A CITY IS BORN
BUILDING THE LANDSKRONA CITY MODEL

HOW HOLYGON CREATED SWEDEN’S LARGEST PUBLIC CITY MODEL 3D-PRINTED IN FULL-COLOUR
– AN ACCURATE TWO SQUARE KILOMETRE 1:1000 SCALE DIGITAL MODEL OF LANDSKRONA CITY
Mission: Build a City
The Landskrona city model is Sweden’s largest public city model printed in full colour. Commissioned by the Swedish city of Landskrona, Swedish 3D-modelling studio Holygon produced the entire city model digitally in the computer program Sketchup Pro in less than four months.

The Good City Model
Some people believe that «computers build the model». But a computer is no more intelligent than a stovetop. Computers are poor at interpreting ambiguous data, miserable at judicious simplification and rotten at making aesthetically meaningful choices. But this is precisely what good city models need. They should be highly discoverable and be as easily navigable as a map. In practice, 3D-modelling is a manual labour – in the case of Landskrona more than a thousand man-hours.

Meet the Landskrona Model
The Landskrona city model covers two square kilometres, containing 23 000 individually crafted roofs and building parts; a continuous terrain; a dozen ground types such as roads, curbs, grass, sand and reed; moats; ocean; islands; jetties; vehicles; dragon’s teeth and 4 000 hand-placed trees – each detail modelled with painstaking precision. The physical model is printed in scale 1:1000, enclosing two square metres in a circle spanning 1.6 metres. The model covers the historical city centre and parts of the Öresund strait.

To the Point Cloud and Beyond
To 3D-model an empirically correct model, high-quality digital data sources are needed, which were provided by Landskrona city. Three sources were used:

ORTHOPHOTO · A camera is flown over the city. Its photos are combined by a computer program, eliminating perspective errors in order to represent every city part straight from above. This enables reliable measurements on the ground plane. The Landskrona ortho photo features 44-millimetre-per-pixel resolution. It is used to draw ground type surfaces, to sample roof colours and to place trees – see images 5 and 6.

TERRAIN HEIGHTS · A regular point grid indicates local terrain heights. The model contains 8 million height points. Connecting them creates a continuous surface. Landskrona is an unusually flat city, but close inspection reveals a subtly undulating terrain.

POINT CLOUDS · A light radar, called lidar, is flown above the city, shooting harmless laser beams. The beams bounce off every surface they hit – roofs, facades, the ground or a mid-air seagull. The lidar measures the return time of each beam and translates it into a point in space. Together, these points make a point cloud – see image 2. Points, however, lack volume and therefore cannot be 3D-printed. Instead, they guide the creation of the surfaces of buildings. The Landskrona point cloud contains 431 million points.
Growing a City

GROUND - The modeler starts by selecting ground types. Their borders are drawn on top of an orthophoto. A terrain is created. The ground types are flowed as volumes on top of the terrain and are coloured.

TREES - An arboretum of stylized tree species is modelled. The trees are hand-placed to match existing ones for type and size, but trunk diameters are exaggerated to safeguard print reliability. They are then dropped to the terrain.

BUILDINGS - Using Holygon’s proprietary city-building 3D toolkit, the modeler now samples planar surfaces from the point cloud – see images 2 to 4. Each surface must be empirically correct within a few centimetres. The surfaces are cut and united into volumes. 3D-printing demands that each volume is a solid – a waterproof body without gaps or overlaps. Roofs are coloured based on ortho photos.

PIECES - The master model is sliced into pieces adapted to the chosen printer and scale. The pieces are supported by thin honeycomb walls to spare material. The bottom has a mark uniquely identifying each piece. The Landskrona model contains 40 pieces.

TEST PRINTING - A representative piece is printed. The global colour palette and delicate details such as bridges are fine-tuned until good.

Time to Print

Once testing is done, each piece is exported for print. The city is modelled och shipped in scale 1:1 and can be printed at any scale. The printer produces three city pieces a night.

The 3D Printer Explained

The city model was printed by Landskrona city in 2018 using the 3D printer Projet 660 Pro from 3D Systems. Its maximum print size is 38 centimetres long, 24 centimetres wide and 20 centimetres high. The print material is stucco – gypsum, glue and dye. The printer stacks 0.1 millimetre layers of gypsum powder. A print head injects pigment and binder, hardening the gypsum around the model shell. Afterwards, surplus powder is vacuumed for reuse. Finally, to improve finish and strength, each piece is treated with cyanoacrylate and wax. Transparent water surfaces are manufactured separately by laser cutting sheets of acrylic glass.

Creating a World

To build a city model is to enter a world. For a few months, the model maker becomes as one with the city. What is the point of a model that may be technically correct, but fails to raise emotions? The task of the model maker is to interpret and to convey a particular local mood, the genius loci, such that each spectator would pleasurably make the city his or her own. It can be similar to losing oneself in a doll’s house, at each revisit discovering unexpected or playful details. The goal is to express a certain feeling of home, even though the spectator may never have been there before.
2. Point cloud of a house
3. Faces are sampled from points
4. Faces are united and coloured

5. An ortho photo...
6. ...is used for ground types and roof colours in the model

About Holygon
Holygon is a Swedish 3D-modelling studio specialising in making accurate models of cities and architecture for 3D printing, visualisation and similar purposes. Holygon was founded by Felix Heuman and Anders Lyhagen in 2017. Learn more at [holYGON.com](http://holYGON.com)

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