



DISCUSSANT RESPONSE

by

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to Robert Machol's

AIR TRANSPORT

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It is my honor and pleasure to be a participant in the 19th International Conference on the Unity of the Sciences, Committee V, as Paper Discussant to Dr. Robert E. Machol.

Dr. Machol is my Sensei. Sensei means a teacher. But mentor may be a better translation. About his excellent academic works, I do not have to mention, I think. Since I met him in 1987 in Cambridge, Massachusetts, he has been so kind and has taught me many things. He invited me as a speaker at the First International Symposium on Aviation Systems Concepts for the 21st Century in September, 1988.

Since he recommended me as his Discussant, I decided to respond to his call. But I am not his match, I know. Yet at least, I can try. I joined the Civil Aviation Bureau as an Air Traffic Controller trainee in 1954. Since then, I have spent over 38 years in ATC and ATC-related fields. So if I have anything to say about it, it is ATC.

I have read Dr. Machol's paper carefully, and I agree to his paper almost to the letter. Yes, air transport is faster, reasonably cheaper, and safer than other forms of transportation, with all three of these advantages becoming more significant as distance increases. And I would like to say how wonderful and comfortable air travel is! Airports have less impact on ecology and environment than highways or railroads. Highway/rail-track construction causes more ecological disturbances than airports unless one is especially careful about it. It is easier to build an airport than to build a highway system. And air transport, particularly helicopters, can reach areas other transport cannot.

As Dr. Machol said, air transport gives much benefit to all people, particularly to such island countries as Japan. Japan has received much benefit by worldwide transport and communications. And we know it is about time we started paying back what we owe.

Right now, 53 airlines of 38 countries operate into New Tokyo International Airport, Narita, and 43 countries are on the waiting list. This is sometimes taken as an example of a typical Japanese way of doing business, slow response to others' request, getting all possible benefits and profits for itself and not giving back much. However, both the Japanese government and New Tokyo International Airport Authority have been trying to expand the airport so that they could accommodate more traffic and respond to those wishing to operate to and from Narita. But there are eight farmers who have resisted this plan. They would not give up their land, and they are there even today. They are almost unique among the Japanese, who are considered as obedient to authorities.

I really want to make Narita much better by adding two more runways, one parallel and one crossing runway; yet I sometimes

admire the strong will power of these farmers. Their resistance shows, in my opinion, that some changes have taken place among the Japanese since the last war.

Japan had been an agriculture-based country for centuries. Of course, it is entirely different now. But an agriculture-centered society produced certain Japanese characteristics. Agriculture (primarily rice production in Japan) is labor-intensive. When the season comes, a farmer whose rice paddies are at the highest ground among his colleagues starts preparation of rice paddies, then the next farmer with his rice paddies slightly lower than those of the first one starts preparation...

There were feudal Lords who were given an absolute authority over their people by the Tokugawa Shogunate. "Thou shalt obey thy Lord" was the rule. Anybody who violated it was executed. Farmers had to help each other so that they could produce sufficient amounts of rice for both themselves and their Lord. They needed good leaders with experience and know-how. They had to listen to their leaders to obtain better crops. Obedience was required for economic reasons.

There also was religious influence of Buddhism and Confucianism, I think. As with most other religions, both Buddhism and Confucianism taught people to respect their rulers. Agriculture, the influence of Buddhism and Confucianism, isolation from other nations by oceans, the obey-or-die rule, and education made the Japanese what they are today.

But not only the farmers of Narita, but all the rest of the Japanese are changing slowly but steadily. Communications helped our people understand what's going on in the world. They've been watching TV, reading newspapers and books, and now over 10 million Japanese are going abroad each year. Most of them go as tourists in groups with guides taking care of their every need. Seeing other cultures with their own eyes broadens their knowledge, vision, and understanding.

The next item on which I would like to comment is safety. Dr. Machol has handled this touchy issue very expertly. Dr. Machol raised the question: "Suppose we could bring that risk (of being killed) down from one in 5 million to one in 10 million by doubling the cost of flying. Would we want to do that?" To that question, I would like to say that we can increase safety without increasing its cost proportionally. Use of new material such as carbon fibers, which is not subject to fatigue failure, is an example.

The concept of safety has much to do with the value of life. Where the value of life is low, people don't or can't pay much attention to safety. To the extent that culture includes a value

of life, then we may be able to say that safety is related to culture.

I would like to add some thoughts from the viewpoint of ATM or ATC service providers. In the North Atlantic (NAT) Region, the airspace over the North Atlantic Ocean, all aircraft have to comply with the Minimum Navigation Performance Specification (MNPS) as set forth in the ICAO DOC 7030. It is stated that aircraft used to conduct flights within the volume of airspace specified in paragraph 2.2.1 of that document shall have navigation performance capability such that:

- 1) the standard deviation of lateral track errors shall be less than 6.3NM (11.7 km);
- 2) the proportion of the total flight time spent by aircraft 30 NM or more off the cleared track shall be less than 5.3×10^{-4} ;
- 3) the proportion of the total flight time spent by aircraft between 50 and 70 NM off the cleared track shall be less than 1.3×10^{-4} .

MNPS is to provide the target level of safety (TLS) of 2.5×10^{-9} fatal accidents per aircraft flight hour. Such navigation performance capability shall be verified by the States of Registry or the State of the Operator, as appropriate (DOC 7030, NAT/RAC-1 and 2).

There were 167,506 flights in the NAT MNPS Area during the period of 1 March 1990 to 28 February 1991, compared to 144,151 in the previous year. Twenty two of these 167,506 aircraft violated MNPS. Of the twenty two, four aircraft were not certified for MNPS operations; one committed an ATC System Loop error; six had equipment control errors including inadvertent waypoint insertion; four had waypoint insertion errors due to the correct entry of incorrect position; four other navigation errors included equipment failures which were notified to ATC in time for action; and there were three other navigation errors, including equipment failure, of which notification was not received by ATC.

There are reported cases of repeated violations of MNPS by a single operator. Incredible, isn't it? Is it a cultural difference or one of human natures or what? There are many drivers without safety seat belt fastened, as Dr. Machol wrote in his paper. But this is much, much worse. A good, law-abiding aircraft is also destroyed when involved in a collision with an outlaw aircraft.

Most of these ocean-going aircraft are using inertial navigation. Its accuracy is better than 2 NM/hour deviation. But when GNSS

becomes operational, order-of-magnitude differences in navigation accuracy will take place. Even with SA (intentional degradation of accuracy), civil users can enjoy 100-meter accuracy (2 sigma) all over the world, and it is available continuously. There remain some problems yet to be resolved before GNSS is approved as a sole means of navigation, but I am sure it can be done shortly. Everyone agrees that we can reduce separation when GNSS is available and aircraft are equipped with satellite nav/com systems. Current lateral separation of 60 NM in the NAT Region or 100 NM elsewhere can be reduced to 20 NM or 10 or even to 5 NM, which is used as radar separation today.

Then I can envisage aircraft flying near optimum tracks separated by 5 NM and cruise-climbing (aircraft maintains gradual climb as it burns fuel--as distinguished from step-climbing). I have no quantitative data how much they can benefit from this, but it should be enormous. The US FAA told us that reduction of vertical separation above Flight Level 290 from 2000 to 1000 feet would save \$40 million in the U.S.A. alone.

So all participants at the ICAO 10th Air Navigation conference, in September of last year, agreed to endorse the ICAO CNS and ATM concept (satellite, data-link, and computer-technology-based air traffic management system). Airspace users, airlines, and business and general aviation recognized that, to participate in the improved ATM system and to enjoy the benefits realized, they would equip their aircraft with new equipment.

About the number of passengers in one B-747. Yes, some B-747s in Japan for domestic service have 528, 550, or 569 seats because we are used to it. Once you have ridden on a commuter train in Tokyo, you do not get upset by such high-density seating arrangements. And you can save a lot of time paying just about the same amount of money. For example, if you want to go to Osaka from Tokyo, where the bullet train takes 3 hours, a B-747 gets there in about 45 minutes. And there is not much difference in the train fare and air fare.

Concerning the concept of man-in-the-loop, I agree 100% with Dr. Machol. It has been my belief for over 30 years that there will be contingencies, even with the most sophisticated systems, if they are made by man; and man is good at handling the unexpected if one is well trained and experienced.

Air transport is the youngest means of transportation. And it was born when the appropriate science and technology base was there to be applied. Wars accelerated its progress. Now is the time for all of us to beat our swords into plowshares and our spears into pruning hooks.

Thank you very much for your attention.