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Motorcycle Safety, Transport and Traffic Control Overseas Visit Report: Japan (August 1977)

M.R. Wigan

AUSTRALIAN ROAD RESEARCH BOARD
RESEARCH REPORT

APPLICATION SUMMARY

Australian Road Research Board

THE PURPOSE OF THIS REPORT ....

Is to summarise discussions with the major motorcycle members of the Japan Automotive Manufacturers Association (Honda, Yamaha), and report on the partial picture of Japanese Traffic Control and Transport gained in supplementary meetings while in Japan to attend the Seventh International Symposium on Transport and Traffic Flow Theory in Kyoto. (Meetings with the Japanese computer manufacturer FACOM are covered in AIR 808-5).

THIS REPORT SHOULD INTEREST ....

- those concerned with motorcycle safety, regulation, and training
- those interested in traffic control
- those interested in environmental standards

AS A CONSEQUENCE OF THE WORK REPORTED, THE FOLLOWING ACTION IS RECOMMENDED ....

- that a specific effort be dedicated to pulling together a comprehensive view of the users of motorcycles and their characteristics
- that training for motorcyclists be specifically directed at avoidance abilities
- that links between avoidance behaviour and training for skills be specifically examined to improve training and provide a quantitative basis for skills assessment
- that testing procedures be developed in Australia to check on wet weather braking performance of disc brakes.

RELATED CURRENT ARRB RESEARCH ....

FS 1049 - Comparison of the effects of the different licencing ages in New Zealand and Australia

P 288 - Area Traffic Control and Network Equilibrium

A 812 - Specialist Advisor to Standing Committee on Road Safety, House of Representatives.

P 278 - Monitoring Environmental Impacts.

CUT OUT INFORMATION RETRIEVAL CARD ....

TITLE: MOTORCYCLE SAFETY, TRANSPORT AND TRAFFIC CONTROL OVERSEAS VISIT REPORT : JAPAN (AUGUST 1977)

KEYWORDS: Japan/conference/report of visit/transport/traffic control/motorcycle/driver training/safety/environment/sound /air pollution

SUMMARY: The report covers two weeks in Japan in August to attend the Seventh International Symposium on Transport and Traffic Flow with the financial support of the Japanese Committee. The paper for this meeting was circulated previously. The areas of motorcycle safety, transport and traffic control were selectively covered, and a separate report has covered briefings on Fujitsu-FACOM M-Series Computers. Discussions were held with the major motorcycle members of the Japan Automotive Manufacturers Association (Honda, Yamaha). One major observation from the visit is that constructive training for motorcyclists may be specifically directed towards avoidance activities.

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*Non IRRD Keywords

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MOTORCYCLE SAFETY, TRANSPORT AND TRAFFIC CONTROL OVERSEAS VISIT REPORT : JAPAN (AUGUST 1977)

by

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November 1977
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Victoria

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SUMMARY

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*WIGAN, M.R. (1976). Dynamic Models of Modal Choice. Australian Road Research Board Internal Report AIR 000-26.

+WIGAN, M.R. (1977). Japanese Briefings on Fujitsu M-Series Computers. Australian Road Research Board Internal Report AIR 808-5.

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1. INTRODUCTION

This journey was undertaken to attend the 7th International Symposium on the Theory of Traffic Flow and Transportation in Kyoto. The opportunity was taken to obtain selective background information on transport and traffic control and operations in Japan, to assess the state of the art in motorcycle safety with two manufacturers, and to gain more information on a Japanese computing company which had responded to ARRB's invitation to tender.

Reports on the Kyoto paper (Wigan 1976a) and on the Japanese FACOM Computing Company (Wigan 1977a) have already been published. This report covers motorcycle safety in Section 2, and transport and traffic control in Section 3. A comprehensive list of the material gathered and its present location is given in Appendix 1. Colour slides taken are listed as Appendix 2. The names of those people visited forms Appendix 3, the Overseas participants at Kyoto are listed in Appendix 4, and the Itinerary in Appendix 5.

The coverage of transport and traffic areas was necessarily tentative and limited, as priority had been given to motorcycle safety in view of the author's ancillary duties as a Specialist Advisor to the House of Representatives Standing Committee on Road Safety. The documentary material goes some way towards covering the imbalance.

2. MOTORCYCLE SAFETY

2.1 HONDA MOTOR COMPANY

Australia-New Zealand lies within the Asia-Pacific Region for Honda, and is atypical, in that all the other such markets are dominated by machines of below 125 cc capacity. Most of these other markets also insist on an ever-rising local content percentage for the machines, and tend to raise this percentage quite substantially with little or no warning. Above 50% this means engines or engine components must be included, which clearly leads to further problems over a short timespan due to the need for high quality control and well developed ancillary industries in the country. Thailand has recently raised its requirement from 50% to 70%, and the very swiftly growing Indonesian market is presently about 25%, and due to rise to 70%. Korea is presently 75%, but has the industrial base to go to 100%, while Taiwan is 95% and short only of being able to prepare for a new model themselves.

Australia is clearly different: without any home production requirement or substantial knocked down (K/D) production, and with virtually no small machine market. The quality control and standards are set, applied, and maintained directly in Japan, and so any safety aspects are directly under the control of the manufacturer.

The Honda involvement in motorcycle training and safety programs is both through the Japan Automobile Manufacturers Association(JAMA) in its national participation with the National Police Agency and the Central Motorcycle Safe Riding Diffusion Council, and also by its directly owned schools. Two of these the author later visited: the school at Suzuka Circuit (Ref. 26) and the Rainbow driving school in Tokyo. Reference 26 shows the layout of the training areas at the Suzuka, Fukuoka, and Rainbow training centres.

The licencing procedure means that everyone must take a written test, but a practical test is also required. Either one goes directly to the police and takes their test (few of those who do this pass the test), or goes to a training course: if the training course is passed, then the Police do not require a further test. 100 written questions are posed to riders of machines of over 51 cc, and only 50 for machines of under 50 cc. Most of these questions are on traffic laws, but include a few skill and road traffic principles questions. There is a triennial re-testing requirement. Apparently, although the difference between trained and untrained tested riders has now been officially recognised, no study of the accident involvement and population has yet been undertaken. (See also Appendix 6).

The National Police Agency is the accident analysis centre, and present indications are that changes to existing pre-driver training courses are not likely to help to increase safety very much, but that remedial training is promising. The Police are now picking out control groups.

The Shinkansen train journey to Nagoya (to the Suzuka Training Centre) was remarkably like the newer Intercity Services in the U.K. with better seats and air conditioning. The ride was comfortable but not as smooth. The Japanese and English station announcements were a real relief to an overseas visitor. Several simulated road areas for bicycle training were seen en route, and numerous 20 km/h speed limit signs painted across minor roads. Railway crossing signs were frequently in both Japanese and English.

The Honda Suzuka factory is one of the largest motorcyle production centres in the world, and turns out over 1.5 million motorcycles and half a million cars a year. The factory is highly automated, including the storage and stacking for outbound shipment, yet uses a great deal of labour backed up by monitoring computers. A fairly large number of mixed lines are run, and can be changed swiftly. As a minor spur to sales Honda owners can park inside the gates while owners of other makes must park outside.

The factory has recently marked off a brown safety strip round the side of all factory roads, restricted to riders of Honda Pal mopeds. A pool of these mopeds and suitable helmets is positioned at various points around the huge site, and are used mainly by female employees. No accidents have occurred in this first half year of operation. In Japan few women hold any form of driving licence, and no licence and no training is required for mopeds (which are limited to 30 km/h).

The Suzuka circuit is superbly laid out, and is a major asset to the Honda Safety Driving Centre adjacent to it. The Honda Safety Driving Centre at Suzuka is heavily used for training Instructors to feed into the JAMA input for National training. The Police also use it (at a fee) both for training and for refresher courses. A full set of training manuals (in English) exist to back up the courses given, and the well known U.S. - MIC*- MCSF course of Dr. Hartman drew heavily upon this material.

Police training for Prefectural forces throughout Japan is given at Suzuka, and has had a visible effect on safety since its inception. Before such training courses were started about 15/16 police died each year: there were no fatalities in 1976-7. The Police undergo a 3 week full time course which starts at 7.30 a.m. each day and includes classroom instruction. Retraining refresher courses are carried out each year. Further courses sharpen up police riders for duty as instructors.

*Motorcycle Industry Council : Motorcycle Safety Foundation.

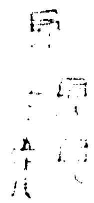
As can be seen on the slides (Appendix 2) the Police reach a remarkable standard of disciplined machine control under easy and adverse conditions. The CB 500 Honda four cylinder machines used show battering of the silencers on both sides: this was observably due to controlled slalom riding across the tight S-bend sequences. The precise use of full avoidance lean and throttle control was most marked in the police close formation passage through these slaloms. The permanent "torture" sections on the training area provide excellent grounds for rider skills development on loose and deep gravel, over cyclic washouts, along narrow beams, and over small rocks set in concrete.

While such permanent and specialised training areas are clearly conducive to a high throughput of trainees, the more diffused Australian population would put costs at a premium due to the wide catchment areas implied. The standardisation implied by such layouts would however be of demonstrable benefit for better training standards, and the use of unpaved compacted areas with similar specialised hazards would serve as well for the less intensive Australian demands due to the smaller training numbers involved.

The training area itself forms only part of the Safety Driver Centre, as the Suzuka circuit is also an essential component of the advanced instructor and police pursuit training: the lecture rooms are accorded considerable importance, and the lecturers have an excellent style and ranges of visual aids to help them. A three day State Electricity Commission course was under way during my visit, and the lecturer (who was holding the class effortlessly) was the same senior instructor who had shown me round Suzuka. Models, layouts, magnetised symbols, moveable cartoons, and cutaway assemblies were all being fully employed.

One small segment of Mr. Ogahara's lecture is worth a special note:

1. "Look:
2. "Look Carefully"
3. "Look Overall"



Consequently, while you might cast your eyes up the road, you must look selectively, identify and pick out the important and significant items needing your attention for safety, and even so the pattern of all the road related events requires a different type assessment. This all has special relevance to motorcycle visibility to car drivers, who may not register the presence of a motorcyclist as something which needs his attention.

All the Honda training staff emphasised that rider attitudes were as important as driving skills or knowledge, and pointed out the time spent on this aspect of safety development. The avoidance training for motorcyclists extends to braking tests on a skid pans, where a great deal of skill is essential: this is generally reserved for the most advanced riders: instructors under training, and police riders.

2.2 RAINBOW DRIVING SCHOOL

The Rainbow driving school is a typical large commercial driver training school, in the outskirts of Tokyo. It caters for all types of vehicles, and undertakes the testing required by the Police Agency for licencing. As no moped (< 50 cc) training is legally required, only the common written motorcycle regulations paper is enforced by law. Rainbow being a Honda subsidiary with massive moped production, Rainbow runs occasional moped training courses, although this is more frequently voluntarily undertaken by dealers.

If any passenger vehicle licence is held *no* test of any kind is required to drive a moped.

The recent post-oil price rise market has siezed upon the low powered moped ("noped"?): 78% of the Honda "Road Pal" ("Express" in the U.S.A.) purchasers are women 25-40 years of age, and ex bicycle users. This is a big change in market type, as they *want* some training for themselves, while the previous sub-50 cc riders were ex-motorcycle riders who did not. Up to 1975 50-60 000 people annually obtained a moped licence: in 1976, 200 000 did so, mainly in response to the serious introduction and promotion of mopeds to the Japanese home market for the first time, and the availability of machines such as the Road Pal (Honda) and Passol (Yamaha). This suggests that the boom was due to the rectification of a marketing error in not attacking the home market, and to the enabling legislation on driver licencing for mopeds which was one result of changes to the Japanese system in 1972 and 1975.

The school had a number of interesting features. A creche was provided to allow married women to attend: not unreasonable in view of the triennial retesting requirement. The classrooms were extremely well instrumented and equipped with back projection, displays, and automatic test response and monitoring equipment on each desk and the instructors console. A bank of car driving simulators were in use for an hour of initial instruction before real car useage: the simulators were not particularly effective for training, but saved valuable car and instructor time by getting the basics of control out of the way beforehand. The final stage of car training is carried out by remote radio commands from a control tower. Right to this point instruction is restricted to the several acres of road layout inside the Rainbow premises. Old ladies take an extremely long time to learn (over 60 hrs of instructor time), and so automatic Honda Civics are used as practise to speed up their learning. No credit against the legal training hours requirement can be given however.

No comment was made on the use of automatic motorcycles (such as the Honda 400 A) for similar purposes in motorcycle training.

The school provides all cars and motorcycles for training (see slides listed in Appendix 2). The motorcycle training area is quite separate from the car area, and *no* dual control machines are used at all. The area simulates urban conditions only, as Japanese law prohibits motorcycles of below 250 cc or carrying passengers from using Highways. Due to the extreme conditions often encountered on the Highways, only very experienced riders are generally prepared to use them.

The Licencing and Examination Structure in Japan under which Rainbow and the others operate are detailed in Appendix 6. The standard curricula laid down by the National Police Traffic Bureau includes the specified numbers of hours of instruction for each examination detailed in Appendix 6.

The minimum car course is stated to be 27 sessions: the national average taken to pass the technical test for an ordinary car is 42, and Rainbow are currently close to this at 39. Motorcycle technical tests regally need 5 and 8 sessions for small and large machines. In practise this corresponds to the time actually needed to pass (5-7, and 8-10 respectively at Rainbow). The previous acquisition of a motorcycle licence certainly cuts the time required to pass a car licence test. Manual transmission cars are used exclusively for training purposes, although 6-7 hours less is needed if automatic transmission vehicles are employed. If a motorcycle licence for a machine of over 250 cc is held, then the law permits a 2 hour reduction in the minimum car practise period required. In practise the previous holding of such a motorcycle licence cuts the average for car learners at Rainbow from 39 to 29 hours. In the reverse direction, if a car licence is already held when seeking a motorcycle licence, the law permits a 1 hour reduction in the statutory motorcycle training periods: in practise a reduction of rather more than this seems to be found, although as it is a rare occurrence the statistics are poor.

2.3 HONDA RESEARCH AND DEVELOPMENT

Car and motorcycle research centres were not separated until three years ago, and it has been quite noticeable that the rate of innovation from Honda has been fairly low in that time: a complete new range of machines is widely speculated to be in the final pre-announcement stages of production, and it is interesting to note that no comments at all were made during my visit on the safety features or aspects of any such new models, or indeed of their existence.

Substantial work has been done at Honda on both primary and secondary safety features for their machines, and the Research and Development resources are generally regarded as the largest of any in the world in the motorcycle field. The Experimental Safety Motorcycle Program stimulated by the USA has now been superseded by a continuing inter-industry effort with less restricted aims, however much of the work carried out is highly relevant at present. Watanabe of Honda arranged the ability of riders to undertake avoidance manoeuvres as a function of training, and developed "agility" or "ease of avoidance" descriptors for different sizes and types of Honda motorcycles. The largest and smallest motorcycles were both superior to the medium sized machine (350 cc), but these differences were completely swamped by driver skill variations. The avoidance distance could be up to 25% less for experienced riders. Watanabe's data also showed that braking as an evasion policy was the best policy only at low speeds; above 30 km/h avoidance was better under this controlled condition. Changes in rider feedback were confirmed to have a greater effect on motorcycle handling than motorcycle modifications, and a dynamic simulation model calibrated on Watanabe's data supported this.(Ref. 59)

Primary stability and handling of motorcycles is known to be a very difficult field: some early work does however suggest that the characteristic "wobble" of motorcycles and the high speed weave stability, can be treated nearly independently of the rider. A general coverage of this background, including Watanabe's paper in English, can be found in the Proceedings of the 2nd Congress on Automotive Safety.*

I first specified precisely the objectives of our meeting, namely to ensure that the views and opinions as generally expressed in my paper (Ref. 61) at the ARRB/DOT Motorcycle Safety Symposium were sustained by the real data at Honda R. & D. and to pursue the state of the art in primary and secondary safety in present work at Honda. After some discussion on antilock braking, Honda R. & D. specifically agreed with the views expressed in Reference 61.

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* Proceedings: 2nd International Congress on Automotive Safety (1973) National Motor Vehicle Safety Advisory Council, US DoT, Washington, U.S.A.

The Honda engineers then described their telemetry system for assessing weave and wobble stability. Strictly, the recording system is a seven channel analog DC continuum record on cassette on the machine, plus telemetry to their IBM 370 (Fig. 1). No wheel force transducers are used, and the centre of gravity is tracked only statistically. The initial work has given a good understanding of straight line wobble and weave, but the tracking of S-shaped rider-guided patterns is still not fully understood. Yaw, roll θ, $\dot{\theta}$, $\ddot{\theta}$ are the primary measurements: pitch is not regarded as being important and is neglected. The man and machine instruction requirements for stability are still being pursued: Honda view tyres as the key factor in stability. (One might however view this in the context of well developed value engineering and typical Honda torsional frame stiffness and suspension design compromises).

Detailed type approval for complete machines is still not regarded as a very practical aim, but it is increasingly reasonable to expect that component systems and manufacturers could be covered. Tyres were stated to be the most influential single item for motorcycle stability, and it can take up to a full year of development with a specific motorcycle to get a reasonable match between machine and tyre: Honda's usual practise is to take a specific tyre and develop the machine with this specific tyre. Honda are currently studying MVSS 119 on tyres, where the DOT wear indicator is set to 0.8 mm tread depth, while Honda feel strongly that 2mm is the point of warning, where all round tyre performance starts to deteriorate quickly.

Honda felt that of the items which *should* be regulated, reserve load for specified tyres should be emphasised and enforcement improved. FMVSS regulate and test only by picking up random machines in the market place. The problems which Honda have had are mainly in the area of the use of non-recommended sizes: e.g. 4.00 x 18 rims and tyres being replaced by 5.00 x 16. Honda even suggested going as far as restricting users to a range of tyres specified by manufacturer and tyre specification, with at least two options. This is an understandable view bearing in mind the design and commercial compromises involved and the solutions selected by this manufacturer, but many users of Honda machines will claim that carefully selected after market tyres can be superior to original equipment in terms of road holding performance, or safety: sometimes at the cost of some weaving behaviour, but with a net performance and safety gain.

The braking performance of disc brakes has been a cause for concern for some time, and it has been suggested that a saturation braking test requirement be added to ADR 33 to give due weight to those designs which perform better in wet weather. The wet weather recovery of a disc brake is considerably better than for a drum, once water gets inside it: fading is rare, and the only widely recognised problem is the apparent wiping or response time for saturated disc brakes to take effect. The Honda reply was to draw two diagrams (Fig. 2): one showing the need to apply double the pressure on the disc brake lever in wet conditions - a reaction which many experienced motorcyclists find very hard to do as a result of their trained reactions linked to dry conditions, and the small 'pip' at the end of the braking period. In principle they contend that much of the wet weather disc brake problem is due to this factor of trained reactions

However, substantial contributions also come from purely mechanical sources. The material of the disc has a significant effect, and while European manufacturers favour cast iron, Honda have found that if a specific special stainless steel is used *and* the surface hardness is held between Rockwell 25∿28 that stainless steel performs as well and has the additional advantage of good appearance and lack of surface rust formation.

Pad materials are extremely important: the author was involved with initial tests with Ferodo UK to improve on the poor dry and wet performance of the JB576 and A21 materials supplied in Honda CB 750 models K0 to K5, which resulted in Ferodo 2340 being selected by Ferodo for replacement pads. Honda have now uprated their pad material to JP8D for K6, K7, F1 and F2 models of the CB 750 and are fairly satisfied with the wet weather performance improvement thereby obtained.

The leading edge shape of the pads is also known to help from the author's direct experience: Honda confirmed that squared off leading edges *do* give a small improvement. This is now embodied in the K2 model of the CB 750. Grooving the disc pad gives a major improvement and the K2 model (and others) now has this groove. It does not make any difference how many or how few grooves are cut, as long as there is at least one.

Machining the disc material in spiral, holed, or slotted configurations was stated to give zero or degradation effects on braking performance. This is not quite in agreement with the author's experience, where dry weather braking power certainly follows this rule, but wet weather response times marginally improved. It is reasonable to assume at present that grooved disc brake pads make the difference between these conflicting findings (which are well confirmed by local Australian racing car practice).

No comment was made on caliper stiffness as a contributory factor: however, the revised design apparent on the K2 would seem to be a tacit confirmation that caliper stiffness of a higher order is needed to provide adequate pressure application under the higher loads required for full wet weather effect.

Measure	Honda Advice	Empirical results
Pad Material	70%	Agree
Grooving of pad	20%	Agree
Disc Material	10%	Agree
Pad leading edge	1-2%	Agree
Disc Machining grooves, slots, holes	NIL	

TABLE I: CONTRIBUTIONS TO WET WEATHER DISC BRAKE PERFORMANCE

Honda R. & D. undertook to provide a letter at a later date confirming the point raised in view of their significance.

Antilock braking systems have been actively pursued at Honda for over 10 years, with unsatisfactory results to date. Weight and cost will not be studied until performance and reliability has reached a satisfactory level. The two basic approaches are mechanical and electronic/hydraulic. The mechanical system is under pending patent protection, and while not fully satisfactory on all forms of slippery surface, provides excellent reliability.

Hydraulic systems are subject to numerous reliability and systems protection problems, not least the final stage braking control before stopping. Kelsey Hayes, Girling, Akebono, have all worked on this type of system, with as yet imperfect - though encouraging - results. The Mullard-TRRL system was offered to JAMA* for purchase, but agreement has not been reached. JAMA provided a machine for TRRL testing, but as far as Honda were aware, no results had yet been fed back.

This possible system apart, Honda were of the firm opinion that production systems could not be expected for *at least* 4-5 years, and even this date is dependent on further developments in other related fields. After 10 years of Honda effort, they place little reliance on *any* forecasts in this area. The commercial importance of anti-lock brakes makes such views hard to assess.

Tubeless tyres were then discussed, and the standards required to make them widely available. Goodyear have finished work on tubeless tyres in conjunction with Honda, and standards for tubeless tyres, rims, and wheels are now appearing.

Country	Organisation	Position
USA	ATRA	Had a standard 3 years ago
	MVSS	No standard
JAPAN	JARTOMA	Proposals for a standard not yet formalised
	JINR	No standard
EUROPE	ISO	Action initiated, due for ratification in 3 years time
	ETRTO	No standard.

TABLE II: TUBELESS TYRE STANDARDS

This timetable is too long for Honda, who have chosen the ISO draft and ATRA's published standard as a basis to get on with, in conjunction with, their COMSTAR wireless wheels, not fitted to much of the Honda range.

Honda have undertaken a further series of collision tests for the Motorcycle Safety Improvement Program (which has replaced the abortive 1972 U.S. initiative of an Experimental Safety Motorcycle program). So far 16 tests were completed by August 1977, and the program is continuing.

Crash bars have been examined in impacts at three different speeds: below 20 km/h (slow) : medium : high. Under 20 km/h crashbars are most effective in restricting injuries below the knee, but there are long standing and intractable problems in trying to extract accurate data from these tests, using scale models and dummies to help in assessing a wide range of conditions. Honda R. & D. is collaborating with a number of Universities in this area, and

* Japan Automotive Manufacturers Association

the results were due to be announced in October. Honda have not as yet supplied copies of these papers. Other sources and previous work suggests that crashbars are on the whole do not add to motorcycle safety, and can shift lower limb injuries to the more serious upper limb locations.

The context of much of the safety work undertaken is best understood by reference to (Ref. 60). The data Table 3 is drawn from this reference, which quotes National Police Bureau statistics for all Japan in about 1972.

	Total No. of Accidents (1972) (in 1000's)	% of accidents attributed to High School Students Total = 17.8%		Less than x years after obtaining driving licence (1,000's of Accidents)			
			No Licence	1	2	3	4
MOPED							
<50cc	23.7	11.3	1.5 (6.5%)	5.1 (21.5%)	3.5 (14.7%)	2.2 (9.3%)	1.5 (6.3%)
50-125cc	22.2	10.2	1.7 (7.6%)	4.3 (19.2%)	3.0 (13.4%)	1.5 (6.8%)	1.0 (4.6%)
SUB TOTAL	46.0	10.9	3.2 (7.0%)	9.4 (20.4%)	6.5 (14.1%)	3.7 (8.1%)	2.5 (5.4%)
MOTOR-CYCLES							
125-250cc	5.6	35.7	.4 (7.8%)	2.3 (41.5%)	1.6 (28.0%)	.5 (8.8%)	.2 (3.2%)
>250cc	11.9	32.7	.9 (7.3%)	4.7 (39.8%)	3.3 (27.9%)	1.2 (10.2%)	.6 (4.6%)
SUB TOTAL	17.5	33.5	1.3 (7.4%)	7.1 (40.4%)	4.9 (27.9%)	1.7 (9.8%)	.7 (4.2%)

TABLE 3: EFFECT OF EXPERIENCE ON ACCIDENTS ATTRIBUTED TO MOTORCYCLE RIDERS. (Data source: Ref. 60).

*1972 Tokyo accidents only.

The emphasis on small machines is apparent, and when it is appreciated that the experience factor tends to show that the risks for large and small machines converge swiftly after a few years, even before correction for the high school component, the high school training program emphasis is easily understood, and the design factors (see the discussion on Ref. 59 by Watanabe earlier), consequently receive a different emphasis than in Australia with its paucity of small motorcycles.

(It should be noted that a substantial drop in highschool student injuries and violations occurred when safety training was introduced to the schools, with a marked further fall when the instructors had been trained within the school to continue the program.)

2.4 YAMAHA MOTOR COMPANY

The Managing Director (Sales) Mr. Eguchi and his staff described some of the basic criteria adopted by Yamaha. One of these is the aim to produce the highest performance for a specified reliability level, and the other is that the key test of satisfaction with a design is the reported assessments of riders and machines in combination. These views are clearly consistent with the market image of the Company, the strong leavening of road holding and handling performance oriented products, and the continuous involvement in competition. A minor comment on tyres supplied as OEM on Japanese machines was the observation that the Japanese Police had recently gone over to the German Metzler tyres after comparative testing.

Yamaha, like all the members of JAMA, participate in the Motorcycle Safe Riding Diffusion Committee (Fig. 3). Yamaha and all other manufacturers contribute to CMSRDC. Yamaha also contributes fully trained instructors to the National MSDC, who also train instructors themselves. The main task of the Yamaha Safety Promotion Centre is to directly train Instructors for MSDC, who in turn are responsible for running the schools at Prefectural level.

Outside the MSDC role, Yamaha also have their own further safety involvements. The drastic recent increase in <50 cc machines has quickly pushed 50 cc machines to half of the domestic market. As *female* riders have provided much of this increase, and represent a new type of market not interested in motorcycles at all, but now riding light mopeds due to the new concept of product represented by the Passol and Road Pal models of Yamaha and Honda. These new machines have a maximum *design* speed of up to 40 km/h, and a maximum legal usage speed of 30 km/h.

Although Yamaha have a 9 year history of <50 cc training, these new moped riders are different, and specialised training has been set up for them, covering traffic regulations, basic riding, and road sense over a 4 hour program for units of 30-40 people. The instructors are not drawn from the JAMA pool, but are trained separately. These moped courses are held anywhere possible, but agreement to be permitted to use suitable sites can often be difficult to obtain, as a flat and paved surface is preferred for this type of machine training.

Other Yamaha activities are aimed at the point of sale or for dealer action, where supporting educational material is supplied. Material has gone to road safety organisations in Perth and Darwin, and copies of the self-programmed teaching manuals form References 56a, 56b. A new English language manual is in preparation and will be sent to ARRB when it is ready. The coverage is of:-

- basic riding techniques
- safety checks on motorcycles
- wearing of helmets
- discouragement of extreme modifications
- supply of supporting text books and documents.

Yamaha has provided (Ref. 57) a comprehensive pictorial and text specification of their safety activities, and a detailed note of these (Ref. 29) in the context of increasing female riding activity, and the organisation of dealer based activities. An interesting approach is the release of 1500 specialised programed slide/tape projection units (FUJIX SP.500) to give a 35 minute briefing on safety driving at dealer premises.

The Yamaha Iwata Technical Centre was one of the first motorcycle driving schools when it opened in 1973: it follows the normal Japanese layout of riding course, problem sections, classrooms, and control tower (see slides) and the fleet of motorcycles are fitted with a ring of lights at front and rear which visibly monitor which gear is in use (see slides). In the last 2½ years 5,300 highschool students, 650 motorcycle driving instructors, 3,600 moped riders, and 2,400 highschool teachers have been trained at Iwata. The Technical Centre is only a few yards from the Yamaha headquarters at Hammamatsu, and after I had observed one of the Yamaha Instructors (recently returned from conducting a Police riders training course for Brazil), demonstrating the required manoeuvres and skills for the 750 cc test on an XS-750D, I was pressed to try. The 750 was clearly in an aged condition with notable driveline backlash, and fuzzy carburetion, and I can affirm that the test sections are indeed testing! A nice feature is the brake testing strip with witches hats which are closed up, and with water sprays to ensure that full competence has been reached in awkward braking conditions. The avoidance manoeuvre training sequence was of particular interest, as it is an essential-and often totally unappreciated-component of any worthwhile training course.

I also tried the Yamaha "Passol", which is simplicity itself to drive with its automatic clutch, single speed transmission, and very light weight. It is easy to see why women purchase them in huge numbers, as it is completely compatible with skirts, and requires little or no effort to drive.

The next session was with a range of Yamaha engineering staff from the design, testing, product planning and engineering divisions on the motorcycle itself from a safety standpoint.

About 2/3 years ago Yamaha conducted a series of collision tests as part of the safety development program. More recently they have moved away from collision testing towards other methods: the collision results covered airbag and crashbar protection tests. Neither were very effective overall, although airbags were useful for headon collisions, these are not the most important impacts, and airbags give no protection for others. Crashbars proved to be of marginal value even for lateral impacts. From the discouraging level of output from complete motorcycle crash tests, Yamaha have moved to a part-by-part improvement policy, which seems in their view to be more effective.

One of the design compromises for complete motorcycle/rider combination is exemplified by tyre adhesion characteristics: I asked if, given the choice of more adhesion with a sudden breakaway tyre characteristic and a tyre with slightly less terminal adhesion but with early warning slip symptoms fed back to the rider, which would they choose? Yamaha responded firmly for the latter compromise, on the grounds of the motorcycle and rider forming a single system in use: this type of policy is followed by design and product teams. One example is the current system under development to give early warning to the rider of tyre malfunctions (tyre temperature and pressure are both included in this program).

The daytime lighting question was posing problems for the generator capacity and bulb life on smaller machines, but these deficiencies are steadily being corrected, although the cost is a clear problem in the marketplace: *At a price* the user can have all sorts of safety factors, but then how many will buy? My response was that economic analyses of safety measures and regulations *should* always be undertaken by regulatory bodies before action is taken (although this is sadly not often the case), and the subsequent regulatory action at least puts all manufacturers on an equal footing.

The question of braking performance in wet weather is an important issue. Yamaha feel that stainless steel is *not* the best material, although it looks good, and are still carrying out research into disc materials. Drilling the disc *does* help to reduce response time in the wet, but only by a very small amount within the experimental error of about 1-2% on the XS750D (Fig. 4a). Radial slotting (as has been used on racing cars) has not yet been tried (Fig 4b), spiral surface trenching (Fig 4c) does help, but the results are barely outside experimental error, and the cost is very substantial for such a small gain. Slotting the disc brake pad in an arc is definitely effective. As the number of slots is increased, so pad life drops. A single arc slot on a pad with a squared off leading edge provides a 10% improvement: no further improvement is found if the number of slots is increased.

All combinations have been tried, with the firm conclusion that pad material is the best single factor to work on to improve wet weather performance. In terms of stopping distance, the best that Yamaha can currently ensure is a 30% increase in front tyre braking distance, and a 20% increase in rear tyre wet braking. Antiskid braking is still very actively being pursued, with reliability as presently the key problem blocking future production.

Yamaha currently regards the full flow approach with linked front and rear brakes as a reasonable line of attack on anti-lock brakes: the approach naturally has both hydraulic and power feed reliability and failsafe problems to be resolved, with general agreement on figures of 3-5 years as the earliest date one could hope for production systems. The TRRL system is however still an unknown as a potential production system.

The various subsystems of the motorcycle were then reviewed. The lighting system of the XS750D has an automatic changeover between filaments if one fails, if the dip beam fails the main beam comes on at 50/60% intensity, and a warning light comes on in either case. The XS650 model uses twin twin-filament bulbs in the rear light housing for tail-light and brake light systems. The direction flashers in several recent models are automatically cancelled by a combination of time and distance computed from the speedometer drive. If the drive cable breaks, the timing-out system still operates.

Brake pad wear indicators by wired pads are not favoured for reliability reasons over visual checking of thickness warning tags on the pad backing plates. Tubeless tyres are likely to be a safety asset, but standardisation in the shape (more precisely diameter and rim profile) of cast wheels is needed: this is in hand within Japan, but not yet generally covered. Telescopic front fork assemblies have inherent limitations, but the greater strength and stability afforded by leading link designs are not regarded as necessary: telescopic forks are rarely fully tested by normal riders. Fuel tank designs have been revised as a result of crash tests, and Australian supplied models of XS750 are of this type. The crashbar tests in collision testing showed that below 5 km/h crashbars can be of some value to the *motorcycle*, but in case of collision riders slide directly forward 200 mm or more on their crash trajectory with potentially lethal effect at over 50 km/h: Relative rider position and trajectory consequently matters. Wider handlebars tend to move injuries from shanks to thighs at the higher speed although they increase controllability: in view of the greater chance of death at higher speeds Yamaha consider better controllability for avoidance is more important.

There are good replacement tyres which can upset machine stability, and this is a point of concern for the motorcycle manufacturer.

Some fairings can upset machine stability, Yamaha are considering optional fairings as original equipment suitable for each market. The USA conditions have one requirement, Europe another: Australia would follow Europe if this went forward. The question was posed: is a system test yet possible to define overall handling and performance? As yet, not: frame development is done with a computer evaluation system, but still only in conjunction with professional test riders. Suspension innovations such as Yamaha's monocross cantilever system is now a confirmed basic part of Yamaha off-road designs, but although equally well proven in road-race competition, the production of monocross frames for street use is still awaited - probably for straightforward reasons of cost and greater seat height.

2.5 MEETING SUMMARY

The acute product improvement competition between the Japanese manufacturers in JAMA is bufferred in the National Motorcycle Safety Division Diffusion Council for their mutual co-operation in rider safety and training. Both of the JAMA members visited were most helpful: quite clearly, had I taken the time to unearth and brief myself in greater detail on previously published work from the two factories concerned, considerably more information could have been obtained. However, as most of the areas of greatest concern at the time of my visit were strictly in safety areas, the broad confirmation of the views expressed in my paper (Ref 61) and the specific responses on training systems and braking in wet weather were a reasonably satisfactory outcome.

3. MINISTRY OF TRANSPORT

With the assistance of Mr. Nonaka from the Public Works Research Institute as an interpreter, I was able to visit the Japanese Ministry of Transport Road Transport Division and Road Transport Bureau. Mr. Imamura of the Road Transport Division gave me (Ref. 37) an English summary of the Annual Report of Transport Economy for Japan over 1976 in a brief meeting. Figures 5-9 provide a concise and illuminating summary of the type of numerate data presented therein on all modes of transport with discussion of the policies involved. A point worthy of note is that the sharp oil price rises of 1972-3 show up in terms of ton-km, but *not* in terms of passenger-km, reaffirming the swift response of the freight movement to economic fluctuations, as distinct from the far less elastic passenger travel demands. Unfortunately, the commodity coding system adopted for official statistics is of 10 broad groupings with somewhat fuzzy boundaries.

Some of the functional responsibilities in connection with Japanese transport were clarified:

(a) Japan National Railways operates on deficit funding, monitored continuously by the Ministry of Finance, but the MoT has a Bureau whose specific task is to check on JNR and refer their requests for control to the MOF whose province it is. The target is to overcome the deficit, a task made even less easy in the past by the previous requirement to have Parliament authorise all rail fare changes.

(b) The compulsory Third Party motor insurance scheme is a Government responsibility handled by the Road Transport Bureau with a special budget for this purpose.

(c) Environmental standards are set and monitored by the Environment Agency, MITI is responsible for design rules in this area, and MoT for the subsequent inspection requirements.

(d) Registration is also an MoT responsibility, which, like inspection, it carries out through Local Government on a collection agency basis.

(e) The Ministry of Construction is reported to by the Highway Corporation (Nihon Doro Kodan) which sets its own toll fees, although the MoT may be required to endorse these.

3.1 ROAD TRANSPORT BUREAU

The Road Transport Bureau gave me a brief note in English on Automobile Safety in Japan (Reference 34). The MoT administers the Road Vehicle Act (English translations are to be found in Refs. 36a, b), and carries out type approval under the Safety Regulation (Refs. 36a, b) which include pollution control requirements.

Research to support this is carried out amongst other places at the Traffic* Safety and Nuisance Research Institute founded in 1970, which covers Traffic Safety, Traffic Nuisance, and Automobile Type Approval Test Divisions with a total of 85 staff (Reference 33). The Safety Division is explicitly concerned with railway, automobile, and aircraft safety work in addition to transport system research. The best source of accident data is the National Police Agency (see Appendix 6). The Safety Regulations (or Design Rules) are very similar to the US FMVSS standards, although the differences can be substantial (e.g. steering wheel impact collapse criteria).

The motorcycle issues at present are limited: a headlights-on regulation or design rule is not being considered at present due in part to the slow processes of administering and obtaining endorsed changes in the published regulations, although consideration is now being given to trying to decide what standards should be applied to vehicles fitted with antilock brakes when they appear. Reliability is once again critical.

The Environmental Branch confirmed that there were *no* motorcycle regulations on air pollution emission standards, simply for noise. The Branch is currently studying the possible need for motorcycle emission standards, and present thinking is that as they are concerned only with the total contribution to air pollution, there is no need for such a regulation unless motorcycle registrations were to rise substantially. The present noise and emission standards are specified (for certain test conditions detailed in Refs. 36a,b) in Appendix 7. The differential allowances for different pollutant levels for different types of engine (2 and 4 stroke, LPG and gasoline) seem to provide a sensible and practical means of obtaining the best overall air pollution reductions by taking advantage of the best features of each type of power plant, at minimum cost in economic disruption terms for manufacturing interests and commitments.

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4. MOTORWAY AND AREA TRAFFIC CONTROL

4.1 KANAGAWA PREFECTURAL POLICE: EXPRESSWAY TRAFFIC PATROL UNIT

At the conclusion of the meetings in Hammamatsu I was taken by Yamaha to the Gotemba intersection on the Tomei expressway (See Refs. 6, 7, 9, 11 for map details), where I was met by Mr. Satoh of Honda and the Chief of the Kanagawa Prefectural Police Expressway Traffic Patrol unit. I travelled the 72 km to the Traffic Control Centre in the Police Datsun 240 Z in the busy Friday afternoon traffic which seemed very similar to UK M1 and M4 traffic flow in volume, but rather slower and with longer vehicle headways than either of these two UK motorways for similar flow levels. The Police used warnings fairly often, and maintained overlapping communications with other continuously patrolling cars, as is normal police practise. Noise barriers, guard rails, and median plane dividers were all much in evidence, and variable traffic signs were set at frequent intervals. Conversation was difficult, but Ref. 10 contains 1976 and 1977 traffic flow and accident data on the 72 km stretch from the Tokyo tollgate to where we met at the Border of Shizuoka Prefecture.

The contrast between violation citations, the kinds, and the causes of accidents are interesting and the patterns are stable over 1976, 1977.

Violation Citations	Exceeding Maximum Posted speed	41%
	Bad loading of goods	32%
	Improper stopping or parking	15%
Causes of Accidents	Inattention to traffic in front	27%
	Improper steering	24%
	Inattention to traffic (change of direction, etc.)	9%
	Following too close	9%
Kinds of Accidents	Rear end collisions	18%
	Road Divider hit	8%
	Guard Rails hit	8%
	Overtaking collision	5%
	Overturn	4%

TABLE 8: ACCIDENTS IN 1976, 1977 ON TOMEI EXPRESSWAY, KANAGAWA SECTION

The violation citations show an interesting feature: drivers without licences, accidents involving alcohol, and accidents caused by fatigue are all under 1%. The causes cited for accidents reflect this, as alcohol is blamed for under .2%, and fatigue for about 1% of these accidents.

4.2 NIHON DORO KODAN (JAPAN HIGHWAY PUBLIC CORPORATION): KANAGAWA CONTROL CENTRE

The traffic control centre maintains a continual surveillance of the expressway, and acts as an information nexus. The Police sit in and feed information to the centre, and accident monitoring displays form a key part of the centre. The variable signs over the 72 km are controlled from the Centre (Ref. 11 has a series of diagrams on the organisation and functions involved).

The Control Centre can selectively refuse entry by closing the toll gates in response to traffic detector volume readings: every morning it is necessary to close some entry points. The use of a variable toll is precluded on expressways as the tolls are set nationally on the basis of a complete network of tolled expressways with a 30 yr liquidation of the serviced debt incurred by the construction and operation of the system over this time. These are:

Vehicle Classification	Toll level (set 1.4.75)	
Compact cars, micro-buses, motor-cycles	13.00 yen/vehicle-km	+100 yen/vehicle
Buses, 2 and 3 axle trucks and semi-trailers	19.50 "	"
Tractor-semitrailers of >4 axles	35.75 "	"
In urban areas: add 20%		
For travel over 100 km: reduce by up to 25%		

TABLE 9: EXPRESSWAY TOLL RATES Ruling in 1977

A deferred and discounted payment system is provided for frequent users of the expressway.

The basis for these tolls is a laid down procedure agreed with the Ministry of Construction, which starts from the triennial national travel surveys carried out by this Ministry (Refs. 9, 31). A 20 year forecast is built up on a full travel matrix with a multiplicative correction factor (P) for generated traffic added.

$$P = \frac{K}{1 + \alpha(T/S)^{\beta}} \qquad (1)$$

P = factor to multiply total traffic
T/S = Toll to time saving ratio (yen/min)
K, α, β = Parameters estimated by regression from Mershin and Tomei Expressways
S = correction factor to take account of increasing standards of living.

The corrected generated traffic is then added to the O-D table values: the basic generated traffic is ΔT_{ij}, where:

$$\Delta T_{ij} = T_{ij} \left\{ \left(\frac{d_{ij}}{d_{ij}} \right)^{b} - 1 \right\} \qquad (2)$$

T_{ij} = P× (traffic volume firm O-D matrices)
d_{ij} = shortest distance via current road system
d_{ij} = shortest distance via planned expressway
b = fitted parameter.

Nihon Doro Kodan also operate and build other types of roads, and charge tolls for them also. The basis for such non-expressway tolls is to set a toll less than or equal to the savings in vehicle operating costs and benefits offered by the new length of road, and in some equal to the total expenses to the government in construction and operation. For a bypass, direct operating costs are used to set the toll: for a new road without a bypass role, the toll is estimated within the range as specified; for improvements to existing roads (usually the widening and sealing of a gravel road) the running expenses of each are compared. In all three cases the toll is set at around 70% of the benefits computed. The expressway fees are based on a detailed calculation of the charge for each km of expressway for each of nine vehicle types, but are finally set nationally (Table 9: Ref. 8). The expressways themselves have varied design speeds which naturally interact with these charging bases. They are:

	Design Traffic Volume (veh/day)			
Terrain	Over 30 k	30 k - 20 k	20 k - 10 k	<10 k
Level	120 (100)	100 (80)	100 (80)	80 (60)
Mountainous	100 (80)	80 (60)	80 (60)	60 (60)

TABLE 10: DESIGN SPEEDS FOR JAPANESE EXPRESSWAYS IN km/h

The organisation of road organisations and the design and operational standards adopted are detailed in Refs. 8, 31.

The environmental protection measures (e.g. noise barriers) in use on expressways are inadequate: as a result the Ministry of Construction decided in 1976 to compensate expressway side dwellers for the costs of window sealing and air conditioning if required. This is presently defined as a nightime noise level of 65 dB(A), and applies only to expressways administered by the NDK (Japan Public Highway Corporation), Tokyo, and Hanshin Expressway Public Corporation. The subsidy levels are given in Table 11.

Number in Family	Wooden Dwelling	Concrete Dwelling
1	1.2	0.6
2	1.7	0.9
3	2.5	1.3
>4	3.0	1.5

Units = 10^6 yen
(approx. = 3600 \$A)

TABLE 11: SUBSIDY FOR SOUND PROOFING WINDOWS BY EXPRESSWAYS PRODUCING > 65 dB(A) AT NIGHT

Further environmental compensatory measures are scheduled for 1977 and following years (Ref. 31). The environmental quality standards for noise, air pollution, and vibration are given in Appendix 8. The noise levels are given in dB(A) in this reference, but do *not* state whether they are hourly, peak, instantaneous or full period averages, L_{50}, or L_{10} levels: normal Japanese practice is to use L_{50} levels for noise control, but the time period over which this is computed for *noise control* purposes was not clearly established in discussion. Vibration levels are defined at the 90^{th} percentile, but this does not include any specification of the time period over which the levels are to be taken.

4.3 EXPRESSWAY CONTROL

A general picture of intercity and urban expressway control, and traffic signal-based Area Traffic Control (ATC) in Japan is given in Ref. 13. The last day of the Kyoto International Symposium included a guided tour of several Expressways and ATC installations.

The link between Kyoto and Osaka is on Japan Highway Public Corporation Expressways of the Meishin-Chugoku-Kinki group: all of which are under integrated control over 257 km. This group of expressways operates a toll system proportioned to distance travelled, so that outflow control can be enforced before people reach their destinations on their intercity journeys: intra-urban expressways must guarantee that arrival at the desired destination offramp be permitted once the vehicle has joined the expressway traffic, so inflow control is crucial here. Clearly in and out flow control is used in emergencies in both cases. Ultrasonic and loop detectors are used, together with three-message variable displays or gantries. These displays have a top band for locational and exit commands, a lefthand lower block for lane closure, speed limit, and warning messages, and a lower righthand block for conditions such as accidents, fog, snow, construction or ice warnings. All are controlled from the control centre (In most areas these are identical to the Control Centre already described on the Tokyo-Nagoya Expressway). The traffic data for this region uses a FACOM-RE computer and an OMRON OMRAC-T traffic information processing unit to concentrate, synchronise, and display the diverse data. The ten most congested lanes and rampways are dynamically displayed in terms of location, speed and volume as one example of these facilities. Further details can be found in Ref. 12.

The Hanshin expressway is an urban road of 91 km within Osaka and Kobe operated by the Hanshin Expressway Public Corporation. Ultrasonic and loop detectors are used, TV cameras, and variable sign boards are all employed, and a FACOM 270-30 computer is used to co-ordinate the information and control system. The Hanshin Corporation constructs the expressway system that it operates over the Osaka-Kobe area, and has a stunning array of multilevel elevated expressways criss-crossing the city at anything up to about 100 metres in the air, running over the roofs of four storey buildings, and occasionally leaving stubs of unfinished freeway high in the air form incomplete multilevel intersections. References 14, 15, 16 cover the Hanshin Expressway system fairly well, and the huge Osaka cantilever truss bridge (Ref 25 and slides) is simply one more major engineering work involved.

The data control is impressive, and detailed speed/volume/occupancy scatter diagrams are continuously produced. Ref 21 is a set of such diagrams for the Osaka-Ikeda Airport segment for July 1977, and includes time of day and volume variation curves also automatically produced. Displays in the control room show location, volume, occupancy, and speed on four continually varied segments every five minutes, and the mimic diagrams use multiple colours for swift visual pinpointing of actual and incipient control problems.

The control philosophies adopted for expressway control are of inflow management to get effective volumetric utilisation of the expressway, by maximising the total steady state inflow and by sequential ramp closure for unsteady state management (Fig. 10). These two procedures require a traffic volume estimation procedure, which is outlined in Fig 11. It works in three stages:

(1) estimation of expected inflow

(2) factoring to account for interactions

(3) application of LP (linear programming) to maximise total inflow when capacity restrictions are pressed by the estimated traffic levels.

The basic data used is held in a route matrix specifying the link between entrances and exits, and an OD (origin-destination) transition matrix specifying the ratio composition of OD traffic volumes. This matrix is computed by the maximum likelihood entropy model on the basis of in-and-out bound flows. The Influence Coefficient matrix is the product of route and OD transition matrices. The LP procedure can then be involved in steady state conditions to ensure flows within capacity yet maximising total volume inbound. Unsteady state conditions involve a sequential ramp closure procedure to damp down the potential rise in congestion in sections predicted to become overloaded. Emergency control exploits both inbound metering and route control via the display boards.

4.4 AREA TRAFFIC CONTROL IN OSAKA

Kyoto University has been deeply involved in the ATC developments in Osaka. Prof. Kometani, Prof. Sasaki, and Prof. Hasegawa have all been actively involved over some years. Refs. 18, 19 are two of Hasegawa's papers on the ATC philosophies espoused. Hasegawa was also involved with the Hanshin expressway control system, which was the first hierachical control system of this scale in Japan. The Osaka ATC system has therefore the properties of graceful degradation (Ref. 18), when any level of control drops out.

The ATC system is operated by the Osaka Prefectural Police who therefore also use the surveillance equipment for enforcement purposes. Reference 17 covers the Osaka ATC system in some detail, and contains excellent colour diagrams which complement the slides listed in Appendix 2. It is interesting to note that the degree of congestion indicators do not start to register until a queue length of over 300 m is noted, and the highest level (3) is for queues of over 1 km. Variable turn signs form an intrinsic part of the system, and are monitored on the mimic display. Traffic surveys were carried out in March 1974 to assess the systems effectiveness, and the results are detailed on pp. 6, 7 of Ref. 17. The major broad figures of merit are:

Travel time	17.4% reduction
Number of stops	25.5% "
Stopped Time	27.7% "
Travel Speed	24.3% improvement

The character of the routes involved is indicated by:

Travel volumes	11 k to 56 k per 12 daylight hours
Percentage of Large Vehicles	41% to 51%.

The three signal control parameters of cycle, split, and offset are all recalculated in real time, and the similar system in Nagoya is detailed in the complementary visit report*.

The cycle, offset, and split resulting procedures are as in Nagoya, and a graphics display unit is kept in the control room to access such data: see Figure 12 for such a display of current offsets.

A major applied research effort is in progression in Tokyo on a comprehensive automobile traffic control (CAC) system (Refs. 23, 24): MITI arranged a visit for Kyoto attendees, but a previous tight program with Yamaha and Honda precluded the author's attendance. This system includes route advice, road pricing, expressway toll collection, parking information, bus and patrol car location, bus priority and ATC elements. The program is for 6 years, and started in 1975. The author was most particularly sorry to have to omit this visit in view of his long standing research interests and publications and active practical involvement in such systems (e.g. the UK Traffic Restraint Study, the GLC Road Pricing Proposals): such an integrated approach to road pricing control, and route advice has always been put forward by the author as the right entry point to pricing techniques for traffic management. Unfortunately only the literature could be obtained.+

+ The contact given was:
I. Suzuki, Assistant Manager of General Section, Research Association for Comprehensive Automobile Traffic Control Technology, Seiwa Ebisu BLDG. 1-18-14 Ebisu, Shibuya-ku, Tokyo. Tel. (03) 446-5989.

* Wigan, M. (1977). Japanese Briefings on Fujitsu M-Series Computers (FACOM). Australian Road Research Board. Internal Report AIR 808-5.

5. MINISTRY OF CONSTRUCTION : PUBLIC WORKS RESEARCH INSTITUTE, CHIBA BRANCH

It would have been most desirable to have spent some time at Chiba, but this did not prove to be possible. Mr. Kaneyasu, Chief of the Environment Section (ex-Chief of the Traffic Safety Section) and Mr. Nonaka of his staff met the author for dinner one evening, and subsequently Mr. Nonaka assisted as interpreter for a brief two hour visit to the Ministry of Transport. As a result of these two contacts a number of documents were given to ARRB (Refs. 30, 31, 32), and a few specific questions left with Mr. Nonaka to pursue. Written replies to these questions were recently received, and comprise Refs. 58.1 to 58.11 inclusive. Ref. 58.12 is a colour picture of the anechoic chamber used for model simulation of noise problems at Chiba.

The organisation of Chiba Branch is shown in Fig. 13, and the project lists are covered at a superficial level in Refs. 30, 32.

Mr. Kaneyasu has published a considerable amount on noise protection measures (Refs. 58.10, 58.11), and noted that the stringent environmental quality standards set for Japan lead to severe problems at the construction stage of road projects. Air pollution levels are also his concern, and he mentioned that the Stanford APRAC-1A simulation for carbon monoxide was of very small value, as it does not work well in Tokyo for CO, and is of no value for NO_x (which is the key pollutant). Chiba Branch are currently building an NO_x diffusion model, and in this and their views on APRAC-1A are in full accord with TRRL's Environment Division.

The IRRD system interests them, but it is not yet computer based in Japan due to Japanese-English bottlenecks in both directions.

The subjects discussed were:

(1)	Noise prediction	(Refs. 58.1, 58.10, 58.11)
(2)	Analysis of traffic accidents	(Ref. 58.2)
(3)	Traffic assignment	(Ref. 58.3)
(4)	Commodity flow models	(Ref. 58.3)
(5)	Galvanic skin response	(Ref. 58.4
(6)	Regional economic impacts of road construction and staging	(Ref. 58.5)

The L_{50} criterion is generally used for noise legislation in Japan, after the American preference. Consequently, analytic models are generally used, assuming equal sound power and equal spacing for each vehicle. This, of course, requires a number of ideal circumstances, and in many practical complex situations physical model simulations in anechoic chambers are used instead. The scale of 1:40 is used: the appropriate corrections for acoustical absorption and reflectivity are made, and 40x frequency is used. The results have been found effective for noise barrier, cutting, embarkment, and screening forecasts on the ground.

One of the recent studies on traffic accidents by Kurimoto (Ref. 58.2) covered the relationships between intersection and non-intersection accidents and geometric road design, as a result of a 3 year survey from 1971-3. The initial analysis found that intersection density was reasonably closely related to total accidents on the route:

$$Y = 33\,X + 76 \qquad (R^2 = 0.82) \qquad (3)$$

Y = accidents/10^8 veh/km

X = number of intersections/km

For the sections of road *between* intersections

$$Y^1 = 63\,X - 1 \qquad (R^2 = 0.77) \qquad (4)$$

indicating that accidents between intersections are affected by the intersections to some extent. Results are then given for accident rates in Urban and rural areas for road width, gradient, vertical and horizontal continuity, and curves of various radii for head on and other collisions. Some quite clear and convincing results are presented for some of these relationships.

The work on traffic assignment is generally restricted to incremental assignment procedures (Ref. 58.3), and has compared

(1) unrestrained assignment on minimum time/distance

(2) capacity restrained assignment

(3) capacity restrained assignment with priorities limited to trip length

(4) assignment with priority accorded to highways.

on a small Tokyo network of 23 zones, 224 links, 127 nodes. Table 12 shows how the vehicle counts compare on a link by link basis.

	Method of Assignment				
Road Type	Links	1	2	3	4
Arterial National	47	1.19	1.06	1.14	1.36
Other National	39	0.92	1.01	0.99	0.84
Arterial local	93	0.98	0.99	0.90	0.79
Other local	31	0.99	1.10	1.11	0.93
All Highways	210	1.06	1.03	1.03	1.05

TABLE 12: RATIOS OF AVERAGE TRAFFIC VOLUME (ESTIMATED) TO AVERAGE TRAFFIC VOLUME (OBSERVED)

Surprisingly no equilibrium assignment or generalised cost functions have been employed, and no data is available to assess the reliability of such comparisons due to uncertainties in assessing the average "measured" traffic flow.

Commodity flows were previously studied using a gravity model, but due to unsatisfactory results an improved distribution model has been developed. Figure 14 shows the logical structure of the new model, and it has been applied to a 114 zone model of the Metropolitan Tokyo Area based on a 2.7% sample of establishments: this gave 27 000 sets of freight distribution data. The coarse commodity group comparative forecasts between gravity and new model are shows in Table 13.

Commodity Group	New Model	Gravity Model
Agricultural Products	0.66	0.56
Mining Products	0.36	0.54
Metal Manufacturers and Machinery	0.82	0.70
Chemical Products	0.72	0.56
Light and miscellaneous Industrial Products	0.66	0.65
Industrial Waste	0.83	0.74
Other	0.57	0.53
All Products	0.76	0.53

TABLE 13: CORRELATION COEFFICIENTS BETWEEN MEASURED ESTIMATED TOKYO FREIGHT FLOWS.

The inter-industry consistency factors (R_{lm}) in Figure 14 are defined as:

$$R_{lm} = G_{lm} \Big/ \left[\sum_{l.m} G_{lm} \right] \qquad (5)$$

Where G_{lm} are the number of inter industrial freight movements

The *intra*-zonal freight (N_{lj}) is given by:-

$$N_{lj} = K \; (2A^*_{lj})^{\gamma} \; (G_{li})^{\beta} \Big/ \left[\sum_{i \neq j} (G_{lj} \; D_{ij}) \right]^{\gamma} \qquad (6)$$

Where N_{lj} = Intra zonal ratio of freight attracted by l-industry in j-zone

A^*_{lj} = Number of freight movements in j-zone attracted by l-industry

G_{li} = Freight generation of l-industry on i-zone

D_{ij} = Distance between zones i and j.

The *inter*-zonal freight (X_{ij}) is given by:-

$$X_{ij} = \sum_{l} (1 - N_{lj}) \; A^*_{lj} \; (G_{lj}/F_{ij}) \Big/ \left[\sum_{i} (G_{li}/F_{ij}) \right] \qquad (7)$$

Where F_{ij} = $exp \; (\gamma D_{ij})$

It would be interesting to compare these results with a direct aggregate demand model as set up for Melbourne by Dumble at ARRB.

The regional impact model is essentially an activity shift formulation, with vectors of zonal characteristics for each zone, and locational accessibility functions with a vector of characteristics for each zone. It is a specifically time staged dynamic model, with urban development, land use, evaluation, and transport segments: the current state of the mode is that the study plan is being developed.

One minor comment was made on the use of GSR (galvanic skin resistance) to relate driver physiological characteristics to roadway conditions. Chiba feel that GSR may well be useful for tension measurement, but simply as a partial index: their work is still at a fairly early stage in the whole area.

6. KYOTO : 7TH INTERNATIONAL SYMPOSIUM ON THE THEORY OF TRANSPORT AND TRAFFIC FLOW

This was an interesting conference, well organised and supported, but of inconsistent quality. The general level of the papers was uneven, and many not of any great note in the tradition of this series of Symposia. The overseas contingent is listed in Appendix 4, and was a most effective body in conjunction with the large Japanese attendance. The Proceedings were published previously from original manuscripts (at the cost of numerous misprints and partial confusions in a number of papers), and is in the ARRB Library already.

7. SUMMARY

The Japanese proved to be expert and remarkably hospitable hosts: it is however critical to acknowledge that previous notice of questions and subject areas of interest are a *sine qua non* for an effective visit. The force of the draft itinerary sent to a Japanese organisation is remarkably strong: if rest days or evenings for note assembly or paper presentation preparation are required, they should be specifically noted in such a draft to ensure that the time will actually remain uncommitted. The over-riding impression of my visit was of unfailing courtesy, and the need for the visitor to have a very clear idea of his goals and communicate them to his hosts in advance. The extensive road system (Fig. 16) and the excellent railways are more useful in practice than internal airlines.

8. ACKNOWLEDGMENT

The substantial financial assistance of the major part of the fare by the organisers of the Kyoto Symposium (Chairman, Professor E. Kometani) was invaluable and very much appreciated.

Report written by: M. Ramsay Wigan

Report reviewed by:

APPENDIX 1

REFERENCE LIST OF LITERATURE - JAPANESE VISIT

AUGUST, 1977

All documents held in file 1D1/28 Annex 000-90 in ARRB Registry unless otherwise noted.

1. Briefing by Rainbow Driving School.
2. Roads and Driving Leaflet - Rainbow Motor School
3. General Car Regulations and Guide, Rainbow Motor School - Illustrated.

4a+
4b+ Two Volumes: Technical Instruction Books - Yamaha Safety Driver Course

5. Honda R. and D.
6. English Language Map of Japan Highway and Toll System
7. Schematic Map (Highway in Japan)
8. Japan Highway Corporation - General Information

9.+ National Expressway Practices in Japan

10. Report on Expressway Traffic Control and Accidents 1976/77
11. Japan Highway Public Corporation - Tokyo First Administration Bureau.

12.+ Traffic Control System for Meishin, Chugoku and Kinki Expressways

13.+ Japan's Area Traffic Control Technology

14. Expressway Control - Illustrated Brochure

15.+ Hashin Expressway

16.+ Hashin Expressway Traffic Control System

17. Osaka Area Traffic Control System
18. Graceful Degradation in Road Traffic Control Systems - Toshiharu Computer Conference 1975 - Second USA-JAPAN. pp. 64-68. Hasegawa.
19. Traffic Control System in Osaka - Toshiharu Hasegawa - First USA-Japan Computer Conference 1972. pp. 494-495.
20. Police Expressway Control Map.
21. Speed Correlation Data from Osaka Expressway Control System
22. Osaka Area Traffic Control Detector - Illustrated Brochure.

23. Comprehensive Automobile Traffic Control System - Japanese Illustrated Brochure.

24.+ (English) Comprehensive Automobile Traffic Control System

25. Osaka Port Bridge - Specification Brochure, English

26. Honda Driving Safety Promotion Center

27. Detailed Brochure - Guide to Honda Suzuka Factory

28. Honda Company Specification

29. Road Safety Campaigns in the Soft Bike Era - Notes prepared by Yamaha Motor Company.

30.+ Chiba Branch Road Division, Annual Report.

31+ Roads in Japan - 1977.

32.+ Public Works Research Institute 1976/77 - Program outline

33. Traffic Safety and Noise Research Institute - Illustrated Program Description Brochure.

34. Automobile Safety in Japan - Prepared by Road Transport Bureau, Engineering Division, M.O.T. Japan.

35. Motor Industry of Japan 1976.

36a+ Safety Regulations for Road Vehicles - 1975
36b+ Safety Regulations for Road Vehicles - 1977

37+ Annual Report of Transport Economy

38* Data Processing Centre - Kyoto University. System Specification and description in English.

39* System Specification and Description illustrated Japanese brochure.

40* Fujitsu Activities Specification - prepared by Fujitsu - English.

41* Fujitsu and the Computer Industry in Japan - English

42* Fujitsu illustrated English Language Reliability Brochure.

43* Fujitsu LSI (English Language) Descriptive Brochure

44* Facom M-Series (English Language) Peripherals Specification Brochure

45* Numazu - Illustrated English Language Brochure

46* Fujitsu Today - Specification (English Language)

47* Fujitsu System Laboratory of Information Processing and Training Services (Bilingual) illustrated.

48* Bulletin (English) Prospectus 1977/78.

49* Computer Controlled Vehicle System Illustrated Brochure

50* Fujitsu Journal, 1975 - Vol.26 No. 4 - Aichi Prefecture Traffic Control System

51* Fujitsu Journal, 1976 - Vol.27 No. 1 - Computer Control Vehicle System Experience in Okinawa in Use.

52* Regional Simulation Urban Model for Analysing Interaction between Land Use and Transportation. Eiich Hashimoto - Extract from Technical Journal Vol. 9, No. 4 (1973).

53* Facom M-160 - Illustrated Brochure (English).

54. Dual Mode Bus System.

55* Facom Presentation Copies -

.1 Application Programs List

.2 Presentation of Urban and Regional Planning Decision Support System

.3 Management Sciences and Management Planning and Control

.4 Request by Yamada and Akiyama - MDS-Management Decision Support System

.5 Information Retrieval Systems - DIR. DISP 3, FAIRS and Illustration shown of FAIRS.

.6 OS IV/F4 Relationship with IBM. Facom TSS and use of special Facom Enhancements (DAT Channel and SVP.)

.7 Group of 3 - Dynamic Linkage and Standard Linkage - Illustrated
PDL/PDA (i.e. System Activity Monitor)
Screen Display,Re-enterable Module Linkage

.8 Tokyo Institute of Technology - Science Department - Small M-160 Configuration

.9 Demonstration for ARRB including UTPS and TSS Facilities - Including Screen Copies Throughout.

.10 UTPS M-160 Demonstration Run with Hardware Monitor in Place

.11 UTPS Re-run Results- Hardware Monitor Overhead removed

.12 Printout of JAPTOWES used in Demonstration.

.13 Computer Graphics - Summary diagram and specification notes.

56a+ Yamaha Rider Safety Course - Volume 1 Textbook
56b+ Yamaha Rider Safety Course - Volume II Textbook

57. Yamaha Photographic Record of Training and Other Activities.

58 Ministry of Construction Documents:

.1 Note on Forecasting Highway Traffic Noise - Traffic Environment Section

.2+ Analysis of Traffic Accidents - N. Kurimoto - Traffic Safety Section

.3 Research on Traffic Assignment and Commodity Flow Models - Traffic Engineering Section

.4 Note on Galvanic Skin Response - Traffic Engineering Section

58 (Cont'd)

.5 Study on the Influence of Road Construction on Regional Economy to Find Methods for Deciding Optimum Roadway Networks and Priority of Construction - New Transport Systems Section.

.6 Traffic Environment Section - No. 1 - Noise Propagation (In Japanese)

.7 " " " No. 2 " " " "

.8 " " " No. 3 " " " "

.9 " " " No. 4 " " " "

.10 Equation for Forecasting Highway Traffic Noise and Counter-Measures for Avoiding Noise - Traffic Environment Section

.11 Noise Attenuation by Acoustic Shielding - Traffic Environment Section

.12≠ Photograph of the Anechoic Chamber - Traffic Environment Section.

59 Watanabe, Y. Motorcycle Handling Performance for Obstacle Avoidance (1973) (In Japanese).

60. Inayoshi, H. (1973) Characteristics of Motorcycle Accidents in Japan (Japanese) {English version published in Second International Congress on Automotive Safety, San Francisco, 1973, as paper 73004}.

61. Wigan, M. (1976) User Issues in Motorcycle Safety (Japanese) {English version published in ARRB/DOT Symposium on Motorcycle Safety, 1976}.

62. Chiba Branch - Report Series: (52:6)

63. Chiba Branch - Report Series: (52:7)

64. Chiba Branch - Report Series: (51:8).

+ Document held in ARRB Library

* Denotes document referred to in AIR 808-5 (Japanese Briefing on Fujitsu Computers, M. Wigan; 1977) and held in File 1D1/28 Annexe 808-5.

≠ Held on File 1D1/28 Annex ARR No. 78.

APPENDIX 2: COLOUR SLIDES LIST.

2.1 TRANSPORT AND TRAFFIC

TT1	Bullet train ("Shinkansen") sleeper construction	(Hammamatsu)
TT2	Armco supplemented by twin wire rope restrainers	(Kyoto: Mountain Rd.)
TT3	Pedestrian and cycleway joint facility: signing, lane and barrier	(Osaka)
TT4	Cycle parking under expressway: signing	(Osaka)
TT5	Overhead cycleway signing on road	(Osaka)
TT6	Bridge spans	(Osaka)
TT7	Expressway termination of Osaka bridge spans	(Osaka)
TT8	Mimic control panel for ATC system in computer room (Facom 230 + U 200)	(Osaka)
TT9	Abacus and Tectronix graphics and joystick in main ATC control room	(Osaka)
TT10	Terminating bridge span and pier with deck construction details	(Osaka)
TT11	ATC control centre displays from mezzanine area of control room	(Osaka)
TT12	Weather monitoring centre at expressway control centre	(Osaka)
TT13	Expressway control centre: Monitors and mimic display	(Osaka)
TT14	Noise screens and double row Armco barriers: expressway	(Kyoto-Osaka)
TT15	Noise screens, houses, and single row Armco barrier: expressway	(Kyoto-Osaka)
TT16	Bus and Truck 'no entry' sign with details	(Kyoto)
TT17	Multibank traffic lights, and electric trams	(Kyoto)
TT18	Temporary ventilated plating over subway construction at a major active intersection	(Kyoto)
TT19	Typical Kyoto traffic in late afternoon: tram and car traffic mix	(Kyoto)
TT20	Pedestrian walkway crossing and signing	(Nagoya)
TT21	Direction and distance sign	(Nagoya)
TT22	Road junction marking, equivalent of "halt" markings	(Nagoya)

TAIWAN TRAFFIC AND TRANSPORT

T 1 Mainstreet Sunday afternoon traffic

T 2 Elevated central city expressway

T 3 Bridge pedestrian protection and road delineation.

2.2 KYOTO UNIVERSITY DATA CENTRE (FACOM M-190 x 2 + 230-8/48)

KF 1 User Self Service Output Room: Single shot card reader and duplicate 3 colour control monitors in the same room as automatic listing output feed from 7 x 2000 lpm line printers and l.p mechanical output buffer storage system.

KF 2 User Self Service minimum RJE point: FACOM small card reader and OEM teletype control.

KF 3 Angled flatbed FACOM plotter driven by FACOM U-200 mini-system under M-190 control.

KF 4 FACOM interactive graphics station driven by FACOM 230-8/48 on CPU to CPU lines with the duplex M-190 mainframe.

KF 5 FACOM 238-8/48 on CPU-CPU drive from M-190, used the servicing 3 full graphics systems

KF 6 User Self Service auto loading and auto threading tape drive bank and open access

KF 7 Digitising table

KF 8 CPU/disk secure housing room: including layout of 2 x M-190 CPU, 6 mb of store, 230-8/48 CPU, massive disk storage, and communications controllers.

2.3 MOTORCYCLE SAFETY

MS 1	Helmet and pillion laws in (differential) action!	(Kyoto)
MS 2	Sidewalk parking of Motorcycle and cycles inside barriers on busy walkway	(Kyoto)
MS 3	Child "pillion" substitute seat on 50 cc moped	(Kyoto)
MS 4	Honda 750 F2 steel/alloy composite wheels, disc brakes and waterguard assembly	(Suzuka)
MS 5	Driver training licence record (Rainbow Training School)	(Tokyo)
MS 6	Helmet display area (Rainbow Training School)	(Tokyo)
MS 7	Yamaha XS360 fitted with special indicator training lights	(Iwata)
MS 9	"Passol" and XS750D on training centre area	(Iwata)
MS 10	Complete view of Yamaha's Iwata Training Centre	(Iwata)
MS 11	Demonstration of swerve training	(Iwata)
MS 12	Demonstration of braking training	(Iwata)
MS 13	Lecturing in Honda Training Centre	(Suzuka)
MS 14	Centaway Honda 'Road Pal' moped in Japan GPO Trim in Training Centre	(Suzuka)
MS 15	Police Training group on refresher course: note bashed in silencers	(Suzuka)
MS 16	Police group on slalom training area	(Suzuka)
MS 17	Police group on slalom section	(Suzuka)
MS 18	Police group on deep loose pebble training area	(Suzuka)

MS 19 One of Police Group getting out of trouble on loose pebble training area (Suzuka)

MS 20 Police group on beam, cross grade, washout, and fixed rock training area. (Suzuka)

APPENDIX 3: PEOPLE MET IN JAPAN

8.8.77 Honda Motor Co. (Tokyo), 27-8, 6-chome, Jingumae, Shibuya-ku, Tokyo, 150 JAPAN.
Telephone: (03) 499-0111
Hideaki Satoh
Secretary General: Honda Driving Safety Promotion Centre.

Hiroshi Isogai
Sales Manager, Asia Pacific — E

Yoshihiro Mukatsu — E/Translator
Asia-Pacific Sales Division

Tadashi Kimura — E/Translator
Australian-N.Z. Sales Department.

9.8.77 Honda Motor Co. (Suzaka), 1907 Hirata-Cho, Suzuka City, Mie Pref, JAPAN.
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Fukuichi Sugimoto
Manager, General Affairs Department.

Syoji Ogahara
(Chief Instructor)
Suzuka Circuit Traffic Education Centre.

9.8.77 Honda Racing Service Centre Corporation, 7992 Ino-Cho, Suzuka City, Mie Pref, JAPAN.
Telephone: (0593) 78-1231
Michihiko Aika — E
President: Honda Racing Service Centre Corporation

General Manager: Honda Endurance Racing Team: 20 Rue Pierre Curie, 93170 Bagnolet, France.
Telephone: 360-01-00.

Satoshi Ichihana — E
Managing Director: Honda Racing Service Centre Corporation.

10.8.77 Fujitsu Ltd: Computer Systems, Furukawa Sogo Building, 6-1 Marunouchi 2-Chome, Chiyoda-ku, Tokyo, 100 JAPAN.
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Shiro Yoshikawa — E
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Ryoichi Moribe — E
Manager: Overseas Marketing Division

Kazuto Kojima — E
Manager, Australian Section,
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10.8.77 Fujitsu Ltd. 140 Miyamoto, Numazu-Shi, Shizuoka, 410-03, Japan.
Telephone: (0559) 23-2222

Takuya Maruiwa,
Manager: General Affairs Division
Numazu Works.

10.8.77 Ministry of Construction. Chiba Branch, Public Works Research
Institute, Ministry of Construction, 12-52 Anagawa,/Chibaken,
Japan. Chibashi
Telephone: (0472) 51-1251 (250)

Kozo Kaneyasu E
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Road Division.

Hiroshi Nonaka E
Researcher: Traffic Environment Section

(Fujitsu Ltd. continued)

11.8.77 Toshio Hiraguri. 1015 Kamikodanaka, Nakahara ku, Kawasaki,
211 Japan
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Manager: Computer Engineering Department E
Mainframe Division.

Yasunori Kanda E
Manager: System Design Department
Development Division.

Eiichi Hashimoto. 17-25 Shinkamata 1-Chome, Ohta-ku, Tokyo,
144 Japan.
Telephone: (03) 735-1111
Manager: Engineering Application Section E
Systems Development Department.

Takashi Ochiai E
Application Software Section (Syslab).

12.8.77 Takesi Maruyama E
Manager, 1st OS Section
Operating Systems Development Department

Naoyuki Akikusa E
Deputy Manager, Public Services Systems
Engineering Department.

Toshio Scenada E
Application Software Section (Syslab).

Takanori Hanafusa E
Systems Engineer: Service Systems
Engineering Department
(an ex Facom Australia resident liaison)

Akira Suzuki E/Translator
Australia Section, Overseas Sales
Division.

12.8.77	Ministry of Transport. Kasumigaseki, Tokyo, Japan. Telephone: 580 3111	
	H. Imamura Director Research and Planning Division.	E
	N. Takashige Deputy Director: Environmental Pollution Control Division Motor Vehicles Department.	
	N. Horigome Deputy Director: Engineering Division, Road Transport Bureau.	E
15.8.77	Kyoto University Data Processing Centre. Yoshida, Kyoto, 606 Japan. Telephone: (075) 751-2111 x 7417	
	Hajime Kitagawa Assistant Professor	E
18.8.77	Yamaha Motor Company Ltd. 2500 Shingai Iwata-shi, Shizuoka-ken, 438 Japan.	
	Hideto Eguchi Managing Director	E
	Takehiro Hasegawa Director (of Engineering)	E
	Kazuo Takeuchi Assistant Manager (Sales Oceania) International Division	E
	Tim Hasegawa Assistant General Manager, International Division	
19.8.77	Kuni Morinaga Motor Cycle Test Division, Test Department Manager	
	Akio Kitano Manager: 4th Design Division	
	Fusaotu Tsugata Assistant Manager, Engineering Administration Division	E
	"Philip" Y. Mori Assistant Manager, Marketing Promotion Department, International Division.	E
	Noboru Yamamoto Manager: Safety Promotion Department.	
	Masanori Ogayu Assistant Manager: Safety Promotion Department.	

19.8.77	Kanagawa Prefectural Police Department Masuo Uotani Head: Traffic Police of Kanagawa Province
20.8.77	Honda Driving Safety Promotion Centre Kazuo Yoshida Director General
20.8.77	Rainbow Motor School Corporation. 465 Shimoniikura, Wako-shi, Saitama, 351 Japan. Telephone: (0484) 61-1101 Alsuo Murota President
20.8.77	Honda Research and Development Co. Ltd. 2177 Hizaori, Asaka-shi, Saitima, 351 Japan. Yuhei Chiuiiwa E Managing Director and General Manager Masahiro Semba E Staff Engineer (for Primary Safety) Osamu Takeuchi, 1-1-1 Chuo. Wako-shi, Saitama 351 Japan. Staff Engineer (for Secondary Safety) Shuji Komori Telephone: 0484-65-3321 Staff Engineer (for Regulations and Standards) Centre for Environmental and Safety Activities.

APPENDIX 4 NAME LIST OF OVERSEAS PARTICIPANTS

IN THE 7TH INTERNATIONAL SYMPOSIUM ON TRANSPORTATION AND TRAFFIC THEORY, AUGUST 14-17, KYOTO, 1977

* Specific Discussions With:

* AKCELIK Rahmi	National Capital Development Commission, 220 Northbourne Avenue, Canberra, A.C.T. 2601. Australia.
* ALLSOP Richard E.	Transport Studies Group, University College London, Gower Street, London WC1E 6BT, U.K.
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* ANDREASSEND David C.	Asian Institute of Technology, P.O. Box 2754. Bangkok, Thailand
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BRILON Werner	Schumacherstrasse 33, 7505 Ettlingen, Germany.
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* CHARLESWORTH J. Anthony	University of Newcastle upon Tyne, Transport Operations Research Group, Newcastle upon Tyne, NE1 7RU, U.K.
* CHU Kai-Ching	IBM Thomas J. Watson Research Center, P.O. 218, Yorktown Heights, New York 10598 U.S.A.
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ELDOR Menahem	Technion-Israel Institute of Technology, Haifa, Israel
* ERLANDER Sven	Mathematics Dept., Linköping Institute of Technology, S-58183 Linköping, Sweden.
* GARTNER Nathan H.	Operations Research Center, M.I.T., Room 24-215, Cambridge Mass. U.S.A. and FHWA at present.
* GIPPS Peter G.	Transport Studies Group, University College London, Gower Street, London WC1E 6BT, U.K.

HACKELMANN Peter E.	Town Planning of Sarrbrucken, Germany.
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* HERMAN Robert	General Motors Research Laboratories, Warren, Michigan 48090 U.S.A.
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* LAM Joseph K.	Toronto Traffic Control Center, 590 Jarvis Street, Toronto, Canada.
LEUTZBACH Wilhelm	Technical University of Karlsruhe, 7500 Karlsruhe 1, Germany.
MAY Adolf D.	Institute of Transportation Studies, University of California, Berkeley, U.S.A.
* MILLER Alan J.	CSIRO Division of Mathematics & Statistics, 60 King Street, Newtown. N.S.W. Australia.
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ROE, Phillip E	Industrial Sciences Section, British Embassy, Tokyo.
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WARDROP John G.	Transport Studies Group, University College, Gower Street, London, WC1E 6BT, U.K.
*WILSON Nigel H.M.	Massachusetts Institute of Technology, Room 1-153, Cambridge, Mass. 02142 USA.
*WIRASINGHE Sumedha C.	Department of Civil Engineering, University of Calgary, Calgary, T2N 1N4 Canada.
*YAGAR Sam	Department of Civil Engineering, University of Waterloo, Waterloo, Ontario, Canada.

APPENDIX 5: ITINERARY

6 August (Saturday)	9.00 a.m.	Depart Tullamarine
	12.00	Depart Sydney Airport
	8.00 p.m.	Arrive Hong Kong
7 August (Sunday)	8.30 a.m.	Depart Hong Kong
	6.30 p.m.	Arrive Haneda Airport, Tokyo.
8 August (Monday)	11.30 a.m.	Visit Honda Motor Co. Ltd. Meet Marketing and Management Staff
	13.30 p.m.	Informational lecture on Honda's Safety Driving Promotion Activity by Mr. Sato, Secretary General of Honda Driving Safety Promotion Center.
	14.45 p.m.	Leave Honda for Tokyo Station
	15.24 p.m.	Depart Tokyo Station for Nogoya by super express "HIKARI 139".
	17.25 p.m.	Arrive at Nagoya and stay at Nagoya Castle Hotel overnight.
9 August (Tuesday)	8.10 a.m.	Leave Nagoya for Suzuka Circuit in Shiroko.
	9.00 a.m.	Arrive at Shiroko
	9.30 a.m.	Visit Suzuka Factory
	10.50 a.m.	Visit Suzuka Circuit
	12.30 p.m.	Observe the Motorcycle Safety Training
	14.42 p.m.	Leave Shiroko by Kinki Nippon Railways
	15.31 p.m.	Leave Nagoya for Tokyo by super express "HIKARI 174".
	17.32 p.m.	Arrive at Tokyo Station
	18.00 p.m.	Meet K. Kaneyasu : Chief, Environment Section: Chiba Branch, Road Division, Ministry of Construction.

10 August (Wednesday)	11.00	FUJITSU - FACOM Welcome greeting
	12.00	Move to Tokyo Station
	12.16	Move to Mishima (Bullet train)
	13.27	Move to Numazu works (by taxi)
	14.15	Film presentation ("LSI")
	14.45	View computer assembly line
	16.15	Drive around the works
	16.30	Move to Mishima Station (by taxi)
	17.11	Move to Tokyo (Bullet train)
11 August (Thursday)	8.45	Move to System Labo. (by car)
	9.30	Briefing on Fujitsu
	10.30	Slide presentation ("System Labo")
	11.00	Presentation of "Fujitsu's experience in transport system"
	13.00	Briefing of demonstrations
	13.20	Demonstration (TSS, UTPS)
	15.00	"M" series hardware presentation "M" series software presentation
12 August (Friday)	9.30	Presentation of "Application Programs"
	12.30	Demonstrations
	13.30	Review
	14.15	Meet Mr. Nonaka, Ministry of Construction: Travel to Ministry of Transport
	15.30	Information Division, Ministry of Transport
	16.00	Road Transport Bureau, MOT : Vehicle Design and Pollution Division.
13 August (Saturday)	7.30	Leave hotel for Hikari
		Register for 7th International Symposium on Traffic and Transport Theory.
14 August (Sunday)		Symposium

15 August (Monday)		Symposium
16 August (Tuesday)		Symposium
17 August (Wednesday)	8.20	Technical Tour. Depart Kyoto via Meishin Expressway - Hanshin Expressway.
	10.00	Arrive Hanshin Expressway Public Corporation Traffic Control Center, Osaka
	10.50	Arrive Osaka Prefectural Police Headquarters Traffic Control Center
	12.50	Arrive Osaka Port Bridge
	18.57	Depart on Kodama 294
	19.50	Arrive Hammatsu.
18 August (Thursday)	9.45	Picked up by Mr. Mori of Yamaha Motor Co. from Hotel.
	10.30	Meet Mr. Eguchi, Managing Director of Yamaha Motor Co. Ltd.
	11.00	Factory Tour
	14.00	Meeting on Yamaha's safety campaigns domestic and overseas.
	15.00	Movie
	16.00	Observation of Yamaha Motorcycle Driving School (Technical Centre).
19 August (Friday)	8.45	To be picked up by Mr. Mori from Hotel
	9.30	Meeting with Mr. Hasegawa, Director in Charge of Engineering and his staff.
	13.00	Movie
	14.30	Drive up expressway to midpoint interchange expressway.
	15.45	Meet expressway traffic patrol police: accompany to expressway control centre.
	17.00	Meet Nippon Doro Kodan Manager of Expressway Section via Control Centre
	18.30	Head of Traffic Police Kanegawa Prefecture and Mr. Sato (Secretary General: Honda Safety Driving Promotion Centre).

20 August (Saturday)	8.30	Depart Hotel Tokyo
	9.00	Rainbow Motor School
	10.45	Honda R. & D. Centre - Discussions with Engineers
	17.30	Depart
	19.00	Arrive Hotel
21 August (Sunday)	6.30	Depart Hotel.
22 August (Monday)	10.15	Arrive Sydney
	12.00	Depart for Melbourne.

APPENDIX 6: SUMMARY OF JAPANESE LICENCES AND LICENCING EXAMINATIONS

1. Management of licencing

Administrative	National Public Safety Commission
P.P.S.C. -	↓
Issue of licence Suspension of licence Sanction of driving-motor school	Local Prefectural Public Safety Commission
	↓
Executive	National Police Traffic Bureau Licence Section
	↓
Enforcement of licence examination standards	Local Prefectural Traffic Division Licencing Section

2. Kind of Licence

1st Class (Own use only)

- Large-sized Bus and truck (not articulated)
- Ordinary - car
- Large-sized special - (construction vehicles)
- Motorcycle
- Small-sized special - (tractors: farm)
- Moped.

2nd Class licence

- Large-sized (passenger bus) - not articulated.
- Ordinary (taxi
- Large-sized special (articulated bus)
- Traction (snow ploughs)

Commercial: hire and reward: taxi etc.,

Must have held a relevant 1st class Licence for 3 years before applying for a test.

3. Licence Examination

(1) Examination of technique

Four-wheel car	Temporary exam. → (a pass permits public road practise to start)	Regular exam.
(Notes:	an off road test course 2km pass above 70 pts.	On road 4km pass above 70 pts.

Motorcycle — Regular exam.

(Notes: on approved test course of 1.2 km
pass above 70 points)

(2) Examination of Traffic Rules (Held at the Traffic Board)

Four-wheel car	Temporary exam.	⟶	Regular exam.
	(Notes: 50 questions in 30 minutes pass above 90 pts.		100 questions in 60 minutes pass above 90 pts.)

Motorcycle — Regular exam.

(Notes: 100 questions in 60 minutes
mopeds < 50 cc 50 questions).

4. LICENCE EXAMINATION FOR MOTORCYCLISTS

(1) Examination of Technique

(a) Vehicle classes examined

mopeds - (<50 cc) only Traffic Regs test by National Police Traffic Bureau (If you hold passenger vehicle licence NO extra tests needed).

small	51-125 cc	:	100-125cc motorcycle
medium	126-400 cc	:	300-400cc "
large	above 401cc	:	750 cc "

(b) Course (off road) — Running distance 1200m.

(c) Subjects of exam.

common		Regular running Running obey traffic-rules
additional	small	Braking test
	medium	Braking test Running on narrow path Running on slalom
	Large	Braking test Running on narrow path Running on slalom Running on weaving path

(d) Marking — subtract from full points (100 points)
pass above 70 pts.

5. MOTOR DRIVING SCHOOL

(1) Number of schools in Japan 1350

(2) Minimum Standard for Sanction

Facilities	Area of Course	(four-wheel vehicles	> 8000 sq.m.
		(motorcycles	> 3500 "
	No. of schoolroom		> 1 room
	Office and waiting room etc.		
People	Inspector: > 3 years experience in safety traffic fields therefore almost invariably ex traffic policemen >25 yrs of age : and approved by N.P.S.G.: Monitor examination standards.		
	Technical instructors		
	Licence Testers		
	Theoretical instructors		

(3) Advantages of motor driving school training

Exemption from the practical driving Examination of National Police Traffic Bureau: which is given if passed examination of Motor School and graduated standard curriculum.

(4) Standard curriculum

Technical			
Car	Ordinary	a course of at least	27 sessions
	Large		17 sessions
Motorcycle	Small	a course of at least	5 sessions
	Medium		8 sessions
Traffic rules			
Car	Ordinary	a course of at least	30 sessions
Motorcycle			12 sessions

(Note: 1 session = 50 minutes)
Must be legally enforced by the Inspector.

6. Accidents, analysis, licencing, and Traffic Control - are all Police responsibilities in Japan: one appropriate contact is:

S. Takei,
Assistant Director,
National Police Agency,
Traffic Bureau,
Traffic Control Division,
Chiyodaku Kasumigaseki 2-3-1,
TOKYO, JAPAN Tel. (03) 581-0141-(x 2157)

APPENDIX 7: JAPANESE EMISSION AND NOISE CONTROL STANDARDS

The standards vary for different types of motorcycle and four(+) wheeled vehicles:

<table>
<tr><th colspan="2" rowspan="2">Category of motor vehicles</th><th colspan="2">Noise limit (phon)</th></tr>
<tr><th>Steady running noise, and stationary noise</th><th>Accelerated running noise</th></tr>
<tr><td rowspan="3">Ordinary motor vehicles, small-sized motor vehicles (excluding motor vehicles exclusively used for carrying persons with a riding capacity not more than 10 persons and motorcycles with or without side cars)</td><td>With a gross vehicle weight exceeding 3.5 tons and an engine power exceeding 200 HP.</td><td>80</td><td>89</td></tr>
<tr><td>With a gross vehicle weight exceeding 3.5 tons and an engine power not exceeding 200 HP.</td><td>78</td><td>87</td></tr>
<tr><td>With a gross vehicle weight not exceeding 3.5 tons</td><td>74</td><td>83</td></tr>
<tr><td colspan="2">Ordinary motor vehicles, small-sized motor vehicles and light motor vehicles, exclusively used for carrying persons with a riding capacity not more than 10 persons, (excluding motorcycles with or without sidecars)</td><td>70</td><td>82</td></tr>
<tr><td colspan="2">Small-sized motorcycles and light motorcycles with or without sidecars.</td><td>74</td><td>83</td></tr>
</table>

TABLE 4: NOISE LEVELS FROM JAPANESE SAFETY ACT (1975)

(Drawn from Reference 36)

The measurement conditions are given in Table 5.

Classification	Measuring method
Steady running noise	When a motor vehicle or motor-driven cycle is running on a level, paved road at a steady speed corresponding to either an engine rotating speed caual to 60 % of the speed at which the engine produces its maximum horsepower or (a) in the case of a motor vehicle or a 2nd class motor-driven cycle, 35 km/h, (b) in the case of a 1st class motor-driven cycle, 25 km/h, whichever is lower, the noise level shall be measured at a point 7 meters leftward from the longitudinal axis of the vehicle or cycle.
Stationary noise	When the engine is running with no load at a rotating speed equal to 60 % of the speed at which the engine produces its maximum horse-power, the noise level shall be measured at a point 20 meters to the rear from the opening of the exhaust pipe.
Accelerated running noise	A motor vehicle or motor-driven cycle to be tested shall run on a level, paved road at a steady speed corresponding to either an engine rotating speed equal to 75 % of the speed at which the engine produces its maximum horse-power or (a) in the case of a motor vehicle other than a light motorcycle with or without sidecar, 50 km/h, (b) in the case of a light motorcycle or a 2nd class motor-driven cycle, 40 km/h, (c) in the case of a 1st class motor-driven cycle, 25 km/h, whichever is lower, and as soon as the vehicle or cycle reaches the acceleration start line, it shall be accelerated and run the 20 meters testing distance, with its accelerator pedal fully depressed or its throttle valve fully opened. Meantime, the noise level shall be measured, in the middle of the testing distance, at a point 7.5 meters leftward from the longitudinal axis of the vehicle or cycle.

TABLE 5: JAPANESE 1975 SAFETY ACT : NOISE MEASUREMENT PROCEDURES (Drawn from Reference 36)

The air pollution standards make similar allowances for different types of motors and motive spirits. Table 6 indicates the degree:

Category of motor vehicles	Emission limit (gram/km)		
	CO	HC	NOx
(1) Ordinary or small-sized motor vehicles carrying passengers exclusively and with a riding capacity of less than 10 persons (excluding motorcycles with or without sidecars), or light motor vehicles carrying passengers exclusively (excluding motorcycles with or without sidecars).	2.70	0.39	0.48
(2) Ordinary or small-sized motor vehicles with a GVW of 2.5 tons or less, or light motor vehicles (excluding the motor vehicles listed in Item (1) and motorcycles with or without sidecars).	17.0	Light motor vehicles with 2-stroke engine 15.0 Others 2.70	Light motor vehicles with 2-stroke engine 0.50 Others 2.30

Note. LPG: Liquefied petroleum gas
GVW: Gross vehicle weight

<u>TABLE 6</u>: EMISSION LIMITS FROM JAPANESE SAFETY ACT (1975)
(Drawn from Reference 36)

to which such variations are permitted (the test cycle is given in Reference 36).

Category of motor vehicles		Emission limit		
		CO (%)	HC (ppm)	NOx (ppm)
Ordinary or small-sized motor vehicles (excluding motorcycles with or without sidecars) other than those coming under Paragraph 2.	Gasoline-fueled.	1.6	520	1,850
	LPG-fueled.	1.1	440	1,850

<u>TABLE 7</u>: EMISSION LIMITS FOR VEHICLES NOT COVERED IN TABLE 6.

APPENDIX 8: JAPANESE ENVIRONMENTAL QUALITY STANDARDS

The main Japanese legal instrument is the Basic Law for Environmental Control, passed in Cabinet in May 1971. The levels specified in Table 1 were to be reached by 1976 for areas facing general roads, and as soon as possible thereafter for areas facing arterial roads.

dB (A)

		Morning & evening	Daytime	Night
District A	areas facing two-lane roads	50	55	45
	areas facing roads with more than two lanes	55	60	50
District B	areas facing roads with two lanes and less	60	65	55
	areas facing roads with more than two lanes	65	65	60

Remarks: District A is a district which is mainly used for housing.
District B is a residential district in which considerable area is used for commercial and industrial purposes.

TABLE 1: ENVIRONMENTAL QUALITY TARGETS SET IN 1971 for 1976

The key phrase in these resolutions is that *traffic regulation including prohibition of motor vehicles can be enforced according to the Noise Control Act in the case of living environment along roads being subjected to levels greater than those in Table 2.*

dB (A)

	Morning & evening	Daytime	Night
Class I and Class II districts;			
areas facing roads with two lanes	65	70	55
areas facing roads with more than two lanes	70	75	60
Class III and Class IV districts;			
areas facing roads with two lanes	70	75	65
areas facing roads with more than two lanes	75	80	65

Remarks: Class I, districts generally correspond to Districts A in Table 1
Class III, IV, districts generally correspond to Districts B in Table 1

TABLE 2: NOISE CONTROL ACT LEVELS

Prefectural Governers may require vibration abatement action to be undertaken if road traffic vibration levels exceed the values set in the Vibration Regulation Law of 1976 (Table 3).

Classification	Type	Daytime L_{10}, dB	Nightime L_{10}, dB
A - Areas	mainly homes	65	60
B - Areas	mixed areas including homes, shops, factories	70	65

TABLE 3: LEGAL ROAD VIBRATION LIMITS UNDER THE 1976 ACT

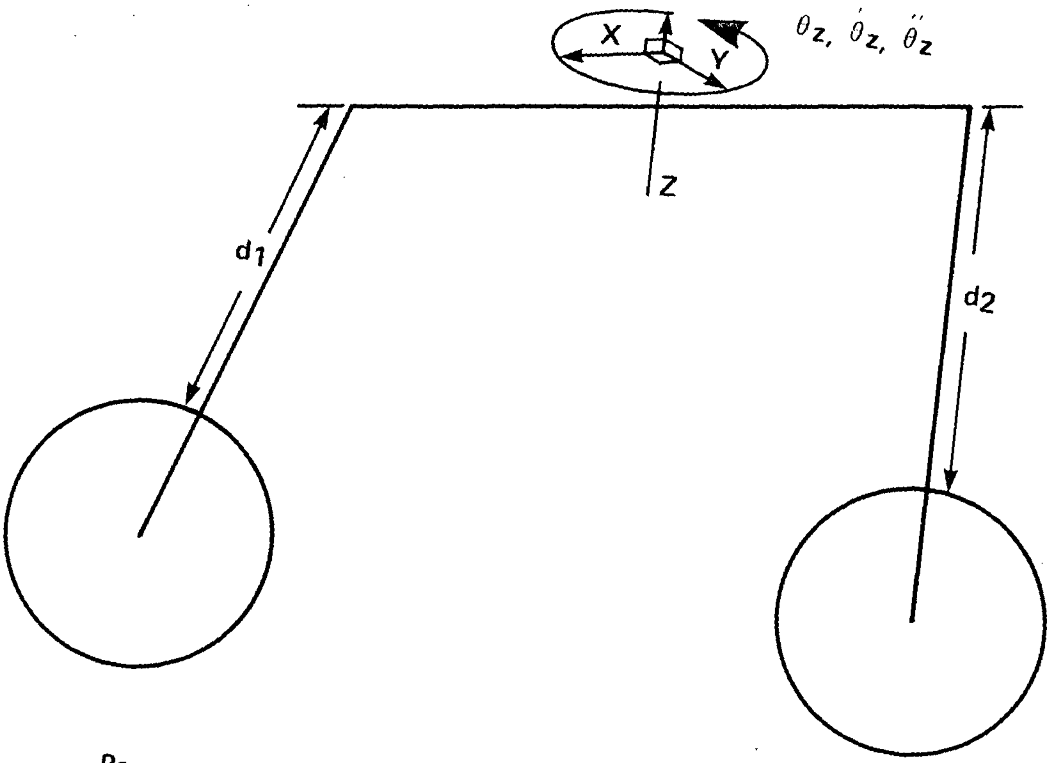
Areas including hospitals, schools, etc. may have the legal levels reduced by up to 5 dB, and under certain circumstances near arterial roads 65 dB may be permitted at night in A-areas.

Environmental standards were set up at various dates: in 1970 the Cabinet set the Carbon Monoxide Standards, on the basis of exposure produced rather than simply the levels of concentration. The Environmental Agency announced the standards for suspended particulate matter in 1972, and Table 4 is the consolidated 1975 announcement of their policy.

(25th official announcement of Environmental Agency, 1975)

	Standard value	Method of measurement	Target date
SO_2	The daily average of hourly values shall not exceed 0.04 ppm The hourly values shall not exceed 0.1 ppm	By means of conductimetry	Unless otherwise required, the standard shall be met as soon as possible within 5 years
CO	Average of hourly values in 8 concecutive hours shall not exceed 20 ppm Average of hourly values in 24 consecutive hours shall not exceed 10 ppm		This standard shall be applied in any districts and places in which the general public live and are engaged in activities.
Suspended Particulate Matter	Average of hourly values of them as measured in 24 consecutives hours should be less than 0.10 mg/m^3. Any hourly value should be less than 0.20 mg/m^3		
NO_2	The daily average of hourly values shall not exceed 0.02 ppm	By means of colorimetry employing Saltzman reagent, or other methods which produce equivalent results	The standard shall be met as soon as possible within 5 years. However, in areas where the population extremely dense etc., it shall be achieved within 8 years
Photochemical Oxidants	The hourly values shall not exceed 0.06 ppm.	Colorimetry employing neutral potassium iodide solution, or other methods which produce equivalent results	The standard shall be met as soon as possible.

TABLE 4: ENVIRONMENTAL AGENCY 1975 AIR POLLUTION STANDARDS



Parameters: $\theta, \dot{\theta}, \ddot{\theta},$

(x, y) (2 gyros)

sideforce and slipangle

d_1, d_2 (length slide transducers)

FIG 1: TELEMETRY PARAMETERS AT HONDA R. & D.

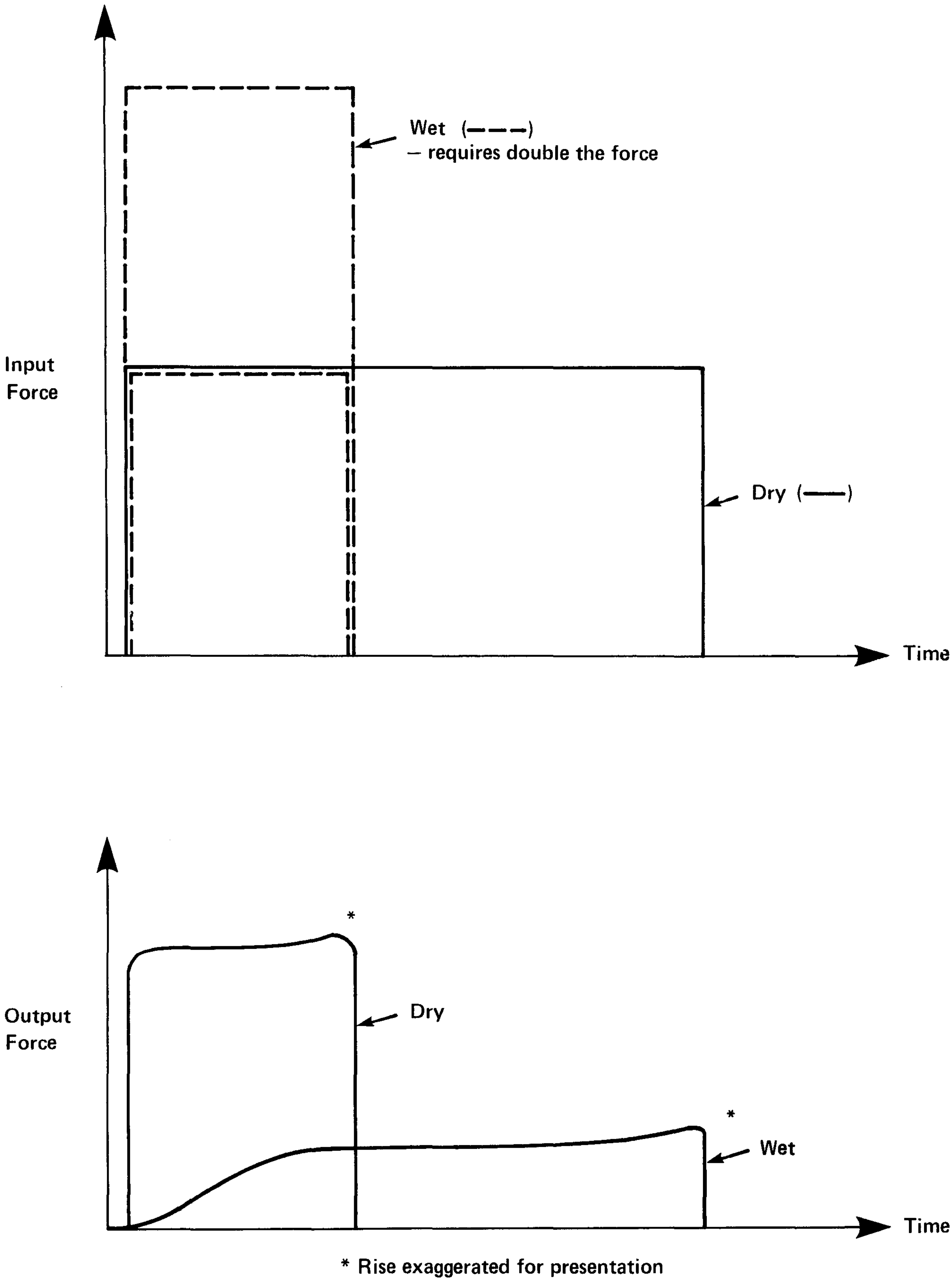


FIG. 2: WET AND DRY RESPONSE CHARACTERISTICS DISC BRAKES

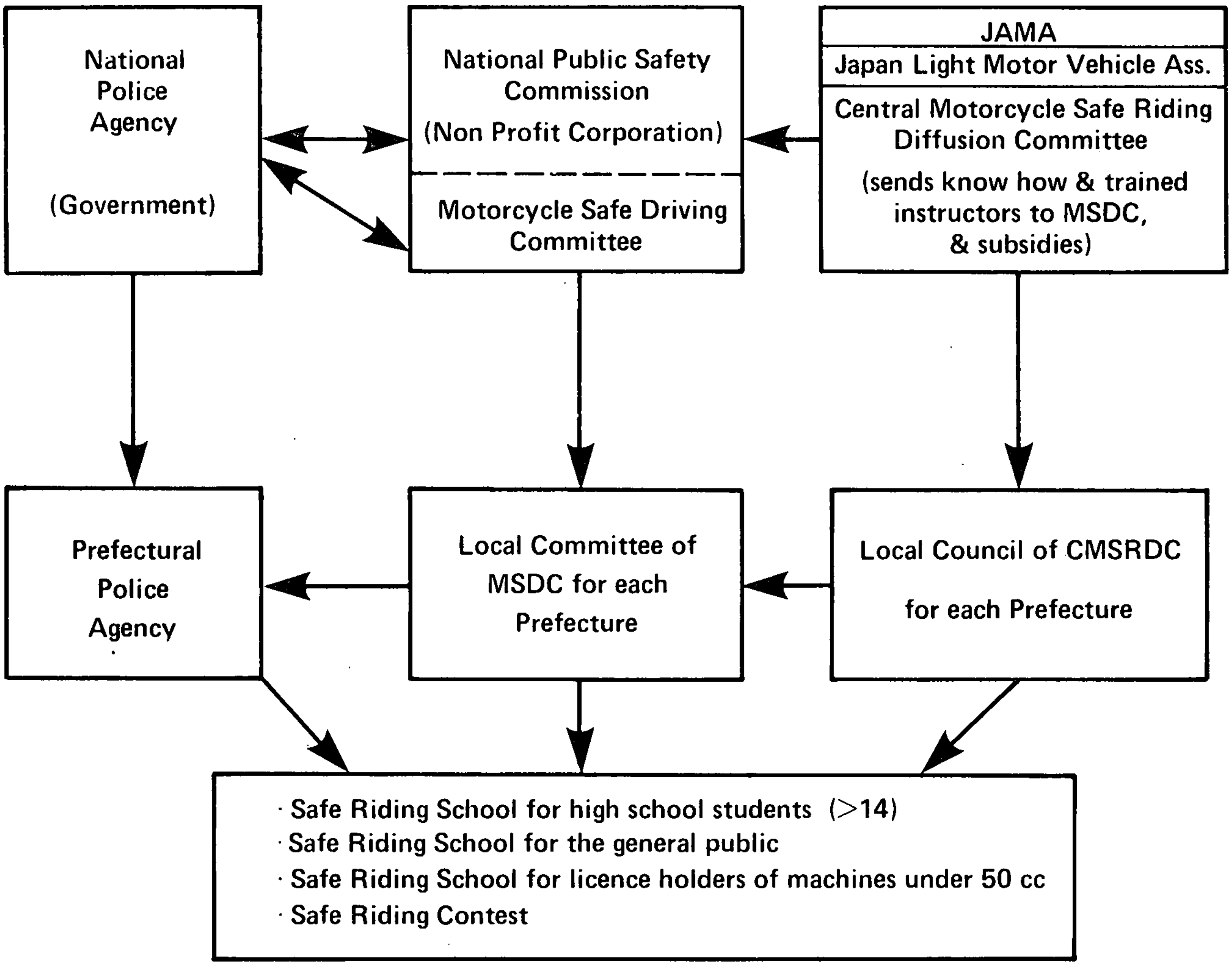


FIG. 3: MOTORCYCLE SAFETY TRAINING ORGANISATION IN JAPAN

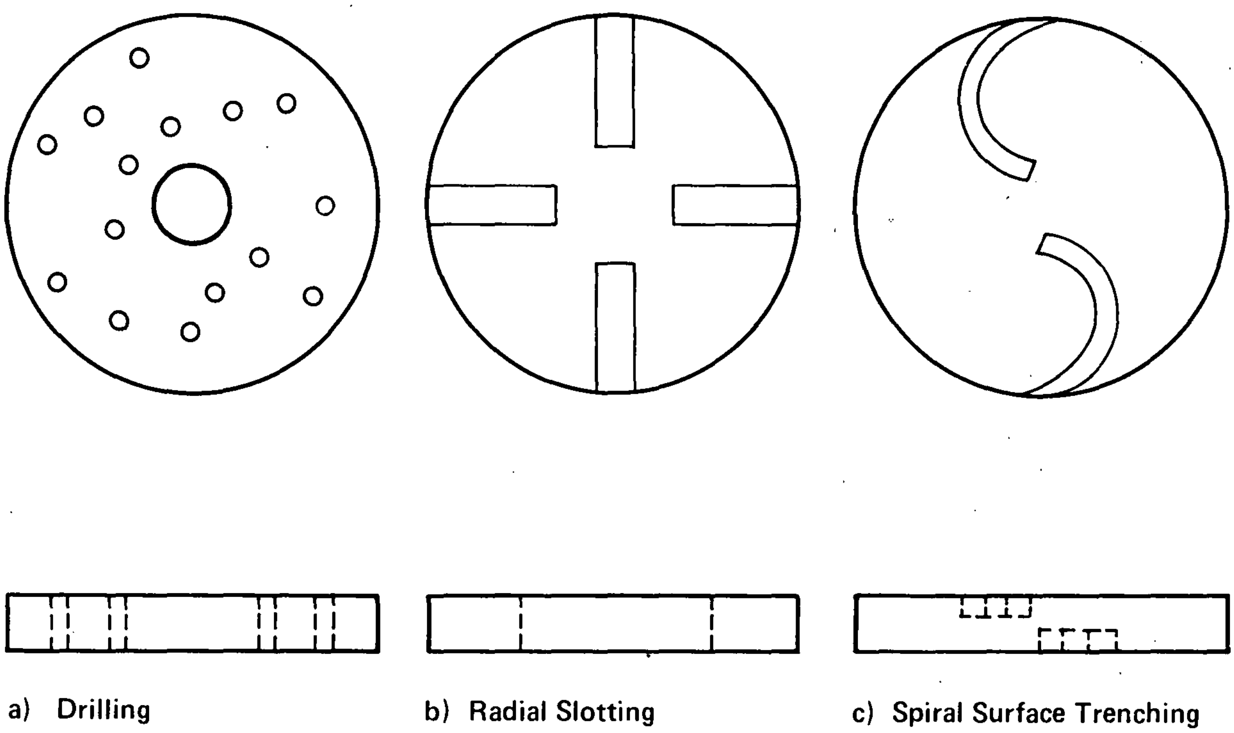


FIG. 4: DISC MACHINING PROCEDURES

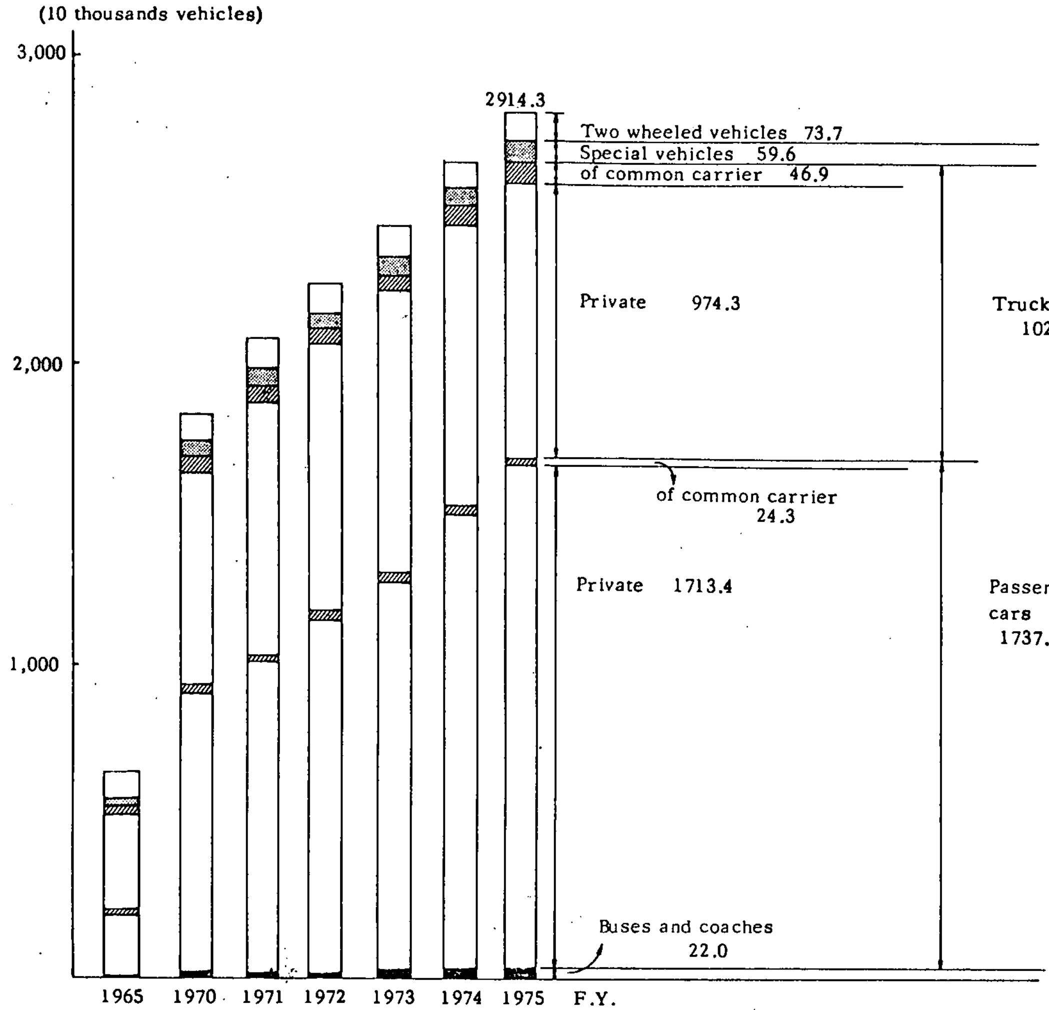


FIG. 5: CHANGES IN MOTOR VEHICLES OWNED
(Drawn from Reference 37)

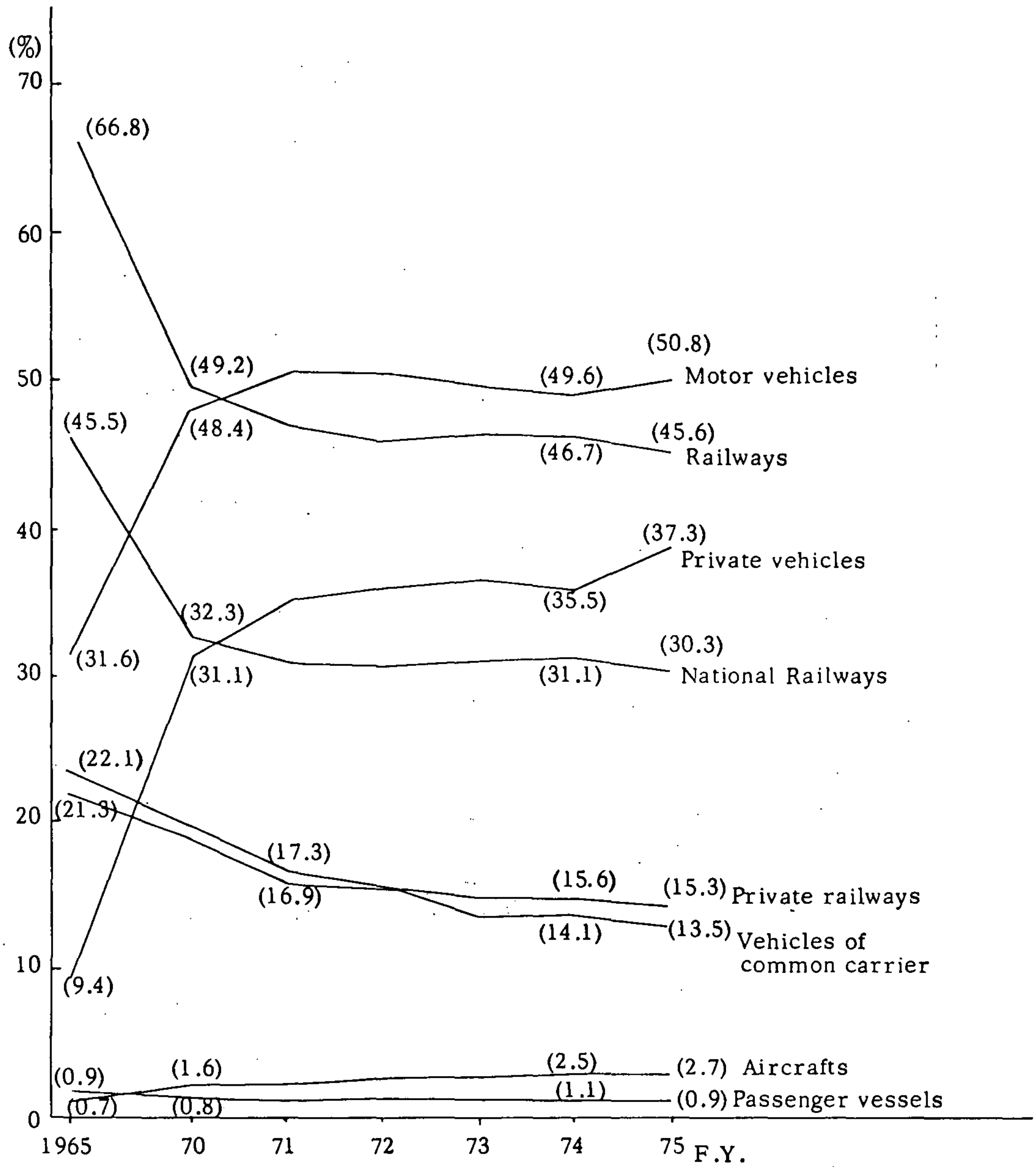


FIG. 6: SHARE OF VARIOUS MODES OF TRANSPORT IN PASSENGER-KILOMETERS

(Drawn from Reference 37)

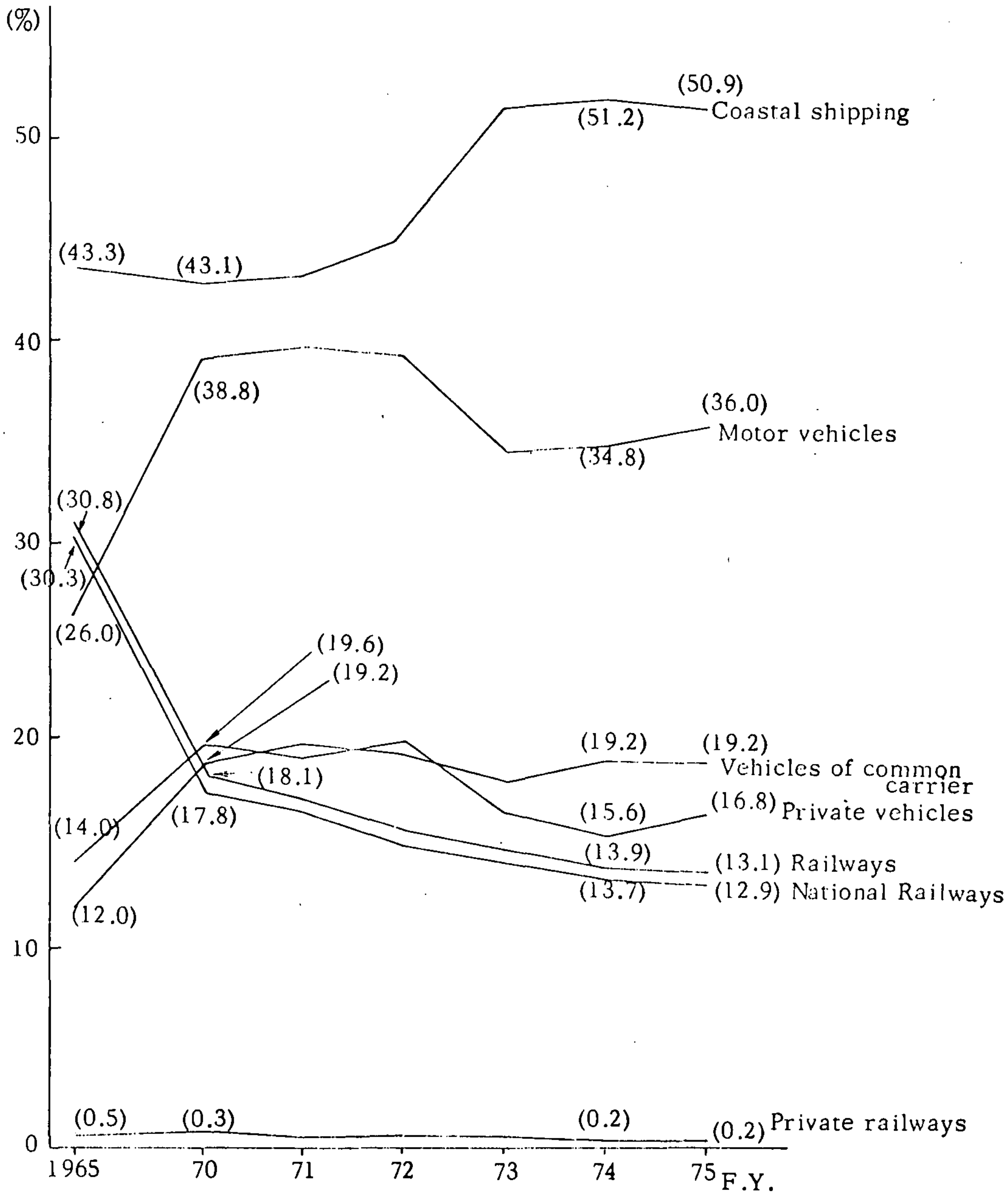
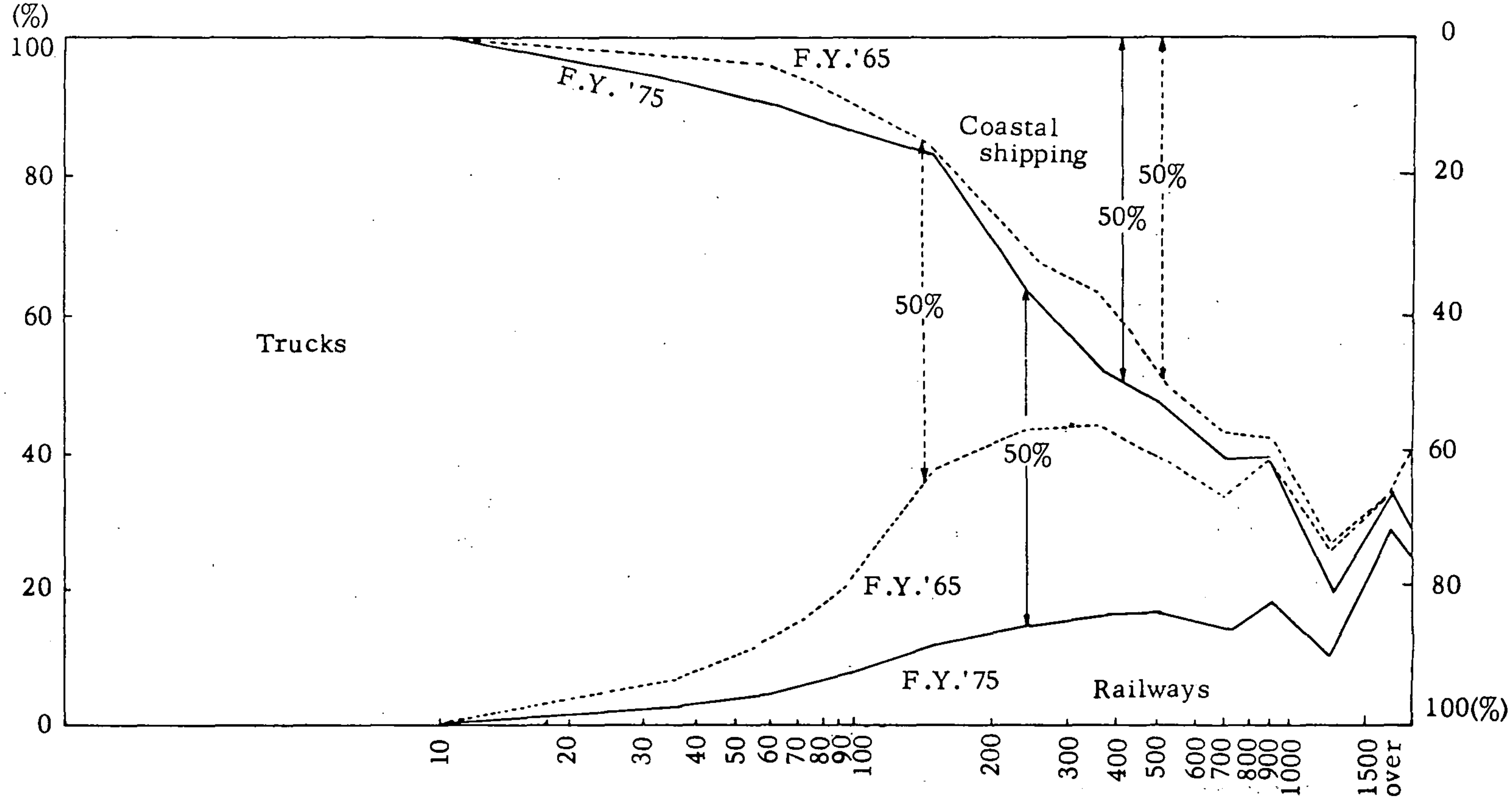


FIG. 7: SHARE OF VARIOUS MODES OF TRANSPORT IN TON-KILOMETERS

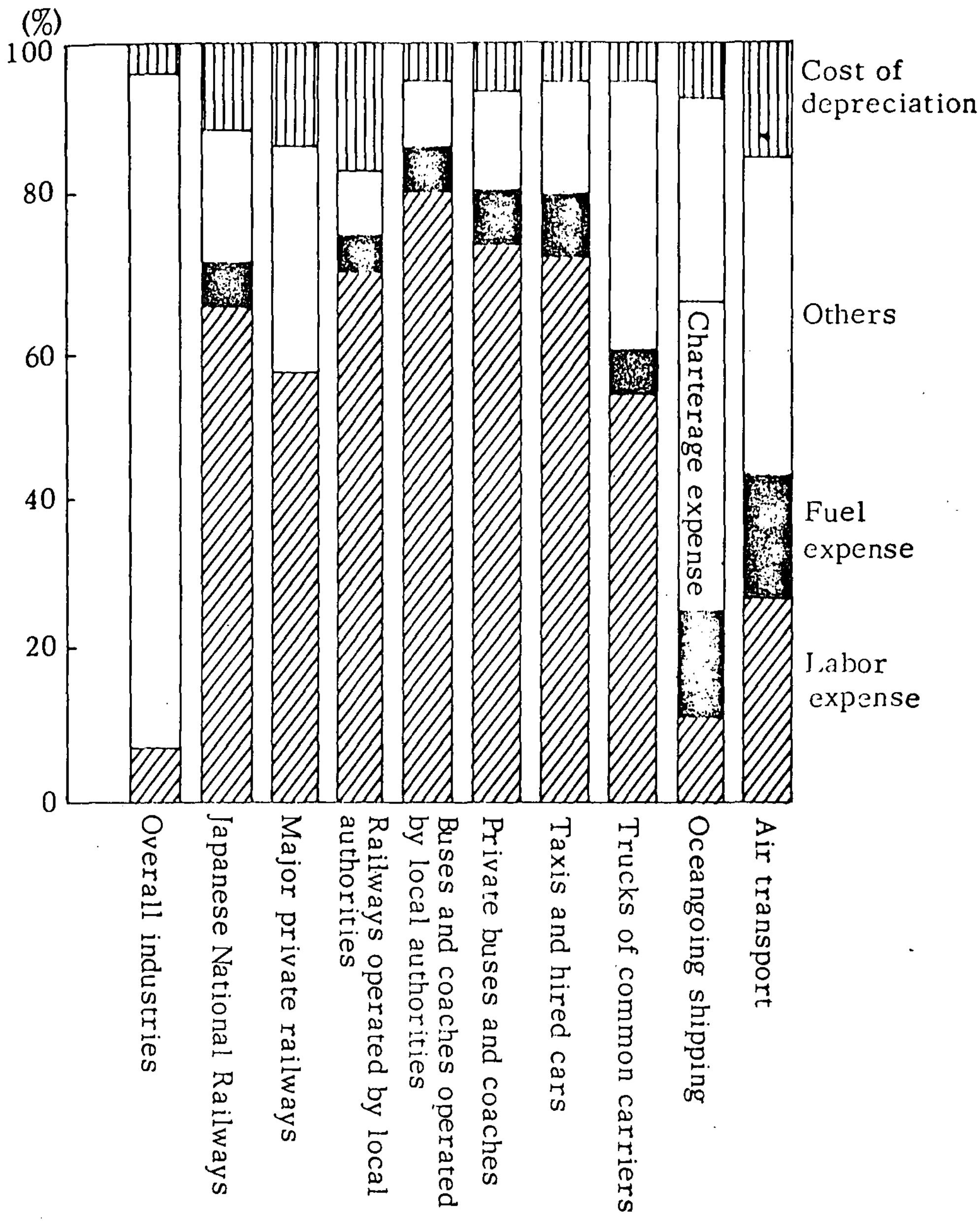
(Drawn from Reference 37)



(1) Transport by common carriers alone is included for coastal shipping.

(2) Transport by car ferries is included as motor vehicles.

FIG. 8: MODAL SPLIT BY LENGTH OF HAUL
(Drawn from Reference 37)



The figures are as of fiscal 1975.
The figures of overall industries are as of fiscal 1974.

FIG. 9: COMPOSITION OF BUSINESS COSTS BY TYPE OF INDUSTRY

(Drawn from Reference 37)

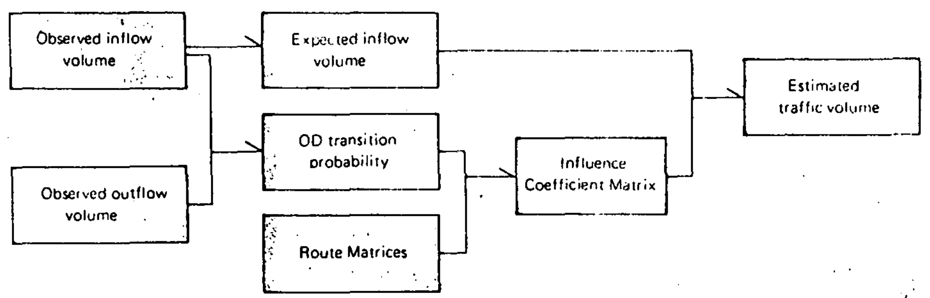


FIG. 10: ESTIMATION OF REQUIRED TRAFFIC VOLUMES FOR CONTROL

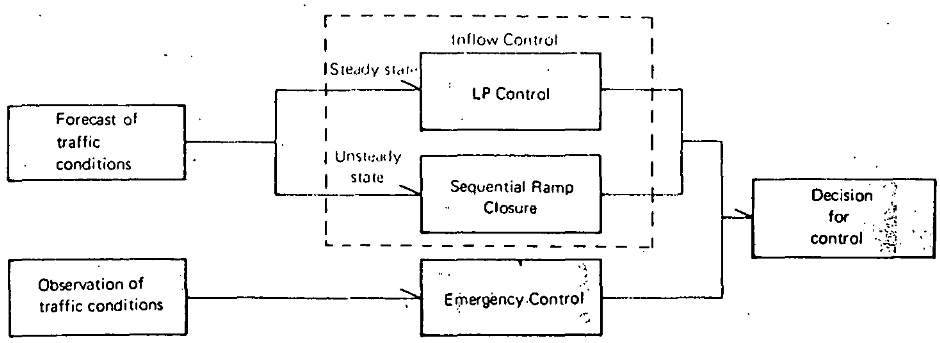


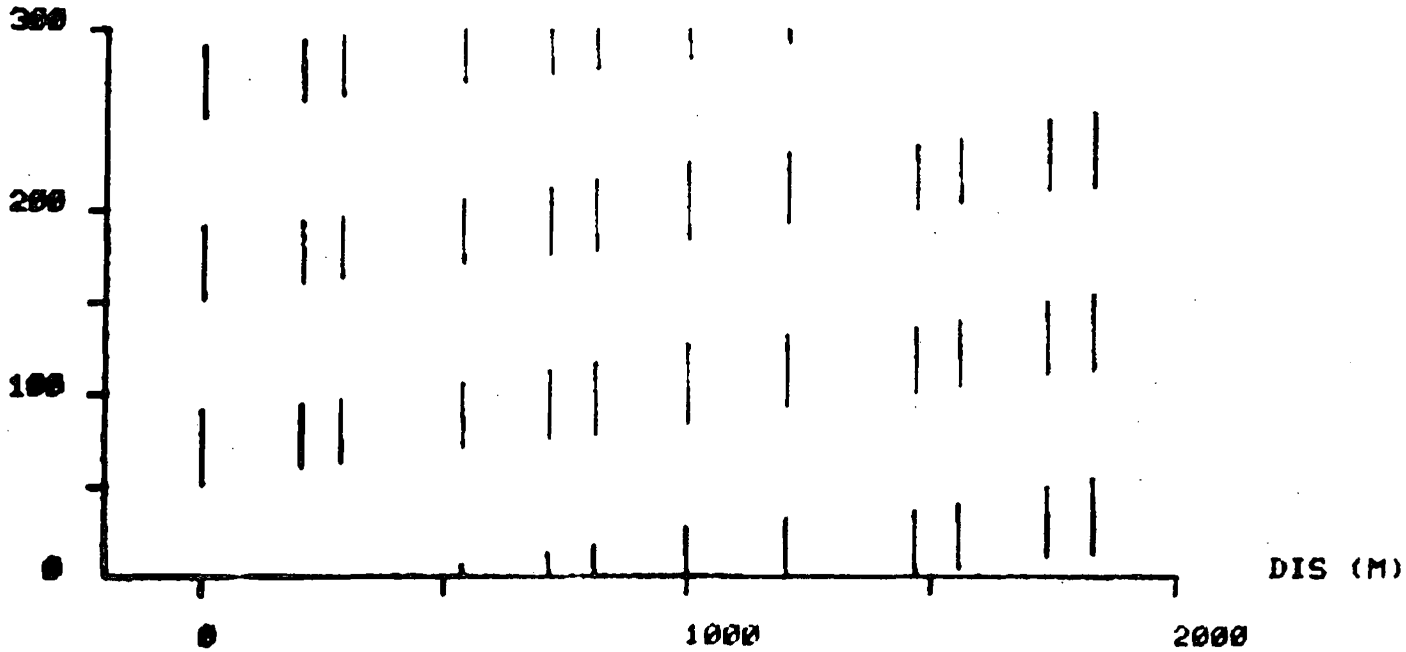
FIG. 11: HANSHIN EXPRESSWAY TRAFFIC CONTROL SCHEMA

*** OSAKA TRAFFIC CONTROL CENTER ***

1977-08-17 11:14

OFFSET DISPLAY LINE NO. = 04
CYCLE = 130 SEC

IC	00	0000	00	0000	00	00	0000	1010
NN	60	6060	60	6060	60	60	6060	1010
TT	01	2121	21	2121	01	21	2121	2125
..	30	0000	00	0000	30	00	0101	0155
NN	02	1324	35	4657	48	79	8394	0500
OO								



OF (%)	91	9497	06	1317	27	32	3640	5054
SP (%)	60	6666	65	6361	57	61	6464	6158

** OFSDSP END **

FIG. 12: TECTRONIX CONTROL ROOM DISPLAY OUTPUT OF CURRENT SIGNAL SETTINGS AT OSAKA ATC CENTRE: (Direct reproduction).

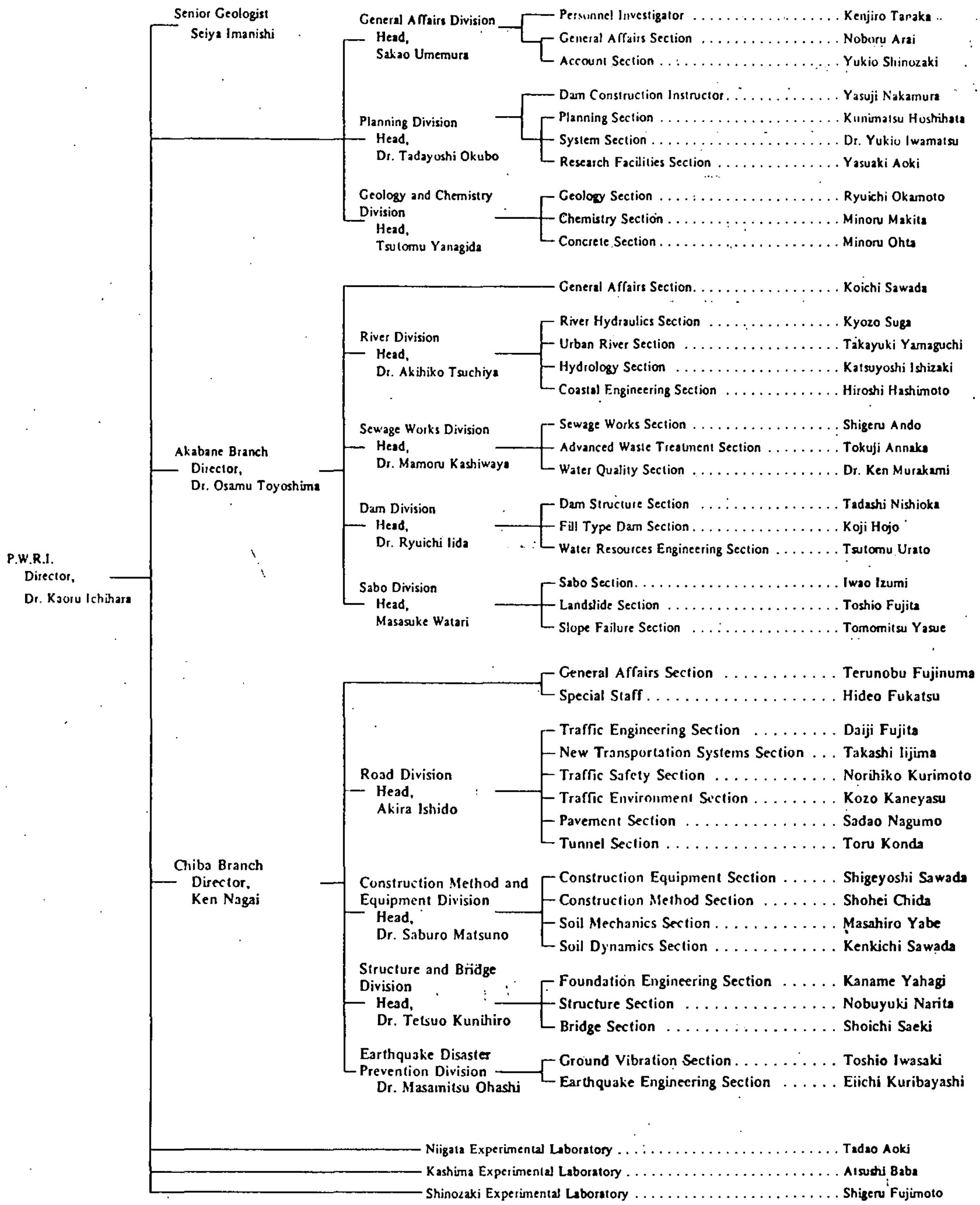


FIG. 13: ORGANISATION OF PUBLIC WORKS RESEARCH INSTITUTE (as of June. 1977)
(Drawn from Ref. 30)

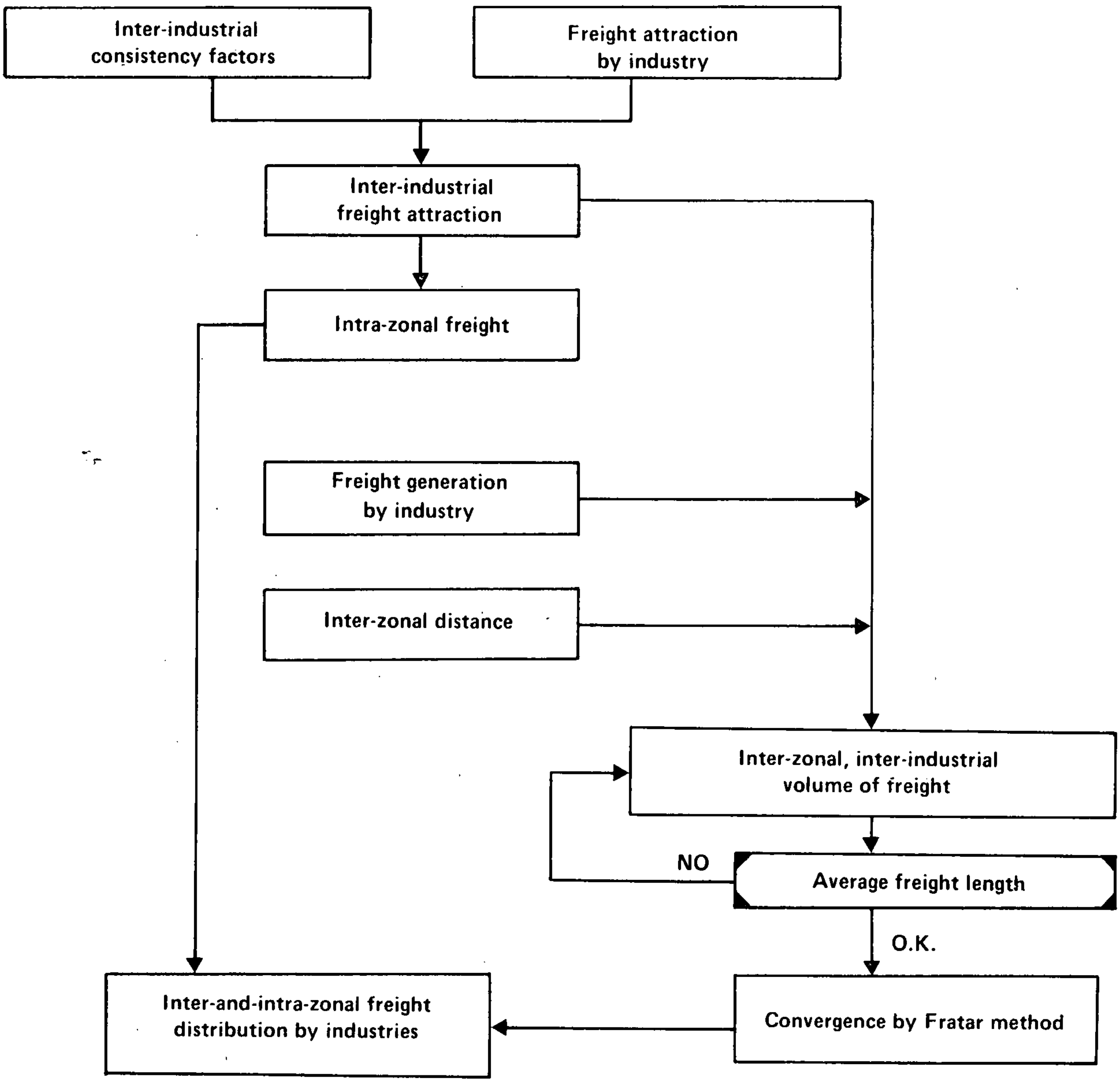


FIG. 14: GENERAL FLOWCHART OF FREIGHT DISTRIBUTION MODELS FOR COMMODITY FLOW.

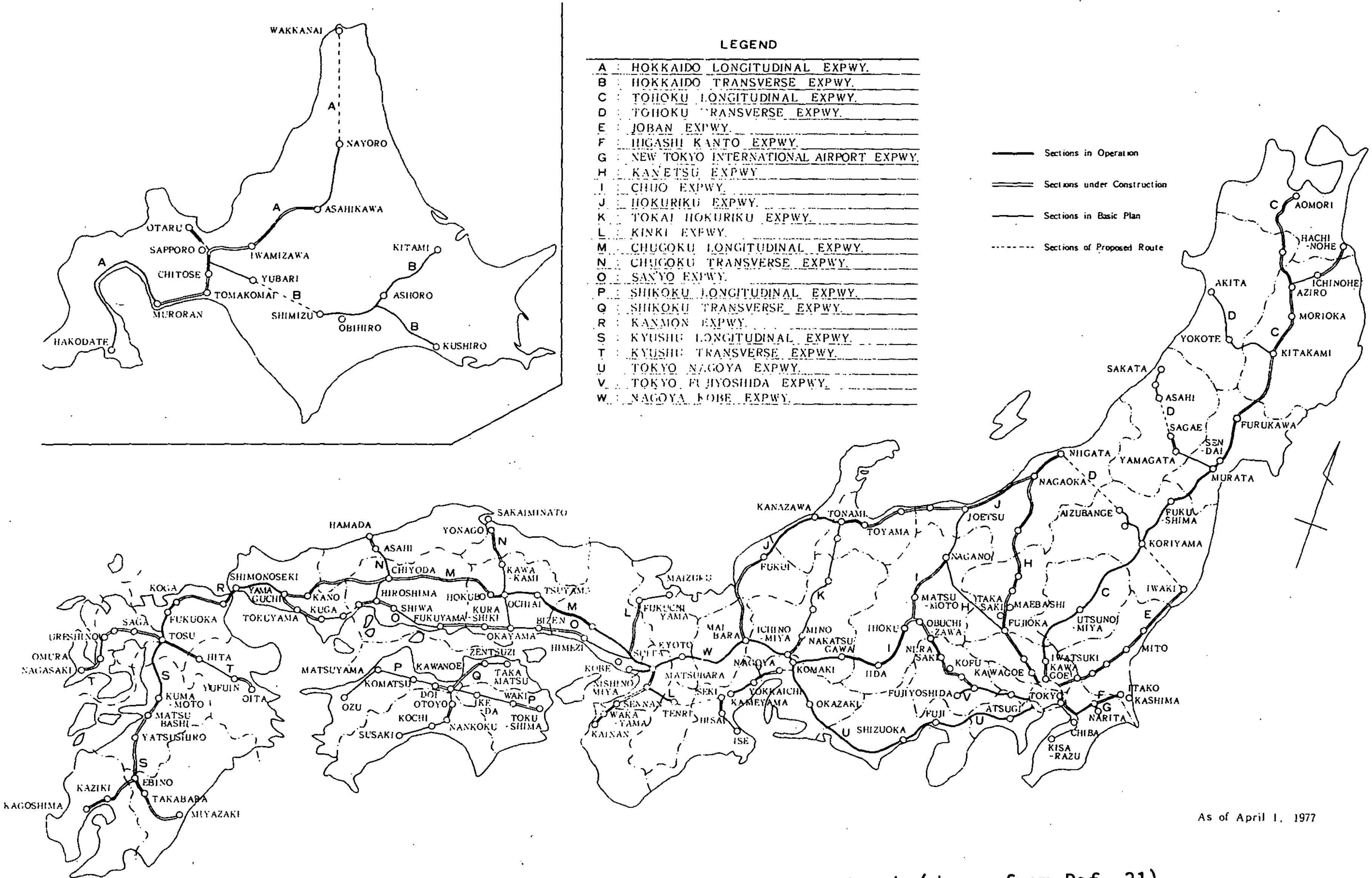


Fig 15 - Japan and the national expressway network (drawn from Ref. 31)