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Book Reviews

Low level radiation and living state by N. G. Huilgol *et al.*, Narosa Publishing House, 6, Community Centre, Panchsheel Park, New Delhi 110 017, 1994, pp. 189, Rs 550.

This book represents the *proceedings* of an international symposium which was held in Bombay from March 13 to 15, 1992. At least one European participant told me that not all papers presented are published in these *proceedings*, that there were a number of panel discussions which raised the temperature of the meeting from time to time and that their inclusion would have added some more colour to the final publication! Nonetheless, the editors deserve to be congratulated for the 20 papers they were able to put together which provide a flavour of the various themes discussed.

Considering first the experimental studies, Rao *et al.* report on the lack of dose-rate effect for the induction (by beta rays from HTO) of gene conversions in the diploid yeast *Saccharomyces cerevisiae*; this was true of cells kept under 'non-growth' conditions as well as of exponentially growing cells. However, when the effects of low dose-rate gamma irradiation (10 mGy/h; dose range 0.2 to 7 Gy) were compared with those of acute irradiation (10 mGy/min; 10-100 Gy) in exponentially growing cells, the gene conversion rates with low dose-rate gamma irradiation were about a six-fold *higher*. In another paper, also with the same organism, Rao *et al.* report that gamma-irradiated exponentially growing cells do not seem to manifest the phenomenon of 'adaptive response' (also for gene conversion) of the kind reported in a number of studies with other experimental systems. (For a reader interested in delving deep into the adaptive response studies in mammalian systems, the 1994 UNSCEAR report provides an excellent source.)

Nomura discusses his (now well-known) studies in mice on the induction of lung tumours, leukaemia and congenital abnormalities in the first generation progeny of irradiated mice, which were first published in the late 1970s. Of these, those on leukaemia have received much attention in view of the Gardner *et al*'s 1990 finding of a statistical association between low dose paternal radiation exposures and childhood leukaemia in workers of the Sellafield Nuclear Reprocessing Facility in the UK. Among the results in the present paper of Nomura the following are significant: (i) striking differences between the three strains used with respect to the induction of lymphocytic leukaemia in the progeny following parental irradiation, and (ii) the majority of tumours seen in the progeny of irradiated mice are adult-type tumours of the lung, ovary, stomach, liver, uterus, etc. He suggests that it would be instructive to examine the children of A-bomb survivors and those from other populations known to have sustained radiation or other mutagenic exposures for these types of tumours at onset ages characteristic of these tumours.

Bhattacharjee's mouse study on the induction (by acute gamma irradiation of male mice) of dominant lethals and of congenital abnormalities confirms results from earlier studies published in the literature and adds nothing substantially new. (In the *Table of contents*, the title of the paper is given as 'post-implementation' mortality instead of post-implantation mortality, an obvious 'transcriptional' error!). In studies on the induction of micronucleated erythrocytes in mouse bone marrow cells by low dose gamma irradiation (range: 0.03 to 0.38 Gy delivered at 0.32 Gy/min), Bhilwade *et al.* address *one* important question of relevance (especially for chemical mutagenesis workers), namely, the influence of sample size. After a reported total of 441 mice sacrificed and nearly 100,000 polychromatic erythrocytes [PCEs] scored, the conclusion that emerges is that the use of 6 mice per dose group and scoring of about 1000 PCEs per mouse will permit the detection of significant increases over controls (the control frequencies in their strain ranged from 1.3/1000 to 4.2/1000). The conclusion is not very different from the suggestion of Heddle *et al.* in 1983 (which they quote), namely, at least 500 PCEs from each of the 8 animals to detect an increase of about 4 to 6/1000 PCEs with 95% confidence when the background is less than 4/1000).

Among the studies on the effects of prenatal irradiation on carcinogenesis in mice and rats reviewed by Einhorn, those in rats on the effects of prenatal irradiation combined with transplacental ENU treatments are particularly interesting. ENU administered after day 12 of gestation in rats produces neurogenic tumours in a high proportion of the offspring. However, when the animals are first X-irradiated (0.05 to 2.5 Gy) on day 16 and ENU treatment is given on day 20, tumour incidence is drastically *reduced* specifically in brains that have developed major radiation-induced dysplasia!.

In their paper, Uchida *et al.* discuss the phenomenon of autologous tumour killing (ATK) with at least three significant findings which are of relevance for radiotherapy of tumours. First, in studies using autologous (*i.e.*, derived from the same individual) combinations of peripheral blood lymphocytes (effector cells) and tumour cells (target cells) from patients with various types of neoplasms, it was found that the cytotoxicity of lymphocytes (ATK activity) on tumour cells varied, depending on the tumour types. More than 80% of patients who were positive in ATK tests at the time of curative surgery remained tumour-free and were alive for more than 5 years after the surgery. Second, X-irradiation of lymphocytes induces a transient increase and a subsequent abolition of ATK activity, but could be protected against the latter by biological response modifiers (BRMs). Third, when freshly isolated tumour cells were X-irradiated and cultured overnight, they exhibited an increased sensitivity to lysis by lymphocytes; the X-ray induction of ATK sensitivity of tumour cells was observed following as little as 1 Gy. On the basis of these and other results the authors suggest that a combination therapy with low-dose X-rays and BRMs may be a potentially useful method in cancer therapy. From studies on the potential uses of immunological parameters as biological indicators of radiation exposure, Dehos *et al.* conclude that many effects occurring *in vivo* cannot be observed *in vitro* and that the types of changes seen several days after *in vitro* irridiation are more close to those seen after *in vitro* irradiation.

Turning now to human studies, the paper of Luxin *et al.* reviews the work on dose assessment and cancer mortality in high-background radiation areas in Yangjiang, China. The comparison groups were constituted by inhabitants of the 'high background radiation areas' (HBRA: an average of 6.4 mSv/y) and those from the neighouring 'Control Areas' (CA; 2.4 mSv/y). The indicators of adverse health effects were: mortality from different cancers, thyroid nodularity in women aged 50 to 65, and incidence of Down syndrome. There was no statistically significant difference between the inhabitants of HBRA and CA with respect to any of these indicators. Aravindan and Mahajan provide a succint review of the various studies that have been carried out in a similar HBRA (due to monazite deposits) in Kerala, India, over the past 20 years or so. These studies included plant systems, rodents, as well as people living in HBRA. No clear cut differences (relative to the 'normal background' areas) were found in the measures of biological effects used. Nair *et al.* provide a glimpse of the studies now underway on health effects of low-level radiation exposures in the HBRA in Kerala. The computer software package for determining statistical significance of radiation effect in high background area developed by Yadav *et al.* which they described in their paper may provide useful not only for the above purpose but in a broader context as well. The paper of Subba Ramu touches on the problem of health impact assessment of indoor radon levels in some high background areas in India; they estimate, on the basis of published data, that in an estimated 13.4 million people living in this area, that the total expected number of lung cancers attributable to radon progeny is only of the order of 150, too small a figure to base a meaningful analysis, considering variation in radon levels from place to place and other confounding factors.

The flurry of scientific activities that were initiated internationally to assess the radiological consequences of the Chernobyl accident is the theme of the review paper by Gopinath. He stresses, among others, that (i) the data available were not detailed enough to exclude the possibility of an increase in some tumour types; (ii) given the estimated doses and the internationally accepted risk estimates, future increase over the natural incidence of cancers and hereditary effects would be difficult to discern; (iii) there may be an increase in the incidence of thyroid tumours, but more data are needed for demonstrating this, and (iv) these comments do not detract from the unprecedented psychological, and economic impacts of the accident.

Burlakova reviews the consequences of low-dose level radiation drawing upon information published in the literature and on the Chernobyl experience. Since no actual data are presented, it is difficult to judge the validity of some of his provocative statements such as "the risk coefficient for neoplastic transformation at lower doses is higher than what is generally assumed" ... "it is more appropriate to assume low dose as the causative factor for deterioration of health status of population exposed to low level radiation following Chernobyl accident."

Taylor addresses the question of the impact of environment radiation exposures on human cancers, one which is raised from time to time. He concludes his review by noting that "with the possible exception of lung cancer, environment radiation plays a minuscule role, if any, in the causation of human cancer'. He cautions however that "in order to be certain of this, we need much more information about the sensitive cells for each type of cancer, the mechanisms of induction and the radiation risk estimates, preferably age-related risk estimates for the individual types of cancer."

Stather's paper on radiation-induced cancers in man, which I immensely enjoyed reading, provides a superb and lucid review of the field, with enough details to guide the reader into how these data are used by both national and international scientific commitees including ICRP in its 1990 recommendations (ICRP Publica-

tion 60), the assumptions and uncertainties involved in the estimation of risks, and what lies ahead in this multidisciplinary area. Even if the reader has no prior knowledge of the subject, after carefully reading it, he or she will come out very satisfied. Parthasarathy's paper on biomedical effects of radiation nicely complements Stather's in that it has more emphasis on medical radiation, lung cancer in underground miners, biological effects of prenatal irradiation and on studies of workers in nuclear power industry. The paper of Soman and Rao deals with the conceptual and biological basis of the recommendations of ICRP publication 60, but content-wise, this paper overlaps with that of Stather. Using the best available Indian cancer mortality and demographic data and ICRP's risk coefficient Mayya *et al.* project cancer risks to the Indian population and conclude that the adoption of ICRP-60 dose limits in India entails a safety margin by at least a factor of 2 at present.

On the whole, I found this book a worthwhile one to have in my collection. It will serve the intended readership (health physicists, radiobiologists and any interested scientist who wishes to keep abreast of the current status in the fields of radiobiology and radiation protection) well.

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Slow potential changes in the brain by Wolfgang Haschke *et al.*, Birkhauser Verlag, AG, CH-4010, Basel, Switzerland, 1993, pp. 288, SFr 158.

Slow potential changes in the brain is the fifth book in the Brain Dynamics series published by Birkhauser. Slow potentials primarily refer to the bioelectrical phenomenon recorded from the neuronal processes in the brain using direct-coupled amplifiers. The potentials observed are beyond the frequency range of conventional EEG. The study of slow potentials in animal models and man provide an important tool to understand aspects of higher brain function such as cognitive processes.

The present volume is an outcome of an interdisciplinary symposium held between July 2 and 6 at the Friedrich Schiller University in Jena, with contributions primarily from scientists in Europe. The volume covers various aspects of slow potentials from the pyschophysiological and neurophysiological attributes, to the single cell level including glial cell involvement.

The introductory remarks by W. Haschke attempts at outlining the 'generator' of the slow potentials, starting from considerations of the basic unit of generator potential, *viz.*, the pyramidal neuron of the cortex, acting as a single dipole with a sink and source component. Collection of such pyramidal neurons acting in synchrony results in sufficient dipole strength to be manifested as a field potential in the scalp. Considerations have to be additionally made about the spatial direction of individual dipoles with respect to each other in the cortex which is not flat but highly gyrificated, arising from the foldings of cortical grey matter.

In Part I, Overview, Caspers discusses the relation of slow potential changes recorded from the surface of the cerebral cortex of brain to behavioural states of sleep and wakefulness, epileptic seizure activity and changes in partial pressure of dissolved oxygen and carbon dioxide. Cruetzfeldt *et al.* present their work on recordings of simultaneous electrocorticogram and single neuronal activity of the cortex in man. The studies indicate that EEG waves and patterns on the one hand, and neuronal discharge probabilities and patterns are related to each other. The recordings from epileptic foci showed sharp spike wave complexes, and the negative components of these coincided with inhibition of neuronal activity.

Part II of Psychophysiology has the first article by H. Bauer where he discusses the various determinants of contingent negative variation (CNV) amplitude. The second article by Haschke *et al.* is an interesting psychophysiological study on members of a football team where the authors establish that the slow potential shifts in the brain are indeed different between action-oriented subjects (who are less affected by failure) and state-oriented subjects, during task performance, in the absence of any actual differences in task performance. The latter group thus seems to have problems with coordinating cognitive activities. The other articles are by Yamaguchi and Knight *et al.* on the relationship between task-related slow potential shifts and DC potential of the brain; Korunka *et al.* on contingent negative variation (CNV) and information processing in patients with

panic disorders, where they establish that information processing in high-anxiety patients is different from healthy subjects; Eulitz *et al.* on the relationship between different levels of motor preparation and lateralization of slow potential shifts and CNV in man.

Part III, Neurophysiology, relates to contributions analyzing the genesis of field potentials. Vaughan H. G. *et al.* review the techniques evolved to study the genesis of cortical event-related potentials in the old world monkey. Herreras and Somjen discuss the phenomenon of prolonged unstable depression, a modified manifestation of spreading depression. Walden *et al.* analyze modulation of glutamate responses by NA and GABA in neo- and archicortical structures which have important relevance to understanding the pathophysiology of several neuropsychiatric disorders. Scheller *et al.* discuss the participation of excitatory amino acids in the generation of cortical spreading depression. The use of field potentials, particularly visual-evoked field potentials in determining neuronal mechanisms of behaviour, is examined by Siegel and Sisson.

Part IV, Glia and microenvironment, considers the role of microenvironment and glial cells to slow field potentials. It has Roitbak's article on the effect of extracellular potassium in glial cell depolarization and their contribution to cortical slow potentials in cats; Steinhauser *et al.* on voltage gated currents in glial cells of mouse hippocampus; Mitzdorf on potassium homeostasis mechanisms in the causation of field potentials; and Hanitzch on slow components of the electroretinogram in the isolated rabbit retina and light-induced changes in extracellular potassium.

Part V, Biomagnetism, considers possibilities in localizing sources at depth by means of their biomagnetic fields. Berthel *et al.* discuss the use of SQUID (superconducting quantum interference device) gradiometer in registering magentoencephalographic signals. Haberkorn's article is a theoretical chapter on spatial source localization using appropriate physical models. Huonker *et al.* discuss the use of balanced second-order gradiometers for measurement of neuromagnetic signals, *e.g.*, visually evoked fields and Vieth *et al.* demonstrate slow magnetoencephalograph (MEG) shifts during epileptic activity.

Part VI, Motor control, has contributions from McCallum; on DC shifts associated with workload in a dual task situation; Uhl *et al.* on spatial bilateral motor coordination-related DC potential shifts in fronto-mesial structures; Beyer *et al.* on shifts in mean alpha frequency of the EEG caused by information processing during motor control and performance. Hausen *et al.* show that motor imagination of swimming movements lead to decrease in the alpha power of EEG indicating activity of specific brain regions.

The material presented in this book should be useful to scientists working on aspects of slow potentials and EEG. The book is put together quite well. I found the articles in psychophysiology section particularly interesting as well as the scholarly article by Creutzfeldt *et al.* on the relationship of single neuronal activity to normal EEG waves and interictal potentials in humans. The book also has obituaries to Professors Creutzfeldt who pioneered modern neurophysiology; Professor McCalllum, the renowned psycholophysiologist who used neurophysiological techniques to study mental processes; and Professor Roitbak who made important contributions in the field of electrophysiology of the brain, particularly studies relating to intracellular recordings from neurons and glial cells in relation to surface field potentials. This volume is a must on the bookshelves of people pursuing interests on slow potentials of the brain in particular, and aspects of brain dynamics in general.

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Dietetics by B. Srilakshmi, Wiley Eastern Ltd, 4835/24, Ansari Road, Daryaganj, New Delhi 110 002, 1993, pp. 325, Rs 120.

Nutrition, through 'diet', is most important for human sustenance and health. Knowledge of this subject is essential to formulate specific and special diets, more so in recent times, where 'food' is implicated in many diseases ranging from malnutrition to cancer. Hence the proliferation of books in this area.

The book under review aims to provide a practical guide to students of nutrition to formulate diets in various disease states. It is praiseworthy that the author has dedicated it to the undernourished children of the world, but it is hard to find its usefulness in preparing recipes to the poor as they are not within their reach. For example, recipes for PEM (pages 64 to 68): Hamburgers and pizzas during adolescence, badamkheer,

basundi, caramel custard for the lactating Indian mother, carrot halwa for Vitamin A deficiency. The undernourished would not have even heard of these dishes, leave alone their preparation! If they can afford these foods they will hardly be malnourished. With her vast experience as a teacher in nutrition the author should have suggested simple, low-cost diets based on the locally available foods.

While it is nice to note that 'breast feeding is not only the best, but it is a must', the author fails to mention the concepts of stored breast milk or breast milk banks. This is useful for working mothers and to children with certain defects like cleft palate.

The author is perhaps unaware of the grandmothers' concept of 'demand feeds' whether breast or bottle-fed. Schedule feed has no place in infant feeding. I wonder what the advice of the author to the mother would be if the baby cries of hunger before the stipulated period of three hours!

A lot of emphasis is laid on symptoms, diagnosis, medical management, etc. This is not required in this volume since these are not in the domain of a dietitian. Also certain statements are vague and unclear. For example in the treatment of hypertension, the author recommends six weeks of dietetic treatment. What after this? Since primary hypertension is a permanent state, how would six weeks of diet suffice?

It could have been unique if the author had included a chapter on special diets for use in inborn errors of metabolism in the Indian context. In some of the metabolic disorders, diet is the only form of treatment, and a dietitian plays an important role in treating these disorders–for example, low-phenylalanine, high-tyrosine diet in phenylketonuria, lactose-free diet in galactosemina, etc.

Coverage of certain points like glycemic index in prescribing diets for obese and diabetes and the work of eminent scientists in nutrition are the positive aspects of this book. It may be useful for housewives to gain a knowledge of certain diseases and the role of nutrition in controlling them. Its usefulness to students of under- and post-graduate courses is however doubtful.

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Chemical approaches to the synthesis of inorganic materials by C. N. R. Rao, Wiley Eastern Ltd, 4835/24, Ansari Road, Daryaganj, New Delhi 110 002, 1993, pp. 101, Rs 110.

Synthesis is the womb of chemical research and industry. It is in synthesis–organic, inorganic, bio and others–that new molecules and materials are born to change the shape of things. Inorganic chemistry has been witnessing remarkable transformations throughout its body for a few decades now. A major sequel is the spectacular growth of the science of inorganic materials. As can be anticipated, synthesis has played a pivotal role in propelling this growth. The present monograph provides cogent summaries of the synthetic methods in the form of a logical strand of twenty chapterlets.

Generally, the stress is on oxidic systems but borides, carbides, nitrides, fluorides, silicides, phosphides, sulfides, etc., find coverage in Chapters 17–19. Intergrowth structures (15), superconducting cuprates (16) and nanomaterials (20) are allocated a separate chapter each. Of the remaining two chapters (1–2) are introductory in nature and in the others (3–14) different synthetic methods are elucidated. Representative examples are ceramic procedures (3), precursor methods (4), sol–gel synthesis (8), electrochemical synthesis (11), reactions at high pressures (14). The importance of using milder methods ('soft chemistry routes') in preference to the more drastic ones is stressed.

The descriptions are uniformly crisp and to the point, well illustrated with chemical equations, examples and drawings of structures and equipment-schematics. Even the uninitiated will have little difficulty in following the methods and their logic. The book is indeed an up-to-date ready-reckoner and the detail seekers have references at the end of each chapter. A subject index is given at the end. The author has pioneered the science of inorganic materials and he has now done a service to the community by presenting this thoroughly useful monograph for the beginner as well as for the expert.

The present reviewer's expertise lies more with molecular inorganic chemistry than with inorganic materials. But such divisions are more mental than real. After all, today's inorganic chemistry is through and through an interdisciplinary subject. This reviewer enjoyed reading this book especially by mentally comparing the methods described with those used for making discrete molecules where 'chimie douce' is the rule rather than the exception.

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Spaceflight mechanics 1993, edited by R. G. Melton, L. J. Wood, R. C. Thorton and S. J. Kerridge, Advances in Astronautical Sciences, Vol. 82, 2 parts, AAS Publications. Orders to Univelt Inc., San Diego, CA 92128, USA, 1993, pp. 1410 + 18, $240.

The proceedings of the 1993 Spaceflight Mechanics meeting is ably compiled by the editors in two parts of this volume. It contains 84 technical papers which are spread over 11 sessions. Careful examination of the proceedings reveals that nearly all the papers are meticulously prepared and are also of good quality.

The largest session was on Attitude dynamics and control. It has 17 papers. The first four papers deal with navigation components and systems. The learning/adaptive-related issues continue to be an active research topic in complex linear/nonlinear systems is demonstrated by the presence of relevant papers on robotics. Next, design of nonlinear control using energy dissipation principle is discussed in two papers. On the same lines, Vadali and co-investigators have successfully developed Liapunov theory-based feedback control of a spacecraft using control moment gyros (CMGs). For over a decade, parallelism is exploited for real-(near real) time implementation of navigation and control systems in aerospace applications. Efficacy of using neural networks for implementing adaptive control for spacecraft is neatly described in a paper. In engineering practice, the analysis of system dynamics including the stability of motion is very important. This section contains six papers on dynamics. Even though the analysis of regular/deterministic system is reported in a majority of publications, the study of chaotic motion is also discussed by some. Though these 17 papers are like a drop in an ocean of aerospace systems, they certainly make productive reading. Two more sessions on related topics are on large flexible structures and tethered/multi-body spacecraft. The former session has a collection of seven heterogeneous papers ranging from flexible boosters to optimal path planning for robot manipulators. Three articles a piece are devoted respectively to identification of structural parameters and analysis of flexible satellites or satellites with flexible appendages. Failure of the tether experiment on a shuttle mission has shown that innumerable publications and reports notwithstanding, there is ample scope for investigations that can provide enough sleepless nights to researchers. The persistent efforts by Misra, Modi, Bainum, Kane and other leading scientists may hopefully throw enough light in the years to come.

All satellites primarily have two kinds of motions, first and the foremost is the orbital motion and the second one is librational motion. Even though for the best part of its operation, a spacecraft has thrust free/coast trajectory, it is subjected to intermittent forces in order to achieve, say, orbit keeping/station keeping, orbital rendezvous/transfer, etc. Rightfully, five sessions containing 28 papers are devoted to intercept, rendezvous, orbit transfer, trajectory optimization, aero-assisted orbital maneuvers. Perhaps these papers along with 24 papers on the topics of orbit determination and guidance and control are the heart of this proceedings. Amongst the six papers in the session on intercept and rendezvous, two papers by Kechichian are noteworthy as they furnish diligent semi-analytical formulation for low-thrust rendezvous. Such papers will definitely increase the usefulness of the proceedings to a better scale than the average class proceedings of many conferences. Equally useful contributions are presented by six papers in the session on rendezvous and orbital transfer. Even though the number of inter-planetary missions have come down aftermath of successful Apollo, Mariner and Soviet missions, there seems to be hope/renewed interest in the missions of technologically greater challenging ingredients.

Success of trajectory/orbit control/maneuvers depends mainly on the guidance and navigation systems on board a satellite or on the terrestrial stations. Therefore, it is natural to expect the outcome of contemporary research pursuit to show up in this premier proceedings too. Orbital analysis and prediction does not fall

strictly under navigation systems; however, its impact on the study of navigational systems cannot be underestimated. In recent times, neural networks seems to intrude this discipline too as seen from a paper on preliminary application to compression of orbital ephemerides. Though orbital analysis is one of the oldest sciences that contributed to the success of aerospace systems, most of the ongoing investigations are at best contributing by only epsilon to the vast horizon of existing fundamental knowledge. With increasing population of Earth satellites, the GPS, TDRSS, DORIS, PRARE systems of satellite-based orbit determination algorithms are becoming popular. The above systems provide technically superior platform/'vehicle' than the traditional navigational platforms. As the demand for better and better accuracies (say, at centimeter level) arises, emphasis is laid on obtaining superior models for gravity, aerodynamic, magnetic and other extra-terrestrial disturbance sources. By looking into the current or projected accomplishments and possible innovations in the future, it is hazardous to even guess the asymptotic limit on demanded accuracy of orbit determination, say, in another 10 to 15 years from now. For such a thing to happen, notwithstanding all the anticipated technological progress, breakthroughs at a fundamental level on orbit determination and control and allied fields of aerospace sciences are essential. It is hoped that these proceedings will bring out one or more of such occurrences.

The proceedings of any conference are important as they disseminate the recent findings in a double quick mode. This proceedings is no exception. However, the bonus for the reader is the high quality of papers which have been carefully selected by the editors and organizers of the *Spaceflight Mechanics 1993* conference. The reviewer strongly recommends these books to individuals and libraries of premier institutions.

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Launchpad for the 21st Century: Yearbook of the International Space Year (A special supplement to Advances in the Astronautical Sciences) by H. Meyerson and D. K. Simonalli, published for the American Astronautical Society by Univelt, Inc., P. O. Box 28130, San Diego, California 92128, USA, 1993, pp. 399, $70.

The year 1992 was celebrated as the International Space Year worldwide to commemorate two historic events: the 500th anniversary of Christopher Columbus' voyage to the New World and the 35th anniversary of the International Geographical Year (IGY). It is surmised that while the discovery of America symbolizes a spirit of exploration and discovery, the IGY ushered in the Space Age in 1957–58 with the launching of the first artificial satellite with its theme of scientific inquiry and global cooperation. While the connection between the Columbus' voyage to the New World 500 years ago to the commemoration of Space Age in 1992 may be somewhat superficial, the idea of making 1992 as a year of globally coordinated space research activities appealed many nations. The United Nations declared 1992 as the International Space Year. A Space Agency Forum on International Space Year (SAFISY), whose membership included 29 national space agencies and 10 affiliated international organizations was formed which coordinated most of the ISY activities. The activities included organizing scientific research and training programs, exhibitions, initiating discussion on space education, international policy matters and global awareness, and, of course, celebrations. More importantly, however, was the fact that it was for the first time the world space agencies agreed to join hands together to coordinate the efforts to study global environmental issues without a supranational bureaucracy under the SAFISY. An account of the various activities held worldwide to commemorate the ISY is given in this Yearbook.

The volume essentially has two sections. The first consists of a thematic narrative account of selected ISY activities; the second combines brief descriptions of all the activities held worldwide. One of the most important R&D themes adopted by the SAFISY members was Missions to Planet Earth (MTPE)–the use of space technologies to address global environment issues. A wide range of specific proposals were developed by the conference working groups to study, for example, deforestation and the greenhouse effect by using remote-sensing satellites. Other proposals relating to Earth and Space Science and Technology were also included under MTPE. The ISY also focussed on educational activities worldwide, and the training initiative aimed at developing countries. A major goal of the ISY, however, was public education on the significance and potential of Space Age, with an emphasis on maximum public participation and creative expression. Under this program, ISY associations were created in the US, Europe and Japan to stimulate public interest in space-related programs by means of ISY posters, and logo, news releases, activities list and calendars, articles on ISY, etc.

Several conferences were organized worldwide to focus attention on specific issues in the ISY 1992. For example, one of the major issues taken up was data management which called for improved collection, consolidation and distribution of Earth and space science data from around the world. A positive result of these coordinated efforts has been that the data on a variety of topics have now become available on CD-ROM computer disks. In some instances, the satellite data were supplied free of charge to developing countries. Similarly, international corporation in space science was the theme of the World Space Congress organized in the ISY. It was one of the major international events involving over 4800 registered participants which emphasized on the worldwide sharing of data and of plans for future global cooperation in space. Other important conferences organized in the ISY on this theme include, World Astronomy Days, International Solar–Terrestrial Physics Symposium, Planetary Systems: Formation, Evolution and Detection, International Geoscience and Remote Sensing Symposium and the European and the Asia–Pacific ISY Conferences. Beside conferences, several activities were organized which could be conducted in school classrooms for young students. To cite a few examples, nearly 30,000 high school students across the US participated in a NASA-coordinated network conducting research on ionospheric radiowaves; students and teachers from 30 countries participated in the international Space Camp 1992 wearing the ISY logo; a school-year-long ISY activity; Mars 2492 was conducted in an elementary school in US, etc.

Capsule descriptions of the ISY activities carried all over the world are given a lengthy appendix covering over 100 pages of the book. It is amply evident that the ISY was celebrated in many countries including the relatively smaller ones like Sri Lanka and Thailand. In India, it almost remained a non-event; not many knew about it. Although, ISRO is a full member of the SAFISY, its involvement was limited to participation in conferences organized by other countries and sponsoring a few ISY exhibitions in India designed to bring out a better awareness of space activities and applications among its citizens.

Overall, the book makes a listing of all the activities held worldwide in the ISY 1992 in one volume. It also gives an account of the background effort and lobby carried out to declare 1992 as the International Space Year. It may serve as a source of reference to the interested people. The book is bound in hard cover. The front cover has logo of the ISY and a magnificient view of the Earth from Apollo 17.

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Guidance and control 1993 edited by Robert Culp and George Buckley, American Astronautical Society, P.O. Box 28130, San Diego, California 92198, 1993, pp. 630 + 17, $120. Orders to Univelt Inc., P.O. Box 28130, San Diego, CA 92128, USA.

The volume contains the proceedings of the 16th Annual Rocky Mountain Guidance and Control Conference which was held at Keystone, Colorado, February 6–10, 1993. The first day of the conference had a tutorial session on applications of modern control to Hubble Space Telescope (HST) performance enhancement study program. The remaining days had five technical sessions on: Advances in guidance, navigation, and control (GN&C); Story board displays on guidance and control; Control system videos; GN&C-embedded flight control systems and the final session on Recent experiences. In all, 36 papers and 11 abstracts are included in this proceedings.

The first section on Advances in guidance, navigation, and control has seven papers on heterogeneous topics with no common theme. Barring three papers, remaining papers are worthwhile only in terms of their bibliography. The paper on 'Middeck O-gravity dynamics experiment' gives valuable insight, but it covers large many issues with least mathematical treatment. However, the beauty of the paper lies in correlating theoretical and experimental results. Likewise, the study on Control of the Magellan during aerobraking continues to draw attention even though it has been plentifully talked about in the past two decades. The vibration control of large space structures using a differential GPS is a novel concept, but its ability to suppress large deformation to low level is not adequate since the resolution of measurement is limited to 1.5 mm. One may have to resort to finer sensor to bring down the vibration level to 10 microns.

Six technical papers from academics and industry on control system applications are presented *via* the powerful video medium. The first four articles dwell on robotics and the remaining two on related issues. The practical values of the these papers is high since they systematically explain the intricacy of design objectives and physics behind making rational assessment from amongst alternate options. It is difficult to get these kind of papers in most of the academically oriented journals. The proceedings of AIAA Guidance and Control Conference has always been in the forefront of dissemination of knowledge and the reader can always look elsewhere for detailed theoretical background.

The third section of the proceedings has seven good papers on GN&C-embedded flight control systems, out of which the first paper is devoted to hardware aspects of low-cost computers, five papers on software aspects and the last on methods of describing the attitude of a satellite. The first paper discusses challenges in employing low-cost high-performance terrestrial computers *in lieu* of prohibitively expensive low-performance (antiquated in terms of present-day technology) space-qualified computers. Similarly, the valuable narration in the first four software-oriented articles deals with complex flight control system of greatly challenging missions. They address guidelines for monitoring and controlling flight software in a cost-effective way.

The design and validation of space systems based on stimulated data and segment of onboard hardware within the simulation loop is only the tip of the iceberg as far as operationalizing a space system. The most critical input to the building of reliable space system comes from the experience earned from actual developmental flights and past missions. Such useful records furnished in seven technical papers in Section Four is a welcome addition in the proceedings of the Conference. These articles deal with subjects like performance of attitude control electronics, tether dynamics and control, star tracker and Earth sensors. Mission performance of Galileo, Magellan and Mars Observer spacecraft are also briefly addressed. For example, lessons learnt from, say, the failure of tether satellite experiment can prevent from history repeating itself if preventive mechanism is built in following thorough failure analysis.

With increasing availability of quality technical papers from around the globe, the story board displays have become popular with the organizers of the Conference. It is said that the authors will have purposeful and leisurely interaction with the Conference participants. Even though the papers under this Section have appealing titles with associated abstracts, only two whole papers out of 13 are available to the reader. Since virtual exit of AI-based control systems from the user industry, fuzzy logic control is emerging as one of the popular topics of research in academic circles. How far such control systems will mature and find acceptance in exacting aerospace industry is a matter of speculation and probably time is the only judge. Similarly, though the active structure–control integration has made great strides in the past two decades, it is not yet ready for practical execution in any major programs and such an event is unlikely within this millennium since more questions remain unanswered than those solved. The laboratory-based experiments are aimed at better understanding and improved design of a structure–control integrated system.

The last section of the proceedings hold seven papers on a specific theme on application of modern control to HST performance enhancement. Efficacy of five alternate control system synthesis procedures can be appraised with specific reference to HST model platform which was designed and built under the direction of NASA Marshall Space Flight Center. The challenges of designing a practical control system to meet the specifications of 0.007 arcseconds (rms) for observations lasting from a few seconds to several hours are summarized along with ways and means to surmount the barriers so as to meet the mission specifications to a large extent are also incorporated. All the five design procedures enunicated in this section, starting from H-infinity optimization, covariance control to disturbance accommodating controllers are the product of design effort from teams from academia led by eminent professors like R. E. Skelton, C. D. Johnson, Mark J. Balas and also others from industry.

The proceedings of Guidance and Control Conference 1993 is carefully edited by Robert D. Culp and George Buckley in spite of wide coverage of topics in a single volume. The aerospace community will look forward to proceedings of such future conferences.

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Space–Business opportunities by W. J. Esser and D. K. Tomajan, American Astronautical Society. Orders to Univelt, Inc., P. O. Box 28130, San Diego, California 92198, USA, 1993, pp. 366, $90.

These proceedings are based on the 37th and 38th Annual AAS Conferences held in November 1990 and December 1991, respectively, in Los Angeles, California. The topic of both these conferences was space business opportunities. The volume presents the complete text of only a few papers; most presentations are given as short abstracts. The theme has been to convey unequivocally that space does offer considerable future business opportunities. It is the methodology to actually exploit them that needs to be worked out. At the time of these conferences, almost the entire US space program is controlled by the government. Over 90% of the space industry output is consumed by the US Government. Although excellent results obtained were accounted for the hold of the government, thus far, serious questions are now being asked regarding the justification of the amounts of spending *vis a vis* the benefits obtained.

The two conferences discuss ways and means to involve private industry in these programs and make it more user oriented. It is advocated that the US Government's space sectors purchase commercially available space goods and services. Several difficulties come to fore. The single biggest impediment to expanding private sector investment in space is the absence of consistent and reliable government policies. Various solutions are discussed to overcome these hurdles. For example, instead of year-to-year allocations, commercial space ventures may be considered for multi-year funding, as carried out by the European Space Agency.

Another issue discussed pertains to joint ventures with private industries. Here again, although the idea of jointness is great several difficulties arise in implementation. Who pays how much? How does one know the amount he contributes as a service would come back to him in the product? Can a joint satellite system be made to work? Can the funding be worked out so that everybody is satisfied? The methodology adopted for technology transfer at the Jet Propulsion Laboratory is described.

As of today, remote sensing and communication satellites are the biggest opportunities for commercial space business. The evolution of GIS (Geographic Information System) digital mapping has become the biggest commercial market place outside of defence requirements and global change research. Commercial application of remote sensing is aimed at enhancing the quality of life worldwide through monitoring of urban environment, transportation planning, pollution measurements, water management, etc. In 1989, the GIS market place was estimated to be $5.3 bn. Several countries, besides the US—ESA, India and Japan—for example, are players in this market place. Problems associated with commercialization of the US Landsat system are discussed as to why this entire program has not been used effectively by the controlling agencies. Participation of the private enterprise in commercial TV and telecommunication satellites is now well established. As of 1990, of the various communication satellites in geosynchronous orbit, approximately half of them were developed by Hughes Aircraft Company. Direct broadcast television systems need only backyard receiving dishes to capture TV programs. The hiring of transponders by private companies in various countries is a common practice now.

A look at the spectrum of privatization/commercial activities shows that besides mature industry that exists in satellite activities, business in other areas is slowly sprouting. For example, in the area of expandable launch vehicles, privatization agreements are in place with the US Government. In sounding rockets and infrastructural facilities, several companies are offering services. These all, however, depend on the government as a customer. Private markets are non-existent. Commercialization of new products processed in space like pharmaceuticals, crystals, polymers, alloys, etc., is still in embryonic stage. In unmanned space programs, the involvement of private industry is sought by the office of Space Science and Applications (OSSA). Already over 700 US companies are working with OSSA.

While space business has been the main theme of the conference, several presentations have simply described the state of affairs in various organisations/areas with a view to involve private industry participation. These titles include, Army space systems and technology; Strategic defense initiative: prospects and opportunities; Launch systems technology; National launch systems program overview; European space agency and its long-term plan; Space launch roadmap: A space system division perspective; New business in US civil space programs–unmanned, etc.

The proceedings can at best be said of transient value only. Many of the US programs described in 1991 for business ventures have already undergone a sea change, and/or their future is in jeopardy. These include the US Space Station, the Advance Launch System Initiative, the Space Exploration Initiative, the Strategic

Defense Initiative, the National Aerospace Plane, etc. The utility of these programs has been the subject of criticism at the time of funding almost every year. A long-term partnership with the private enterprise in such a scenario is understandably difficult. The superiority of the materials processed in space *vis-a-vis* the cost of production is yet to be proven. Many of the benefits envisaged in 1991 thus have not been proven to be as beneficial and attractive in 1994 itself. The private business is likely to invest only in proven technologies and services. Another shortcoming of this volume is that full texts of many of the papers are not included. Some are given as charts only. However, the proceedings cover several issues which are worth pondering over in spite of their transient value. A beginning is made to think of space business, and, in this sense, this proceedings, scores a point. The volume is bound in hard cover and has a drawing of some of the key aspects of the Ground Networks Program.

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