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Book Reviews

Vaulting ambition: Sociobiology and the quest for human nature by Philip Kitcher. The MIT Press, 55, Hayward Street, Cambridge, MA 02142, USA, 1985, pp 456, $ 28.75. Indian orders to Affiliated East-West Press Pvt Ltd, 25, Dr Muniappa Road, Kilpauk, Madras 600 010.

Following the shockwaves of Wilson's *Sociobiology*, there flourished a stupendous number of books, monographs and articles aspiring to unravel the mystery of human nature essentially under the lens of ethological models of non-human social behaviour. Not all of them gave new insights, approach, or speculations. Rather, many were based upon misunderstandings of either Darwinian evolution ('perpetuation of species') or the role of culture in human evolution. As Malamud said, when your train is on the wrong track, all the stations you arrive are wrong stations. No wonder most of the inferences made in these studies by human sociobiologists are flawed by a proclivity to explain human culture in terms of biology which denies the autonomy of human cerebral functions any significant place.

The polemic that has followed the publication of sociobiological literature is almost entirely predicted on the connotations, extent and significance of the 'biological bases' of culture. There is of course no dispute over the fact that potentials of development of human culture are essentially limited by human anatomical, physiological and developmental constraints which shape the human behavioural repertoire. Examples are innumerable. All our tools are thus *manipulable* with human hands, and the tiniest of pocket calculators must be big enough to accommodate our fingers for their use. Our languages contain a large number of words relating to our visual sense-data and perception, only a few to smell, and none corresponding to electroception, and so forth. However, the sociobiology debate is concerned with a more specific claim: that human social behaviours are determined by a biololgical basis explained by kin selection and the individual's endeavour to maximize its inclusive fitness.

The basic structure of this claim consists of the following syllogism. Behaviour B in a group of animals appears to be beneficial for enhancing the (inclusive) fitness of those who display it. Since B is found in virtually all members of the group, B must have been fashioned under natural selection, and hence, B is adaptive. But natural selection operates only on genetic variations. Therefore, there must have been differences in genotypes between the group that displays B and its ancestors who did not. Finally, since B has a genetic basis and is adaptive, it is costly for a society to deviate from that pattern of behaviour. This train of logic construes what Kitcher sees as the Wilsonian ladder. (One can detect a circularity in this argument, but Kitcher draws attention to more serious fallacies). He sets out to dismantle each rung of the ladder by critical analysis, which I find rigorous, comprehensive, and well balanced. For Kitcher not only identifies the hard- and soft-core schools of sociobiology, but also reveals the flaws in their critiques. He points out that sociobiological questions are legitimate questions within the framework of the synthetic theory of evolution; the trouble begins with the ambitious conclusions of sociobiology concerning the adaptive significance of a particular (set of) behaviour—conclusions drawn without the necessary methodological caution about evidence. Thus "the defects lie in the method, not the matter" (p. 132).

Very few philosophers have a good knowledge of biology. Kitcher is one of those who also have a grip on mathematics strong enough to fathom the formalism of models in evolutionary biology. He exposes the faulty presuppositions and biases underlying the sociobiological explanations of parent–offspring conflict[1], homosexuality[2], xenophobia[3], avunculate[4], female infanticide and upper-class polygyny and hypergamy[5], incest in European royal families[6,7], conflict in an Yanomamo village[8], etc., and proves what he proclaims as the central theme of his book: "the dispute about human sociobiology is a dispute about evidence" (p. 8).

And with no convincing evidence available, the sociobiological accounts of the behavioural 'traits' turn out into just so stories, as Lewontin put it. "We can be liberal in granting the right to tell stories, as long as we are clear that is exactly what is being done" (p. 251).

Kitcher uses a brilliant and witty language (sometimes redolent of Dawkins') which makes his book fascinating. One can easily discern in his writing a bias, which is inevitable in any polemical writing. Nevertheless, his critique is not bereft of fairness and decency insofar as he chooses to attack only the strong and rigorous instances of sociobiological arguments rather than the weak and vulnerable ones.

While there have been some overreaction and undue attacks on sociobiology and the sociobiologists, it is not difficult to understand the concern of the critics for forestalling the dangerous consequences of biologism in modern politics. Sociobiologists argue that they are not racists nor sexists, neither do they support imperialist wars, but are merely endeavouring to unravel the truth, pure and simple. But Kitcher rightly states that truth is rarely pure and never simple. "The genuine worry behind the political criticism of sociobiology is that, while claims about non-human social behaviour may be carefully and rigorously defended, the sociobiologists appear to descend to wild speculations precisely where they should be most cautious"—in human affairs (p. 9).

What justifies all the caveats underscored by the critiques of sociobiology is that sociobiological literature has been repeatedly used by the organs of the New Right to erect justifications of racism, sexism, and to stand for the imperialist vested interests. What with Wilson's clear statements about his views on racism, his works, along with those of Lorenz, Morris and Dawkins, are being widely cited by the New Right in support of their political agenda. Of late, Dawkins has realised the situation clear enough to regret in the recent edition of *The selfish gene* the misuse of his metaphors.

The confusion created by mathematical simplification is another point utilised in *biopolitics*. Carefully constructed, illustrative models such as those of Boyd and Richerson[9] can contribute to understanding the complexities of biocultural interactions and the 'run-away' evolution of culture. However, mathematical models of complex phenomena can often be misleading, due to the simplification and abstraction necessary for the sake of tractability of analysis, which the non-mathematical readers are obliged to take mostly on faith. Thus mathematical formalism, when uncautiously employed, can generate obfuscation and popular misunderstanding of the problem. An egregious example of such obfuscation of the issues is the book by Lumsden and Wilson[10] which seems unnecessarily complicated, because Kitcher's relatively elementary probabilistic computations can lead us to a more realistic conception of the situation than the tortuous exercises in higher algebra (including Fourier transformations!) they indulge in. The risk of misunderstanding is increased by the few mistakes in parts of their analysis.

One may be generous, attributing the errors to the authors' carelessness and bias. There is of course a moral distinction between the puerility of biased arguments and deliberate deception, though the consequences are often just as bad. Much has been said about the potential danger of misusing and misinterpreting the popular works of sociobiology, if only because almost nothing is decisively known, to be frank and honest, about human biology. History is gore with the irretrievable losses incurred in the experiments perpetrated in the name of science on human freedom and destiny. And evolutionary theory is the most effective tool in the hands of Establishment for justification of the multitude of social injustice, in terms of the Nature of human nature, red in tooth and claw. In any case, how the fact of white Anglo-Saxon technological–military supremacy co-mingled with racial prejudices and theories of IQ contributed to the origin and perpetuation of Social Darwinism ever since Herbert Spencer had promulgated it is an interesting, and (at least to us) alarming, page of history. Equally interesting is the fact that the same old arguments of Social Darwinism are being given by the 'New' Rights to buttress the old ideology of the *status quo*. Which shows that 'human nature', the sociobiological will-o'-the wisp, is one of the baneful ideas that seem immortal. And equally alarming, scientists shun their responsibilities when their findings are misinterpreted in the media (like the Document Associates' film *Sociobiology: Doing what comes naturally*). More surprising are the strangely irresponsible statements some sociobiologists deliberately make in their writings, apparently to catch the eyes of popularity. And these are the cases which have provoked even a champion of sociobiology into declaring it "necessary to save sociobiology from the sociobiologists" (Ruse[11], p. 86).

One always finds functionalistic explanations endemic in sociobiology. This can be related to the epistemological reductionism in which one part of the theory is deduced from another[12]. The last step in Wilson's ladder, namely, that the only possible environments in which the optimal behaviour B can be replaced with a mutant behaviour M are undesirable, is deduced from the assumption that B displayed by the animals that exist today is the best or optimal solution to the imperative of individual reproductive success. The numerous research papers published in the last two decades describe almost everything that animals do as 'optimal', and appear to have been embedded in the Panglossian conviction that whatever exists is the best of all possibilities. It is therefore necessary to identify the double-edged sword that has been made of human sociobiology by the New Right. The blow from the sword must be parried while it is in the air. Kitcher has made a valiant attempt at it by a graceful counter-blow.

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Technical briefing: Skills for success and survival by Stockham, Leo W., Univelt Inc., P. O. Box 28130, San Diego, CA 92128, 1989, pp 64, $ 20.

It is debatable whether books, which are essentially meant to be read or referred to, can help any one improve the quality of something as practice-dependent as oral presentation of technical information. Yet books with this avowed purpose continue to come out in fairly large numbers. The book under review is one such.

But one with some interesting differences from many others of its genre. For one thing, it is written by a practising technical professional, and not by a professional technical communication teacher like your reviewer. So he is able to bring an insider's perspective to bear on issues in preparing for, and actually making, technical presentations. Next, the book eschews 'theory' almost completely, and deals with points of a practical kind.

This exclusive concern with practical problems is reflected in the author's devoting most of the book to the do's and don'ts in the preparation of 'visual aids'. We all know that visual aids represent an area of weakness of the most damaging kind in technical presentations. Many things can and do go wrong with them, spoiling the 'impact' of the whole presentation. The author has valuable suggestions regarding the ideal dimensions of transparencies, their margins and the lettering used on them, and the nature of information that can and should best be graphically represented, the qualities of penmanship to be ensured, and the colours that should not be used. One of the points of difference of the book, noted earlier, has to do with its production of a large number of 'bad' slides. Attention is drawn to the lapses that make them 'inadequate'. There is a disquieting air of familiarity about these countermodels, but their instructional value is undeniable. I used some of these to my advantage in a few of my courses on oral presentation.

The book has just a two-page section on 'Audience behaviour'. I wish this section were longer. For in this the author has demonstrated his uncanny powers of observation and categorisation of personality types and the quirks of their behaviour as members of an audience. The humour that underlies the entire book acquires a ring of reality in this chapter that compels the reader to take serious note of the author's intended message. A sample.

> The Perfectionist: There will be a perfectionist at most meetings. One who is extremely capable and knowledgeable himself and who expects every one else to share and/or instantly adopt his convictions. He will be intolerant of those who disagree with him or who cannot immediately see the worth of his position. He will be difficult to deal with and blunt with his comments. He's probably worth heeding, if you can stand the pain, but his manner will reduce his influence.

Almost a leaf from our experience, isn't it?

Tips on stage behaviour, posture, voice modulation, audience contact, appearance, etc., are presented in simple, non-technical terms. However, support in the form of photographs or drawings would have gone very well with some of these. For example, suggestions on the speaker's positioning himself with respect to the projector, the screen, and the audience's visual path could be concretized with graphics showing right and wrong positions.

I recommend the use of the book as a self-help manual for technical presenters. Following its guidelines may not help you do everything right, but can sure help you avoid doing many things wrong.

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Global environmental change: The role of space in understanding earth by Richard G. Johnson. Published for the American Astronautical Society by Univelt Inc., P. O. Box 28130, Diego, CA 92128, 1990, pp 167, $50.

It is a direct consequence of the communication revolution sweeping the world during the last four decades that global concerns have begun competing with the local. Up until just a generation ago, the average citizen, or the 'man-on-the-street', occupied himself essentially with matters of direct concern to his livelihood and left matters beyond his perceptual reach to be handled by a chosen few. Often those few were chosen by the God or his men, heredity, or intrigues, and controlled the destinies of the lesser mortals.

Mass mobilization and great revolutions have taken place in the past, and great popular leaders have been born. The Crusades, the French and Russian revolutions and numerous freedom movements in modern times have changed the nature of human civilization. However, most major movements of the past have resulted from tangible factors such as food shortages and/or religio-political oppression. Less-perceptible factors were generally allowed to grow until they were destructive enough to be grossly visible, before action took place, usually in the form of retribution. The insidious induction of opium into China by the British went on smoothly and unopposed till it led to the Opium War. That was barely a century ago. It is not that a few savants did not sense these subtle changes and foresee their efforts. But they did not have the means and the framework to convert their sense into a movement.

We now have the tools. Several factors have contributed. We have devised extremely sensitive instruments and indicators to sense the minutest changes in our economy, social outlook, and physical surroundings. Our understanding of large systems has improved to the point of making reasonable predictions of the future effects of these changes. Then, there are the technical means available to disseminate the observations, predictions and opinions over wide audiences. The audience, the populace at large, is more educated on the average, to appreciate the logic of what is being communicated. And last, but not the least, there is a near-universal acceptance of the concepts of freedom of speech and communication, which permits free flow of ideas and opinions across the globe.

The results are there to see. A global consciousness has been built up on a wide range of topics from political and economic to social and cultural, but nowhere is a consensus more evident than issues concerning our common environment. A barely sensible rise in the average temperature of the earth, yet to be confirmed amid the statistical grass, has struck a loud alarm bell in the global psyche. So have a slight fall in the total ozone content in the earth's atmosphere, a reduction in the earth's forest cover, loss of the earth's fertile top soil, and an expansive march of the desert frontiers.

The spring door seems to have swung to the other extreme. We now have global movements on problems whose existence has not even been definitely established, but merely intelligently conjectured. But it is better to be safe than sorry. Too much is at stake, and by the time the problem is 'established', it may be too late, and the damage irreversible.

We need everything at our command to settle these issues one way or another, and we need to monitor these phenomena closely enough to characterize them, evaluate their intensity, and predict their effects. The most effective vantage point for such monitoring is the space, which offers a global view of the large-scale happenings here on earth. The book under review provides a diversified, but up-to-date status report on this aspect of space programs. The book is a record of the 27th Goddard Memorial Symposium held in Washington, DC, USA, in March 1989.

The importance of the topic of the book in public perception is made evident right in the introductory section. Of the two talks presented there, one is by the US Senator Ernest F. Hollings, who is on the committee on Commerce, Science and Transportation. The other is by Richard Johnson, the editor of the volume, who is the Vice Chairman of the Committee on Earth Sciences. The authorship of the rest of the articles includes other luminaries in their own disciplines.

The concern with which depredation on the environment is viewed in some of the better-informed societies has been promoted to the level of threats to national security. To quote US Senator Hollings in his introductory article: "One immediate task will be to fashion a *broadened* concept of national security—a concept of national security that is less obsessed with the military dimension of space and more attuned to the environmental dimension of space. This means looking beyond strictly parochial interests and jockeying for national advantage. It means refocussing on *global* security and the fate of the earth". A major achievement of the mankind during the last couple of decades is that it is not just the scientist that is sounding the alarmist note, but the politician, articulating popular opinion. For a change. The scientist is being *driven* to produce facts of the global ferment.

The volume devotes an entire section with five articles to issues relating to the policies and plans of various US space and scientific agencies, based on talks delivered by high-level administrators of these agencies. Particular mention is made of the 'Mission to Planet Earth' as a new concept in orienting the space programs for a close monitoring of the earth itself.

The section on Global earth sciences focuses on the various science issues, and discusses global change from the perspective of atmospheric sciences, biological systems, ocean sciences, and solid earth and hydrological sciences. This is a well-balanced section covering the major spheres of the earth having a direct bearing on global change.

The major strength of space sciences and technologies in monitoring global change has been brought out in a section on technology trends. The status of major space-based remote-sensing techniques is covered here. These include the active and passive microwave remote sensing, and the technologies of active optical sensors, passive electro-optical sensors, and ultraviolet remote sensing. Between them, these technologies provide the most modern and accurate means of measurement of the parameters of the global environment, which will lend far more definiteness to the debate on the status of our environment than is hitherto the case.

More is in the offing. A manned US space shuttle flight entirely dedicated to monitoring of the global environment is due any time now. Given that most of the shuttle flights of the recent past have been largely in support of military activities, such an event is a confirmation of the gravity of the concern regarding the state of the earth, and the willingness of the nations, that can afford, to commit resources to the study and alleviation of the problem.

The book presents a high-level perspective of the problem, and progress towards its solution. Volumewise, there is now a surfeit of literature on detailed aspects of the environmental problem. But this book provides a bigger picture. It gives a complete view of the field as seen by people at the apex. For the scientist as well as the administrator, and even the politician, it is a one-stop source to get a bird's eye view of one of the most profound problems of our time.

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Space utilization and applications in the Pacific edited by Peter M. Bainum, Gayle L. May, Tatsuo Yamanaka and Yang Jiachi, Vol. 73 in Advances in Astronautical Sciences, An American Astronautical Society Publication by Univelt, Inc., P. O. Box 28130, San Diego, CA 92128, 1990, pp 748, $80.

The Third Pacific Basic International Symposium on Advances in Space Science Technology and Applications (PISSTA) was held in Los Angeles, CA, during November 6–8, 1989. Over seventy papers from representatives of major nations of Pacific basin are presented in the opening and closing sessions plus thirteen technical sessions. These papers mostly dwell on launch-vehicle technology, large space structure/station and allied topics. The Proceedings also contains a large number of papers on space programs and other mission-oriented subjects, thus providing a good blend of theoretical and descriptive papers.

Two sessions on launch-vehicle technology deal with the Japanese and Chinese missions as well as American Delta launch vehicle. Some aspects of guidance and control are also mentioned for the sake of completeness. Here, a large number of papers deal with the Japanese H-II rocket program, while particulars of Chinese Long-March series and Delta vehicles are touched upon in the rest. The H-II rocket has two-stage cryogenic propellant rocket motors with two solid rocket strap-ons. The large solid rocket boosters (strap-ons) use movable nozzle thrust vector control (TVC). On the other hand, the air-breathing solid rocket engineering is a new concept which needs a detailed probing, both theoretical and experimental, before it can be accepted as viable. When majority of space-faring nations are moving toward high-efficiency (large I_{sp}) liquid and cryogenic rocket motors, the Japanese have proposed a new low-cost three-stage solid rocket vehicle which is technologically simple, thereby making it a possible condidate for use by many developing countries in the near future.

The space program has components like launch site/facility, launch vehicle and satellite which are akin

to soil, tree and a fruit, respectively. Hence, a full session is rightfully devoted to space ports. The geographic location of a launch site has large bearings on economy, efficiency and success of any launch mission. However, development and maintenance of a launch facility is expensive. The viability of such a facility depends on the total work load. It is in this background, the building of international facilities assumes great significance, which should also help to share the cost of maintaining them With the increasing demand on number of satellites in geostationary orbits for multifarious applications, it is natural to look for selection of a number of launch stations for equatorial launch. The paper Potential equatorial launch sites makes an interesting reading. Also discussed are the issues related to spaceport in Hawaii, and aerospace-related super structure in Japan. The concept of underground compressed air-launching system sounds more like a science fiction as it is difficult to pass judgements on the cost effectiveness and implementability of such a scheme.

In the opinion of the reviewer, nearly three sessions on utilization of space technology contain most comprehensible papers of this Proceedings. Though it will be impossible to address all the research and developmental issues on the theme in single volume like this one, the 17 papers address themselves to specific issues related to satellite technology of the present and future. Three papers on dynamics, variable structure control of space station and selection of actuator for large space structure are some such fine examples. The session on Space stations (9 papers) provides exhilarating view of various space subsystems and their functional as well as structural details. The development of space technology and infrastructure including the space station is an important milestone of the human endeavour. However, equally prominent aspect is the operation of various space station segments which requires the use of space robots, proper up/down communication with the earth station, thermal management and so on. Further, last but not the least, one has to give attention to real-life satellite applications. The most notable application definitely relates to 'education' with special reference to developing countries. The other applications are earth observation, remote sensing, and earth resources survey. In summary, though the Proceedings of the conference addresses the issues mentioned above *vis-a-vis* Pacific basin nations, they are equally useful to all space-faring and other nations world wide.

This Proceedings holds a wealth of information that is extremely useful for the entire spectrum of aerospace community, and is a must for all institutions of higher learning, aerospace industry and managers of all related disciplines.

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History of rocketry and astronautics edited by K. R. Lattu. American Astronautical Society, 1990, pp 356, $ 50. Orders to Univelt, Inc., P. O. Box 28130, San Diego, CA 92128.

To those who feel disconcerted that this review is appearing too late after the publication of the volume, it may be some comfort to learn that the volume is indeed the proceedings of the Seventh and Eighth History Symposia of the International Academy of Astronautics held in USSR and Netherlands as early as 1973 and 1974! The volume consists of twenty separate articles dealing with concepts, theories and designs in rocketry and astronautics. The articles while providing improved understanding of the contributions made by the Soviet and European scientists reflect the excitement of Europe's active entry into the space programme. Even a cursory glance shows how much of these contributions had gone unnoticed hitherto.

Part I dealing with early solid propellant rocketry mentions briefly of the contributions by Willam Hale and by an early Hungarian designer Lajos Martin around the period of Hungarian war of independence. Although very little technical information is provided, the article draws one's attention to less-known ventures in rocketry.

The second part consists of a few articles stressing on the conceptual developments in rocketry since 1880. Beginning with the first ideas of launching, through the navigational concepts to the contraptions

like Rogallos wing to land back on the earth, the presentations seem to prepare the ground for the ne part. A particularly interesting description is with regard to the origin of the well-known rocket equatio The chapter on the development of space transportation describes the chronology of development whic had brought the technology to " . . . the limit of what expendable launch vehicles using chemical prope lants can do technically and economically". The reader may be amused that expendable launch vehicle continue to be in the scene, though the space shuttle has since been a breakthrough.

The next section, Part III, titled Development of liquid and solid propellant rockets 1880–1945, has in fact, very little to do with the title. Soviet contributions to rocketry and automatic flight control o rockets through the Jet Propulsion Research Institute and to ramjet engines are narrated in a goo historical perspective wherein the nascent ideas of air-breathing space vehicles can be traced. A specia mention must be made of the article by F. H. Winter on camera rockets and space photography. The view of the earth from space which, today, is taken for granted as routine, was a fond dream of pioneers like Tsiolkovsky. The historical details of several ideas and contraptions towards realizing this dream are fascinating.

More recent developments in astronautics are described in Part IV, which understandably forms the bulk of this volume. Most significant among the articles in this section is that of Thomas Carroll on the historical origins of the Sergeant missile power plant. The trials and tribulations which eventually led to the successful design of this missile read as a lesson in solid propellant rocketry. The historical description of sounding rockets, Veronique series in France and the experiments of Polish researchers, is relatively brief and, in a way, pales in the background of the earlier paper. An Indian reader would not miss the mention of BIT rockets, a Indo–Polish joint effort of 1972.

The long journey from the first artificial earth satellite, Sputnik, to the interplanetary mission like Explorer I is well documented in this section by the authors who themselves have played active roles in its development. Nothing speaks better than one's own experience and such experiences are found also in other articles in this section like the one on high-energy rocket propellant research at NASA Lewis In another article of interest, the American experience with rocket aircraft (especially X-15), precursors to manned flight beyond the atmosphere are discussed including many intricate details and the gradual growth of technology.

In the concluding section (Part V), the accomplishments of two pioneers of rocketry and astronautics, Robert Goddard and Mikhail Tikhonravov, are highlighted. About Goddard much is known to every rocket-engineer, yet the article, running like the personal diary of the great pioneer, provides an insight to his logical thinking and systematic working.

Any student of history of science would find this volume precious. Almost all the articles include elaborate reference lists which make this a worthy collection. One should perhaps study this volume consisting of what appear to be a set of disjointed articles as a continuation of the earlier volumes of AAS History Series to obtain a better appreciation of the complete history. Finally, this history is not meant for any easy-chair reading; it is a serious study.

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Selective laser spectroscopy of activated crystals and glasses edited by V. V. Osiko. Nova Science Publishers, Inc., 283, Commack Road, Suite 300, Commack, NY 11725–3401, 1990, pp 220, $ 62.

The book contains two chapters. Chapter 1 titled, 'Spectral and relaxation characteristics of local electron states of impurities in structurally disordered matrices', and contributed by Alimov *et al* deals with selective laser spectroscopic methods to understand electron and vibronic states, radiative and non-radiative relaxation process and doped ion–host lattice interaction mechanism in glasses and crystals doped with

with rare-earth and Fe-group elements These systems are very important from the point of view of their applications for lasers and luminescent media for quantum electronics and optics (*e.g.*, Nd–YAG laser, colour center laser, etc.). Apart from their practical value, these are model systems to study local electron and vibronic states, ion–ion interaction and non-radiative electron energy transfer in condensed matter. The inhomogeneously spectral broadening of the rare-earth ions masks the spectral characteristics of individual optical centres and makes the study of relaxation process and energy exchange rates within the inhomogeneous band very complicated and difficult. This also results in the limited applicabilities of conventional spectroscopic techniques. The new selective non-stationary laser excitation technique pioneered by Denisor and Kizel (1967) is one of the most appropriate experimental probes to understand the physics of inhomogeneously broadened spectra of doped ions in the glasses. This technique is well discussed in Chapter 1 of the book. It provides some systematic insight into the causes of inhomogeneous spectral broadening and relaxation broadening mechanism due to single-phonon inter-stark non-radiative transitions.

Chapter 2 titled 'Electron excitation energy transfer among impurity ions in disordered media', and contributed by Alimov *et al* deals with the problem of optical excitation transfer involving absorption and emission between interacting impurity particles in a solid. This problem is not only interesting in itself *per se* but also has relevance in fabricating new optical, luminescent and laser materials of enhanced efficiency Chapter 2 contains a detailed discussion on the theoretical models as well as on the experimental techniques of non-stationary kinetic spectroscopy under selective laser excitation. The theoretical studies deal with statistical computer modeling of the energy migration process in an ensemble of ions interacting with each other *via* dipole–dipole, dipole–quadrupole, quadrupole–quadrupole and short-range interactions. The experiments on time-resolved luminescence and excitation spectroscopy under selective excitation yield valuable information on the spectral and kinetic features of direct and indirect phonon-assisted energy transfer. The authors have shown that these experiments together with computer statistical modeling make it feasible to understand, both qualitatively and quantitatively, the mechanisms of excitation transfer.

It is felt that the book deals with a subject of immense relevance to quantum optics and solid-state physics. The reader is also made familiar with the Russian literature which normally is overlooked due to its limited exposure. However, the English translation is not smooth and the sentence structuring is unnecessarily complicated. It takes a while to get used to the style of English language used in the book. If this can be overcome, the book will prove to be useful.

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Standard and nonstandard analysis, fundamental theory, techniques and applications by R. F. Hoskins. Ellis Horwood Ltd, Market Cross House, Cooper Street, Chichester, West Sussex, P019 1EB, England, 1990, pp 269, $ 83.20.

The concept of an infinitesimal is the most pivotal and at the same time, one of the most elusive concepts of calculus. Even a layman can understand statements like "A function is continuous if an infinitesimal change in the independent variable causes only an infinitesimal change in the dependent variable" or "Instantaneous speed is the speed over an infinitesimally small time interval". The trouble, however, is how to define 'infinitesimally small' in rigorous terms. This difficulty persisted for quite some time even after calculus was in full swing.

In 1872 Heine presented a clever way to bypass this difficulty by giving a definition of limit, which is essentially the same as the present-day definition in terms of ϵ and δ This definition became so standard that the analysis based on it was called 'standard analysis'. It has dominated the curriculi for over a

century. Although logically unassailable, the trouble with this definition is that it really does not answer the question 'What is an infinitesimal?'. Rather, it simply avoids this question.

So attempts to formalise the intuitively clear concept of an infinitesimal continued and led to the foundations of what is called 'non-standard' analysis. In essence, one enlarges R, the field of real numbers, to another ordered field $^*R$, whose elements are called hyper-real numbers. These are defined as the equivalence classes of the set of all real sequences under a certain equivalence relation. Specifically, let $\mathcal{U}$ be a fixed ultrafilter on N, the set of position integers, containing the cofinite filter on N. Then two real sequences (x_n) and (y_n) are called equivalent if $\{n : x_n = y_n\}$ is in $\mathcal{U}$. The field operations as well as the order on $^*R$ are defined in the expected manner. An ordinary (or 'standard') real number a is identified with the equivalence class of the constant sequence (a). This way R becomes a subfield of $^*R$. An element $[(x_n)]$ of $^*R$ is called an infinitesimal if its absolute value is positive and smaller than every standard, positive real number. For example, $[(1/n)]$ is an infinitesimal.

As Hoskins shows beautifully in this book, this definition of an infinitesimal does meet the challenge posed by calculus. The author confines himself to the study of real-valued functions of a real (or an integer) variable and the topics covered are among those generally found in any standard, elementary text on analysis. What makes the book unique is that after giving a self-contained treatment of hyperreal numbers, the author shows how they can be used to paraphrase the basic concepts and proofs of standard analysis. The book thus represents a fine blend of the standard and the non-standard analysis. There are a few misprints, some of which might confuse a beginner, but over all the book makes a very good reading. Exercises and references to current texts serve to enrich it further.

Although the author expounds non-standard analysis, he refrains from pleading for it, or from claiming that it is superior to the standard analysis. This is probably because he is aware that this is no easy task. Besides the general reluctance to accept anything new (which, even people like Cantor had to face), there are two serious difficulties in propagating non-standard analysis. First, the very definition of hyper-real numbers depends on the ultrafilter $\mathcal{U}$, whose existence requires axiom of choice. No explicit construction of $\mathcal{U}$ has yet been given by anybody. As a result, even for the hyper-real numbers represented by such a familiar sequence as $((-1)^n)$, all we can say is that it equals either the real number 1 or the real number -1. But we cannot tell which possibility holds. This may not matter for theoretical purposes, but it does matter in the acceptance of the theory. Another pedagogical difficulty is that the degree of maturity needed to understand hyper-real numbers is at least as high as (and perhaps even higher than) that needed to understand the conventional definition of a limit. So it is unlikely that in the near future, the hyper-real numbers will replace limits in calculus textbooks.

It is of course unfair to blame the author for this state of affairs. On the other hand, he is to be credited for having shown that non-standard analysis deserves to be studied along with, if not instead of, the standard analysis. The book is a welcome addition to libraries and an excellent source material for those who want to introduce innovation in traditional calculus/analysis courses.

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H^∞-optimal control and related minimax design problems: A dynamic game approach by Tamer Başar and Pierre Bernhard. Birkhauser Verlag, CH-4010, Basel, Switzerland, 1991, pp 396, SFr 118. Indian orders to Springer Books (India) Pvt Ltd, 67, Community Centre, Panchsheel Park, New Delhi 110 017.

Initiated by George Zames in the early eighties, the area of H^∞-control theory has generated a tremendous amount of interest in the past decade, as witnessed by the publication of a large number of papers and a few books and monographs on the subject. The primary reason for this sudden interest in this subject was the growing conviction among control theorists that the necessity of having a controller and

a feedback control is not just for stabilization but chiefly to achieve disturbance attenuation, model matching, and tracking. This is a point which was seldom stressed strongly in the actual design of controllers in the design methodologies discussed in most control theory textbooks published earlier to the current decade. However, it must be pointed out that the importance of these ideas had been recognized as early as in the sixties by a handful of researchers (*e.g.*, Horowitz).

The notation H^∞ represents the Hardy space of all complex-valued functions of a complex variable, which are analytic and bounded in the open right-half complex plane. For a linear, continuous-time, time-invariant plant, the H^∞ norm of the transfer matrix is the maximum of its largest singular value over all frequencies. The fundamental problem of H^∞-control theory is the minimization of this H^∞ norm to achieve robust control in the face of uncertainties.

The initial stages of the research carried out in this area involved the use of operator and approximation theory, spectral factorization, and Youla parametrization, which led to somewhat complex controllers. Subsequent researches revealed an important fact that the maximum McMillan degree of these controllers is in the order of the McMillan degree of the overall system transfer matrix. It was also shown that in a time-domain characterization of these controllers, generalized Riccati equations of the type that arises in linear-quadratic differential games play a key role. In fact, the framework of dynamic games appears to provide a natural setting for these problems as the time-domain formulation of the original H^∞-control problem is in fact a zero-sum game, where the controller can be viewed as the minimizing player and disturbance as the maximizing player. The authors of this book (especially Basar) have been stressing this aspect of the problem in their research for the past few years. The book under review collates this work and its extensions at one place. It also presents a number of new results. The book contains seven chapters and two appendices.

The first chapter provides a comprehensive history of H^∞-optimal control designs, and draws an analogy between H^∞-optimal control and linear quadratic zero-sum dynamic games for both continuous and discrete time models.

The second chapter presents the formal definitions and concepts in discrete and continuous time games. A number of possible information patterns are also discussed.

The third chapter presents a complete solution of the discrete time disturbance attenuation problems with perfect state measurements in the minimax framework. Both finite and infinite horizon problems are discussed. This chapter also discusses extensions to more general classes of problems involving other performance indices, nonzero initial states, nonlinear plants, etc.

The fourth chapter presents results similar to those in the third chapter, but for the continuous-time counterpart. Unlike the discrete-time case it was shown here that an optimal controller may not exist, though a sub-optimal one always does. The chapter also discusses similar extensions.

The fifth chapter takes up the continuous-time case with imperfect measurements. Near-optimal controllers are obtained for the finite and infinite horizon cases.

The sixth chapter deals with the discrete-time counterpart of the problem in Chapter 5. The characterization of the controller that guarantees a given disturbance attenuation level is obtained. Extensions of the results to the other cases mentioned above are also discussed.

The seventh chapter provides a brief analysis of a class of minimax filter, prediction, and smoothing problems for linear time-varying systems in both discrete and continuous time. The main difference from the previous chapters is the performance index which is now formulated using a pointwise approach rather than a cumulative one. This leads to a structurally different solution which says that minimax decision rules can be obtained without computing the associated minimax attenuation levels. This is a property which the controllers in the previous chapters did not have.

Appendix A presents an introduction to conjugate points arising in dynamic linear quadratic optimization in the context of differential games. Appendix B presents a proof of the Danskin's theorem. These results are used in Chapters 4 and 5, respectively, to prove the main results.

The book presents a number of new results on the game-theoretic approach to H^{∞}-optimal control problems and strengthens the case of analysing the time-domain characterization of these problems in the natural game-theoretic setting. The book will be a valuable source of reference to researchers in game theory and robust control theory. With some additional introductory material, the book may also serve as an advanced graduate-level textbook.

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Estimation and control of distributed parameter systems edited by W. Desh, K. Kappel and K. Kunish. Birkhauser Verlag, CH-4010, Basel, Switzerland, 1991, pp 396, SFr 118. Indian orders to Springer Books (India) Pvt Ltd, 67, Community Centre, Panchsheel Park, New Delhi 110 017.

The volume under review is the proceedings of the 'International Conference on Control and Estimation of Distributed Parameter Systems' held during July 8–14, 1990 at the Chorherrenstiff Vorau, Austria. This Conference provided a forum for exchange and development of new directions in the field of control theory of distributed parameter systems. Some specific subtopics of control and estimation such as nonlinear control systems, feedback stabilization of infinite dimensional systems, parameter estimation and inverse problems, optimal control problems, controllability problems and numerical treatment of control and estimation problem have attracted special attention at this Conference.

The volume contains 27 original research contributions on the broad spectrum of the afore-mentioned topics. In most of the papers the authors carry out their analysis using the tools of modern analysis such as semigroup theory, multivalued analysis, operator theory, Sobolov spaces, HUM, viscosity solution methods, etc. Along with abstract results, many authors have proposed numerical algorithm for the computation of control and parameter using finite element schemes and finite difference schemes and thus the present volume is aptly chosen in the series of Numerical Mathematics. It would have been better if the papers in the volume had been arranged under different headings like parameter estimation and inverse problems, optimal control problems, controllability problems, feedback controls and stabilization problems, etc.

Parameter estimation and inverse problems: Tai and Neittaanmaki have derived a new error estimate with numerical illustrations for the numerical identification of a d.p.s. (distributed parameter system) with two-point boundary value. The FEM and fit-to-data output-least-square techniques are employed for the identification. It is shown with numerical tests that for higher accuracy of the identified parameter, one has to choose higher order finite-element spaces rather than refining the grid. Rosen and Raghu utilize the Trotter–Kato Theorem for the approximation of linear semigroup of bounded linear operators to obtain approximation scheme for identification problem of an abstract linear degenerate system. Bank *et al* establish an existence and uniqueness result for a d.p.s. modeled for the evolution of populations with size structure. The equivalent variational formulation discussed in the last section of this paper is useful in the study of approximation schemes for inverse problems.

The paper of Janno focusses on the inverse problem of determining the creep function for the oscillation process of a semi-infinite string with memory. A certain method of solution is proposed and the error estimation is obtained. The paper of Vainikko deals with a class of ill-posed extremal problems, and the discrepancy principle for the choice of the regularization parameter in the Tikhonov method is discussed. The paper of Kurzhanski and Khaplov introduces a series of problems on state estimation for parabolic systems on the basis of observations generated by sensors with unknown but bounded noise. A 'filtering scheme' is derived which is similar to the Kalman filter in the case of stochastic noise. Employing the tools from parameter estimation theory Kojima has proposed an algorithm to estimate the corrosion shape of materials.

Though many popular approximation schemes fail to hold stability aspects, Banks *et al* have derived certain techniques in their paper to guarantee the uniform preservation of exponential stability under several approximation schemes for a d.p.s.. Numerical illustrations are also provided. Using Gauss–Newton method for the solution of nonlinear least square in the context of parameter estimation problems, Heinkenschloss *et al* have derived a scheme in which discretization error is controllable.

Controllability problems : By using Hilbert Uniqueness Method, multiplier techniques and the theory of homogenization, Cioranesue *et al* have investigated the exact boundary controllability of the wave equation in perforated domain. In the paper of Tiba *et al* exact and approximate controllability-type properties of an elliptic system are discussed. Though this concept does not correspond to the standard controllability concept, this can be nicely employed for the study of optimal design problems. Kim utilizes Carleman estimate to prove a unique continuation property of a beam equation with variable coefficient. The author has mentioned a few references for the application of this property for the study of exact controllability.

Optimal control problems: The paper of Fattorini focuses on the optimal control problem for a semilinear system in Banach space setting. By using relaxed controls he weakened compactness condition on the control set and convexity condition on the nonlinear function to derive optimality results. Haslinger and Panagiotopoulos, utilizing 'hemivariational techniques' introduced earlier by Panagiotopoulos obtained optimality result for a system described by nonmonotone mappings. Due to nonmonotonicity, convex analysis techniques do not apply to such problems. Chen and Hoffmann establishes optimality results for phase field model by means of discretization techniques and its convergence analysis Using the notion of viscosity solution, Tataru has proved the equivalence of dynamic programing principle and dynamic programing equations for a general optimal control problem with infinite time horizon with unbounded nonlinear term. Roubicek considers optimal boundary control problem for a Stefan problem and after discretizing the state model proposes an efficient procedure for the evaluation of Clarke's gradient at 'every control but only almost all problem'. Although the same problem has been tackled by smoothing techniques, the present result is obtained *via* 'nonsmooth methods'. Carja obtained some continuity properties of the minimum time function associated with a time optimal boundary control problem of the heat equation. In Sritharan's paper optimality result is derived for a general nonlinear system with unbounded nonlinear-ity. The value function is shown to be a viscosity solution of its Hamiltonian–Jacobi–Bellman equation. Along the same line he has also derived the Pontriagian's maximum principle for the Navier–Stokes equations.

Feedback controls and stabilization problems: Burns and Kang compute feedback control laws using FEM for the stabilization problem of Burger's equation with unbounded control and observation. In their analysis, they first compute feedback control laws for the linearized system and apply them for the nonlinear model. By means of Laplace transforms, Hannsgen and Wheeler obtain a representation formula for one-dimensional viscoelasticity with stabilizing boundary feedback.

Using the steady-state solution of a linear system, Ichikawa extended a servomechanism problem of Davison in finite dimensions to infinite dimensions. The author also obtains results to find a feedback controller which assures a given system to track a known signal. After giving different models for the transient deformation of a thin elastic plate, Lagnes discusses the asymptotic stability of one of such model. With the help of 'pseudodifferential boundary calculus' Pederson analyses d.p.s. with feedback acting on the boundary. The aim of Yamamoto's paper is to present conditions for the existence of a stabilizing operator for a linear system with a self-adjoint operator in Hilbert space.

The paper of Grabowski gives a technique to determine the transfer function of an n-dimensional lumped parameter SISO system using the method of 'best L^2-approximation with exponential sums'. This paper is less relevant to the topics of the book. Weiss states two interesting conjectures on the admissibility of unbounded control operators on Hilbert spaces. Using the tools of operator theory he has proved both the conjectures in some particular cases. Also the author offers \$100 for the first proof or disproof of the first conjecture. For the second conjecture \$100 has already been offered in another paper of the author.

The authors attempted to give up-to-date information about their respective problems with good

bibliographies. Control theorists and mathematicians should find it useful for gaining a quite large amount of information in the field of control and estimation.

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Modeling, estimation and control of systems with uncertainty by G. B. Di Masi, A. Gombani, A. B. Kurzansky (eds), 1991, pp 467, SFr 148, and **New trends in system theory** by G. Conte, A. M. Perdon, B. Wyman (eds), 1991, pp 722, SFr 198, both by Birkhauser Verlag AG, Ringstrasse 39, CH-4106, Therwil, Switzerland.

Both the volumes under review are part of a series of conference and workshop proceedings being published by Birkhauser under the series *Progress in Systems and Control Theory*. The first is a conference held in Sopron, Hungary, in September 1990 under the auspices of the International Institute for Applied Systems Analysis in Austria. As the blurb on the back cover and the preface suggests, the idea is to get a flavour of current developments in two distinct methodologies for handling uncertain systems. The first is the approach based on set-valued dynamics to model uncertainty, the second being the use of stochastic models. This suggests that the conference perhaps lacks a single focus, but has two instead, which is not too bad. The actual contents of the volume indicate that even the latter is an overstatement unless one interprets the two in the widest possible sense. Thus what one has is a motley collection of thirty-one papers on virtually anything that can qualify as systems and control. Under the same umbrella, one has nonsmooth analysis, realization theory, stochastic control and filtering, application to pricing of electric power, aircraft control, control of gas supply and so on. The flavour of the contributions also varies drastically from paper to paper. Thus, a collection that begins with esoterica from nonsmooth analysis (heard of 'contingent derivatives'?) leads after some four hundred and odd pages to a case study of control of the Czech gas supply under uncertain perturbations that include change in Soviet policies (certainly an uncertain factor these days). One also gets the impression that many contributions are secondary (or tertiary or lower) results of the respective authors, their primary work being saved for publication elsewhere. Overall, the volume conjures up a vision of people somehow associated with IIASA getting together for a nice scientifico-social event, renewing and making acquaintances, exchanging professional gossip and producing *en passant* this volume as a memento for the event.

This is perhaps being a bit harsh, because there are a few interesting contributions. On the theoretical side, there are contributions by Aubin and Frankowska on feedback control of nonlinear differential equations and inclusions, Colonius and Kleimann on stabilization of uncertain linear systems and contributions to time series analysis (deriving error bounds for estimated transfer functions) by Hjalmarsson, Ljung and Wohlberg. On the applied side, one has contributions to aircraft control by Leitmann and Pandey and a model for pricing interruptible electric power supply by Tan and Varaiya.

The second volume under review is a whopper of a conference proceeding, with an impressive total of ninety papers. This is the joint conference organized by Universita di Genova and the Ohio State University in Genoa during July 9–11, 1990. The topics covered touch the entire spectrum of systems and control, but no focus has been claimed anyway. The avowed goal of the conference is to get a flavour of all the new trends in the subject and true to this aim, there are contributions on all the latest rages among the systems and control community—neural networks, robotics and robust control, to name a few. Also present are some of the diehards from 'old trends', such as nonlinear control, stabilization, adaptive control, system identification. But despite the large number of papers and diversity of topics, this is a much more substantial conference volume, perhaps because the participants took it a lot more seriously.

It is pointless to list even a reasonable fraction of the contents, so I shall mention a few representative ones. There are two papers based on the 'Principal lectures' at the conference. The first is on asymptotic tracking and disturbance rejection in nonlinear systems by Isidori and Byrnes where the problem is reduced to the solution of a system of algebraic–differential equations for which an approximation scheme

is proposed. The second paper is by Ikeda *et al* and introduces the concept of parametric stability, a variant of structural stability for control systems. Among the rest, one has Abed *et al* on control of bifurcations, Aicardi *et al* on covergence of learning algorithms in robotic systems, Aicardi *et al* on neural networks for dynamic routing, Bertsekas on the auction algorithm for network flow problems, Bressan on nonprobabilistic filtering, Brockett and Wong on gradient flow algorithm for the assignment problem, Hermes on local stabilization of nonlinear systems *via* approximation, Hinrichsen and Pritchard on robustness of discrete time linear systems, Jacubczyk on stability of asynchronous systems and nonsymmetric neural nets, Fan and Tits on H_∞ performance under structured perturbations, Ozveren and Willsky on control of discrete event dynamical systems, Sontag on generalization of Liapunov and BIBO stability to systems with saturating controls, Rantzer on a generalization of Kharitonov's theorem and so on.

To summarize, the first volume is worth a glance, just in case one's interests coincide with something in it, but not worth a second glance otherwise. The second volume is definitely useful to have around.

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Nonlinear synthesis edited by C. I. Byrnes and A. Kurzhansky. Birkhauser Verlag, CH-4010, Basel, Switzerland, 1991, pp 305, SFr 128. Indian orders to Springer Books (India) Pvt Ltd, 67, Community Centre, Panchsheel Park, New Delhi 110 017.

The volume under review is the proceedings of a workshop held in Sopron, Hungary, during June 1989 under the auspices of the International Institute for Applied Systems Analysis, Austria. It has twenty-three papers on varied aspects of nonlinear control systems. A randomly chosen sample is Morse theory and optimal control problems by Agrachev and Vakharameev, Viability kernel of control system by J. P. Aubin and H. Frankowska, Methods of nonlinear discontinuous stabilization by M. Fliess and F. Messager, Invariant manifolds, zero dynamics and stability by H. W. Knobloch and D. Flockerzi, Factorization of nonlinear systems by H. Nijmeijer, On the approximation of set-valued mappings in a uniform (Chebyshev) metric by M. S. Nikolskii, and so on.

Compared to another Sopron conference whose proceedings (*Modelng, estimation and control of systems with uncertainty*, edited by Di Masi, Gombani and Kurzhansky), were reviewed by the present reviewer for this journal (this issue), the present volume is far better focused. The contributions are of a very high standard and clearly indicative of the current trends in the area of nonlinear control. (A contributing factor perhaps is a sizeable representation of the activity in the erstwhile 'eastern block' which, in particular the (erstwhile, once more) USSR, has always maintained a leading position in control theory). As has been the case for some years now, controllability, stabilizability, feedback linearization, etc., are the dominating issues, though under these general themes, several new ideas are seen to emerge. One particularly notices in this collection the predominance of papers concerned with 'zero dynamics' of the system (the trajectories that get mapped into zero output) and the invariant sets/manifolds of the system. As for techniques, the obvious forerunners are geometric methods and set-valued analysis. (*see* Isidori's *Nonlinear control systems*, 2nd edn, Springer, 1989, and Aubin-Frankowska's *Set-valued analysis*, Birkhauser, 1990). Robotics emerges as the prime application being pursued.

I found a couple of inclusions odd. The first is the Di Masi-Angelini paper on Adaptive methods in piecewise linear filtering which seems a bit out of place here, the second being Petrov's Limit sets of trajectories which is out of place more because of its format than because of its topic – it is an ultra-brief research announcement that gives very little away.

Overall, the collection is likely to prove quite valuable for researchers in nonlinear control systems.

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