Area Navigation Technique for Air Traffic Services

by A T A Ansary

PRESENTLY aircraft navigation systems is based on point source in the ground but sophistication of airborne navigation equipment over older forms of navigation. This mean's navigating from one aid to another aid stationed on the ground will be replaced very soon or complimented by one based on station with reference from navigational aids. Area navigation-equipped aircraft performing on board position determination, could plan and operate along the most direct route on any desired flight path within the coverage of station referred navigation aid or within the limits of the capability of self contained aids or a combination of these aids. In a RNAV system a computer on board of an aircraft is employed to convert navigation data inputs into aircraft position, calculate aircraft track and distance and provide steering guidance to the next way point. This concept is known as Area Navigation (RNAV).

Efficient use of airspace through RNAV

In the modern air traffic control system the flight plan of an aircraft will still define the intended flight path but efficient use of airspace will be a major factor. The use of RNAV will allow each aircraft to use direct, fuel efficient route to fly in place of track, based on ground-based navigational aids. As a result the airspace route structure will change remarkably. Providers and operators utilising RNAV capabilities in a particular airspace is expected to gain economically in respect of navigational aids. Under RNAV concept installation of navigational aids at each significant point/or aerodrome would not be necessary thus cutting the equipment costs and its installation charges. Distances along and across the track are computed to provide the estimated time to a selected way-point together with a continuous indication of steering guidance for the destination. It permits aircraft to fly along any track within prescribed accuracy tolerance without the need to fly directly over ground-based navigation facilities.

The global Navigation Satellite Syestem (GNSS) will provide navigation coverage for enroute, terminal areas and precision and non-precision approaches for aircraft landing. Two aspects concerned the question of separation to be applied in RNAV equipped aircraft. One is Horizontal Separation Minima to be applied between the flight paths of aircraft on random routes and the second aspect is the control methods to be applied to such aircraft.

Horizontal Separation Minima is primarily dependent on the accuracy of navigation from each pair of aircraft. Applying area navigation along random routes, the outstanding ATC problem being the presentation of different routes planned by individual flying. Apparently, it will be difficult to know when and where two aircraft will be essential traffic i e loose minimum required separation. The other problem will be necessary coordination to be made between adjacent ATC units.

Unless area navigation concept is restricted to within one control area at a time, continuous change of transfer of control points will pose a difficult task to ATC. These problems can be resolved by the availability of radar and /or automation. For these problem for the time being area navigation concept is to be confined to only selected portions of the airspace and / or specific groups of users who are prepared to meet a mutually agreed upon degree of accuracy in navigation while operating in the portions of airspace defined for that purpose. Area Navigation concept can be applied also in areas of high traffic density to establish parallel ATS routes to relieve airspace congestion.

While considering traffic handling in RNAV routes the air traffic controllers will have to consider the following factors:

1) geographical familiarisation beyond his own sector of airspace.

2) different methods of identifying conflicts which could occur any where in the airspace.

3) radio telephoning procedures.

4) new civil/military coordination procedure.

As far as the pilots are concerned they must have through understanding of the RNAV equipment on board the aircraft and awareness of its limitation and training in the operating procedures. Safeguarding it if necessary to obtain accuracies on a continuous basis.

2) Provisions to specify, in detail the procedure to be used for aircraft in transition between an established ATS routs network and on RNAV area.

These provisions must also cover cases of temporary loss of the RNAV capability by aircraft operating in RNAV area.

3) Provisions which ensure a continued monitoring of the navigation performance in the RNAV area in order to ensure that the condition upon which RNAV is based are met.

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Airborne RNAV Equipment

RNAV equipments can accept a variety of navigational inputs; it is therefore convenient to consider the general characteristics of RNAV airborne equipment under the following headings:

1) VOR/DME;

2) OMRGA/very low frequency (VLF);

3) LORAN-C;

4) inertial navigation systems (INS);

5) DME/DME; and

6) global navigation satellite systems (GNSS)

All of the above systems are either coupled or capable of being coupled directly to the auto-pilot of the aircraft. This facility may become a prerequisite of future RNAV equipment.

Factors to be considered for Area Navigation Application

The use of RNAV in a given area and the user's ability to comply with necessary conditions must be based on:

1) Agreement between airlines operator and provider authority to meet navigational optimum efficiency and navigational accuracy and familiarisation with RNAV radio telephoning phraseologies.

4) Provision which relating to suspension of RNAV method and reversal to conventional form, in case deterioration of the situation demands. Provision should also cover the case of the restoration of RNAV method.

5) Provisions regarding full or 'partial immediate' suspension of the use of the essential facility upon which RNAV is based during temporary out of service of the system.

Advantages of RNAV

1) establishment of more direct routes (permitting a reduction in flight distances);

2) establishment of dual or parallel routes to accommodate a greater flow of en route traffic;

3) establishment of by-pass routes during bad wx condition or for overflying aircraft in high density terminal areas;

4) establishment of alternative or contingency routes either planned or on ad hoc basis;

5) establishment of optimum locations for holding patterns; and

6) a reduction in the number of ground navigation facilities.

Planning for RNAV procedure

Before planning any flight based one RNAV technique, pilots must ensure that:

1) the aircraft is equipped with serviceable RNAV equipment which has been approved by the State of Registry or State of the Operator for the appropriate level of RNAV operations;

2) they have a through understanding of the equipment and its limitations and a current knowledge of how to operate the equipment in order to achieve the optimum level of navigation accuracy;

3) when using RNAV equipment which depends on ground aids for navigation data input, there are sufficient serviceable aids available to provide continuous determination of the aircraft's position for the planned operation;

4) whenever possible cross-checking procedures are employed at the flight planning stage in order to reduce the in-flight workload required to ensure the safe operation of RNAV flights, for example:

a) by taking account of the designated operational coverage of VOR/DME facilities to ensure best use of available aids;

b) by plotting check fixes on each leg which show DME distances/VOR bearings on the en route chart;

c) by highlighting track/distance information between way-points;

d) by careful crass-checking of the flight plan details of way-points against source material;

e) by checking that, for equipment utilizing a data base, the materials is current for the date/time of the planned flight; and

f) by taking account, especially for operations in the lower airspace, of the effect of terrain and ground aid coverage.

Considering the continued development of aviation and increasing demands for optimum utilisation of airspace, Future, Air Navigation System (FAN) is based on RNAV in different types of airspaces being used by the aircraft throughout the world.

Big Deposit Promises Big Return

QUEENSLAND Metals Corporation is using Australian technology to turn a huge deposit of magnesite into value-added products aimed mainly at the export market.

QMC is working on using magnesia for effluent treatment, lighter metal parts in cars, better linings for steel furnaces, and magnesium cements and building products. "All of these projects are on the basis of having sufficient raw materials to run between 40 and 50 years at world scale," says QMC managing director Ian Howard-Smith.

Magnesia, the oxide produced by heating magnesite, can be recovered from seawater, but the process is costly. The discovery of 800 million tonnes of magnesite at Kunwarara in central Queensland in late 1985 has made large-scale commercial applications possible.

A 13-year research and development agreement has been signed with CSIRO, and Dr Malcolm Frost is coordinating a range of magnesia-based projects at the Division of Mineral Products in Port Melbourne.

Mr Howard-Smith describes the CSIRO involvement as "absolutely critical."

"CSIRO had been working on magnesite for about 15 years, but there wasn't a lot around that was commercial. When we found the Kunwarara deposit in late 1985 there was a meeting of the minds, a realisation that both sides would benefit from the involvement."

A project called ENVIROMAG, a joint venture with ICI, is working on the use of magnesia in effluent treatment. Dr Frost says that magnesia is suitable for many kinds of waste streams, including industrial acidic effluents and sewage, where it can reduce sludge volumes. It is also used in Japan and elsewhere for removing gases such as sulphur dioxide.

Magnesium oxide is a gentle alkali, so the rate of neutralisation is slower than with sodium hydroxide or a lime. The heavy metals precipitate to a very dense sludge that is easier to filter and cheaper to dispose of than sludge from other alkalis.

QMAG, a joint venture with Pancontinental Mining and Radex of Austria, will make deadburnt magnesia for industrial refractories to line steel furnaces. Produced by heating magnesite to extremely high temperatures, deadburnt magnesia is chemically inert and a good thermal insulator.

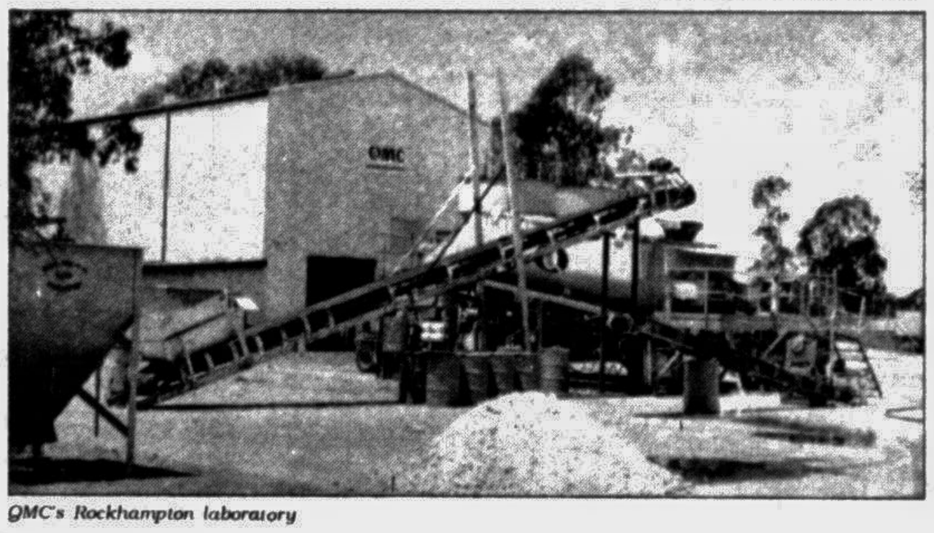
Worldwide demand to reduce motorvehicle emissions has focused attention on the use of a magnesium alloy to produce lighter metal part for cars. A QMC project called MAGMETAL is researching the possibilities. The United States and Japan have legislated to require vehicle emissions to be reduced and fuel economy to be improved. Making smaller cars is seen as commercially unacceptable, so the answer is to make them lighter — a 1% weight reduction gives roughly a 1% reduction in fuel consumption.

Japan has a programme to reduce the weight of an average car from 1300 kg to 850 kg by the year 2000. It is proposing that cars be made of much less steel and much more aluminium, plastic and magnesium. "Instead of about 1 kg of magnesium they are suggesting about 40 kg," says Dr Frost, adding that magnesium is very well-suited for die-cast parts, which could weigh less than a third of the present aluminium parts.

Mr Howard-Smith believes magnesium metal will become a big export industry, and says it could be used for parts such as steering columns, dashboards and seat supports.

QMC's fourth project, CEMAG, is a joint venture with Queensland Cement to develop magnesium cements and building products. Dr Frost's research programme is also examining the use of magnesium hydroxide as a fire retardant in plastics.

Dr Frost says the Kunwarara magnesite will be the highest-quality natural magnesia on the market.' — Australian Science



QMC's Rockhampton laboratory

Plant Breeding for Better Crops

NUCLEAR techniques — sometimes in combination with other biotechnology — can be used to develop valuable new strains of food crops. "Mutants", which are genetically different from parent stocks, are selected from irradiated populations in the laboratory, greenhouse, or field. Those with desirable characteristics are then used after rigid field trials, in mutation breeding.

Techniques such as these have yielded hundreds of new varieties of many different crop species, such as rice, wheat, and soybean. The resulting varieties may have a better resistance to diseases, a better product quality, and higher yield. For example, during 1987, more than 30 new cultivars of rice were developed by breeders and made available to rice farmers.

Mutations are changes in the hereditary substance of living things. In nature, they are ultimately the source of evolution. Scientific methods, mainly the use of radiation, can increase by a hundred to a thousand times, the likelihood of beneficial changes in plants grown for man's use, and provide a tool to break through present limitations in variability. The Joint Division assists Member States in the application of nuclear techniques to induce plant mutations.

In 1964, the Joint Division was faced with a number of unresolved questions of procedures and methods, choice of terms, effective treatment conditions, and screening and selection for effective application of radiation to plant breeding.

At that time, a number of plant geneticists were working in the field, mostly with interest in radiation biology. Therefore, improved crop varieties usually came out as a by-product. The "mutation breeders" were few and far apart and there was no co-operation between them.

In the spring of 1964, the FAO and IAEA jointly sponsored a major international conference on mutation breeding, one which power to be a milestone. During the conference, many active workers in the field discussed the necessity of co-operation in approaching the many outstanding problems in mutation breeding. The number of known released mutant varieties at that time was less than a dozen.

A spin-off of that conference was the initiation of a Joint Division programme in Southeast Asia to stimulate co-operation among rice breeders using induced mutations. The initial meeting in Bangkok in 1965 was the first time these rice breeders in Southeast Asia had ever met to discuss common breeding problems.

Partly as a by-product of the success of this programme, the Society for Advancement of Breeding Research in Asia in Oceania (SABRAO) was established in 1986.

The main result, however, was a high number of improved rice varieties bred with the help of induced mutations. Before the programme began, there were four mutant varieties of rice on the market. Now the number of mutant derived rice varieties is 190 and the area under mutant rice varieties is counted millions of hectares.

In the early days of the development of this technology, there was a lack of knowledge of how to initiate a mutation breeding programme to incorporate a desirable trait into the best existing varieties.

Therefore, one of the Joint Division's early programmes was to compile a manual on mutation breeding. It was important to solve the problem of how induced mutations could fit into the regular plant breeder's way of doing business in a practical way. A number of technical problems and scientific conflicts were resolved and agreement was reached on terminology which eased communication and understanding of methodologies.

The resulting manual has been used subsequently as the standard text for plant breeders worldwide.

Where appropriate methods were not available, solutions had to be found experimentally. Thus, since there was no existing facility to make fast neutrons available to plant breeders, a SNIF (Standard Neutron Irradiation Facility) was designed and tested.

This funnel-like contraption shielded with lead and boron, when lowered into a pool-type reactor, became an almost pure source of fast neutrons.

Another early programme focussed on the testing of mutant durum wheat varieties in the Mediterranean region and the Near East. Mutant durum wheat varieties are now among the most successful durum cultivars grown by farmers.

A change in emphasis

In the following decade, the Joint Division turned its attention to other problems, such as resistance to diseases and cereal grain protein content. From annual self-pollinating cereals, like barley, rice, and wheat, with already well established mutation breeding techniques, technology research moved to grain legumes, fruits, and root and tuber crops, many of which are particularly relevant to developing countries.

The international co-operative programmes on grain legume improvement proved to be quite effective and produced more than 100 improved cultivars. However, considerable problems were encountered in vegetatively propagated crop plants.

There was remarkable economic success in applying the technique of mutation breeding to vegetatively propagated annual ornamental plants. This encouraged researchers to look for improvements in the methodology. Ultimately, the sue of in vitro culture techniques appeared to be successful. Thus, in vitro culture techniques have been used in the Joint Division's programme since 1982 and problems that were considered taboo in the 1960s, such as improving disease resistance in the apomictic and triploid banana are now being attacked.

In line with the needs of Member States, the development and transfer of technology now also includes various oil seed and industrial crops, such as sesame, rape, and cotton.

Recognizing how crop species used for human food are impoverished through the intensification of productive agriculture, the Joint Division also looked into the possibility of "up-grading" traditional, but now neglected, crops to levels of profitability for today's farmers.

It appears that induced mutations are an appropriate tool for such "second cycle domestication" and also could be promising in attempts to domesticate new crop plants of interest for food, feed, or as raw material for industrial purposes.

Hands on experience

Under 32 country projects and two regional projects, the Joint Division is assisting developing countries in the proper application of mutation breeding techniques in highly diversified plant breeding programmes.

Research contracts and agreements in recent years have focused on advancement of mutation breeding technology to improve root and tuber crops, and cereals, and on developing the technique for "test tube selection" of mutants with better disease resistance.

Knowledge and skills in the use of nuclear techniques in modern plant genetics and breeding are shared with scientists from developed and developing countries during scientific and technical conferences and workshops.

Scientific publications, including proceedings of conferences, technical documents and manuals contribute to the dissemination of scientific results obtained in Joint Division projects.

The Joint Division emphasizes support for mutation breeding in developing countries. New unconventional breeding methods are begin developed for improvement of tropical crops. Palms, tropical fruits, cassava, yam, and cocoa are among the tropical crops being studied at the Seibersdorf Laboratory. Tissue cultures of these crops are prepared for mutagenic treatment and plant regeneration.

Bananas and plantains are staple food crops for millions of people in developing countries. Because they are asexual plants, the classical corss breeding approach cannot be used to solve disease problems. Cultures of banana tissues and cells significantly enhance the effective use of irradiation and chemical mutagenesis for induction of new genetic variation.

Plants regenerated in vitro are evaluated under tropical conditions. The new breeding methods developed at Seibersdorf are transferred to tropical countries where they are most needed.

The most effective way to transfer new technologies to developing countries is by training young scientist. Every year, the Joint Division organizes an international training course on the use of induced mutations in plant breeding at the Seibersdorf Laboratory.

Future directions

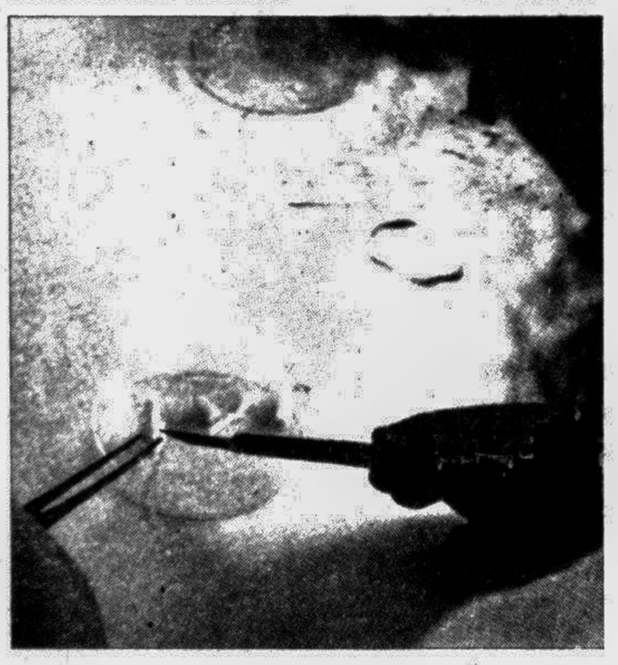
Progress in modern scientific disciplines, primarily molecular biology, opens up new horizons for the improvement of crops through mutation breeding. Promising research areas are DNA technology and genetic transformation. Methods for specific site directed mutagenesis in crop plants are being developed.

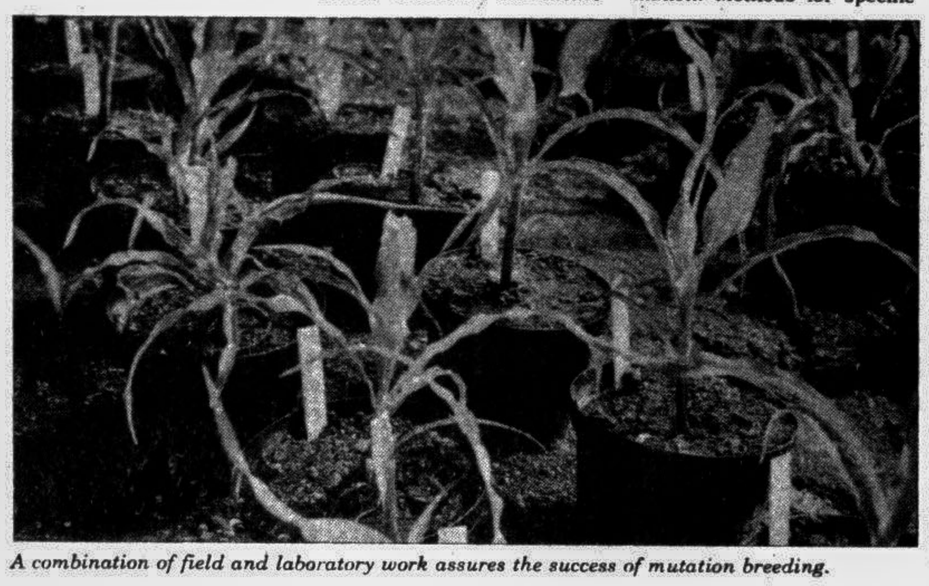
Selection of superior mutants at the cell level could revolutionize plant breeding. It is a new challenge for the Join Division to introduce molecular genetics and gene engineering in its programmes, aimed at speeding up the improvement of cultivars in developing and developed countries.

By 1960, 15 induced mutant crop varieties had been released to growers. Now, almost 30 years later, more than 1200 mutant cultivars of crop plants and ornamentals have been released.

Many of these mutant cultivars have significantly increased yield, higher market value, improved quality, increased disease resistance, and stress tolerance. Biotechnology and genetic engineering, combined with the use of induced mutation, have a great potential in the hands of the plant breeder to raise levels of human nutrition and standards of living through better crop plants.

— FAO/IAEA




A combination of field and laboratory work assures the success of mutation breeding.

Technology Scaled Down to A Hair's Breadth

THE continuous downscaling of electronic components has become so common that it now seems perfectly normal to pack a personal computer under one's arm and carry it everywhere like a briefcase — in the form of a laptop. However, the fact that this device still has gigantic proportions compared with other developments is shown by the field of microtechnology, where the most recent accomplishments include a tiny motor, whose rotor is not much thicker than a human hair.

Such extreme miniaturizations became possible once suitable tools could be developed to fashion structures whose dimensions lie in the range of just a few hairs' breadths, thus rendering them invisible to the naked eye. The Kernforschungszentrum Karlsruhe (Nuclear Research Centre Karlsruhe) is the world's leading producer of such micromechanical components made from a wide range of materials. As opposed to conventional processes which give rise to seemingly two-dimensional structures, the LIGA process developed at the Nuclear Research Center's Institute for Microstructure Technology is the first one ever to allow the production of three- dimensional mechanical components like gearwheels, turbines and filters a high degree of precision and, above all, so that they can be reproduced.

In the LIGA process, the researchers from Karlsruhe combined the methods of lithography and electroplating with plastic forming techniques. In the first stage, lithography, the extremely minute "blueprint" of the planned component is first projected on to a layer of radio-sensitive plastic, using penetrative and extremely parallel X-rays from a synchrotron. After that, the exposed areas are dissolved out with a developing fluid. In the second stage, the resulting is filled out with metal which is applied galvanically, i.e. electrochemically. With the help of this process, it is then possible to produce the desired structures themselves, or just the corresponding metal forms at first, which can then be used for an economical mass production involving plastic moulding.

As the synchrotron radiation is very concentrated, thus outlining images very sharply, it is also capable of providing great structural depth. Consequently, it has allowed, for the first time, the production of structures having extremely small horizontal dimensions of a few micrometers, but nevertheless, having a height of several hundred micrometers. In this manner, the institute at Karlsruhe has been able to produce microstructures from metals, metal alloys, various plastics, and even ceramics.

However, the fact that this device still has gigantic proportions compared with other developments is shown by the field of microtechnology, where the most recent accomplishments include a tiny motor, whose rotor is not much thicker than a human hair.

By combining the steps of the LIGA process, it is also possible to produce components for very tiny machines, an example of which is provided by an electromotor designed at the laboratories in Karlsruhe. It consists of a rotor with a radius of 200 micrometers, rotating on an axis having a radius of 115 micrometers.

With a height of roughly 100 micrometers, which is considerable, the rotor is surrounded by six stators where the rotating electromagnetic field, which makes the rotor turn, is generated at approximately 100 volts. The speed of the motor can be varied from stepping operation up to 3,400 rotations per minute.

Suitable material developments and the combination of data processing, process control and robotics technology will open up a completely new range of application for this process. According to Dr. Peter Bley from the Institute for Micro-structure Technology, a new technical revolution is in the making here— future applications will not only include measurement and automatic control technology as well as communications systems but, above all, industrial production techniques as well as medical and environmental technology.

(German Research Service)