In the classical works on dialectical materialism it is indicated that the study of the interrelationship between phenomena does not consist in observing an infinite number of causes which determine each separate phase, but of studying the principal, decisive reasons which determine the result. The entire mass of small, secondary causes cannot be taken into account by the investigator; otherwise, he will sink in a sea of details of no essential value. The task of investigators of relationships between phenomena consists in discovering the principal reasons for changes in them and the existence and amount of their interrelationship.

Complicated multiple-factor phenomena and processes whose physical meaning and structure are known only at a qualitative level are a natural field for applying statistical methods. The wise application of statistical methods in various fields of investigation and measurements determines to a considerable extent the appearance of complicated technical systems and aggregates. Moreover, probability models which represent such systems and the phenomena occurring in them by means of random quantities and functions are considerably more convenient than dynamic models based on the application of only nonrandom (determined) quantities and functions.

The possibility of using statistical methods for investigating processes and phenomena is due to the statistical nature of a wide range of fundamental natural laws. Moreover, the random nature of events which form a complex physical process forces the investigator to reject the usual "point" measurements and to adopt an aggregate analysis of separate events for finding their causality and their influence index.

The necessity and pertinence of a statistical approach to the problems of raising quality indices of measurement results (precision, trustworthiness) and to optimizing the parameters of measuring aggregates which provide these results can be best traced on a generalized measuring system consisting of an analog of Shannon's communication circuit, well-known in the theory of information. A message-transmitting circuit can be represented according to Shannon in the form of series-connected sources of messages (information), an information transmitting channel, and a receiver of messages. The manner of implementing separate links of the system and their functional loading are determined by the specific tasks of the system.

With such an approach any modern information measuring system (IMS) can be considered in the following manner. This system's primary link, which supplies the measured information, consists of the measuring transducer located in the physical field. The processes occurring in this field produce given operational (as a rule not structural) changes in the transducer's condition, thus modulating a certain physical quantity which is convenient for each specific case and is selected for transmitting useful information subject to measurement (usually consisting of electrical signals). The statistical nature of processes occurring in actual physical fields makes it necessary to use the probability approach for describing the sequential states of the IMS primary link and for optimizing its characteristics (raising the sensitivity of primary transducer units, improving the parameters of its conversion channels, etc.). It is also necessary to take into account the continuity of the frequency spectrum of random processes representing the state of the field, and the existence of statistical relationships among the various factors which excite the measuring transducer's receiving units and also of the probability of these factors appearing.

The second IMS link, which consists of the channel for transmitting information from the primary link to the measuring and recording equipment proper, is also subject to random fluctuating processes. Statistical methods for describing its condition and optimizing its characteristics serve to determine ways for raising the channel's noise...
stability, i.e., methods for providing an undistorted transmission of the measured information. A particular place is occupied in this connection by the problems of transmitting nonstationary stochastic information, whose statistical characteristics depend on time. An important feature of these processes consists of a continuous variation of their spectral content.

The final IMS link, which consists of the measuring and recording equipment, is intended for processing the information received from the transmission channel, analyzing its stable (in the statistical sense) characteristics, and their subsequent recording. The precision indices of the final IMS link are affected not, as a rule, by the quality of measuring the current values of the received signals, but by the value of the error in determining their aggregates statistical parameters. When the metrological characteristics of this IMS link are being improved, it is necessary to pay considerable attention to the methods for raising its speed of operation, since in analyzing random signals the precision and speed of operation in a given sense supplement each other and are transformed into each other.

The complex study and statistical approach in analyzing information measuring systems constitute the basis for optimizing their characteristics as a whole.

The application of the statistical analysis methods serves to solve many practical problems which to date had no scientifically substantiated solutions. Such problems include raising the precision of measuring a range of parameters in the presence of noise and improving the methods of statistical forecasting from the known preceding history. The latter is important both for such sciences, as economics, agricultural technology, and sociology, and for the technical designing of cybernetic systems and tracking and controlling systems in their application to the problems of extrapolation and interpolation. It can be asserted with confidence that an active application of the automatic statistical analysis methods and equipment to the most diverse fields of our national economy is already producing certain results and is undoubtedly very promising.

The probability nature of actual processes and phenomena due to a simultaneous variation of an entire aggregate of physical factors makes it necessary and advisable to measure their parameters with statistical analyzers intended for different purposes.

The very fact of using statistical instruments in the measuring aggregates which use information accumulating methods serves to raise to a considerable extent the metrological indices of the system. Owing to the utilization of all the available information, i.e., data on the type of signal distribution, on the nature of their spectral density curve, on the degree of statistical linkage between the ordinates, etc., it becomes possible to raise the trustworthiness and the precision of measurement results.

The next step in developing metrology in the field of statistical measurements consists of working out methods for raising the quality of the statistical measuring instruments proper. This task is particularly topical for the problems of applying electrical and magnetic measurements the further raising of whose precision is difficult, and often impossible, owing to the relative proximity of the measured quantities to the level of the internal electronic fluctuation noise of the equipment. Practice has shown that investigators are often obliged to measure useful information parameters whose level lies considerably lower than that of the interfering noise. The application in this case of statistical analysis instruments is probably the only method of obtaining trustworthy results.

There are three basic trends for raising the precision of specialized statistical equipment:

- Improvement of existing measuring methods, and careful detailing and working up of the instruments' basis units;
- Development of new methods and principals for constructing statistical analysis instruments;
- Utilization of an a priori determined quantity of measured information.

Despite certain difficulties, the latter tendency is sufficiently promising and acceptable for a wide range of problems in the practice of measurements, since in the majority of cases it is perfectly justifiable to use a priori information about the processes known only at the qualitative level. It is then useful to adopt definite hypotheses about the statistical parameters of the processes. Thus, in a number of cases it is possible to assume that the distribution of the signal ordinates follows a normal law, and the fluctuation spectrum is uniform within the equivalent transmission band of the measuring system as a whole.

It is very advantageous to use statistical methods in measuring phase relationships, power factors, and nonlinear distortion of signals in the presence of random noise. In this case the application of accumulation and averaging methods (for instance, by means of a correlation measuring instrument) serve to lower the interference level and thus raise the precision of measurements.