Research and Development Explanatory Meeting
"The Optimal Relationship Between People and Machinery"

June 19, 2019

Kotaro Hirano
Representative Executive Officer, President and CEO

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Executive Officer and CTO

Hitachi Construction Machinery Co., Ltd.
1. Research and development to realize the corporate principles
2. Research and development strategy for the future
3. Enhancement of safety
4. Improvement of productivity
5. Reduction of life-cycle cost
6. Achieving a sustainable society
7. Summary
1-1. Our Vision and Principles of Hitachi Construction Machinery

Our vision

To pass on productive environment and prosperous cities to future generations

Hitachi Construction Machinery Group helps to create comfortable living spaces

Our principles

To activity develop machinery to make the relationship between people and work, more comfortable, advanced, and efficient.

To continuously develop and provide our customers with technology, products, and services that generate new value.

To act as a decent corporate citizen maintaining harmony with the environment, contributing to society, participating in cultural activities, and striving for a symbiotic relationship with society, while maintaining profitable operations.
1-2. Rapid Changes Advancing on the Construction and Civil Engineering Industries

Social challenges
Decreasing birthrate and aging population
Insufficient labor force and shortage of experts

Growth slowdown
Shift from expanding production volume to improving productivity

Sustainable growth (SDGs)
Climate change, gas emission regulations, CO2 reduction

Rapid progress of digitization
IoT technology and big data
All objects connected by data

Fusion of the real and virtual worlds
New paradigm of automation and labor saving

Rise of ventures
Collapse of barriers to entry and competitive rules

Shift from “Tangible Goods” to “Intangible Goods”
1-3. Targets for Sustainable Growth Initiatives (Product Development)

Curb CO₂ emissions via new products in FY2030:
Reduce by ▲33% (compared to FY2010)

- Set 10 key goals to align our activities with SDG's.
- Established Sustainability Promotion Division (April 2019)

HCM set a CO₂ reduction target for production and products according to the requirements of an IPCC 2°C scenario (21% to 37%). The target value for product development is a decrease of 33% in FY2030 compared to FY2010.

This target will be achieved through advanced energy-saving in our major products which are hydraulic excavators, mini excavators, wheel loaders, dump trucks, and compaction equipment. In addition, we will promote IoT and electric solutions to save energy.
1-4. Shifting from New machine Sales to a Value Chain

**Mega Trend**
- Aging, labor shortage
- Tightening of Environmental regulation (SDGs)
- IoT/Digital revolution
- Electrification /Automation

**Customer Needs Change**
- “Ownership to “Sharing / Rental”
- Tangible goods to intangible goods
  - Operation support / Automation
  - Operation management – from machine to entire construction site
- Safety, Environmental Regulation

**Core Competence of OEM**

**Base**
- Digital Technology
- Big Data/AI

**Technology**
- Engine/EV
- Internal manufacturing of major component

**Solution**
- Information-oriented construction
- Autonomous operation
- One Stop service
- Preventive maintenance

**Focus on new machine sales**
**Value chain model**

Operational data (Total num. of units)

Number of units in operating

Number of sales

Utilizing data by AI

New business areas

Value chain business

*Including rental and used

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1-5. New value created by Hitachi Construction Machinery - Solution Linkage

Customer’s needs
- Enhancement of safety
- Improvement of productivity
- Reduction of life-cycle cost

Solution Linkage
ICT/IoT solutions solving problems together with customers

One Hitachi
Customer collaboration
Open innovation

AHS: Autonomous Haulage System
ICT: Information & Communication Technology
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2-1. HCM's Vision for the Site of the Future

Proposing the optimal relationship between people and machinery to maximize the customer's enterprise value

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- **Visualization**
- **Site management**
- **Automation**
2-2. HCM Machinery Development Concepts

Equip a platform which presupposes built-in digital features

Open innovation

Big data analysis
Machine status monitoring and predictive diagnostic, work process analysis, AI

New business models
Data-driven businesses
Customer process innovation, shared services

Sensors and new features built-in
Satellite positioning, cameras, LIDAR Inertial measurement devices

Communication and network features built-in
High-speed, high-capacity, and real time Control, construction, and monitoring

Machine foundation
Safety standard measures
Electronics and electrification
Automation and robotization

Manufacturing foundation
Components which support electronics and electrification
Easy to build
Can be built by anyone
2-3. Aims of Solution Linkage

**Enhancement of safety**
Safety solutions for "people" and "machinery" to confidently coexist

**Improvement of productivity**
Site management and automation solutions to cope with the decreasing birthrate and aging population

**Reduction of life-cycle cost**
Data utilization services such as predictive diagnostics to minimize lifecycle costs

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**Solution Linkage® Cloud**

- **Visualization**
- **Site management**
- **Automation**

- **Civil engineering**
- **Mining**
- **Wi-Fi**
- **ConSite®**
- **Mobile**

**Solution Linkage®**

- **Global e-Service®**
- **Wenco®**

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3-1. Aims of Solution Linkage

- **Enhancement of safety**
  - Safety solutions for "people" and "machinery" to confidently coexist

- **Improvement of productivity**
  - Site management and automation solutions to cope with the decreasing birthrate and aging population

- **Reduction of life-cycle cost**
  - Data utilization services such as predictive diagnostics to minimize lifecycle costs
3-2. Enhancement of Safety

Realizing a safe site where people and machinery cooperate

**Enhancement of safety**
- Rear camera
- Support operator awareness

**Enhancement of construction site safety**
- Support operator decisions
- Moving object detection and warning features
- RF tag integration
- Operation support solutions

**Support operator handling**
- Safely guide people
- Site where people and machinery cooperate
- Site safety solutions

Support operator awareness

Technology evolution

2016 2017 2018 2019 2020

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3-3. Operation Assistance Package for Enhancement of Safety

Provide the operation assistance system for enhancement of construction site safety as a common package on major models

- Awareness
- Judgment
- Operation assistance
- Information sharing

Wheel loader  Hydraulic excavator  Compaction equipment
3-4. Enhancement of Safety of Mass-produced Products

Improve detection features with cameras and sensors to alert operators

[2018] Optional configuration (camera and infrared sensor)

-[2018] Standard equipment (camera only)

Camera and infrared sensor ⇒ easy to confirm detected objects
3-5. Examples of Proving Tests With Customers

Hydraulic excavator warns the operator and those nearby when a person enters the detection area.

RF tag integration
Operation support solutions

the detection area
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4-1. Aims of Solution Linkage

- **Improving safety**: Safety solutions for "people" and "machinery" to confidently coexist
- **Improving productivity**: Site management and automation solutions to cope with the decreasing birthrate and aging population
- **Lifecycle cost reduction**: Data utilization services such as predictive diagnostics to minimize lifecycle costs

**Solution Linkage® Cloud**

- **Visualization**: Globale-Service®
- **Site management**: Solution Linkage®
- **Automation**: Wenco®

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4-2. Improvement of productivity (Future of Remote Control)

Creating new forms of value through remote operation

HCM's approach

Application of 5G and other next-generation communication technologies
Remote control over typical lines by combining automation technologies

- Visual remote operation
- Remote operation in a specific radio environment
- Remote operation in an Internet environment

- Special low-power remote control unit
- ASTACO-Sora for the Fukushima Daiichi Nuclear Power Plant
- Unmanned construction at Mount Unzen Fugen-dake and Mount Usu

- 5G high-speed, high-capacity remote operation
- Low bandwidth support remote + autonomous and automatic

- Ultra high-speed compression and expansion technology
- Low delay remote control technology

Developed in 2013 ahead of the industry

Technology evolution

1990  2000  2010  2020  2030 (Year)
4-3. Improvement of productivity (Future of Automation)

Automation solutions realized by "machinery that cooperates with people"

- **Wheel loader automatic excavation and loading**
  - Level master
- **Awareness of the surrounding environment and planning**
- **Semiautomated excavation according to the target surface**
- **Semiautomated excavation based on 3D data**
- **Control multiple units Manage productivity**
- **Dump truck Autonomous Haulage System (AHS)**
- **Automatic operation of compaction equipment**
- **Autonomous operation at a typical construction site**
- **Operates automatically in cooperation with people**

Technology evolution:
- 1990
- 2000
- 2020
- 2030 (Year)

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4-4. Dump Truck Autonomous Haulage System (AHS) Status Update

Proven Wenco® FMS x HCM AHS moving to commercial operation

Commercial operation scheduled to start in FY2019
Carrying out user tests for a full-scale rollout at an actual site in cooperation with Whitehaven Coal

FMS: Fleet Management System
Automatic operation tests of compaction equipment (tire roller)
4-6. Automatic Operation (Mini Excavator Automatic Excavation and Loading Tests)

Mini excavator automatic excavation and loading tests
4-7. Aims of Solution Linkage

- **Enhancement of safety**
  Safety solutions for "people" and "machinery" to confidently coexist

- **Improvement of productivity**
  Site management and automation solutions to cope with the decreasing birthrate and aging population

- **Reduction of life-cycle cost**
  Data utilization services such as predictive diagnostics to minimize lifecycle costs

**Solution Linkage® Cloud**

- **Visualization**
- **Site management**
- **Automation**

**Global e-Service®**

- Civil engineering
- Mining operation management system
- Dump truck autonomous driving system

**Solution Linkage®**

- Wi-Fi
- Mobile

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Development of site management solutions which integrate the knowledge and technologies cultivated on typical civil engineering sites with the Wenco FMS.

### Target markets

- **Number of sites (worldwide)**
  - 500: Large-scale mines
  - 1,700: Small to medium scale mines
  - 10,000: Quarries/stone crushers
  - 48,000: Typical civil engineering and other industry types

### Integration of site management solutions

- **Wenco® FMS**
  - Solution Linkage® Mobile

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4-9. Wenco® Mining Fleet Management System (FMS)

**Wencomine**
- Dump truck allocation management system for large-scale mines
- World's second largest number of operation systems (Wenco® survey)

**Wencolite**
- Vehicle asset management system for small to medium scale mines and quarries
- Limited features to control implementation and maintenance costs

**Implements allocation, safety, and asset management of dump trucks and heavy machinery at mines and quarries**

Wencomine allocation management system

Wencolite safety zone setting screen
Implement site management by linkage with the smart devices of construction workers

Solution Linkage® Mobile

IoT solution has (three or standard) features for position identification, understanding work volume and progress, and approach notification.

Construction managers understand the position of heavy machinery and workers.

Efficient site management and operation.
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5-1. Aims of Solution Linkage

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**Solution Linkage® Cloud**

- **Visualization**
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**Global-e-Service®**

**Solution Linkage®**

**Wi-Fi**

**ConSite®**

**Mobile**

**Mining**

**Mining operation management system**

**Dump truck autonomous driving system**
5-2. Initiative to Improve Remote Failure Detection

Target to achieve 90% of major components failure detection & prediction after 2020

- **KPI:** major component fairer to be covered by sensing data
  The remote failure prediction & detection rate indicate the coverage rate of major components failure

In June 2000, Hitachi introduced the world's first general-purpose hydraulic excavator equipped with information communication terminal

**ConSite**

<table>
<thead>
<tr>
<th>Phase</th>
<th>Year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>2000</td>
<td>Start of IoT</td>
</tr>
<tr>
<td>1.5</td>
<td>2013</td>
<td>Utilization of Existing data</td>
</tr>
<tr>
<td>1.0</td>
<td>2015</td>
<td>Big data analysis</td>
</tr>
<tr>
<td>2.0</td>
<td>2017</td>
<td>ConSite-embedded machines</td>
</tr>
<tr>
<td>3.0</td>
<td>2020</td>
<td>Failure prediction &amp; detection rate of 90%</td>
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</table>

2000 - Start of IoT
2013 - Phase 1.0
2015 - Phase 1.5
2017 - Phase 2.0
2020 and beyond - Phase 3.0

**Global deployment**

**Data usage enhancement**

**Differentiated service provided with ConSite-embedded machines**

**Ideal Goal**

**Small start**

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Global start from December 2018

• Don’t expect AI to provide 100% accuracy in risk calculation.
• Do use the result of risk calculation to conduct the Digitalized “health check” inspection to prevent the major incident. (fix before it brakes.)
• AI DO continuously monitoring with the result data gained through Digitalized “health check”. The result data enhance the accuracy of risk calculation.

(1) Risk calculation (AI)
Calculate the risk according to the use of each machine
・Use data obtained via IoT
・Extract high-risk machinery

(2) Health check (mechanic)
Conduct Digitalized “health check” inspection
・Check the health of high-risk machinery
・Standardized accuracy can be provided by the smartphone app

(3) Retrain (automatic)
Use the results data to retrain the AI and continue the condition monitoring
5-4. The example of ConSite AI Application

Implement failure prediction & detection of the main pump (heart of the hydraulic excavator)

- Failure in main pump may cause the damage for the entire hydraulic system.
- In the machine down situation, considerable time & cost will be required.
- Low failure rate. Extremely difficult to predict the failure.

**Points**

- The actual picture of Inner parts of a damaged (scratch) main pump

**Main pump**

[Aichi Prefecture] Machine shows signs of a clear pump performance decrease

[B Rank (Notice)] Machine shows signs of a slight performance decrease

[D Rank (Warning)] Requires repair or replacement
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6-1. HCM's Electric and Hybrid Initiatives

Contributing to various social issues through electric and hybrid development since the 1990s

**Motorization**

- Hybrid wheel loader LX70 (~1990)
- Hybrid excavator ZH200 (2000)
- Battery type electric excavator ZX70B (2010)
- Battery type electric excavator prototype models "ZE85", "ZE19" (Reference exhibit, 2020)

**Hybridized**

- Hybrid excavator ZH200 (2010)
- EH3500AC-3 Trolley specifications (2020)
- Battery type electric excavator ZX35B
- Cable type electric excavator ZX70B

HCM's Electric and Hybrid Initiatives

Hybrid excavator ZH200-6

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Full-scale shift to EVs expected to start from mini excavators in each country and region

- More European countries will ban internal combustion in the future
- Alternative fuels are also advancing in China

<table>
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<tr>
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<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
<th>2040</th>
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<tr>
<td>Europe (internal combustion ban)</td>
<td>![Flag]</td>
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<tr>
<td>China (shift to alternative fuels)</td>
<td>▼20% NEV shift*1</td>
<td>▼EV, PHEV*2</td>
<td></td>
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*1 NEV: New Energy Vehicles  
*2 PHEV: Plug-In Hybrid Electric Vehicles
6-3. HCM: Joint Development of an Electric Mini Excavator With Our European Distributor

Promoting the development of electric construction machinery through "EAC*", a new company established with the German distributor KTEG who understands the trends at European sites

Toni Kiesel (left), President of KTEG, and Hideshi Fukumoto (right), Executive Officer and CTO of Hitachi Construction Machinery, shake hands at the contract signing ceremony

*: "European Application Center" established in October 2018
Reference exhibit of 2t and 8t class electric mini excavator models at bauma2019
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