



The class will
start at 16h15

Also part of :



sia

Schweizerischer Ingenieur- und Architektenverein
Société suisse des ingénieurs et des architectes
Società svizzera degli ingegneri e degli architetti
Swiss society of engineers and architects

 Dimitrios Terzis

An aerial photograph of a city waterfront, likely New York City's Hudson River. The image shows a dense cluster of skyscrapers on the left, a wide river with several sailboats in the center, and a green park area with a path and trees on the right. A blue rectangular box is overlaid on the right side of the image, containing the title text.

Innovation for construction & the environment

A solid black rectangular box used as a background for the speaker's name.

Dr. Dimitrios Terzis

05/11/2024

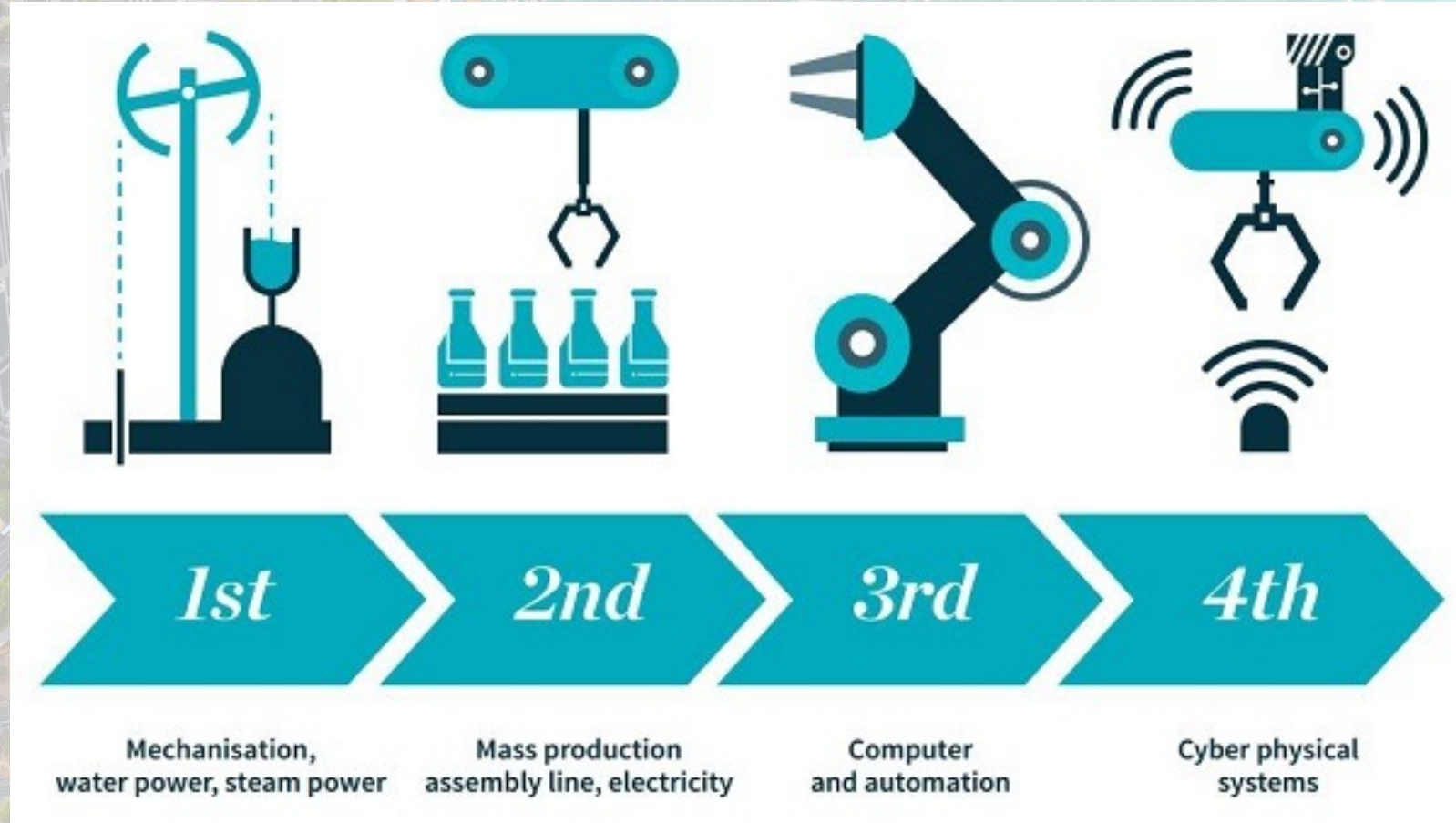
Today's class

- 1) 3D printing and sustainability / Lessons from Mobbot
- 2) S-curves and pivoting while innovating
- 3) Parametric design

Today's class

**If you went to bed last night as an industrial company,
you're going to wake up today as a software and analytics
company.**

Jeffrey Immelt, former CEO of General Electric



The four Industrial Revolutions (Source: [Marcellus Drilling](#))

Understanding the scale of natural resources depletion

50bn tonnes of sand and gravel extracted each year, finds UN study

Calls for international standard on extraction and better monitoring of most-exploited resource after water



📷 A front loader is used to clear and area for sand mining on a dried lake bed in Jiangxi province, China. Photograph: Aly Song/Reuters

Humans extract 50bn tonnes of sand and gravel every year, according to UN research, enough to build a wall 27 metres high by 27 metres wide around the planet.

Sand is the most-exploited resource after water. But unlike water, it is not recognised as a key strategic resource by governments and industry, something, the UN says, that must change and fast.

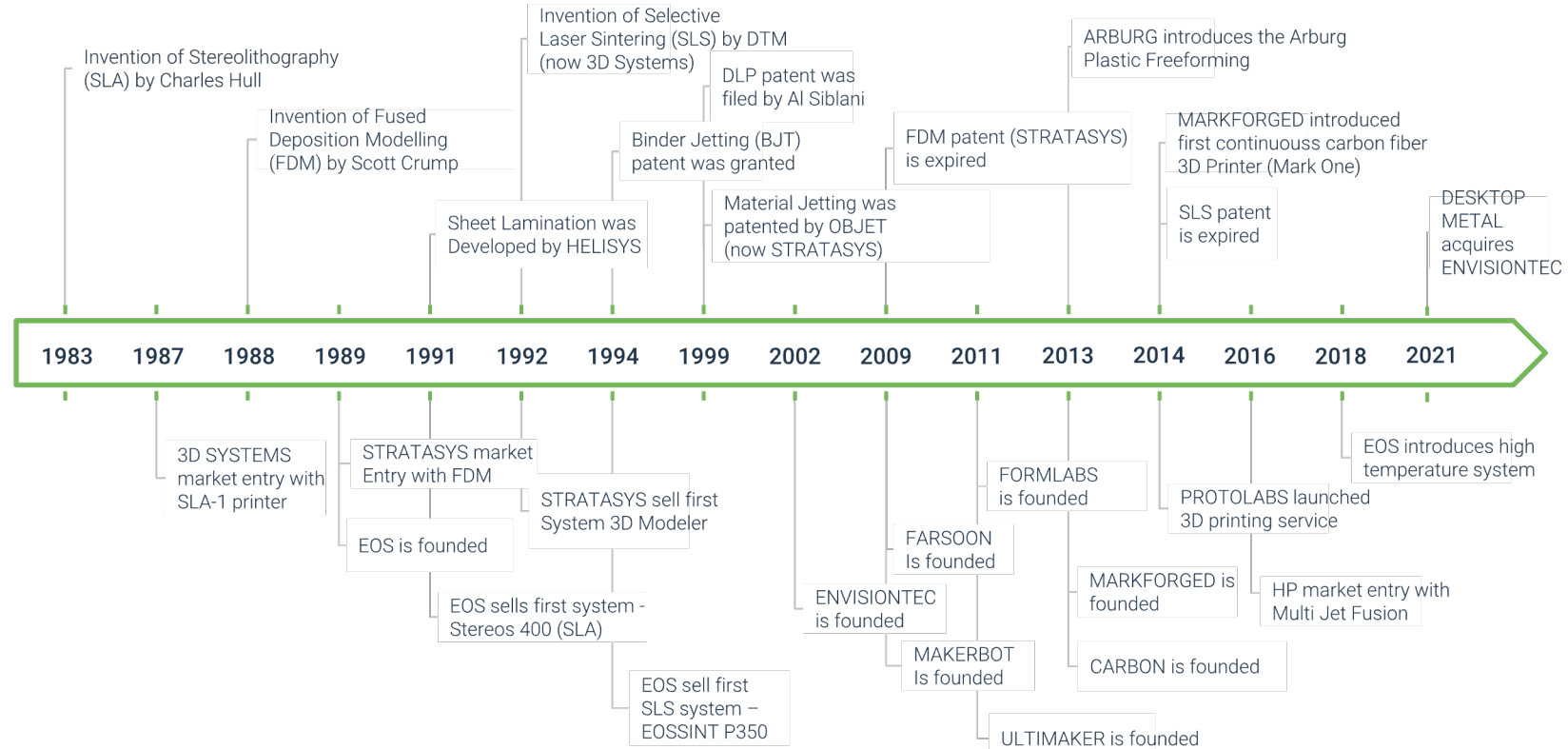
Understanding 3D printing



Source: <https://parametric-architecture.com/apis-cor-completes-the-dubai-municipality-largest-3d-printed-construction/>

Understanding 3D printing implies understanding additive manufacturing

Polymer Additive Manufacturing History



Overall, the link between 3D printing in construction and additive manufacturing is that 3D printing is a specific application of additive manufacturing technology within the construction industry. It leverages the principles of additive manufacturing to create customized, efficient, and often innovative building components and structures.

Understanding 3D printing through a Swiss-made example



AUTOMATION AND ROBOTICS OF SPRAYED CONCRETE

Using less concrete for
Sustainable
infrastructures

Concrete is the second most consumed material on Earth and is responsible for massive CO₂ emissions

Concrete consists of cement, sand, aggregates, and water.

Cement is responsible for 7% of the global CO₂ footprint.

Beside this the world is running out of crucial commodity which is sand.

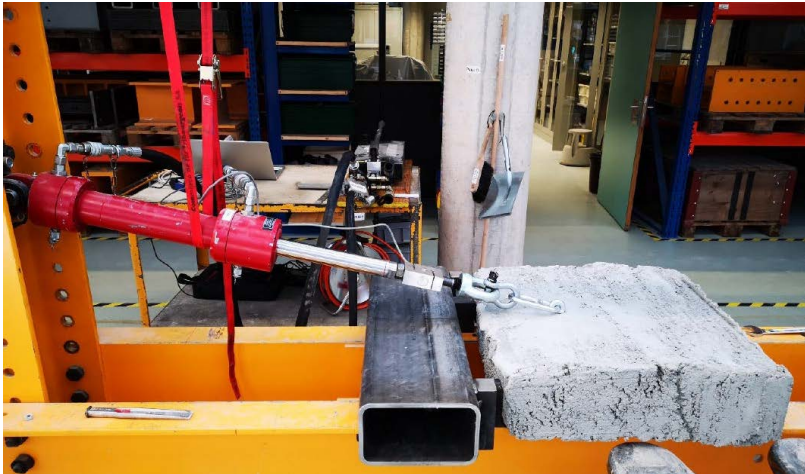
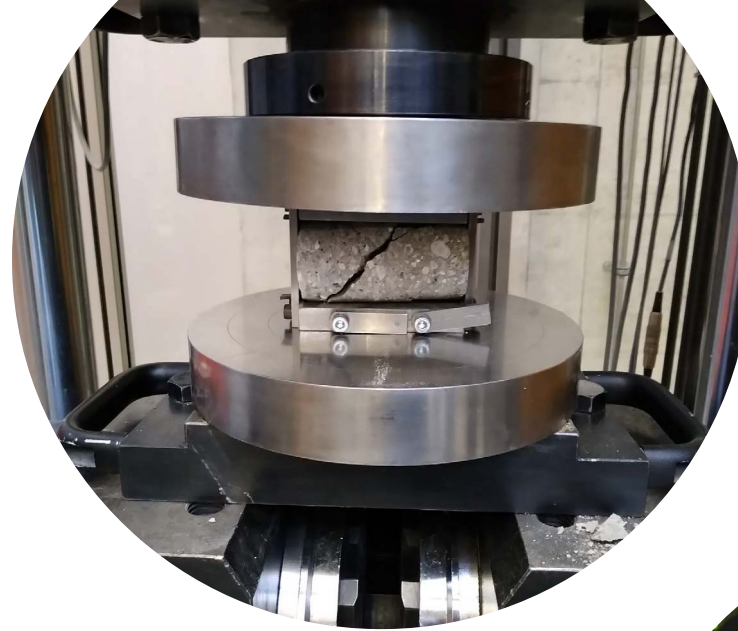
We therefore need to reduce the consumption of concrete on a global scale and use construction materials in a more efficient and sustainable way.



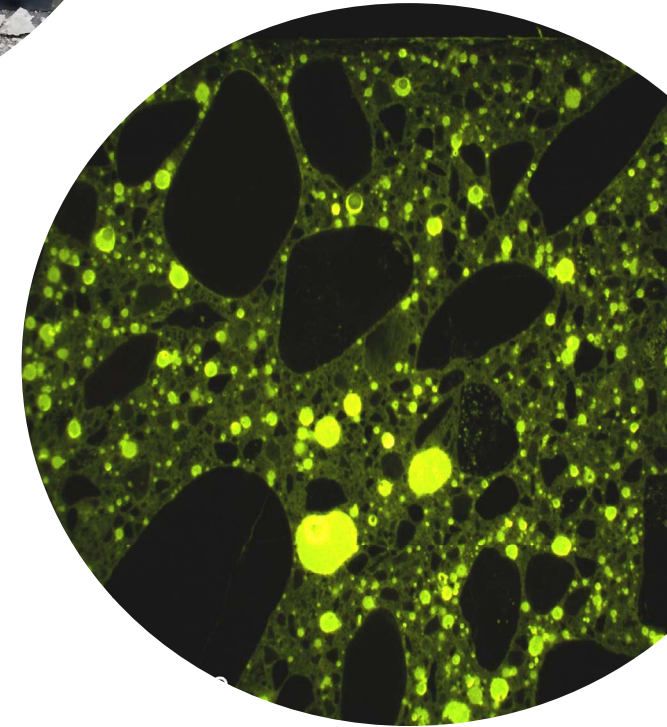


But what about our working processes, are the really efficient and safe ?

Key features of mobbot 3D printing technology



- Sprayed material
- Aggregates Ø 8mm
- Use of local sand, aggregates, cement
- Waterproof products
- No “cold joints”
- Integration of rebar / reinforcement
- Conventional structural dimensioning
- Integration of anchors
- High durability (Freeze, Thaw, Cl etc)
- Versatile methods

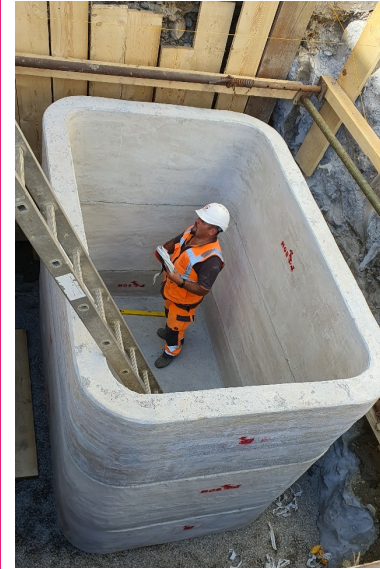


Comparison of 3D concrete printing

“traditional 3D concrete printing”

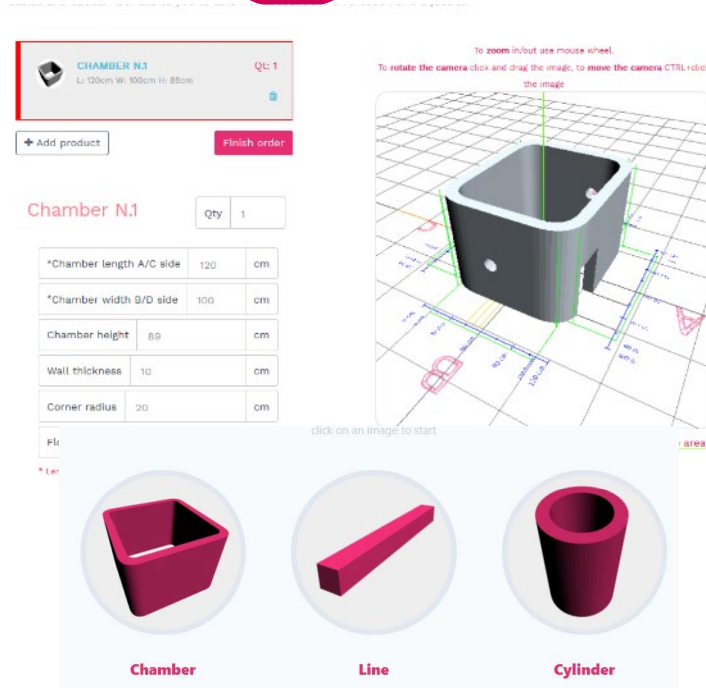


- Extrusion of fine and special mortar Ø 2-4mm
- High price of raw materials
- Weaknesses between the layers = cold joints
- Not compatible with existing standards
- No rebars



- Sprayed concrete Ø 8mm
- Conventional concrete and recycled material up to 45%
- Price of raw material
- Monolithic elements
- Compatible with standards
- Integration of traditional rebars
- Watertight

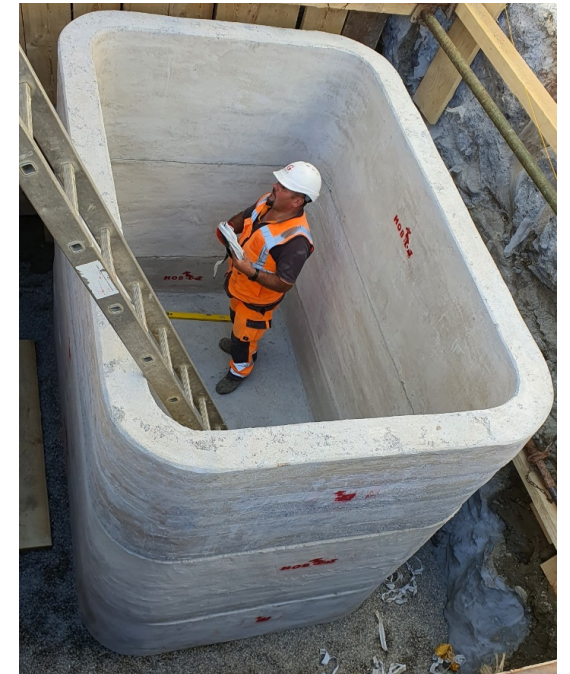
We have developed a robotic system that enables to design, fabricate and deliver concrete elements within 24 hours using less materials



Design

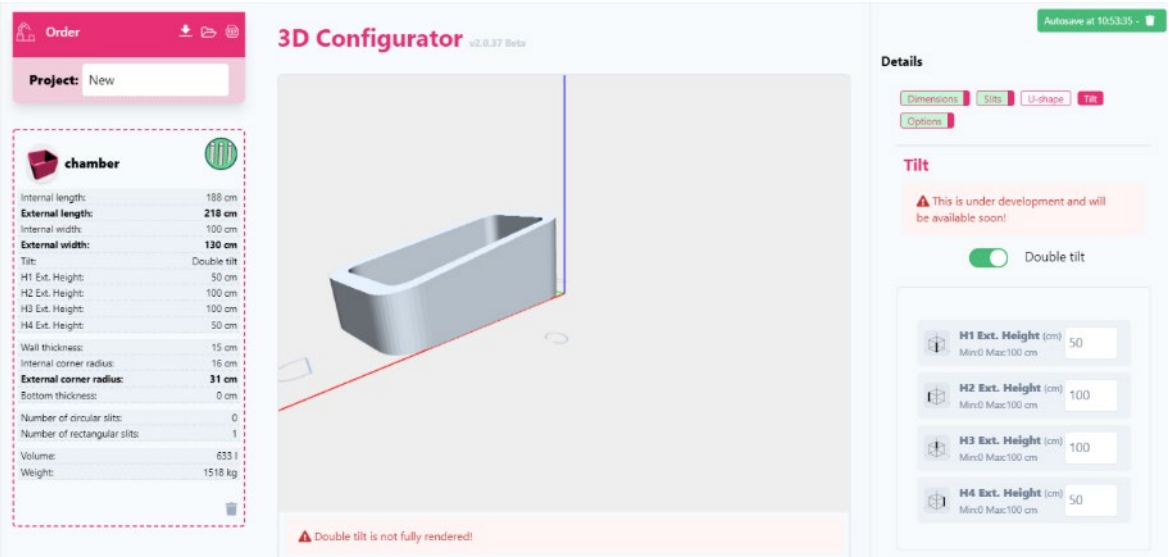


Sprint

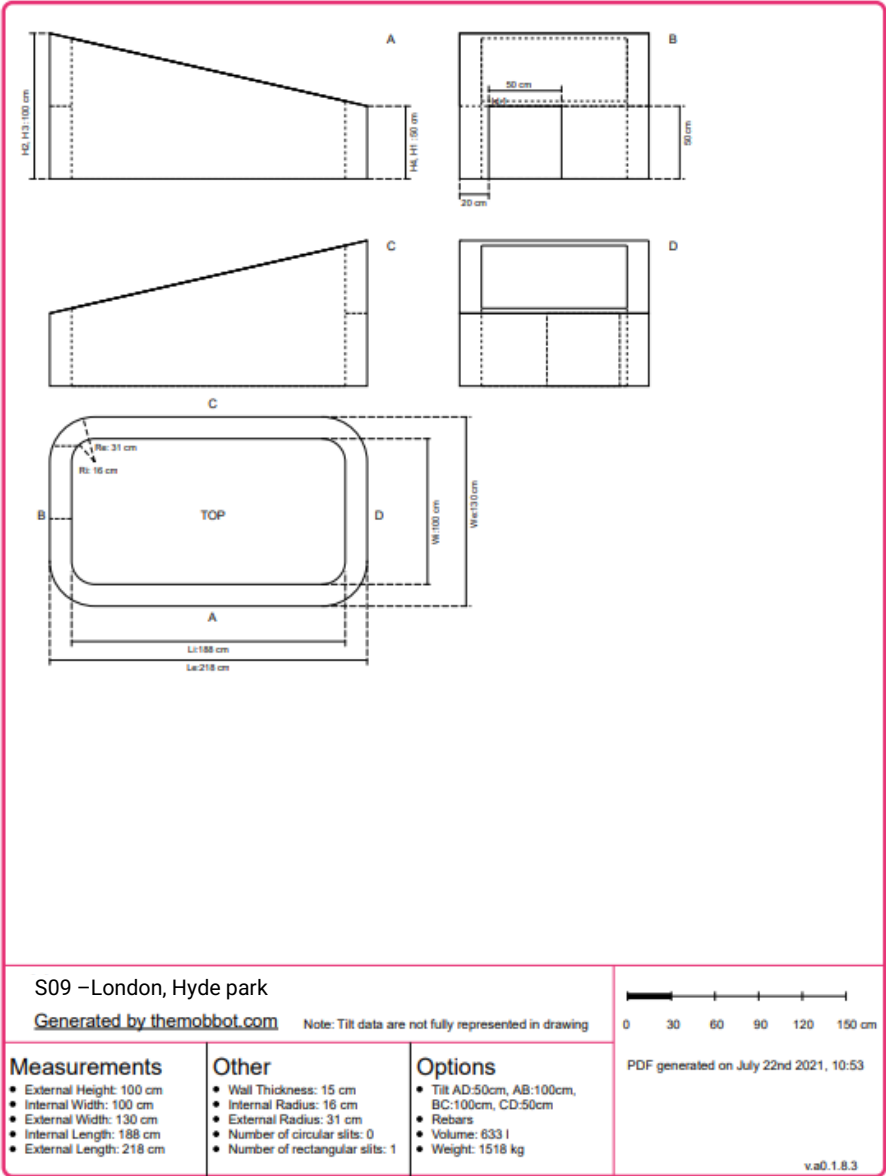


Delivery

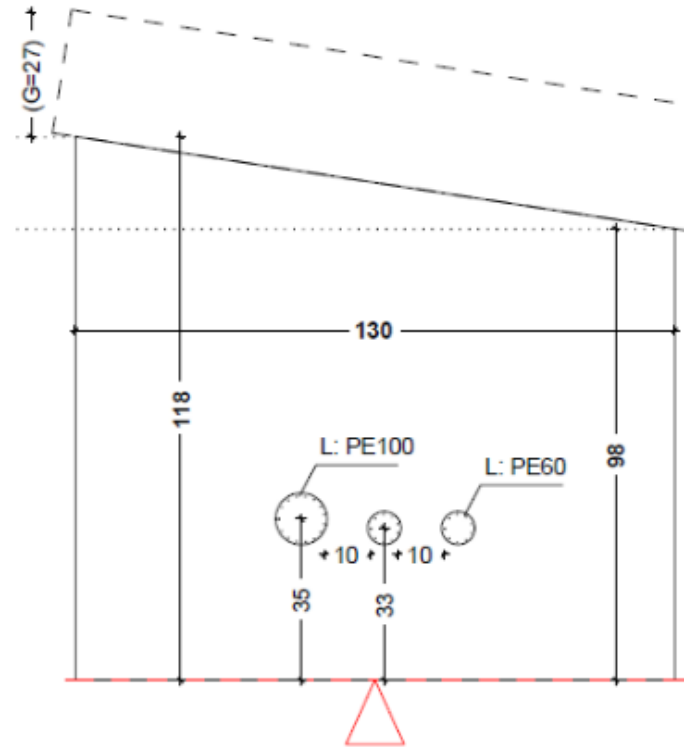
Digital design with an online configurator



[PRODUCT CONFIGURATOR | themobbot.com](https://themobbot.com)



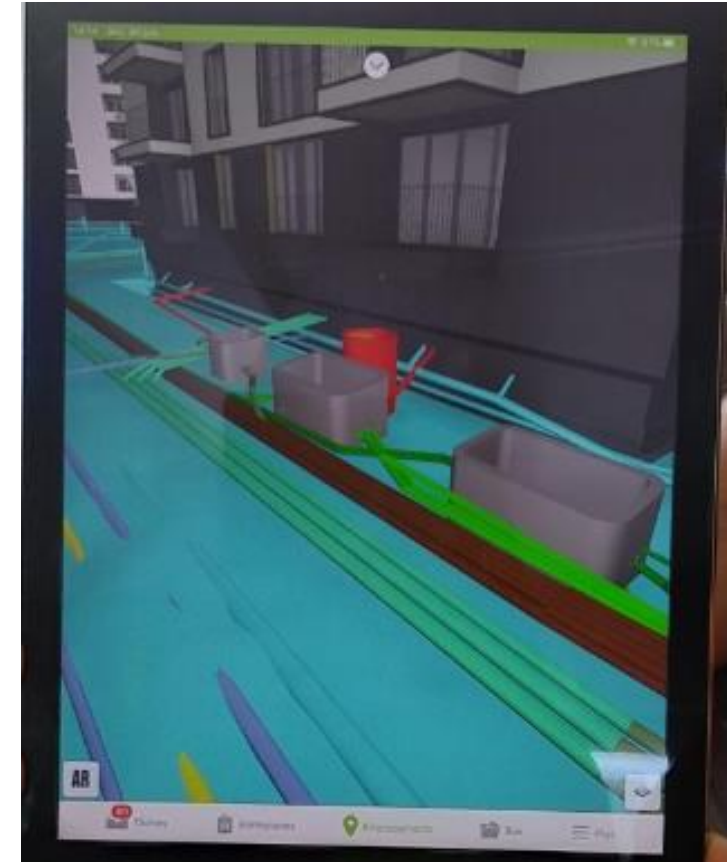
But we can use and generate BIM model



Project owner:



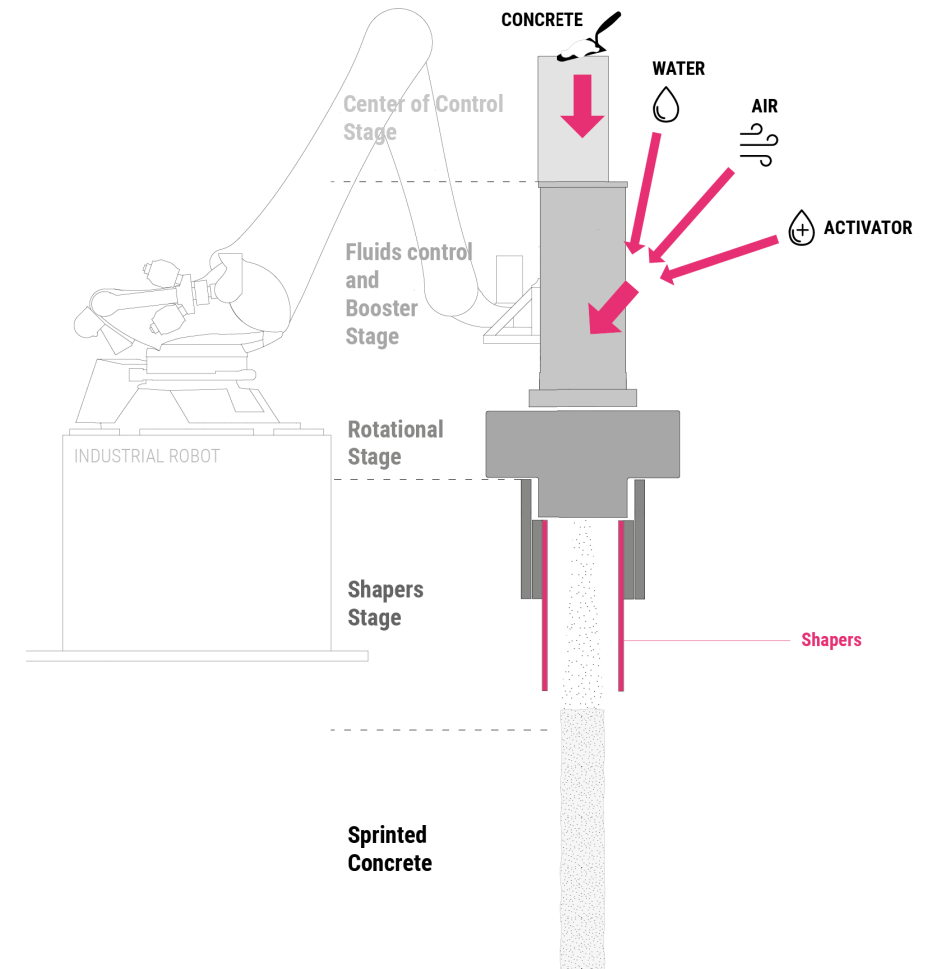
Contractor:



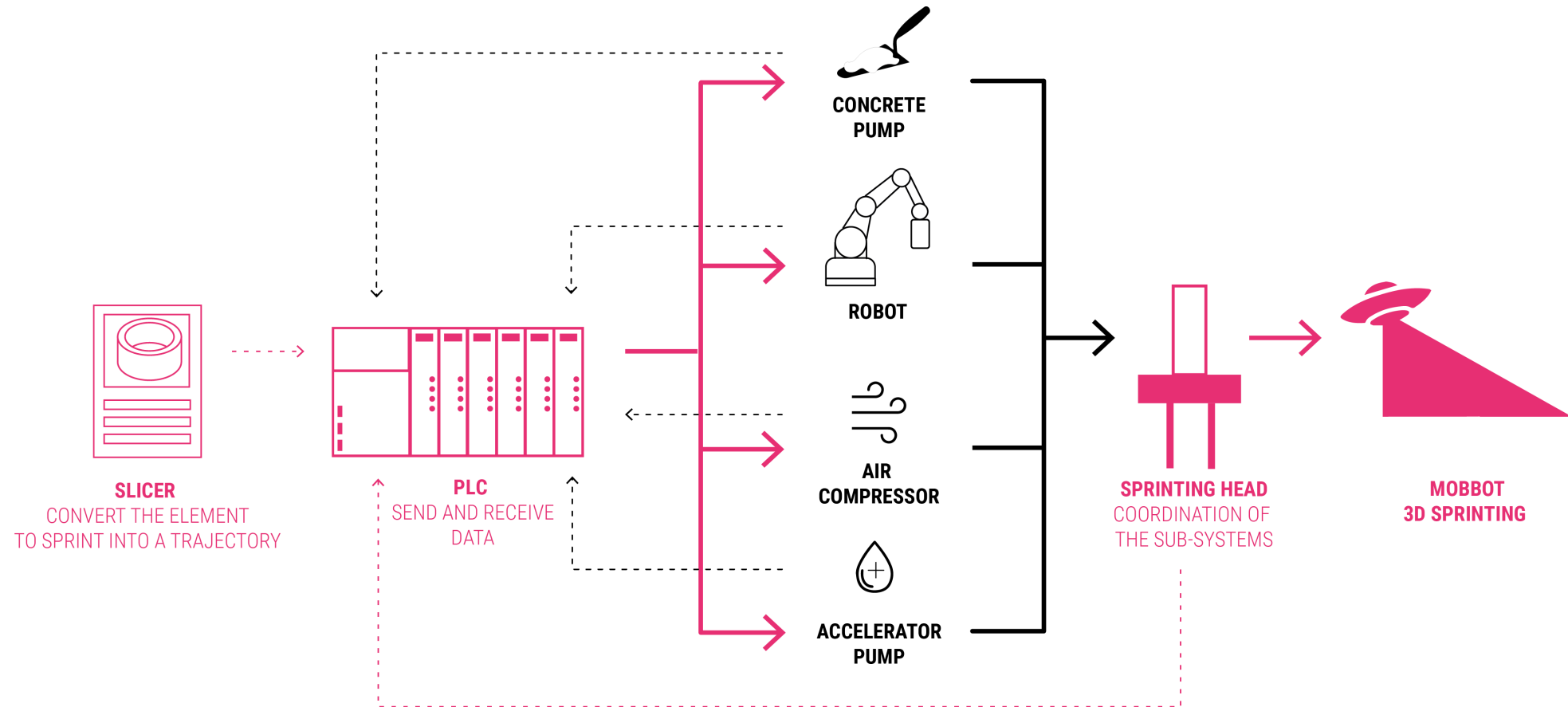
Benefits :

- Solution « Plug & Play »
- Integration in BIM and georeferenced
- Ergonomic and safe for workers

So how does the system work ?



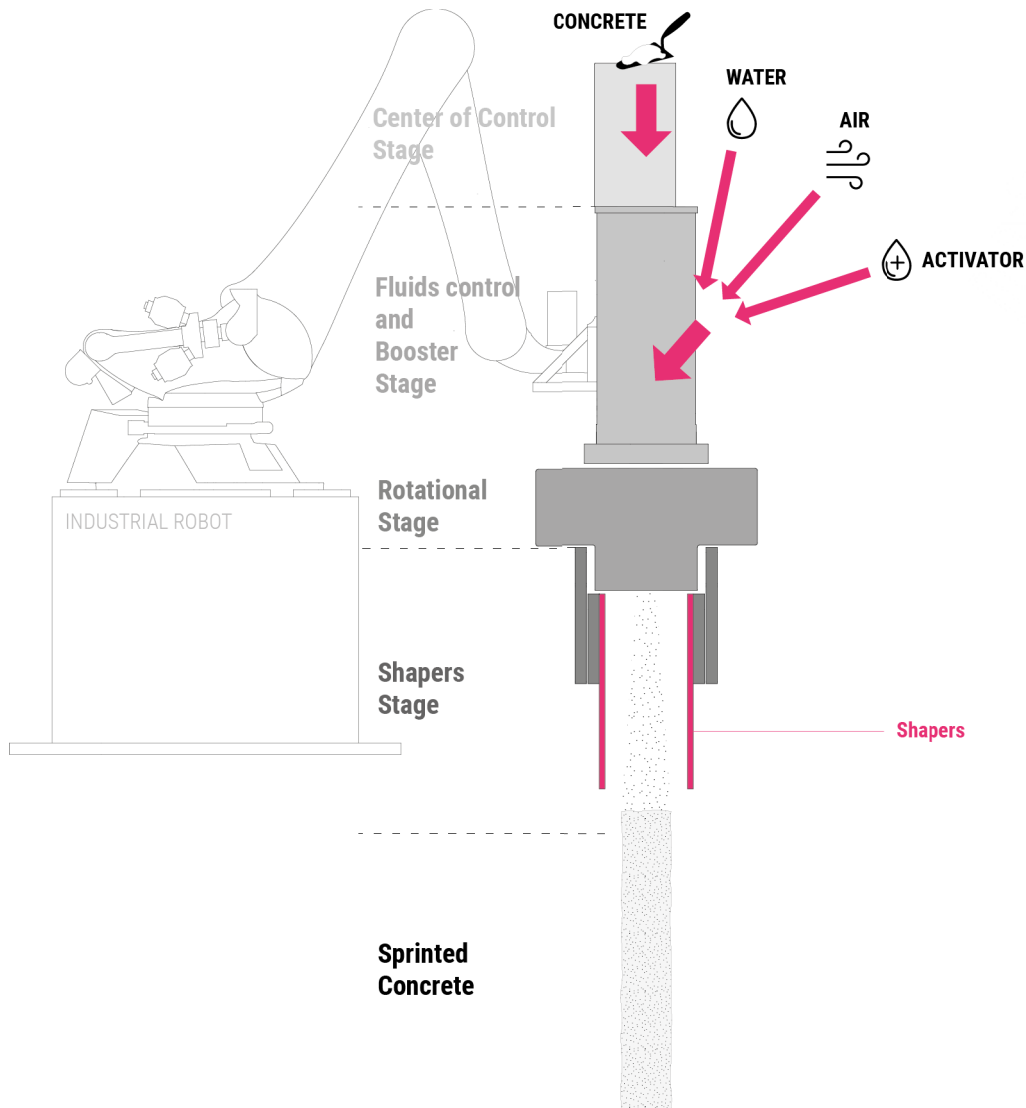
How does it work ?



We combine additive and subtractive methods



Why does it work well?



Our know-how lies in the modelling, simulation and prediction of the concrete flow to have optimum strength performance. To do so, we control:

- Spraying angle control
- Speed control
- Flow and pressures

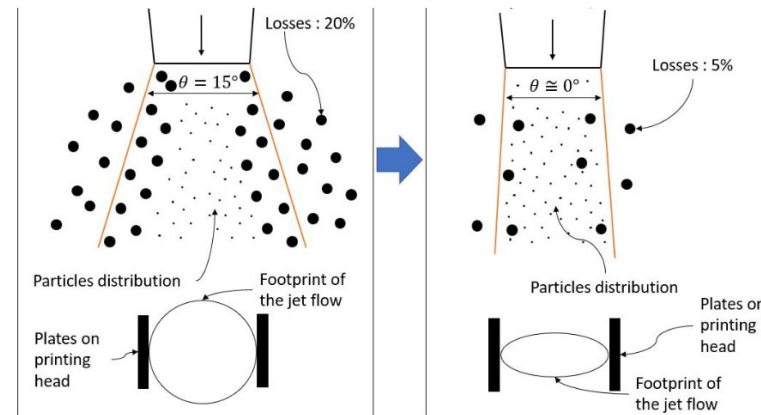


Image 1: standard nozzle



Image 2: Mobbot nozzle stage 1



Image 3: Mobbot nozzle stage 2

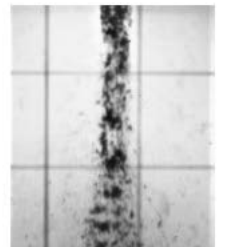
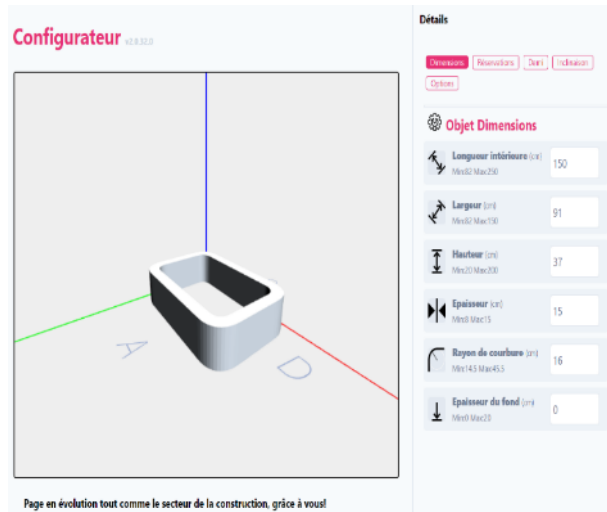


Image 4: Mobbot nozzle stage 3

The benefits for the customers

Online design



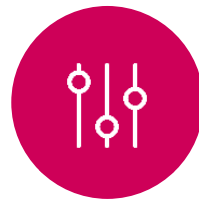
Offsite
production



New value
chain



Installation



Flexible



2 hours
instead of 2
days



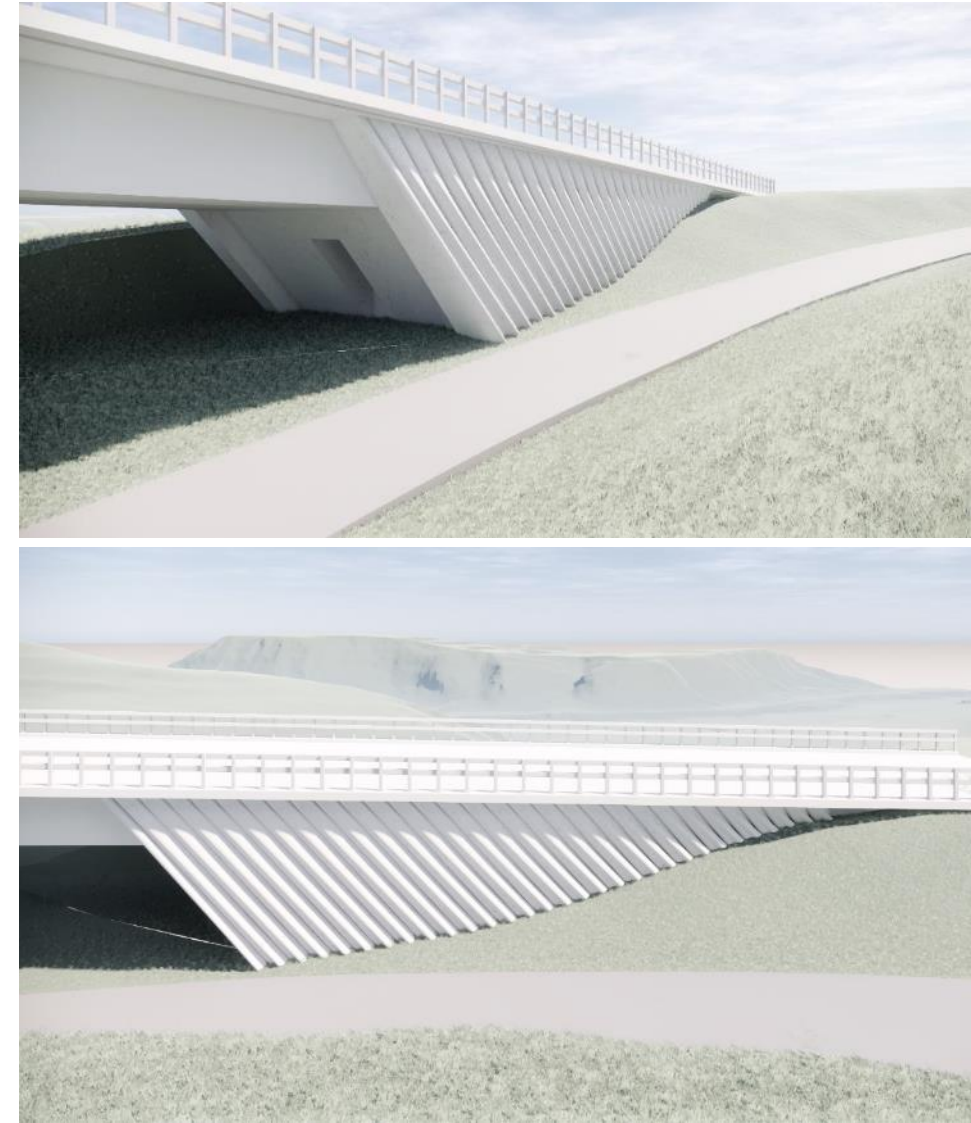
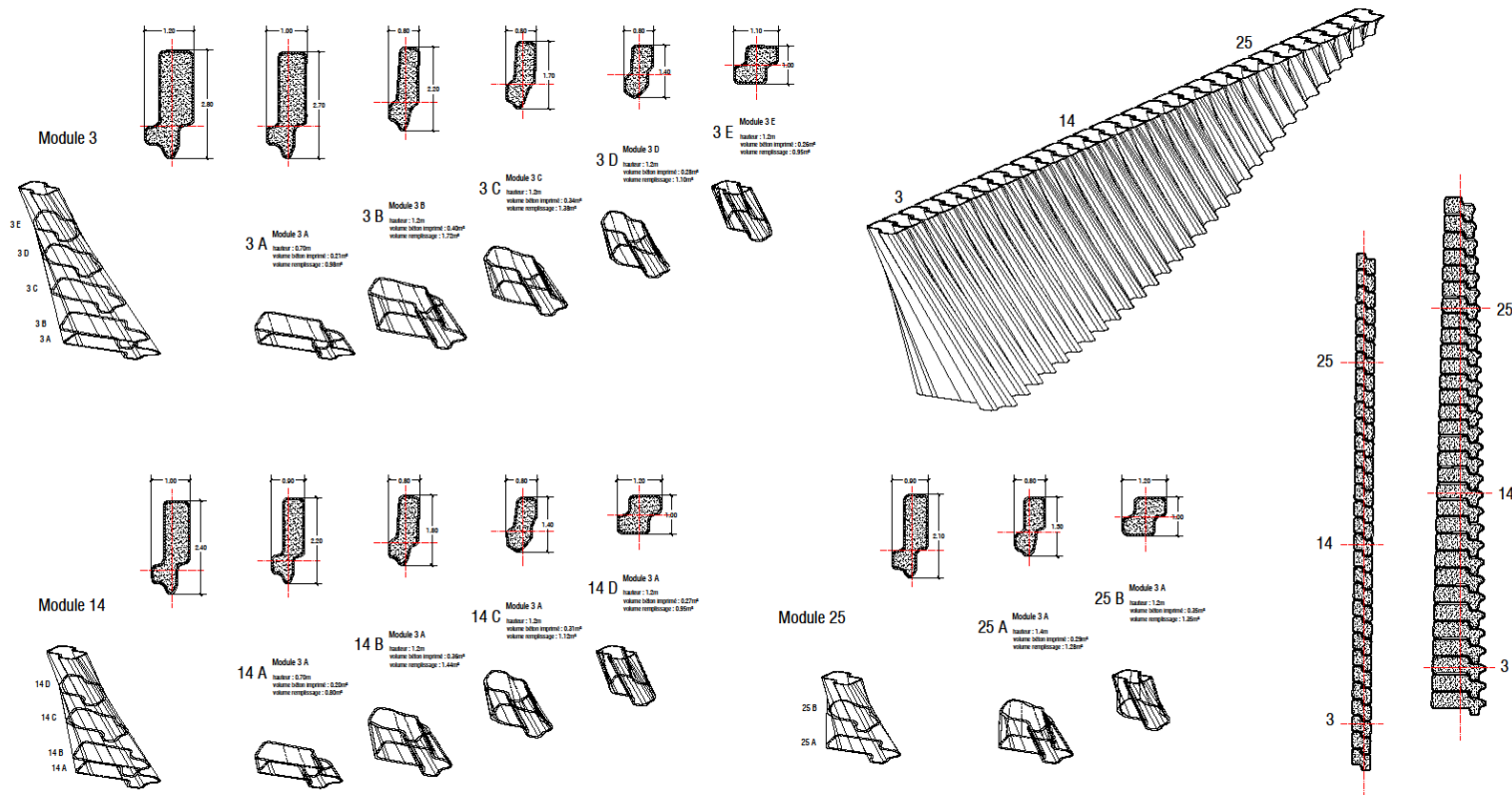
> 30-50%
less CO₂

Today the method is used for telecom, railway, energy and water utilities



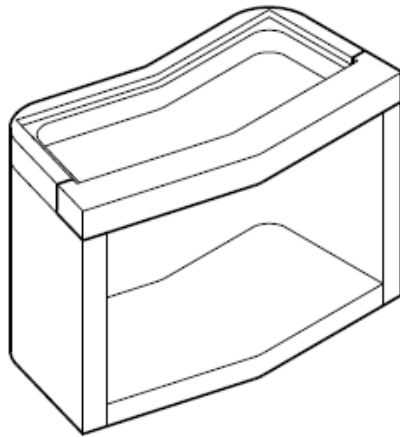
Chesalles Bridge – Fribourg -CH

MARC MIMRAM | ARCHITECTE DPLG
INGÉNIEUR ENPC



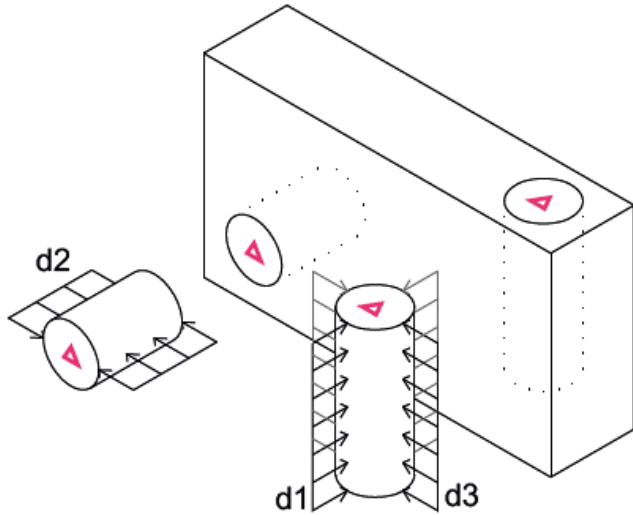


Other possibilities



What is unique with MOBBOT

Isotropic performances



*Brazilian splitting test

Conventional concrete & Local raw materials



Rebars integration



How 3D printing integrates into circular economy

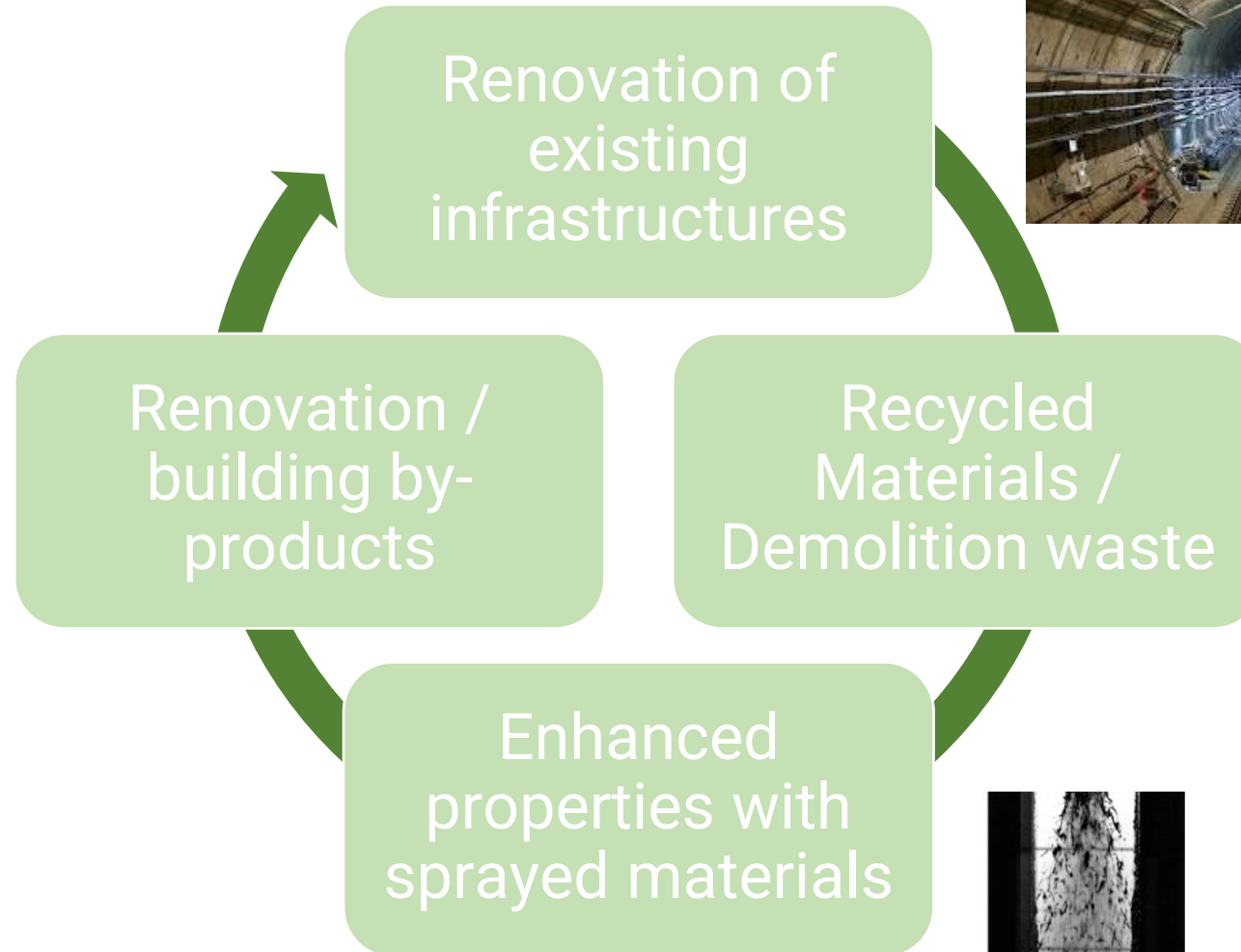


Image 1: standard nozzle

Unique value proposition



Digital design and personalised elements



Optimized concrete performances



Precast offsite production



Recycled materials



compatible with a large amount of raw materials type

Temperature: 4 – 30 °C

Humidity 37-70%

MOBBeton

0 – 4/8 mm

Local raw materials

RMX Fribourg

0 – 8 mm

CEM II 42.5 N

Premix A

0 – 2 mm

High Sulfate
resistant
C3A<8%

Customer

0 – 8mm
grey / white

Local raw material
CEM I 52.5 N/R
CEM II 52.R

Customers

0 – 8mm
Grey

Up to 45% recycling
aggregates
Susteno



We turn data into
sustainable construction



Our vision

At Mobbob, we **empower the construction** industry to build the required **next generation sustainable infrastructures**.

Using our unique **digital construction technology and data** our clients have a way to build robust and innovative construction elements with a climate-first priority for all.

Our company in a nutshell

Mobbot

- ❖ Founded in 2018 in Switzerland
- ❖ Headquarters in Fribourg, Switzerland
- ❖ 8 employees

Awards

- ❖ Winner 1st Prize - Swisscom IoT Climate Award 2022
- ❖ Top 100 Swiss Startups 2020, 2021



Successful market introduction and development potentials

Hundreds of civil engineering elements executed according to the swiss construction and safety standards

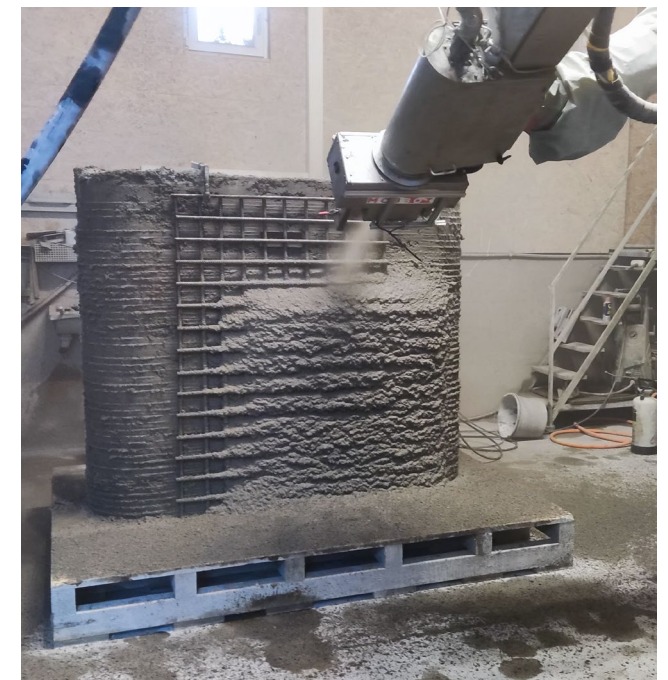
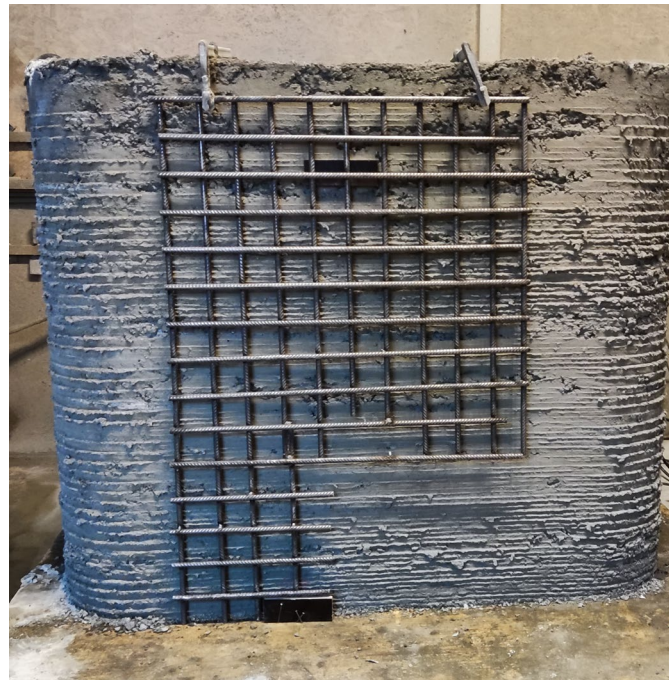


The method offers unique possibilities to integrate structural reinforcement

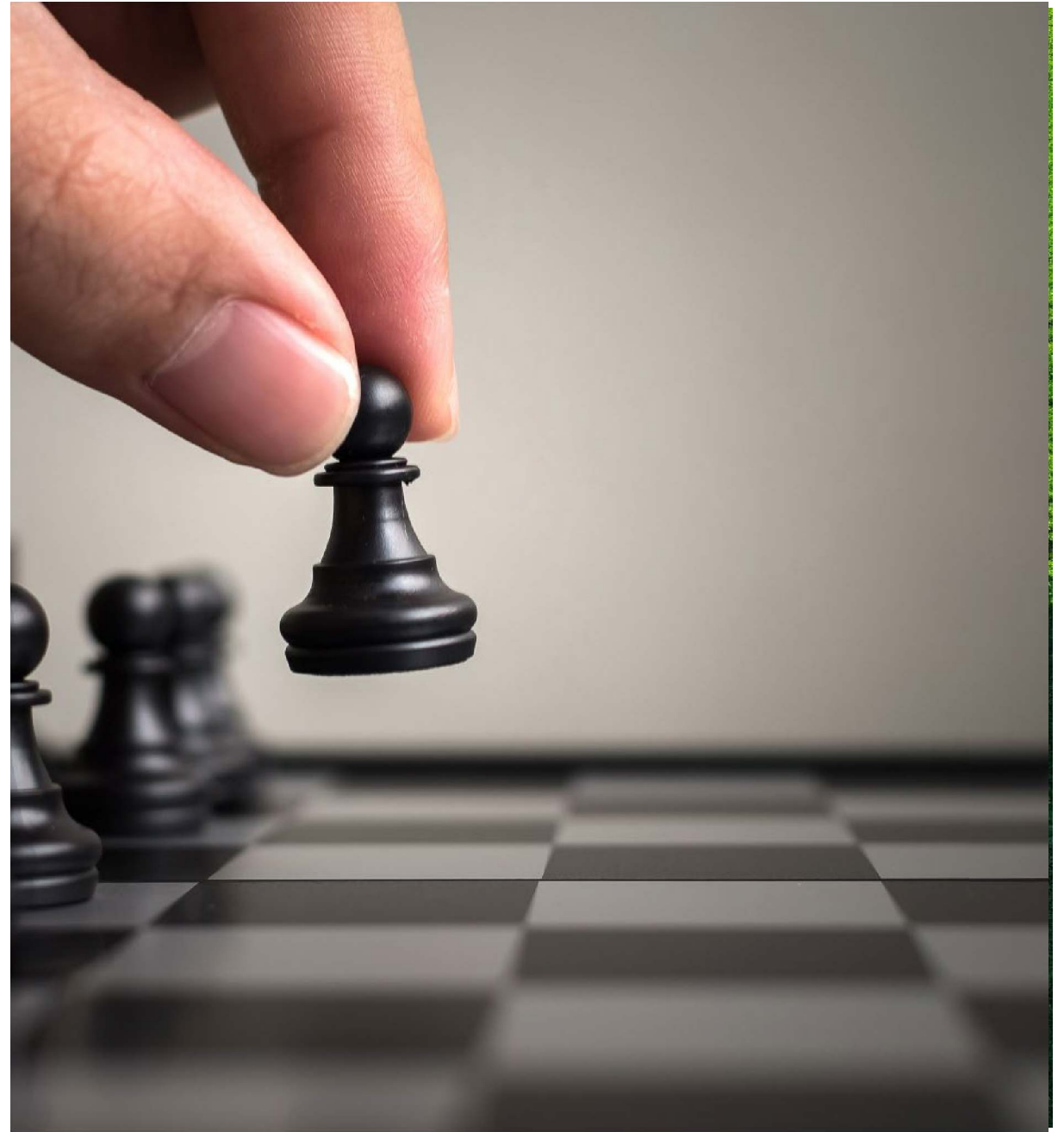
Rebars \varnothing 14-16mm, sp. = 10cm

No rebar phantoms

Rebound: < 5%



Is the business scalable ?
Is the market ready ?



**Are there
opportunities in
other segments?**

The challenges of underground projects

No visibility on operations

Spraying managed by
feeling

High overuse of concrete

Health and safety issues





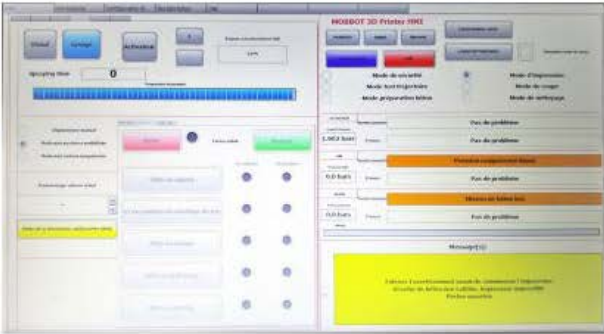
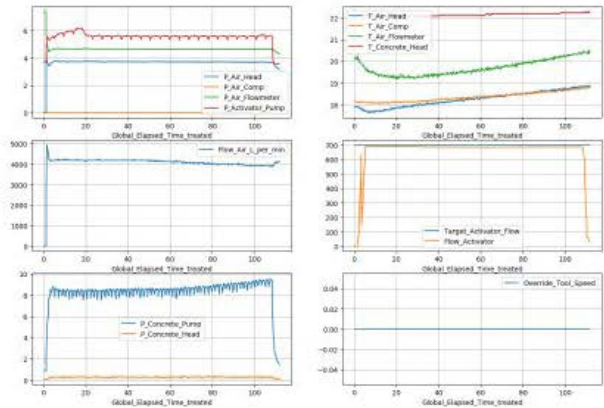
Tons of concrete
wasted

What could we offer to these contractors ?

Waste reduction thanks to nozzle geometry and aerodynamic optimization



Process and equipment efficiency with real time data control



Automation of existing equipment
Use of our automated spraying equipment

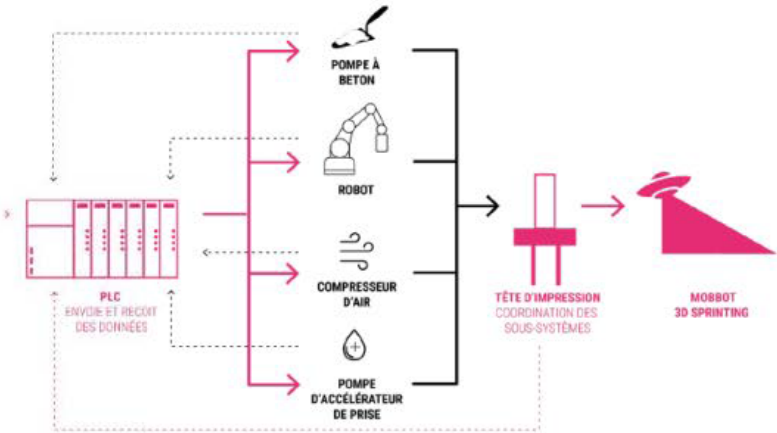
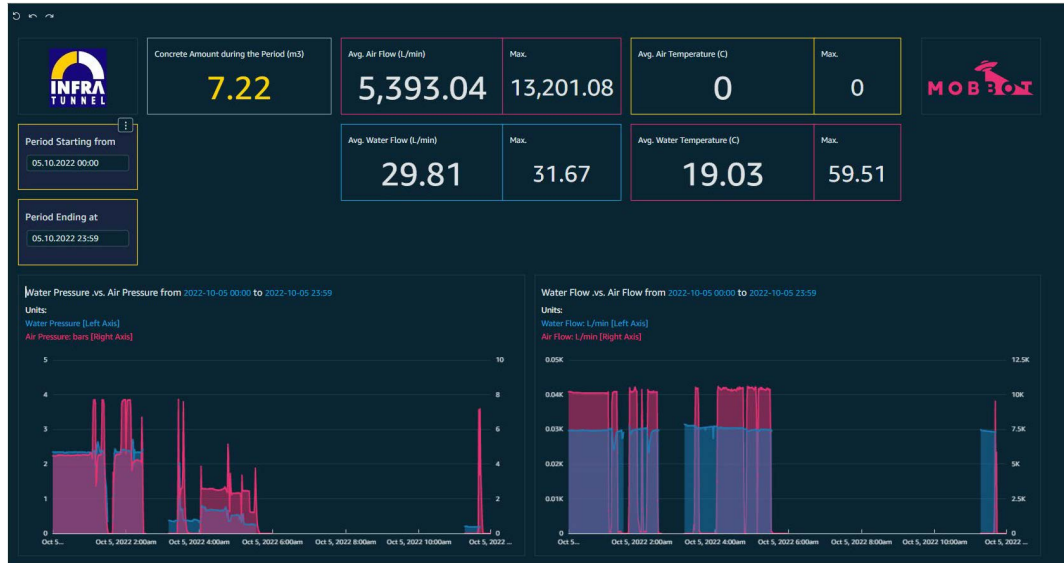


Image 1: schéma plc et sous-systèmes

The pivot toward underground projects



Turning data into material and time savings

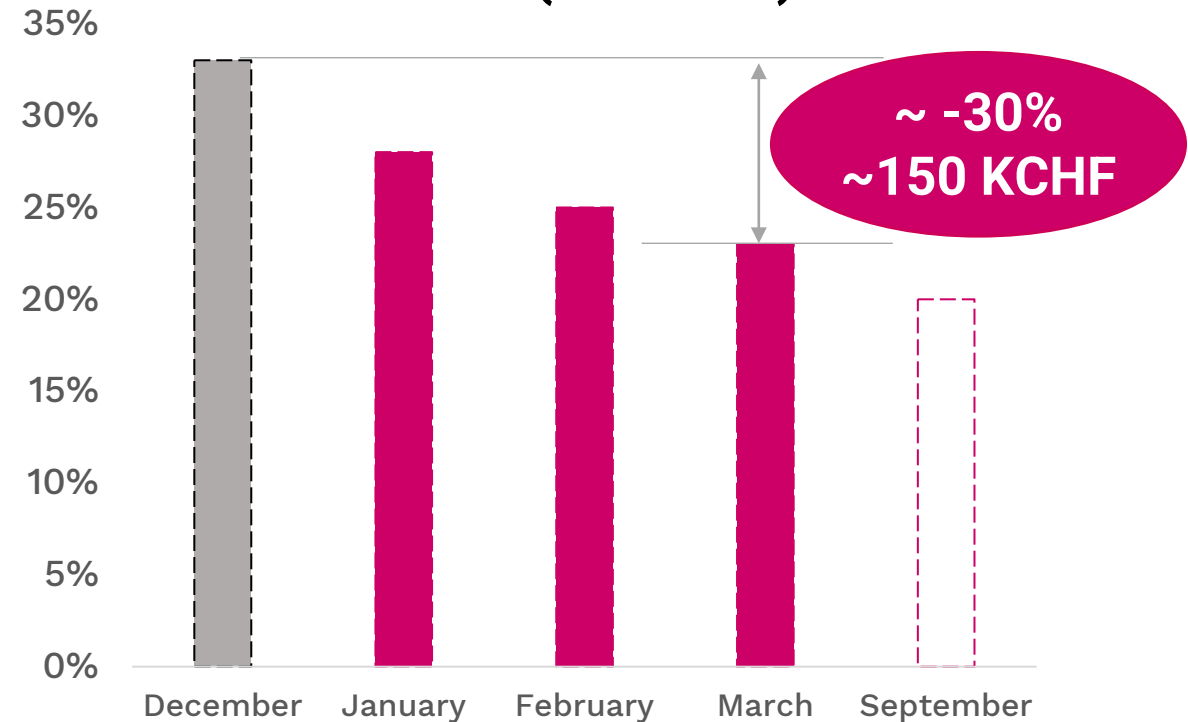


“The monitoring system is an aid to standardize spraying practices to **optimize spraying phases and identify equipment usage issues**.

The **real-time visualization**, allows the foreman and myself to follow the spraying phase and intervene if necessary to **correct usage**.

M. Petit, Head logistics and machine, InfraTunnel

Rebound (= waste)



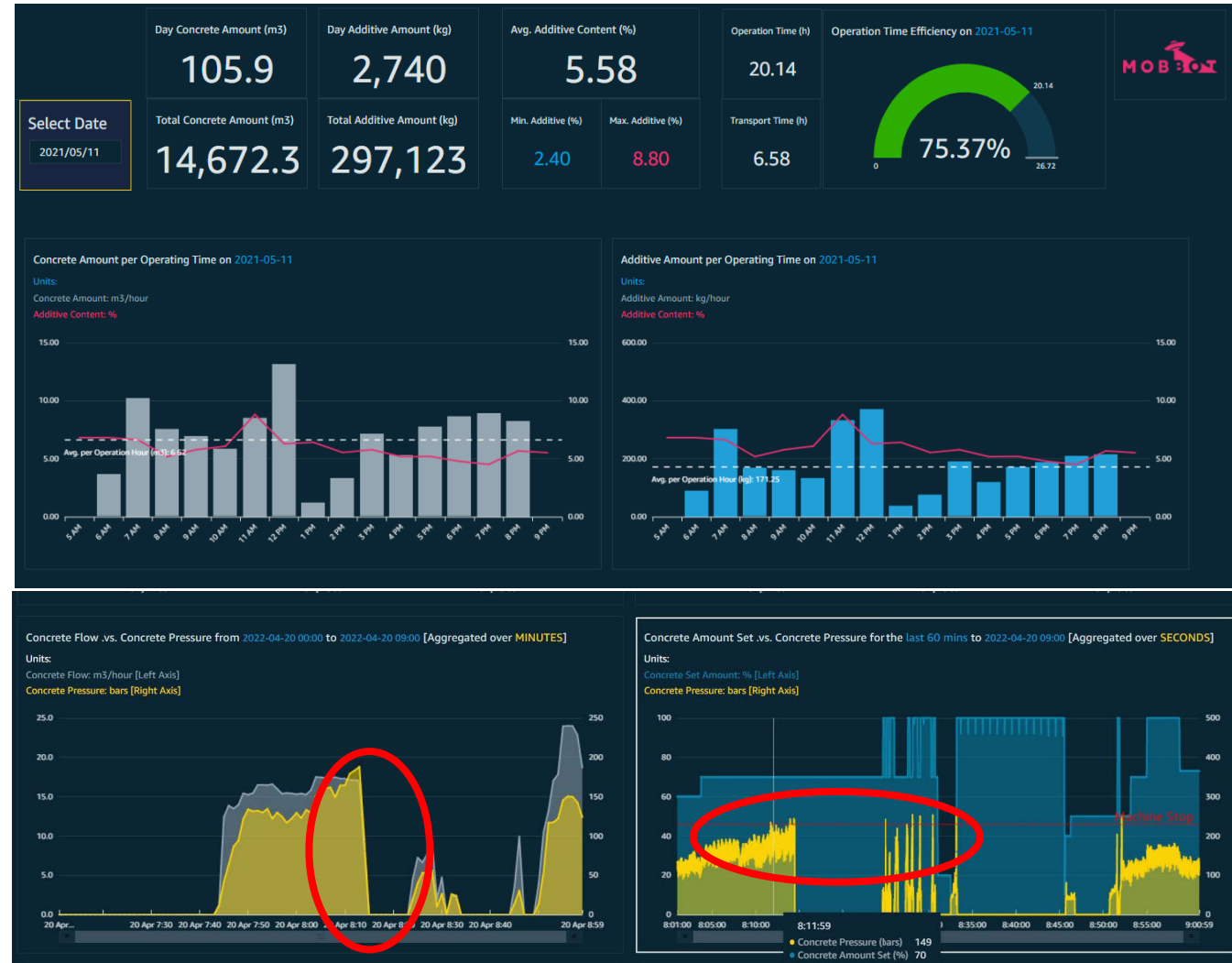
Remote access to your spraying data

Product

- Data acquisition frequency 10 Hz
- Daily reports
- Alerts send automatically
- CANBus port
- Help in the identification of problem
- Customizable interface
- Machine errors for technical service support
- Historical data for quality assurance

Benefits

- ✓ Visibility on spraying data
- ✓ Save time in the resolution of problems
- ✓ Predict clogging (under development)



Note: We analyse your data, develop algorithm to identify and classify problems and customize the output to your need – Also available for TBM spraying data.

Real time monitoring and immediate feedback

Interfaces



Fieldbus Interface
to construction
equipment

Software



IoT for machines and
operations

Benefits:
Analysis and corrective
measurement

Unique Sensor Technology



Distance to Excavated
Profile sensor

Benefits:
Reduce concrete
waste



Immersive
Thickness control
Device

Benefits:
Reduce concrete
consumption

DEP™ – Distance to excavated profile sensor

Description

- Real-time nozzle distance to wall
- Provide a real time feedback to the operator
- Data available in a dashboard
- Ideal for training purposes

Benefits

- ✓ Reduction of rebounds
- ✓ Increase learning curve
- ✓ Save time

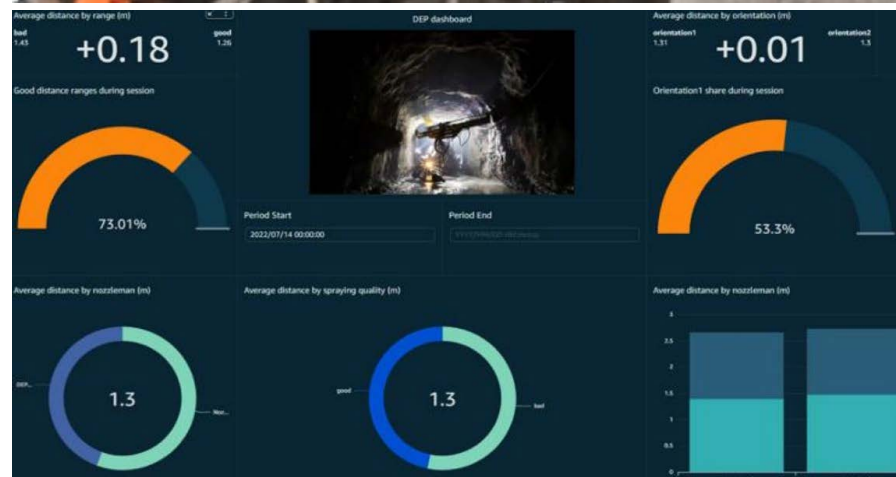


Distance to excavated profile sensor



Auto wash with air/ water

Light signal on/off when distance is outside of the set range



Dashboard for teaching purposes

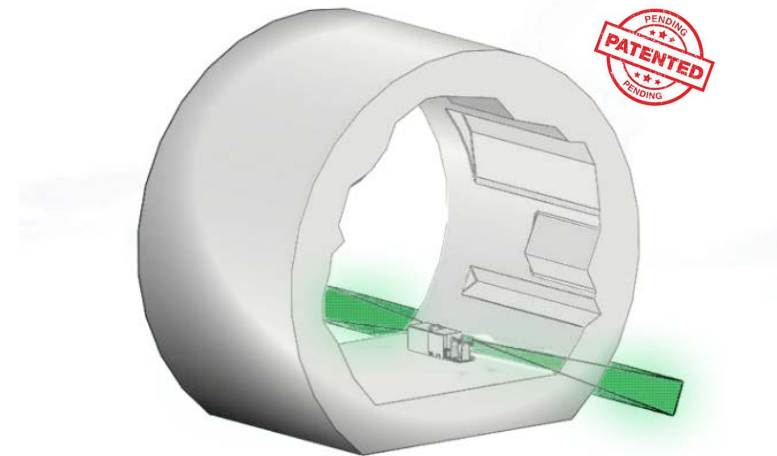
Thickness measurement in real time

Product details

- Scan with LiDAR in a continuous way
- Display the shotcrete thickness measurement in real time on the tunnel profile
- Device measure also removable material
- Refresh cycle of 60-90sec

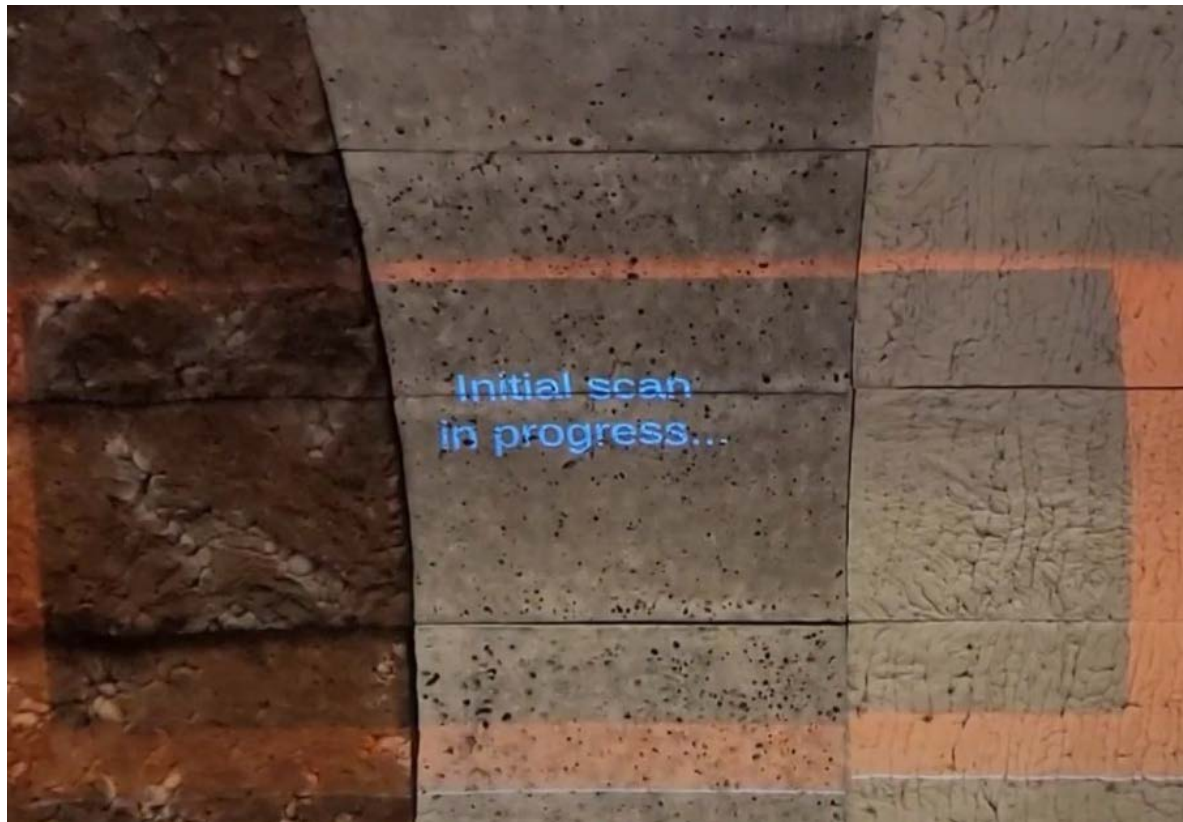
Benefits

- ✓ Reduce use of concrete
- ✓ Improve productivity
- ✓ Reduce logistics of rebound/waste



Real time thickness measurement

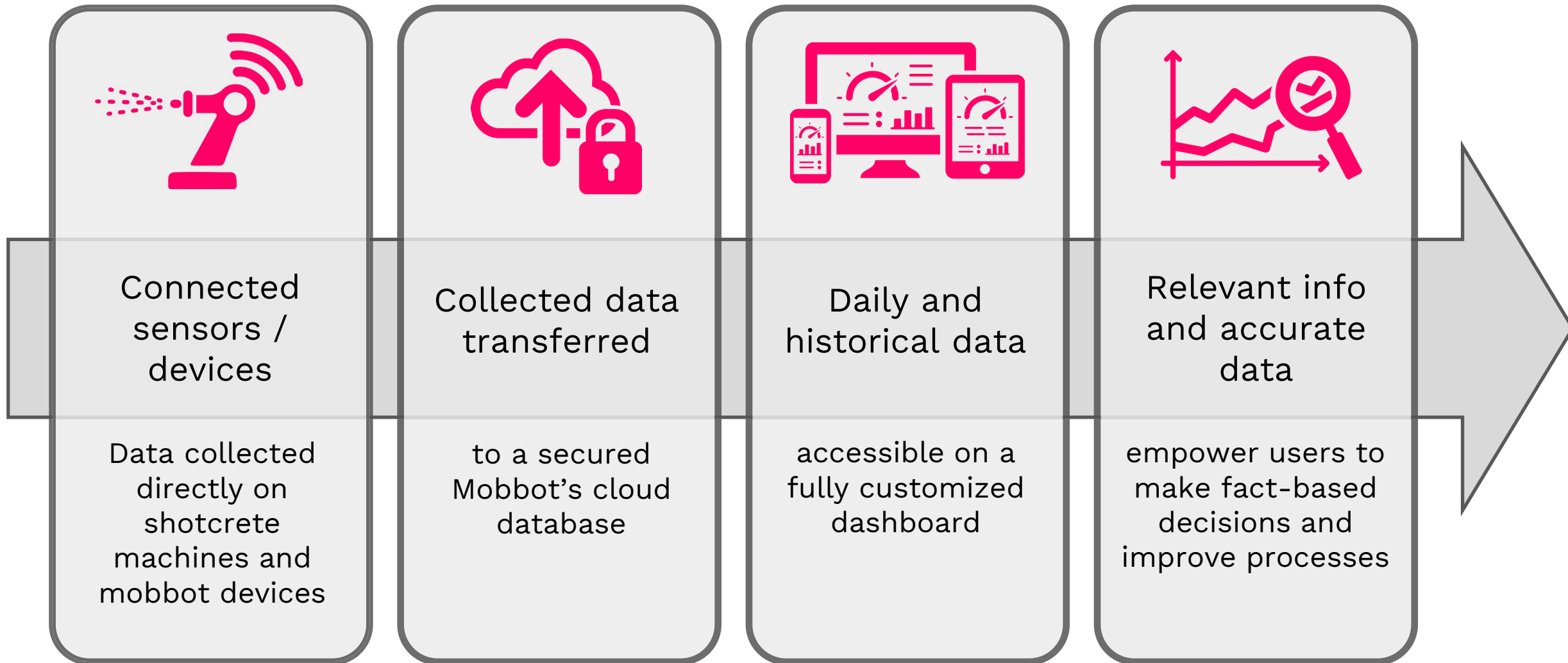
Initial scan



Continuous & real time display of thickness in the tunnel



A centralized dashboard to improve shotcrete processes



What our client says about Mobbot

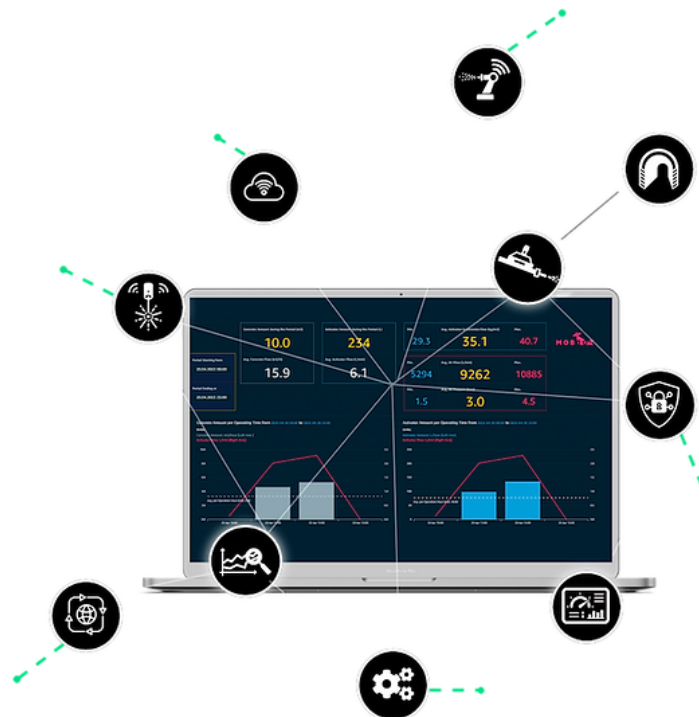


G. Lequertier
Managing director, Infra Tunnel SA

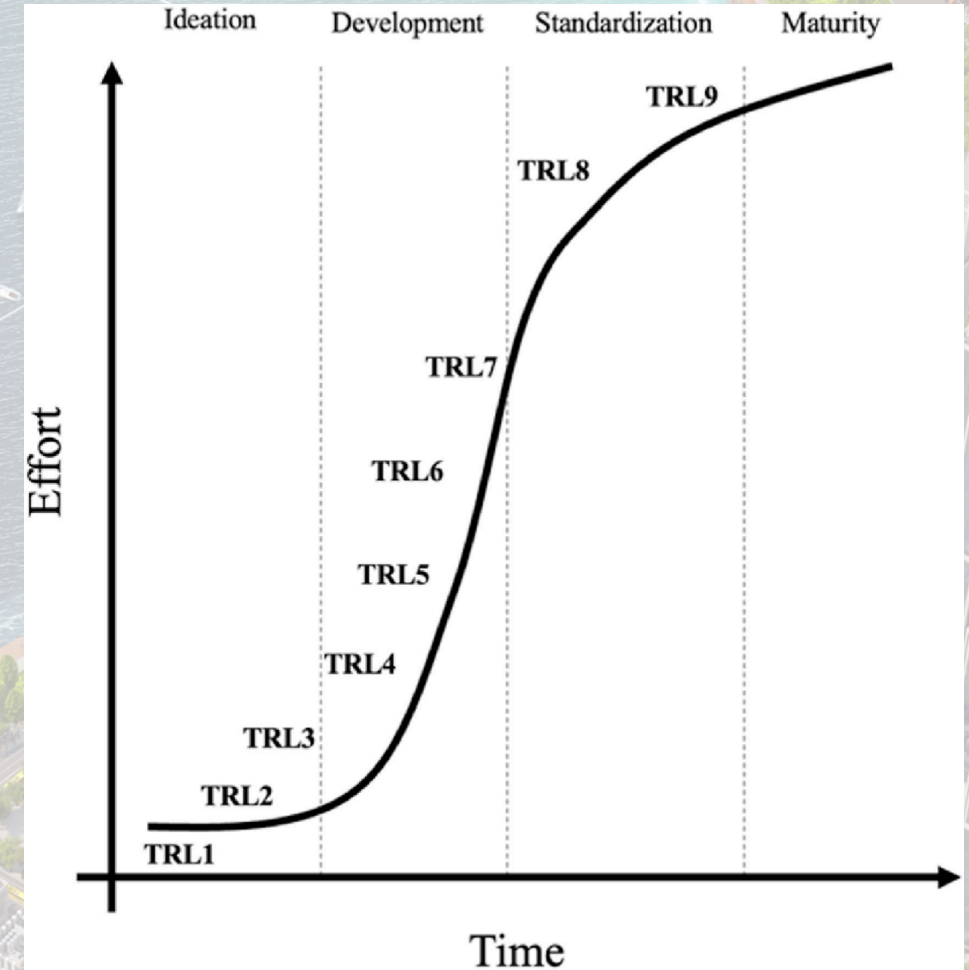
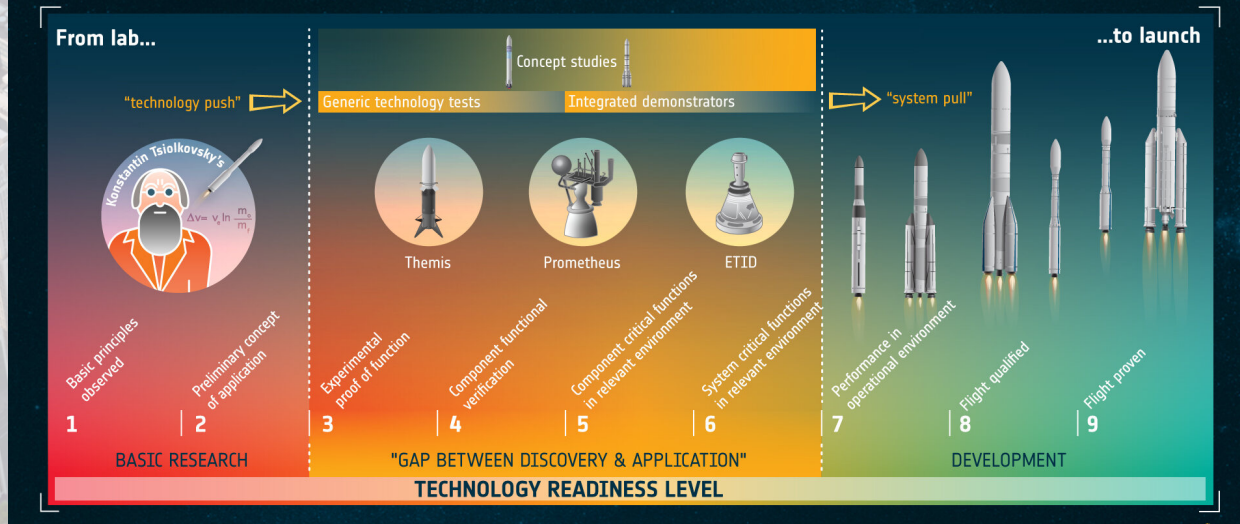
"Thanks to Mobbot, we were able to win in visibility of our shotcrete operations and were able to take corrective actions."

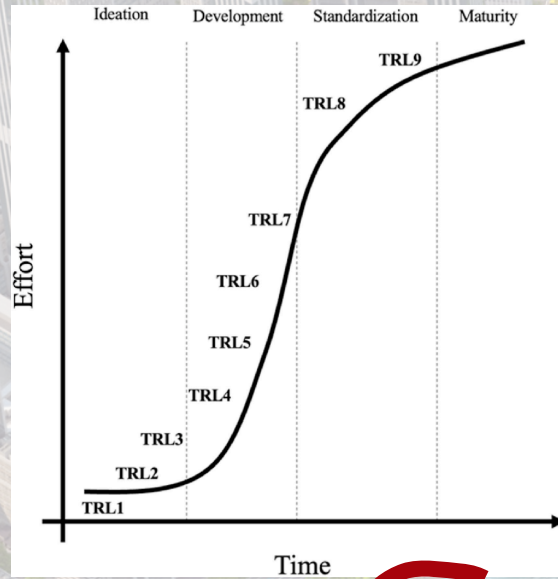
Bridging asset data with operator behavior and real time feedback opens many opportunities

There are hundreds of thousands of construction machines that cause massive, unplanned downtime and delay construction projects. It is necessary to provide real-time monitoring tools to employees to make the right decisions at the right time, reduce overconsumption of raw materials and decrease waste.



→ FUTURE LAUNCHERS PREPARATORY PROGRAMME

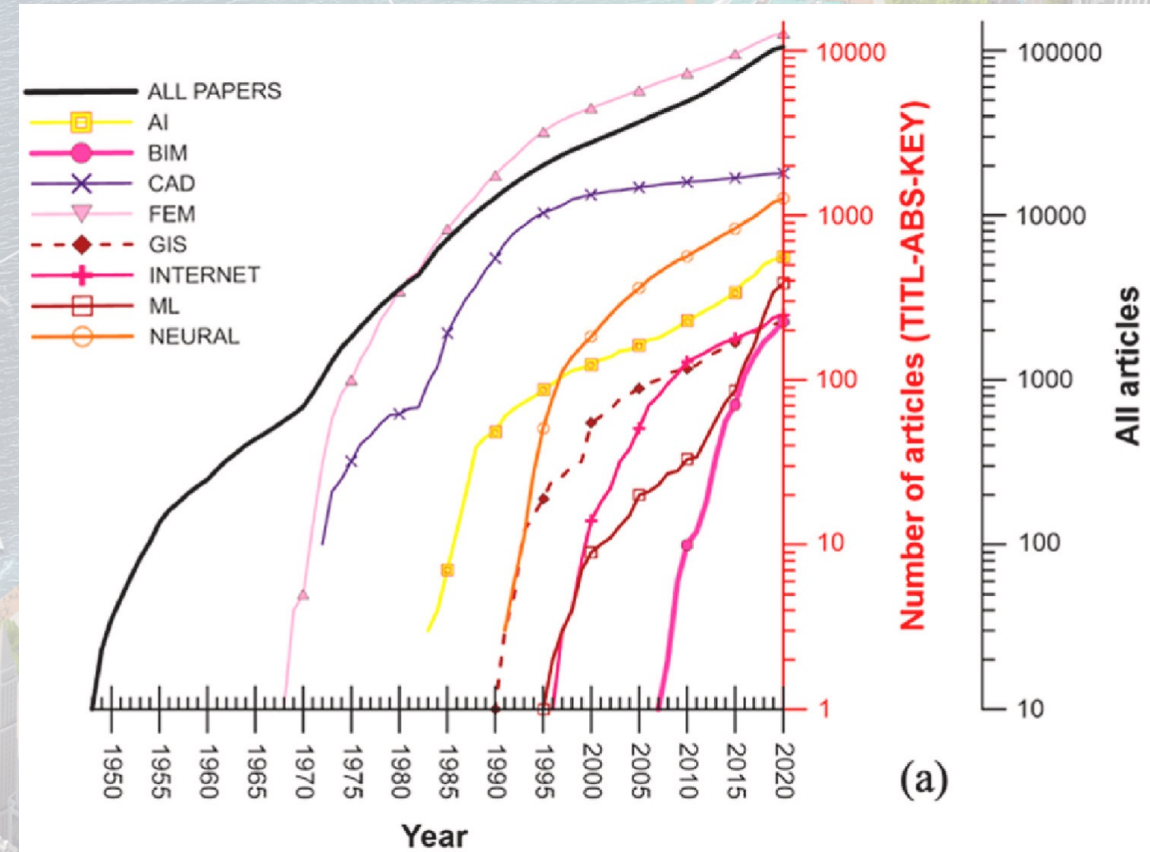




+ parametric
design

+ reinforcement

3D Printing



Terzis, D., 2022. Monitoring innovation metrics in construction and civil engineering: Trends, drivers and laggards. *Developments in the Built Environment*, 9, p.100064.

Parametric design

Parametric design is commonly believed to be a design **language** but refers at the base merely to a method of designing, that is, via **computing specific parameters**. Buildings can then be seen as the physical result of the interplay of various such parameters. This circumstance makes parametric design essentially well-equipped for its **surroundings**, cost-effective, and highly unique, raising the question of **possibilities for prefabrication**.

Parametric design and execution





The class will
start at 16h15

Also part of :



sia

Schweizerischer Ingenieur- und Architektenverein
Société suisse des ingénieurs et des architectes
Società svizzera degli ingegneri e degli architetti
Swiss society of engineers and architects

■ Dimitrios
Terzis ■



Thank you!

Dr. Dimitrios Terzis

05/11/2024