

The application of robotics in construction

Vincent AGIE DE SELSATEN, Belgium

- **Key words:** Construction Robotics, Surveyor, Robot, Machine control, 4.0 Construction, Digital transition, BIM

SUMMARY

Will construction robots replace surveyors on construction sites?

First, let's have look at the types of robots arriving on construction sites:

Concrete 3D printers
Robots for drilling holes in ceilings
Painting robots
Masonry robots
Robots to equip elevators
Robots for attaching rebars
Quadruped robots
Humanoid robots
Exoskeletons
Tracing robots
Plan projectors

Let's recall the different tasks that a surveyor performs on our construction sites.
What kind of instruments he use?

Many new technologies have already been adopted by surveyors in last few years.
GNSS RTK, Drones, Photogrammetry, 3D Scanners, mobile mapping...
These new technologies scared us at first.
Then they were widely adopted as new tools by survey companies.

Most of these technologies were designed for scanning.
The transition from "Physical" to "Digital".

But construction is the transition from BIM, from the plans designed by the architect to the real project.
The transition from "Digital" to "Physical".

Which robots could replace the surveyor's job and which ones will help him?

The story of a surveyor who wanted to create a "simple" topography tool so that he no longer had to work on his knees on construction sites.

And which resulted in the very first autonomous printer robot for tracing the full layout in real scale. The Bimprinter was born.

The application of robotics in construction

Vincent AGIE DE SELSATEN, Belgium

1. WHY INTRODUCE ROBOTS INTO CONSTRUCTION

Problems:

- Construction work is not often attractive, and even often painful and repetitive.
- There is a significant shortage of workers. Especially among surveyors who set up on construction sites.
- Young people are less attracted to the construction jobs due to the difficulties of these missions to work outside and in these conditions. They prefer some painless job and are very good with the informatics and the use of their tablets.
- Construction workers comes from different countries and doesn't speak the same languages.

2. DIFFERENT TYPES OF CONSTRUCTION ROBOTS

First, let's have look at the types of robots arriving on construction sites:

(In a random order)

Concrete 3D printers

Robots for drilling holes in ceilings

Painting robots

Masonry robots

Robots to equip elevators

Robots for attaching rebars

Quadruped robots

Humanoid robots

Exoskeletons

Tracing robots

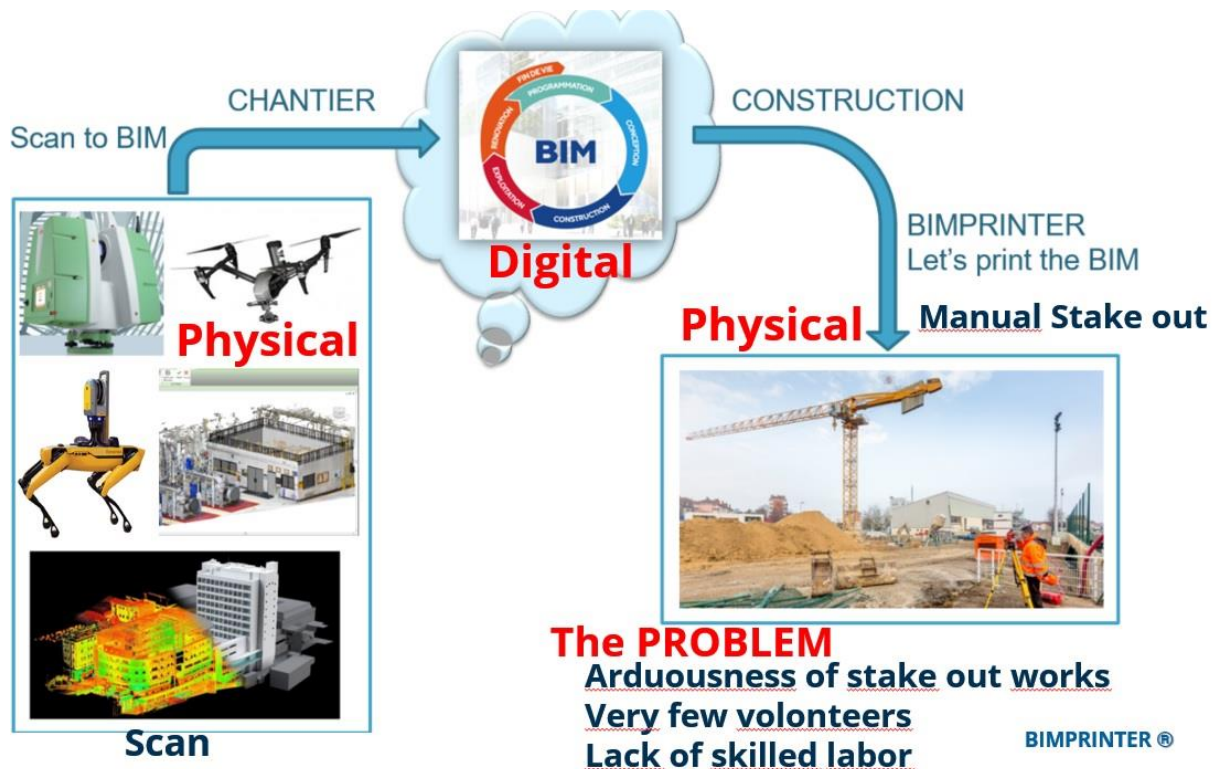
Plan projectors

Robotic total stations

3. IS THERE ANY ROBOT TO HELP SURVEYORS ON A CONSTRUCTION SITE?

Two types: scanning robots and stake out robots.

3.1 scanning robots



Credit : Bimprinter

Some robots help the surveyor to **scan and digitalize** the existing constructions. For example Spot from Boston Dynamics in association with a 3D scanner. This solution is proposed by Trimble and Leica. It is very interesting in dangerous environments and for repetitive surveys. From Physical to Digital – New notion of “Phygital”



3.2 Stake out and tracing robots.

From Digital to Physical – the new notion of “DigiPhy”

3.2.1 Premarking robots - for example:

Civ Robotics - Tiny mobile Robot – Robot Plotter



Those robots are perfectly adapted for low accuracy premarking (around 2cm of accuracy)
Good for road works and...

3.2.2 Layout construction printer robots - for example:

Bimprinter – Dusty Robotics – HP Site Print – Hitachi Sumi Robo - Mirai



Those robots are adapted for different use cases on construction site.

3.2.3 Ceiling robots for tracing, painting and drilling - for example:

Some examples :

Hilti Jaibot robot

Baubot – Fischer robot

Schindler robot

Okibo robot

Ceiling Bimprinter



Those robots can help for works at height.

Credit : Bimprinter, Hilti, Schindler, Fischer.

There are very few construction robots because of the very difficult construction environments:

- Sites changes
- Dust and dirt on the floors
- People are turning around the robots
- Weather
- Quality of surface
- Obstacles

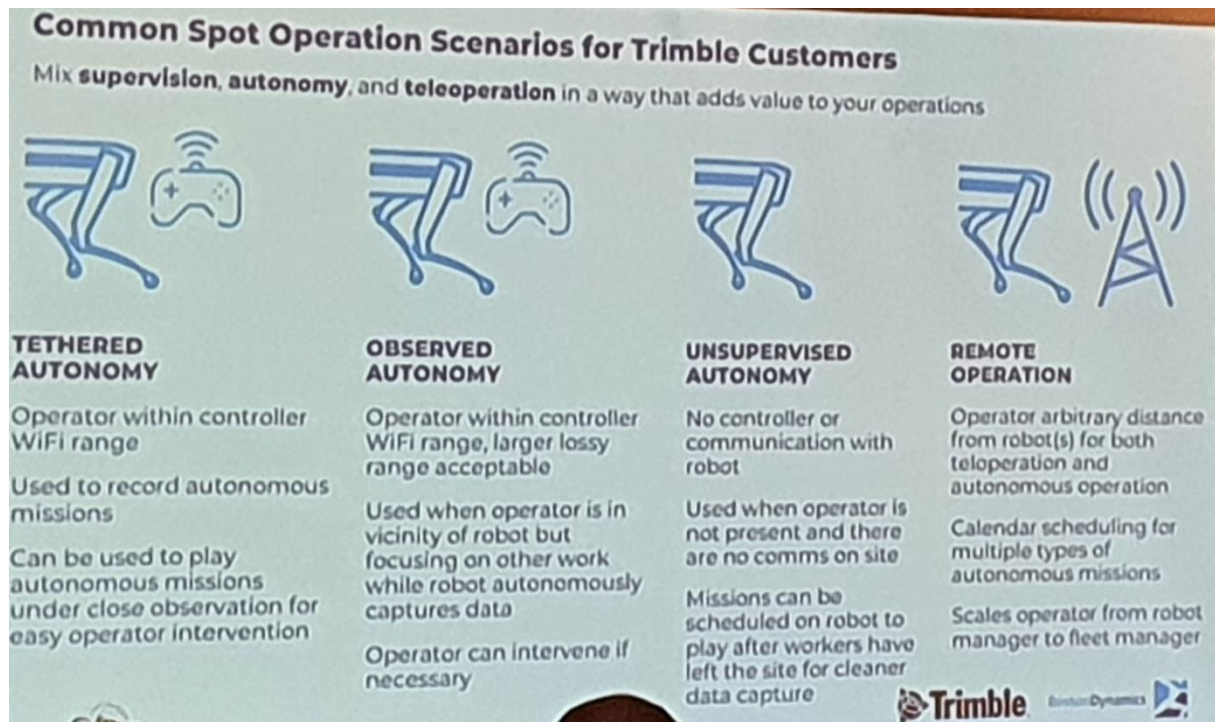
The robot prints on:

- Concrete
- Asphalt
- Roofing



Credit : Bimprinter®

Degree of autonomy of the different robots: Example from Spot Robot from Boston Dynamics



Credit : Trimble Dimensions + 2022

How to choose the right layout printer robot?

- Type of construction site (indoor and/or outdoor)
- Requested guaranteed accuracy (2mm ?)
- Type of support (rough concrete,...)
- Presence of dust and dirt on the floors,...
- Business model : Selling - rental – as a service
- Availability in different countries
- Price – ROI

Questions:

- Is it compatible with my total station ?
- Is it really accurate and precise for the stake out ?
- Is it working on real construction site ?
- Is it working on inclined slabs ?
- Is it working on rough concrete ?
- How long is the ROI ?
- Does it print all the layout automatically ?
- Is it easy to do pilot ?
- ...

- Leica Geosystems & Icon (Swiss)
- Topcon (Japan)
- Trimble (USA)



Use cases:

Example of the “Mohammed VI Tower” in Rabat – Morocco

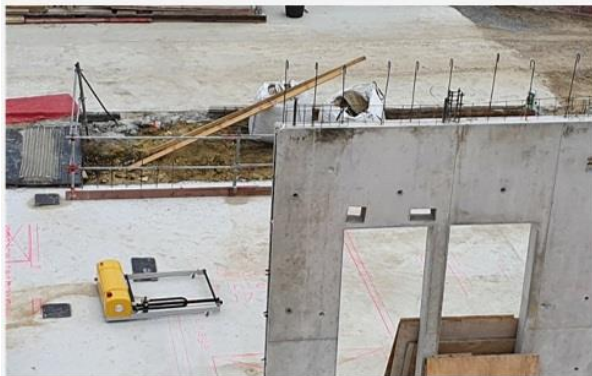
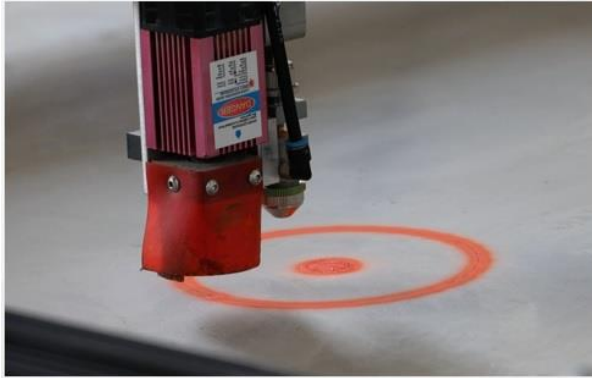
The general contractor Besix-TGCC chose the Bimprinter robot to stake out all the different layout on the 55 floors of the sky scrapper. All the section wall were curved inside. A very difficult stake out job for a strict architect.



One day per floor – Validation by the Architects – Smart stake out

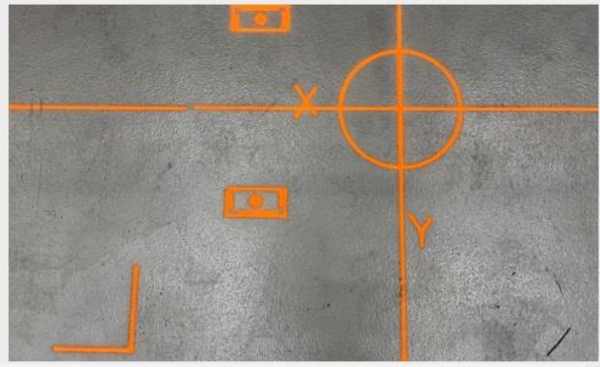
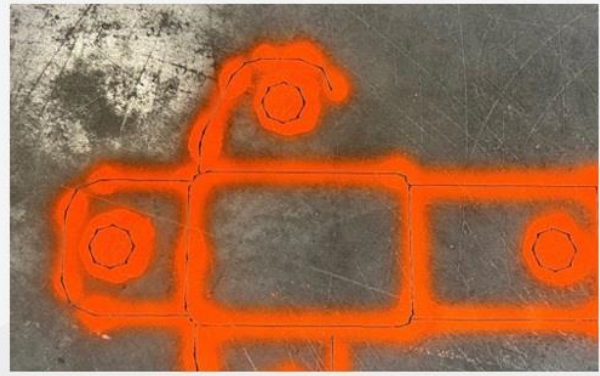
The Application of Robotics in Construction (12243)
Vincent Agie de Selsaten (Belgium)

FIG Working Week 2023
Protecting Our World, Conquering New Frontiers
Orlando, Florida, USA, 28 May–1 June 2023



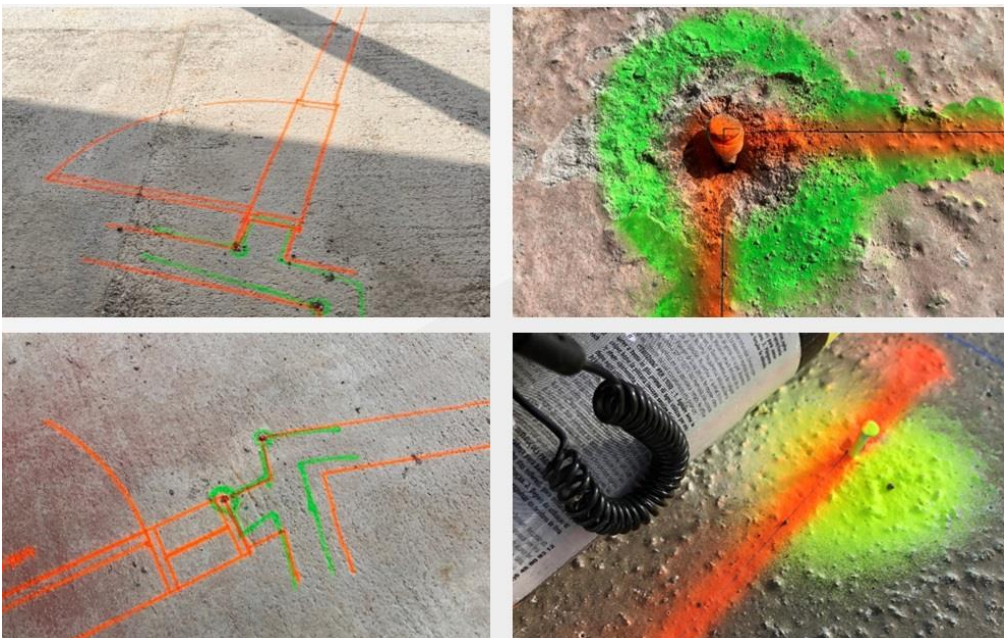
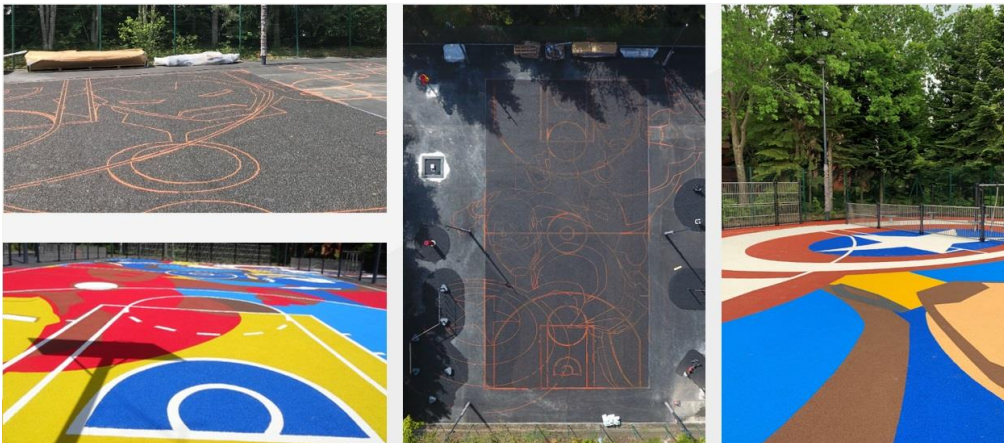
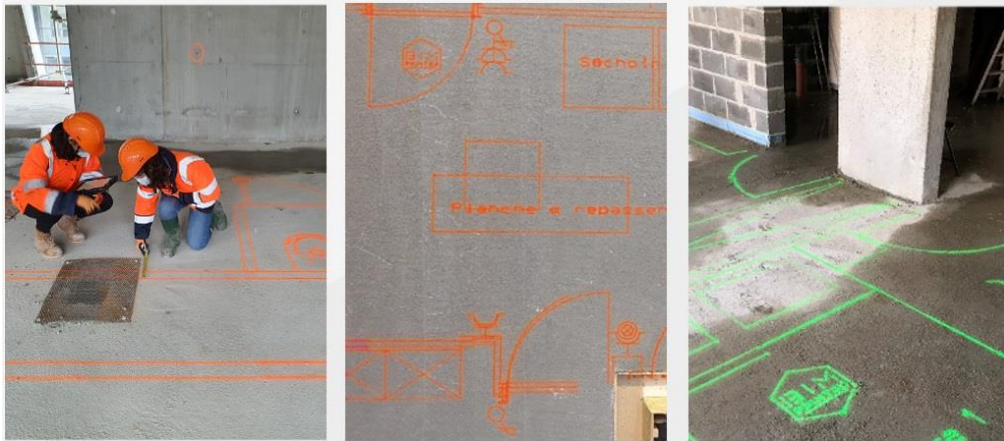
The Application of Robotics in Construction (12243)
Vincent Agie de Selsaten (Belgium)

FIG Working Week 2023
Protecting Our World, Conquering New Frontiers
Orlando, Florida, USA, 28 May–1 June 2023



The Application of Robotics in Construction (12243)
Vincent Agie de Selsaten (Belgium)

FIG Working Week 2023
Protecting Our World, Conquering New Frontiers
Orlando, Florida, USA, 28 May–1 June 2023



The Application of Robotics in Construction (12243)
Vincent Agie de Selsaten (Belgium)

FIG Working Week 2023
Protecting Our World, Conquering New Frontiers
Orlando, Florida, USA, 28 May–1 June 2023

REFERENCES

- Wikipedia - <https://fr.wikipedia.org/wiki/Robot>
- Boston Dynamics – Trimble – Trimble Dimensions + 2022
- Module de numérisation laser autonome Leica BLK ARC | Leica Geosystems (leica-geosystems.com)
- Mohammed VI Tower – Rabat – Besix TGCC

BIOGRAPHICAL NOTES

Vincent Agie de Selsaten is a survey engineer with more than 20 years of experience on construction sites. He has work also at CERN for particles accelerator alignment and installation of proton therapy facilities in Korea and Florida.

Inventor of the Bimprinter, Ceiling printer and other topographical accessories.

CONTACTS

Vincent AGIE DE SELSATEN

Survey Engineer – CEO - Inventor

Bimprinter®

Rue de Melroy 441

B 5300 Vezin

BELGIUM

Tel. +32496297124

Linkedin : [linkedin.com/in/vincent-agie](https://www.linkedin.com/in/vincent-agie)

Email: va@Bimprinter.com

Web site: www.Bimprinter.com



VINCENT Agie de Selsaten
BIMPRINTER® CEO & INVENTOR
Mobile : +32 496 297 124