The six-cornered snowflake, by Johannes Kepler. Edited and translated by Colin Hardie, with essays by L. L. Whyte and B. J. Mason. Clarendon Press Oxford, 1966. xv + 75 pages, 1 plate. 21 s.

In 1611 the great astronomer Johannes Kepler published what is probably the most charming New Year's gift that has ever been presented to a man (in this case: the Imperial Counsellor Johann Matthäus Wacker von Wackenfels) by a friend. Wacker is addressed by Kepler as a Lover of Nothing - for what reason, we do not know - , and Kepler therefore presents to him a witty essay about Nix which in Latin means "snow" but in colloquial German stands for "nichts", i.e. "nothing". It is the hexagonal shape of the snowflakes, these tiny, perishable and yet so marvellously organized crystals that attracted Kepler's attention and caused him to speculate about the origin of this particular materialization of symmetry. Reading how he pondered on the problem shows the curious blend between the sober mathematician and the speculative philosopher so typical for Kepler. As a mathematician, he here discussed for the first time the cubical and hexagonal close-packing of equal spheres; as a philosopher he searched, medieval in outlook, for a facultas formatrix, a formative faculty secretly at work.

In the present edition the modernized Latin text is confronted with the first English translation ever made of this lively essay. Kepler's numerous allusions are explained in carefully prepared notes while the synopsis helps the reader to follow his thread of thought. B. F. Mason has contributed an essay on the history and modern explanation of Kepler's problem, and L. L. Whyte examines the sources of his idea of a facultas formatrix. "Strena seu de nive sexangula" by Kepler, in this bilingual edition, is still a precious little gift.

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Strategy for R & D, Studies in the Microeconomics of Development, by Thomas Marschak, Thomas Glennan, Jr. and Robert Summers. A RAND Corporation Research Study published as Volume VIII in the series "Econometrics and Operations Research". Springer-Verlag, New York, Inc. 1967. 330 pages. U.S. $14.20.

The book describes three different approaches to a systematic study of the process of the development of advanced and complicated systems, such as military aircraft. It has been assembled from past studies by the RAND Corporation, without much effort at cohesion.

The strategy concerns the decisions as to how many separate sub-projects should be pursued in parallel, how often they should be reviewed, and when some should be terminated and others continued, or accelerated. The chief objective is to attain a satisfactory prototype with the least possible expenditure of time and money.

The first approach consists of a qualitative study of case histories. It demonstrates that an "inflexible" strategy, which tries to make most of the crucial decisions early and force the development into closely specified channels, will save time and money if the decisions were wise ones, but all too often unexpected events will force abandonment or wholesale revision. More fortunate results generally followed from a "flexible" strategy, keeping several parallel lines open and making decisions late in the process as new knowledge was acquired.

The second approach examines cost forecasts made at various stages in large development programs that have now been completed. They were often very much too low. Two frequent causes of error were a significant change in the number of units ordered, and price inflation. When these factors were

removed, a regression curve was calculated to show how the accuracy of the forecasts improved with time, and how it depended on the degree of technical novelty and the duration of the development program.

The third approach is the construction of a theory of optimal strategy. This is the only section with any mathematical interest. It consists of manipulations of various combinations of conditional probabilities, with emphasis on the "expected least value". All of the distributions used are purely hypothetical. A number of "rules of thumb" for strategic choice which appear quite plausible intuitively are shown (by the use of some rather artificial counter-examples) to be not generally valid.

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Bibliography on time series and stochastic processes, edited by H.O.A. Wold, published for the International Statistical Institute by Oliver and Boyd, Edinburgh and London, 1965. 516 + xiv pages. £5. 15s.

This bibliography was compiled by a very distinguished panel of collaborators. The main virtue of the bibliography is the great care which was taken in the selection of the entries. The titles are divided into three groups: up to 1930, 1931-1950 and 1951-1959. Included with each title is certain coded information on the type of process, scientific nature of the entry, group of problems, presence of empirical applications, field of application and language. The review number in the Mathematical Reviews is also given.

A graphic introduction to stochastic processes and time series is included. This introduction briefly reviews the history and rudiments of the subject and contains graphs of computer simulations of sequences of random variables which illustrate the law of large numbers, the law of the iterated logarithm, the arc sine law, correlograms, periodograms and Markov chains.

It is unlikely that a similar bibliography will be produced at the end of this century - before then there will be mechanized information retrieval methods of obtaining complete and up-to-date bibliographies on any specialized scientific subject at any time.

D.A. Dawson, McGill University

Optimization of stochastic systems, by M. Aoki. Academic Press, New York - London, 1967. xv + 354 pages.

The book, in essence, presents the optimal control and filtering problem of stochastic control systems in discrete-time. It also extends this to the parameter adaptive systems.

The Kalman filtering theory is the main theme in this book, but various derivations and extensions of that filtering theory have been worked out and scattered through different chapters. The order of the chapters seems to be mixed up and it is not surprising that very lengthy equations in discrete time are evolved. The author discusses the optimal Bayesian control of stochastic systems in great detail in Chapter II then suddenly in Chapter III he goes on to adaptive control systems. Chapter IV goes on to partially observe Markovian systems and in Chapter V the estimation problem. This appears to be the reversal of order since the estimation problem is normally derived before going on to partially observed systems. All the important results are derived from the Bayesian approach and