Technology Research and Development at JR Central

Toshiaki Doi

In July 2002, the Central Japan Railway Company (JR Central) was restructured with a changed focus on tackling technological development from a different direction. We needed to change because the company had entered a stable period with no clearly apparent driving force pushing us ahead. First, our infrastructure, passenger numbers and travel patterns seemed all set to continue with little change and remarkable future trends. In fact, conditions were so stable it seemed difficult to imagine the large managerial fluctuation.

Second, after JR Central was established in 1987, we began recruiting many engineering staff members each year. As a result, flexible personnel management became possible. Since many new employees will have little chance of future promotion, we decided to recruit both specialists and generalists.

Third, the maintenance of safety was another important aspect of the restructuring. We could see that the prospect of long-term stability with little incentive to change could result in us dropping our guard, leading to an accident. Obviously we had to avoid this, so we decided to set new technical goals. Just as an aeroplane has to get its nose up for a level flight we likewise thought we should raise our technology levels to ensure safe and smooth passenger services. Then we thought of broadening our scope to include technologies from other sectors. This would boost and broaden our technological capacity, letting us promote advances both in rail transport and other sectors too.

Komaki Research Facility

Our Komaki Research Facility is close to the Chuo Expressway and about 30 minutes by car from Nagoya.

The 20-ha area is similar to the Railway Technical Research Institute (RTRI) in Kunitachi, Tokyo. Surrounding trees provide an excellent shield for privacy and a pleasant canopy of shade and greenery, making it an ideal location to focus the mind on R&D.

The main facilities include the R&D buildings, external structures with research equipment, and a solar system for generating electricity. We are expanding our facilities and will end up building more infrastructure to fill some of the space. We have enough land for a 600-m straight test track that will not bother any neighbours living quite far away.

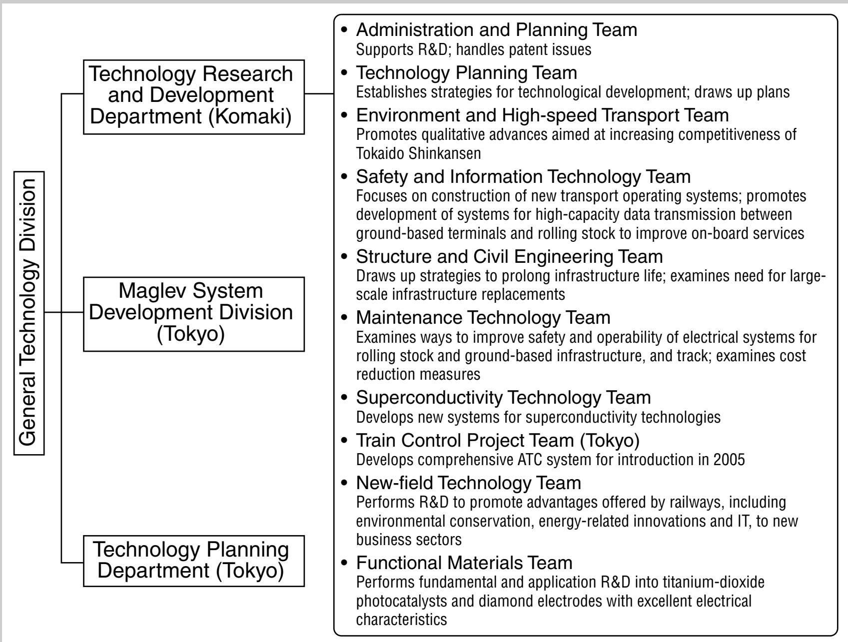
Our organizational structure and work system are quite innovative (Fig. 1). Our former Technical Research and Development Division was restructured and renamed as the General Technology Division. It has three departments: the above-mentioned Technology Research and Development Department in Komaki; the Maglev System Development Division in Tokyo for research into Maglev technology; and the Technology Planning Department in Tokyo for handling outside discussions and negotiations.

The Technology Research and Development Department is composed of a number of teams, each dedicated to a specific goal or research field. Two teams are involved in general affairs and technical planning. Others are focused on objectives including: environment and high-speed technology; safety and information technology; and structure and civil engineering. Each team includes specialists with expertise in a specific technical field so that the team as a whole can exploit a range of talents in different fields. This approach avoids the conventional focus on a specific system and promotes comprehensive development in a specific area.

The Department has about 120 staff members and is unique in four ways.

- We function as an independent entity. The department does not have

Figure 1 Organization of General Technology Division and Goals of Technology Research and Development Department



some esoteric mission, as might be if its name were something like 'ABC Research and Development Center,' or 'XYZ Research Institute.' Since our Technology Research and Development Department is not attached to our company headquarters, but functions as its own head office, it can make its own and even management-related decisions.

- We have unique personnel management system in the department. Talented employees working in the company's operations divisions must gain R&D experience in our department in Komaki before they can be promoted. Similarly, even the most talented person cannot become an expert technician by spending his or her entire working life in our Technology Research and Development Department—cross-pollination of experiences is required. This approach may not be ideal for someone interested in pure research, but it creates opportunities to obtain and apply all kinds of information in the field. Of course, we need generalists and specialists conducting pure research, but we need well-rounded talent as well. As a consequence, our personnel management system is not applied to all employees in technical fields, but the aim is to apply it to as many people as possible.
- We motivate our researchers by putting priority on talent. Important questions about what we need to develop, what level of work is involved, how long the project should last, are discussed by all team players, including myself and section chiefs. Once these issues are decided, our researchers focus on the technical aspects they feel are most relevant. They conduct research within the Department and outside it too. My job is to evaluate the results (comparing results with objectives), to coordinate their activities, and to encourage and praise them. Our job is not to pursue pure research for its own sake, but to set objectives and evaluate the results.
  At Komaki, employees choose their own working hours. Just showing up at the workplace counts as a full 7.5-hour working day. In an extreme case, someone could spend only 10 minutes at the workplace, but that would still count as 1 day of work. What counts are the results that come from the talent.
- We use financial incentives to create greater enthusiasm and bring results. When a researcher increases our know-how and the result is greater profits for the company, he or she receives a bonus. The bonus used to be a maximum of ¥200,000, but now there is no maximum. So if the company benefits greatly from a researcher's development, he or she could receive a bonus of ¥10 million on top of regular salary. Dedication to the company is important as it raises individual potential, and it is also important that the company rewards employees' enthusiasm.

These unique features and our restructured organization, represent dramatic changes over the way we used to do research, and will help us stay ahead in the R&D race.

Table 1 JR Central's Technological Advances, Past and Future

1987	Company established
1992	Began operating Series 300 shinkansen
1996	Achieved Japan record wheel-on-rail speed of 443 km/h with Series 300X test cars
1997	Launched *Doctor Tokai* track inspection car
1999	Began operating Series 700 shinkansen
2001	Launched *Doctor Yellow* (T4 train set) shinkansen track inspection car
2002	Established reserve fund for future major repairs to shinkansen infrastructure
2003	Opening new shinkansen station at Shinagawa in Autumn
2004	Completion of prototype Series N700 shinkansen (scheduled)
2005	Completion of new ATC system (scheduled)
2007	Starting operation of new Series N700 shinkansen (scheduled)

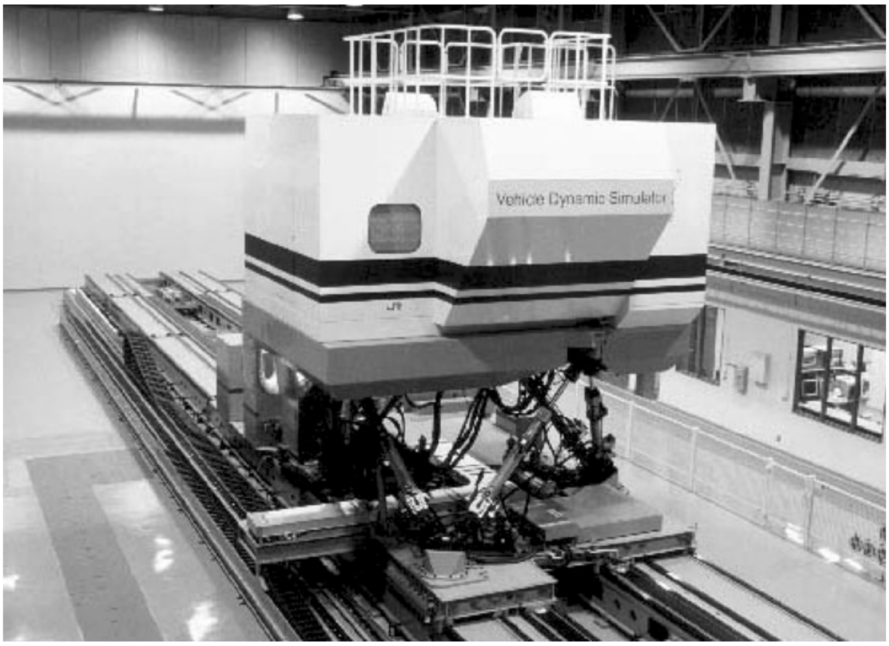
Fundamental Approaches

Our R&D has two approaches—improving railway technology and challenging new fields. Table 1 lists JR Central's revolutionary developments as well as four new projects.

In 1992, 5 years after our establishment, we introduced the Series 300 shinkansen rolling stock. The cars combined an excellent streamlined design with light body, making it possible to achieve a maximum speed of 270 km/h. This reduced travel time between Tokyo and Shin Osaka to 2.5 hours, cutting almost 30 minutes off the previous schedule. A full decade has passed since then. In 1996, we built an experimental 300X shinkansen train to test various factors to aim for the best and most-advanced high-speed railway system. In July 1996, the 300X train achieved a maximum speed of 443 km/h, the highest iron-wheel-on-rail speed achieved in Japan up to that time.

In 1997, JR Central introduced its *Doctor Tokai* track inspection cars. They were the first diesel-powered inspection cars running on both electrified and non-electrified track. Their image processing and other new technologies make the work of inspecting tracks, catenary, and signalling and communications devices much easier with greater precision and efficiency.

In 1999, we introduced the Series 700 shinkansen rolling stock combining the



Vehicle Dynamic Simulator recreating interior of Series-700 train set (JR Central)

best features of our Series 300 and 300X experimental train with those of JR West's Series 500.

In 2001, we introduced new *Doctor Yellow* track inspection cars that were the first in the world able to monitor track while running at 270 km/h. Since *Doctor Yellow* runs at the same speeds as commercial shinkansen, it can monitor conditions during daytime operating hours, rather than only late at night when there are no commercial services.

In 2002, the company established a reserve fund for future major repairs to the shinkansen system. The fund was established because estimates showed that ¥1.1 trillion will be needed some day to repair and upgrade the aging (almost 40 years old) infrastructure of the Tokaido Shinkansen. Funds are being accumulated over a 15-year period. They are not taxed while under deposit but will be taxed when withdrawn for repairs. Research to develop better ways to replace deteriorated track is urgently needed.

This autumn, a new shinkansen station is opening at Shinagawa, Tokyo, making it possible to eliminate 220-km/h services that now operate simultaneously with 270-km/h services over the same track. As a result, all trains will be able to operate at the higher speed.

Our plans for 2004 include a prototype Series N700 shinkansen. (N stands for new.) It is for testing the next generation of shinkansen prior to mass production in 2007. Our present R&D goal is to determine the new train's specifications. In 2005, we will introduce a new automatic train control (ATC) system offering higher performance, greater comfort, and more flexible scheduling.

Improving Passenger Comfort

To give an idea of our research at Komaki, I would like to explain the large, innovative testing equipment we have.

One is the Vehicle Dynamic Simulator used to find ways to improve passenger comfort. The most interesting features of the new Series N700 mentioned above is the tilting mechanism. Shinkansen bogies use air springs and we intend to modify the configuration to change the air pressure in the left and right springs to tilt the carriages by about 1°. This will ensure better passenger comfort on sharp curves. The latest shinkansen track generally has a minimum curve radius of 4000 m, but the first Tokaido Shinkansen has curve radii as sharp as 2500 m. This means that although the maximum speed on the line is 270 km/h, shinkansen must reduce speed on sharp curves to 250 km/h. By tilting the new cars, we will be able to maintain the maximum speed through sharp curves at 270 km/h, because the tilting cancels out the centrifugal force that throws cars and passengers away from the centre of the radius of curvature towards the outside of the curve.

The tilt angle and timing can be changed. A tilt of 5° or more for a period of 1 s makes passengers feel uncomfortable. And if the tilt action is too slow, the train enters the curve before the required tilt is achieved. So the degree of tilting and the timing must be carefully controlled. Our simulator holds about 15 passengers. Their 'travelling' environment closely resembles that of a moving train—even the windows have a digital video to simulate passing scenery.

Flight simulators are used in many parts of the world. They simulate real flight, using the three axes of rotation (yaw, pitch and roll). Movement along these lateral, vertical, and longitudinal axes can be in any of six directions, but a flight simulator does not simulate the centrifugal forces experienced on curved track. Our carriage movement simulator can because it permits horizontal movement along a 30-m long path.

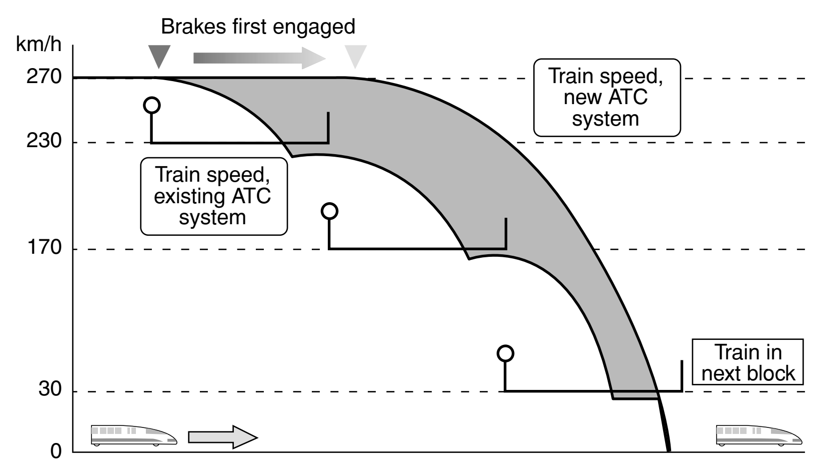
The Tokaido Shinkansen between Tokyo and Shin Osaka has 50 curves with a radius of 2500 m. The new rolling stock with the tilting mechanism will be able to negotiate these curves 20 km/h faster, cutting 4 to 5 minutes off the present journey time assuming that no other factors affect the calculations.

New ATC System

The new ATC system we are developing will serve two purposes: increase passenger comfort, and permit more-flexible scheduling.

The current ATC system automatically reduces the speed of a train to the targeted speed in tiered reductions in accordance with speed signals. Figure 2 shows the example of a shinkansen train travelling at 270 km/h that slows to a stop because there is another train ahead (or because of a station stop). The tiered curves shows how the shinkansen first slows to 230 km/h, runs for a short distance at that speed, reduces speed to 170 km/h, runs at that speed, slows to 30 km/h, continues for a moment at that speed, and then finally stops on the command of the operator. The stopping involves four tiers of deceleration.

Figure 2 Comparison of Current and New ATC Systems



As seen in the same figure, the new ATC permits gradual, continuous braking without tiered deceleration. The rate of deceleration is faster and braking starts later—about 3 km later in this example. The angled straight lines between the single smooth curve and tiered curve show the extent to which the new ATC permits higher speeds, resulting in less time required to stop—a 2- to 3-minute time reduction in this case. Since the tilting mechanism mentioned above also cuts running time, when the two reductions are added, the run between Tokyo and Shin Osaka run could be shortened by quite a few minutes.

However (and somewhat contradictorily), when the new shinkansen station is opened at Shinagawa, the time between Tokyo and Shin Osaka will increase for trains that stop there. This may seem like we are moving away from the endless goal of ever-shorter running times. Railway developers can only respond with a dogged determination to reduce times once more through innovations like tilting mechanisms and better train controls. You may wonder at our persistence in trying to cut a few seconds off running times that than end up longer than before due to other operations changes, but I assure you the goals are worth pursuing!

As an example, on the Tokaido Shinkansen, the slower *Kodama* trains wait at stations for the faster *Nozomi* and *Hikari* to pass. This operation will be made smoother and more comfortable by the new ATC system because braking to a stop will be continuous and smooth without the jerking caused by intermittent braking and free running.

Although the recent decision to construct a new station at Ritto (in Shiga Prefecture) was made so that the faster trains can pass the *Kodama*, it also offers passengers a more convenient schedule.

Noise Reduction

Faster speeds change the trackside environment. One negative environmental factor that must be tackled is noise. We constructed the Low-noise Wind Tunnel with this in mind.

Our car tilting mechanism and the new ATC reduce running times by increasing speeds (and hence running noise) on curves and near stations. People living near these track sections might experience a worsened environment unless we develop noise countermeasures. JR Central was the first operator in Japan to construct a wind tunnel for the purpose of developing noise countermeasures. We force air at speeds up to 350 km/h through the tunnel and examine the characteristics of various noise sources.

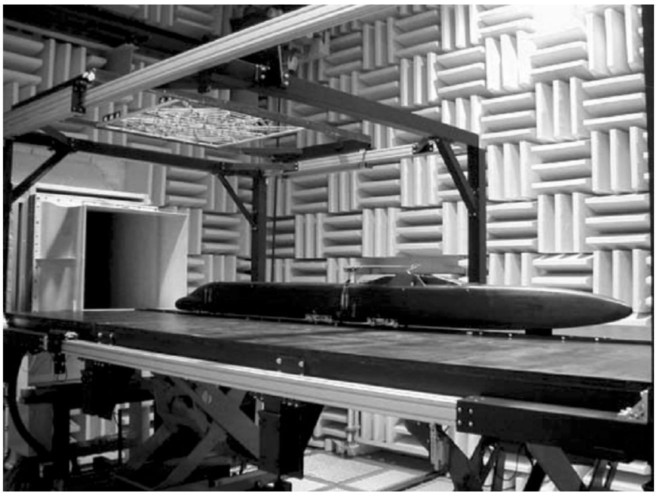
When the Series 300 shinkansen was developed some 10 years ago, no Japanese operator had a wind tunnel to test noise levels. Designs for pantographs and other noise sources were modified after conducting experiments in a wind tunnel owned by an auto manufacturer. However, the tunnel was not really suited to our needs and we finally realized we would need our own tunnel to design low-noise rolling stock.

RTRI owns the world's largest experimental wind tunnel in Maihara City, Japan. Ours is only one-third the size of RTRI's but the smaller size makes it easier to conduct experiments and cheaper to build test models. The lower cost translates into more varied tests. We have tested hundreds of different shapes of pantographs, insulators, reduced-size train sets, etc. When we think we have a good low-noise candidate design, we go to the Institute's wind tunnel in Maihara City and test it there to finally arrive at the best configuration.

Theoretical calculations alone can only assist with low-noise design—trial and error model experiments bring us close to the ideal.

Reducing Ground Vibrations

Faster speeds result in more vibration that also impact the trackside environment.



Low-noise Wind Tunnel for studying aerodynamic phenomena (JR Central)

Track and Structural Dynamics Simulator—full-scale track test under real shinkansen bogie (JR Central)

Our job as researchers is to discover ways to reduce ground vibration.

Our Track and Stractural Dynamics Simulator reproduces the same load and vibrations experienced on shinkansen track when trains pass by. We use it to examine track properties when the track is subjected to vibration.

The car itself looks very different from Series 700 shinkansen rolling stock, but the bogie components are mounted at exactly the same positions as on the real cars using the same configuration and mass. Hydraulic pressure is exerted via the wheels onto the track and ground at fixed points to simulate the vibrations of a moving 16-car shinkansen train set. Our studies show the conditions under which vibration is transmitted to the track and then to the ground.

The current maximum speed on the Tokaido Shinkansen is 270 km/h. It will be difficult to increase this maximum in the near future, because of limitations imposed by factors such as track alignment. However, we aim to maintain the maximum 270 km/h speed on curve sections with a radius of only 2500 m and to introduce the new ATC system for smoother braking (which translates into faster speeds). One of the biggest challenges on such track sections is finding a way to keep vibration within acceptable levels.

Ground vibration is transmitted in a complex manner that may be modified by the different conditions at each location. Because the phenomena surrounding vibration are so complex, the subject has been researched in detail—indeed, research on ground vibration is more advanced than in most other engineering fields. Our findings have advanced the study considerably.

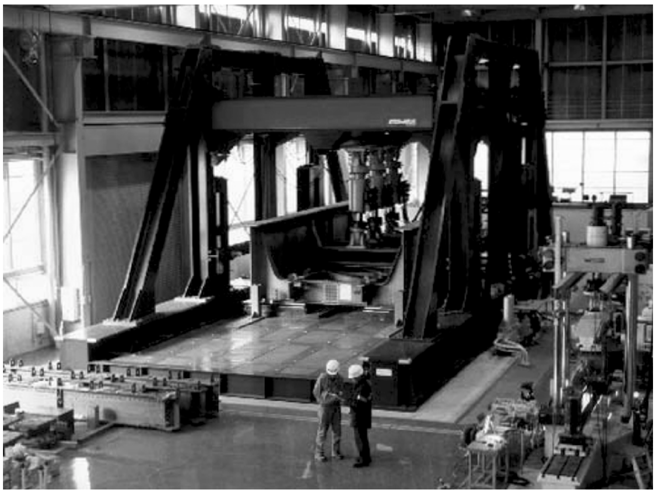
For example, we have studied the effect of fast trains on bridges. The bridge sides are buffeted by air turbulence from each train, but this buffeting and the resultant vibration can be reduced by adding more supports under the bridge sides. For the track bed, we have injected resin into the ground to form 'stakes' that are slightly harder than the surrounding ground. The stakes transmit the vibrations vertically downward, preventing horizontal transmission of shock waves. Sleepers are fastened by steal beams in a ladder-like configuration to rigidify the track and reduce vibration. Our research into vibration reduction continues to build on past experience with the aim of protecting the trackside environment.

Infrastructure—Maintenance and Reinforcement

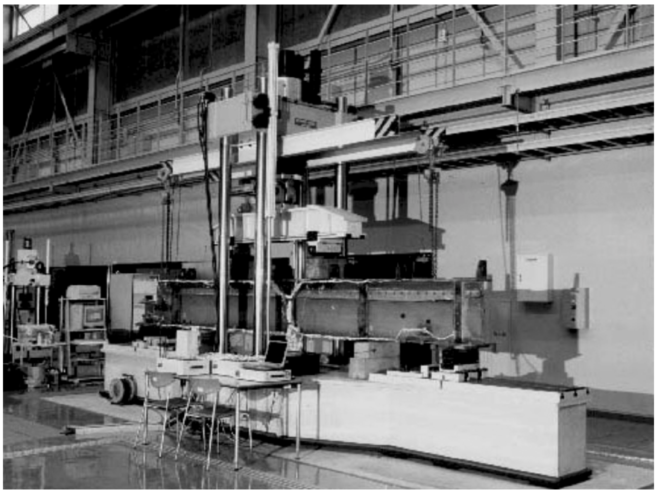
This article has briefly mentioned measures to ameliorate the impact on the environment when speeds are raised to 270 km/h, but another important issue is maintaining and reinforcing railway infrastructure.

Bridges, steel girders and other structural elements deteriorate with age. The Tokaido Shinkansen was constructed more than 38 years ago and the infrastructure has aged since then. The track was built using the most advanced and sometimes pioneering technologies. However, seen through the prism of hindsight, the pioneering construction may not have been sufficiently strong to last many decades. For example, the welding techniques chosen for such a massive undertaking had never been used before and the designers could not rely on computer simulations to verify the reliability of welded joints. Instead, design details were based on accumulated experience and know-how. To avoid any possible misunderstanding, the existing shinkansen infrastructure is completely safe and is being thoroughly inspected and maintained to keep safety levels high. But we do need to prepare for the future.

Another important research goal is to learn more about fatigue cracks that cannot be predicted by calculations. Fatigue is initiated at the molecular level so it is very hard to use scale models like we do with noise experiments. Instead, the actual girders must be tested by subjecting them to the same loads that a train exerts. We use the Railway Structure Loading Test



Railway Structure Loading Test System (JR Central)



Fatigue Testing Machine (JR Central)

System for these experiments.

We use the tester to examine girders from actual shinkansen bridges. A girder from a bridge that was removed for construction of the new shinkansen station at Shinagawa was brought to Komaki for testing. The test equipment has three jacks aligned in the direction of the track. The jacks apply a sequential load to the girder, simulating the load of a passing train. We began the girder fatigue tests 6 months ago and have already simulated the equivalent of 40 years of passing shinkansen trains. Some cracks formed in small members, but none in the main member. Without getting into a detailed discussion, it seems that such a girder is likely to withstand loads for at least another 40 years when properly maintained.

We use the Fatigue Testing Machine for similar tests. The girder shown in the photograph came from Hamamatsucho south of Tokyo Station, where rebuilding of the station involved replacement of the shinkansen tracks. The girder was subjected to fatigue tests simulating 100 years of service. Some small fatigue cracks were found but they were small enough to allow the girder to have remained in service with repairs.

Other apparatus is aimed at developing efficient methods for maintaining infrastructure, including the Catenary Vibrator and Track Vibrator.

From Testing to Operation

Some of our test apparatus, including the Vehicle Dynamic Simulator, Low-noise Wind Tunnel, and Track and Structural Dynamics Simulator are the most advanced in the world.

But ultimately it becomes necessary to put newly developed equipment into actual use. Obviously, this should not be done before thorough testing proves that the equipment is safe and reliable, but the paradox is that only actual use can fully verify safety.

One solution is to construct a test track to verify safety and reliability. However, it is impossible to replicate reality—doing so would involve running full Tokaido Shinkansen services over many years at speeds up to 270 km/h on the test track! There are only two realistic options: (i) proceed without verifying all factors beforehand by performing small-scale tests on a siding, then on a spur line, and then on the main line, carefully verifying safety and reliability at each stage; or (ii) use the above-mentioned equipment to simulate conditions on the main line and then place the new equipment on the main line and perform final verification checks. At Komaki, we choose the second option using simulations that try to replicate main-line conditions as faithfully as possible.

And yet, however faithfully one may try to replicate actual conditions, the tests are not actually on the main line. As a result, it is very important to use technologies that can compensate for differences between actual and test conditions.

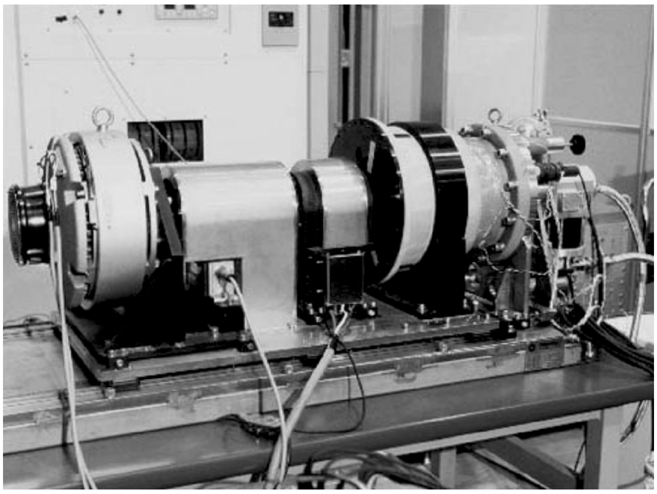
Developing New Technologies for Non-railway Fields

So far, this article has reviewed some of our R&D in railway-related technologies, but now I would like to mention our second major goal—developing new technologies for non-railway fields.

Our railway-related R&D has given us new technologies that we can refine into new products rather for other markets. In addition, we will soon be pursuing R&D into non-railway fields. This will be briefly described when the time comes.

We believe that the R&D into superconducting technologies on the Maglev Test Line in Yamanashi Prefecture has applications in other fields.

One example is our Superconducting Motor-generator. In an ordinary generator, a coil (rotor) turning inside a magnetic field generates electricity. The amount of electricity depends on the strength of the magnetic field and the rotor speed. Our Superconducting Motor-generator roter turns in very strong magnetic field that is generated by the superconducting magnet, so a slow-moving rotor can produce almost as much electricity as a fast rotor in a conventional generator. This


Superconducting Motor-generator (JR Central)


Superconducting Magnetic Gradient Levitation System (JR Central)

feature would be ideal for water wheels, windmills and other environmentally friendly energy generators where the rotor is turned slowly by wind, tidal currents, etc. The high efficiency levels offer advantages for the global environment and we believe it is only a matter of time when this development is applied.

Another application of superconducting technology can be seen in our Superconducting Magnetic Gradient Levitation System. A magnetic shields shape the strong magnetic flux generated by a superconducting into a specific pattern, thereby permitting to be levitated without any active current control. This technology has potential applications in magnetic bearings and other linear axles.

Parametric Loud-speaker System

Next, as another example of developing new technologies, I would like to describe our Parametric Loud-speaker System and its applications (Fig. 3). The system is far more directional than a conventional speaker system—sound is emitted like a spotlight beam at a specific target, making it possible to limit public announcements to a specific part of station platform. For example, passengers waiting on one side of a platform for an inbound train to the city centre will hear only their relevant announcement, while passengers waiting on the opposite side of the platform for an outbound train will hear only their announcement. The overall result is a less confusing station environment. In non-railway applications like museums, such a system would permit an explanation of one artwork to be heard only by people near the work.

Other companies have already been expressing a keen interest in the system. Possible applications include giving: audible instructions to people with poor sight at pedestrian crossings; audio instructions in tunnels; and audio instructions on escalators.

Figure 4 shows the principle behind the system. Two sound waves (f1 and f2) are broadcast from a speaker and mix in the air. The f1 waves are a mixture of ultrasonic and audible sound waves, but the audible sound cannot be heard because it is mixed with the ultrasonic waves. The f2 waves are entirely ultrasonic, so they cannot be heard. The higher harmonic waves created by the mixing of the f1 and f2 waves are extremely erratic and cannot be heard either. However, since the wavelengths of the two sets of waves cancel each other out, the ultrasonic waves (f2) are subtracted (f1 – f2) from the ultrasonic plus audible sound waves (f1) leaving only the audible component of f1. Since ultrasonic sound waves are sharply directional, these two waves can be focused in a specific direction allowing the audible sound resulting from the subtraction effect to be heard only where required.

R&D at JR Central and Other Research Bodies

Lastly, to give a better overview of our activities, I would like to discuss how our R&D relates to and compares with similar activities at other research bodies.

A commonly asked question is what percentage of total sales does JR Central spend on R&D? It is about 2%. How does this compare to other major manufacturers? According to our studies, the ratio of R&D costs to total sales revenue is about 5% at Toyota, Honda and Nissan. Among heavy industries, Hitachi, Ltd. spends about 5.2% on R&D while Toshiba, Ltd. spends about 5.5%. The ratios for Tokyo Electric Power and Tokyo Gas are around 1%. JR Central's figure includes high R&D costs for linear motor technology so it is slightly higher than other Japanese railway companies.

Another question we are often asked is, how does our R&D fit that of RTRI in Tokyo and research facilities operated by JR East? The RTRI has a number of roles. Its primary role is to act as an independent third party in investigating the cause of accidents on lines operated by the various JRs. The second is to promote R&D in areas where the JRs have common needs. The third role is to support the individual JRs by assisting in conducting experiments in areas where it has superior know-how and testing devices.

We believe that in other cases each

Figure 3 Parametric Loud-speaker System

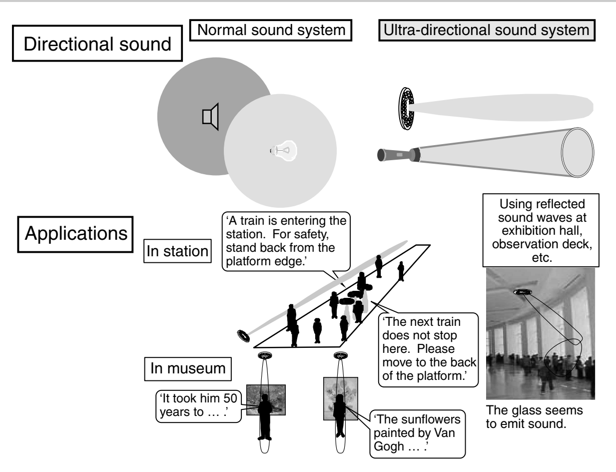
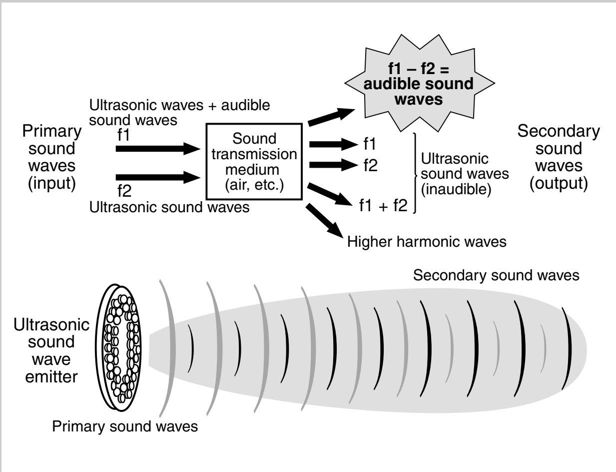


Figure 4 Principle of Parametric Loud-speaker System



railway company should handle its R&D, especially with regard to matters related to operations and maintenance. Each company must deal with its own situation. At JR Central, our shinkansen elevated structures are slenderer than on the other shinkansen lines (meaning we require different elevated structures strengthening and maintenance techniques); our shinkansen track is on ballast rather than on concrete slabs and generally passes closer to houses than the other shinkansen (requiring greater focus on noise and vibration countermeasures); and more of our lines pass areas prone to major earthquakes (meaning infrastructure must be more earthquake-resistant). These unique differences mean we cannot farm out research, but must tackle our problems ourselves.

Thus, we feel that our research is well coordinated with the work of the RTRI with each body having its own niche.

How does our R&D differ from that of JR East? JR Central's R&D focuses heavily on shinkansen infrastructure and rolling stock with little emphasis on conventional track. Perhaps I should not speak for JR East, but my impression is that R&D at JR East places at least as much emphasis on conventional lines as on shinkansen, even JR East's research on shinkansen is focused on achieving higher speeds up to 360 km/h.

Whatever the differences, we hope that the technological advances achieved by each group will be readily shared by all to the benefit of railways as a whole.

Four Objectives for Researchers at Komaki

I would like to finish this article by summarizing the four key objectives we believe all researchers should set themselves at our Department in Komaki. They are posted on the walls of our facilities in the hope that they will always be an essential part of our work ethic. I am sure following these objectives will guide our R&D efforts to success.

- Set high, rational research goals.
  This can be achieved through a relaxed atmosphere where researchers feel free to follow their ideas. Of course, it is important that the chosen goals show a clear understanding of future possibilities.
- Ensure that when you begin your research it will lead within the specified time to positive results that can be applied in the real world.
  In the past, researchers often did not know if or when the knowledge they gained through research would be ready for application. This was a cause of irritation for some, so it is important to establish a schedule, keep to it, achieve the sought-after results, and apply them.
- Results achieved through research must be based on scientific principles, be easy to understand, and fully logical.
  The logic must be able to withstand the test of time.
- Remain dedicated to your research.
  Researchers are expected to acquire a high level of knowledge, train their minds, and exhibit strong will-power during their endeavours. ■

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Dr Doi is Corporate Officer and General Manager of the Technical Research and Development Department in the General Technology Division of JR Central. He joined JNR after obtaining a masters degrees in science and engineering from Waseda University in 1971. He joined JR Central after the JNR privatization 1987 and has spent 15 years working on various projects including the Yamanashi Maglev Test Line, the planned Chuo Shinkansen, and new stations for the Tokaido Shinkansen. He obtained a doctorate in engineering from the University of Tokyo in 1997.