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BOOK REVIEWS

Applications of mathematics in technology edited by V. Boffi and H. Neunzert (Proceedings of the German-Italian Symposium, March 26-30, 1984, Rome). B.G. Teubner, Postfach 80 1069 D-7000 Stuttgart 80, 1984, pp. 484, DM 82.

This book represents the proceedings of a German-Italian symposium held in Rome in 1984. The editors say that the symposium had two objectives. The first was regional cooperation; as the editors remark, "Living in the shadow of the impressive American potential of modern mathematics, we sometimes tend to miss even outstanding achievements of our European neighbours". We in this country are also largely ignorant of work in the continent, partly because of linguistic barriers and partly because of our rather weak contacts with European scientists. The second objective was to discuss what mathematics can contribute to the development of modern technology. The editors quote with approval the President of Exxon Research and Engineering as saying, "Apparently too few people recognise that the high technology that is so celebrated today is essentially mathematical technology".

The volume proceeds to give examples of what mathematics can do through 29 papers. Many of these appear with a note that says that the paper will not be published elsewhere —which in some cases will be a pity, because some of the papers do have archival value, and may get lost in a volume of this kind, as opposed say to appearance in a standard journal.

More than half of these papers are in fluid dynamics; as Rautmann says, after quoting Heracleitus from 2500 years ago ("Everything is always flowing"), fluid flows offer a real El Dorado for applied mathematicians. Some of these papers are of great interest: the first by Prof. Nickel of Freiburg is a model for its kind. It starts with a very real practical problem that an aircraft designer faces, *viz.*, how to fight adverse yaw. (This is an ancient problem: an aeroplane initiating a turn normally moves in the wrong direction unless the rudder is also deflected). This phenomenon has not been studied much by engineers, partly because on large airliners an autopilot easily takes care of the problem and in the smaller planes the required investment in research cannot be made. What is impressive about Prof. Nickel's paper is that it starts by posing three questions in almost exactly the terms that a designer might use. It then proceeds to answer these questions as a mathematician would present them: theorems are proved, existence and uniqueness are demonstrated, and optimum solutions computed. Finally the theory is put to the ultimate test: a novel ultralight aeroplane is designed, constructed and flown.

An Italian paper on freezing in porous media has a somewhat similar flavour. It starts by looking at the problems often encountered of 'frost heave', consisting in a lifting of the soil surface as a result of freezing of water. The problem is stated in practical terms and then the mathematical models that enable one to tackle the problem are described in detail.

Among other papers of interest is one by Tebaldi over studies in truncated Navier-Stokes equations, showing how by adding or even changing a few modes the phenomenology of the developing turbulence can be significantly altered.

There are six papers on inverse problems (including the one on porous media, already mentioned). There are also eight papers in a section titled Mathematical methods in reactor technology, but in fact generally dealing with the Boltzmann equation, to whose study Italian scientists have made many notable contributions.

In a volume of this kind, it is unlikely that any single reader - or reviewer - will be able to assess all the papers included. Nevertheless the volume provides a picture of the kind of mathematics that is popular in Germany and Italy. The flavour of this applied mathematics is somewhat different from the Anglo-Saxon variety that is familiar in India: the chief difference appears to be that there is rather more of the mathematician's mathematics in the German-Italian variety. I am sure that most readers will find something or other of interest in the volume.

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Mathematics in industry edited by H. Neunzert. B.G. Teubner, Postfach 80 1069, D-7000 Stuttgart 80, 1984, pp. 287, DM 52.

Perhaps the most reassuring feature of this volume to the Indian reader is that the gap between the teaching and applications of mathematics, which we know to exist in India, exists in the Western countries as well; and in nearly equal measure. The only difference, if this volume is any indicator, is that there is a more serious effort in the West to bridge this gap. Again, it appears that there are no ingenious solutions to this problem being conceived in the West; all the recommendations being proposed are easily deduced and, indeed, Indian R&D managers too have been talking about them for a long time.

The volume under review compiles the proceedings of a conference held at Oberwolfach, West Germany, in October 1983. The objective of this conference was to promote 'possibilities for developing cooperative efforts between industry and universities' on mathematical problems of a 'technical' nature. The first section of the Proceedings includes papers which deal with general aspects of this cooperation while the next two describe some common research projects originating both at the universities and the industry.

The last two sections are clearly for the specialist reader. The problems considered appear to encompass a wide spectrum: structural acoustics of passenger cars, icebreaking by hovercraft, computer-aided design in piping for chemical plants, geometric design of mobile radio telephone systems, problems in fluid dynamics as well as the singular problem of the Trippstadt swimming pool. Also included is a rather long article by Aulback which takes a critical view of some of the most commonly used linearization techniques.

The first section, on the other hand, is intended for managers of education and industry. It describes experiences of cooperation between universities and industry in many of the Western countries, with special emphasis on the West German experience. Perhaps the best essay in the entire volume, and certainly the most readable, is by Editor Neunzert himself. Here, Neunzert makes no effort to hide his contempt for traditional mathematics and mathemati-

cians. These mathematicians when "confronted with springs and bolts", instead of precise theoretical formulations, usually choose to "hide (their) heads in the sand", he says. Taylor (page 36), while describing the Oxford Study experience, makes the same point: mathematicians must "appreciate that industrial deadlines may be more important than proofs"; faculty at the Institute will recall similar comments he made during a recent visit to Bangalore.

While all this may not entirely please the mathematician, Neunzert is really criticizing a certain educational system and not an individual. The refrain in this volume, and this is echoed by each of the contributors, is the following: reject the definition-proof style of conventional mathematics and start, instead, with a real problem, formulated preferably in non-mathematical terms. As Anderssen (page 13) puts it: "The situation where one has a method without a problem has to be reversed to the situation where one has a problem without a method".

To achieve this, three scenarios are proposed: (a) the industry takes the lead and presents interesting mathematical problems to the universities, in some cases even developing methods "hardly known" by universities; (b) the university develops programmes of study "strongly influenced" by professional industrial requirements; and (c) the university and industry agree to collaborate on some kind of a mutually beneficial continuing education programme. All this is, of course, old hat and *deja vu*. The more interesting point that the volume makes is that each of these scenarios calls for great patience, understanding, skill at communication and commitment.

Briefly, what this volume is saying is that future mathematical effort must be directed in very great measure to the solution of problems posed by industry: typically, problems in the areas of optimization, finite element methods, stochastic processes and inverse problems. The tone towards mathematicians may, at first sight, appear too strident; but the grouse is really against the system of mathematical teaching and not the mathematician per se. After all, only an outstanding mathematician can solve the kinds of problems being thrown up by industry.

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The culture of technology edited by Arnold Pacey. The MIT Press, Cambridge, Masschusetts, 1983, pp. 224, $ 20.13 (Indian orders to Allied Publishers Pvt. Ltd.).

Is technology "essentially amoral ... an instrument that can be used for good or ill", as Buchanan said, or should *technology* be blamed when people starve, the atmosphere is polluted or wars are fought with deadly weapons? Is it true, as a guide-book to the 1933 Chicago World's Fair proclaimed, that "Science finds — Industry applies — Man conforms", or do human affairs determine the technologies that will be developed? Did James Watt's steam engine lead to the Industrial Revolution in Britain, or did "the prior development of factory organization (give him) the opportunity to perfect his inventions"?

It is such fascinating questions as these that Pacey's book wrestles with. Arguments are cited on both sides of these and various other similar issues, connected with technology and culture. The book can be opened on almost any page, and the reader can involve himself, with the author, in an absorbing debate.

The book is divided into nine chapters, whose titles will give a rough idea of its contents and approach.

1. Technology: practice and culture
2. Beliefs about progress
3. The culture of expertise
4. Beliefs about resources
5. Imperatives and creative culture
6. Women and wider values
7. Value - conflicts and institutions
8. Innovative dialogue
9. Cultural revolution

There are nuggets of intriguing information in every chapter. Consider for example the question of whether the development of the steam engine in the 18th century was "inevitable", which immediately raises the next question about why the development was so rapid in Britain and not in the rest of Europe and in America: "From 1712 until Watt extended the range of their application, most steam engines were used to pump water from coal mines. In any other situation, the early, inefficient engine used far too much fuel to be of much economic worth. And Britain was far in advance of most of Europe in mining coal, because deforestation had gone much further in Britain than elsewhere, and firewood was scarce and expensive. In much of the rest of Europe, as in America, wood fuel continued to be relatively abundant for another century; so there was less need to mine coal, less need for engines at mines, and little other opportunity for the economic application of steam. Thus there were strong ecological or environmental reasons for the adoption of steam power in Britain which were less important elsewhere. But there is no ecological determinism, and the environmental condition of Britain in 1712 did not dictate the development of the steam engine. A vigorous policy of reafforestation and fuel-wood coppicing could have solved the problem".

Again, why are nuclear arsenals being expanded?

"Freeman Dyson, professor of physics at Princeton, believes that 'The intellectual arrogance of my profession must take a large share of the blame'. Conventional weapons, especially of the type that are defensive rather than offensive, 'do no spring like the hydrogen bomb from the brain of brilliant professors of physics', but are 'developed laboriously by teams of engineers'. Professors have prestige and influence; engineers who do painstaking work have almost none. The engineers' work may be real high technology; it may require patience, organization and attention to detail, and thus may involve the values and attitudes we saw characterized by maintenance work in other technologies. But as Dyson concludes, defence is 'not technically sweet'."

The fourth chapter is particularly interesting, after the long debates we have all been exposed to since the Club of Rome report. Is there a real, absolute food shortage in the

world, or is it that the food-rich countries like so to believe, to justify (profitable) export drives or aid? What are the true global reserves of various minerals? Is Wilfred Beckerman right when he estimates that the quantity of key metals available within a one-mile depth of the earth's surface is a million times the present 'known' reserves, and declares that, by the time we need these minerals, 'we will think up something' in technology that will ensure their continued availability? Is Julian Simon's analysis correct when it concludes that the relative price of food and energy (relative, that is, to average income) is actually *falling* over the centuries?

The sixth chapter sounds strange to Indian ears not because of the contents but because of the source: here is an Anglo-Saxon canto (if you can imagine it) in praise of *Stree-shakthi:* feminine virtues are lauded, cooking and weaving are analysed as technology, and it is suggested that women may be able to run the world better than the men have.

Enough, I hope, has been said about the book to give the reader a flavour of its contents. Every page raises some fascinating issue. But at the end, after you have thumbed through all the pages, the final result is a little disappointing, because the author does not take a stand on any issue. He quotes a variety of interesting opinions, but does not analyse them or take them to their logical conclusion. He seems confused, and is likely to communicate this confusion to the reader. Admittedly the questions he deals with are complex, but it is disappointing that a physicist's skills leave him with little positive to say about what should be done.

Two things seem clear to me: engineers and technologists should study the history and philosophy of their own subject more seriously; and the other professions, apart from scientists, lawyers, historians, philosophers, politicians — should actually *learn* something about technology, which everybody agrees is and has been a great force in this world. Is it not strange that nobody blames *literature* (say) for the lurid junk that is sold in road-side book-stalls, but everybody blames *technology* for the (physical) junk that litters the same road-side? Is that not possibly because everybody (- well, *almost* everybody!) can read, but far fewer know anything about technology, which is therefore simultaneously feared and admired? Dr. Pacey unfortunately falls far short of touching the heart of these problems.

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Managing the flow of technology edited by Thomas J. Allen. The MIT Press, Cambridge, Massachusetts, USA, 1984, pp. 336, $ 28.75 (Indian orders to Allied Publishers Pvt. Ltd.).

The author of this book is an engineer from Boeing who was invited in 1963 to join the Sloan School of Management at MIT to work on a programme of "research on research", especially on R&D management. This book is the outcome of the studies subsequently carried out, and is concerned mostly with transfer and dissemination of technological information.

A recurrent theme running through the book is that the flow of information in technology is very different from that in science. Unlike in science, the formal written paper in a technical journal plays a relatively minor role in technology development, compared to the informal report, the restricted document, and the discussions with colleagues *within* the organization.

A communication system that works effectively for scientists may therefore fail for technologists. The UNESCO World Science Information System called UNISIST recognizes the importance of informal sources, but devotes most of its attention to the more formal variety; the System therefore is likely to have limited validity for technological information.

There are many reasons for these differences between science and technology. First of all the goals are different; science takes in verbal information in the form of papers or discussions, and produces more verbal information in the same form; technology also takes in verbal information, but its chief output is some kind of hardware or product, additional verbal information being only a byproduct. In a very interesting chapter on the communication system in technology, the author shows how the common habit of including engineers and technologists under the umbrella term of 'scientist' often leads to a great deal of confusion. Goals, motivations, methods of work, reward systems, and attitudes to management - all these are different for scientists and technologists. Indeed, history shows that civilizations often tend to emphasize activity in either science or technology to the exclusion of the other. The Greeks were active in science but not greatly interested in applications; the Romans in contrast were great engineers, and had no taste for 'pure science'. Britain and Japan provide similar contrasts today. The confusion is illustrated by the comment from the engineer who expressed his annoyance that every successful space launch is a triumph for science, but every disaster is a 'failure of technology'! A picture of the successful launch of the SLV-3 adorns INSA's Golden Jubilee Volume on the Sciences in India, but those responsible for the success may not be easily elected to its fellowship!

As the author points out the widely held notion of "a continuous progression from basic research through applied research to development and utilization has found little support in empirical investigation... Science builds on prior science; technology builds on prior technology; and utilization grows and spreads in response to needs and benefits". (Our Departments of Science and Technology must note this!) Many earlier studies including the well-known one of Price in 1965 show that communication between science and technology is at best a weak interaction. The well-known historian Toynbee put it picturesquely when he said that "physical science and industrialism may be conceived as a pair of dancers, both of whom know their steps and have an ear for the rhythm of the music. If the partner who has been leading chooses to change parts and to follow instead, there is perhaps no reason to expect that he will dance less correctly than before".

There is in fact no doubt that there are many instances where technological developments have preceded scientific understanding. The steam engine is one; the science of thermodynamics flowered in the 19th century, *following* wide-spread use of steam engines in Britain during the late 18th century - so I think thermodynamics could well have been called Applied Steam Engines — *i.e.* steam engines applied to understand nature! The Wright Brothers built their 'Flyer' at a time when many scientists, including the redoubtable Lord Kelvin, had declared that aviation was impossible. It may be true that in recent decades certain scientific discoveries have found their way more quickly to technological applications. But the number of occasions when development in technology have fed on previous developments also in technology is in fact still extremely large, as the author shows. Even now, however, it is likely that science has gained far more from computer technology than the other way round.

In conclusion, this is a book full of interesting things to say about information in technology. Considering the author's aeronautical origins, it has one surprising omission; namely that it does not examine the role of the great national agencies in technology development and information dissemination. For example, NACA and NASA in the United States, and the late Aeronautical Research Council in Great Britain, have played a key role in the development of aerospace technology. The information, data and analyses provided by these agencies were crucial for aircraft design *everywhere* in the world; Prof. Bisplinghoff has narrated how Japanese designs, *e.g.*, were also often based on the same data, as Japanese students at MIT copied all reports before the War. It seems to me therefore that apart from the two ends of the spectrum considered by the author, namely science and technology, there is in fact some important middle ground especially in the newer technologies. And in this middle ground one will find that the methods of science and the methods of technology interact in a fascinating way that still needs to be studied in greater detail.

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Approximation of weak convergence methods for random processes with applications to stochastic systems theory by Harold J. Kushner. The MIT Press, 28, Carleton Street, Cambridge, Mass. 02142, USA, 1984, pp. 269, $ 46 (Indian orders to Allied Publishers Pvt. Ltd.).

The fields of signal processing, communications and control stand as well developed disciplines by themselves. However, researchers in these fields will find that they have to use tools developed in all of them to solve future problems. Harold Kushner's present book bridges these three disciplines effectively. The motivation for developing the mathematical theories has come from these disciplines, and the author has devoted three chapters of applications in these areas. During the Fall of 1981, Kushner also taught from a preliminary version of this book while visiting the Tata Institute of Fundamental Research in Bangalore, India.

Engineers have often confronted with the problem of modelling physical processes. In many cases, the full model may be intractable in which case an approximation to the model itself is needed. For example, in adaptive estimation, the gradient algorithm by itself may not be amenable to computational efficiency or adaptation and it has to be replaced by a stochastic approximation algorithm. These algorithms have been analysed by Ljung[1]. While several approximation methods have been developed heuristically during the past several years there still remains a need for theoretical developments to indicate precisely the conditions under which the approximations hold. Kushner's book is perhaps one of the first ones which satisfy this need. He develops in this book a comprehensive theory for approximation of complex models of random processes by simpler dynamic models. An example taken from the introduction of Kushner's book will make the preceding statement clear.

Consider the model of a random process

$$\dot{X}_t = f(X_t) + g(X_t)\ Z_t$$

where Z_t is a wide band random process. Clearly, Z_t fluctuates more rapidly than X_t. It is usual to replace Z_t by a Gaussian white noise and find a suitable white noise model that approximates X_t in some suitable sense. What one looks for is a nice approximating process Y_t such that the distributions are as close to X_t as possible. What is done is to imbed the process X_t, in a suitable parametrized family $\{Y_t^\epsilon\}$ and find a process Y_t such that $Y_t^\epsilon \to Y_t$. In a similar manner, Z_t is parametrized as the sequence $\{Z_t^\epsilon\}$ such that as $\epsilon \to 0$, the band width becomes infinite. Even though the original process X_t may be intractable, the limit process Y_t, hopefully, will be more tractable (diffusion process) mathematically and numerically. This book investigates the conditions under which the limit process exists, using weak convergence of measures.

Chapter 1 contains a review of stochastic processes and basic probability theory as expounded in Krishnan[2]. Two points of view are brought into focus. The first is the solution to the standard Ito or stochastic differential equation; the second is the solution to the martingale problem of Stroock and Varadhan[3]. It may be much easier to show that the process solves the martingale problem than to show that it solves the stochastic differential equation. Chapter 2 gives the basic results from the theory of weak convergence of measures as given in Billingsley[4].

There are two general methods to obtain weak convergence and identify the limit processes; the perturbed test function method and the direct averaging method. The perturbed test function method is introduced in chapter 3. Chapter 4 systematically develops useful methods for obtaining these perturbed test functions. A special feature of chapter 4 is the user's guide in which the author has summarized the procedure for obtaining perturbed test functions for a special case. The first half of chapter 5 discusses weak convergence by direct averaging methods. This method is preferable when the limit process satisfies an ordinary differential equation rather than a partial differential equation. The second half of chapter 5 discusses a hybrid method using the best features of perturbed test functions and direct averaging methods for obtaining weak convergence. Chapters 3,4 and 5 basically discuss the two main steps in using weak convergence theory: (i) checking whether there is a limit and identifying it and (ii) given that there is a limit, characterising it.

Weak convergence theory by itself does not tell much about what happens to the approximating sequence $\{Y_t^\epsilon\}$ for small ϵ and large t. Thus the stability criteria are very important in many applications. Chapter 6 obtains usable criteria for these stability properties.

Chapter 7 is concerned with singular perturbations and the use of weak convergence and stability ideas are outlined in it. Basically, one can say that most of the book is concerned with singular perturbations where slow and fast dynamics play complementary roles.

Numerous applications such as adaptive filters and antenna arrays, adaptive quantifiers, phase-locked loops with and without limiters, etc., are discussed in chapters 8-10. The central idea in all these applications is to show how to use stochastic approximation techniques to obtain diffusion approximations to a canonical problem in each class.

The final chapter (11) treats a class of problems and asymptotic methods of a different type. This chapter concentrates on problems where the noise effects are small and the time of

interest is large and the mean escape time from a neighbourhood is of interest.

This book is extremely well written. The ideas presented are lucid and clear. But by the very nature of the subject, the treatment involves careful and very precise mathematical analysis and hence it is not a book which can be used as a night-cap. To develop a working knowledge of the various methods a greate deal of investment of time is called for. Having mastered the fundamental techniques, this book will open the gate for interesting and esoteric applications. It is an excellent addition for researchers working in the expanding field of stochastic approximations.

In the earlier chapters, a few errors have invariably crept in, and these (not exhaustive) are listed.

Page 4 — No distinction made between quadratic variation and quadratic variance.
Para 16 — Second line from the bottom — such that —
Page 26 — 13th line from the bottom — for example, it may —
Page 28 — 8th and 9th lines — from top $\beta_\epsilon \in \beta$, $\inf_\alpha P_\alpha\{B_\epsilon\} \geq 1 - \epsilon$
Page 30 — 3rd line from top — Lebesgue.

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Time series analysis, identification and adaptive filtering by Daniel Graupe. Robert E. Krieger Publishing Company, Malabar, Florida, 1984, pp. 402, $ 34.50.

Many of the statistical methods of analysis are concerned with models in which the observations are independent of one another. In fact, statisticians go to great lengths to randomize their experiments to remove any dependence (confounding) among observations. However, in many physical processes the observations are dependent and the exact nature of this dependence is of particular interest. A body of techniques, both theoretical and practical, have been developed for analysing the dependence among the observations and they are called *time series analysis*. Time series analysis can be classified into time domain and frequency domain techniques. One of the early books on the time domain analysis of time series is by Box and Jenkins[1].

In most of the time series we may not know enough about the desired signal properties to develop fixed parameter models. In some other cases, we may know the signal well but the noise background may be varying with time. Thus, techniques have been developed to process the signal adaptively, depending upon the environment on which it operates. Graupe's book presents the time series analysis in the time domain with emphasis on adpative filtering. The author claims to unify linear time series analysis, adaptive filtering, adaptive control and adaptive decision and signature discrimination. But, in my opinion, each of these topics stand by themselves. The basic emphasis of the book is on situations where the time series occurs in a noisy environment and the signal parameters are unknown. Perhaps, this is the first book to deal with adaptive filtering in its generality. The earlier book by Monzingo and Miller[2] deals specifically with adaptive filtering problems associated with array processing. I know of three other books in the area of adaptive filtering which will be coming very shortly, if they have not already come. The present book does not by any means serve as a text on theory of time series. It provides with the necessary tools for employing time series analysis in an adaptive way to retrieve information (signal) in the presence of a noisy environment.

The book consists of 12 chapters and five appendices. Chapters 2 and 3 are introductory chapters dealing with probability theory, time series and stochastic convergence theorems. Chapter 4 discusses briefly linear models. Chapters 5-7 discuss the identification of parameters of the time series. Chapter 5 discusses identification using least squares or sequential least squares methods. Chapter 6 discusses the proof of the convergence of such identification algorithms. Chapter 7 deals with the sequential gradient stochastic approximation algorithms and the gradient lattice algorithms. The time series model used in these three chapters is the autoregressive (AR) model. Chapter 8 goes on to identification of non-AR models like moving average and mixed models. Identification of non-invertible processes having zeros on the unit circle in the z-plane are also discussed. Chapter 9 discusses the problem of adaptive decision or learning decision theory as propounded by Tsypkin[3]. Chapter 10 reviews the theories of optimal linear estimation. In chapter 11 adaptive filters are derived. The book ends with chapter 12 on adaptive control in the presence of unknown parameters and unknown noise.

Thirteen computer programs for the algorithms presented in the book are given in Appendix A with computer printout of examples considered. Appendix B deals with an application of adaptive discrimination of signals in biomedical processes. Appendices C, D and E discuss some theoretical results pertinent to the book.

Even though many of the adaptive estimation algorithms are given with computer programs and results, I get the distinct impression that the book is not well organized. In fact, many theoretical results have been derived almost as an after thought. The connection between chapters is not very clear. The computer programs appended are excellent and they clearly bring out the usefulness and drawbacks of the various algorithms. Anybody who reads the book can analyse the algorithms with the computer programs supplied. It does discuss some of the least square algorithms encountered in adaptive filtering theory. For research workers working in the area of adaptive estimation techniques this book will give a useful introduction to the subject. However, I find that the proofreading is very much to be desired. Just to give a sample, I am listing below errors that I have found in the first five pages of chapter 7. I have neither the patience nor the desire to list all the errors.

Page 111 — Third line from the bottom — ρ_k for $\int_k$
Last line — ρ_0 for $\int_0$
Page 112 — Eqn. 7.2 — lower case x_k
Second line after Eqn. 7.2 — $X_k^T \triangleq$
Eqn. 7.5 is in error
Page 113 — Fifth line from the top — $a_{k-1}^T X_k$
Eqn. 7.7 is in error
Eqn. 7.8 — $-E[X_k \ldots$
Eleventh line from the bottom — ρ_0 for $\int_0$.
Page 114 — Fourth line from the top $\tilde{a}_k = \tilde{a}_{k-1} \ldots$
Theorem 7.1 Fourth line .... outside for inside
Page 115 — Second line after Eqn. 7.20 — Equation (7.16)

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Fundamentals of the average case analysis of particular algorithms by Rainer Kemp. Wiley-Teubner series in Computer Science, Wiley, 1984, pp. 233, DM 55.

The average case analysis of algorithms poses some challenging problems and offers interesting solutions. While the worst-case complexity measures are adequate from a complexity theory viewpoint, from a practical point of view the average-case results are more useful. Consider the problem of characterizing the number of one bit additions required to add 1 to a string of n bits. The number of additions is 1, n and 2 in the best, worst and average cases, respectively. The average-case measure of 2 is obtained as a weighted average of the number of additions required for each of the 2^n possible input strings. This simple example conveys the fundamental mechanics of the average-case analysis of algorithms, namely, a characterization of the input probability distribution and the corresponding measures of algorithmic effort.

The analysis involves the use of sophisticated and powerful tools of discrete and continuous mathematics ranging from combinatorics, probability theory, asymptotic analysis and complex variable theory. Counting arguments and combinatorial reasoning are first employed to set up recurrence equation models of algorithmic measures. Generating functions, passage to limit and asymptotic analysis are then employed to estimate the average-case performance measures. D.E. Knuth's three-volume work[1] and the monograph by

Greene and Knuth[2], constitute the foundations of this subject. In fact no other material is available in a book form on this subject. This book is a welcome addition to a researcher in this area. To a large extent this book complements the books of Knuth. It is particularly interesting for its thorough mathematical presentation, based upon many recent results, of the average-case analysis of algorithms in the domains of enumeration of trees and and derivation tress, recognition of grammars and reduction of binary trees for evaluation of expressions. This book thus preempts the long awaited future volumes by Knuth.

This compact book is organized in five chapters and two appendices. The first two chapters present briefly the introductory material. The third chapter presents a battery of results on permutations, cycle structures, cycle index of a permutation groups, runs, rises and falls and inversions. The machinery set up in this chapter is essentially useful for the analysis of sorting algorithms. It is therefore surprising that there is no mention of the connection between h-ordered sequences and the Shell sort algorithm. There is a discussion on the analysis of 2-ordered permutations in connection with the odd-even exchange sorting algorithm, in the last chapter of the book.

The special features of this book are chapters 4 and 5. Chapter 4 deals with plane random walk models, for problems of enumerating lattice paths, ordered trees, derivation trees and various combinatorial configurations. It presents a very interesting section on asymptotic techniques for getting bounds on the coefficients in certain recurrence equations. Chapter 5 presents analysis techniques for the reduction of binary trees as applied to the process of evaluation of expressions in code generation. Every chapter is followed by a set of interesting exercises.

The notations employed are somewhat dense and there are a few ambiguities - for example,

(i) the use of 'o' (lower case 'oh') for asymptotic order (p. 23) and for the composition operator (p. 26),

(ii) the use of 'p' for probability and length (p. 39).

The absence of equation numbers, in a book of this kind, is inconvenient at times. The term 'level order' is used for the usual term 'inorder'. The definition (p. 83), however, should read "$LO(T) = LO(T_1)\, r(T) \ldots LO(T_k)$" instead of "$LO(T) = r(T)\, LO(T_1)\, r(T) \ldots LO(T_k)\, r(T)$" and the binary tree example should read "$LO(T) = v_5 v_3 v_1 v_0 v_2 v_6$". The notion of involution is introduced in an exercise (p.48), but the closely related notion of tableaux is left out completely. On the whole this book is a valuable addition to the material on the beautiful interplay of mathematics and computer science.

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Mechanical vibrations (fourth edition) by G.K. Grover. Nem Chand and Bros, Civil Lines, Roorkee 247 667, 1983, Rs. 35.

This is the fourth edition (1983) of the book published first in 1970. The fact that this book has come up to the fourth edition in 1983 is itself an eloquent testimony of the popularity commanded by this book. Dr. Grover is to be congratulated on the success of this small, but fairly comprehensive text book on mechanical vibrations. In the third edition (1977) itself, SI units have been introduced in keeping with the current practice. While retaining all the features of the earlier editions, a brief section on computer-oriented numerical analysis of multi-rotor shafts with different end conditions is added in this edition.

There are, in all, eleven chapters and two appendices in the book. Answers to numerical problems and an index are also provided. The fundamentals of vibration are introduced in chapters 1-4. The author then goes on to discussion on two- and multi-degree of freedom systems in chapters 5 to 7. The topic of critical speeds of shafts is presented in chapter 8. The topics 'Transient vibrations' and 'Non-linear oscillations', as the author stated in his preface to the second edition, were introduced appropriately on the basis of suggestions. The book ends with a discussion on the use of electrical analogies.

On the whole, this book has been a lucid presentation of the important subject of mechanical vibrations for use as a text in undergraduate and post-graduate courses in mechanical engineering, machine dynamics and structural dynamics. The illustrative examples are effectively drawn from appropriate practical, real life applications which is laudable. The book has also been useful to practising engineers. The reviewer would have liked to see even more emphasis on computer-oriented numerical analysis particularly keeping in mind the increasing availability of mini-computer systems in the country. Similarly, it is also felt that a brief exposure of the students to measurement and analysis of vibration would have been very worthwhile. It is the belief of the reviewer that this book would continue to remain popular with students and teachers.

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S. DURVASULA

Modern digital electronics by R.P. Jain. Tata McGraw-Hill Publishing Company, New Delhi, 1984, pp. 468, Rs. 39.

Digital electronics is today all pervasive. With the advent of integrated circuits (ICs) and availability of a wide range of functions, digital electronic circuits have not only become more reliable but also cheap. It is now possible to implement any complex system including intelligent functions with a few ICs. The microprocessor has been one of the most important developments of the last decade which has already drastically affected lives of common folks in developed countries and is likely to touch our daily routines in this country also.

Thus it is necessary that electronic engineers be familiar with digital electronics and with various ICs that are available. The book under review provides the necessary material for a

third year engineering student. The book is well-written and self-contained starting from the basic Boolean algebra and the number systems. A chapter is devoted to the semiconductor devices to give the student a feel of how it all works. Various digital logic families have been presented and compared. Both combinatorial logic and sequential systems have been presented with a large number of examples. Specific IC chips and their functions have been presented and discussed. Analog to digital convertors are presented. Basic concepts of microprocessor are also introduced. If the course is run parallel to a laboratory programme, the student will get a good feeling for the ICs and the systems capabilities.

A few of the important functions have not been discussed. In particular, a presentation of various display devices such as light emitting diodes, liquid crystal displays, plasma displays etc., would have been useful since they form an integral part of any digital electronic systems. Another important component which is not discussed is the crystal oscillator which is mandatory in any microprocessor system. This should have been mentioned in the chapter on timing circuits. The chapter on memories deals only with semiconductor memories and ignores other widely used memories such as floppy discs, tapes and bubbles.

Overall, this is an excellent book which is likely to find wide usage by the students of digital electronics. It can also be used for self-study since sufficient number of solved and unsolved problems are included.

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VIKRAM KUMAR

Electrical power system design by M.V. Deshpande. Tata McGraw-Hill Book Company, New Delhi 110 002, pp. 362, Rs. 27.

This book is aimed at undergraduate and post-graduate students and those preparing for professional examinations in the subject of power systems and power engineering. Apart from being useful for course work, this book is claimed "to be particularly useful for design and project work".

This book easily meets its claims of being useful for a course. It covers a large background starting from basic concepts. It is well illustrated and has a large number of worked-out examples and a larger number as exercises. It will also be useful for those who wish to have a general idea on almost any topic in power systems.

Having said this, I wish to add that the title of *Electrical power system design* is somewhat misleading. The author has tried to cover vast grounds ranging from transmission line design, system stability, HVDC and EHV transmission within 362 pages. As such the book is useful for a general course or reference as has been mentioned earlier, but I am afraid it is inadequate for design purposes or even for project work.

A few sample programs written in FORTRAN or BASIC would have certainly enriched the book.

Electrical Engineering Department

D.P. SEN GUPTA

Power systems operation and control by P.S.R. Murthy. Tata McGraw-Hill Publishing Co., New Delhi 110 002, 1984. pp. 320.

In most of the Indian universities, the undergraduate program in power systems comprises courses in transmission, distribution, protection and switchgear. It is at the post-graduate stage that students encounter topics such as optimal operation and control, computer-aided power system analysis and power system dynamics. As the power industry in the country gradually introduces modern computer techniques for the design and control of system, it will be necessary for the engineers to update their skills through self-study and short-term courses. For these, as well as for the students in ME programs in power systems, there is a need for good text-books on the subject.

Although the book under review does cover many interesting and important topics, it is unfortunate that the mode of presentation renders it unsuitable for self-study or use as a text-book. Any power system problem has three aspects, namely the physical problem, the mathematical technique and the solution algorithm; of these, only the third receives adequate attention, while the other two are only briefly dealt with. To make things more difficult for the average reader, the worked examples are too complicated to provide any insight; in particular, these reviewers find it difficult to appreciate the 51 bus load flow example that is provided, and would be reluctant to use it as an illustration in the classroom.

For the average reader with a bachelor's degree in electrical engineering, the book can be used only with supplementary reading material and close interaction with a specialist in power system. However, for the research worker, it is a useful publication since it comprises a wide selection of mathematical techniques and algorithms that have been the subject of many recent papers in the field of power system operation and control.

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K. PARTHASARATHY
LAWRENCE JENKINS

Alternative energy systems - Electrical integration and utilisation edited by Mike West *et al.* Pergamon Press, Oxford, 1984, pp. 289, $ 48.

This book constitutes the proceedings of a conference of the same name held at the Coventry Polytechnic, England during September 1984. In the recent years there have been a glut of conferences on some aspect of energy or the other and many such proceedings. But this particular conference has a refreshingly different theme concentrating on electrical integration and utilization, which is normally neglected, although of great practical importance. This conference was organized by the Wave Energy Group of the Coventry (Lanchaster) Polytechnic, which has been involved in mainly wave energy research and is currently designing a wave energy device for meeting the needs of isolated or island communities. This group has also some involvement with other aspects of alternatives. Thus the subject matter of the conference was chosen to be contiguous with the general interests of the members of the Wave Energy Group.

It is thus seen that out of the 24 papers presented as many as nine deal with several aspects of wave energy conversion and off-shore energy systems, three with low head and tidal

hydro-energy conversion, two with wind energy, two with energy storage using flywheels, three with solar energy, two with refuse and wood residues and the rest with other aspects like electrical machines and reliability, etc., of energy systems. Although many of the papers deal with utilization and integration and generation of electricity, a fair number of them have nothing to do with electricity. Some of the papers clearly are run of the mill which have nothing novel or new about them to recommend their inclusion. Some other papers, for example such as: Optimum positioning of solar collectors for summer applications in Baghdad, a solar experiment, dealing with merely a description of a demonstration project of use of photovoltaic devices for meeting the energy needs of a community college in Arkausas, Wood residues as fuel in pulp paper manufacturing industries in Nigeria, are out of context, or not of sufficient detail as far as this conference proceedings are concerned. Only about half the number of papers are of some value bringing new aspects and insights to the energy scene. But then this is true with most conference proceedings, which is the reason why their usefulness declines quickly. This volume is no exception and its usefulness lies mainly with the papers dealing with wave energy converters and some others dealing with electrical aspects. Hence this conference proceedings will find place in some libraries and will have limited reference and tutorial value. Although the conference theme raises much promise, the proceedings have not delivered on the promise and instead the outcome is very diffuse and hazy.

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C.R. PRASAD

The heat generator by R. Metzlen, 1983, approx pp. 110, S. Fr. 22 and **The Segner turbine** by Veli Meier. Markus Eisenring and Alex Arter, 1983, pp. 14, S. Fr. 4. Swiss Centre for Appropriate Technology (SKAT), CH-9000 St. Gallen, Switzerland.

Both the publications deal with harnessing water power on a small scale. The first publication describes a device called the heat generator. The basic principle here is to utilize power available from a water turbine (Typically 10 KW) to generate process heat which could be used for several applications like drying of agricultural products, making of paper, etc. The heat is generated by operating a 'Fan' connected to the turbine and is as a result of turbulent energy dissipation in the form of temperature rise of the working fluid. It is claimed that temperatures of the order of 250° C can be achieved with air as working fluid with input power levels of the order of 10 KW. The publication is about 100 pages in length out of which about 40 pages are devoted to fabrication drawings, 20 pages to the description of the heat generator and remaining 40 pages to essentially introduction and to the description of various possible uses of the device. The performance analysis of the heat generation is very elementary and it is not clear from the description as to how for a given input power various temperatures of the working fluid are possible. In addition, there is no justification provided for the assumption of 75% efficiency for the device in comparing with other modes of energy transfer. Finally, to quote from the author "it is important to realize, that the processes described and the design used here are related to the specific situation in Nepal. Generally

speaking, this means mountainuous areas with many small rain and spring-fed rivers, no roads, all transport done on porter's back. The only available fuel is firewood and kerosene; the workshops for manufacturing the equipment have only basic machinery and general workshop equipment. Therefore this manual cannot be a cook-book for heat generators. If the approach, or the designs described in this manual should be applied in another country, they will certainly need changes to be appropriate to the different situation found there".

The second publication describes a device called the Segner turbine which is claimed to be a low cost solution for harnessing water power on a very small scale (of the order of 1-5 KW). The basic principle of the Segner turbine is the same as that is used in lawn sprinklers. Thus, the segner turbine consists of an inlet channel with a cylindrical tunnel through which water enters a vertical pipe and at the bottom of this pipe two (or more) radial pipes are provided with bends to which nozzles are fixed. The power from the rotating nozzles is used to drive a rice huller or a flour mill. The publication is only 12 pages in length; however, consists of sufficient description of a typical design of a Segner turbine and its use in Nepal: It should be pointed out that unlike conventional turbine the Segner turbine requires a vertical drop in the topography to utilize water head.

In summary, in the Indian context it is doubtful that either of the devices could find widespread or even limited application. The booklets, however, do provide interesting information to those who are interested in small hydropower development.

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The design of higher efficiency turbomachinery and gas turbines by David Gordon Wilson. The MIT Press, Cambridge, Masschusetts, 1984, pp. 496, $ 43.13 (Indian orders to Allied Publishers Pvt. Ltd.).

Cascade aerodynamics by J.P. Gostelow. Pergamon Press, Oxford, 1984, pp. 270, $ 45.

The design and analysis of a complex product such as a turbomachine embraces the entire spectrum of mechanical engineering though the subject of turbomachine theory usually limits itself to the aerothermodynamic aspects of turbomachine flows. The internal flows in a turbomachine are a complex and challenging field of study that will continue to interest and intrigue designers, researchers and students for years to come. The first book under review is addressed to the students of design and prefers to eschew the complexities of internal fluid mechanics while giving a sound enough grasp of the basic principles to understand the design process. It is based on lecture notes evolved in teaching graduate courses in gas turbines and turbomachine design at MIT and shows every evidence of its origin. While avoiding analysis for analysis sake there is every attempt to include an understanding of the physics, exemplified in the extended discussion on diffuser flows, etc.

The book opens with a discussion on the development of turbomachines and has a large number of drawings and diagrams that help the student visualise and understand the hardware he is dealing with. It goes on to a review of thermodynamic fundamentals written

very much with the student in mind, pointing out popular misconceptions and giving rules of procedure for the use of formulae and charts. Gas turbine cycles are then discussed with a good treatment of the effect of the various design parameters on performance. The design of various categories of turbomachines are discussed in the following chapters. Heat exchangers and blade cooling are discussed with description of the geometries of modern cooled turbine blades. The book concludes with a brief excursion into a cursory overview of mechanical design considerations. In spite of its title the emphasis in the book is largely on gas turbines. The theoretical treatment is compact and there are a wealth of correlations to guide rational choices in the design process. The emphasis is throughout on design and the balance of topics treated perhaps reflects the authors' own interests. The extensive treatment of diffusers and blade cooling for example are in contrast to the almost total lack of any discussion on secondary flows, etc. The treatment of three-dimensional flow is limited to simple radial equilibrium. One is a little disappointed in seeing specific speed again treated as in so much of the modern literature as a mere parameter of some convenience and use in correlations. Not every one would agree with the far too brief discussion of compressor surge which might even leave a student with the wrong ideas. One would have liked to see in a book on design at least some treatment of the problem of matching the components that go into a complete engine. To sum up this is a welcome book that would be very useful not only to students and instructors alike but also to practising designers. The style and organisation of the material is ideal for student use and one hopes subsequent editions would improve the undergraduate balance and fill in the lacunae. The level of treatment is appropriate for a master's level course but could also be used by final year undergraduates.

The second book, *Cascade aerodynamics,* deals exclusively with the fluid mechanics of the heart of a turbomachines-the impeller blade rows. It is an extensive review confined largely to axial flow blade cascades. Starting with a discussion of the cascade model itself it goes on to review methods of low speed and high speed cascade testing and all aspects of cascade flows including theoretical methods, experimental results, their application in design and estimates of prediction accuracy, etc. It is essentially a review of the state of the art summarising the latest approaches to particular problems. The area covered is so vast that it would be unrealistic to expect all the conclusions to be judiciously considered. All the same this compendium would prove invaluable as a review and source book for researchers and advanced students. For the designer it would be an useful supplement to the earlier book reviewed. Both books can be warmly recommended.

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S. SOUNDRANAYAGAM
Editor.

Engineering hydrology by K. Subramanya. Tata McGraw-Hill Publishing Company Limited, 12/4 Asaf Ali Road, New Delhi 110 002, 1984, pp. 312, Rs. 30.

The book under review completely fulfils the intended objective and serves as an excellent text-book for a first course in engineering hydrology at the undergraduate level in the civil engineering discipline.

The book covers a wide variety of topics, describes various aspects of engineering hydrology in a simple and lucid manner, and more importantly, maintains a careful blend of basic and applied aspects throughout the presentation.

After an introductory first chapter describing the hydrological cycle and applications, the book deals with precipitation (mainly rainfall) and its abstractions in all its aspects in chapters 2 and 3. Chapter 4 presents a wide variety of stream flow measuring techniques. Estimation of yield, mass curve analysis are presented in detail in chapter 5. Justifiably, the next chapter on hydrographs gives an elaborate coverage on the derivation and application of unit hydrographs along with an introduction to the instantaneous unit hydrograph (IUH). Chapter 7 deals with floods and flood frequency studies while the entire chapter 8 is devoted to routing in which both hydrologic and hydraulic methods are discussed. Basics of groundwater flow hydraulics are presented in chapter 9.

Many well thought out example problems are worked out in the book which aid in the understanding of the text. The problems and the multiple choice questions posed to the reader at the end of each chapter are well designed to stimulate thinking and an overall comprehension of the topics covered. The book is amply illustrated with neat and clear sketches.

A significant feature of the book is its orientation to the Indian environment and its extensive reference to Indian experiences and practices which should be of special interest to students in this country.

On the whole, the book is an excellent presentation of the basic aspects of engineering hydrology. Though intended mainly for the student community, the book serves the purpose of providing a basic reference text to water resources engineers as well.

It is hoped that occasional minor printing mistakes (*e.g.*, spelling/grammatical/others on pages 10, 18, 22, 58, 77, 98, 130, 136, 144, 156, 210, 246, 255, 262 and 287 and reference numbers to references/earlier sections on pages 135, 211 and 236), will be rectified in the next printing which should further enhance the quality of the book.

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S. VEDULA

Astrodynamics 1983 (Advances in the Astronautical Sciences, Vol. 54, Parts I and II) edited by G.T. Tseng, P.J. Cefola, P.M. Bainum and D.A. Levinson. American Astronautical Society, San Diego, Calif., U.S.A., 1984, $ 120.00 (Orders to Univelt, Inc., P.O. Box 28130, San Diego, CA 92128).

The proceedings of the AAS/AIAA Astrodynamics Conference held on August 22-25, 1983 at Lake Placid, New York, are presented in this volume in two parts. Part I includes 38 full papers and 19 abstracts and Part II 34 full papers and 11 abstracts. The papers, for which only abstracts are included, appear in full in the microfiche supplement (Vol. 45, AAS

Microfiche Series) or in periodicals such as the Journal of Astronautical Sciences. The papers are grouped into the following topics:

Attitude dynamics, mission analysis for planetary exploration, orbit determination, attitude determination and control, flexible spacecraft dynamics and control, celestial mechanics, mission analysis for earth orbiting transfer and reentry, autonomous navigation, trajectory optimization and analysis, and space telescope. There are many excellent papers presenting significant contributions to both theoretical and practical aspects of space technology.

The papers on attitude dynamics include: nonlinear behaviour of orbiting tethers, a computer programme for generation of symbolic equations for spacecraft, remote orbital capture using robot spacecraft, nutational motion of asymmetric dual-spin spacecraft, convective instability in solid propellant rocket, dynamics of variable mass systems with application to the star 48 solid rocket motor, a free-fall technique to measure nutation divergence, limit cycle behaviour of dual-spin spacecraft with spherical dampers, annihilation of angular momentum drift during spinning-up and thrusting manoeuvers of rigid bodies, and analytical solution for dual-spin spacecraft during platform motion. In general, most of the papers are well presented. They analyse the system behaviour of some of the present and future spacecraft.

The results of the investigations reported on attitude determination and control deal with Landsat-4 horizon scanner flight performance, Galileo scan platform control and attitude control, injection module thrust vector control, gain measures for controllability and observability, maximization of torque capability from control moment gyro systems, attitude control for the Extreme Ultravoilet Explorer Satellite, system parameter refinement of low-momentum reaction wheel attitude control system, and an improved convergence of Kalman-filtering attitude determination. In this group, most of the papers deal with systems and algorithms designed for present spacecraft.

On flexible spacecraft dynamics and control, the topics covered are shape control of a flexible beam under solar radiation pressure, shape control of large aerospace antennae, active nutation control for a flexible momentum biased spacecraft, influence of time and normalization on actuator placement by degree of controllability, time periodic attitude control, parameter simplification in linear systems, large space structures with stiffness control, optimal slewing manoeuvers for flexible spacecraft using a closed form solution, for the linear tracking and the terminal tracking problems, minimum time and fuel on/off thruster control, and fuzzy concepts of the degree of controllability and observability. Most of the papers presented in this group are relevant to the needs of the future large space structures. The theoretical developments are interesting.

The paper on mission analysis for planetary exploration and earth-orbiting applications cover a wide range of missions/topics such as: Asteroid/comet and Saturn missions using Galileo spacecraft, large microwave radiometer, propellant longevity prediction, Heliographic mission, GPS/Shuttle orbit navigation, SIR-A payload for shuttle, future space transportation system concepts, IRAS mission, orbital constellation to minimize revisit time, and NAVSTAR satellites. Four papers related to space telescope mission planning and pointing control are also included. For several other missions, only abstract of the papers are included.

A few papers present theoretical developments in celestial mechanics. These include an analytical method to determine close approaches between satellites, synodic motion of satellites related to Sun, effect of eccentricity on halo orbits in the restricted three-body problem, closest approach and duration of encounter between two satellites, empirical atmospheric density models, ephemeris of communication satellites, short-periodic perturbation due to third bodies, Earth's field representation, series approximation to Kepler's equation, and orbit prediction using vector techniques.

The section on orbit determination includes studies related to VLBI system for TDRSS navigation, HEAO-2 spacecraft, Giotto, extended semianalytic Kalman filter to synchronous orbit, and autonomous orbit computation. Abstracts of papers of a few more topics are also included.

A few papers deal with orbit-transfer, reentry, and trajectory optimization and analysis. These relate to orbital transfer of large deployable systems, adaptive guidance for an aeroassisted orbital transfer vehicle, optimization of spacecraft aerobraking missions, aerocapture and ballistic flythrough trajectories, and ballistic orbital motion in a rotating atmosphere. The investigations are of value to mission analysts.

The papers presented at a special session on autonomous navigation are also included in the volume. In these papers the ARMMS concept, satellite orbit theory for a small computer, autonomous satellite navigation using the stellar horizon atmospheric dispersion sensor and Landsat-4/GPS navigation results are discussed.

The range of topics covered, the standard of papers (some are by by the best known persons in the field today) and its elegant presentation make Astrodynamics 1983 an important reference volume for research workers as well as mission analysts dealing with spacecraft dynamics and control. It presents some of the latest developments on the subject in the US.

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Guidance and control 1984 (Volume 55 of Advances in the Astronautical Sciences) edited by Robert D. Culp and Parker S. Stafford. American Astronautical Society, San Diego, California, USA (Orders to Univelt, Inc., P.O. Box, 28130, San Diego, CA 92128), 1984, $50.

The Guidance and Control series of the proceedings published annually by the American Astronautical Society (AAS) is a fine example of according recognition where it is due. The Annual Rocky Mountain Guidance and Control Conference, whose proceedings form the AAS Guidance and Control series, began as an informal exchange of ideas and achievements of a local group. In 1977, the conference was formalized, and since 1978 it has been sponsored by the American Astronautical Society.

Guidance and Control 1984, in organisation, is a typical scientific conference proceedings. The papers fall over a broad area within the designated field, and cover hardware, software,

analytical, conceptual and performance aspects. There are thirty-two papers, organised into five sections. One aspect of this series that contrasts it from the typical scientific/engineering conference proceedings is the exhaustiveness and detail contained in many papers. One measure for this is the average length of the papers, which is about fifteen pages in this volume as compared with about four to six pages for the typical proceedings.

A distinct feature of this proceedings is that most of the papers here are mission-oriented rather than fundamental-oriented. This is perhaps in order, since theoretical aspects of guidance and control do have other forums and media for expression and publication. A very good example is AIAA's Journal of Guidance and Control. Mission-oriented information and analysis, on the other hand, are not too well-suited for refereed journal publication since their essence is freshness which would not be preserved through the publication procedure.

Be that as it may, the reader is exposed to the experiences gained from a large number of U.S., European and Japanese space missions. An entire section with six papers has been devoted exclusively to recent experiences. Prominent among them is a fairly detailed account of the in-flight rescue of the TDRS-1 spacecraft which was left stranded after launch by the space shuttle Challenger due to a malfunction in the Inertial Upper Stage (IUS) booster. This particular article makes very good reading partly because it is a good blend of narration and scientific/engineering analysis, and also because it had attracted worldwide attention, even in the semipopular press, when the feat was actually performed. Other articles in this section deal with cosmic ray effects, autotracking from space in the TDRSS, and aspects of Inertial Upper Stage.

Among the other sections is one devoted to international space programs. Developments on the attitude and orbit control of the European Olympus, Eurostar, Infrared Space Observatory and the Hipparcos satellites and the Japanese Marine Observation Satellite-1 and Planet-A are reported. The next section is devoted to instrumentation such as star trackers, angle sensor, field tracker, airborne laser lab, artificial intelligence and computer vision, and strapdown inertial guidance packages. The section on Rendezvous Docking and Orbit Servicing has an interesting coverage on the Manned Manoeuvering Unit (MMU) which is the wellknown 'flying seat' which space shuttle astronauts use for precision manoeuvering during detached spacewalk. Also covered are laser-docking system, rendezvous with remotely piloted vehicles and flexible robots. The section on Guidance and control and payload effects analyses the IUS propulsion, guidance and control, gamma guidance, guidance software of Centaur D-1A, space-based orbital manoeuvering systems and the transfer orbit stage.

The geographic distribution of the source of the articles generally tallies with the level of space-related activity within the western world — U.S., Europe and Japan in that order, with the U.S. activities way above the rest, at least in volume. Although the Proceedings under review does not purport to be international — at least by title — it would have been beneficial to the reader if its transnational nature had been extended to include the experiences of other space-venturing nations, such as the Soviet Union and India. However, this does not in any way obscure the fact that the volume is a rich source of information for scientists and

engineers working in the field of guidance and control, and aerospace systems in general, and even for intelligent and interested laymen.

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P.R. MAHAPATRA

Space safety and rescue 1982-1983 (AAS Science and Technology Series, Vol. 58) edited by Gloria W. Health. American Aeronautical Society, 1984, pp. 366, $ 40 (Orders to Univelt, Inc., P.O. Box 28130, San Diego, Ca 92128, USA.).

The volume presents the proceedings of the 15th and 16th symposia of the International Academy of Astronuatics held in conjunction with the 33rd and 34th International Astronautical Congress in Paris in 1982, and in Budapest in 1983. The subject is discussed basically under two headings: (I) Space safety and rescue and (II) Worldwide disaster response, safety and rescue employing space-borne systems, in both the years' proceedings covering about a dozen papers each year.

Safety and rescue in space, air, sea or land, is a vital area. The safety of a space mission could depend upon several factors. For near-earth missions, collision of spacecraft with man-made debris could be serious; whereas the safety hazard for manned missions could involve, human error, behavioural derivations due to long duration in weightless environment, equipment failure, meteoroids, space radiation and even possible hazard to microelectronics by radiation. These aspects are discussed under 'space safety and rescue' papers. The other aspect dealing with a system of international satellites, which could be used for search and rescue location for earth-bound, land, sea or air mishaps, is presented under the second title. The optimal use of the existing communication satellite systems, such as INMARSAT, SARSAT, COSPAS, etc., as well as potential of the in-coming systems such as the GPS NAVSTAR is discussed for search and rescue operations for earth-bound mishaps covering the entire world.

The topic of these symposia is such that it is difficult for any author to go into technical details. Most of the papers are therefore like status or progress reports. The information given, however, provides a fairly good semi-technical overviews of the subject. It also makes a strong case for international cooperation in this vital area. The book should be of value to the planners and users of space systems. It is a welcome addition to the literature on space science and technology.

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Space and society: Challenges and choices (AAS Science and Technology Series, Vol. 59) edited by P. Anaejionu, N.C. Goldman and P.J. Meeks, American Astronautical Society, 1984, pp. 429, $ 35. (Orders to Univelt, Inc., P.O. Box 28130, San Diego, Ca 92128, USA.)

How future space activities are going to affect our attitudes - social, political and economical? Who owns rights of mining on the Moon? What is the share of the third world in space benefits? Does space industry have a future? What are the major space benefits and how serious is the US to commercialise them? Who lobbies for support of space activities in the US? What are the future issues of colonizing space? Are ecological problems a major setback in extra-terrestrial life support systems? What are the current major interests of various countries in space?

These are some of the topics discussed at the Space and Society Symposium held at the University of Texas (1982) whose proceedings have been compiled in the present volume. The symposium theme is divided into five sections: (i) American government and space (ii) Political economics and space (iii) Foreign space programs (iv) Space applications and (v) The future, covering four to six papers in each section.

The volume presents a profile of things-to-come on the space activities scene - in the near and not-so-very near future-which would affect the human society as a whole. Some of the issues put forward are highly involved and cannot be considered in isolation solely by the advanced nations. For example, although in principle it is agreed in the 'Moon Treaty' that space resources are for all people of the planet earth but how this 'property right' is to be implemented is the key question. Other issues discussed reflect mainly the impact of the future U.S. activities in space on its own affairs - social, political, economic and scientific & technological. As expected in such a symposium, the military arena has been excluded.

The book is an assemblage of views expressed by the U.S. people from multidisciplinary areas, such as economics, history, political science, government and public affairs, etc., and is essentially non-technical in nature. The 'soft science' presented in these papers, however, provides valuable general information to space-oriented minds, in a package form. Most of the papers make interesting reading. The book should be useful to people generally interested in space science.

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