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Ohne Titel
ICD-ITECH (MSc) Maria Yablonina (Prof Menges)

“Beyond the one-architect-one-machine dialogue, the milieu of adaptable machines must adapt further contacts with the real world. It must receive direct sensory information. It must see, hear, and read, and it must take walks in the garden.” N. Negroponte, 1970

Since the industrial revolution the tools and techniques within building industry have been evolving rapidly. But the general concept of how we design and construct has stayed the same: design is an iterative process that includes detailed planning of the fabrication processes in a specific sequence. In order to construct a large amount of planning represented in hierarchical drawings is being produced. Complex geometries often require even more complex formworks that can often be more energy and cost consuming that the actual final object itself.

Looking at the way construction processes are organized in nature, one can observe an approach where stages of design and construction are a single emerging process. On an example of the spider web one can see how the structure evolves depending on the environment where it is built. A spider does not have a plan or a drawing of the future web, instead he follows a complex set of rules and behaviors that allow him to construct complex structures based on multiple inputs he receives from his surroundings. That means that the same spider can apply the same “design behavior” to different environments and construct an infinite catalogue of geometries without changing the “design” itself.

This project lies within a bigger body of research conducted here at ICD and ITKE addressing the topic of robotic fabrication with fibre composite materials. For this thesis the materiality of the building material is not as relevant as the morphology of a slender thread-like object of virtually infinite length (hereinafter referred to as filament).

Filament types of materials applied to large scale construction bring special qualities into the fabrication process that are not present in most classical construction materials. Filament with its virtually unlimited length, brings unique scalability to the system, where spanning long and short distances becomes equally achievable within the same material system. Filament allows for an iterative fabrication process where properties of the object such as density, strength and transparency can be varied throughout the structure via local manipulation. Finally, filament structure always exists in a specific relationship to its formwork or anchoring structure, its environment.

This project is aiming to remove the fabrication process outside of the lab-like or construction site- like space into urban or interior environment, where the environment itself can be used as a formwork.

The architecture that is being created then becomes a parasitic structure growing upon existing (naturally occurring) architectural environment, using its input as a design driver and as a formwork for the structure that is being created. One can imagine structures being created in an urban environment without human interference by autonomous machines. A space created where and when it is needed and disassembled once no longer relevant.

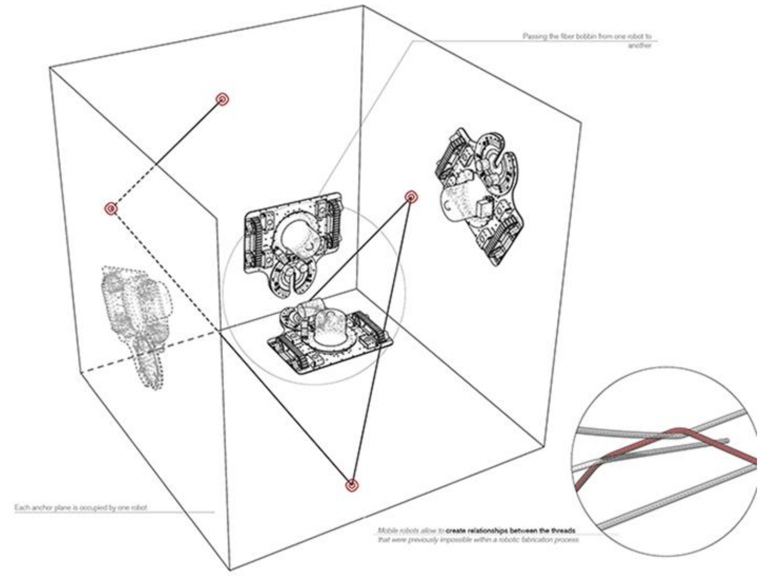
In order to achieve that, I am proposing a robotic fabrication with mobile small scale robots. Mobile robots have the potential of further expanding the morphospace that the robotic fabrication can offer. Small machines enabled with locomotion can operate in environments that are not necessarily equipped to house large industrial robots. One can imagine a fabrication process where an operator is arriving to the scene with a small suitcase housing all the necessary robotic tools for creating a large pavilion structure. Due to lower costs of mobile machines and their maneuverability multiple units can be used in the fabrication of a single object, thus increasing the speed of production. Finally, mobile robots can be combined with other types of robots, like CNC machines or robotic arms to create more complex collaborative systems of robotic fabrication.

The final iteration of the robot is enabled with 4 key features: locomotion from point A to point B avoiding obstacles on a plane of any inclination (wall climbing locomotion system), approaching and wrapping filament around a hook, passing bobbin of thread to the other robot on another surface and finally maneuvering between hooks, creating bundles of filament.

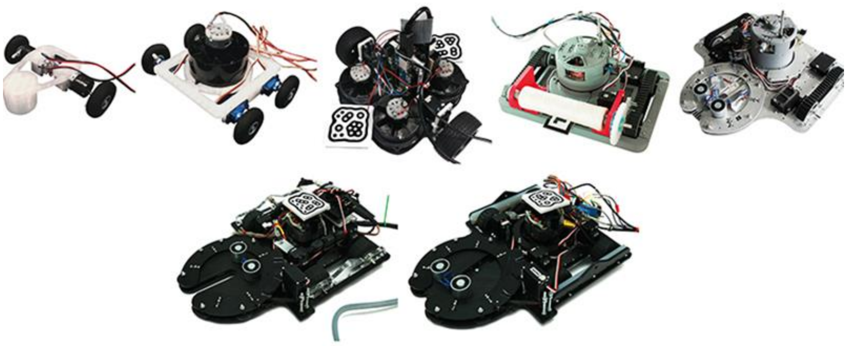
For the final prototype two robots in a setup of two walls are winding a structure that can eventually support a human.

As a result of the investigations throughout the research this project proposes a physical/digital system for building filament structures using wall climbing mobile robots with minimum input from the user. Proposed design tool requires the user to input a simple geometry as a parameter. The user input in this case is not a design, but rather a request for a function. The geometry represents a space desired by the user to be enclosed. Once the input is received, the software checks the feasibility of the geometry position and if it is correct, proceeds to the next step. The input geometry is then projected onto the anchor planes and resulting curves serve as a basis for the anchor points that the robots use for the construction process.

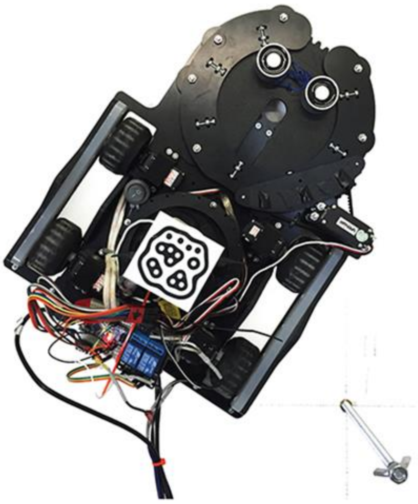
At the current state the system proposed is capable of creating room scale installations that can support a human. If the project was to be continued, a larger scale fabrication process could be achieved. One can imagine a more robust version of the proposed machines constructing enclosures and walkthroughs using buildings in a city as the formwork structure.



up concept

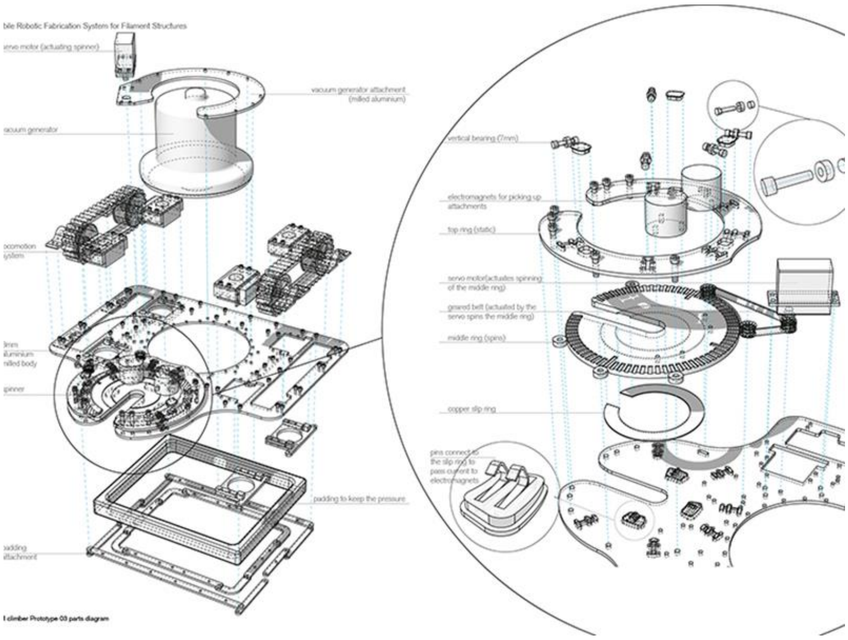


tory of the prototypes. *From prototype a simple 2 wheel locomotion system to l fully functional robotic prototype*



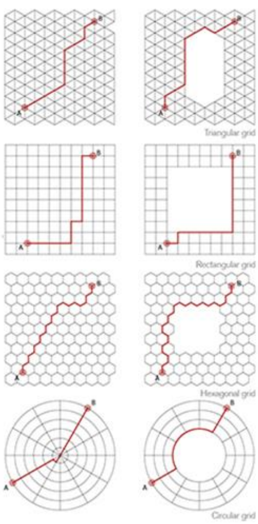
al robotic Prototype and the anchor hook

bile Robotic Fabrication System for Filament Structures

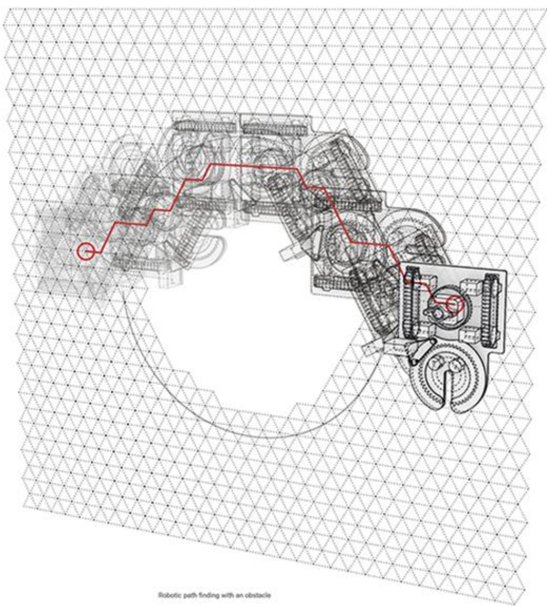


l climber Prototype 03 parts diagram

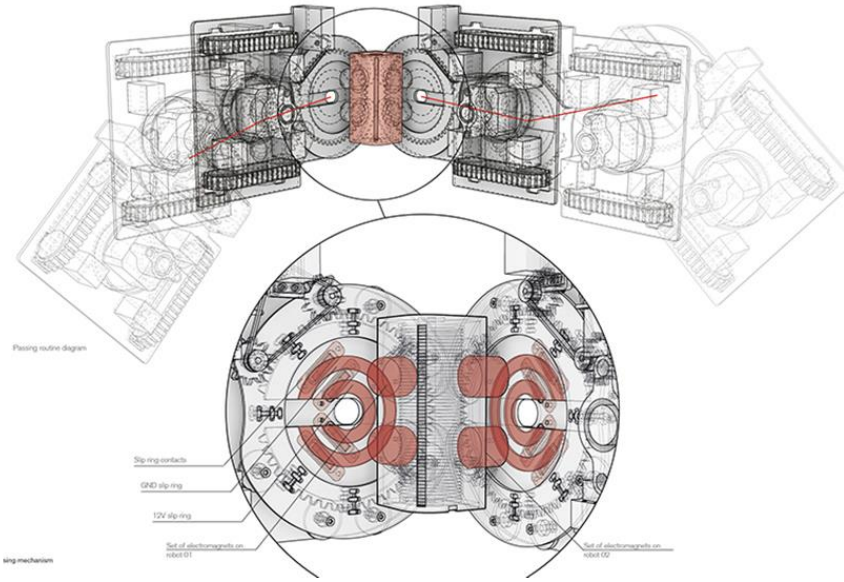
Mobile Robotic Fabrication System for Filament Structures



Comparative analysis of grid geometries for optimal pathfinding with simple obstacles



Robotic path finding with an obstacle



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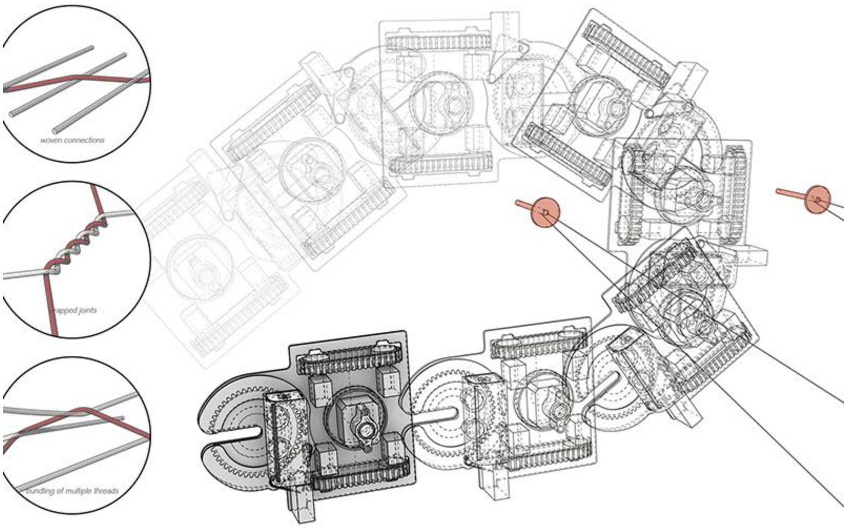
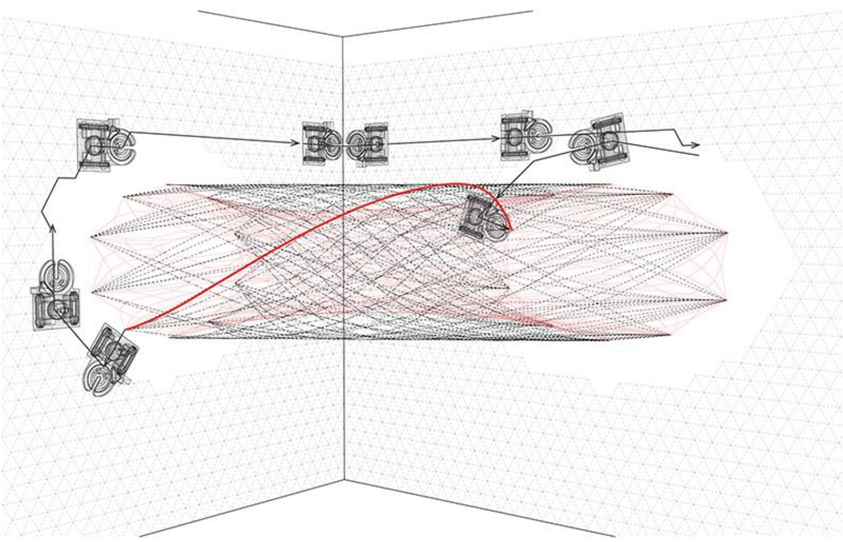
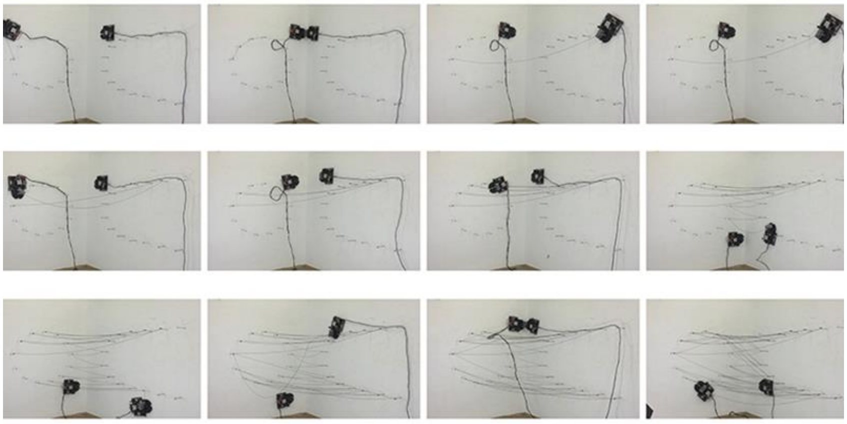


al manipulations achievable with
noeuvring routine

Manoeuvring between anchor points diagram



robotic path diagram



al prototype timelapse

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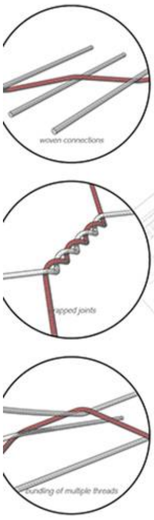

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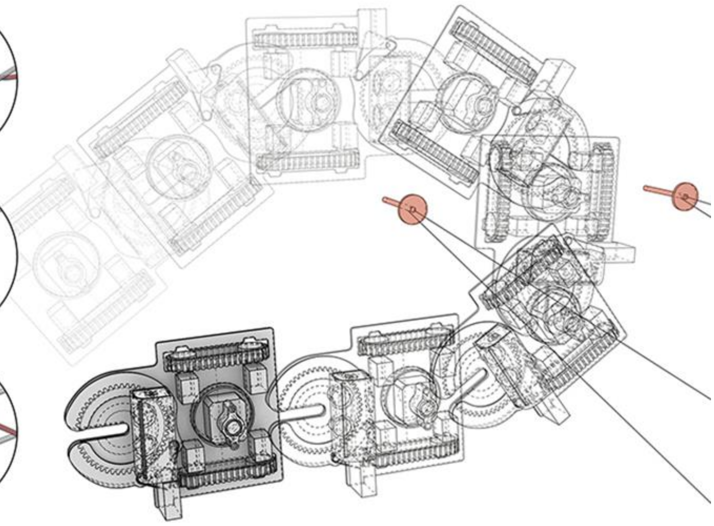

Manoeuvring between anchor points diagram

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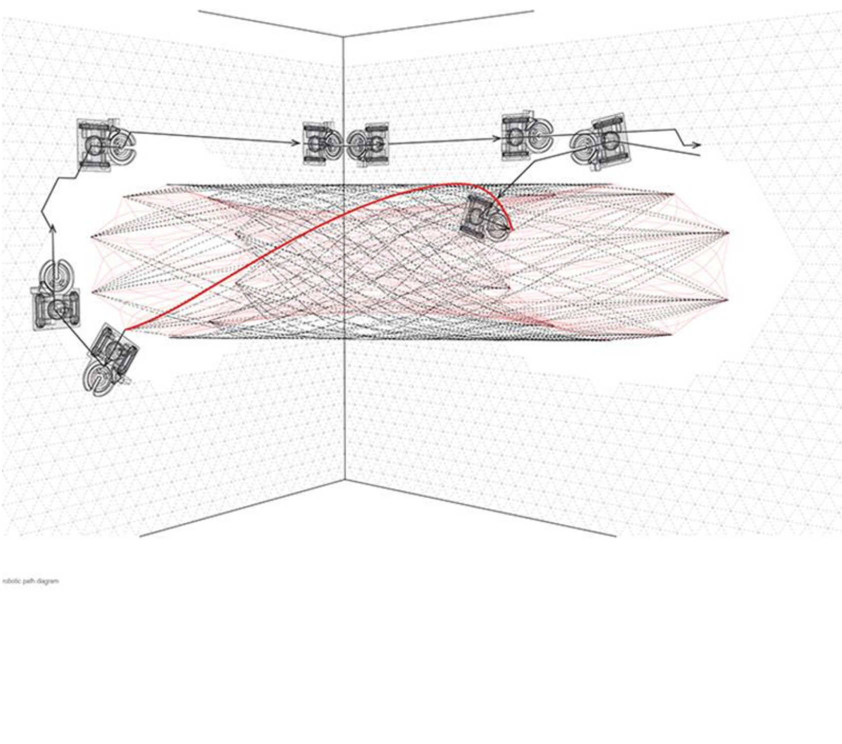

robotic path diagram

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