topics

2011 Placement of UH03 in Japan's "Mechanical Engineering Heritage" by The Japan Society of Mechanical Engineers

—First Hydraulic Excavator Made from Entirely Japanese Technology—

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In 1965, the division of Hitachi, Ltd. that manufactured construction machinery at that time developed the UH03, the first hydraulic excavator to be based entirely on Japanese technology. With features that included use of hydraulics and two boom cylinders, the configuration of the UH03 could be seen as the model for the hydraulic excavators of today. A combination of factors specific to Japan soon brought hydraulic excavators into widespread use, and Japan today remains a center for the development of these machines. In 2011, the UH03 was formally added to the "Mechanical Engineering Heritage" compiled by The Japan Society of Mechanical Engineers.

CONTINUED ROLE AS MODEL FOR MODERN HYDRAULIC EXCAVATORS

HYDRAULIC excavators are an archetypal construction machine. The first machines were built in Europe and it was through technical collaboration with Europe that they were introduced to Japan. In 1965, the division of Hitachi, Ltd. that manufactured construction machinery (which later became Hitachi Construction Machinery Co., Ltd.) released the first hydraulic excavator to be developed based entirely on Japanese technology. Called the UH03, the machine had a bucket capacity of 0.35 m^3 and a gross mass of 8.7 t (see Fig. 1).

Around the same time as the release of the UH03, a series of other hydraulic excavators produced through technical collaborations with European manufacturers were also appearing on the Japanese market. While models with a single-pump/single-valve hydraulics had previously been the mainstay of the market for these machines, the two-pump/two-valve hydraulics system on the UH03 is essentially the same configuration used today, and it gave the UH03 superior control of combined movements and allowed it to work faster. A catalog from that time lists the cycle time for digging as between 15 and 20 seconds, indicating its speed was not notably inferior to modern machines. Table 1 lists the main specifications of the UH03. With features that include a boom driven by two hydraulic cylinders, the design of the UH03 serves as a model for modern hydraulic excavators of this class.

Also, the small size of the cab that minimizes the space for the operator is evident at a glance. The cab contains an assortment of levers, the usual configuration consisting of six in total, of which four are used for swing (superstructure rotation) and front attachment operation, and two are used to operate the crawler (see the top photo of Fig. 2). As the four different operations used during conventional digging

Fig. 1—UH03 Hydraulic Excavator Now Designated Part of "Mechanical Engineering Heritage."

Table 1. UH03 Main Specifications

Gross mass	8,700 kg (approx.)	Hydraulics		Two pumps
Total width	2,340 mm (approx.)	Fuel tank capacity		125 L (approx.)
Total height	2,680 mm (approx.)	Engine	Name	Isuzu DA220
Track width	400 mm		Type	Water-cooled 4-stroke with precombustion chamber
Operation cycle time	15 to 20 s (approx.)		Displacement	4,084 cc (mL)
Speed	2.56 km/h (approx.)		Continuous rated output	50 ps/1,800 rpm

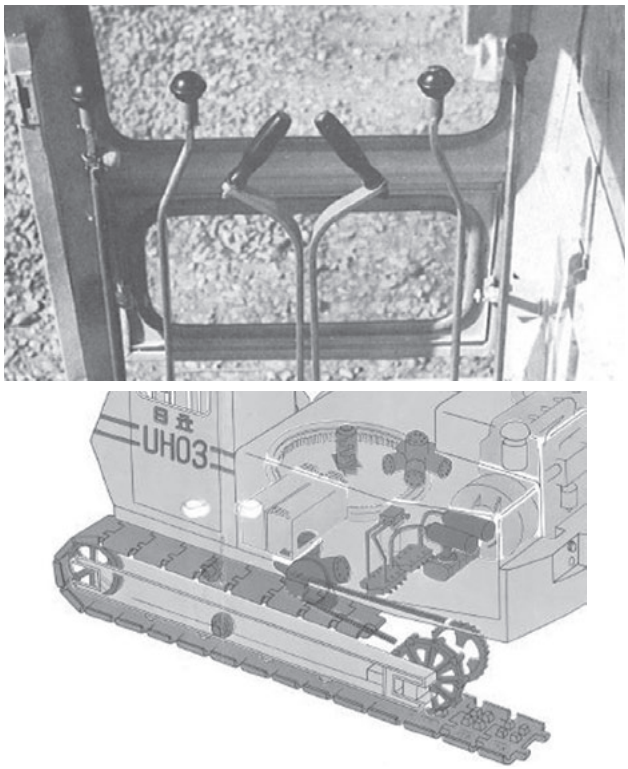

Fig. 2—UH03 Operator Controls (Top) and Crawler Design (Bottom).

involving the front attachment (consisting of a boom, arm, and bucket) and swing are too difficult to perform simultaneously by hand alone, the boom and swing are controlled by the left and right hands and the arm and bucket are controlled by foot using pedals attached to the bottoms of the levers.

While the crawler tracks are hydraulic-powered, they use a chain-driven sprocket configuration with the crawler itself having no track links, what is known as an excavator-type drive mechanism (see the bottom figure of Fig. 2). The engine and fans are visible through vents in the engine cover and other covers, indicating that the machine dates back to a time when noise was not a major consideration.

PROGRESS IN ADOPTION OF HYDRAULIC EXCAVATORS IN JAPAN

The catalog gives the impression that a strong emphasis was placed on crawler performance. Examples include, “if the tracks become stuck, the machine can be easily jacked up at the front so that it can free itself,” “spin turns and pivot turns can be performed at will,” and “the machine can cross a 1-m wide ditch.”

Prior to the arrival of hydraulic excavators, most digging and loading work was done by mechanical

Fig. 3—Mechanical Excavator.

excavators equipped with a power shovel front attachment (see Fig. 3). These were widely used in the post-war recovery, and during the period of rapid economic growth, for tasks such as river improvement, dam construction, and mining development. However, their front attachments did not have the same flexibility of control as hydraulic excavators, making them much more difficult to operate. Moreover, the machine traction was mechanically driven using a mechanism in which power was transmitted via a shaft from the superstructure and transferred to the left and right crawlers via a clutch. In addition to being subject to numerous limitations, such as the steering not working on slopes or other difficult locations, the heavy weight of the vehicles and their high center of gravity meant that the machines were largely confined to use on easy sites with flat terrain.

The arrival of the hydraulic excavator onto this scene greatly expanded the scope for mechanized earthworks. The worksites shown in catalogs, manuals, and photographs tended to feature soft or uneven ground of the sort that a mechanical excavator would find difficult to cope with, indicating that not long after hydraulic excavators entered use, their applications had already expanded to encompass a level of use not dissimilar to the present day, such as the building of forestry roads or the shaping of sloped ground. The following three reasons can be suggested for why hydraulic excavators became so prevalent in Japan.

(1) No other types of earthmoving machinery were yet in widespread use.

(2) Topographical and soil characteristics meant that the machines were frequently used on soft or

uneven ground, and often in confined spaces. Their use of hydraulics not only gives hydraulic excavators a high level of traction, they can also use their front attachments to assist in their movement. This means that they can be used in locations that could not be reached using their traction capabilities alone.

(3) As unfavorable soil conditions mean that sand is used for backfilling in tasks such as ditch digging, the machines are frequently used for digging and filling up dump trucks. The backhoe loaders commonly used overseas are impractical for this work.

For these reasons, hydraulic excavators rapidly expanded their scope of use beyond merely being a replacement for mechanical excavators, with demand in Japan surpassing 20,000 machines in 1973 (see Fig. 4). Demand went on to exceed 50,000 machines in 1990, representing more than 50% of total international demand of about 100,000 machines. While Japan's share of the market shrunk after the bursting of the economic bubble, the country remained a center for the development of hydraulic excavators, including parts, and it is currently estimated that about 70% of the world's hydraulic excavators were developed in Japan. As the first hydraulic excavator to be based entirely on Japanese technology, the UH03 can be seen as one of the starting points for these Japanese hydraulic excavators.

Having been formally recognized as part of Japan's Mechanical Engineering Heritage, a UH03 is currently displayed at the Tsuchiura Works of Hitachi Construction Machinery Co., Ltd. along with Hitachi's first mechanical excavator, the U05. Anyone visiting Tsuchiura Works is encouraged to take a look.

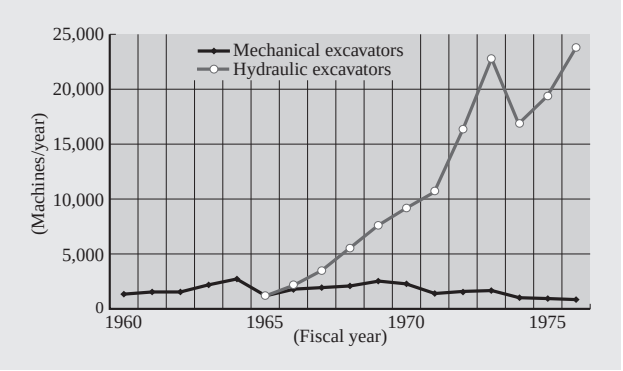

Fig. 4—Production of Mechanical and Hydraulic Excavators in Japan (Based on Statistics from the Former Ministry of International Trade and Industry).

ABOUT THE AUTHOR

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Joined Hitachi Construction Machinery Co., Ltd. in 1975, and now works at the Application, New Product & Construction Equipment Division. He is currently engaged in providing technical and commercial back-up to the sales staff and organization.