

Introduction of Product

Introduction of Medium sized Bulldozer D65EX/PX/WX-16

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New bulldozer, models D65EX/PX/WX-16, have been developed and introduced into the market based on the Komatsu concepts of “environment”, “safe” and “IT” with the outstanding productivity and economy as “Dantotsu” feature.

The background to the development and its technology are described and the sales features of new products are introduced as well.

Key Words: Bulldozer, D65-16, “Dantotsu” feature, Sigmadozer, Lock-up automatic transmission power line, Monocoque cab, Large-screen color liquid crystal multi-segment monitor, Power angle and power tilt dozer, Work execution by IT design, Fully automatic air conditioner

1. Introduction

After its full model change in 1992 to dash 12, the D65 has been upgraded to dash 15 featuring enhanced operability and comfortability, meeting various regulation requirements, and serving a variety of market demands.

Due to model changes made by competitors, however, the merchandise power of D65 has relatively waned gradually and the development of a commodity that surpasses competitor products in performance and meets customer needs has been desired as a successor model to D155AX-6, which has enjoyed a good reputation among its customers as a “Dantotsu (outstanding)” machine. Against this backdrop, the D65-16 has been developed featuring Dantotsu productivity and economy, as well as various selling points, as outlined below.



Photo 1 D65EX-16

2. Aims of Development

A medium-sized bulldozer significantly upgrading the merchandise power to meet user needs has been developed incorporating various selling points and featuring Dantotsu basic performance through the use of new technologies based on the concepts of “environment,” “safety,” and “IT.” A full-scale PAT (power angle and power tilt) bulldozer was also developed tailored to market trends. An activity to reduce the number of parts to enhance price competitiveness was also aggressively implemented. **Figure 1** illustrates the aims of the development.

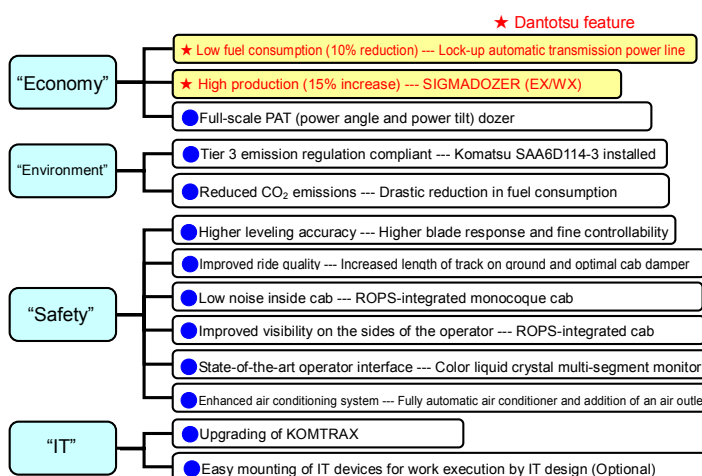


Fig. 1 Aims of Development

3. Dantotsu features

The following two new technologies have achieved a 15% increase in the production (m³/h), a 10% reduction in fuel consumption (l/h), and a 25% increase in fuel efficiency (m³/l) compared with a conventional model (Fig. 2).

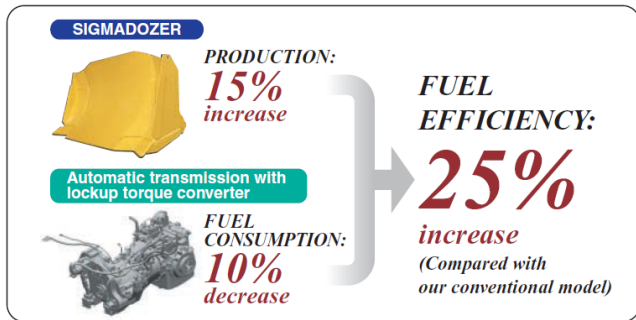


Fig. 2 Comparison of work rate and fuel consumption

(1) Low fuel consumption through a “lock-up automatic transmission power line”

The D65-16 is installed with a lock-up automatic transmission power line that transmits its effective engine output to the undercarriage and work equipment without losses and has a function of automatic gear shift without shocks. In addition to the power line, higher operability and visibility, as well as total controllability, of the vehicle are achieved by controlling the engine output in accordance with the vehicle load and by installing a color liquid crystal multi-segment monitor.

① Lock-up control and automatic gear shift

The power line efficiency had to be increased over a wide load range from traveling to dozing work to achieve a significant reduction in fuel consumption in usage of the medium-sized bulldozer (Fig. 3). A drastic reduction of shocks at gear shift was essential to have the power line accepted by the operator without feeling uneasy. To accomplish this, new technologies were employed such as controlling the lock-up clutch pressure by changing the power line input and output revolution speed ratio and momentary torque increase by controlling the engine. Through these controls, torque losses and slow engine revolutions during a gear shift could be improved significantly, accomplishing gear shift control of the next generation making a clear distinction compared with conventional machines.

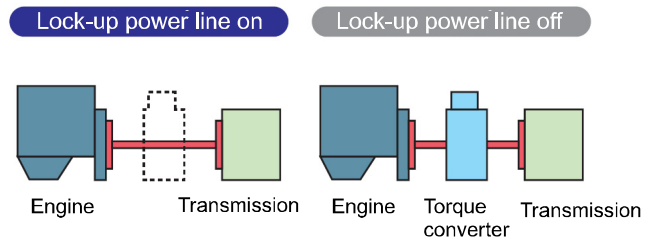


Fig. 3 Lock-up control

② Engine control

The engine output is minutely selected in each mode and during turning, gear shift, and locking up, making a contribution to fuel efficiency improvement. For example, when the lock-up mechanism is functioning, power losses by the torque converter can be eliminated and the engine output is reduced to limit the quantity of fuel injection (Fig. 4). Engine control achieves full-range power control and maximum vehicle speed control by combining a mid-range governor and high-speed idling (HSI) mechanism.

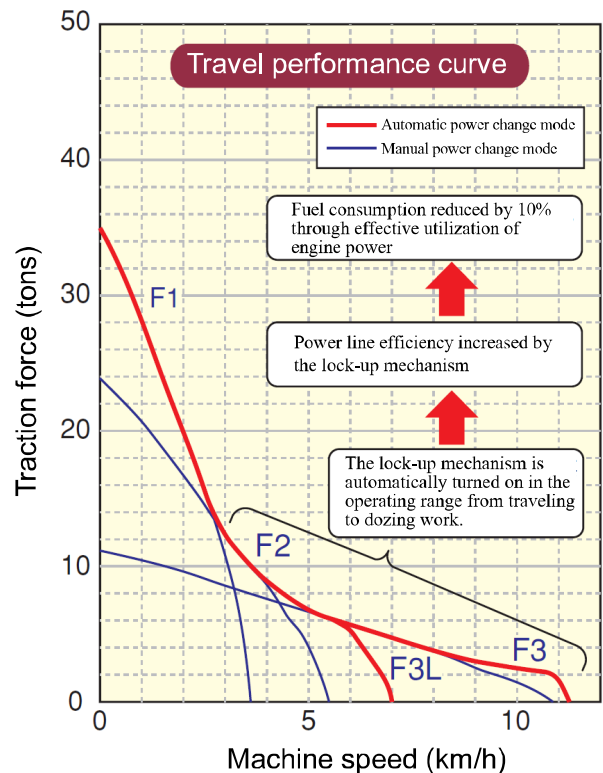


Fig. 4 Traction diagram

③Mode setting

The D65-16 has two gear shift modes, enabling selection between the “automatic gear shift mode” for automatic acceleration or deceleration by the load through direct drive and “manual gear shift mode” in which the speed is automatically changed only in deceleration through torque converter drive. Additionally, two operation modes can be selected, namely, “P: power mode” for full power operation or “E: economy mode” for fuel consumption economy. Furthermore, the “backward traveling slow mode” slows the backward machine speed.

The characteristics of these modes are summarized in **Table 1**. **Table 2** lists a recommended mode for each work and operating condition.

Compared with the “P mode,” the “E mode” reduces fuel consumption by 10% in a wide range from traveling to a medium-load work by reducing engine output. Conversely, the engine output is increased in a heavy-load work so that the operator does not feel lack of machine power.

Table 1 Characteristics of each mode

Gear shift mode	Characteristics
AUTO (Automatic gear shift mode)	<ul style="list-style-type: none"> This mode is recommended for ordinary soil properties and work such as digging, earth moving, leveling, and spreading and grading. The power train is driven at high efficiency so that fuel consumption can be reduced. An optimum machine speed is selected automatically, free from troublesome gear shift operation in acceleration or deceleration.
MAN (Manual gear shift mode)	<ul style="list-style-type: none"> Recommended for digging work on uneven terrain and for ripper work where the load readily varies Recommended for tree root clearing and side cutting work where deceleration operation is necessary.

Operation mode	Characteristics
P (Power mode)	<ul style="list-style-type: none"> This mode generates full power and is recommended in work that requires moving large production volumes of earth or on an ascending slope.
E (Economy mode)	<ul style="list-style-type: none"> Select this mode when saving of fuel consumption is desired. Operate in this mode when soil readily causes shoe slips and deceleration is necessary. Operate in this mode when not much power is needed such as in dozing down work and leveling work.

Backward traveling slow mode	Characteristics
ON	<ul style="list-style-type: none"> Operate in this mode for comfortable ride quality during backward traveling in work on uneven ground or on soft rock ground.

Table 2 Recommended modes

Work	Soil	Operating condition	Speed change mode		Operation mode		Backward traveling slow mode
			AUTO	MAN	P	E	
Digging, earth moving	Ordinary soil	Heavy-duty work: A high production is desired.	○		○		
	Sand, soft soil	Light-duty work: Soil is slippery.	○			○	
	Uneven ground, soft rock	Load readily varies.		○		○	○
Dozing up		Ascending road	○		○		
Dozing down		Descending road	○			○	
Leveling, spreading and grading		Light-duty work	○			○	
Ripping	Uneven ground, soft rock	Shoes slip readily.		○		○	○
Tree root clearing and side cutting				○	○		

(2) Increased production by SIGMADOZER

Two models of SIGMADOZER with a new blade that can increase the production by 15% at the same dozing resistance as that of the conventional semi-U blade and straight tilt blade have been developed. They are Models D65EX-16 and D65WX-16 (Photo 2). The new concept of SIGMA dozer design can increase production because the center and front part of blade dig ahead and the both sides avoid to be spilled reduces earth spilling from both sides of the blade (Fig. 5).

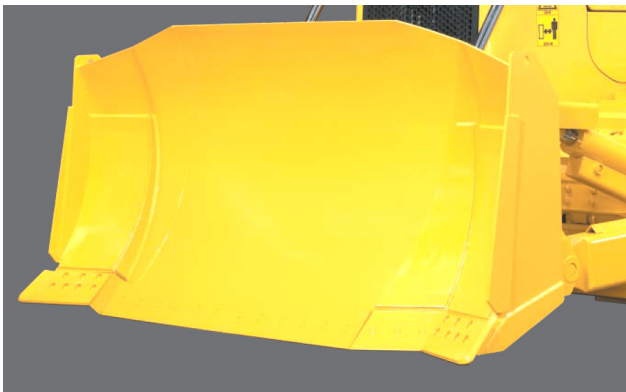


Photo 2 Full view of Sigmadozer

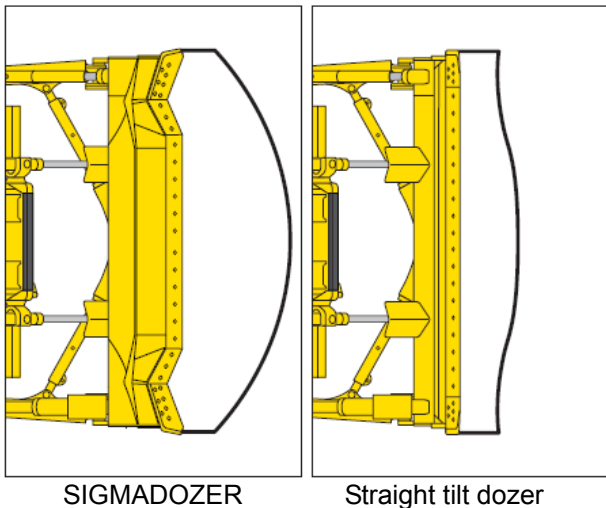


Fig. 5 Hauling of earth by Sigmadozer

4. Selling Points

(1) “Economy”

- ① Development of a full-scale power angle and power tilt (PAT) dozer

Conventional bulldozers have mounted a PAT dozer manufactured by a local supplier. This PAT dozer was designed for a limited space and its frame is made of a one-piece plate. It was limited to light-duty work only.

The PAT dozer is especially advantageous in land development by an angle mechanism, and the demand for PAT dozers is forecasted to increase in the future because of their universality and mobility. It has been added to the D65 series (Photo 3).



Photo 3 Full view of the PAT dozer

The new PAT dozer incorporates a variable-pitch function and allows replacement of the center ball. It features an add-on structure with standard frame so it excels in manufacturing efficiency (Fig. 6).

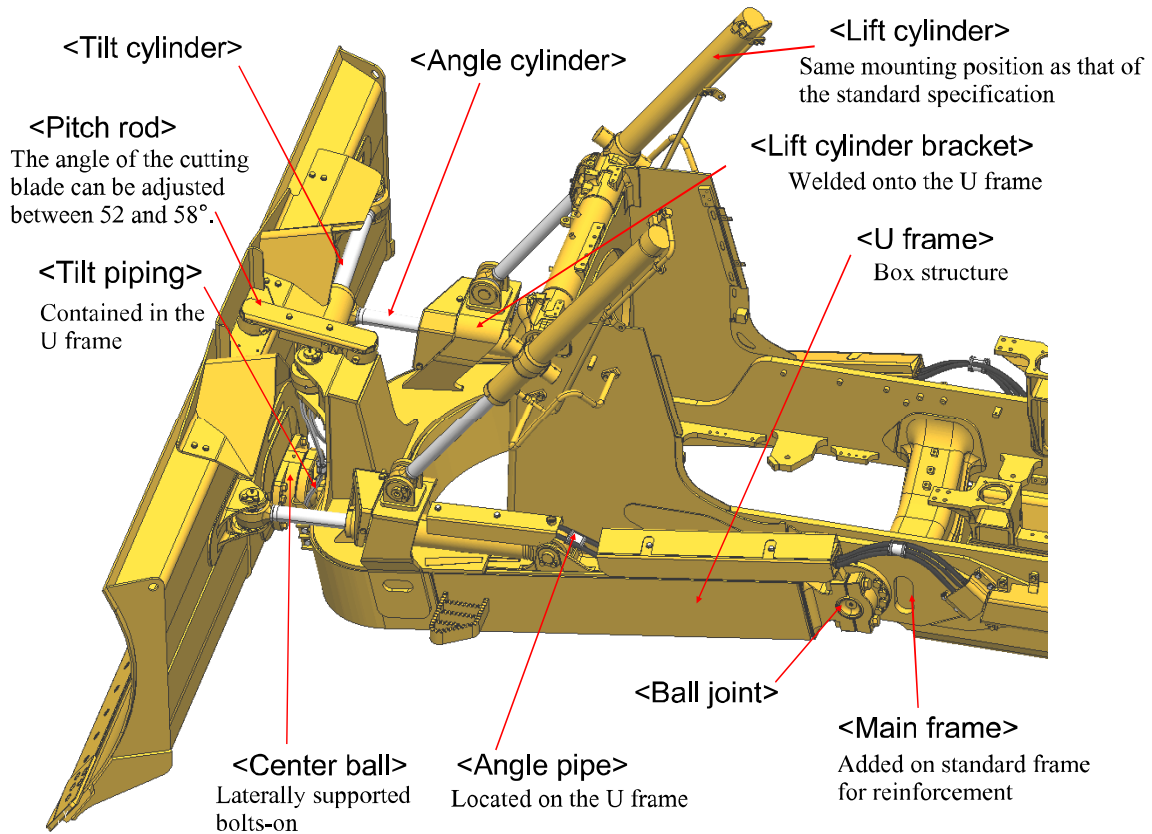


Fig. 6 Structure of the PAT dozer

(2) “Environment”

① Engine conforming to Tier 3 emission regulation

Equipped with the Komatsu SAA6D114-3 engine featuring an electronically controlled common rail fuel injection system, the D65-16 has achieved clean emission performance of the highest level in the world, cleaner diesel smoke, and low fuel consumption.

② Reduction in CO₂ emission

The D65-16 has achieved a Dantotsu reduction in fuel consumption through the employment of a lock-up automatic transmission power line, thereby drastically reducing CO₂ emissions (Table 3).

(3) “Safe”

① Higher leveling accuracy

The principal work of medium- and small-sized bulldozers is digging of ground, moving of earth, and leveling of ground. Accuracy is an especially important element in leveling performance, which is affected by many design characteristic values. The D65-16 minutely incorporates a variety of improvements made through machine body stability to response to work equipment, fine controllability, and visibility under the blade. As a result, its leveling accuracy has been significantly improved (Fig. 7).

Table 3 CO₂ emissions

	Unit	D65-16	Conventional machine
CO ₂ emissions	kg/h	74.8	83.1
Ratio	—	90%	100%

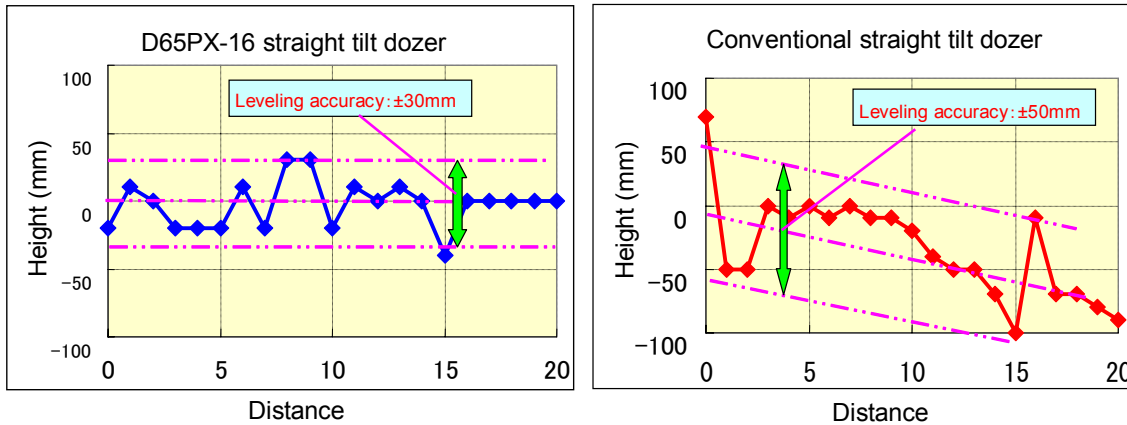


Fig. 7 Leveling accuracy

②Enhanced ride quality

A cab damper mount is installed as in the conventional machines to absorb vibration transmitted by the undercarriage. The D65-16 has expanded the horizontal and longitudinal distances of the mount by 7%, and damper characteristic values are tuned minutely so that vibration is reduced 20 to 35% during traveling and 12% in actual work, thereby reducing operator fatigue (Fig. 8).

③Low noise inside cab

The floor and cab monocoque structure has improved the air tightness of the cabin, and noise around the operator ears is reduced by 2dB (A) compared with the conventional machines (Table 4). Furthermore, thanks to the high-rigidity cab also featuring the ROPS (roll-over protective structure) function, creaking sound and chattering sound while traveling on uneven ground is drastically reduced.

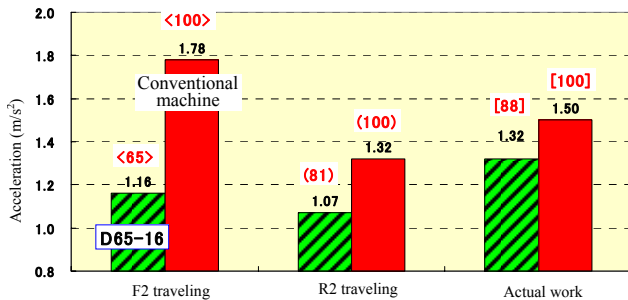


Fig. 8 Comparison of ride quality

Table 4 Comparison of noise around the operator’s ears

Fan revolution speed: 70%			
	Unit	D65-16	Conventional machine
Air conditioner OFF	dB(A)	72.2	73.9
Air conditioner ON	dB(A)	73.5	76.0

④Improved visibility on the sides of the operator

ROPS is integrated, and the “monocoque cab” structure integrating the cab and the floor is used. As a result, the pillars have been eliminated and side visibility of the operator has been improved substantially (Fig. 9).

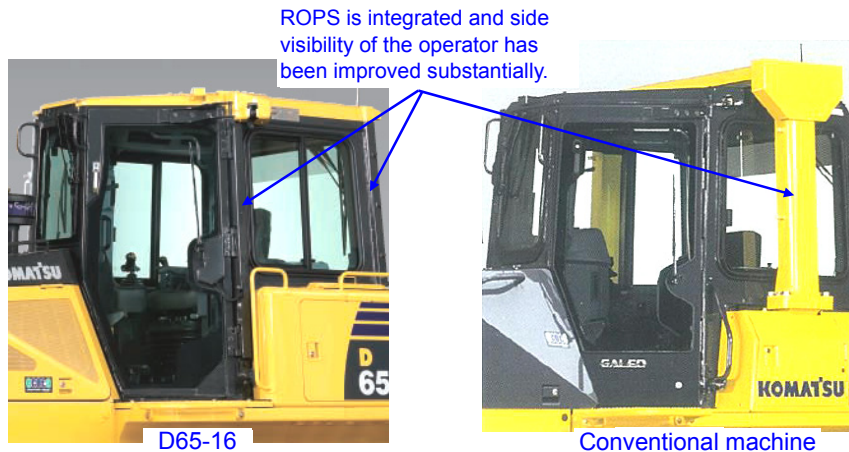


Fig. 9 Monocoque cab

⑤State-of-the-art operator interfaces

State-of-the-art and user-friendly operator interfaces are installed to freely operate the electronic automatic lock-up transmission and to achieve low fuel consumption through total control with the engine.

A large-screen color liquid crystal multi-segment monitor with which Komatsu hydraulic excavators are equipped is installed. Displays of gauges, gear shifts, modes, operating status of the air conditioner and fan, and caution and error codes are placed in an easy-to-see layout in a uniform design (Fig. 10). The screen also displays KOMTRAX information and announcement e-mails, as well as images of a rear view monitor-

ing camera as an option.

Furthermore, the steering lever incorporates the palm command control system (PCCS) lever that has been popular with users. Pressing the acceleration switch or the deceleration switch in the neutral position will set a gear pattern for forward traveling and backward traveling. The operation patterns have been increased to six by adding the “3L” gear which is useful for rough leveling work and is created by engine control. An optimum preset gear shift can be selected suiting operator choice or work (Fig. 11).

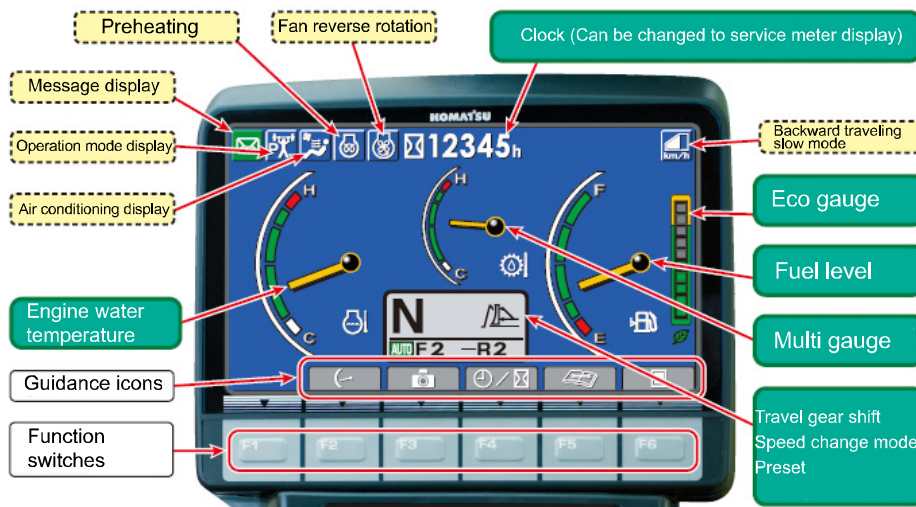


Fig. 10 Large-screen color liquid crystal multi-segment monitor

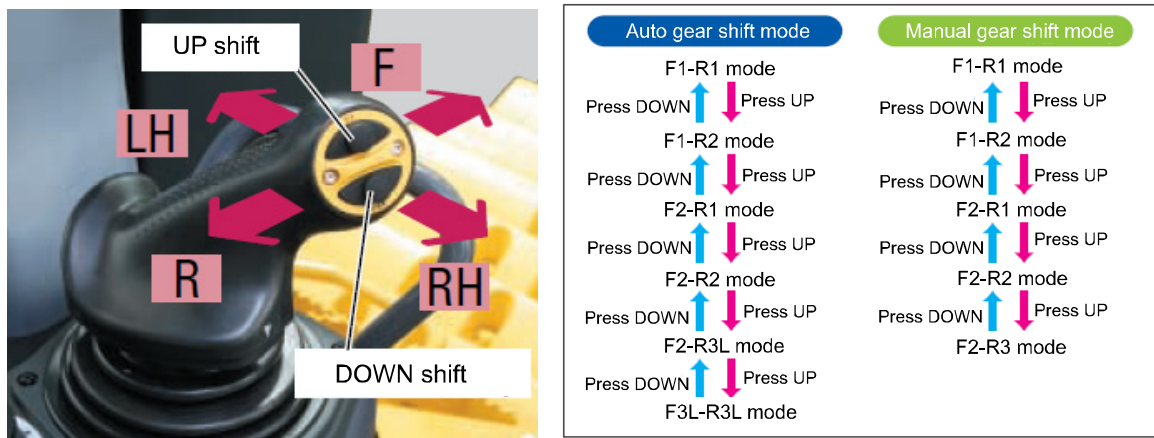


Fig. 11 PCCS lever and preset gear shifts

⑥ Improved air conditioning system

Settings can be made minutely while watching the large liquid crystal screen, a fully automatic air conditioner of an outdoor air inlet type is installed (Fig. 12), and a comfortable cab environment is maintained throughout the year by adding air outlets and by optimizing the layout of air outlets to keep the head cool and the feet warm.



Fig. 12 Air conditioning adjustment screen and operation panel

(4) “IT”

① KOMTRAX upgrading

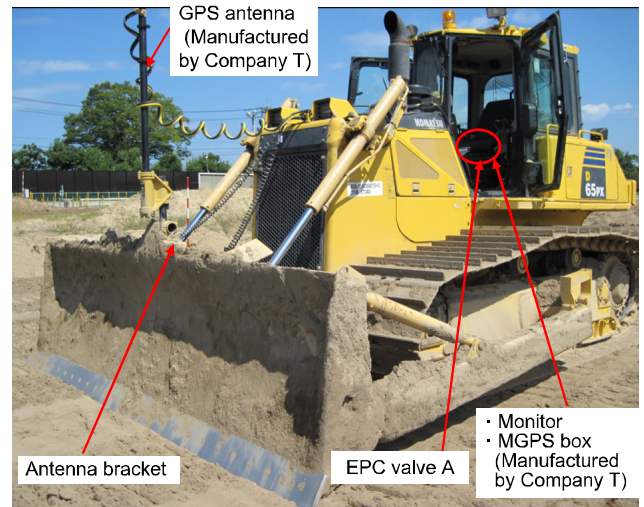
KOMTRAX has been upgraded and can provide a report to support energy-saving operation based on work information such as load information and fuel consumption quantity, in addition to the status of operation and position information that has been supplied in the past.

② Easy installation of IT devices for work execution by IT design (Optional)

The installation of IT devices for work execution by IT design is a new system that accomplishes automation of construction machinery through information communication technology for a higher productivity and work execution quality through automation of machines at construction sites. The conventional execution method requires land survey, placing of

finishing stakes, accuracy of land creation skilled operators, and measure taking. However, in work execution by IT design, the blade is automatically set based on design drawings and information on the work equipment position through a satellite (GPS), and measure taking can be eliminated using the locus information of the blade.

By add-on structure, the welding work has become unnecessary and parts can be mounted in a short time (Fig. 13). Furthermore, parameters that are optimum for the test machine was decided and the high accuracy of land creation was confirmed so that tuning can be performed easily at customer sites (Fig. 14).



	D65-16	Conventional machine
Mounting time	12h [Assembling only]	40h [Welding + Fitting]

Fig. 13 Comparison of time for mounting IT devices for work execution by IT design

PX straight tilt dozer and single shoe [Sandy ground]

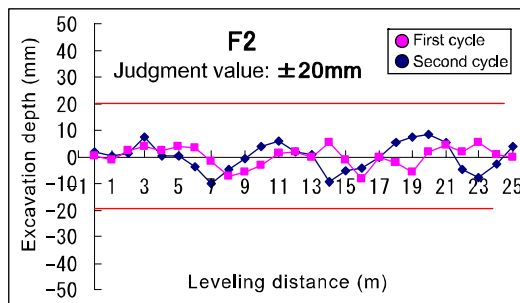


Fig. 14 Leveling accuracy and execution plane by leveling work execution by IT design

(5) Fewer parts needed

In this development project, the production, purchasing, and development departments organized a project team to begin the planning stage and strenuously implemented simultaneous activities. Going back to the origin of manufacturing of goods, a study was persistently repeated from design philosophy to productivity indicators, facility, logistics and flow of ownerships, money, and information (Fig. 15).

The functions of individual parts were analyzed and integration and reviews of individual functions of the parts were conducted, layout of individual equipment was made optimum, and designs and specifications were changed so that the number of parts could be reduced by about 10% (Fig. 16).

5. Conclusion

Beginning with the two “Dantotsu” features, the D65EX/PX/WX-16 are machines of a new type that incorporate many selling points and that are endowed with price competitiveness. The writers confidently believe that these machines will win a high reputation in individual market segments. Information from the market will be responded to swiftly and minutely and will be followed up so that the machines will be honored to receive the title of “excellent machines” from customers throughout the world in the near future.

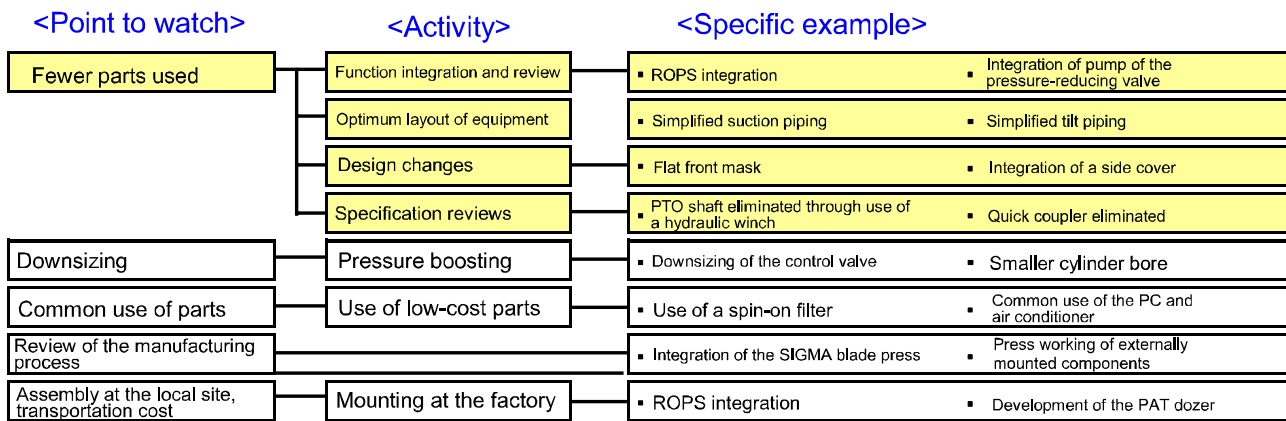


Fig. 15 Simultaneous activities and specific examples

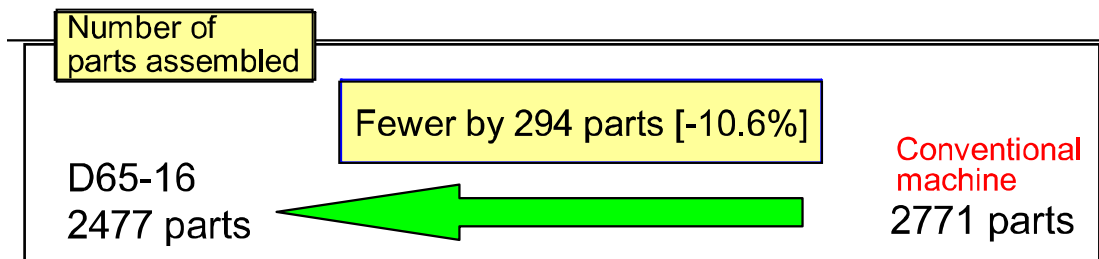


Fig. 16 Fewer parts used

Introduction to the writers



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[A few words from the writers]

More than one year was spent on this project in developing a planning conception. During this period, engineers from various departments participated in the project to discuss what the machine condition must be and an ideal image of it from all aspects with the result, which we believe, that fresh ideas were put forward and an ideal image of it was pursued without abandoning halfway. Fully utilizing the technology and experience gained in this development project, bulldozers providing greater customer satisfactory will be continuously developed.