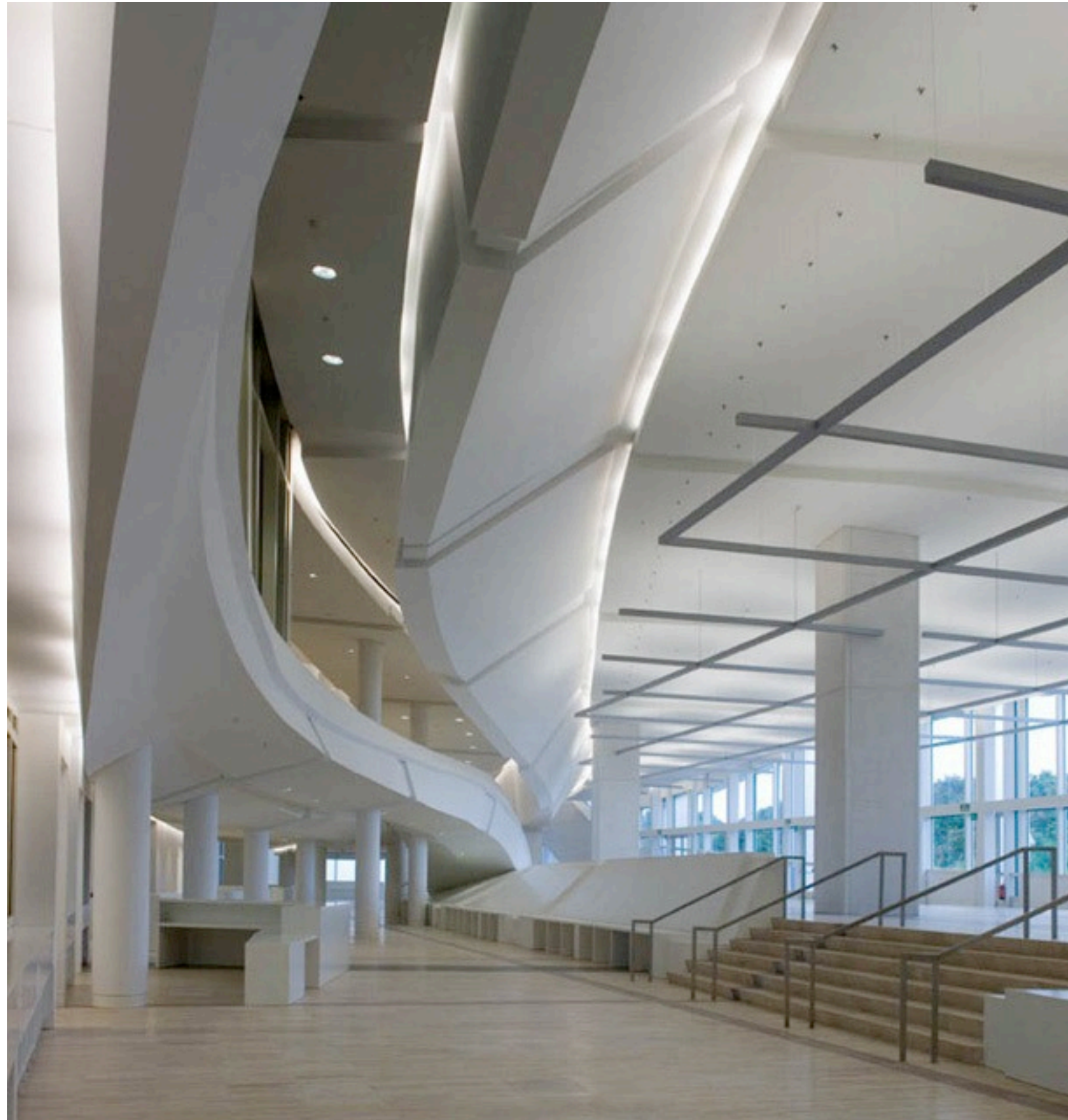
# about algebra

geometry  
arithmetic  
logic

*the power of  
symbolization*

*universal  
turing  
machine*





the **GAP** and the *phantastic vector*

```
Vector3D copy(Vector3D v) {
    return new Vector3D(v.x, v.y, v.z);
}

void add(Vector3D v) {
    x += v.x;
    y += v.y;
    z += v.z;
}

void sub(Vector3D v) {
    x -= v.x;
    y -= v.y;
    z -= v.z;
}

void mult(float n) {
    x *= n;
    y *= n;
    z *= n;
}

void div(float n) {
    x /= n;
    y /= n;
    z /= n;
}

void normalize() {
    float m = magnitude();
    if (m > 0) {
        div(m);
    }
}

void limit(float max) {
    if (magnitude() > max) {
        normalize();
        mult(max);
    }
}

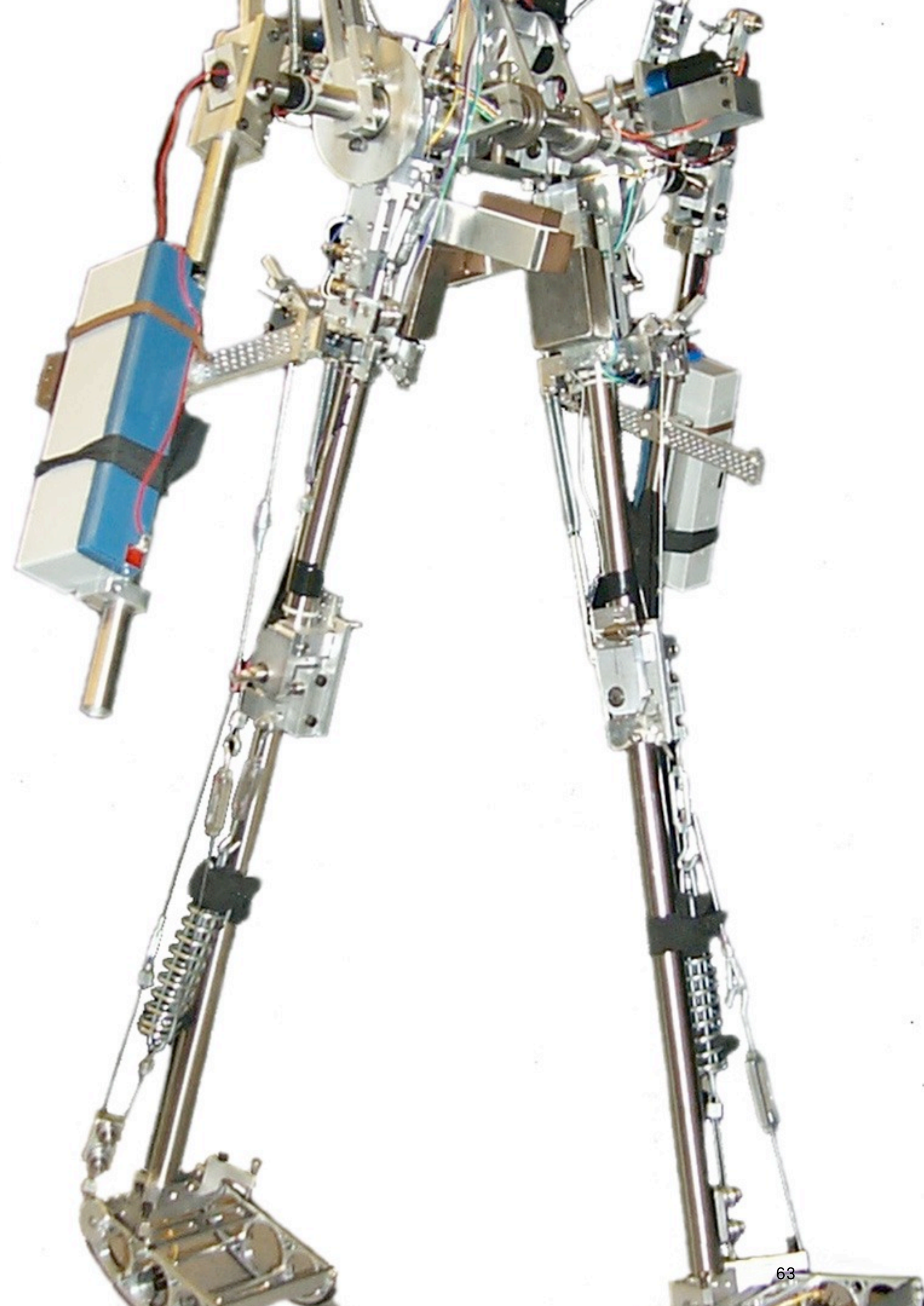
float heading2D() {
    float angle = (float) Math.atan2(-y, x);
    return -1*angle;
}

Vector3D add(Vector3D v1, Vector3D v2) {
    Vector3D v = new Vector3D(v1.x + v2.x, v1.y + v2.y, v1.z + v2.z);
    return v;
}

Vector3D sub(Vector3D v1, Vector3D v2) {
    Vector3D v = new Vector3D(v1.x - v2.x, v1.y - v2.y, v1.z - v2.z);
    return v;
}

Vector3D div(Vector3D v1, float n) {
    Vector3D v = new Vector3D(v1.x/n, v1.y/n, v1.z/n);
    return v;
}

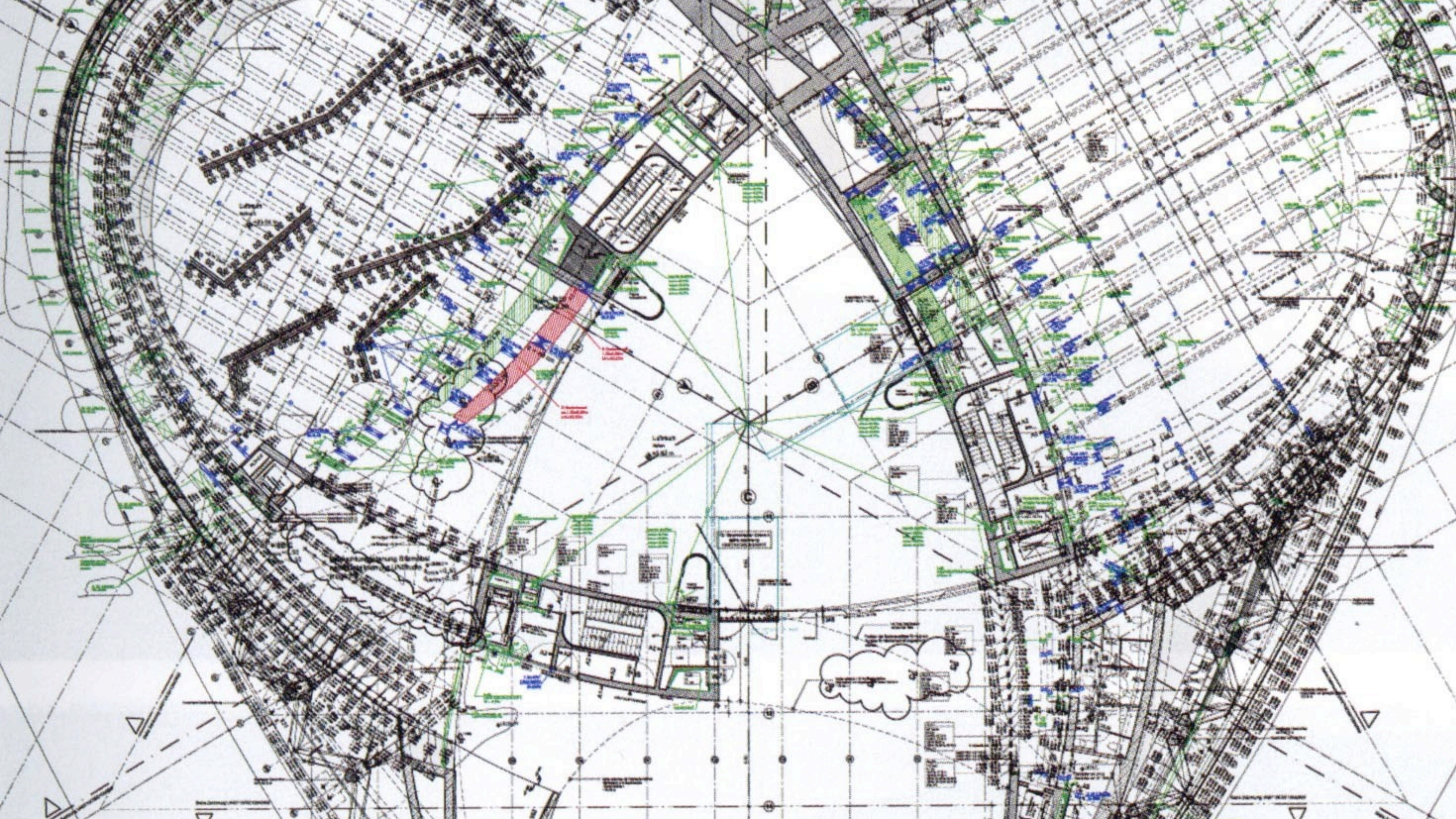
Vector3D mult(Vector3D v1, float n) {
    Vector3D v = new Vector3D(v1.x*n, v1.y*n, v1.z*n);
    return v;
}
```





Frei Otto / München

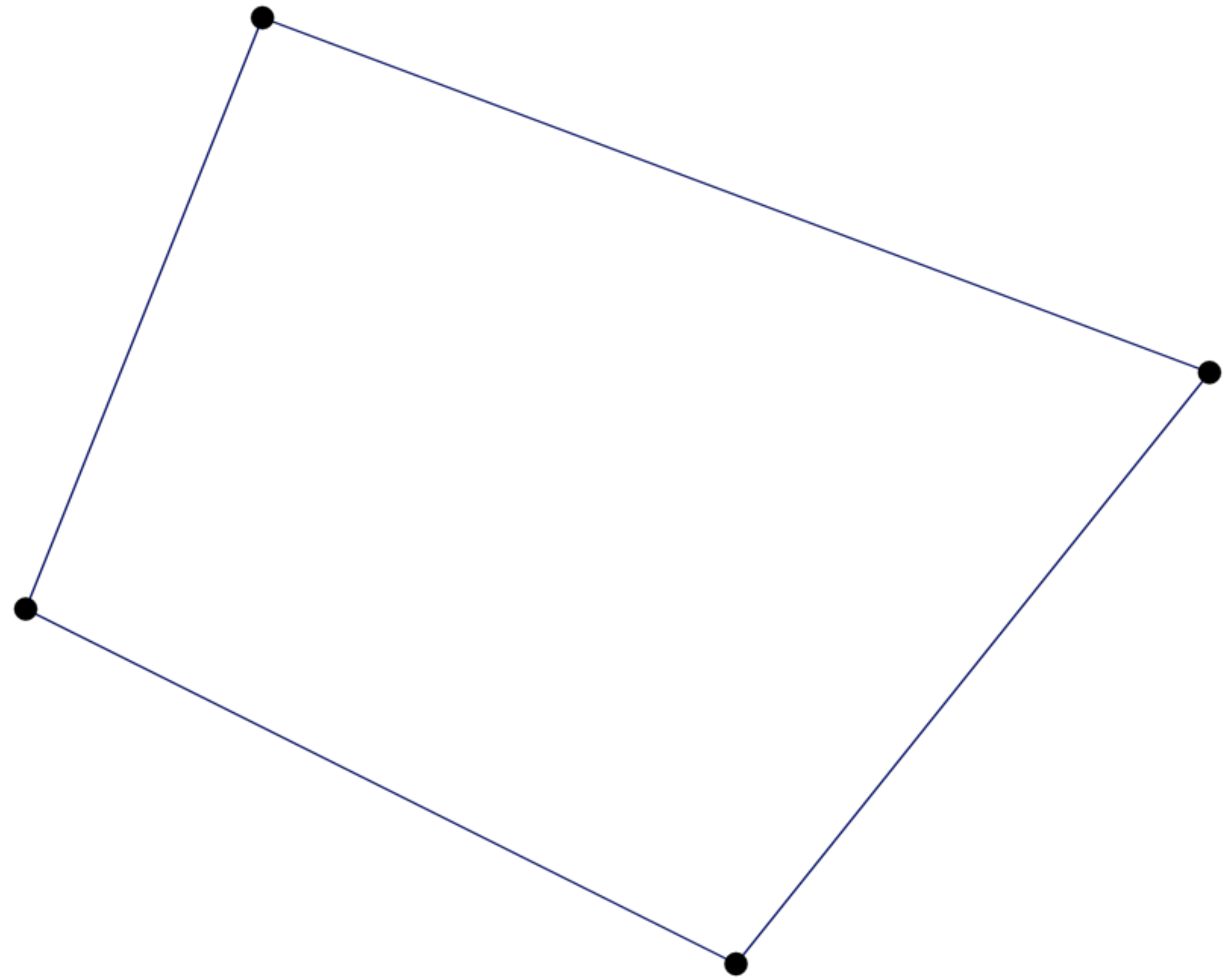




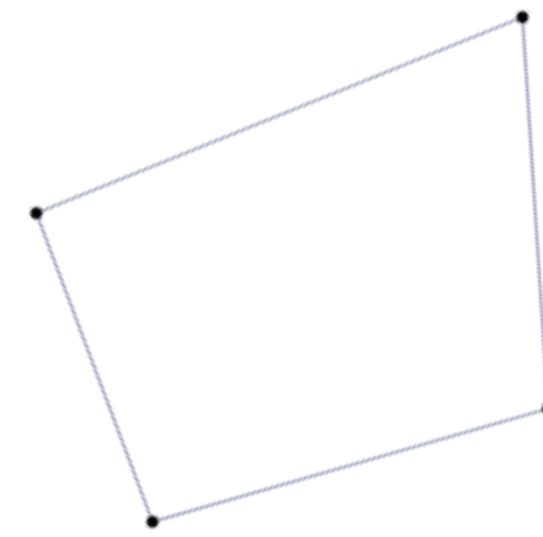
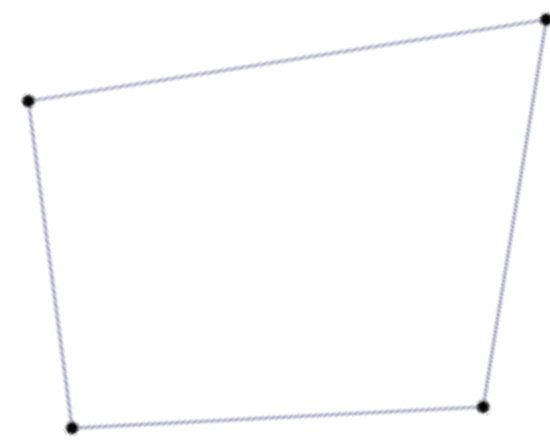
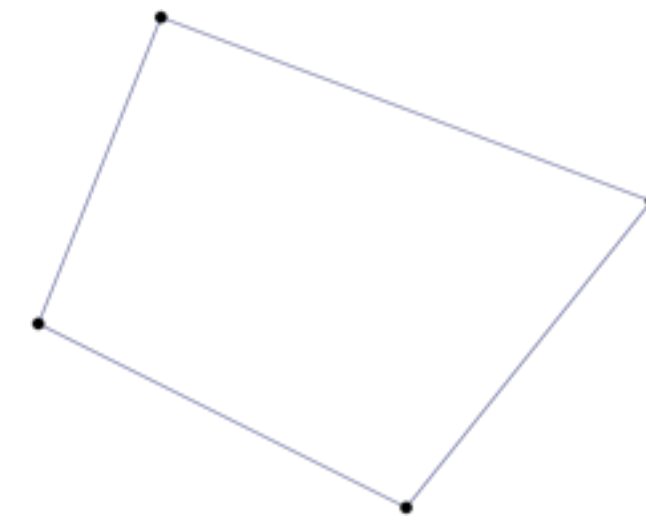
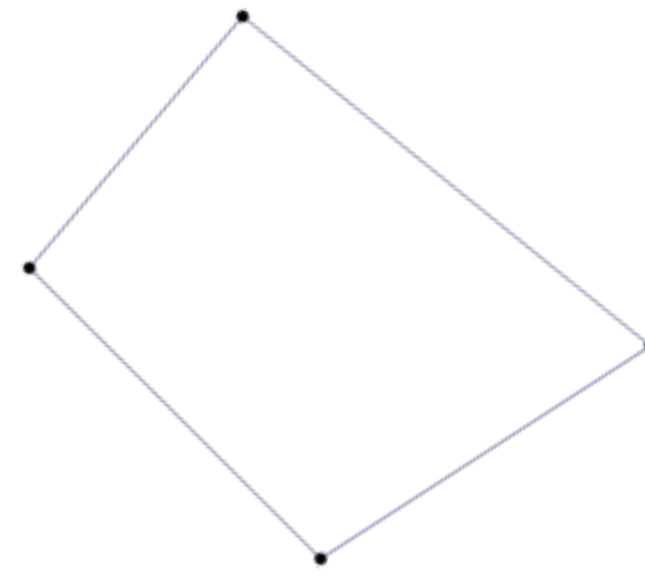
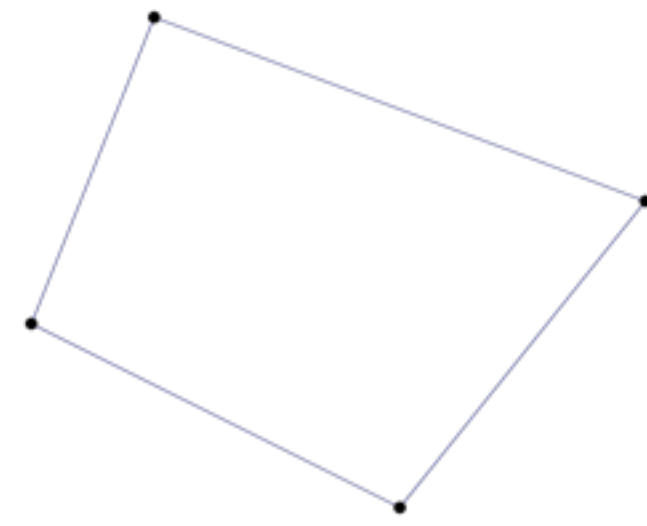
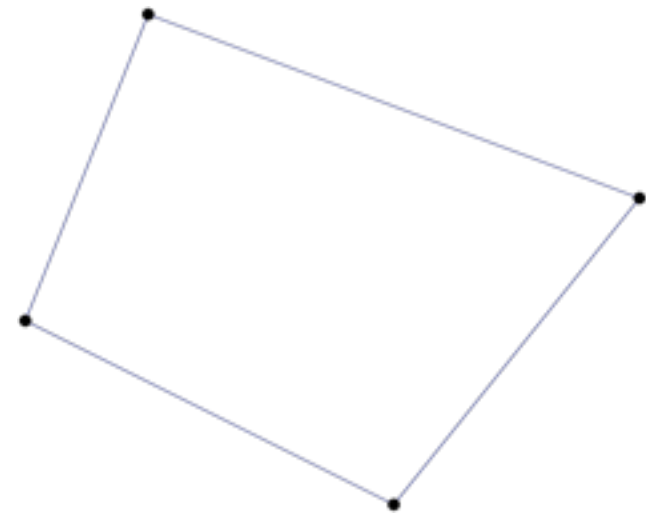
















# growth

CRYSTAL :

undirected

*quantitative* growth

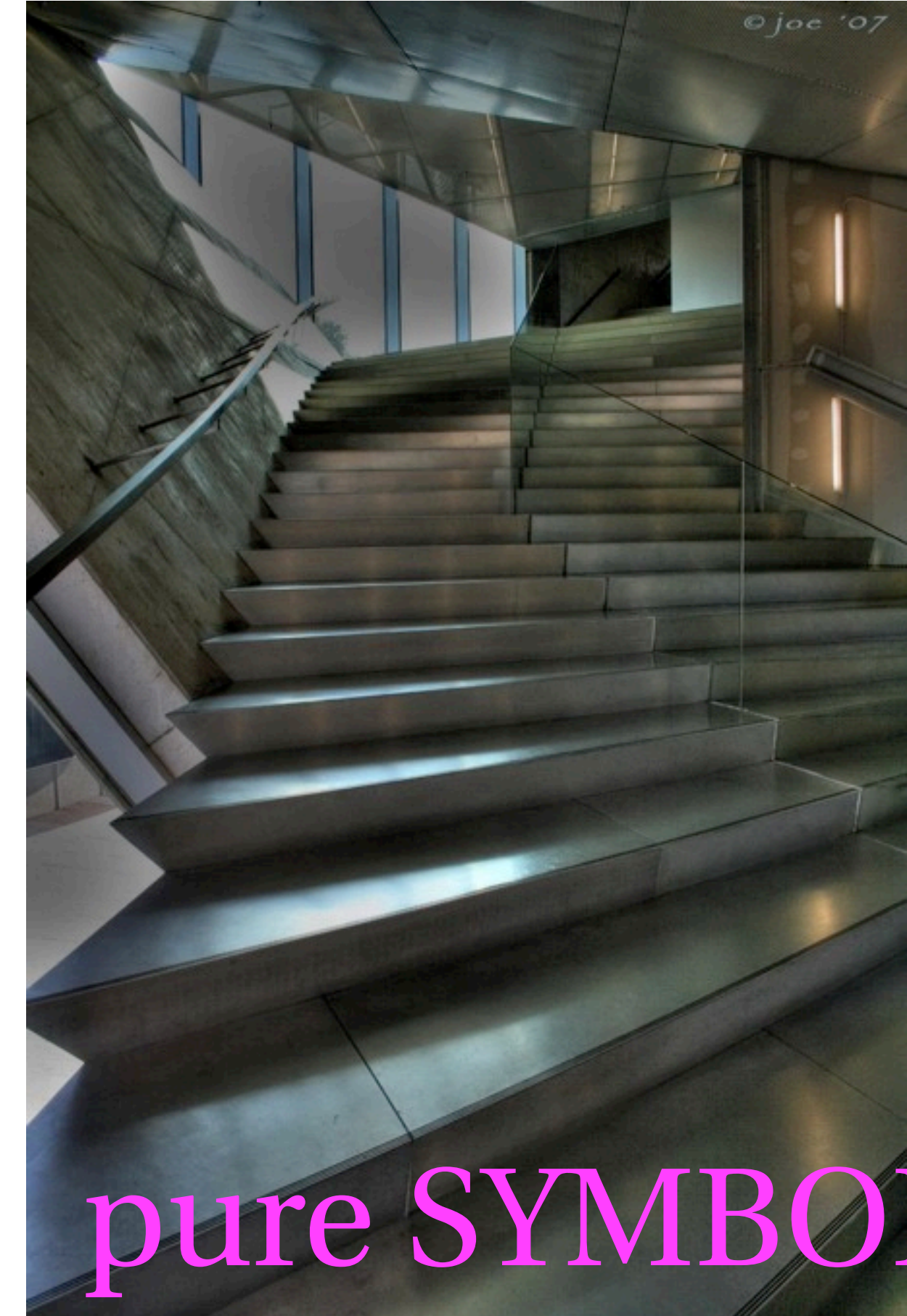
FLORA : excentric

*quantitative* growth

FAUNA : concentric

*qualitative* growth

# ANY-geometry

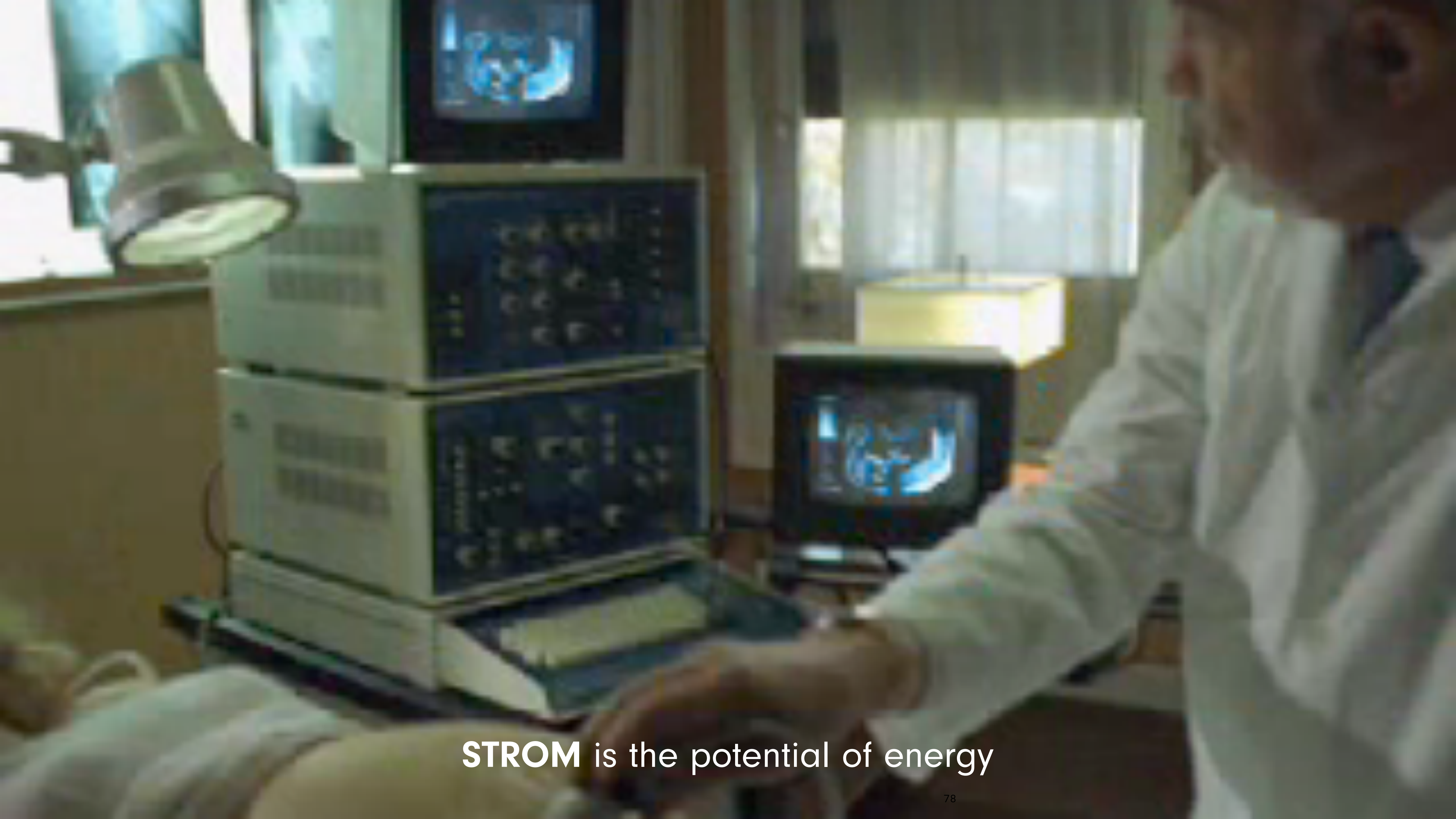


pure SYMBOLICS





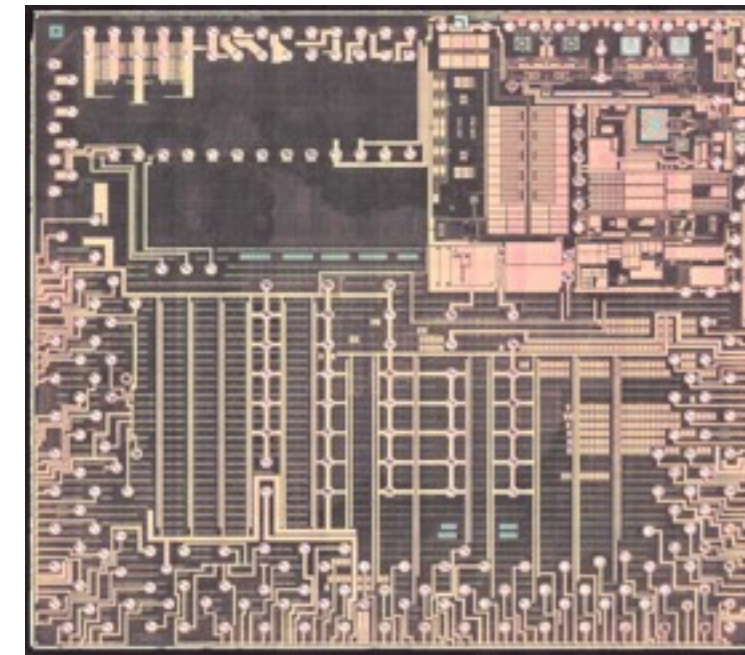




**STROM** is the potential of energy

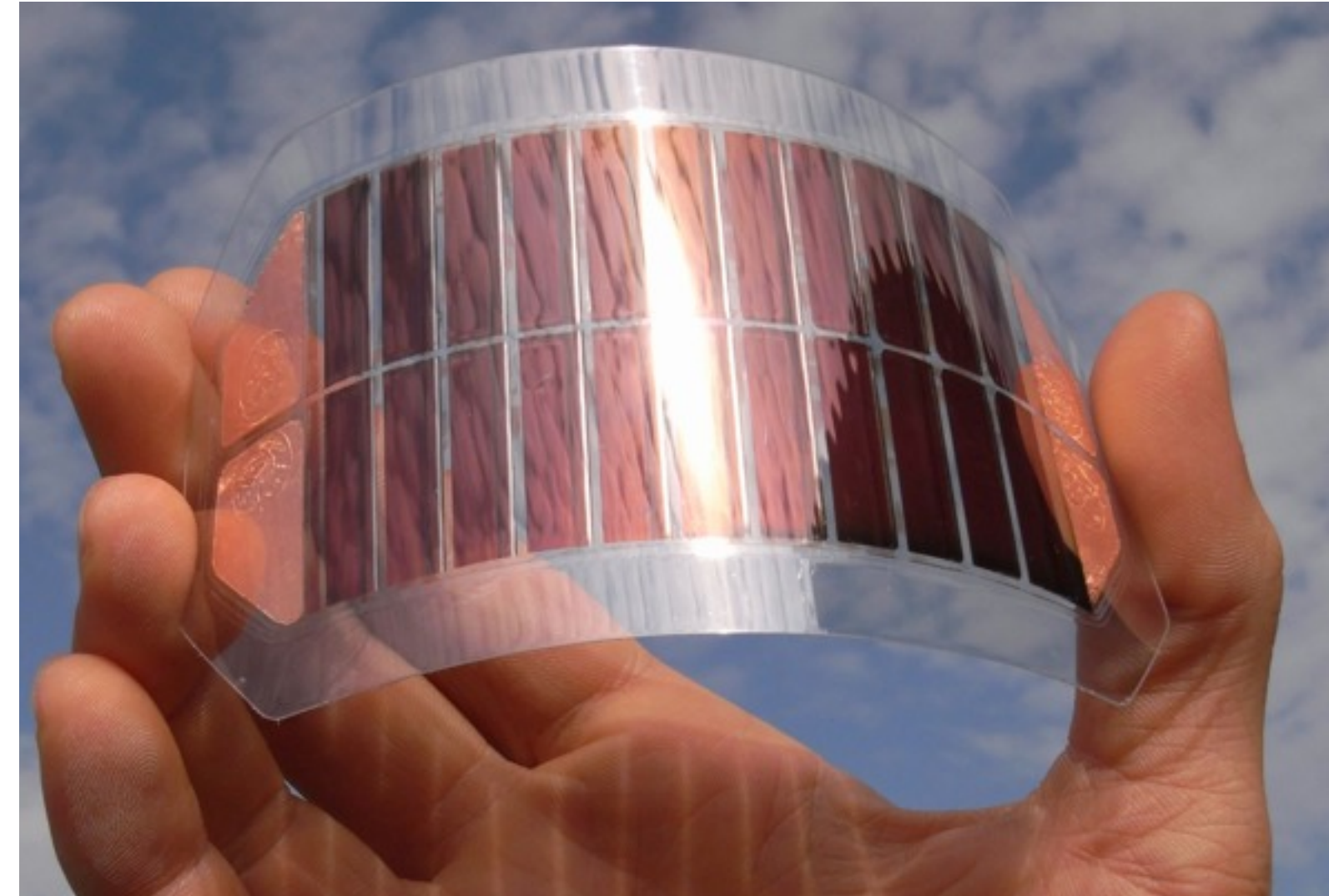
# good stories

*mobile phone*



*5 out of 7 bn in 10 years*

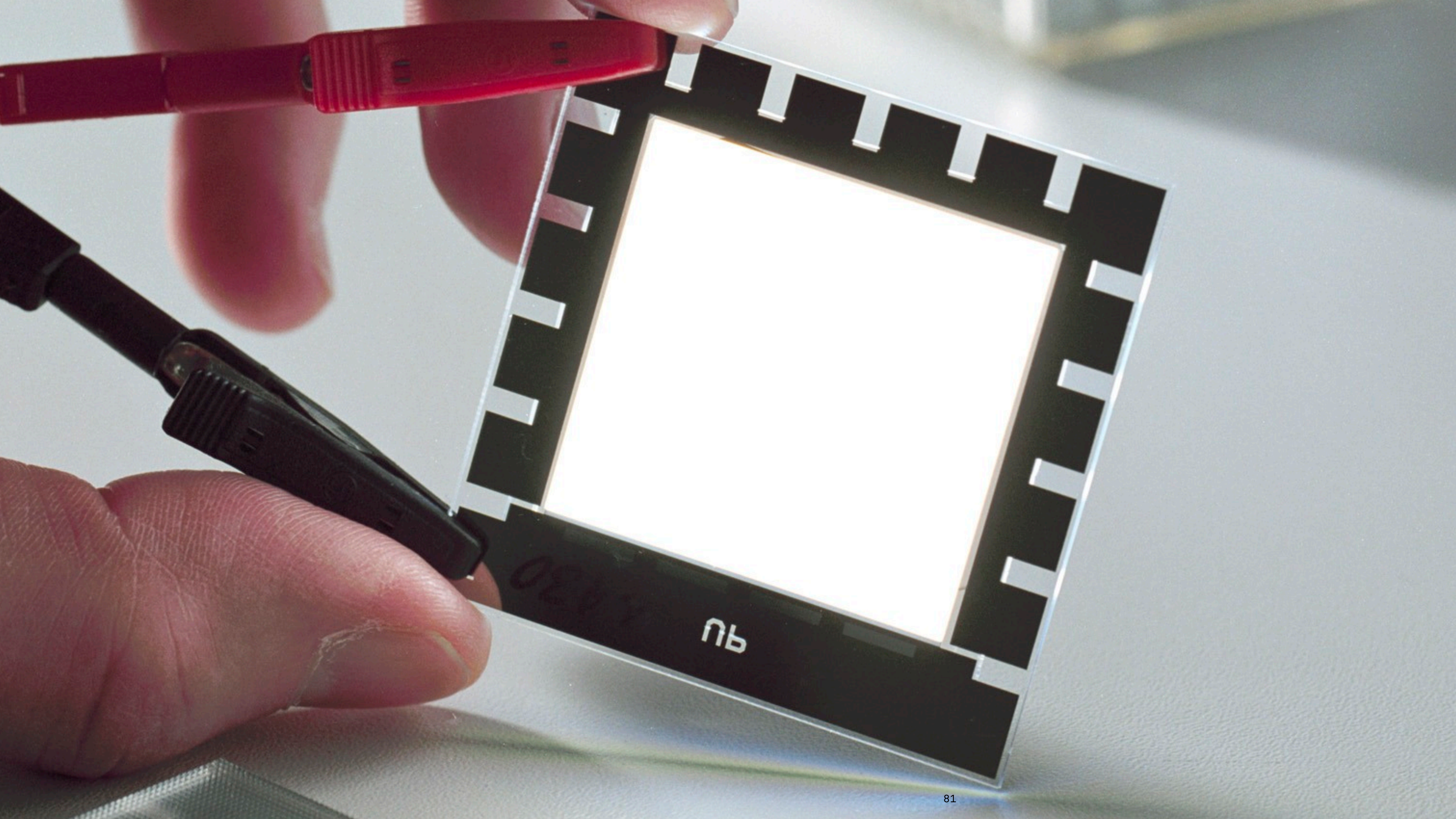
# good stories



*photovoltaic*

*160'000 km<sup>2</sup> are enough*





UB

