Petrus Aejmelaeus-Lindström

Handledare/ Jonas Runberger & Oliver Tessmann
Supervisor
Examinator/ Anders Johansson
Examiner

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FAD* for Stadsgårdskajen
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* Fabrication Aware Design

Re-introduction of some of the knowledge from the master builder to the contemporary architect.

During the last 10 years robotic fabrication in architecture has been researched and gone from basic research to full scale research project as well as been used in commercial projects [1]. The aim of this project is to investigate the interaction between designing architecture and building architecture in a computer controlled context.

Brick laying is a well researched topic for robotic processes. It’s an ideal material for building with robots (in Stockholm) since it is a generic building block that is cheap and easy to produce locally. Corbeled vaults, instead of keystone vaults, can be built without support and with all identical elements and are therefore also very suitable for robotic fabrication. The project tries to answer to a). What kind of architectural spaces an automated, corbeled bricklaying process results in? b). What qualities and limitations are inherited from the building process? c). What kind of typology would be suitable for the process? d). What does the design process/method look like?

To answer this the question formulation, algorithms [2] have been developed to simulate and control an automated in situ brick stacking processes, which have been tested and developed in both physical models and computational models [3]. First the algorithms have been scripted to handle structural (structural bricks and minimal use of scaffolding during construction etc) and technical needs (weather proofed and openings etc) and then they have been modified after design intentions and needs. Basic libraries of brick laying algorithms were created, combined and incorporated in a parametric model to be used for design development. The parametric model does also react to site and program. By integrating the construction method in the design process it’s restrictions and freedoms have been a driver of the design. The behavior of the algorithms (and thereby the behavior of the construction method and material) have resulted in massive and heavy architecture with similarities to medieval architecture, particular castle typologies.

To enhance the thick walls, smaller spaces and circulation have been carved out of a solid model. The volume have been modeled by hand in a 3D software and then the parametric design restriction aware model has been used to create the negative spaces in the massive walls. Then the model have been fed to the brick laying algorithms witch have recreated the whole building brick by brick. The final generated model consists of more than 7 500 000 bricks.

FAD is a monumental public building with a massive appearance at Stadsgårdskajen, a 2 km long quay situated at the north eastern shore of Södermalm, the southern island of Stockholm. Along Stadsgårdskajen there is a fault that is between 25 and 30 meters of height separating the waterfront with it’s popular walking passage from the lively and much frequented neighborhood of Sofia and Katarina. In between the quay and the ridge there is heavy traffic underlining the separation. FAD’s generous arcade-like staircase is connecting the quay and the city and invites and activates Stadsgårdskajen as an attractive walkway as well as an efficient way to walk to the south east part of Stockholm from the city center. The roof is sloping to ward east and west creating great places with sun from early morning to late evening that can be accommodating small cafés and bars. FAD is housing flexible exhibition spaces that all can be closed from the public and be used for closed events. Arcades are going around the building and containing staircases connecting the different spaces in an exiting way creating views trough the building and over Stockholm and it’s bay.


3. The Algorithms have been scripted in Python. Python is a general purpose programming language. See: http://www.python.org/ (08-08-2014)

4. All computational modeling has been done in Rhinoceros 5.0. Rhinoceros is a 3D modeling software that also provides an Application Programming Interface (API) to use its native commands within the Python language. See: http://www.rhino3d.org/ (08-08-2014)
View from Kastellholmen
View from Lilla Eriksbergen.
Interior View of the Top Floor
Interior View of the Staircase connecting Stadsgardkajen with Lilla Essunga
simpleBrickPattern_PA_001.py
Input: NURBS Surface (1 degree)
3000 x 4000 mm
Thickness: 1 brick
Simple porous wall. Not a climate wall.

simpleBrickPattern_PA_002.py
Input: NURBS Surface (1 degree)
3000 x 4000 mm
Thickness: 2 bricks
Simple double curved porous surface. Not a climate wall.

doubleBrickPattern_PA_001.py
Input: NURBS Surface (3 degree)
3000 x 4000 mm
Thickness: 1 brick
Double layered porous surface. Not a climate wall.

doubleBrickPattern_PA_002.py
Input: NURBS Surface (3 degree)
3000 x 4000 mm
Thickness: 2 bricks
Double layered double curved porous surface. Not a climate wall.

festungsverband_PA_001.py
Input: NURBS Surface (1 degree)
3000 x 4000 mm
Thickness: 2 bricks
Straight wall with festungsverband. Traditional german bricklaying used for fortresses.

festungsverband_PA_002.py
Input: NURBS Surface (3 degree)
3000 x 4000 mm
Thickness: 2 bricks
Double curved wall with modified festungsverband. Very rough surface and edges.

curvedFestungsverband_PA_001.py
Input: NURBS curve (1 degree)
3000 x 4000 mm
Thickness: 1 brick
Straight wall with modified festungsverband. Bricks rotate to stretch according to the definite distance between input surface's edges.

inputCrvFV_PA_001.py
Input: 2 x NURBS Curve (1 degree)
3000 x 4000 mm
Thickness: 1 brick
Straight wall with modified festungsverband. Brickwall between two input curves. Reasonably smooth wall with controlled edges.
Input: 2 x NURBS Srf (3 degree)  
3000 x 4000  x 1000 mm  
300 x 400 x 150 mm  
Thickness: 2 - 5 bricks

Wall - brick differences are compensated on both sides.

Input: 2 x NURBS Srf (3 degree)  
3000 x 4000  x 1500 mm  
300 x 400 x 750 mm  
Thickness: 2 - 7 bricks

Wall - brick differences are compensated on both sides.

Input: 2 x NURBS Srf (3 degree)  
3000 x 4000  x 750 mm  
300 x 400 x 150 mm  
Thickness: 2 (1) - 5 bricks

Wall - brick differences are equally compensated with distances between every brick. The script does not add brick if thickness < 1 brick to create openings and smooth surfaces. It creates openings and smooth surfaces on both sides when wall is thinner than 5 bricks.

Input: 2 x NURBS Srf (3 degree)  
3000 x 4000  x 1500 mm  
300 x 400 x 750 mm  
Thickness: 2 (1) - 7 bricks

Wall - brick differences are equally compensated with distances between every brick. The script does not add brick if thickness < 1 brick to create openings and smooth surfaces. It creates openings and smooth surfaces on both sides when wall is thinner than 7 bricks.

Input: 2 x NURBS Srf (3 degree)  
3000 x 4000  x 750 mm  
300 x 400 x 150 mm  
Thickness: 2 (1) - 5 bricks

Wall - brick differences are equally compensated with distances between every brick. The script does not add brick if thickness < 1 brick to create openings and smooth surfaces. It creates openings and smooth surfaces on both sides when wall is thinner than 5 bricks.
Solid wall with deep curvature both on the outside and the inside. The wall - brick differences are compensated on both sides. Semi rough surface. Symmetric opening in the wall. Inside and outside are the same. The angular inputs gives a rougher impression.
Solid wall with shallow curvatures outside and deep curvatures inside. The wall-brick differences are compensated only on the inside. Smooth surface on the inside and very rough surface on the outside.

Solid wall with deep curvatures both on the outside and on the inside. The wall-brick differences are compensated only on the inside. Smooth surface on the inside and very rough surface on the outside. Symmetric opening in the wall. Inside and outside are the same.

Solid wall with deep curvatures both on the outside and on the inside. The wall-brick differences are equally distributed and slightly stretched on both sides creating a semi-smooth finish. Brick layer angle is 30 degrees.

Solid wall with deep curvatures both on the outside and on the inside. The wall-brick differences are compensated only on the inside. Smooth surface on the inside and very rough surface on the outside. Symmetric opening in the wall. Inside and outside are the same. The angular inputs give a rougher impression.

Solid wall with deep curvatures both on the outside and on the inside. The wall-brick differences are equally distributed on both sides creating a rough surface. Brick layer angle is 30 degrees.

Solid wall with deep curvatures both on the outside and on the inside. The wall-brick differences compensated by stretching the brick rows creating smooth surfaces. Brick layer angle is 30 degrees.