



한국 총괄 본부장 한종한 | **Trimble Inc.**

국내외 스마트 건설 현황 및 디지털 트윈 in Construction

_스마트 얼라이언스 디지털센싱 기술위원회



한중한 | 한국 총괄 본부장

About me...

- 현) Trimble Inc. Field system 한국 총괄
- 현) 국가건설기준위센터 기준위원회 위원
- 현) 스마트 건설기술 개발사업 I - 중점분야 자문위원
- Leica Geosystems 건설부문 Manager
- 10년간 토목 설계 및 건설현장 근무
- 토목공학 전공



Agenda



- Trimble Inc.
- 건설현장의 필요충분조건
- 국내외 스마트건설 현황 및 국내 스마트건설의 한계
- 건설산업 현황 및 이슈
- 스마트 건설기술 및 디지털 데이터의 중요성
- Connected solution in Construction
- Autonomy in Construction



Evolution Driven by Innovation and Experience

GPS
TECHNOLOGY



PRECISE
POSITIONING



PRODUCTIVITY
OPTIMIZATION



CONNECTED
WORKFLOW

STRATEGIC AND MANAGERIAL CONTINUITY THROUGHOUT OUR HISTORY



1978 – 1998



1999 – 2019



2020 –



Our Success is Linked to Our Customers' Success



FINANCIAL STRENGTH

\$3.6B
(매출 약 4.8조)

13.3% Revenue CAGR
from 1999–2021

NASDAQ
TRMB

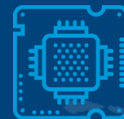


GLOBAL VISION

12,000+
임직원

Facilities in
40+ countries

150+개국 고객지원



TECHNOLOGY LEADER

R&D 센터
15 국가

\$400M+/년
R&D 투자

2,000+
특허



BUILDINGS



CIVIL ENGINEERING
& CONSTRUCTION



AGRICULTURE



TRANSPORTATION



GEOSPATIAL

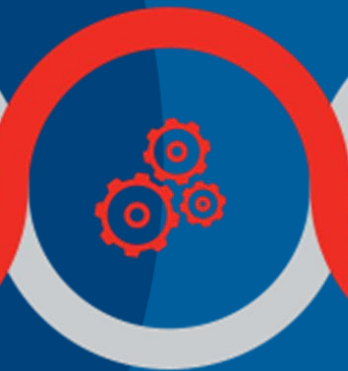
건설향장의 필요충분조건



SKILLED LABOUR
SHORTAGES



COST
CERTAINTY &
OVERRUNS



SPEED OF
CONSTRUCTION &
DELAYS



PRODUCTIVITY/
QUALITY CONTROL/
CONSISTENCY



HEALTH &
SAFETY

건설산업 현황 및 이슈

Construction constitutes 13% of global GDP worldwide
...but productivity growth remains dramatically low

Process - Complex projects, generally unique

85%

Projects
Exceed
Budget

92%

Projects
Exceed
Schedule

63%

Projects
Have Quality
Deficiencies

4%

Average Profit
Margin
Construction
Firms

People - Skilled Labor is a Top Priority

90%

Face Talent
Shortages

30%

Decrease in Workers Less than
24 Years old

Technology - Investment is Low

- Low adoption of Digitalisation
- Reluctance to adopt Change
- Lack of ROI evaluation

90%

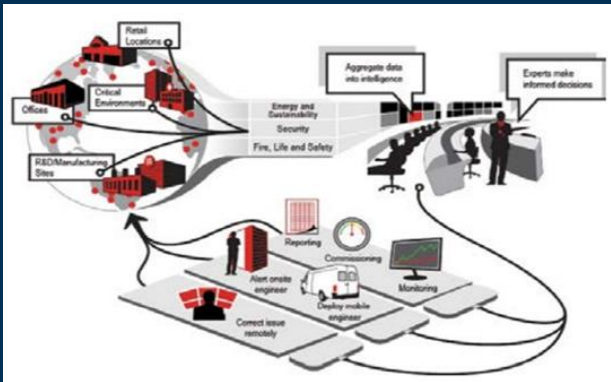
Critical to Collect Data to
Improve Project
Performance

>50%

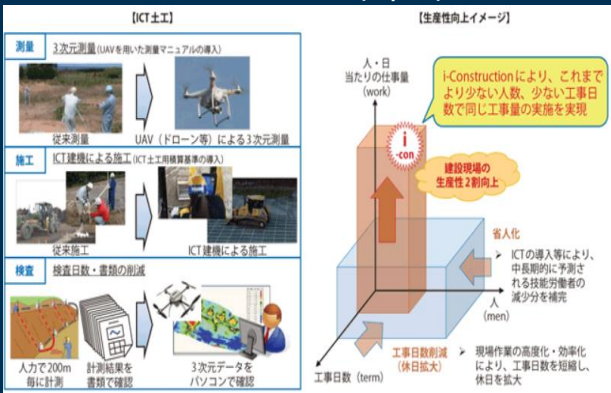
Use Paper Forms and
Spreadsheets

10

Construction 2025(UK)



i-Construction(Japan)



Global Startup Heat Map(US)

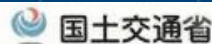


Construction 21 (Singapore)



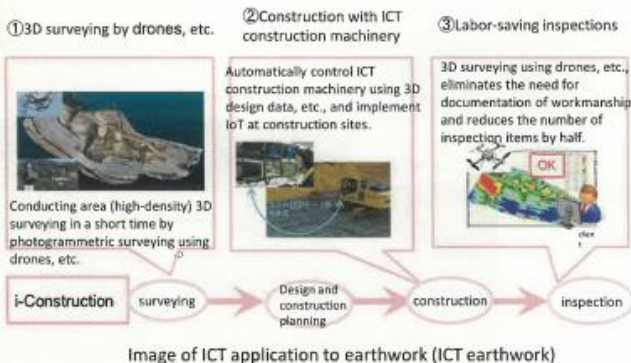
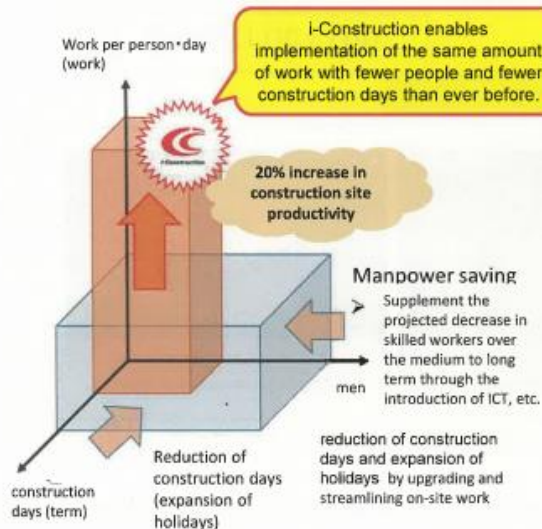
일본 i-construction 1.0

i-Construction ~Improving productivity in the construction industry~



- At the Japan Government Conference on September 12, 2016, Prime Minister Abe announced a policy aimed at improving productivity at construction sites by 20% till FY2025, as part of the "Construction Site Productivity Revolution" through the Fourth Industrial Revolution.
- Toward this goal, within three years, new construction methods will be introduced at public construction sites such as bridges, tunnels, and dams, including the use of drones, etc. for surveying and connecting the entire construction process, from construction to inspection, with 3D data.

【Productivity Improvement Image】



Key point

건설현장의 생산성 향상

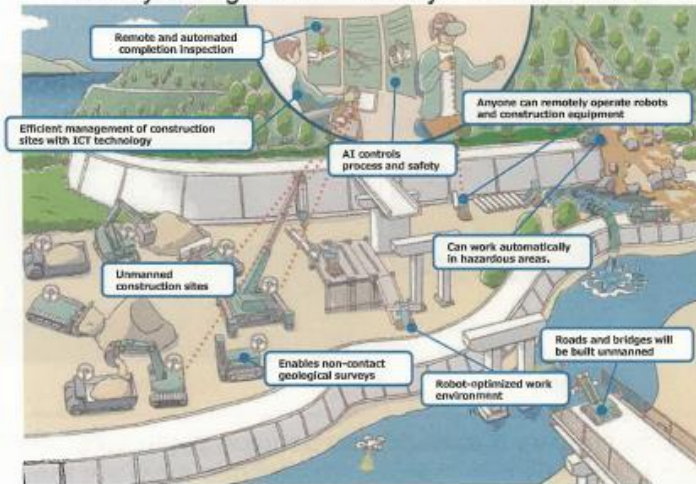
- 법령은 아니지만 추진안으로 Drive
- ICT 적용에 대한 가점 부여
- 국토교통성 -> 재무성
 - ICT 적용에 따른 비용증가
 - 3~4% 추가 산정
- 공기단축에 따른 비용절감을 해당 시공사에게 그대로 보전

일본 i-construction 2.0

i-Construction 2.0 (FY2024~) ~Automation in construction sites~ 国土交通省

- "i-Construction", an initiative to improve productivity at construction sites, is being deepened as "i-Construction 2.0" to achieve automation of construction by FY2040.
- By maximizing the use of digital technology, we will realize highly productive construction sites where fewer people can work safely and in a comfortable environment.
- We will continue to protect the infrastructure that forms the foundation of people's lives and economic activities by improving the production output and added value of each and every person working at construction sites.

Society aiming to be realized by i-Construction 2.0



i-Construction 2.0 By FY2040 with Targets to be achieved by FY2040 through i-Construction 2.0

Manpower-saving

Aim for a system that enables sustainable infrastructure development and maintenance management even in a declining population. Aim for at least 30% Manpower- savings, or 1.5 times productivity, by FY2040.

Ensure safety

Reduce fatal accidents at construction sites.

Reform of work style

Convert outdoor work to remote and off-site work.

i-Construction 2.0: Efforts toward automation of construction sites

Key point

Automation 현장에서의 안전기준

후생노동성 주도

- 완전 무인화 -> 안전기준완화 추진
- Hybrid (Automation + 작업자)
- 작업자 100% 관여

스마트 건설기술의 국내 동향

국내 정부 정책

스마트 건설기술 육성을 통해 글로벌 건설시장 선도

'25년 스마트 건설기술 활용기반 구축, '30년 건설 자동화 완성

2025년
목표

- ◆ 건설 생산성 50% 향상
- ◆ 건설 안전성 향상 [사망만인율 1.66 → 1.0]
- ◆ 고부가가치 스타트업 500개 창업

로드맵

로드맵 이행방안

단계	'25	'30	민간의 기술개발 유도
설계	·드론측량 ·BIM 전면활용	·자동 지반모델링 ·설계자동화	·발주제도의 개선 ·테스트베드 지원 ·혁신 공간대의 확산
시공	·자동장비 활용 ·가상시공	·로봇시공 ·AI 공사안전관리	·핵심기술 개발 ·BIM 확산 여건 조성 ·공공기관의 역할 강화
유지 관리	·IoT드론 모니터링 ·빅데이터 구축	·로봇 자율진단 ·디지털트윈 관리	·스마트 건설 지원센터 설치·운영 ·스마트 건설 전문가 양성 ·지식플랫폼 구축·운영

8-5-9 [80]스마트 건설장비

기종	분류번호	가격(W)
3D GNSS 머신 가이던스(굴삭기용)	8201-0100	55,000

대한민국
미래를 위한
기술혁신

2023 건설공사 표준품셈

공통·토목·건축·기계설비·유지관리



8-3-9 [80]스마트 건설장비

(8201) 3D GNSS 머신 가이던스(굴삭기용)

분류 번호	규격 (mm)	내용 시간	연간표준 가동시간	상각 비율	정비 비율	연간 관리 비율	시간 당(1 시간)		
							상각비 계수	정비비 계수	관리비 계수
8201-0100	3D GNSS 머신 가이던스	5,000	1,250	0.9	0.8	0.1	1,800	1,600	1,000

2023년 품셈 적용

3-9 스마트 토공

3-9-1 머신 가이던스(MG) 굴삭기('23년 신설)

1. 3D GNSS 머신 가이던스 장비조립·해체

(회당)

구분	단위	수량
중급기술자	인	2
보통인원	인	1
용접공인	인	1
조립	일	1
해체	일	1

[주] ① 본 품은 머신 가이던스 장치들을 굴삭기에 조립 및 해체하는 데 소요되는 품이며, GNSS 기준국(Base station) 설치 및 해체품은 별도 계상한다.

② 공구손료 및 경장비의 기계경비(측량기기, 용접기 등)는 별도 계상한다.

2. 3D GNSS 머신 가이던스 굴삭기 작업능력

(일당)

공종	사공량	단위	비고
터파기	850	m3	
성토면고르기	1,200	m2	

[주] ① 본 품은 3D GNSS 머신 가이던스(Machine guidance) 시스템을 1.0 m3 굴삭기에 적용하여 사공하는 기준이다.

② 머신 가이던스(Machine Guidance)는 건설 장비의 위치와 자세 정보를 이용하여 설계 목표 대비 현재 작업정보(작업종류, 작업상황, 목표수치, 지면과의 거리 등)를 장비 조종자에게 실시간으로 제공하는 기술을 말한다. 3D GNSS 머신 가이던스는 3차원 도면과 GNSS를 이용한 머신 가이던스 시스템을 말한다.

③ 3D GNSS 머신 가이던스의 구성품은 머신 가이던스 장치(GNSS 이동국, 관성 측정 장치(Inertial Measurement Unit: IMU), 케이블 및 브래킷, 메인 통합 컨트롤러, 머신 가이던스 디스플레이 화면)

등을 포함한다.

④ 본 품은 굴삭기의 말단 장치(End-Effector)에 별도의 어태치먼트(예: 펄트, 로테이터 등)를 부착하지 않은 기본 버킷 규격품을 기준으로 한다.

⑤ 3D GNSS 머신 가이던스 굴삭기의 운용에 3D 도면 제작·변환 작업이 필요한 경우 별도 계상한다.

⑥ 장비는 현장여건에 따라 장비 규격을 변경하여 적용할 수 있다.

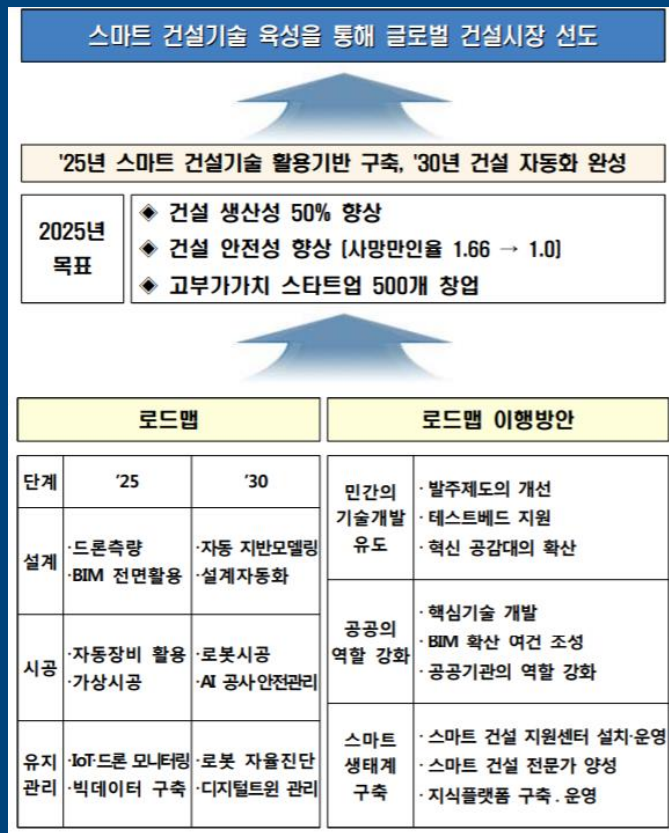
⑦ 본 품은 전체 토공량이 중규모(10,000 m3) (8-1-2 공사규모별 표준건설계획) 이상의 공사 규모에 대한 품으로 중규모 미만의 공사에 적용할 수 없다.

⑧ 본 품은 연속터파기 작업이 가능하고 작업 방해가 없는 조건에 한하여 적용한다.

⑨ 3D GNSS 머신 가이던스를 사용하는 굴삭기는 주연료에 15% 할증을 적용한다.

(현)국내 스마트 건설 도입의 한계

- 실제 건설현장에 자동화 건설기술의 도입율은 크게 변화가 없음
- 우리는 무엇을 해왔는가?
 - 로드맵
 - 정책
 - 연구 및 개발
 - 자동화 건설 기계 실증사업
- 현재 결론 도출
 - 자동화 건설 기술이 생산성, 원가, 공기, 안전 등에 많은 향상을 가져온 다는것을 인지
 - MG/MC 품셈 개발, 시방서 제작 등의 결과가 도출
- 왜 BIM 인가?



Impact of Digitalization

\$0.7-1.2 trillion

Potential annual global cost savings over a period of 10 years through the adoption of full-scale digitalization in non - residential construction projects.

- *'World Economic Forum', 'Shaping the future of Construction'*



BIM 디지털 데이터의 중요성

Real Time Digital Data is what matters

Why Real-Time Information and Data is important for Construction ?

Improves the decision-making and problem-solving strategy

This results in

Increased employee productivity
Less spending
Faster and better communication
Higher accuracy

Trimble Solutions provide it all!

Return on Investments is in your Interest

30%

Reduction in Errors
and Clashes with
Augmented Reality

Free up Capital by

5-15%

Allocating Money to
Value Add Projects

90%

Decrease In Time
Measuring and
Processing Site Data

10%

Improvement in
Project Schedule

80%

Reduction in Rework

5%

Increase in
Material Savings

50%

Increase in
Productivity of Field
Tasks

5%

Increase in Accuracy
of Estimates

30%

Reduction in
Operations and
Maintenance

From concept to design, to build and maintain. Digital technology gives customers true visibility and real-time control of their projects.

Between Stakeholders

- Owner**
Capital Program
Management
- General Contractor**
Project Management
And Controls
- Self Perform Contractor**
Production Schedule,
Work Order Management
and As-built QA

In the Office



In the Field



The Right Data to the Right Person at the Right Time



Digital Workflow

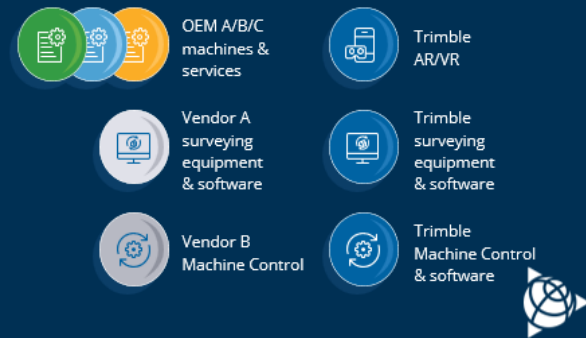
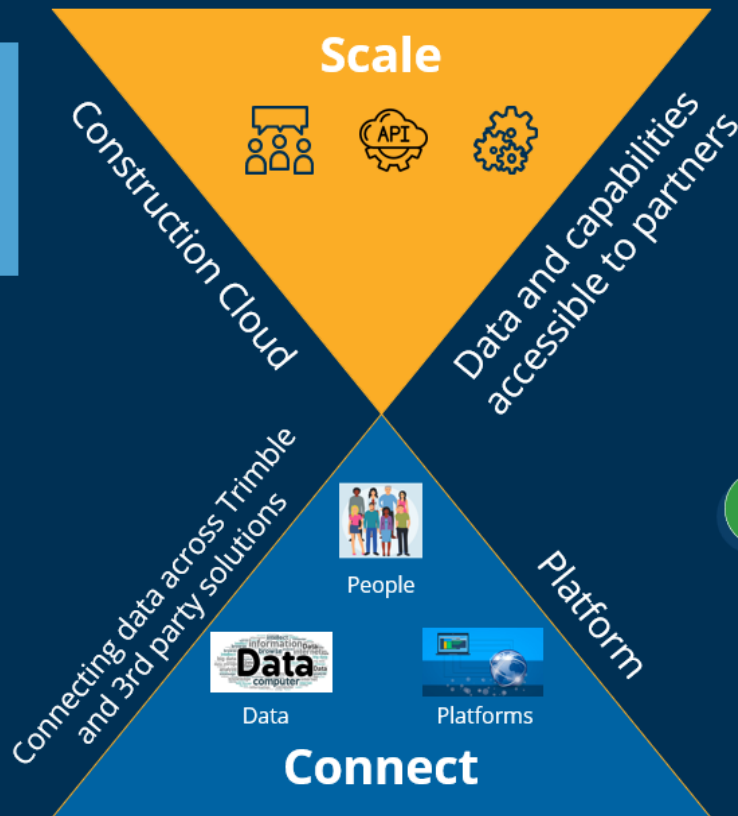
Construction cloud and platform

Construction cloud:

Aimed to connecting workflows, people, data and platform in (civil) construction industry

Platform:

A set of capabilities, workflows, common data environments and APIs enabling Construction Cloud co developed with Microsoft



From Product-led to Platform-enabled

Connected Products

- Individual users/personas
- Hard to scale customer segment
- Lack of data accessibility and collaboration

Customer
focus



- Duplication of effort
- Longer time to market and high maintenance cost
- Isolated people incentives

Execution
focus



Platform enabled

- Connected networks of users
- Multiple addressable market segments
- Accessible and interoperable data
- Reduced risk for R&D investment
- Enables automation of routine tasks
- Harmonized stakeholder incentives



TRIMBLE CONNECTED CONSTRUCTION

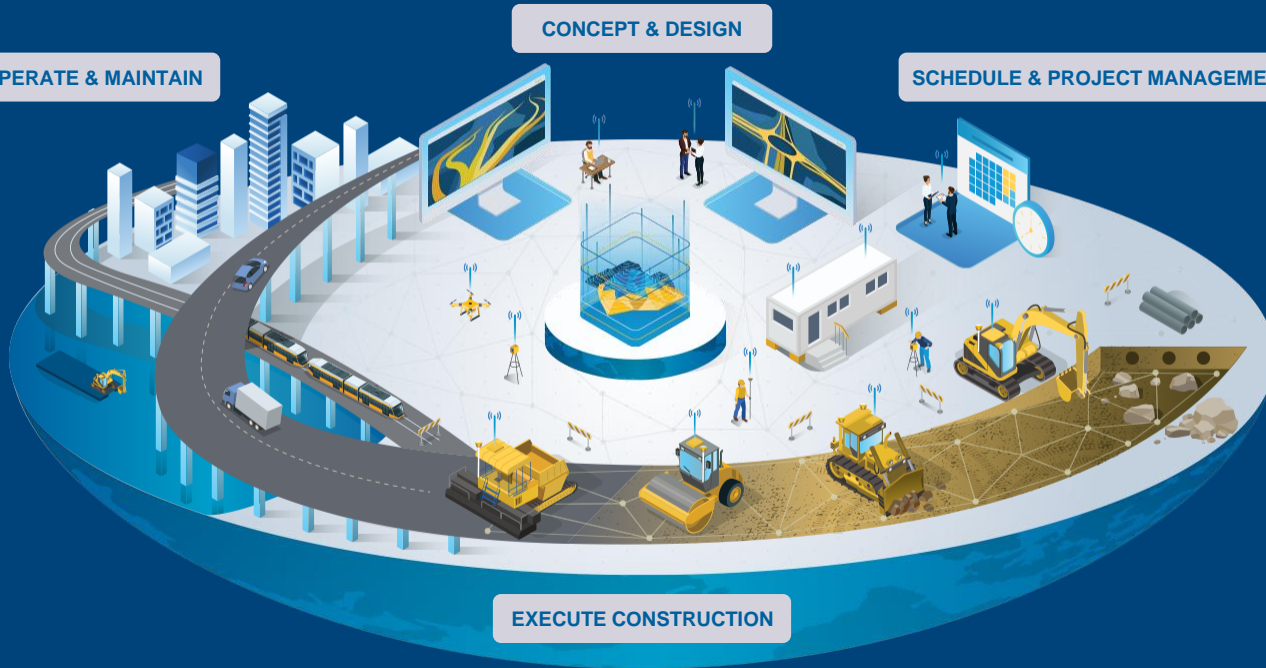
Tap the area you want to explore

OWN, OPERATE & MAINTAIN

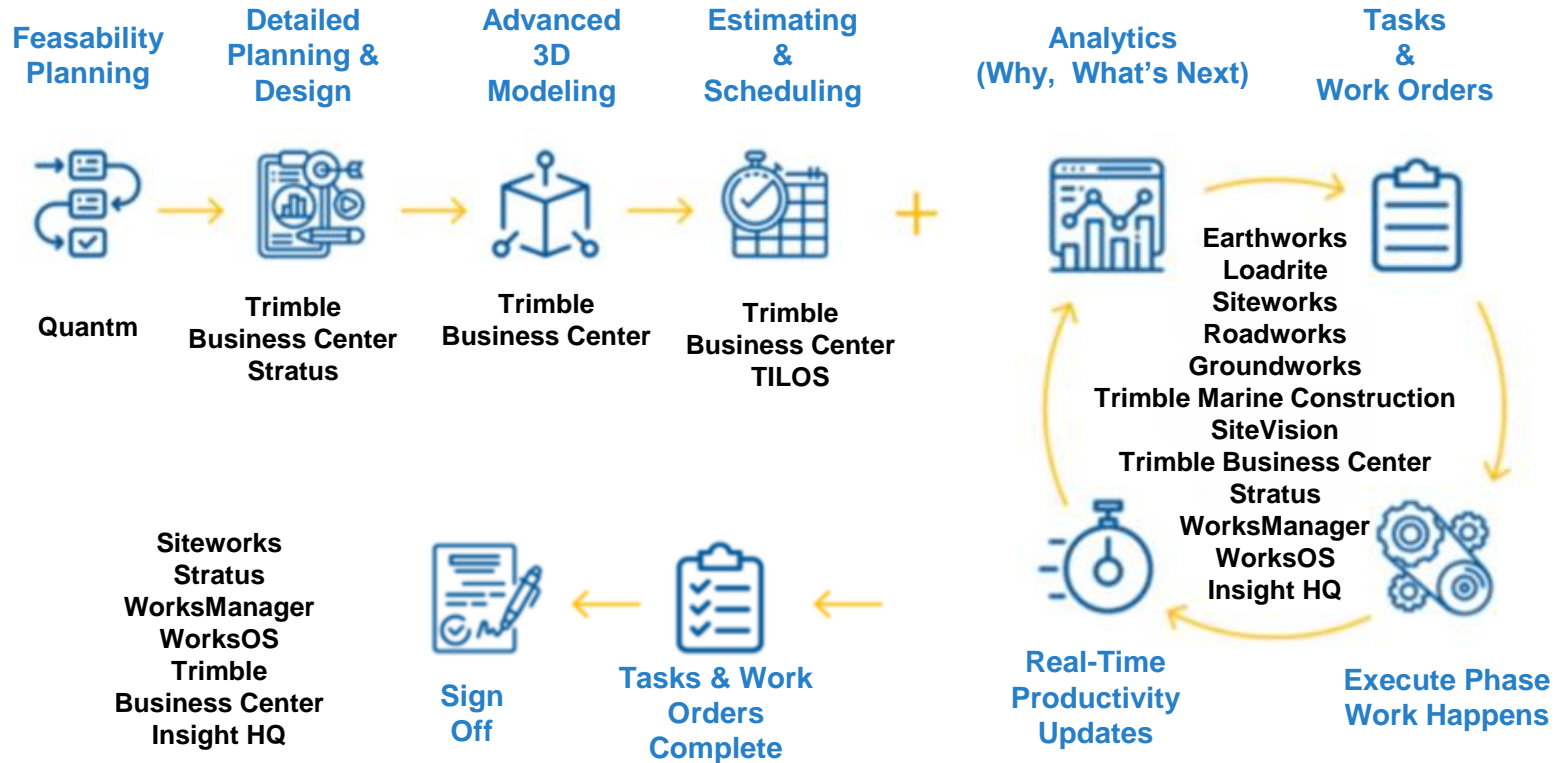
CONCEPT & DESIGN

SCHEDULE & PROJECT MANAGEMENT

EXECUTE CONSTRUCTION



Trimble Connected Construction Solutions

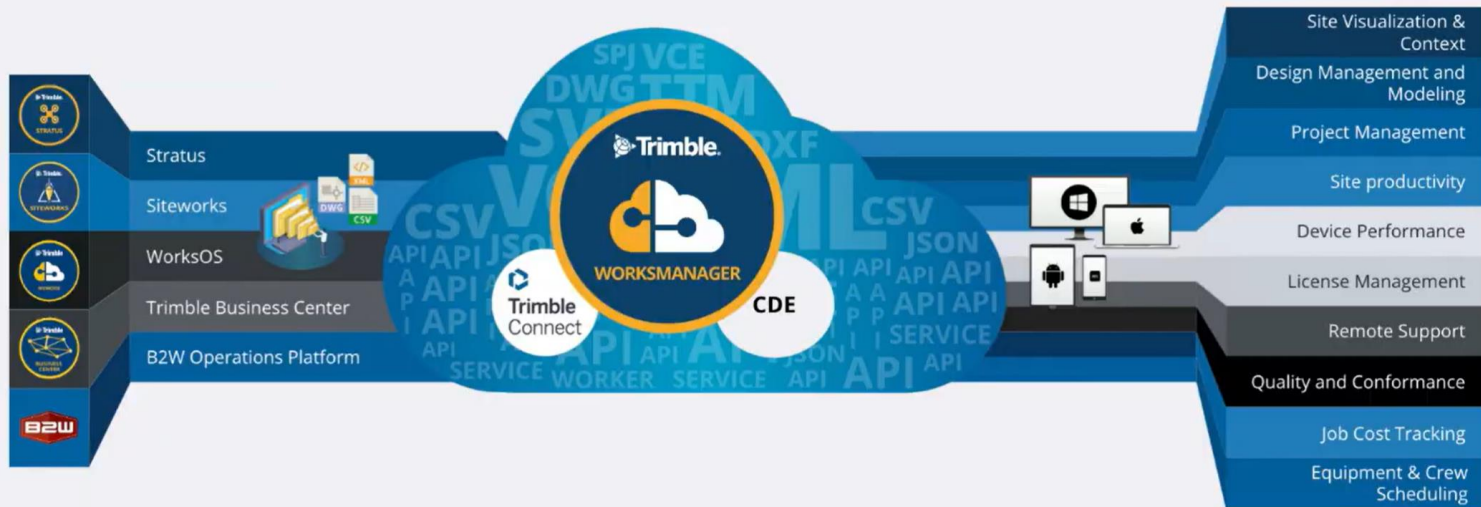


Digital Platform

From Products to Capabilities

Products Today

Tomorrow's Capabilities



Connected solution Use case _ Road construction





OUR ROAD TO AUTONOMY



오토메이션

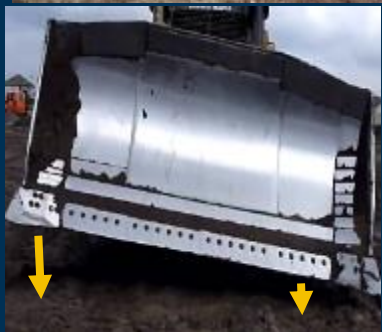
건설현장 오토메이션의 시작은 50년전...
아직도 머신컨트롤 단계 (블레이드 & 스티어링 제어)



Factors driving increased levels of automation:

- Population increases driving infrastructure needs
- Increased productivity required
- Skilled labor shortages
- IT capable workforce
- Higher safety regulations

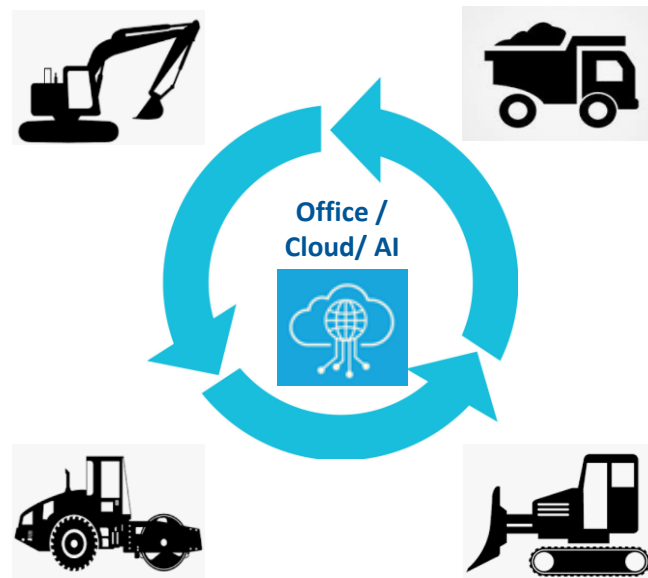
Today's automated solutions do not offer the intelligence of experienced operators



Become the Site Operating System

Our Approach.

- Trimble end-state-vision is to **automate the job site**, not just the machines
- Earthworks is the **platform** that connects the job site and the mixed-fleet
- The purpose of the platform is to enable **third-party integration** with high-value functionalities:
 - Operator assistance (present)
 - Workflow optimization and guidance (present)
 - Safety (present & future)



오토메이션

Working towards jobsite autonomy – we are developing solutions in all categories simultaneously

1 Core Platform

- New on & off machine platform's enable high velocity SW dev.
- UI rich capability
- Win OEM's



2 Connectivity

- Data sharing between all site assets
- High bandwidth connectivity **everywhere**
- Live collaboration/model



3 Site & Safety

- Real time terrain updates
- Sequential decision making
- Optimized earthworks
- Sequence automation
- Personnel awareness & Safety lockouts



4 Site Automation

- Redundant positioning and connectivity
- Continuous site monitoring
- Real time optimization
- Semi autonomous

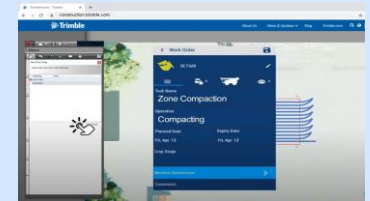
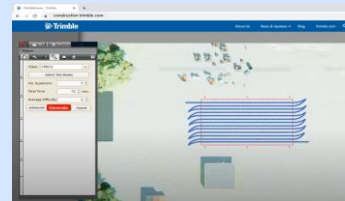
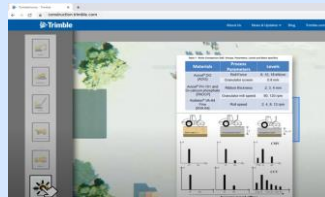
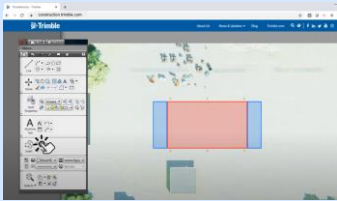


Automated Work Process Management

Trimble WorkOS and Earthworks - Soil Compaction Example.

Trimble WorksOS

1. Create Work Zone
2. Choose compaction parameters
3. Compute optimized pre-planned path
4. Create, transmit Work Order to Machine / Operator



Trimble Earthworks

5. EW automatically drives machine to Work Zone start location
6. Operator begins automated compaction process
7. Earthworks compacts to plan, logs production data
8. Compaction monitored in real-time in WorksOS



Road To Autonomy

From simpler Soil Compactors....



....To more complex excavators



Thank You

감사합니다
GRAZIE VINAKA
TERIMA KASIH
THANK
YOU
TAKK
merci
謝謝
ありがとう