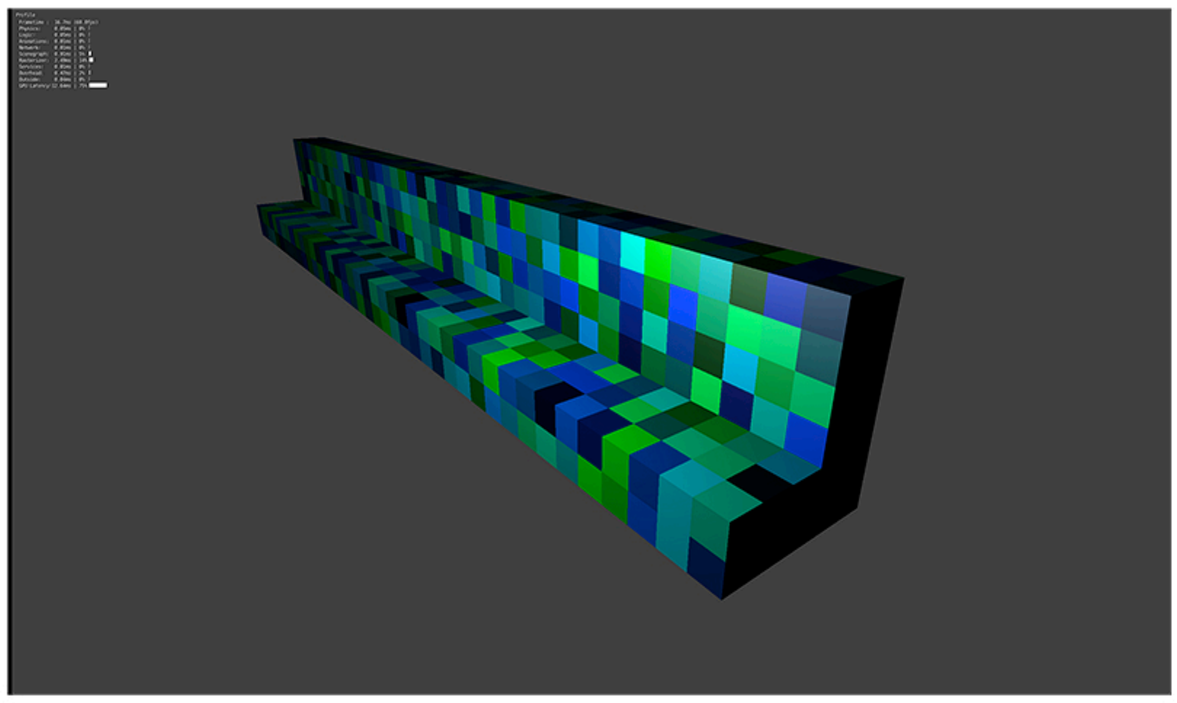
Dynamic Structures in Cityscape
Consisting of Replicating Components



The goal of this simulation is to give the basic feeling of what it means to have three-dimensional self-replicating component based structures that are dynamically growing, changing, and disintegrating.

This is, obviously, only an extremely simplified barebones model that uses basic geometric primitives and trivial designs for conveying the main idea. The actual possible design space of both the replicating components and the structures made of them is huge.

The use of self-replicating artificial systems in urban environment can give us **a whole new set of ways to design, construct, and experience our living environments**.

So far, we have mostly been thinking of the designed and constructed parts of the streetscape as relatively static objects, carefully predesigned and constructed to then last relatively unchanged over longer time periods, possibly occasionally abruptly removed or redesigned and reconstructed by forceful interventions. Most of such objects are thought of as inanimate pieces of material slowly eroding in the flow of time.

Now, however, **it is becoming technologically feasible to start creating structures that are semi-autonomous, dynamic, and adaptive**, consisting of self-replicating components that can grow and disintegrate and grow again relatively fast during the whole life cycle of the structure. This would partially replace the classical slow 'geological' change of the solid constructed part of the streetscape with a faster and more responsive 'biological' / 'animate' change.

Dynamic Structures. The structures can be changing their form and function continuously over their whole lifetime, possibly transforming into totally different structures, and possibly moving continuously from one place to another.

Temporary Structures. The structures, especially smaller ones, can 'pop up' and disintegrate relatively fast and within the natural daily life of the streetscape (that is, without turning the place into a closed construction site). This can also include various temporary extensions, both laterally and upwards, of the existing static buildings.

Adaptive Structures. In addition to being just dynamic, such structures can easily be also responsive to their environment and the needs of the people, by adaptively changing their form and function relatively fast.

Interactive Participatory Design. The dynamic and adaptive nature of such structures allows for making the streetscape design interactive and participatory in various different ways for various groups of people (including, for example, kids and students, active citizens, local residents, or even including either directly or indirectly anybody or everybody who happens to be around), and this interaction and participation can happen during the whole lifetime of the structures.

Real Parametric Generative Architecture. So far, the parametric and generative design in architecture has mostly been thought of and used only during the separate design phase before the actual construction starts — the resulting building is basically a frozen snapshot of the parametric computer model. The use of self-replicating artificial systems in the actual realization of the buildings and other city and street structures allows bringing the parametric generative architecture to life in the real world — the actual physical structure itself dynamically generates and regenerates the forms and reacts to the changes in parameters.

Possibilities of realization with already existing technologies

Biotechnology. Biology is largely based on self-replication. The advances in Systems Biology and Synthetic Biology already allow modifying and creating organisms that are designed to have different abilities than their purely natural counterparts. For example, modified or synthetic bacteria or plants can be used as the basis for (semi-)organic self-replicating components for the architectural structures. This would also allow for easy and environment-friendly degradation of the components as needed.

For cases where particularly strong structures are required, one promising option is to use bacteria that convert the atmospheric CO2 into solid calcium carbonate (microbiologically induced calcium carbonate precipitation). Research and development work for using such bacteria in building materials is already ongoing in multiple research groups and companies around the world (for example TU Delft is working on self-healing concrete, bioMASON is developing a technology to 'grow' bricks, etc.).

Robotics. There are many different ways to implement various degrees of self-replication with robotic systems. Each component might be a separate robot that can assemble and construct other similar robots, or there could be robots that are an integral part of the whole system but that work as replicators of more passive building blocks that would be the main structural elements of the resulting structure. In some cases, these service robots could be equipped with 3D-printing capabilities that allow producing required structural parts directly on site from simple raw materials.

Example ideas of possible dynamic structures: benches that grow and multiply during warmer seasons when more people are walking in the city, paved footpaths that grow where needed, sunshades for summer, dynamically changing street lighting fixtures, pop-up gardens and pools, dynamic sculptures, all kinds of decorative elements for the streets and buildings, structures that slowly move around on the streets by growing new components on one side and disintegrating on the other, seasonal small buildings and street furniture for the tourist seasons, all kinds of temporary structures for events (concerts, etc.), seasonal extensions of existing static buildings, and an endless variety of further possibilities.