Activities of Honda Racing Development

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ABSTRACT

In conjunction with the launch of our Formula One project in 1998, Honda Racing Development (HRD) was established as the British base for administering the Honda Formula One team. Subsequently, plans were modified to supply engines and joint development efforts with the BAR Team, and HRD came to assume the role of Honda's frontline European base for timely project and decision-making. This article describes the roles and accomplishments of HRD.

1. The Roles of HRD

All engine development was formerly carried out at Honda R&D Co., Ltd. Tochigi R&D Center (HGT), including design, assembly, testing, and shipping (including performance checks and packing). Since the Formula One team, which was a customer for Honda engines, was based in the UK, and since almost all the running tests were conducted in Europe, HRD has functioned as a logistical supply base for providing engines and parts for races and running tests in a timely manner. It was the site not only for receiving and managing parts sent from Japan and then sending them to the circuit, but also for reassembling engines, checking shipments, and procuring parts locally.

The technical staff that manages the testing site was initially made up of mostly of visiting personnel from Japan, but as ties with the team grew stronger, it became essential to assign regular personnel to the UK base in order to enhance communication between the two facilities. Employees from several sectors, including Engines, Electrical Components, Materials, Design, and Assembly, were dispatched to HRD on long-term assignments, and they performed the pivotal roles of onsite administration and maintaining ties with the team.

The Formula One Team and HGT were each assigned roles in chassis development, but in the interests of sharing technology and enhancing the abilities of the team, HGT staff members took part in each area of the team's concerns, including Aerodynamics, VDG, Composite Materials, and Mechanical Design, and worked on chassis development as members of the team.

In addition, HRD took advantage of its location to promote personal interaction with other Europe-based Formula One teams and suppliers, and gathered technical information.

2. Location

As shown in Fig. 1, HRD is located in Bracknell, almost in the center of Berkshire, about one hour west of London by car. This location is 80 km from the Formula One team's base in Northamptonshire and 20 km from Heathrow Airport, making it a convenient location for Formula One-related activities, which require a lot of travel.

The layout of HRD, comprising an office building and a factory, is shown in Fig. 2.

In addition to local British employees, half the staff was made up of Japanese employees on long-term or temporary assignments, which made HRD's employee-mix somewhat different from that of other overseas locations. Many Japanese employees are there on short-term assignments, and in addition to working on projects, HRD also played a major role in managing housing, hotels, and travel arrangements for the Japanese employees.

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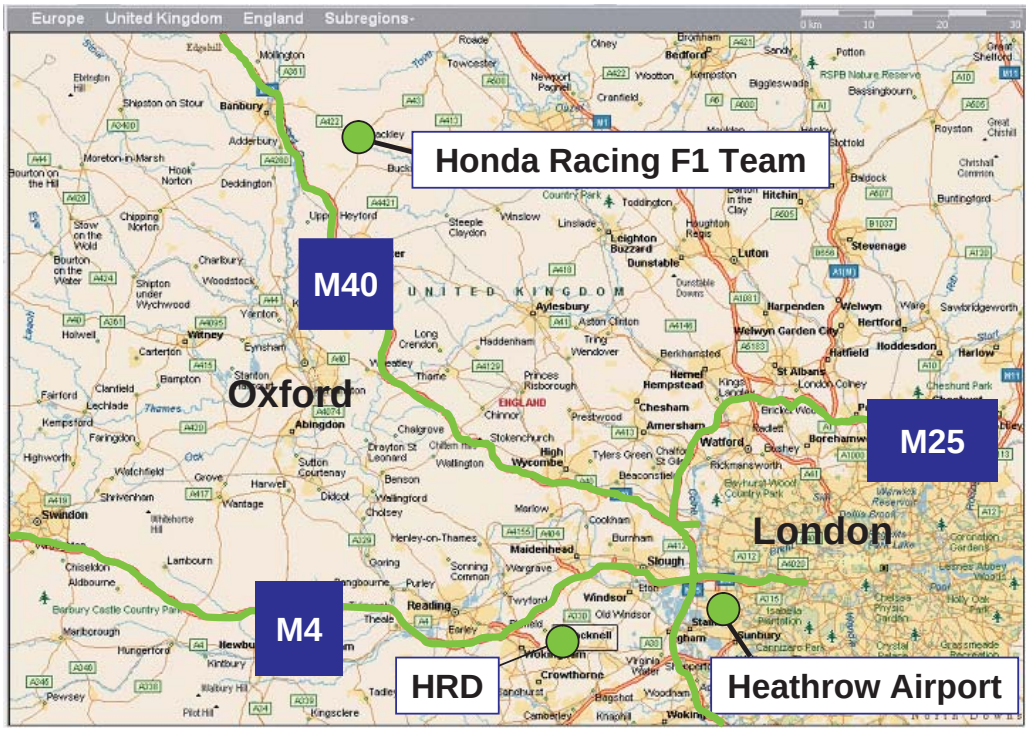


Fig. 1 HRD Location (Source: Microsoft AutoRout)

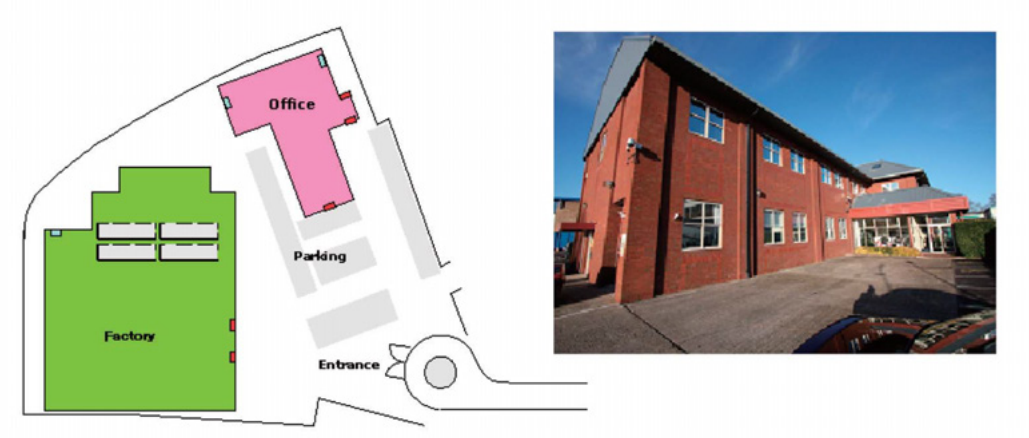


Fig. 2 HRD Factory and office layout

3. Factory Management

Figure 3 is a chronology of activities at HRD. The Formula One team was BAR at the beginnings, and then became BAR-Honda, with a 45% investment by Honda. During the transition to all-Honda-owned HRF1, HRD's functions also evolved one after another. The division of labor between HRF1 and HRD can be essentially described as vehicle body on one hand, and engines on the other.

Initially, HRD's function was to serve as a contact point for BAR, FIA and other Formula One associations, and as a logistics and supply base. However, as BAR HONDA shifted to Honda Racing Formula One (HRF1), contact point for BAR became no longer necessary and the contact point for FIA and other organizations was also shifted to HRF1.

Management of the factory, which began in 1999, started with a focus on engine maintenance and parts supply to testing sites.

Partly due to almost yearly modifications of regulations and changes in dealing with the second-string team, HRD expanded its functions beyond those of a logistics and supply base. From 2005, HRD functions have been shifted away from only engine and parts supply and replacement, making HRD an organization that takes advantage of its location and its mobility for primary analysis and solution of racing test issues, initial powertrain checks and settings before running tests, local parts procurement and other such functions. It also worked on gathering information by investigating European technology, which will be discussed later.

Due to modifications of regulations and other factors, the number of engines supplied decreased or increased

as the occasion demanded, but the share of engines shipped from the UK was increased. The reason for the increase was a shift of the routine business of shipping engines to HRD, with the objective being to allow the Japanese side to strengthen its development efforts. In fact, an initial ratio of approximately 4:1 (HGT:HRD) had shifted to 1:3 by 2008, leading to an environment in which HGT could more easily serve as the main player in engine development.

Primary analysis and solution of racing test issues, and powertrain initial checks and settings before running tests, which were the core of HRD's expanded functions, took the greatest possible advantage of its location. HRD conducted bench tests, including initial settings, before shakedowns of new vehicles or functions, helping to prevent issues from occurring during initial runs.

As shown in Fig. 3, the increase in engines supplied, early analysis and solution of issues, and enhancement in engine quality led to changes in the HRD facility. HRD was equipped with dynamometers and materials inspection devices. At first there was only one stationary dynamometer, but as HRD's role changed, transient dynamometers were added, and powertrain settings performed. At the same time, the Materials Department upgraded its equipment to include such things as a scanning electron microscope, making it possible for the department to analyze factors that contributed to issues at the test site and to make the primary judgments. A five-axis milling machine and three-dimensional measuring machine were installed, and a clean room was introduced in connection with assembly machinery and inspection equipment. In this and other ways, efforts were made to enhance parts inspection and quality and efficiency of the assembly process.

These actions facilitated the HRD factory's basic role as a frontline base for managing races and running tests.

4. Races and Running Tests

Of the 18 races in which the team participated in 2008, there were eight Grand Prix races that required travel to distant countries such as Japan or China and 10 races in the European round. Some of the teams participated in running tests in Bahrain, but Honda conducted all of its tests in Europe, mainly in Spain.

Parts were transported overland by trailer or truck in Europe, while engines from Japan were shipped to the UK by air, after which they were transported to the circuit overland along with the HRD engines.

When there were overseas races, the components that were normally transported by trailer were packed into a crate for long-distance shipping commonly called a black box, and transported by air. Some components were used only for overseas races and were usually stored at HRD.

In addition to engineers and mechanics, the racing staff consisted of support personnel, such as truck drivers. There could be more than 30 persons from HRD alone, in addition to the team members, making a total group of nearly 100 persons comprising one team. On the circuit, this included staff members who prepared meals for team members and their guests, since each team had to prepare its own meals.

An important duty of the HRD onsite staff was to guarantee the reliability and performance of engines on the circuit, and in order to get the maximum performance out of an engine, they had to set the engine equipment and data according to the weather, the features of the course, and the race strategy, as well as the driver's own

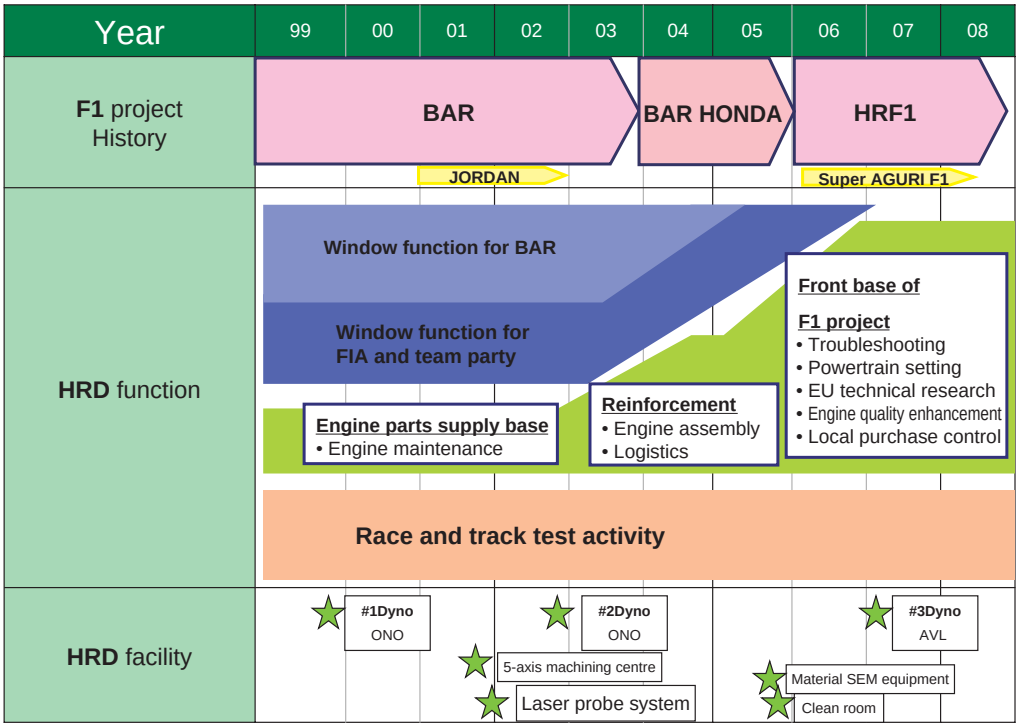


Fig. 3 HRD history

driving habits and preferences.

Running tests were thought of as the final checks for items that already had been checked for performance by unit test and bench test. Drivers' comments and data were used to check performance, while checks of race mileage reliability, temperature, and vibration were among the tests performed to check conformance to actual vehicles.

Ignition timing settings were changed in 0.5-degree increments based on the outside air temperature, humidity, and engine temperature. The whole process was painstakingly managed, so that, for example, during a pit stop in the middle of a race, drivers were told to change the engine mode if the engine temperature was too high.

Since shift-timing and straight-end speed affect lap time and frequency of maximum engine speed, gear ratios were selected with consideration for the features of the circuit and the direction of the wind, and in consultation with the vehicle engineer. Since 2008, gear ratio exchanges have been limited to one per race, so ratios have to be selected in advance in anticipation of the preliminary rounds and the final race. This led to serious discussions after the practice runs on Friday. Since cooling performance is directly linked with the reliability of the hardware, it is important to ascertain the cooling settings of each part at the assembly stage of new vehicles in particular. It was therefore adjusted for throughout the season, depending on the outside air temperature and use environment. In reality, however, it was difficult to determine everything beforehand in low temperature conditions during winter tests, so we often struggled with onsite settings due to unanticipated intense heat or unusual weather conditions.

It is usually difficult to determine whether or not an engine setting is appropriate through data alone, so settings were carried out in consultations with the driver and the vehicle engineer, as they determined what points could be enhanced and what the general settings should be. For example, when the safety car was introduced, the lean driving limits for saving fuel were determined by the driver in the midst of joint runs, and on the basis of whether engine response would become an issue. The pedal-to-torque characteristics in a drive-by-wire situation, as shown in Fig. 4, were tuned for each circuit based on the driver's comments.

When engine blow and other mishaps occurred, primary factor analysis was conducted on the circuit, and the secondary analysis was conducted at HRD, depending on the urgency of further investigations. HRD often had to take emergency measures when trouble arose during a race or during the test runs just before a race.

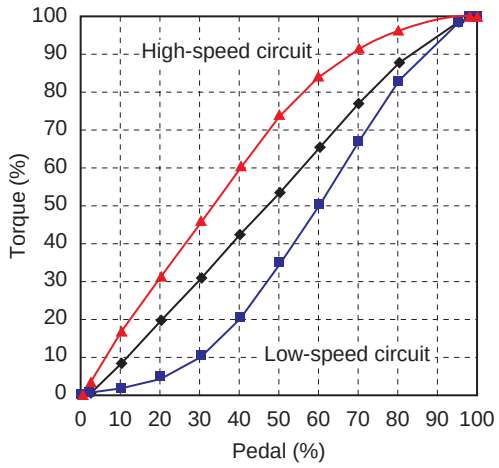


Fig. 4 Pedal-to-torque characteristics

5. Investigating European Technology

Another responsibility of the onsite personnel was to gather information about trends in regulations, competitiveness, and technology, whether through official or unofficial channels. Since it was difficult for HGT to gain an overview of this information, it was considered to be one of the major roles of onsite personnel to feed back their perceptions of directions in technology to development.

Programs that took advantage of HRD's location as a Formula One base in Europe were the Formula One Engine European Technology Research and Manufacturers' Joint Development Project, which began in 2006 with HRD local staff playing the central role.

We first contacted Formula One engine builders, design consultants, parts manufacturers, and simulation development manufacturers who were based in Europe and surveyed them, comparing Formula One engine technology trends in Europe with Honda's engines.

As a result of comparative surveys, it was found that Formula One engine trends in Europe revolved around systems with high-lift, narrow-duration camshaft profiles, lightweight valve-train systems, and cam gear-train damper systems.

In particular, they led the way in the development of cam gear-train damper systems, with damper characteristic specifications being determined with gear-train simulations.

Figure 5 and Table 1 show the names and locations

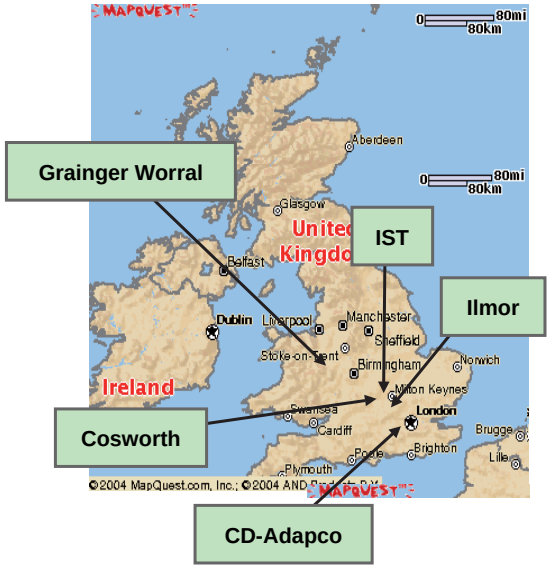


Fig. 5 Supplier location (Source: MapQuest)

Table 1 Supplier and development items

Supplier	Company profile	Development item
IST	Consulting company for F1 engine design and material	EU concept cylinder head assy
		Inlet valve (Ti3Al) (high stiffness / light weight)
		High-lift + narrow-duration cam profile
		EU concept cylinder block assy
		Light-weight piston (5-axis machine)
		Twin oil circuit system (piston jet - crank)
		EU concept air box
Ilmor	Ex. F1 engine design and manufacturer	8-cylinder LAF sensor +Real-time mapping
		EU style head-port design
		High-energy IG coil
Cosworth	Ex. F1 engine design and manufacturer	Tortional damper for cam gear-train
		Gear train (+damper) simulation
Grainger Worrall	F1 casting parts manufacturer	Forced-air chill-casting for cylinder head
CD-Adapco	CFD simulation development	Port / Expi / Airbox 3D CFD simulation

of the manufacturers with which HRD carried out its joint development projects. Most of the development projects were eventually carried out with manufacturers in the UK, and this is believed not unconnected to the fact that Mercedes High Performance Engine, Cosworth, Ilmor, and other top-ranked racing engine constructors are based in the UK.

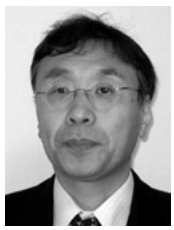
These joint projects allowed HRD to propose the aforementioned high-lift, narrow-duration camshaft profile, cam gear-train damper system, and simulations, and their effectiveness was verified in preliminary tests conducted with HGT. Subsequently, in 2009, while they were preparing to manufacture parts with the aim of adapting this technology for the Formula One engine project, Honda decided to withdraw from Formula One racing.

6. Conclusion

At HRD, which functioned as a frontline base far away from Japan, both short-term and long-term personnel encountered difficulties due to the overseas working environment and unique strictures of racing. As we struggled on the front lines in direct contact with races and teams, we learned a great deal and were able to grow.

We would like to take this opportunity to thank everyone inside and outside Honda who constantly gave priority to local programs and supported and cooperated with us.

■ Author ■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