Contributions to Operator Theory and its Applications. T. Furuta, I. Gohberg and T. Nakazi (eds). Volume 62 in the series Operator Theory: Advances and Applications, Birkhäuser, P.O. Box 133, elt 4010. Basel. 1993.

The name Tsuyoshi Ando is well known to research workers in functional analysis, operator theory, linear algebra and the mathematical theory of networks and systems. This volume consists of thirteen papers in these areas dedicated to Ando on his sixtieth birthday. A brief biography of Ando and his list of publications is also provided.

Since the papers in this book are on diverse problems, the best way to review it might be to give the reader a general idea of some of the topics covered, with particular reference to the work of Ando.

Let $\mathcal{H}$ be a Hilbert space contained in a larger Hilbert space $\mathcal{K}$. An operator T on $\mathcal{K}$ is called a *dilation* of an operator A on $\mathcal{H}$ if T can be written as

$$T = \begin{bmatrix} A & B \\ C & D \end{bmatrix}$$

when $\mathcal{K}$ is decomposed as a direct sum of $\mathcal{H}$ and its orthogonal complement. The operator A is then called a *compression of T*. A *dilation theorem* is a statement that certain operators can be dilated to 'nicer' operators on a bigger Hilbert space. For example, if A is a contraction ($\|A\| \leq 1$) on $\mathcal{H}$ then

$$U = \begin{bmatrix} A & (1-AA^*)^{1/2} \\ (1-A^*A)^{1/2} & -A^* \end{bmatrix}$$

is a unitary operator. This is a generalization of the elementary fact that if a is a real number and $|a| \leq 1$ then

$$\begin{bmatrix} a & \sqrt{1-a^2} \\ \sqrt{1-a^2} & -a \end{bmatrix}$$

is a rotation matrix. Thus, *every contraction has a unitary dilation.*

If A is a contraction then so are its powers A^n, $n = 1, 2, \ldots$. Each of them will have a unitary dilation. It is somewhat surprising that there exists a single unitary operator U such that U^n is a dilation of A^n for all n. This is a famous theorem proved by, Sz.-Nagy in 1953. (The discrete variable n here can be replaced by a continuous variable t: every contraction semigroup can be dilated to a unitary semigroup).

Results such as this are typical in dilation theory, now a major subject. One of the famous results of Ando, proved in 1963, says that a *commuting pair of contractions can be dilated to a commuting pair of unitaries*, i. e., if A_1, A_2 are commuting contractions, then there exists commuting unitaries U_1 U_2 such that for all positive integers n, m, $U_1^n U_2^m$ is a dilation of $A_1^n A_2^m$. In 1970 it was proved by Parrott that an analogue of this for three or more commuting contractions is false. The *commutant lifting theorem* to which this line of work ultimately led has been found to be very useful in the theory of linear systems.

Let P_1, P_2 be two projection operators in a Hilbert space. Long ago, von Neumann observed that the infinite product $(P_1 P_2)^n$ converges to the projection operator whose range is the intersection of the range of P_1 and P_2. In 1961, Burkholder and Chow proved that the same is true for any finite number of projections $P_1, P_2, \ldots, P_k$, and when the Hilbert space is L^2 and the projections are conditional expectations then the convergence takes place not only in the strong (L^2) topology but also pointwise, almost everywhere. In a different direction, Amemiya and Ando proved in 1965 that if $T_1, \ldots, T_k$ are contractions then any *random* product $T_{i_1} T_{i_2} T_{i_3} \cdots$ of elements chosen from $\{T_1, \ldots, T_k\}$ converges weakly. Such results are closely related to problems in ergodic theory, dynamical systems and computer tomography.

The arithmetic, geometric and harmonic means of positive numbers are familiar objects. Lots of interesting difficulties arise in defining similar means for positive Hilbert space operators, because of the noncommuting nature of the variables. Such means are of interest in quantum theory and also in the theory of electrical networks. For example, the parallel sum is just one half of the harmonic mean. Ando has studied such objects in great detail. In a paper with Kubo in 1980, he gave an axiomatic characterization of such means. In a very interesting paper (which drew this reviewer to his work) Ando used these ideas to give a simple proof of a theorem of Lieb that established the Wigner–Yanase–Dyson conjecture about the concavity of entropy in quantum mechanics.

From the late seventies, much of Ando's work has been on matrices, specially on matrix inequalities. He has mastered the techniques of majorization and the theory of operator monotone functions, and used both of them in spectacular ways to prove delicate and elegant inequalities for operators and matrices.

The book under review has papers on many of the problems to which the work mentioned above leads. It would be of interest to anyone working in these areas.

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Science in Society: Some Perspectives. Yash Pal, Ashok Jain and Subodh Mohanti eds. NISTADS, Dr K. S. Krishnan Road, New Delhi 110 012. 405 pp. Rs. 400.

This handy anthology starts with a magnificent introduction from Prof. Yash Pal; he leads off the discussion with a characteristically brilliant and thought-provoking statement, as arresting as it is pithy. The lead sentence 'the difference between science and society and science in society is very important for me' sets the mood and the direction for all the essays in the book although not all of them reach the standard of clarity of thinking or of focused purpose that illuminate Yash Pal's lead. The book demonstrates congruence of views and should provide the basis for concerted action, review and mid-course corrections in policy.

One difficulty that an average reader will find is that the book bears no explicit reference to the year in which these essays have been prepared and no indication if some of the initiatives mentioned are under implementation or if they are mere expressions of hope (the case of INFLIBNET is a clear case in point). Some of the articles would have been more convincing if they had included some idea of costs to the user. An epilogue to show how far the movement initiated by Yash Pal in the 77th Indian Science Congress has developed momentum would have been useful.

Science in society

Yash Pal leads the way with a complete statement of the case for 'science in society'. Three quotes would give the reader an insight into what to expect: 'science should not be treated as an additional activity or a tool . . . instead it should be treated as part of the culture of society, integral to our thinking . . . connected with our dreams, connected with concepts of ethics, beauty and spirituality', 'if we make science as a part of our culture they (benefits) would all come, much more naturally, more creatively and *more in tune with our living, not as an assault from outside*', 'in science and technology you cannot imbibe the true spirit of the craft *unless you do some things on your own*, do your own inventing'. Yash Pal covers a wide territory: the value of innovations to true development, the imperative need to invest in education if S & T (science and technology) R & D is to be supported, an equal emphasis on investments in S & T and in science education. There is a touch of humour in his development of the relationship of ethics and law in an age of 'technological exuberance': he says that 'it was not unethical 500 or 1000 years ago to throw your muck into the Ganges . . . because Ganga had sufficient powers to purify it'.

Many of the contributors clearly link their contributions to 'science in society', the absorption of science as an integral part of our culture. The contributions can be divided into three categories: those with a philosophical flavour representing *cultural absorption*, those with plans and ideas to *involve the population* in developmental activities as a practical illustration of how 'science in society' could operate, and those which demonstrate *vigour in scientific thought and practice* and induce in the reader a sense of optimism that Yash Pal's vision can indeed become a reality.

Cultural absorption

Pushpa Bhargava and Chandana Chakrabarti see a commonality in the origins of the creative urge in scientific and artistic works, describe practitioners of art and science as seekers of beauty and assert that both (art and science) 'are becoming increasingly interdependent in terms of materials, ideas and ideals'. In a fine essay 'The symphony of symmetries', Babu Joseph points to developments in the study of open systems which 'include the whole living world as well as most nonliving things'. His development of ideas on 'spontaneous symmetry breaking' as the mechanism of growth and decay should be fed into the curriculum for science at several levels with increasing depth of presentation. Ashok Parthasarathi's coupling of non-alignment, self-reliance and innovation gives practical shape to 'science in society' (particularly Yash Pal's call for 'doing something on your own') and brings policy-making into focus. In particular, his declaration that 'while it is true that S & T intersect at many points, the intersections are less and less matters of accident and more and more matters of design in terms of policies and programmes' deserves the basis for non-partisan policy-making. Another very interesting articulation of the concept of 'science in society' is the use of energy as a measure of programme content (C. V. Seshadri), which leads to sustainable development through the blended use of resources combining development with avoidance of environmental degradation. D. P. Chattopadhyaya's article draws attention to the two faces of technology: estrangement and enlargement, and emphasizes the need for an awareness of the consequences of the use of technology. His is a timely call for 'workers and thinkers to control technology and institutions more effectively than they can control us'. A similar warning on the impact of technology on society comes from V. Sudarsen, who calls for alternative paradigms of development citing the irony of continuity in the pursuit of an imperial forest policy even after independence. He warns against the disregard for social consequences and asserts that 'technological progress is not necessarily axiomatic for development processes'. Ashok Jain echoes this thought with 'environmental crisis is a sign of saturation of the conventional paradigm'.

Precept and practice

Jayant Narlikar's fine essay 'Education through astronomy' will find an echo in many whose introduction to astronomy was wholly through gymnastics in integral or differential calculus. Equally well-correlated to the theme of the book is V. G. Bhide's note on interuniversity centres; he is the lone author tracing lack of a clear career path (salaries included) as one major cause of student apathy. He also relates the government-inspired and organized techniques to the dual demands of the 'product of science' and the 'process of science'. His essay is the kind of core strategy that matches the vision of 'science in society', catching them young as it were. Vinod Raina's article describing a programme of the 'People's science movement' is an excellent example of how a concept can be translated into practice and harmonized with the circumstances in a given location. This article should give a fillip to the emergence of more initiatives of the kind. M. S. Swaminathan's contribution 'Biotechnology and ecological security' is scholarly and practical, introducing us to the concept of 'ecological security'. His article is an outstanding example of how a versatile mind can be ahead of formalized thought. His suggestions and ideas on directions of development give practical content to the concept of 'science in society' through the fusion of physical and social sciences to produce worthwhile and commercially viable goals.

Excitement of science

The articles on scientific projects (earthquakes, monoclonal antibodies) reveal the capabilities of vigorous research in India but the authors would have expanded their audience reach if they had explained the techniques and results in layman terms. The sense of excitement in science needs to reach young minds in as many directions as possible. For example, apart from publications intended for professional journals exclusively dedicated to research material, can we not think of articles on S & T that describe briefly, or at least enumerate, the different technologies on which the conduct of an item of research or production of specified goods and services depend? Such articles would show young enquiring minds what career path options in S & T may be available for them to choose from, and also infuse in them a sense of team-orientation in S & T work.

A strong public opinion is the proper basis for the percolation of the 'science in society' concept and its acceptance. The editors of the book have rendered a great service by bringing out this volume

in order to catalyse this process. Broad-based initiatives which bring the concept into practice using local resources would be necessary. This also suggests that research effort is needed for the evolution and adoption of organizational structures suitable for the task on hand in the region where the initiative takes shape. The apparent apathy in 'science in education' can be overcome only through multiple techniques and structures. Perhaps the disavowal of the editors about the book not being a 'cogent articulation of various tenets' clearly recognizes the need for further effort. The mention of a 'think tank' might draw cynical expressions of elitism but the time is opportune for one or more 'think tanks' to address these issues and develop a menu of options to carry Yash Pal's lead concepts onward; local groups could choose their strategy from this menu for use as suits circumstances in their area. The ideas sprouting from the studies will motivate policy-making at governmental and other levels. This should lead to the gradual infusion of science in national culture. Thoughtful leaders of public opinion (of the kind who have contributed to this book) should also find out how the stated objective could be reached in an environment of limits to the efficacy of governmental patronage.

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Annual Review of Cell Biology 1994. J. A. Spudich, S. L. McKnight, R. Schekman, eds. Annual Reviews Inc., Palo Alto, California, USA. vol. 10. 478 pp. Price: USA $ 49; elsewhere $ 54.

Cellular biology continues to grow and diversify, encompassing the broad areas of biochemistry, genetics and molecular biology, in order to obtain an understanding of the inner working of the cell in molecular terms. These endeavours have now been extended to the study of whole life forms, as topics in developmental biology find a larger representation in this volume of *Annual Review of Cell Biology*, paving the way for a formal merger of these two disciplines from 1995 onwards, when the name of the series will change to *Annual Review of Cell and Developmental Biology*.

The pathways that control cell growth and differentiation, in mammals in particular, are undoubtedly complex. Recent progress in this field has been remarkable and five reviews are devoted to advances in the broad area of cell regulation. In a lucid article by D. J. Riley and coworkers on the retinoblastoma protein, the properties of this key regulator of cell division have been discussed. In the normal cell cycle, activated retinoblastoma protein restricts further cell proliferation. However, binding of oncogene products to this protein can block its activity and lead to unscheduled cell division, resulting in malignancy. U. Siebenlist and coworkers have reviewed the structure and functions of the transcription factor NFκB family of proteins, which serve to coordinate the rapid induction of a range of defence genes in the immune system. A unique feature of NFκB is its rapid translocation from the cytoplasm to the nucleus in response to extracellular signals, and the complexities of this process have been analysed in depth.

Signal transduction pathways in the cell basically depend on the fine tuning of phosphorylation of specific proteins by kinases and phosphatases. P. van der Geer and others have given a detailed account of a major class of transmembrane receptors called the receptor protein–tyrosine kinases. Studies on these kinases have contributed significantly to an understanding of how cells are regulated by extracellular signals. S. Shenolikar has written a comprehensive review on the protein serine/threonine phosphatases, highlighting their physiological functions and cellular regulation. A group of proteins that play a crucial role in signal transduction pathways are the GTPases. T. A. Glomset and C. C. Farnsworth have documented the different posttranslational modifications found in these GTPases (such as farnesylation of the carboxy terminus and acylation of the amino terminus) and presented evidence for their role in determining the interactions between the GTPases and the cell membranes. Additional studies are required before the functions of these modifications are firmly established.

In the area of intracellular sorting of proteins, which found exhaustive coverage in last year's volume, there is a single review on protein targeting to the endoplasmic reticulum by P. Walter and A. E Johnson, which emphasizes the common steps in targeting in eukaryotes and prokaryotes. However, the mechanism of translocation of the nascent protein across the endoplasmic reticulum remains less well-defined.

The cytoskeletal framework of the cell, for long a favoured topic for cell morphologists, is emerging as a dynamic and complex structure, subject to a variety of regulatory phenomena. Five reviews are devoted to recent developments on the structure and function of cytoskeletal and associated proteins. A. Hall has contributed a highly topical review on the regulation of the actin cytoskeleton in response to extracellular signals through the ras family of small GTP-binding proteins. A comprehensive review on the three-dimensional structures of 12 actin-binding proteins has been provided by T. D. Pollard and others. E. L. F. Holzbaur and R. B. Vallee have discussed the recent findings on the structure and functions of dyneins, one of the largest and most complex motor proteins. A major class of cytoskeletal proteins, the microtubules, are involved in cellular elongation and cytokinesis. Their role in cellular patterning in the growing plant has been elegantly discussed by R. J. Cyr, who has also presented a hypothesis for the mechanism by which microtubules bring about cellular elongation.

Vertebrate limb development has been one of the best-studied systems for understanding cell and tissue patterning, mechanisms of innervation, cell differentiation, angiogenesis and programmed cell death. C. Tickle and G. Eichele have reviewed the embryological data on limb patterning, and presented recent work that has begun to unravel the molecular responses to signalling molecules involved in the process.

Intensive research on the mechanism of Alzheimer's disease has led to the identification of cerebral deposits of the amyloid β protein as the causative agent of the disease. D. J. Selkoe has reviewed the cell biology, in particular the intracellular processing, of the amyloid β protein precursor. Several mechanisms have been proposed for the eventual imbalance between amyloid β protein formation and clearance which results in