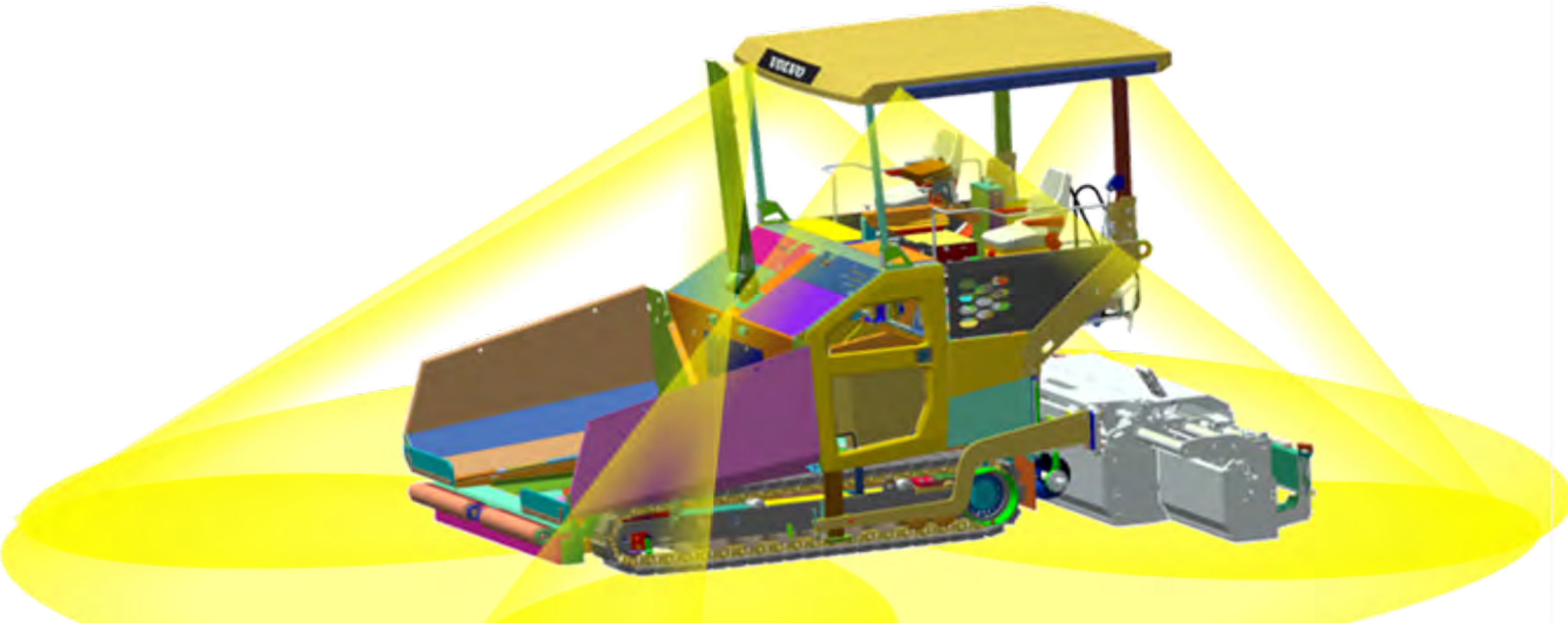
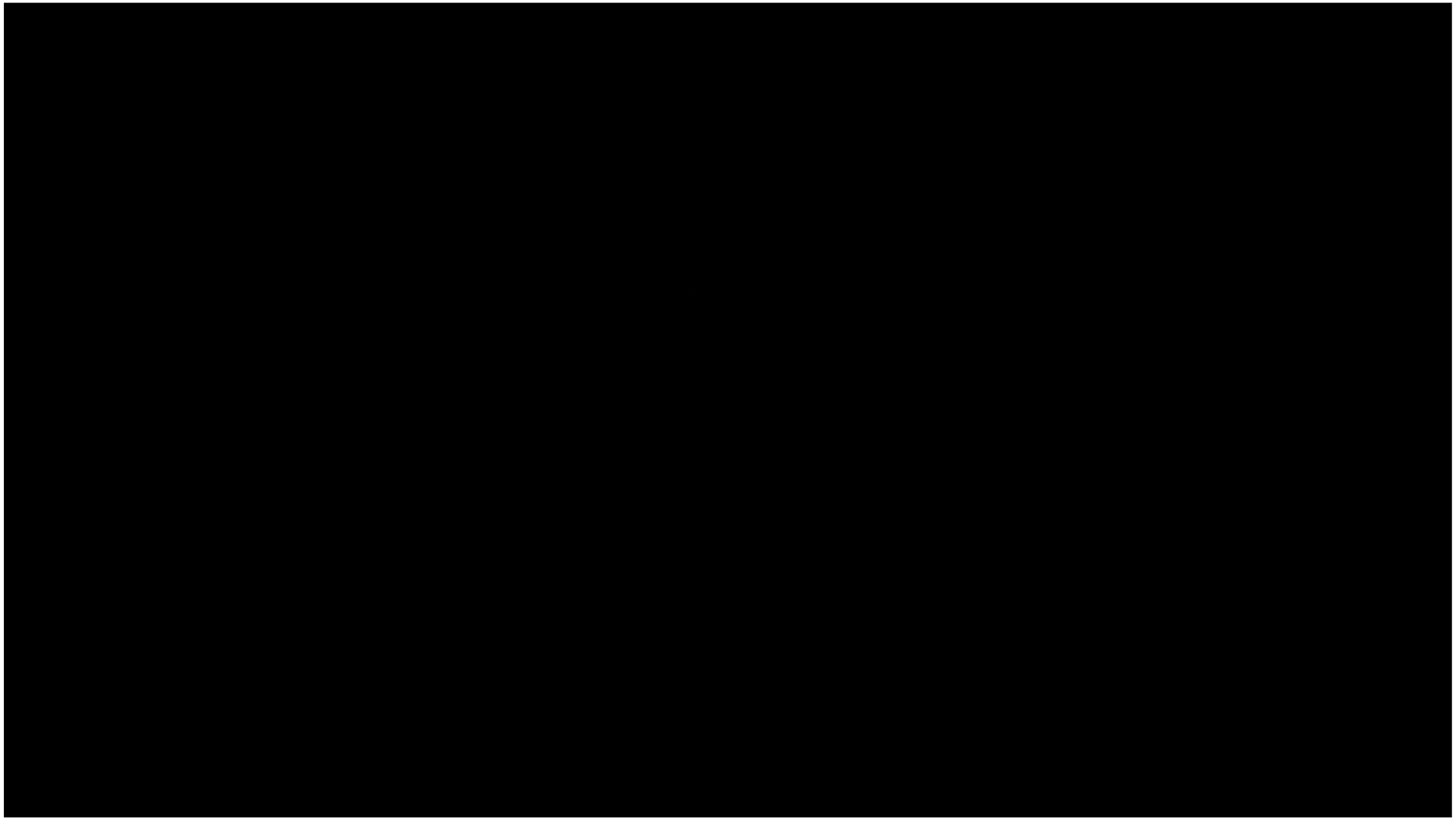
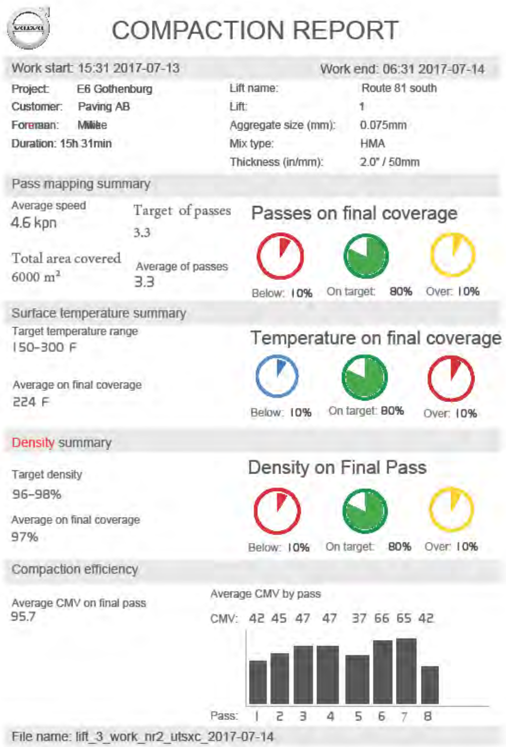
CONSTRUCTION 4.0



MAYBE THIS ?



BUT DEFINATELY THIS


COMPACTION REPORT

Work start: 15:31 2017-07-13 Work end: 06:31 2017-07-14

Project: E6 Gothenburg | Lift name: Route 81 south
Customer: Paving AB | Lift: 1
Foreman: Mike | Aggregate size (mm): 0.075mm
Duration: 15h 31min | Mix type: HMA
Thickness (in/mm): 2.0" / 50mm

Pass mapping summary
Average speed 4.6 kpn
Target of passes 3.3
Total area covered 6000 m²
Average of passes 3.3
Passes on final coverage
Below: 10% On target: 80% Over: 10%

Surface temperature summary
Target temperature range 150-300 F
Average on final coverage 224 F
Temperature on final coverage
Below: 10% On target: 80% Over: 10%

Density summary
Target density 96-98%
Average on final coverage 97%
Density on Final Pass
Below: 10% On target: 80% Over: 10%

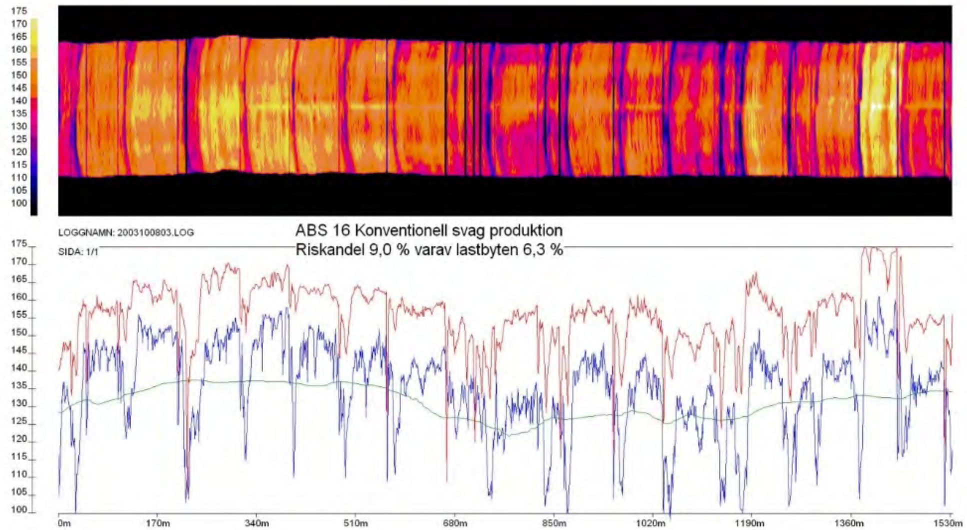
Compaction efficiency
Average CMV on final pass 95.7
Average CMV by pass
CMV: 42 45 47 47 37 66 65 42
Pass: 1 2 3 4 5 6 7 8

File name: lift_3_work_nr2_utsxc_2017-07-14

Volvo Construction Equipment
Building Tomorrow

THERMAL MAPPING

Poor Thermal uniformity

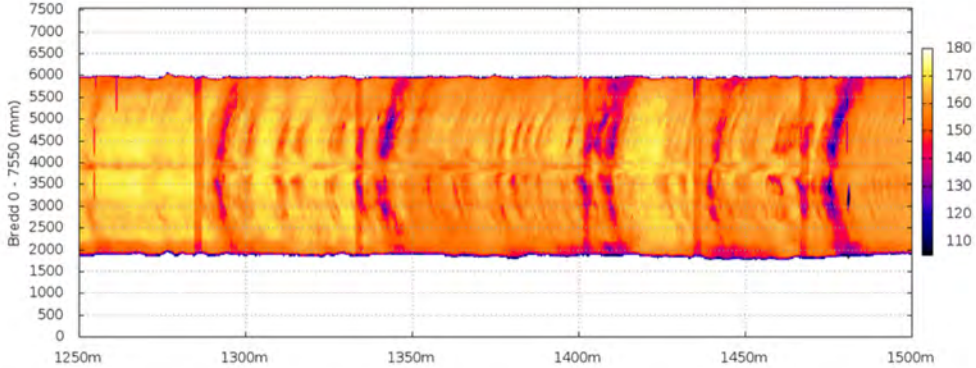


Here the effect of thermal segregation can be seen for different parts of the process.
Measured as a percentage of the area behind the paver that is below what is the minimum compaction temperature.
9% of the area is uncompactable (of which 6,3 % is because of the trucks).

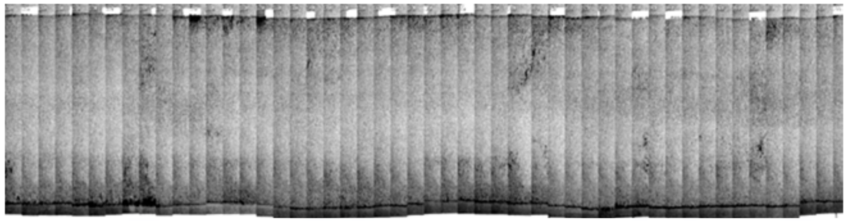
THERMAL MAPPING

E20 Stockholm 1998 - 2013

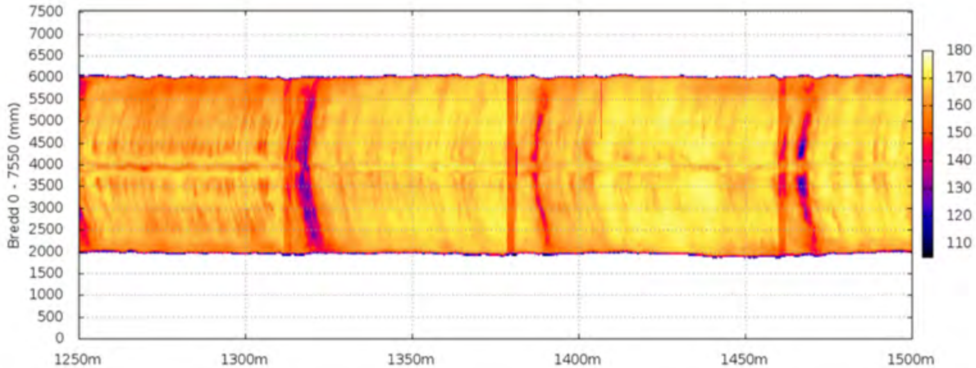
Wearing Course



15 Years Later



Binder Course



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Building Tomorrow

CONSTRUCTION 4.0

1st Industrial Revolution – Late 18th Century – Steam Engine

2nd Industrial Revolution – Late 19th Century – Abundant mass Energy

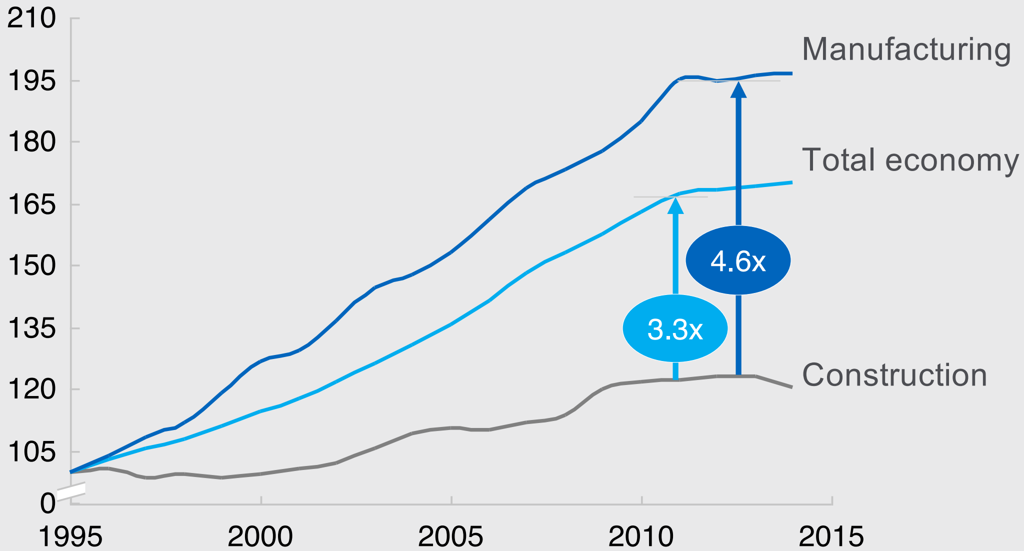
3rd Industrial Revolution - 70´s of the 20th Century – Process controlled mass production- Computers

4th Industrial Revolution – Early 21st Century – Internet, sensors, online, AI

BIM – Building Information Modelling, Building Information Model or Building Information Management

Mckinsey Analysis

The construction industry is behind ...



Global productivity growth trends

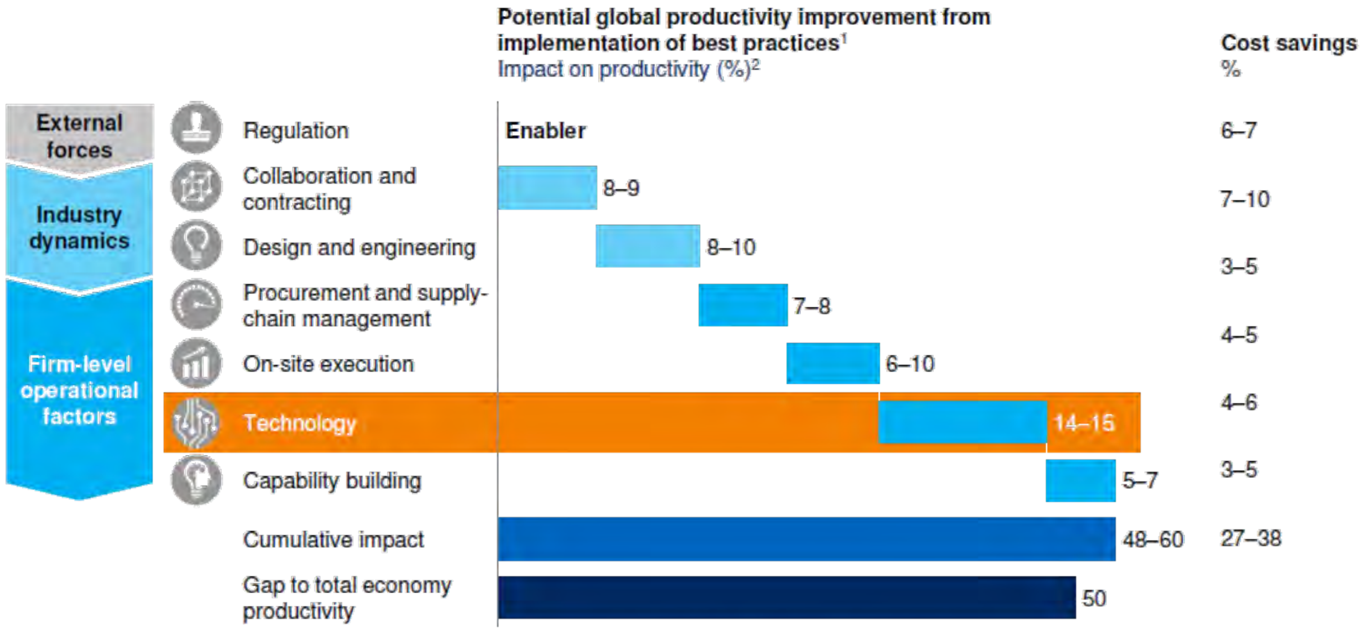
Real gross value added per hour worked by persons engaged, indexed 1995 = 100.

20 year growth differential

Mckinsey analysis

Digitalization increases Productivity significantly

Regulation changes facilitate shifts in industry dynamics that enable firm-level levers and impact

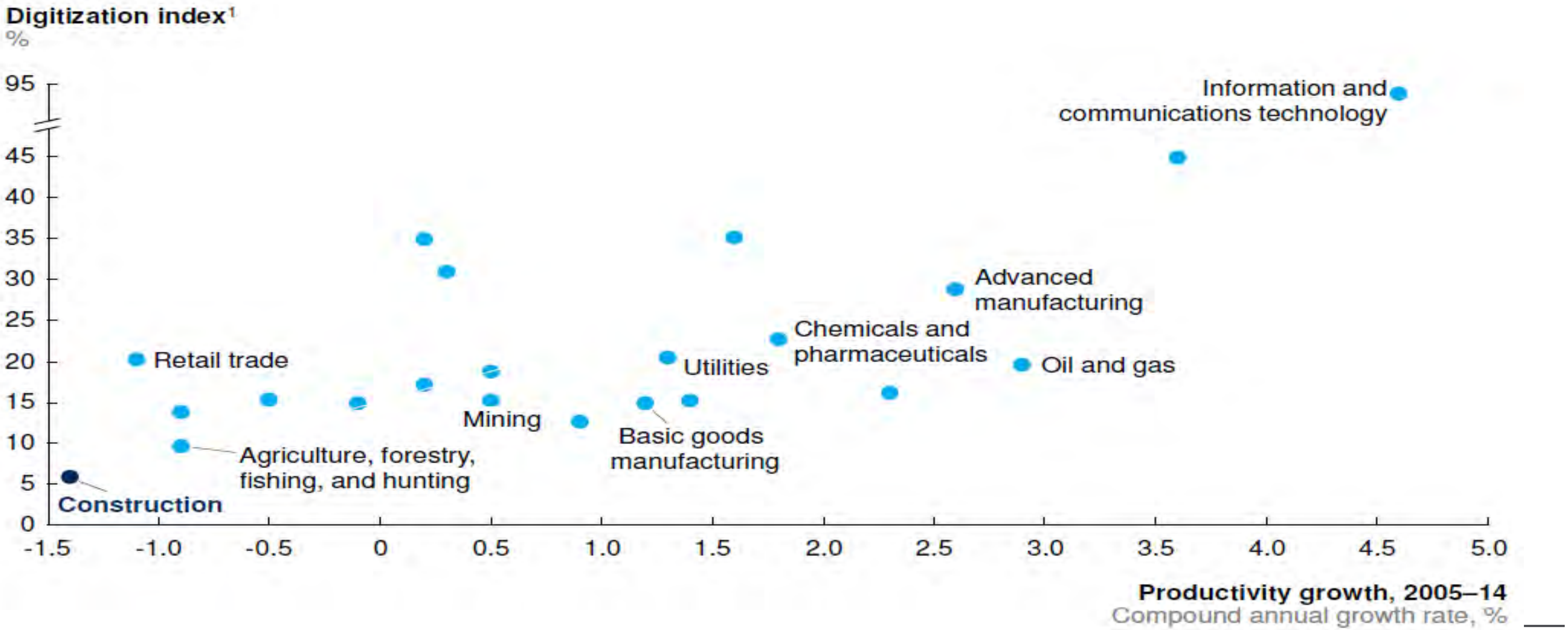


reference:
Mc. Kinsey Global Institute analysis

1 The impact numbers have been scaled down from a best case project number to reflect current levels of adoption and applicability across projects, based on respondents to the MGI Construction Productivity Survey who responded “agree” or “strongly agree” to the questions around implementation of the solutions.

2 Range reflects expected difference in impact between emerging and developed markets.

Construction today at the bottom of adoption rate for Digitilisation



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Motivation for Harmonized M2M Communication

Clear statement of our Customers

Construction Equipment Forum 2018
Hannover – 09. / 10.10.2018

DIE DEUTSCHE BAUINDUSTRIE
BAUEN UND SERVICES

Let's start with cross-manufacturer standardization….
… otherwise real digitization on our construction sites is impossible

#1 ***Beginnen wir endlich mit herstellerübergreifender Standardisierung …***
… sonst ist echte Digitalisierung auf unseren Baustellen unmöglich !

reference: M. Lüddemann

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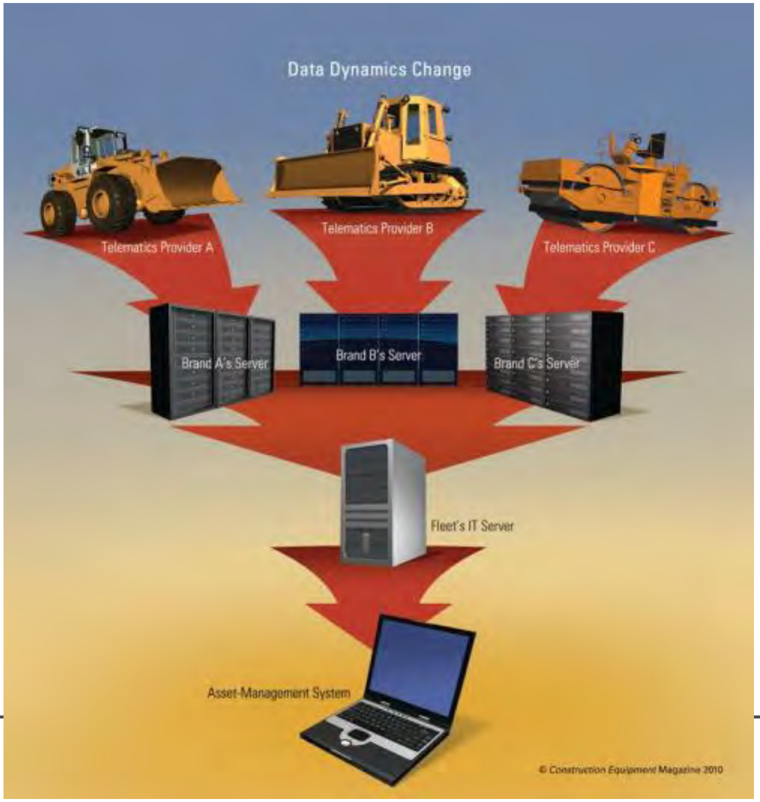
EAPA/CECE Working group

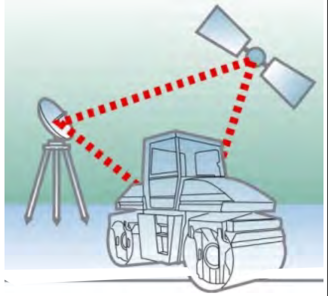
- Amman – Anton Demarmels (also chairman of the CECE group for Road machunery
- Caterpillar –Kevin.J.Lueschow, Jean-Jacques Janosch, Holger Kellerbauer, Jeremy.j.Wilson
- Dynapac – Ulf Siemen
- Q Point – Lukas Reicher
- Topcon – Paul Conlon, Michael Kaak, Raimo Vllstaedt
- Trimble – Geoffrey Kirk
- Veidekke – Geir Lange
- Voegele – Arnold Rutz, Stephan Weller
- Volvo – Hans-Juergen Vogel

Motivation for Harmonized M2M Comm

Proprietary solutions (too) complex for Mixed Fleet



Connected Machines (Telematics)



Machines Availability

GSM, WLAN LORA, …

Networked Machines

Job Site Efficiency

WLAN, 4G (5G)

Working Group Results (activity 1)

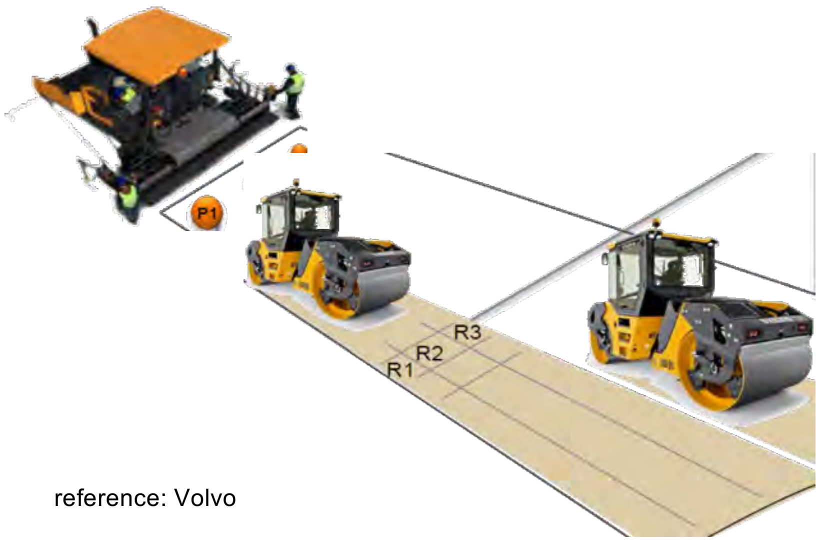
General Findings

1) **Common view on data to exchange**

2) **Data defined (39 data, not yet error codes)**
   6 for site, 6 for position,
   13 for machines in general,
   7 on paving, 7 on compaction

3) **Data format defined: JSON**

4) **Real time or slow communication**



reference: Volvo

Harmonized M2M Communication

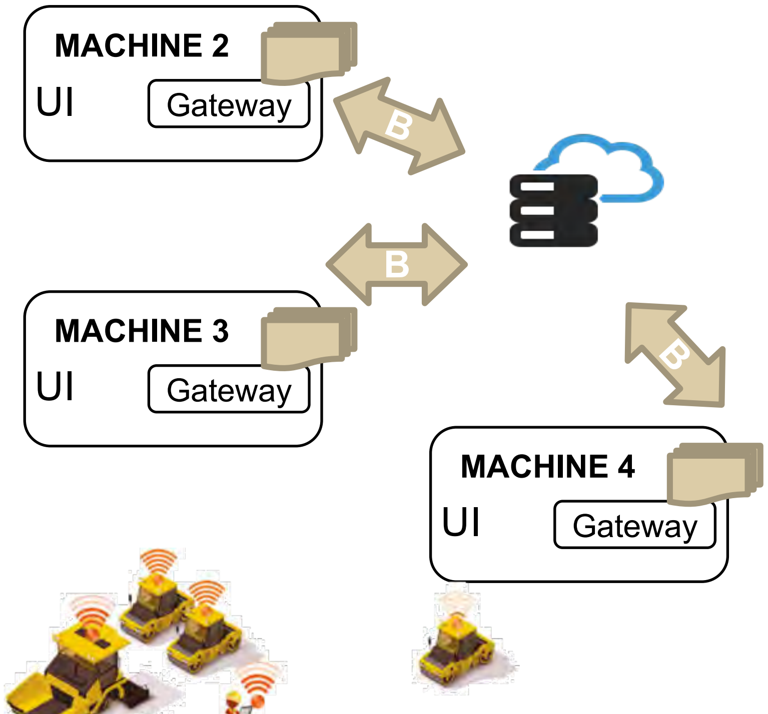
4 Use Cases

Case	Sender	Description	Data Set	Exchange Type
A	all	Exchange current project data *(for synchronization)*	job identifier, site name, job name layer name, material type, ayer thickness	on demand _on change
Bp	Paver	Paver definition (machine definition)	UUID of machine, SN, machine model, temp. measuring principle, screed max. width left (from center), screed max. width right (from center), machine weight	at start _ on request
Br	Roller	Roller definition (machine definition)	UUID of machine, SN, machine model, compaction measuring principle, compaction principle rear, cxcitation principle front, excitation rear, exictation front, drum width, machine weight/axis load	at start _ on request
C	Roller	Transfer of temperature and vibration status, *compaction value (optional)*	UUID of machine, GPS position,: driving speed, driving direction, crab steering offset, vibration setting rear, vibration setting front, asphalt surface temperature, *compaction measurement (optional)*	periodically _ on change
D	Paver	Transfer of temperature and speed	UUID of machine, GPS position, driving speed, paving status, screed width left, screed width right, asphalt surface temperature, *ambient air temperature (optional), driving direction (optional)*	on demand _on change


reference: AMMCOA

Working Group Results

Basic Use Cases



reference: AMMCOA

Harmonized M2M Communication

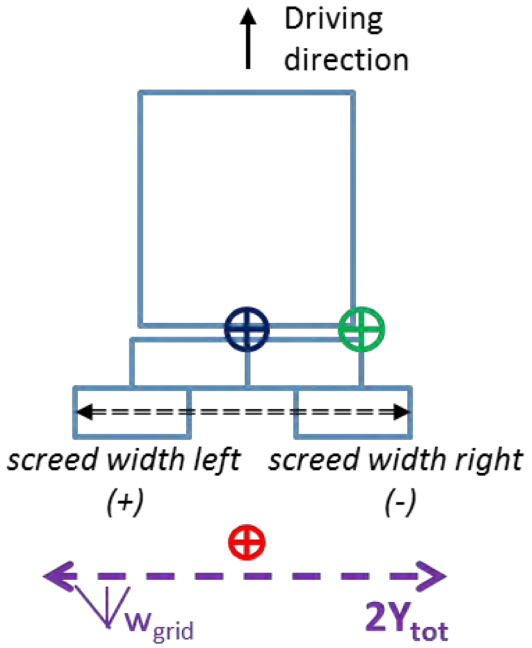
Data set (I of II)

Category	Data description	data type	Units SI	Origin of data Paver	Origin of data Roller
site	Job identifier	string	-	M	M
site	Site name	string	-	O	O
site	Job name	string	-	O	O
site	Layer name	string	-	O	O
site	Material type	string	-	O	O
site	Layer thickness	number	mm	O	O
machine	UUID universally unique identifyer	string	uuid format	M	M
machine	SN of machine	string	-	M	M
machine	Machine model	string	-	M	M
machine	Temperature measuring principle (spot, scanner)	string	-	M	
machine	Screed maximum width left (from center)	number	m	M	
machine	Screed maximum width right (from center)	number	m	M	
machine	Compaction measuring principle	string	-		M
machine	Compaction principle rear (steel drum / tire)	string	-		O
machine	Compaction principle front (steel drum / tire)	string	-		O
machine	Excitation rear (vibration / oscilation / directed / none)	string	-		M
machine	Exictation front (vibration / oscilation / directed / none)	string	-		M
machine	Drum width	number	mm		M
machine	Machine weight / Axis load	number	kg	O	O
position	Timestamp (UTC)	string	ISO8601 / UTC	M	M
position	Data Position latitude	number	° (WGS84)	M	M
position	Data Position longitude	number	° (WGS84)	M	M
position	Heading	number	°	M	M
position	Correction Signal type / FixQuality	number	-	M	M
position	Signal precision / Standard deviation	number	m	O	O

Harmonized M2M Communication

Data set (II of II)

Category	Data description	data type	Units SI	Origin of data Paver	Origin of data Roller
compaction	Driving speed	number	m/s		M
compaction	Driving direction (forward / backward)	number	-1=bw / 0=n / 1=fw		M
compaction	Crab steering offset	number	mm		M
compaction	Vibration setting rear (small / big / off)	number	1 / 2 / 0		M
compaction	Vibration setting front (small / big / off)	number	1 / 2 / 0		M
compaction	Asphalt Surface Temperature(s)	number	K		O
compaction	Compaction measurement value	number	-		O
paving	Driving speed	number	m/s	M	
paving	Driving direction (forward / backward)	number	-1=bw / 0=n / 1=fw	O	
paving	Paving status (on / off = driving not paving)	boolean	-	M	
paving	Screed width left (from center)	number	m	O	
paving	Screed width right (from center)	number	m	O	
paving	Asphalt Surface Temperature(s)	number	K	O	O
paving	Ambient air temperature	number	K	O	O
error	Error codes (tbd)	number	tbd	O	O

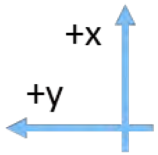


position of data measurement

machine position

antenna position

measurement data



Position of Data Measurement*

(Offset X = 0)

Asphalt Surface Temperature*

$(Y_{tot} / w_{grid} / T_i)$ with $i = (2Y_{tot} / w_{grid}) + 1 =$
$(10m/0.25m)+1 = 41$

Latitude	Longitude	Correction	Sreed left [m]	Screed right [m]	Y_{tot} [m]	w_{grid} [m]	5,00 m T[°C]	4,75 m T[°C]	0,25 m T[°C]	0,00 m T[°C]	-0,25 m T[°C]	-0,50 m T[°C]	-0,75 m T[°C]	-4,50 m T[°C]	-4,75 m T[°C]	-5,00 m T[°C]
51.935579	8.471182	DIFF GPS	3.82	-3.82	5.00	0.25	7	6	7	7	7	7	6	7	7	0
51.935573	8.471186	DIFF GPS	3.82	-3.82	5.00	0.25	7	6	7	7	7	6	6	7	7	0
51.935581	8.471187	DIFF GPS	3.82	-3.82	5.00	0.25	11	11	7	7	7	7	7	7	7	0
51.935583	8.471188	DIFF GPS	3.82	-3.82	5.00	0.25	7	7	7	7	7	7	7	9	10	0
51.935583	8.471191	DIFF GPS	3.82	-3.82	5.00	0.25	7	7	7	7	7	7	7	9	9	0
51.935586	8.471192	DIFF GPS	3.82	-3.82	5.00	0.25	8	8	8	8	8	8	11	10	10	0

Disruptive technologies

Electromobility

Automation

Connectivity

0 emissions, 0 accidents, 0 unplanned stops and 10x higher efficiency

Disruptive Technologies

Digital ideas				Today	Future
1	**Higher definition surveying and geolocation**		SKYCATCH	Geological surprises a major reason for delays and cost increases	Integration of 3-D laser scanning, geographical information systems and drone technology dramatically improving accuracy and speed
2	**5-D (or 6-D) Building Information Modeling**		Trimble RIB	Today lack of one single source for real time view of project design, cost and schedule	5-D BIM considers project's cost and schedule in addition to design parameters. Sixth dimension include SCM
3	**Digital collaboration and mobility**		FIELDWIRE	Industry still relies heavily on paper such as blue-prints, orders, logs, punch lists and progress reports	Online, real-time sharing of information ensures transparency and collaboration for reliable outcome
4	**The internet things and advanced analytics**		QUANTUMBLACK	Vast amounts of data not processed, measured or even captured	Sensors and wireless technologies enables intelligent assets for e.g. repair, ordering and energy efficiency
5	**Future proof design and construction**		Thermoblok	Materials usually account for >half of project costs	New building materials, e.g. self-healing concrete, aerogels and nanomaterials and innovative construction approaches, e.g. 3-D printing and preassembled modules can lower cost while increasing speed, quality and safety

- Exponential technologies (Can be Disruptive technologies)
- What do we mean with exponential? Developing faster than our common sense, our linear ways of thinking can grasp – while I am speaking computational power, performance of electric energy storages and internet of things have improved in an exponential pattern….
- Human mind grasps linear – like age – weight – age(I am 43 now, then I turn 44 – or my weight, a few kilos up or down, even if it feels like exponential around X-mas ☺)
- Exponentials can help us or totally disrupt the industry (examples like Facit, Kodak, Nokia come to mind…)
- Let's look at an ongoing research projects, the electric site!

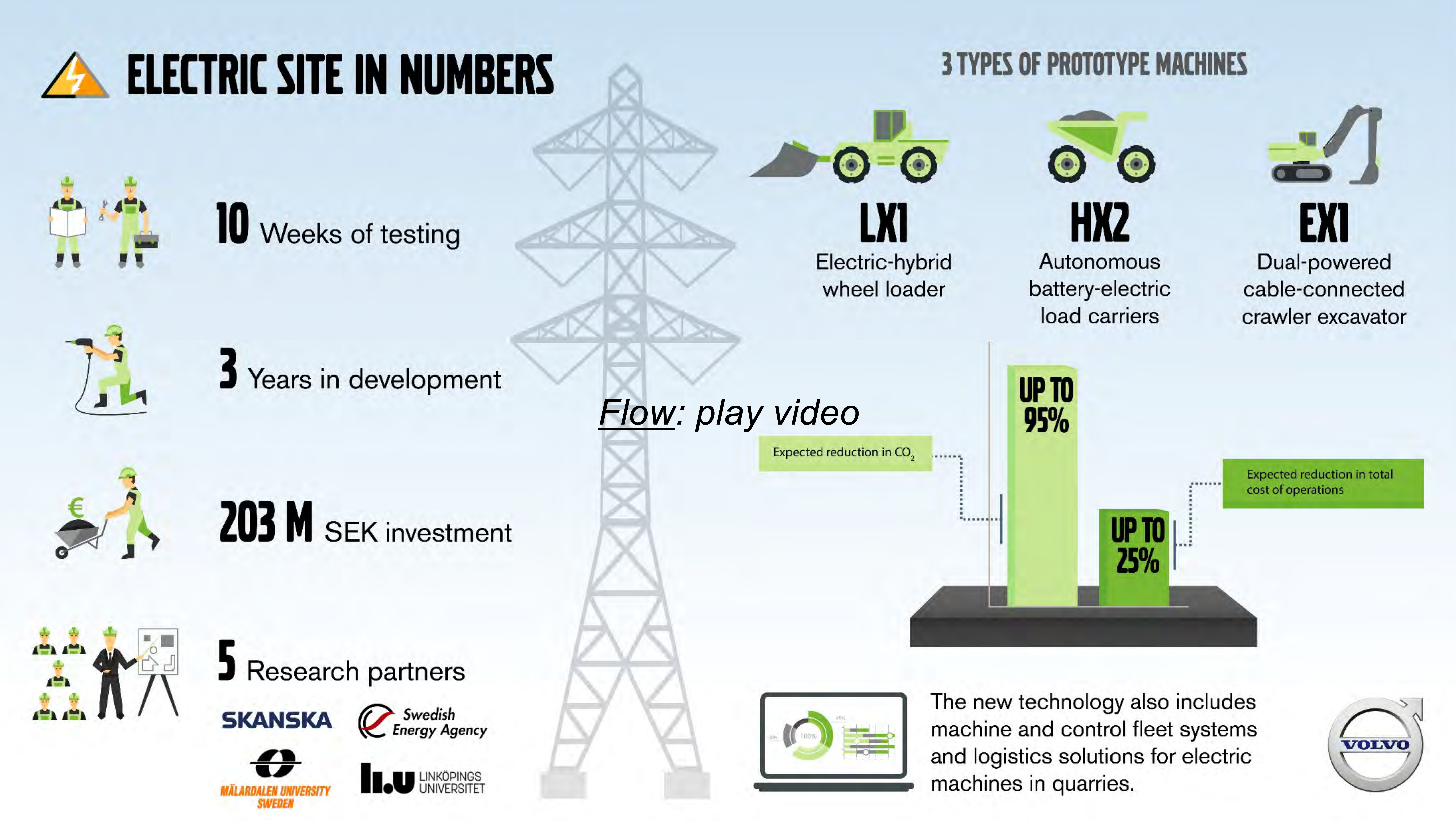

RESEARCH PROJECT
95%
Potential reduction of carbon emissions
25%
Potential reduction in cost
ELECTRIC SITE | Quarries of the future

Electric Site

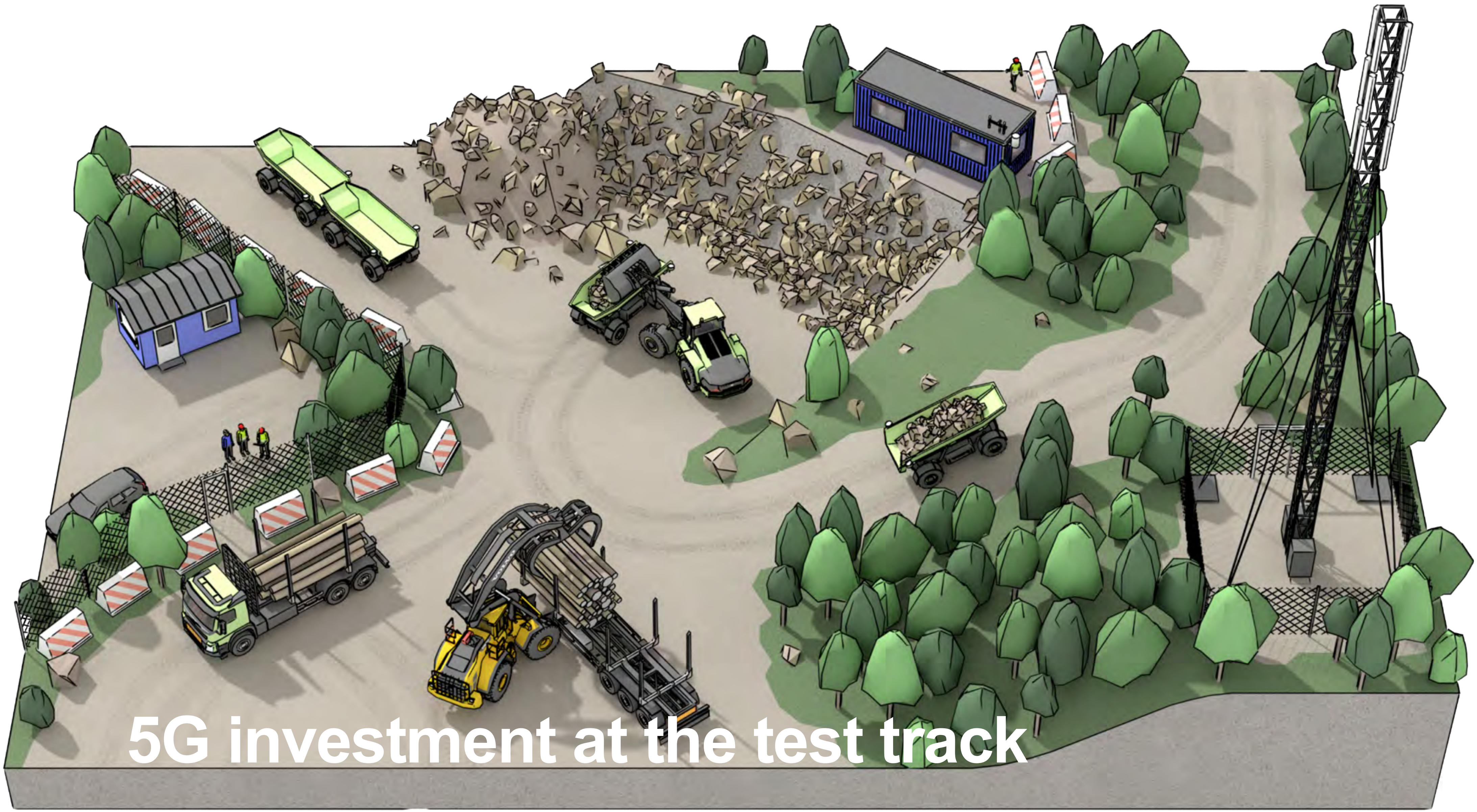
- The **HX1** autonomous, battery electric, load carrier is the first-generation prototype, which served as proof of concept for the updated, second-generation prototype, HX2.

- The **HX2** autonomous, battery-electric load carrier prototype incorporates shared technologies and components from the Volvo Group. The HX2 also has a completely new drivetrain and a vision system that detects humans or obstacles in the machine's vicinity.

- The **LX1** electric hybrid wheel loader can deliver up to a 50% improvement in fuel efficiency. The machine also offers a significant reduction in emissions and noise pollution compared to its conventional counterparts.


ELECTRIC SITE IN NUMBERS
10 Weeks of testing
3 Years in development
203 M SEK investment
5 Research partners
SKANSKA
Swedish Energy Agency
MÄLARDALEN UNIVERSITY SWEDEN
LINKÖPINGS UNIVERSITET
Flow: play video
3 TYPES OF PROTOTYPE MACHINES
LX1
Electric-hybrid wheel loader
HX2
Autonomous battery-electric load carriers
EX1
Dual-powered cable-connected crawler excavator
UP TO 95%
Expected reduction in CO_2
UP TO 25%
Expected reduction in total cost of operations
The new technology also includes machine and control fleet systems and logistics solutions for electric machines in quarries.
VOLVO


Pioneering 5G technology



5G investment at the test track


02
AUTONOMOUS
VOLVO
02
VOLVO
charge node 4