The City as Canvas
Architecture as Painting
An intuitive approach to 3D printing

Tiwánee van der Horst
28 January 2016
Introduction

Research
  The architectural potential
  The architectural language
Introduction

Research
- The architectural potential
- The architectural language

The machine as the painter
The nozzle as the brush
The building material as paint
Material properties as pigments
Needed developments
Introduction

Research
The architectural potential
The architectural language

The machine as the painter
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Needed developments

Design
The city as canvas
Architecture as painting
Inspiration

Architecture

Painting
Inspiration

Architecture

3D printing

Painting
The 3D printer

<table>
<thead>
<tr>
<th>digital code</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
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<tr>
<td>C</td>
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<tr>
<td>D</td>
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<tr>
<td>E</td>
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</table>

Digital model of design → 3D printer → Physical output
The architectural potential of 3D printing
Canalhouse [3D print in Amsterdam] - DUS Architects (2013 - present)
Joris Laarman bridge [3D print with steel] - Amsterdam (to be constructed)
Current limitations

Horizontal layering
Machine design
Nozzle shape
Material properties
The architectural potential

- Melting down to reuse
- Material color transformation
- Endless transformation of form
- Building in narrow leftover spaces
- Low labor costs
- Light weight structure
The architectural language
Formstudies on the materiality of 3D printing
Formstudies on the materiality of 3D printing
Architecture as painting
Architecture as painting

Kissed by the Sun [Oil on Canvas] - Friedrich Hundertwasser (1951)
Architect: an engineer and an artist

Scientific

Artistic
‘When it has plumbing it is architecture’ - Frank Stella

‘When it is inhabited it is a home’ - Martin Heidegger
Research process

3D printing
Research process

3D printing

Painting
Research process

3D printing Machine

Painting
Research process
Research process

3D printing  Machine  Nozzle

Painting  Painter
Research process

3D printing → Machine → Nozzle → Painting → Painter → Brush
Research process

3D printing

Machine

Nozzle

Plastic

Painting

Painter

Brush
Research process

3D printing → Machine → Nozzle → Plastic → Painting → Painter → Brush → Paint
Research process

3D printing  Machine  Nozzle  Plastic  Hypothetical material
Painting  Painter  Brush  Paint
Research process

3D printing → Machine → Nozzle → Plastic → Hypothetical material → Experiments → Painting → Painter → Brush → Paint
Research process

3D printing → Machine → Nozzle → Plastic → Hypothetical material → Experiments → Needed developments in disciplines

Painting → Painter → Brush → Paint
Research process

3D printing

Painting

Machine

Nozzle

Plastic

Hypothetical material

Experiments

Needed developments in disciplines
Architecture as painting
Architecture as painting

inspiration

pointillist

impressionist

expressionist

action painting
Architecture as painting

**The machine as painter**
- Bodily movements
- Layering technique

**The building material as paint**
- Solidification process
- Material transformation

**The nozzle as the brush**
- Resolution
- Texture

**Material properties as pigments**
- Blending technique
- Palette
The machine as the painter  bodily movements
The machine as the painter  

bodily movements  

Jackson Pollock at work
The machine as the painter

bodily movements

Sunday afternoon on the island of La Grande Jatte [Oil on canvas] - Georges-Pierre Seurat (1884)
The machine as the painter  layering technique
The machine as the painter

layering technique

The Starry Night [Oil on canvas] - Vincent van Gogh (1889)
The machine as the painter  bodily movements and layering technique

**Pointillism / Impressionism**

**Expressionism**

**Action painting**

Fingers

Hand

Arm
Research process

3D printing

Machine

Nozzle

Plastic

Hypothetical material

Experiments

Needed developments in disciplines

Painting

Painter

Brush

Paint
The nozzle as the brush

resolution and texture
The nozzle as the brush

resolution

Junger Mann, beunruhigt durch den Flug einer nicht-euklidischen Fliege - Max Ernst (1942-1946)
The nozzle as the brush

texture

Vogel [Oil on canvas] - Robert Zandvliet
The nozzle as the brush  resolution and texture

fan  flat  spatula  rigger  round

good

approximation
Research process

3D printing
Machine
Nozzle
Plastic
Paint
Painting
Painter
Brush
Hypothetical material
Experiments
Needed developments in disciplines
The building material as paint
The building material as paint | material transformation

- **plastic**
  - additives
  - polymers
  - renewable resources
  - reusability
  - solidification process

- **hypothetical material**

- **paint**
  - additives
  - polymers
  - pigments
  - solvents
  - drying process
The building material as paint  material transformation

The building material as paint  solidification process
The building material as paint

Movement in two levels

1. Movement along path

2. Movement through physical states
The building material as paint solidification process
The building material as paint
solidification process

full control  no control  0.5 s  1 s  2 s  5 s  60 s
Material properties as pigments
Material properties as pigments palette
Material properties as pigments palette

La Gare Saint Lazare [Oil on canvas] - Claude Monet (1877)
Material properties as pigments

La Gare Saint Lazare [Oil on canvas] - Claude Monet (1877)
Material properties as pigments palette

Microscopic detail of La Gare Saint Lazare [Oil on canvas] - Claude Monet (1877)
Material properties as pigments
Material properties as pigments

- Loadbearing structure
- Divisioning
- Plumbing
- Light and sunblinding
- Enclosure
- Interior
- Substructure
- Wiring
- Opening
Material properties as pigments

Enclosure

- Adhesion
- Hardness
- Tensile strength
- Compressive strength
- Shear strength
- Shrinkage
- Density
- Viscosity
- Sound barrier
- Insulative capacity
- Thermal expansion
- Specific heat capacity
- Thermal conductivity
- Melting point
- Thermochromatics
- Water resistance
- Fire resistance
- UV - resistance
- Electrical conductivity
- Porosity

100%
## Material property rate per building function

<table>
<thead>
<tr>
<th>divisioning</th>
<th>loadbearing structure</th>
<th>enclosure</th>
<th>interior</th>
<th>light and sunblinding</th>
<th>opening</th>
<th>plumbing</th>
<th>substructure</th>
<th>wiring</th>
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<tbody>
<tr>
<td>material</td>
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### Material properties:

- Adhesion
- Hardness
- Tensile strength
- Compressive strength
- Shear strength
- Shrinkage
- Density
- Viscosity
- Sound barrier
- Insulative capacity
- Thermal expansion
- Specific heat capacity
- Thermal conductivity
- Melting point
- Thermochromatics
- Water resistance
- Fire resistance
- UV - resistance
- Electrical conductivity
- Porosity

### Machine properties:

- Light and sunblinding
- Opening
- Plumbing
- Substructure
- Wiring
### Material property rate per building function

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<td>Shear Strength</td>
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<td>Density</td>
<td>Viscosity</td>
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</table>
Research process

3D printing → Hypothetical material → Experiments → Needed developments in disciplines

Painting → Machine → Nozzle → Plastic → Paint
Hypothetical material

Melting down to reuse

Endless transformation of form

Transformation of material properties

Solidification of an architectural idea
Hypothetical material

melting down to reuse

A \((X_1, Y_1, Z_1)\)  \(\rightarrow\)  B \((X_2, Y_2, Z_2)\)
Experiments
Experiments

Acrylic seal on MDF

brushstroke
Experiments

interior

structure

divisioning

interior

enclosure

light and sunblinding
Experiments

brushstroke

Acrylic seal on MDF
Experiments materializing movement
Experiments fall-line

- glue
- paint
- ink
- candle wax
The architectural language inspired by painting

<table>
<thead>
<tr>
<th>materializing movement</th>
<th>movement of the material along a path</th>
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<tbody>
<tr>
<td>brushstroke</td>
<td>movement within the liquid and solid state</td>
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<tr>
<td>fall-line</td>
<td>movement of a daily ritual</td>
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<tr>
<td>constellation</td>
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</tbody>
</table>
Needed developments in disciplines

- architectural language
- physics
  - solidification process
- chemistry
  - material transformation
- mechanical engineering
  - machine design
- material science
  - melting down to reuse additives
- painting
Research process

3D printing  Machine  Nozzle  Plastic

Painting  Painter  Brush  Paint

Hypothetical material  Experiments  Needed developments in disciplines
The city as canvas
Plot

50 m²
Painting in three dimensions
Painting in three dimensions
Painting in three dimensions
Painting in three dimensions
Materializing movement
Materializing movement
Materializing movement

gravity and centrifuge
Materializing movement centre and periphery
Materializing movement
daily routine
toilet
shower
sleeping
dining
chilling
cooking
looking
wardrobe
gathering
entrance
Materializing movement

south
west
north
east
Materializing movement
Materializing movement

south  west  north  east
Materializing movement
Materializing movement
The home

Wat is thuis zijn?

Voor mij is thuis zijn een herinnering
Voor mij is thuis zijn me veilig voelen
Voor mij is thuis zijn me niet hoeven te schamen
Voor mij is thuis zijn alleen van mij
Voor mij is thuis zijn een gevoel
Voor mij is thuis zijn niet gebonden aan een vaste plek
Voor mij is thuis zijn waar ik mezelf kan zijn
Voor mij is thuis zijn waar mijn regels gelden
Voor mij is thuis zijn niet fysiek
Voor mij is thuis zijn me comfortabel voelen
Voor mij is thuis zijn een plek waar liefde, vriendschap en geluk samenkomen
Voor mij is thuis zijn vrij zijn

Interview ‘Wat is thuis zijn?’ - Exposition TENT Rotterdam (2015)
The home
The home
The home
Material properties as pigments palette

Chemical properties

- UV - resistance
- Fire resistance
- Water resistance
- Electrical conductivity

Thermal properties

- Thermo chromatics
- Melting point
- Thermal conductivity
- Specific heat capacity
- Thermal expansion
- Insulative capacity

Acoustic properties

- Sound barrier
- Viscosity
- Density
- Shrinkage
- Shear strength

Mechanical properties

- Compressive strength
- Tensile strength
- Hardness

Loadbearing structure

Divisioning

Plumbing

Light and sunblinding

Opening

Enclosure

Interior

Substructure

Wiring
Materializing movement
Materializing movement
Materializing movement

Loadbearing structure

Adhesion
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Thermal expansion
Specific heat capacity
Thermal conductivity
Melting point
Thermochromatics
Water resistance
Fire resistance
UV-resistance
Electrical conductivity
Porosity

Plumbing wiring

Wiring

A X3.5 Y3.0 Z2.5
B X0.0 Y6.5 Z0.0
C X-3.5 Y4.5 Z3.0
D X3.0 Y3.5 Z5.5
E X-4.5 Y4.0 Z7.0
F X-2.0 Y2.5 Z9.0
G X0.0 Y0.0 Z7.0
H X0.0 Y0.0 Z0.0
Materializing movement

Q X-2.5 Y3.0 Z1.5
R X-2.0 Y2.5 Z4.0
S X3.0 Y3.5 Z6.0
T X3.5 Y3.5 Z8.0
U X-3.5 Y5.0 Z6.0
V X-4.0 Y3.5 Z7.5
W X-2.5 Y3.0 Z9.0

Substructure

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Shrinkage
Materializing movement

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</table>

<table>
<thead>
<tr>
<th>X</th>
<th>X-1.5</th>
<th>Y3.0</th>
<th>Z0.5</th>
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<tr>
<td>Y</td>
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<td>Y3.5</td>
<td>Z7.0</td>
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<td>Z</td>
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Brushstroke
The architectural drawing
The architectural drawing

substructure
loadbearing structure
enclosure
interior

light and sunblinding
divisioning
opening
plumbing
wiring
The architectural drawing
The architectural drawing
The architectural drawing
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The architectural drawing
Material properties as pigments

- Waterresistant
- Soundbarrier
- Insulative
- Compressive strength
- Tensile strength
Material properties as pigments
Architecture as painting