

## JAPAN'S AIRCRAFT INDUSTRY

### Ted Wilding-White reports from Tokyo

**B**OTH TECHNICALLY AND INDUSTRIALLY Japan's aerospace industry is still behind those of the West. The output of the industry is still limited and has yet to make any significant impact on the global market. Annual production is now worth about \$360 million, generating a net profit of only about 1.2 per cent.

In spite of this, Japan has already established some form of presence in the aerospace world. There is a quiet determination which has generated concern in the West that Japanese aeroplanes may be next in the line carved by ships, cars and radios. Twenty years of licence-building other people's designs is beginning to show results. The industry now seems ready to move and only lack of money and characteristic cautiousness are delaying it.

It was not until seven years after the war that Japan was allowed to begin rebuilding her aircraft industry. The same year that saw the first jet airliner enter service in the West also saw Japan starting virtually from scratch.

Work was initially devoted to overhaul of US military aircraft, but the establishment in 1954 of the Defence Agency placed priority on production of military aircraft. A number of companies, including many established in other heavy industrial fields, had prepared themselves for the resumption of aircraft work and were able to meet US standards for licence building. As a result, numerous licence agreements were set up and rapidly generated a diffuse industry comprising a number of modest companies all requiring work. The early growth is described in detail in *Flight* for October 14, 1971.

Japan was not, and constitutionally still is not, permitted to export military aircraft. This meant that the industry was devoted to domestic military requirements. In other words it worked under the direction of the Japanese Government which, in turn, had a responsibility to ensure that all obtained a suitable portion of the work. Such an arrangement provided little chance for rapid expansion.

During this time, however, technology has been steadily

acquired and applied. The first steps involved modification of licence-built aircraft. The first independent work, the small J3 turbojet and the T-1 trainer, were military-orientated. Then came the turboprop YS-11 airliner and the first industrially independent projects, the Mitsubishi MU-2 executive turboprop and, more recently, the Fuji FA-200 single-engined light aircraft. Military requirements spearheaded advanced work and prototypes are now flying of a jet transport, the C-1, and a supersonic trainer/interceptor, the T-2. An R&D programme for a 10,000lb civil turbofan is well under way and a 20,000lb engine is projected. Finally, planning now extends to a jet airliner, the YX, which, if not technically ambitious, does anticipate a future requirement rather than chasing past trends.

This is the course from which Japan's unique system of work-sharing has evolved. Collaboration between companies was necessary to achieve any kind of strength. Skills have now been established on a broad front, and the last two years have seen the first major steps towards large-scale independent programmes.

The fourth five-year defence build-up plan, which began in April this year, was to be the key period—the prime mover for a number of national projects. A year ago several clear programmes were being prepared. These included the PXL, an ASW/airborne early warning aircraft; the HX, a helicopter for similar roles; the FX advanced supersonic fighter and the XT-3 basic jet trainer. In an advanced state of development were the T-2 and the C-1.

The last two projects had vastly overrun their budgets, however, and when the YS-11 loss figures were added up the Finance Ministry found the first four unsupportable for the time being and the rest debatable.

The Finance Ministry is not a strong supporter of the aviation industry. This creates a difficult situation for an industry totally dependent on Government requirements. The Government has traditionally supported all major industries in Japan until they were able to operate

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independently. This is the approach taken to the aircraft industry. Unfortunately, as all its support must be devoted to supplying military needs, limited by the export ban, independence is hard to achieve. The only way out is the civil market. This needs more money but requests for it have met with the response that the industry is still too embryonic to merit it.

All attention is therefore focused on the YS-11 successor, the YX, slowly growing into a visible project. The YS-11 taught both Government and industry to be cautious and to appreciate the risks involved. Both have come to believe that the risk on this scale is too great—in effect finding themselves in the same situation that has forced Europe into collaboration. International collaborative thinking is beginning to find a strong foothold throughout the industry and much of the Government:

**Tetsuya Senga, secretary-general, Defence Production Committee:**

"I personally favour co-operation with Europe on any new aircraft to follow the F-4E. I place great emphasis on this point. By the time we need to start preparing for this, Japanese technology will have reached a level where Japan has a freedom of choice, and this includes avionics."

**Kohnosuke Kashima, director, Aircraft and Ordnance Division, Ministry of International Trade and Industry:**

"There is a national trend towards international co-operation. The industry is seeking joint efforts, which means establishing harmonious international relationships."

**Masato Yamano, space counsellor, Science and Technology Agency:**

"We are currently examining the feasibility of joint development work with Esro. We are also in contact with CNES and are discussing specific projects with India and Australia."

**Mitsuo Arimori, executive director, Society of Japanese Aircraft Constructors:**

"Collaboration will be a good thing, otherwise the industry will be isolated from the rest of the world. We want to expand, but it takes time and we need foreign collaboration to prevent isolation. Co-operation will be on a national level because of the costs involved, but collaboration on an industrial level is preferable in the long term."

**Yoshitoshi Sone, managing director and general manager, aircraft headquarters, Mitsubishi Heavy Industries:**

"Because of the cost and risk involved in major programmes, the future must lie in international collaboration. Expansion is closely tied in with international work but collaboration at an industrial level on major projects is too risky."

**Kaneichiro Imai, general manager, Aircraft Engine Division, Ishikawajima-Harima Heavy Industries:**

"The industry is not strong enough at the moment to work independently and without Government help. National collaboration aims at Government level do exist at the moment but only unofficially. I believe that collaboration is certainly one solution to keeping up with world technology."

**Gensuke Okada, planning and control manager, Aircraft Group, Kawasaki Heavy Industries:**

"I am personally inclined to a collaborative future for the industry, especially as the military market is getting smaller and more emphasis on civil work is required."

Japan suffers from the curious situation of achieving international unpopularity through being too successful in its ship, car, radio and other industries. The aerospace industry, which feels slightly sensitive to this, believes that collaboration will also help to amend the situation. In addition, the Aviation Council of the Ministry of International Trade & Industry considers that Japan should aim at making aerospace its primary industry.

Mr Arimori considers that the industry now has the ability to licence-build any kind of aircraft but is still restricted in development skills, the T-2 being about the limit of present development capability. He feels that the YX schedule is compatible with the knowledge rate and could not really be done more quickly, largely due to a shortage of skilled design engineers. He says that he is unable to see the time when independent civil work without Government help could be possible.

Mr Nichiro Ishida, R&D assistant general manager of NAMC, stresses the importance of achieving, under any circumstances, a balance between military and civil work to ensure a healthy growth. With the end of the YS-11 programme the industry has become one-sided again. This carries through to Government support of R&D, where military projects receive 100 per cent backing while civil R&D often has as much as 50 per cent-75 per cent paid for by the company involved.

The total number of aircraft manufactured after the resumption amounted, by the end of 1971, to 2,466. Of these, 1,470 were built for the Defence Agency and 27 for the US Air Force. Domestic civil demand absorbed a total of 519 aircraft and 450 were exported for sales or war reparation. By categories, the totals are 773 helicopters and 1,693 fixed-wing aircraft, of which 813 are jets. Aero-engine production was resumed in 1957 and a total of 984 jet, turboprop and piston engines had been built by the end of last year.

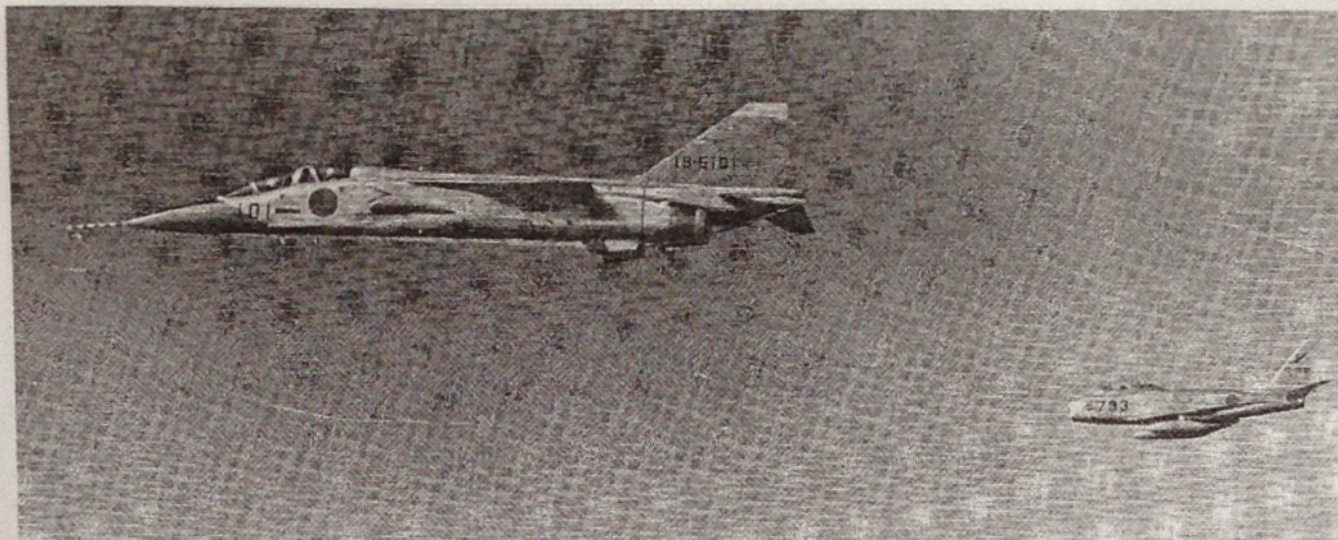
Government involvement, up to the end of the 1971 financial year last April, included investment of \$11.67 million in NAMC capital and underwriting debentures of \$139.7 million. The Government has also contributed some \$16.51 million to machinery purchase and subsidised R&D to the sum of \$21 million.

### PRODUCTION VALUE OF THE AIRCRAFT INDUSTRY (\$ MILLION)

Calendar year	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
Production value	0.08	6.81	6.69	8.33	11.80	27.94	52.31	51.83	69.01	75.51	101.42
Calendar year	1963	1964	1965	1966	1967	1968	1969	1970	1971	Total	
Production value	169.38	202.30	152.91	147.36	219.08	256.18	273.87	306.41	309.33	2,448.66	

### GOVERNMENT FINANCING, SUBSIDY AND INVESTMENT (\$ MILLION)

Fiscal year	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
Financing	0	0	0.55	7.05	1.09	0	3.14	0	0	1.67	0.89
Subsidy	0.10	0.37	0.23	0.16	0.13	0.16	0.41	0.27	0.21	0.33	0.65
Investment	0	0	0	0	0	0	0	0.83	2.08	2.78	1.53
Fiscal year	1963	1964	1965	1966	1967	1968	1969	1970	1971	Total	
Financing	0.29	0	0	0.09	0	0.28	0.56	0.56	0.28	16.43	
Subsidy	0.85	1.05	0.78	1.11	2.89	5.73	2.51	1.88	0.29	20.09	
Investment	0	1.11	0	0	3.33	0	0	0	0	11.67	



## Development strategy

**T**HE JAPANESE AEROSPACE Government structure is, as usual, dominated by the Finance Ministry. The Defence Agency controls military requirements and spending, subject to Finance Ministry approval. It also counts a high number of Finance Ministry representatives among its own staff and is itself a Ministry headed by a civilian ministerial bureau.

Assisting it is the Defence Production Committee, responsible for assessing aircraft requirements and making recommendations on new aircraft. It is also responsible for formulating the defence production policy and co-ordinating production.

It was set up at the same time as the Defence Agency and its first ten years' activity was, to some extent, limited by overriding US recommendations that Japan concentrate on the T-33A, P-2V-7 Neptune and the F-86 Sabre. DPC chief Tetsuya Senga considers, however, that this period did offer the opportunity to develop expertise.

Mr Senga stresses that military planning is geared purely to national defence. Initially this was based on the US philosophy that attack is the best form of defence. Unable to build strike aircraft, Japan has concentrated on achieving a quick-reaction capability. Until now this has been difficult because of treaty limitations. By 1976, at the end of the fourth defence build-up plan, Japan will have consolidated at least the basis of its defence force. The whole emphasis will then be devoted to shortening the reaction time. Mr Senga emphasises that there is no intention to go nuclear.

The long-term strategy, therefore, is to achieve an efficient early-warning network, with rapid interception backed up by missiles. The recent handover by the Americans of the Okinawa islands has considerably stretched Japan's defence responsibility. Protection of such peripheral areas has therefore become a significant element of defence planning.

Japanese military-aircraft production has developed under a series of five-year defence build-up plans, the fourth of which began in April this year. The fourth plan, as originally formulated 18 months ago, was aimed at completing consolidation of the JSDF over a ten-year period. This involved implementing a comprehensive range of new national programmes during the first half of this period, i.e. the fourth DBUP.

The T-2 and C-1 roles are fairly well defined. Additionally a P-2J replacement for anti-submarine warfare and airborne early-warning duties is required. Research programmes on this, the PXL, and on a helicopter for similar tasks, the HX, were being performed by Kawasaki, mostly under Defence Agency contracts. Looking beyond the Phantom, initial studies had begun on an advanced fighter, designated the FXS. A basic jet trainer, the XT-3, was also being planned as a T-1 replacement.

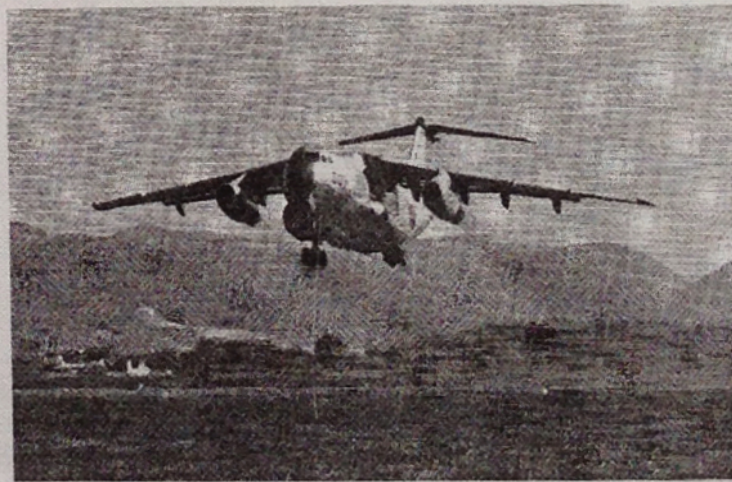
To get these going the Defence Agency requested a five-year budget of nearly \$17,000 million, double that of the previous defence plan. True to form, the Finance Ministry rejected it and agreement was finally reached on \$15,000 million (about 0.8 per cent of the GNP). The advanced projects, however, had to be scheduled over a much longer period and the others seriously reviewed. A committee is to be set up to consider the future of the PXL and HX projects and the other two appear to have been shelved for the time being. Instead, more Phantoms have been ordered and the T-2 has been adapted to a fighter role as the FST-2 and the C-1 is being considered for AEW duties.

The Defence Agency is also studying other options for an F-4E follow-on. Mr Senga says that these options include improved versions of the F-4 as well as the possibility of a completely new aircraft, either of US or Japanese design. A new aircraft would probably require international co-operation and would be an advanced type of multi-role aircraft in the European MRCA category. Serious planning would have to begin in 2-3 years' time. He strongly believes that by then Japanese technology will have reached a satisfactory level.

Extensive research is being directed towards this defence objective in both missiles and electronics. Basic R&D is performed by the Defence Agency research labs. Budget requests to cover research work next year amount to four per cent of the defence budget for major R&D programmes, or two per cent of the total defence budget.

Aircraft manufacture, both civil and military, is managed by the aircraft and ordnance division of the Ministry

*T-2 prototype, above, tracked by a Japanese-built F-86. Below, the C-1 prototype demonstrates its Stol capabilities*



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The table below gives an estimated breakdown of defence procurement for the fourth defence plan. It was compiled by Japanese press sources, only the total number of aircraft having been released by the Defence Agency

### FOURTH DEFENCE PLAN, 1972-1976; 560 AIRCRAFT

Air SDF		Marine SDF		Ground SDF	
F-4EJ	46	P-2J	43	OH-6	79
*RF-4E	14	PS-1	12	V-107	20
FST-2	68	YS-11	3	UH-1H	55
T-2	59	IFR trainer	6	*TH-55	36
C-1	24	KM-2	9	LR-1	5
†BTX	12	HSS-2	34		
MU-2	12	Mash	1		
V-107	12	V-107	5		
		S-61A	4		
		OH-6	5		

\* Direct purchase from US.

† Primary trainer (unspecified).

of International Trade & Industry (Miti). In this capacity Miti organises the work distribution and issues manufacturing licences. Under the 1952 aircraft manufacturing regulations, a licensing system was set up to ensure responsible participation. This still exists to prevent new companies from upsetting the delicate balance. In effect Miti has responsibility for upholding the industrial *status quo*.

Work distribution is arranged on a basis of individual capability regarding facilities, appropriate manpower and current workload. Subcontracts are awarded in agreement with the prime contractor. If the industrial balance is stable and prime contractorship on a project which encourages growth lies within the capability of more than one firm then tenders are invited. On military programmes subcontract assignment is agreed among Miti, the prime contractor and the Defence Agency with the final decision resting with Miti.

## YS-11 and beyond

**P**RODUCTION OF THE YS-11 short-haul turboprop airliner ended this spring after 182 aircraft had been built (including two prototypes), of which 70 were sold abroad. The project lost \$60 million and resulted in a more cautious attitude being shown by industry and Government. The absolute necessity for maintaining a civil programme, however, is now stimulating the development of a successor—the YX.

The YS-11, first proposed by the Ministry of International Trade & Industry (Miti) in 1956, was designed initially by an industry team. In 1957 the Government established the Transport Aircraft Development Association to lead the project and this was replaced in 1959 by the Nihon Aircraft Manufacturing Company (NAMC), 53 per cent Government owned with industry, including a banking consortium, holding the rest of the capital.

A jet transport was proposed at the same time as the YS-11, and there is still some feeling in Miti that the project should have been started then, alongside the turboprop aircraft. It was shelved, however, largely because of the lack of a suitable engine at the time. More feasibility studies two or three years ago produced a concept, designated YX-33, for an aircraft in the 111-to-149-seat bracket. The appropriate engines, the Adour for the smaller size or the Trent for the larger, were not available at the time and the project was shelved again because the demand was uncertain.

IHI has for some time been studying a civil turbofan in the 10,000lb class, but work on this did not receive full Government financing until the beginning of the fourth DBUP this year, when the project was relegated to pure research status. Testing of the engine should begin early next year.

The five-ton engine is now seen as a technology project prior to the development of an engine in the ten-ton class.



The YS-11, Japan's first excursion into the international civil market. Production has now ended with 180 built

Full financing for the bigger powerplant is planned for the next DBUP. The direction which YX planning is now taking may mean that a still-larger engine is needed, however, and it is uncertain whether the ten-ton engine will itself become a technology project or go into production.

Miti officials are unwilling to say definitely at this stage whether or not this engine would power the YX. Its use depends on the ultimate size of the YX and whether development of the powerplant can be accelerated. Foreign engines would definitely be used on the YX prototypes. It is still undecided whether licence-holding, outright purchase or partial co-operation in production would be employed if a foreign engine were selected for the YX.

The choice will depend on the quantity required. Discussions are already being held with foreign manufacturers, possible contenders including a scaled-down RB.211. Long-range planning for a YX successor, the "YXX," is already in progress and Miti considers that this must definitely use Japanese engines.

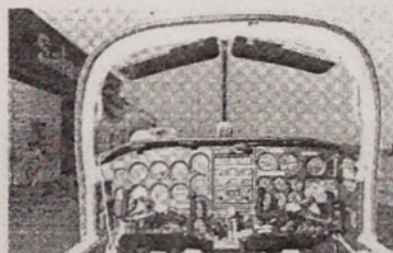
The YX is currently seen as a twin-engined short-haul RtoI aircraft with 150-200 seats. Detailed study is to begin next year and the airlines will be brought into this to enable the optimum size to be established. Test flying may start as early as 1976 and it is hoped to have the aircraft in service in 1978.

Detailed market forecasting will also be carried out next year. Preliminary studies predict domestic sales of about 60 aircraft, while an overseas market of from 800 to 1,300 aircraft is hoped for. Domestic predictions include consideration of the potential growth of surface transport, notably the "bullet train" network which constitutes a formidable competitor while the airports maintain their present inaccessibility. Miti officials consider that the longer and inter-island routes will form the bulk of the domestic requirement.


The project will almost certainly be internationally collaborative. Both Government and industry feel that the risk is too great when the large independent investment must be set against an independent sales programme. Offers to collaborate were invited from Boeing, McDonnell Douglas, Lockheed, BAC and VFW-Fokker, and all but VFW-Fokker expressed strong interest in the possibility. Boeing has been selected (although this has yet to be made official) largely because of the strong position which the American company already has in the international market, and as a result of its comprehensive product-support network which Japan could not provide by herself. Boeing is also planning a new aircraft similar to the YX. Aeritalia, too, has been looking at such a project and talks between

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# FUJI/FA-200



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Italy and the US company indicate that it might end up as a three-way programme.

Miti officials are very much in favour of working with Boeing, maintaining that only that company was willing to co-operate on an equal basis. The selection was made by the Japan Aircraft Industry Council, which includes industrial representatives and which was unanimous in selecting Boeing.

Some sectors of the industry are unhappy about the selection, however, particularly in the light of possible Aeritalia involvement. It is felt that such an arrangement could lead only to temporary work, followed by a vacuum. There is also some concern that too close a tie-up with Boeing would deprive Japan of the freedom to work with other partners.

One industry official believes that it would be better if possible to wait until an advanced and therefore technically rewarding programme (such as a STOL or VTOL project) appears before collaboration is introduced. He favours the largest YX configuration—the 200-seater—which would place it sufficiently below the A300B category.

## MITSUBISHI

THE BULK OF Mitsubishi's efforts over the next few years is likely to be absorbed in production of the T-2 and F-4Es. Approval to begin production of the first batch of 20 T-2 trainers was given by the National Defence Council on October 9. Two prototypes and two pre-production models have already been delivered. Orders under the fourth defence plan amount to 59 of the trainer version and 68 of the fighter version, the FST-2. Both will be ordered in batches. The first eight trainers will be delivered in 1974 and 12 more in the following year. A second batch of 20 will be ordered in 1974 for delivery in 1976-77 and the final 17 in 1978-79. For the FST-2 the first 22 will be ordered in 1974 for delivery in 1976. The remaining 46 will be ordered that year for delivery of 24 in 1978 and 22 in 1979. The breakdown is based both on company capability and budget limitations.

The T-2 is a supersonic trainer similar in size and performance to the Jaguar and is also powered by two R-R/Turboméca Adour turbofans (licence-built by IHI). Available figures give gross weight as 20,850lb, service ceiling as 50,000ft and maximum speed and range as Mach 1.63 and 1,400 n.m. respectively.

The design, which represents the limit of Japan's present technical skill, does contain some advanced features, notably in the use of lightweight materials. Extensive use has been made of titanium alloy and honeycomb structure. Such work has resulted in a development bill of \$29 million, three times the original budget, and in unit costs of \$4.2 million for the T-2 and \$4.8 million for the FST-2, as much as four times the planned figure.

Mitsubishi is also prime contractor for the F-4E which has just gone into full-scale production following knock-down assembly of the first two. Only about 60 per cent of the aircraft is actually manufactured in Japan and this is shared mostly with Kawasaki. In addition the USA has supplied 50 per cent of the tooling. One hundred and twenty aircraft are to be produced domestically under the fourth DBUP at a unit cost of just over \$6 million. Two others were bought outright and the first of the two assembled by Mitsubishi has just been delivered. Of the first 80 ordered under the third defence plan, the first batch of 34 is to be completed by next April at a total cost, including tooling, of about \$200 million. The rest will follow during the subsequent financial year. Another 60 were ordered last March under the fourth defence plan for delivery between 1974 and 1977. Including the 14 RF-4Es bought outright, the total force will then amount to 134.

The important considerations are reducing take-off distance and minimising noise.

Collaboration arrangements will be drawn up next year. Initial planning is for a straight 50:50 cost- and work-sharing arrangement, but this is still to be discussed in detail. Miti is still uncertain as to how to evaluate Boeing's contribution. In this Miti has also to cope with the Finance Ministry, which is described as being "not enthusiastic" about the aviation industry and offers no firm prospect of approving sufficient money next year. Industry is trying to get Japan's R&D contribution wholly paid by the Government, but the Government has said that the matter is not yet ready for discussion. Miti is therefore pressing the Finance Ministry to supply 85 per cent of the R&D budget.

The YX project will not be managed by NAMC, which is shortly to be dissolved and replaced by a new organisation which will be almost wholly Government-controlled. The change is largely the outcome of the YS-11 financial loss, nearly all of which the Government is refunding. (Some dispute is still in progress over an increase in the figure which has emerged since the payback was agreed early this year.) A major difference in the new organisation will be that it will take responsibility for development only, whereas NAMC managed both development and production.

Mitsubishi's independent project, the MU-2 twin turbo-prop, has been appearing almost annually in a new improved form since its introduction on the market six years ago. The latest models, the J and K, have been re-engined with the AiResearch TPE-331 at 665 s.h.p. to improve high-altitude performance. The K is the standard 6/9-seater but the J has the stretched 8/14-seat fuselage first introduced on the G.

MU-2 sales, although representing only a modest proportion of Mitsubishi's business, had reached a total of 262 by the end of October. Some 234 of these have been sold in the USA but these are 50 per cent built by Mitsubishi's US subsidiary. Of the remainder, four were sold in Europe, two in Australia and 22 to the home market.

Target for the financial year (until next April) is 60 aircraft and production is now at six per month to match this. 1972 has been the most successful year to date with 33 sales from April to September and the company is confident of reaching target. Next year's target is already set at 84 aircraft and production is to increase to seven per month accordingly.

The Mitsubishi MU-2J is the stretched 8/14-seat variant re-engined with two 665 s.h.p. turboprops



## FUJI

FUJI HEAVY INDUSTRIES owes its post-war growth to production of variously modified Beech Mentors and Cessna L-19s. Production of Bell 204/UH-1 helicopters has continued since 1962. Fuji's first independent design was the T-1 jet trainer, 300 of which were built for the JASDF. Since then Fuji has independently developed the FA-200 single-engined light aircraft.

Production of the FA-200, which began in 1968, has now reached 210 and settled down at about one per week. This is expected to remain constant for the foreseeable future unless the financial situation deteriorates. More than 190 aircraft have been sold so far, half of them abroad. To date, attention has only been paid to Europe and Australia but a demonstrator is now in South Africa. Penetration of the US market depends on the money situation settling and this may take two or three years. Meanwhile, Fuji still has hopes of military trainer sales in Japan.

Planning for a twin, the FA-300, began in 1970 with a target first-flight date in 1974. The Yen devaluation severely altered the planning which has progressed no farther than the basic design stage. It is still seen basically as a 6/10-seat executive aircraft or military trainer/communications aircraft but Fuji is still undecided as to whether it will be piston- or turboprop-powered.

Production of the Bell 204 still continues after ten years, during which 120 have been built, 90 of them as the military UH-1B. All have been for the domestic market except for seven bought back by the USA. Production is now at 15 per year, four of which are civilian models. The military version now produced is the UH-1H and production of this is expected to continue for the next five years.

Independent helicopter work is still centred on the "XMH," a modified 204 which has been flying for nearly two years. The main modification is the addition of stub wings to off-load the rotor blades and this alone has increased the speed by 34kt. Rotor tip-drive has also been incorporated and both changes are being tested exhaustively to accumulate basic data for an independent design.

## SHIN MEIWA

THE SS-2 FLYING BOAT has been the mainstay of Shin Meiwa since development work, based on the Grumman Albatross, began in 1966. Two prototypes were delivered to the JMSDF in 1968 for testing and evaluation. Of the \$27 million development cost \$24 million was paid by the Government.

The SS-2 (military designation PS-1) is powered by four IHI-built T64 turboprops. In addition a 1,400 s.h.p. IHI-

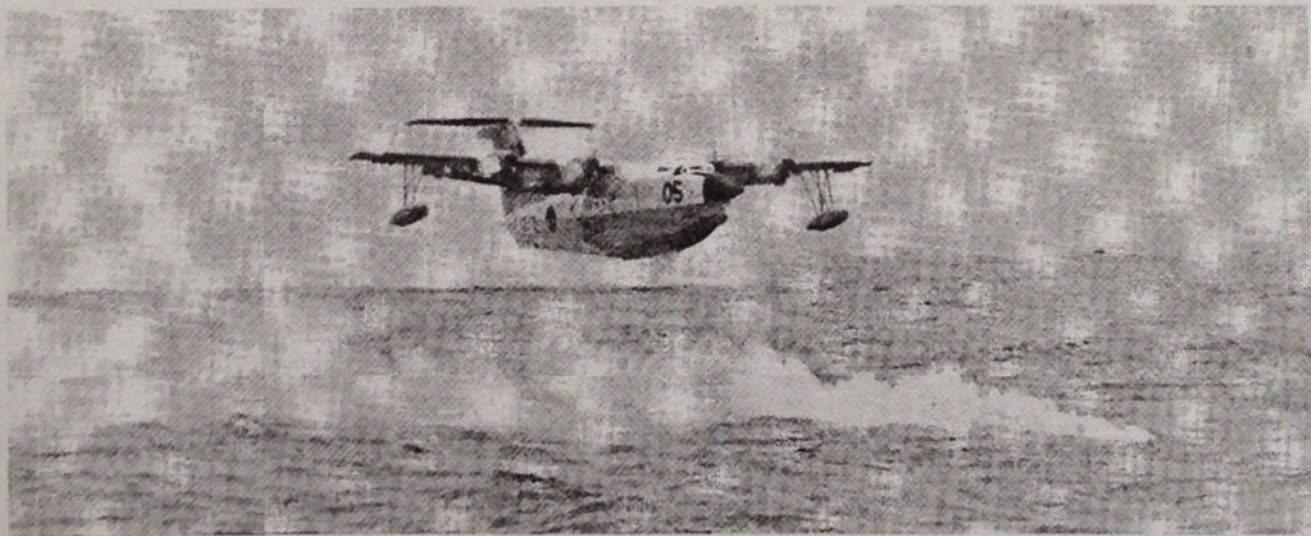


One Fuji FA-200 now leaves the company's Utsunomiya works each week (above). The first production SS-2 (below) performs Stol tests between marker floes

built GE T59 gas turbine is housed in the upper central fuselage to drive an air compressor. Compressed air is ducted to inner and outer flaps, rudder and elevator to provide boundary-layer control. This, plus the extensive flap system, provide distinctive Stol characteristics and the narrow hull enables the aircraft to operate in waves up to 10ft high. The extreme operating conditions necessitated development of a unique spray-suppressor groove which protects propellers and engines by ducting spray back to a point behind the wing leading-edge. The aircraft is also equipped with a retractable tricycle undercarriage designed for beaching only.

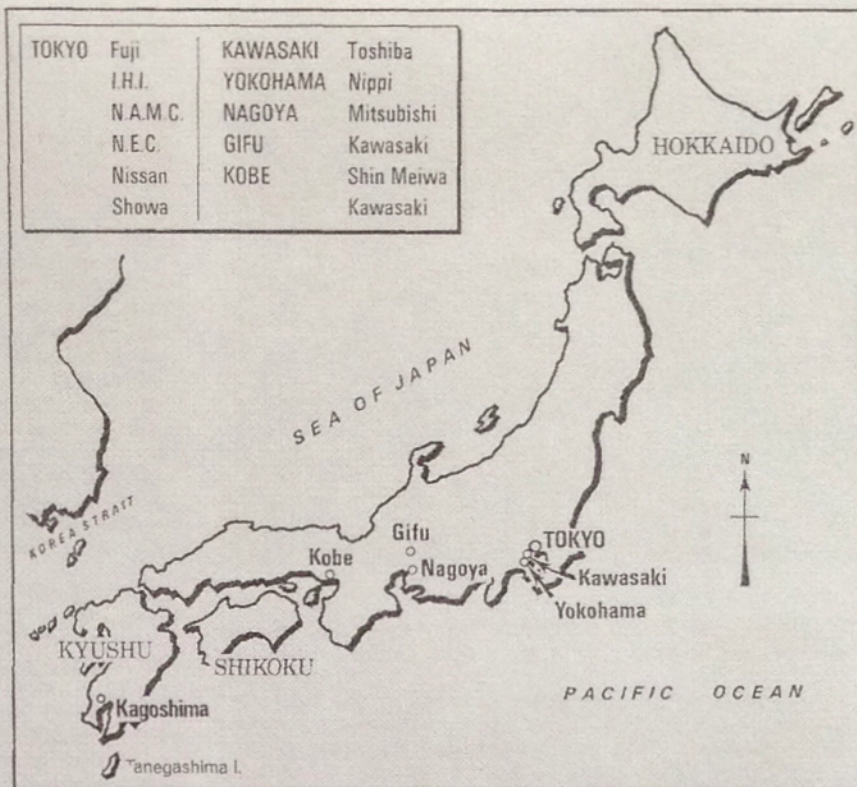
As a private venture, however, Shin Meiwa is developing a fully amphibious version, the SS-2A, with a heavy-duty tricycle undercarriage carrying two wheels on each leg. The main wheels require the addition of special pods to the side of the fuselage. The aircraft is expected to achieve land take-off to 50ft altitude in 2,000ft at a gross weight of 99,200lb. Landing distance from 50ft should be less than 3,000ft.

Two pre-production ASW PS-1s were delivered to the JMSDF this year and a further ten were ordered last year under the third defence plan, the first of which, No 05, was delivered in October. Roll-out of No 06 was expected this



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Hughes 500 licence-built by Kawasaki



week and production will continue at a rate of six per year to complete deliveries by March 1974. Under the fourth defence plan another 12 aircraft have been ordered, three of which will be the amphibious version for search and rescue work. Shin Meiwa expects to continue production at the same rate for at least another year after these orders are filled in anticipation of further orders. These could come from abroad now that the aircraft, in its SAR role, is suitable for the civilian market. The company is, in fact, building another plant at Tokushima Air Base specifically for SS-2A production.

Another outlet which Shin Meiwa is examining is the short-haul commercial airliner market. In this role the SS-2A could carry 69 passengers at 230kt over dense inter-city routes. The company maintains that the ability to operate away from airports and/or out of small airports will find increasing favour. This conviction has resulted in plans for a pressurised 100-seat version and initial design is under way in collaboration with Grumman. Only the upper fuselage would be changed to give a circular cross-section and permit six-abreast seating. Freight and oceanography applications are also being considered as a means of reaching the widest possible civil market. No attempt is being made at present to find overseas dealers,

but Grumman has expressed interest in assembling the aircraft for the US and Canadian markets. A company spokesman said that other dealership enquiries have been received.

Apart from assembly and testing, Shin Meiwa builds about 50 per cent of the aircraft, the remainder being distributed among Fuji, Showa and Nippi. Shin Meiwa is also building rear fuselage and tail assemblies for the P-2J and tail control surfaces for the C-1.

Production of PS-1 variants, present and future, is planned to continue until 1985. A study team has already been organised to examine a follow-on project. Attention is being focused on a turboprop aircraft, probably an amphibian.

## KAWASAKI

**K**AWASAKI OWES its post-war development to helicopters, beginning with licence-construction of the Bell 47 in the early 1950s. Nearly 500 Kawasaki-built Bell 47s in different guises, including a four-seater, have been sold to date, but production has been slowed down to one per month just to keep the line going. Since 1959 Kawasaki has been producing the Vertol 107 of which about 80 have now been sold, including several exported. Production of the Hughes 500 was subsequently undertaken but production of each of these is now down to one per month for the same reasons.

The company is also doing some independent research in the helicopter field, particularly regarding rigid rotors, twin engines and IFR factors. Although its helicopter work has significantly declined in importance, Kawasaki is deliberately keeping strong connections in firm anticipation of renewed popularity for the helicopter in the next 4-5 years. Meanwhile, soundings have been made regarding international collaboration at industrial level and interest is being shown in recent overtures by MBB to achieve

	62	63	64	65	66	67	68	69	70	71	72
Jets	J3-3										
	J3-7										
	GE J79-11										
	GE J79-17										
	GE J47-27										
	R-R Adour										
Turboshaft	GE T-58										
	GE T-64										
	Lyc T-53										
	All T-63										

This chart, left, shows the approximate timescale of the major aero-engine programmes undertaken by the industry, and illustrates the rate of expansion. Research engines are not included





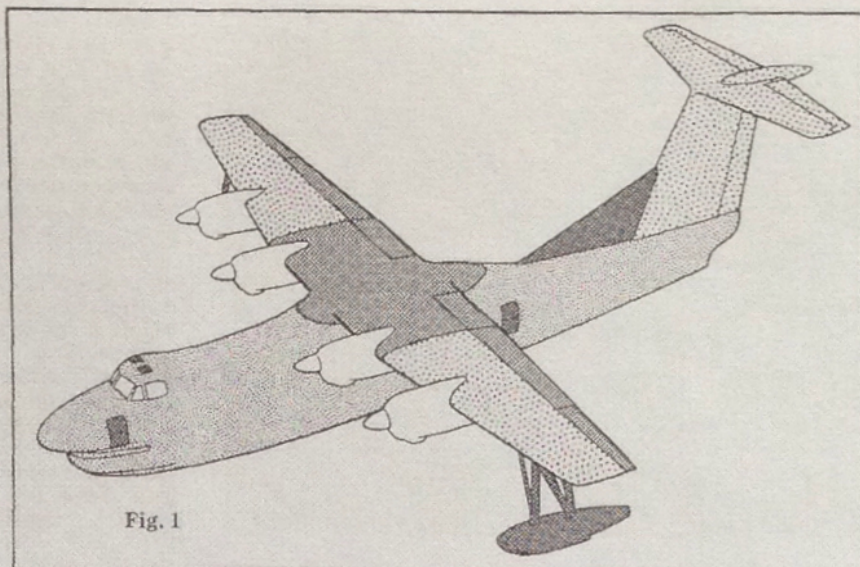
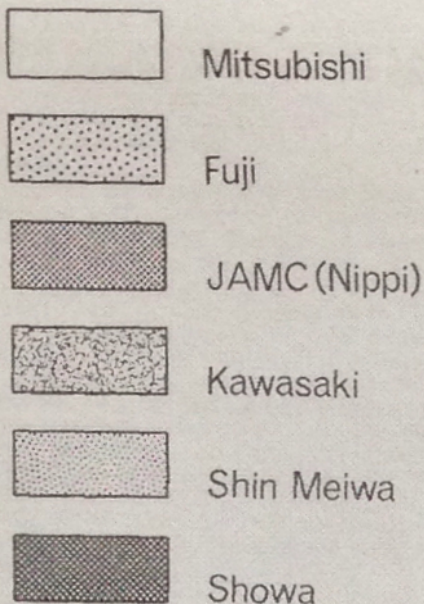


Fig. 1

### JAPAN'S AIRCRAFT INDUSTRY

under the fourth plan, production is now scheduled at one aircraft every two months as from early 1974.

Mitsubishi is to licence-build some of the engines, although most of them will be only assembled in Japan because of the small requirement. Eventually up to 40 aircraft may be produced. There is some hope that the aircraft may also achieve export sales for civil use, on the basis that it is the only available aircraft of its size and particular configuration, including a rear-loading ramp. There is also hope that export sales of military equipment may be permitted at some time in the future.

## ISHIKAWAJIMA-HARIMA

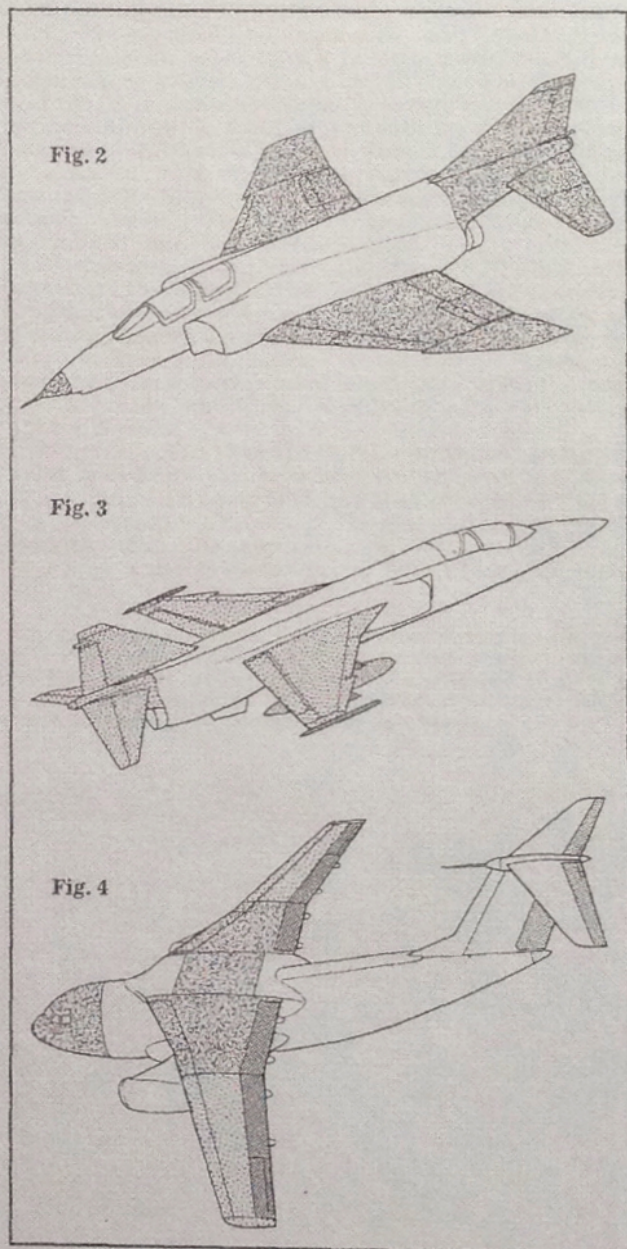
COMPLETION IS EXPECTED this month of the 1,000th engine to be built by IHI—one of 300 J79-17s being constructed under licence for the JASDF's F-4EJs. Approximately 30 have been built so far at a rate of about three per month.

Major engine programmes have included 160 J79-11s for the F-104s, and 120 J3s. IHI expects a requirement for a further 200 of the 1.4-tonne-thrust, domestically developed J3. The C13 is under private-venture development as a J3 successor to power the proposed XT-3, and scheduling is geared to the fifth defence plan. Development is still at an early stage and the thrust level has yet to be settled, but will probably be about 1.2 tonnes. Testing of the five-stage compressor is to begin next year, to be followed by work on a core engine.

Design of the 10,000lb technology engine, the TF-1002, is now nearly complete and metal is already being cut. Bench testing is scheduled to begin next May. The thrust level of the follow-on engine, although arbitrarily set at 20,000lb, will actually be in the 20,000-30,000lb bracket. The exact thrust will not be determined before about 1976. This, too, will probably become a technology engine and will therefore be 100 per cent Government-financed up to the bench-testing stage. It is expected to lead directly to development of an engine for a YX successor.

The licence-construction of the Adour (for the T-2) represents something of a departure from normal practice.

Primary work distribution for some of the major programmes. Fig 1 SS-2, Fig 2 F-4EJ, Fig 3 T-2, Fig 4 C-1



The bias has always been in favour of the Americans rather than European manufacturers, who have shown a reluctance to commit any effort to a job before agreement formalities are fully completed, which tends to prove too slow by Japanese standards. The USA is considered to have made very much more effort to co-operate with Japanese needs.

Adours are being delivered in knock-down state at the moment for IHI assembly. Full production is not scheduled to begin until 1974. The present requirement is for 234 engines, but IHI is taking the optimistic view and planning for production of at least 400.

IHI is clearly representative of the long-term optimism that pervades the industry. The company's new Mizuho assembly and overhaul facility is operating on a single-shift basis and therefore at less than 50 per cent capacity. Yet plans are in hand for new buildings which will increase the assembly area by 3-4 times. The plant has one turboprop and three jet test cells, the largest capable of taking engines up to 40,000lb thrust. All Nippon Airways' TriStar order means RB.211s to overhaul, necessitating a larger cell. IHI is taking no chances this time and is planning one with 100,000lb capacity. Six more turboprop cells are also to be built.

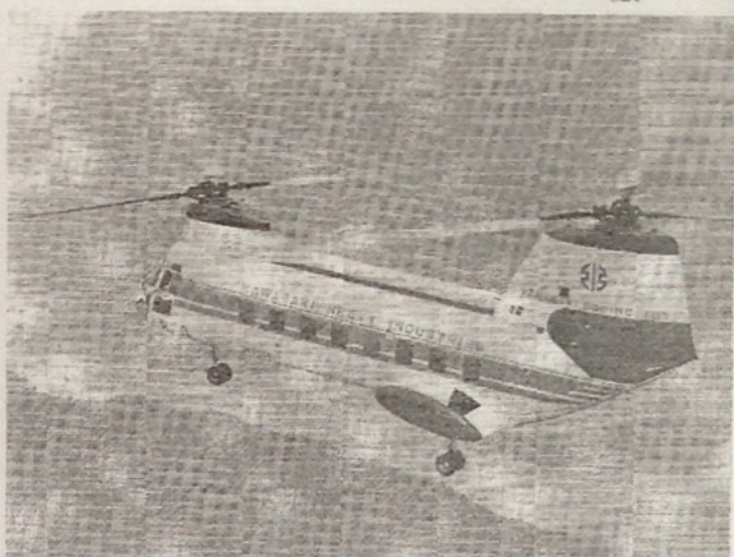
Production of the Rocketdyne MB-3 engine for the Thor N first stage will be IHI's biggest space project to date. The initial requirement is for 12 engines, the first three of which are being bought outright. A further three will be assembled by IHI before beginning full production of the final half-dozen. Static testing of the first knock-down engine is due to begin at the end of 1974. This is arousing some concern because contractor selection for development of a test stand, a critical factor in the scheduling, is being delayed until next year. The Government maintains that the money is not available.

Previous rocket research has included building two small engines (the largest of 22,000lb thrust) and some cryogenic, turbopump and ablative-nozzle development. The national launcher programmes have led to some work on launch-vehicle reaction-control systems. Following a technology project for a 5kg-thrust roll-stabilisation RCS, IHI is now working, with aid from TRW, on a 10kg thruster system which will be used in the second stage of the N vehicle.

## NIPPON ELECTRIC CO

**D**OMESTIC SELF-SUFFICIENCY is the prime objective of Japan's electronics industry. NEC's radio division is one of the most active exporters in the aircraft industry, the bulk of its work being devoted to radars and telecommunications. Sales of satellite ground terminals have now reached 47, including one to Peking, and total annual sales now amount to some \$36 million.

Extensive research on military and civilian radar appli-

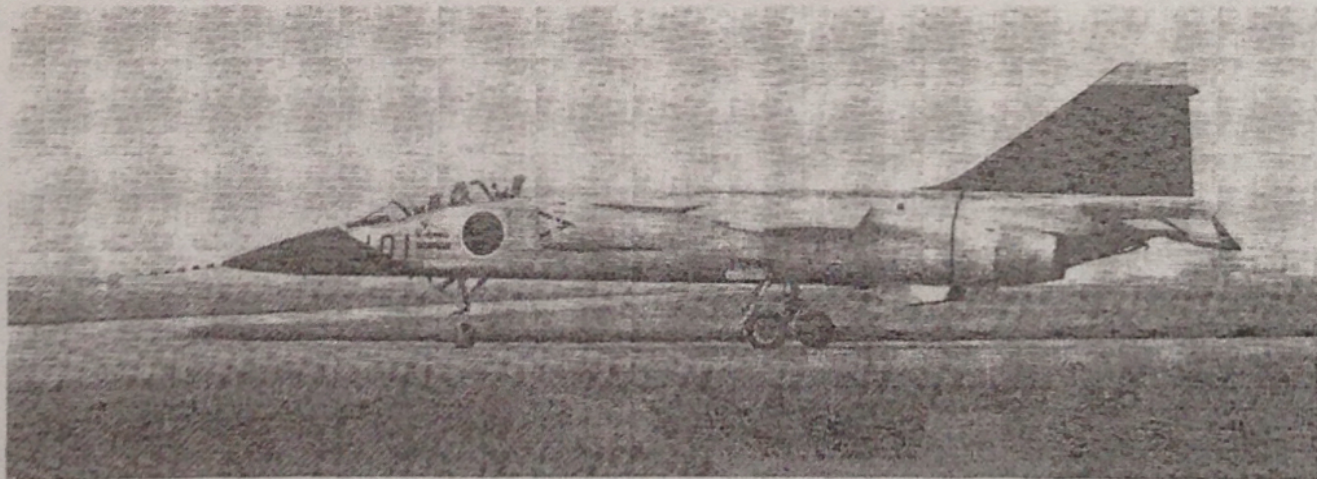


cations has resulted in a wide range of complete systems. Work has focused on solid-state and phased-array radars, although much of this is military-orientated. The Defence Agency is considering use of phased-array equipment for its future airborne early-warning network and is currently evaluating a 3D transportable air defence radar delivered by NEC early last year. Orders for several more are expected from the Defence Agency to support the Base Air Defence Ground Environment (Badge) early-warning network. The Badge system was completed by NEC in 1966 under licence from Hughes.

The company is Japan's main supplier of ATC equipment and ground-based nav aids for both civil and military use, as well as airborne VHF and Tacan equipment. Much of NEC's domestic civil work is performed under contract to the Civil Aeronautics Board. To prevent duplication of effort, NEC concentrates on ILS and DME systems while Toshiba, Japan's other major electronics company, handles VOR installations.

NEC has supplied 12 of the 14 ILS installations in Japan. Export sales in the past have been limited by the fact that US and European equipment has been cheaper and have been hampered by UK influence in eastern Commonwealth countries. With the application of its own solid-state systems to a design based on its licence-built ITT unit,

*Kawasaki-built KV-107, above. The sale of seven of these in civil guise last year to Sweden for SAR work represented the first departure from sales limitations on military products. Below, prototype of the T-2 supersonic trainer powered by two Rolls-Royce/Turbomeca Adour engines. It is also to be developed as a light fighter*



## JAPAN'S AIRCRAFT INDUSTRY

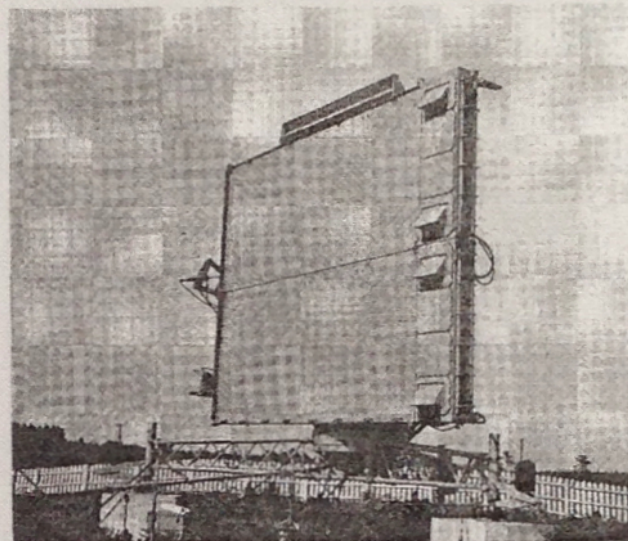
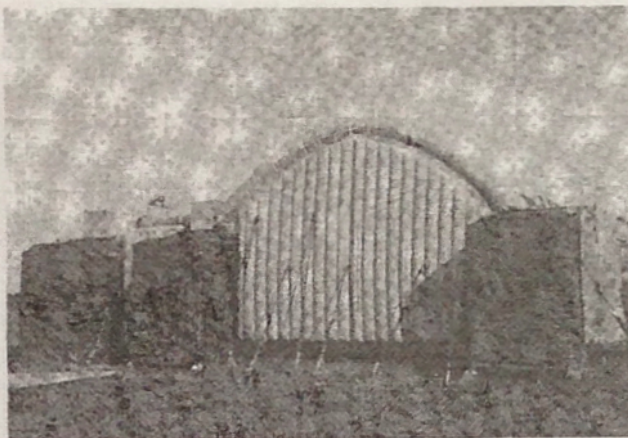
Top, inflatable shelter which NEC has developed for use with its transportable 3D air-defence radar. Below, the phased-array radar antenna. The whole system, which can be transported in six 2.5-ton vehicles, is currently under evaluation by the JSDF

NEC believes it can now offer competitive equipment. Its two-beam, solid-state ILS sells domestically for \$180,000-\$210,000. NEC feels it is now in a good competitive position in the navaid field and is making major efforts to exploit the growing overseas market.

An ambitious project facing NEC is the completion of the automatic ATC system at Tokyo Area Control Centre. The project is being performed in two phases, the first of which, covering the flight-plan handling, was installed by the company in 1969. Phase 2, for which proposals are now in, involves automation of the radar-data processing. NEC is also developing an improved version of its 200-mile radius, solid-state air-route surveillance radar for the new Tokyo airport. Similar equipment is already in service at Fukuoka control centre. The transmitter uses an NEC-designed variable-frequency L-band magnetron and the receiver is a digital MTI system for higher reliability and stability. The antenna has been given a sharp low-angle cut-off to minimise ground illumination and provide higher antenna gain.

Under development is a cheap, simplified ILS for general-aviation airfields which is expected to sell for about 20-25 per cent of the price of the full-scale system. The equipment will include an optional DME and is expected to reach the market in 3-4 years.

NEC and Toshiba are both making privately financed studies of microwave instrument landing systems. NEC is concentrating on electronic scanning, having developed an MLS test antenna three years ago, while Toshiba is looking at mechanical methods. The scanning-beam system has been favoured by a Government study group because of its proven background, although US firms are examining the use of Doppler.



## Plans for space

JAPAN'S SPACE DEVELOPMENT is largely due to the efforts of the Institute of Space and Aeronautical Science (Isas) of Tokyo University. Rocket work by Isas has resulted in a family of sounding rockets, the largest of which, the Lamda 4S, was used to launch Japan's first satellite, *Osumi*, in February 1970. Isas also developed the four-stage Mu vehicle which has been used for all subsequent launches.

The National Space Development Agency (Nasda) was set up in 1969 and took over launcher development and all launch operations. Nasda is also responsible for technology and applications-satellite programmes. Isas retains responsibility for scientific satellites and scientific sounding-rocket activities. The Kagoshima space centre at Uchinoura is to be devoted to sounding-rocket launches, and a site for the new N launcher is being built on Tanegashima Island.

The governmental Space Activities Commission, the controlling authority for space, is now in the course of reviewing the complete space programme, including examination of the fundamental aspects of the entire space policy. Decisions on the future of various activities are expected by the end of this month or early next. The review is not as ominous as it appears, its main purpose being to define future applications-satellite requirements.

Satellites for meteorology and communications are the prime objectives. The metsat programme is aimed at participation in the World Weather Watch Garp project. This means developing both the satellite, and the launcher to place it in geostationary orbit, by 1977.

Considerable US aid was expected for the project, but there is now some discussion on whether or not to buy the satellite outright from the USA. If it is domestically built the satellite will probably be of US design with the first prototype being built by the US contractor, probably either Philco-Ford or Hughes. The programme has yet to be approved but Engins Matra of France has already been asked, through Esro, to develop the camera system.

Japan's main interest in the project is the opportunity it offers to obtain responsibilities in an international programme. A more direct advantage, however, is the experience likely to be gained towards operating a regional metsat system.

A communications-satellite programme will be included in next year's budget request to enable development work on an experimental regional cosmat to begin in 1974 for launch in 1977. US aid will also be required for this.

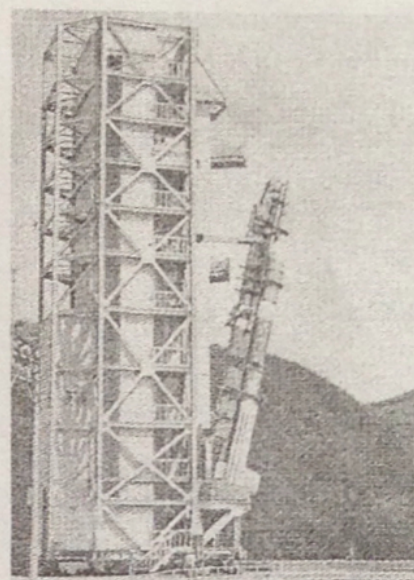
The Ministry of Posts and Telecommunications has, however, stepped in and stressed the necessity of having an operational system in service by 1976. Nasda doubts whether it could launch a geostationary satellite by then. The Government is somewhat sensitive about the low educational level still existing in parts of the country and it is now a national policy that every community in the country must have access to national communications. Japan is 90 per cent mountains and a cosmat is therefore

### SPACE EXPENDITURE (\$ MILLION)

up to	1963	1964	1965	1966	1967	1968	1969	1970	1971	Total
	9,286	7,347	9,624	12,386	17,244	21,914	26,656	41,438	42,920	188,820

**JAPANESE SATELLITE PROGRAMME**

Satellite	Mission	Weight (kg)	Orbit (km)	Inclination	Launch rocket	Launch year
Scientific satellites	Observation of ionosphere, cosmic rays, short-waveband radio noise.	70	500 3,000	30°	M-4S	1971
No 1 Shinsei (F2)						
No 2 Tansei (Rexs)	Observation of plasma waves, plasma density, electron particle rays, electromagnetic waves and geomagnetism.	75	500 3,000	30°	M-4S	1972
No 3 Srats	Observation of solar soft X-rays, solar vacuum u-v radiation, u-v terrestrial corona lines.	75	250 2,000	30°	M-3C	1973
No 4 Corsa	Observation of cosmic X-rays, cosmic $\alpha$ particles and cosmic heavy particles.	90	500	30°	M-3C	1973-75
No 5 Exos-A	Measurement of electron density and temperatures, observation of distribution of electron energies and aurora particles.	70	250 3,000	50°-70°	M-4SH	1973-75
No 6 Exos-B	Measurement of electron density, particles, plasma waves, etc.	50	500 3,000	30°	M-4SS	1973-75
Engineering test	Rocket-launching technology, satellite tracking and controlling technology, extension of antennae.	about 85	1,000	30°	N	1975
satellite 1	Stationary satellite.	about 100	35,800	30°	N	1976
Engineering test	technology, attitude control of stationary satellite.	100				
satellite 2	Stationary satellite.					
Ionosphere sounding	Observation of worldwide distribution of critical frequencies and radiowaves.	85	1,000	70°	N	1975
satellite						
Experimental comsat	Space communications tests and improvement of satellite functions.	100	35,800	Equatorial	N	1977



the only feasible means of achieving this. The Space Activities Commission recognises the necessity of an earliest possible launch, and the matter has priority in the current review.

Aeronautical and navigational satellite plans are still very loose, but Japan is showing strong interest in participating in the proposed US-Esro aerosat project. Apart from aeronautical use, Japan would very much like to see a satellite for maritime navigation to support its considerable fishing fleet.

The commission is also studying the possibility of participating in the US post-Apollo programme, but conclusions are not expected before next April. The 1973 budget request includes appropriation for feasibility work on the sortie lab.

Although Japanese launcher work is centred on the N vehicle, Isas is preparing several improvements to the Mu launcher to enable it to be used for the remainder of the present scientific satellite programme (see table). Most significant is the introduction of radio guidance and thrust-vector control. Previous Mus have had only a programmed trajectory and have suffered from high-altitude wind deflection which could not be corrected.

Modification will begin with the launchers for satellites 3 and 4. Designated Mu 3C, these will have only three stages but will have TVC on the second stage and radio guidance on the third. No 5 satellite will have a full four-stage Mu 4SH with TVC on both second and third stages. The last satellite in the series will be launched by the Mu 4SS with TVC on the first stage as well. The Mu

The Mu-4S3, above, ready for launch of the F2 "Shinsei" satellite in September last year. The four-stage solid-fuel rocket is launched directly into an angled trajectory. Below, the N launcher, cut away to show the upper two stages, will use a Thor with three strap-on boosters as the first stage. Geostationary capability will be 100-130kg

vehicle will continue in service as a basic workhorse.

Two larger launchers, designated Q and N, were started in 1969 but the Q, an intermediate vehicle, was cancelled by the commission in 1970. It will be used only for two proving launches in 1974 and 1975. The N launcher is a three-stage vehicle comprising a licence-built Thor for the first stage, and a solid-fuel motor for the third. The liquid-fuel second stage is being developed in Japan. The launcher is designed to place 100kg-130kg into geostationary orbit. The third stage will be bought from Thiokol, but Mitsubishi is building the external structure and Nissan Motor has responsibility for integration. Mitsubishi is building the MDAC Thor structure while IHI builds the engine under licence from North American Rockwell. MDAC is assisting Mitsubishi with the N<sub>2</sub>O<sub>4</sub>/Aerozine 50 second stage. The total vehicle will be integrated by Mitsubishi. Growing involvement is reflected in quantum jumps in the budget. The 1973 space budget request of \$135 million includes \$117 million for Nasda, predominantly for the launcher and launch facilities. The total is nearly double the 1972 figure and four times that of 1971. Peak development years will be 1974-1975 during which expenditure will exceed \$150 million per year.

The geostationary capability of 130kg is now considered too small for future applications satellites. The commission is expected to study the question of a larger rocket, probably in next year's review. At the moment only two choices are considered feasible, either to invite assistance, i.e. licence-building, or to improve the N. The decision is up to the commission.

Japan, like other space nations, is beginning to experience diminishing public support for its space activities and there was some public outcry when work began recently on launch facilities for the N. Nasda officials feel that the N programme is not likely to suffer from this but suspect that it might affect subsequent work. ■

