WHITHER STATISTICS?

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ABSTRACT

Some directions and developments in Statistics over the last half-century are discussed briefly. Those considered are statistical methodology books, sample survey theory and design, quality control and product improvement, factorials, incomplete block design, multivariate analyses, regression and related procedures, multiple comparisons and subset selection, combining results for several investigations, data analysis, computing hardware and software for statistical procedures, and hypothesis testing. This is followed by challenges to Statistics with a listing of ten problems. These include model formulation and selection, planning investigations, ratios of random variables, sequential methods, quality control and improvement for laboratory analyses, disease surveillance and control procedures, correlated observations, teaching survey techniques, and dissemination and incorporation of statistical research.

INTRODUCTION

It is a great honor and privilege to have this Conference by noted and illustrious statisticians presented on my behalf. The efforts of my Biometrics Unit and Statistics Center colleagues, under the able direction of S.R. Searle and G. Casella, in arranging this conference is greatly appreciated. The willingness of all individuals including attendees, to take the time to be here and to participate in the Conference receives my deepest appreciation. The Biometrics Unit in the College of Agriculture and Life Sciences has been and is a great place in which to pursue a professional career. The College Administrations over the years have been supportive in the growth and development of the Unit and of my professional career. I very much treasure the professional cooperation of and interaction with many of the Cornell University Faculty, including D.S. Robson, C.R. Henderson, J.C. Kiefer, P.J. McCarthy, M.E. Brunk, N.F. Jensen, U. Bronfenbrenner, J.H. Whitlock, A.M. Srb, B. Wallace,and R.L. Plaisted, as well as many others. To all, I extend a warm and hearty thank you.

On such an occasion as this, one could dwell on the past and present a sunset salvo, *or* one could look to the future for a sunrise glance. I chose to do some of both but to concentrate on the latter approach. If an account of my professional activities was desired, it may be found in the 38 Annual Reports of the Biometrics Unit. Having been involved in the field of Statistics for almost one-half century, I deemed it appropriate to reflect on some of the more useful developments and some directions for the future. As I reflected on the accomplishments over the past fifty years, I was amazed on what was accomplished on one hand but was appalled on the other by what had been omitted.

To acquaint you with my statistical orientation, my first course in Statistics, "Field Plot Technique," was given by W.H. Leonard, Colorado State University, in Fall 1938. My second course, "Mathematical Statistics," by A.G. Clark, was taken in Spring 1939. From this time onward I have been involved in statistical consulting with investigators. My next statistics courses (9/41 - 7/42, 11/44 - 6/48) were taken at Iowa State University under G.W. Snedecor, F.A. Brandner, G.M. Cox, W.G. Cochran, E.E. Houseman, A.M. Mood, G.W. Brown, P.G. Homeyer, O. Kempthorne, and T.A. Bancroft. I arrived at Cornell in August 1948 and have remained here except for sabbatics with the Hawaiian Sugar Planters' Association and Pineapple Research Institute in 1954-5, Mathematics Research Center and University of Wisconsin in 1962-3 and 1969-70, and University of Sydney in Spring 1977 and Spring 1984.

Having been a statistical consultant for 47 years, my view of what constitutes important developments in Statistics is colored by what I have found to be useful for real world investigations as opposed to classroom applications. It is also colored by my eight year tenure as Book Reviews Editor for *Biometrics*. The majority of text and reference books published were disappointing. The profession and investigators in other fields would have been better off without many of these books. During the years I have progressed from being *only* a statistical consultant to a research consultant.

SOME DIRECTIONS AND DEVELOPMENT IN STATISTICS OVER THE LAST HALF-CENTURY

Probably the most significant works in Statistics relative to their impact on science were the statistical methodology books of Sir Ronald A. Fisher and George W. Snedecor. Their books have ranked in the top fifty most cited references in scientific literature for many years. Their effect on the use of statistical procedures can be considered as a mega-jump forward. Life is easier for all statisticians today because of their influence on scientists, on fund grantors, and on educators about the importance of Statistics to science and education.

gation. Mixed model theory has been studied extensively since Yates (1939) proposed recovery of interblock information. It is a viable research topic for today and the future.

The ideas of multiple comparisons and different error rate bases dates back to R.A. Fisher (see Hartley, 1955). Following some ideas in Student (1927), Newman (1938) proposed what might be called a multiple comparisons procedure. This was followed by many other proposers of methods by such people as D.B. Duncan, J.W. Tukey, and H. Scheffe. About the same time ranking and selection procedures by E. Paulson, R.E. Bechhofer and others began receiving considerable attention. About ten years later this was followed by subset selection procedures by S.S. Gupta, M. Sobel, and others. The above procedures have been and are used in comparative experiments in many fields of endeavor.

The excellent and classic papers of Cochran (1937) and Yates and Cochran (1938) on combining results from a series of similar experiments have not had the impact they should as statisticians and experimenters focus on the experiment at hand and pay little formal attention to all the other experiments that have a bearing on the results. Despite this, the subject of combining results has received some attention over the years and many papers have been published. In fact, my Ph.D. dissertation was on a method for combining a series of experiments where the treatments varied from experiment to experiment. Masquerading under the name meta-analysis (see, e.g., Glass *et al.*, 1982), a method for combining results from experiments, is now receiving much more attention than in the past. Perhaps the name is attractive or perhaps investigators see the real value of combining results from many investigations.

Data analysis and data analytic procedures have developed considerably over the years since the appearance of the paper by Yates and Cochran (1938) which I consider to be an excellent paper on data analysis. The subject has been considerably expanded, amplified, and codified by J.W. Tukey and many others.

metricians have worked with dependent observations for years. Also, in the last twenty years work has been done on competition studies and intercropping investigations.

Multivariate analysis has progressed mathematically and to some extent conceptually since its introduction in the 1930s by Sir Ronald A. Fisher and H. Fairfield Smith. Principal component, discriminant function, cluster, factor, and multidimensional scaling procedures have been developed and applied in many types of investigations. The rapid advance in high speed computing has solved the computational problems. As described in Federer and Murty (1986), many extensions are required to meet present day problems.

From the time of Gauss (1821) and Galton (1889), regression has been an extremely important aspect of statistical methodology. Regression procedures form the backbone of statistical procedures for investigations. It has been said that 80 percent of statistical consulting involves regression procedures of one form or another. Whether or not 80 percent is a meaningful statistic, regression procedures are important in the analysis of data from investigations. The computational ease and simplicity of R.A. Fisher's analysis of variance as introduced in the early 1920s did much to increase the use of this form of regression. It should be noted that the analysis of variance as originally introduced was not accompanied by "A linear model" as is the rule today. The many forms of regression from fixed to random effects, from linear to nonlinear functional relationships, from homoscedasticity to heterogeneous error variances, from single regressions to segmented regressions (splines), from fixed sample size to sequential, etc., have been and are receiving considerable attention over the last half century. Although Wright's (1921) path coefficients were introduced more than sixty years ago, they are beginning to appear in various areas of investi-

A fourth development was factorial design theory in the 1920s and 1930s (Yates, 1937, e.g.). Sometime later the theory for fractional replication factorial began to appear (e.g., Finney, 1945). It should be noted that Yates (1935) had devised fractional replicates earlier in the discussion of confounding arrangements. These developments have considerable importance in product improvement investigations where fractional replication is the rule. They are useful in many other areas including computer simulation studies. Another development that is used extensively in product improvement areas is response surface designs and EVOP (evolutionary operations procedures) as introduced by G.E.P. Box in the 1950s. A fairly recent development is called the Taguchi method which utilizes both engineering and statistical concepts, especially fractional replication. The verdict on this development is currently occupying the attention of a number of individuals. There are sessions at Statistics meetings and conferences on the procedure.

Incomplete block design applications and theory have progressed considerably since the introduction of the experiment designs by F. Yates and R.C. Bose in the 1930s. Incomplete block designs have been used extensively in a wide array of applications. The control of experimental heterogeneity by blocking has greatly increased the efficiency of experimentation. Many methods for constructing classes of designs have appeared and still are appearing. More recently the emphasis has shifted from presenting catalogues of plans to methods of obtaining a design for the demands of a specific investigation. This follows a statistical design axiom (see Federer, 1984b) to "design for the experiment; do not experiment for the design." The presentation of tables of experiment design plans tends to make the experimenter use what is available rather than seeking a plan which meets the goal of the experiment. Another recent emphasis in design and analysis is for nonindependent observations in experiments, much of which goes under nearest neighbor design. Econo-

A second important development was sample survey design and analysis theory. Despite the paucity of course offerings in survey design and interviewing techniques in statistics departments, it should be noted that the majority of the world's statisticians work on surveys. Sample survey design theory began in the early 1920s in India, England, and the United States. Such people as P.C. Mahalanobis and J.A. Hubback in India, C.F. Sarle and A.J. King in the United States, and F. Yates and W.G. Cochran in England were among the early leaders in this area. In the late 1930s and early 1940s sampling theory and application received a major push forward under the influence of W.G. Cochran, R.J. Jensen, A.J. King, E.E. Houseman, P.G. Homeyer, and others at Iowa State University and by M.H. Hansen, W.N. Hurwitz, and others at the Census Bureau. There was considerable cooperation and interaction between these two groups. It was interesting to note that theory which was common knowledge to the above individuals and statistics graduate students at Iowa State, was sometimes published ten to twenty years later by other individuals.

A third development was theory and procedures for quality control and product improvement in industry. Early beginnings of quality control theory and application were at the Western Electric Company in the 1920s and a little later at the Bell Telephone System. W.A. Shewhart and others were involved. An account is given in the Dodge and Romig (1941) paper, which formed the basis for their 1944 book on the subject. In 1942, I designed a sampling procedure for a guayule rubber factory using Cochran-Houseman sampling course material. Today my procedure would have been called a mean (x-bar) chart and a sampling inspection plan to maintain quality. The application of quality control procedures is presently becoming the rule in U.S. industry. Coupled along with sampling inspection plans has been procedures for product improvement.

Procedures for the detection of outlying observations in univariate and multivariate situations, patterns in the data, modeling responses, and checking assumptions, are important for interpreting data from experiments. The detection of outlying treatments and/or blocks has also been studied. The importance of data analysis will continue to increase especially as Statistics moves more to modeling responses rather than obtaining a model by definition.

Another amazing development over the last forty years has been computing hardware, statistical computing, and software. In the 1940s Iowa State University was considered to be one of the top computing centers in the world by Mr. Watson of IBM fame. They had a tabulator, a card sorter, card punchers, a gang summary punch, and a competent staff. They routinely processed data for investigators on a large scale. Seeing the developments in computing hardware and software from then until now is mind-boggling. The nature and kinds of research have changed over the years. The computer's impact on research will increase as computing power increases.

The last and twelfth area I wish to discuss is hypothesis testing. The publication of the Neyman and Pearson (1932) paper has had a profound effect on the teaching, and of course the use, of statistical procedures. So much emphasis has been placed upon hypothesis testing in academic circles that material related to the planning and design of experiments, sample survey design, quality control, product improvement, model formulation and selection, and other important topics to users of statistical procedures, is omitted or receives inadequate attention in the curriculum of a statistics department. In fact, the dominant theme of the Annual (Joint) Statistics Meetings from about 1950 to 1977 was hypothesis and significance testing and decision theory. J. W. Tukey stated that he saw a change in theme starting in 1971 and by 1978 the theme of the San Diego meetings was data analysis, statistical design, and statistical computing.

It appears that the multitude of papers on decision theory have had little or no impact on procedures used by investigators. Currently, academicians appear to be placing less emphasis on hypothesis testing and decision theory than formerly. They are tending to gravitate toward procedures which have greater practical value.

There are several other areas such as quantitative genetics, clinical trials, epidemiological methods, reliabilitiy, spectral analysis, graphics, econometric methods, psychometric methods, etc., which have been developed and proven useful for analyzing data from investigations. Instead of dwelling on these, let's look ahead at needs in selected areas.

CHALLENGES, PITFALLS, AND PROBLEMS FOR STATISTICS

A question that should be uppermost in the minds of statisticians is "How well are statistical procedures fulfilling the needs of investigators." In certain cases investigators may not have formulated the needs because of unawareness or inability. It is up to the statisticians to take the lead in these situations. This is currently happening in the design and analysis of intercropping experiments. The above question is not what motivates the major part of statistical research in such journals as the *Annals of Statistics, Annals of Probability, Sankhya, Communications in Statistics, Journal of Statistical Planning and Inference, Journal of the Royal Statistical Society B, Biometrika,* and others of a similar nature. For these journals an individual decides he can write a publishable paper for one of the above journals by extending results of previously published papers. Thus, previously published papers, and not the needs of investigators, form the basis for new research. Personally, I can vouch for this after publishing twenty papers in the *Annals of Mathematical Statistics* and its successor *The Annals of Statistics.* Also, note that only a small fraction of the research results in the above journals has any impact on scientific investigations and in teaching statistics courses for investigators. Statisticians perform their research much in the same manner as mathematicians who state that they do research for mathematics as a science and not for its usefulness in solving the problems of investigators. I am not saying that this research should not be done but I am saying that our emphasis is misplaced if Statistics is to continue expanding rapidly. There are numerous real world problems, many very difficult, that are crying for solutions. Serious consideration of the question posed above should change statistical research emphasis. A few areas where considerable research emphasis by statisticians is needed, are outlined below. I have outlined other unsolvable problems before in at least six papers, (see Federer, 1967, 1976, 1984a, 1984b, Federer and Murty, 1986 and Federer *et al.*, 1973). However, not all the problems posed arose from needs of investigators in subject matter areas.

Problem 1. Formulation and selection of appropriate response models. This is an area demanding considerable attention by statisticians. Philosophical as well as statistical and mathematical research is required. Statisticians almost universally assume a model, generally "the" linear model and proceed from there. Thus, their model is obtained by definition and "the" general linear model which may be defined as $Y = X\beta + Bu + e$ where $EY = X\beta$, Y is a vector of observations, X and B are design matrices, β is a vector of fixed parameters, u is a vector of random effects, e is an error vector, $\binom{u}{e}$ have mean and covariance

$$\left[\begin{pmatrix}0\\0\end{pmatrix}, \begin{pmatrix}G & M\\M & R\end{pmatrix}\right] .$$

For u=0, then $E(Y) = X\beta$, $\varepsilon = Y - E(Y)$ and $E(\varepsilon'\varepsilon) = V$; in many cases V is taken to be σ^2_ε I where I is the identity matrix and

σ_{ε}^{2} is a scalar. Many assumptions are involved in using the above formulation, some or all of which may be violated (see, e.g., Tukey, 1975).

At best the linear models used by statisticians must be considered to be an approximation to the true underlying response models. For example, William Lawton said that he seldom ever encountered a linear model at Eastman Kodak and that nonlinear models were the rule. Sir David R. Cox in his recent lectures at Cornell University selected a class of plausible models and then selected one or more as an appropriate model. This was in line with the excellent paper by Box and Cox (1964) on modeling. The challenge to statisticians is to follow the lead of these individuals. If they do not, the model formulation and selection will flourish in another field. There is every reason why this theory and use should come from Statistics. The subject will expand considerably in theory and usefulness if modeling is a part of Statistics. There are some encouraging notes in that the number of papers on model formulation and selection has been gradually increasing over the years. Let's hope that this subject will be the main topic at the Joint Statistical Meetings in the not too distant future, say before the end of the 20th century.

Problem 2. Planning investigations. Once statisticians become involved in modeling, they will be forced to become involved in the planning and design of investigations. They will be unable to obtain designs by definition as is frequently done now. Over the years, several prominent statisticians have told me that the planning and design aspects belong in the field of investigation and not in Statistics. They forget that this is one of the three parts of Statistics. To today's statisticians, the term statistical design or the term experimental design may mean any one of the following:

-sample size determination,

-response surface or factorial design,

-geometrics or partial geometrics,

-combinatorics of blocking and symbols,

-statistical analyses for something defined to be an experimental design.

-computing procedures or software for something denoted as an experimental design.

The term experimental design (note that it would be more appropriate to use experiment design, as the design should not be experimental) does not have a precise meaning as used today in Statistics. The use of the term statistical design (see Federer, 1984b) is deemed to be a better term and one which has a much broader connotation than experimental design. Perhaps the term statistical planning and design would put the emphasis where it belongs, i.e. on planning *and* design. This was one of the reasons for selecting the name *"The Journal of Statistical Planning and Inference."* Many statistics books with the phrase "experimental design" or "design of experiments" in their title often have nothing on planning and almost nothing on design. Others may present a number of plans but have nothing on planning investigations.

To fill the gaps, statisticians must set up procedures and/or provide descriptions of the following:

-the population structure, including descriptions of the sampling units, experimental units, and the observational units, for any specified statistical design (note that no resent day textbook does this for such designs as the randomized complete blocks and Latin square designs),

-formulating a class of plausible response models both prior to and after the application of treatments for an experiment design,

-procedures for selecting an appropriate response model from a class of response models,

-nature of error variation as to whether or not it is an add-on as in $Y - E(Y) = \varepsilon$ or whether it is part of the stochastic process,

-procedures extending the results of Box and Cox (1964) for other families of responses,

-data-analytic methods for subdividing the responses in an investigation into homogeneous groups with respect to one or more response models,

-response models for multivariate responses,

-principles for model formulation and selection,

-sequential procedures for modeling.

Problem 3. Ratios of random variables. Biologists and other investigators frequently use ratios of random variables, say Y/X, to describe various phenomena. The nature of the process may dictate the use of Y/X to interpret the data. If a bivariate normal distribution for Y and X is postulated, then the distribution of the ratio does not have a finite second moment. A transformation of data may be undesirable or nonsensical as, for example, a land equivalent ratio statistic which is of the form $Y_1/X_1 + Y_2/X_2$. Because of this need, it is suggested that one consider:

i) the class of all bivariate distributions with nonnegative responses,

ii) the distribution of ratios and sums of ratios for the distributions in i),

iii) the subset of distributions with finite second moments and which are tractable for interval estimation, and

iv) the distributions in iii) which are useful in practice.

The use of a bivariate normal distribution assumption is inappropriate for many measurements of biological, chemical, and physical variables. Negative responses may be impossible. For many variables, the distribution bounds should start at zero and have some finite upper limit. Thus, the use of truncated bivariate normal distributions may be candidates to include in i) above. Perhaps truncation should be at both ends.

Problem 4. Sequential statistical methods. As a great majority of investigations are sequential in nature, it is inappropriate to treat them as if they were not. What is sorely needed is a Snedecor-Cochran type textbook written from the sequential point of view. It appears that considerable extensions of sequential design theory are needed before such a book can be written. Many new and difficult problems arise (see, e.g. Federer, 1967). Not only is there the sequential selection of observations but the sequential selection of treatments should be considered. Non-contenders should be eliminated as quickly as possible.

Problem 5. Random sample size. When the sample size configuration for the investigation is a random variable, it may be inappropriate to analyze the data using fixed sample size procedures. For most so-called unbalanced data analyses, the results given are conditional upon the particular sample size configuration obtained. The same is true for post-stratification of observations after the sample was taken. In observational studies, not only is the sample size a random variable but certain segments of the population may be omitted. What can be done about interval estimation and hypotheses testing for these situations? It would appear that a random sample size version of the Snedecor-Cochran textbook would be most valuable.

Problem 6. Quality control, product (method) improvement, and sampling in a laboratory. In order to improve the quality of data obtained from analyses by laboratories, a considerable amount of statistical input will be required. Sampling procedures such as group testing, sequential, etc., can be used to greatly reduce the cost of laboratory analyses without sacrificing information. There can be considerable savings financially by instituting these procedures. For example, it is reported that the New York State Diagnostic Laboratory has an operating budget of around four million dollars annually. Using the above suggested procedures, the results could most likely be obtained for three million dollars. If all laboratories of the world are considered, the savings could be tremendous. A laboratory manual written for laboratory workers describing quality control and sampling procedures is very much needed. Also, statisticians should strive to have funding agencies insist upon procedures which will produce high quality data efficiently. If statistics departments would become involved in the conduct of laboratory analyses in their universities and if one-half of the savings as described above would be given to them, their financial worries would be over! The savings is only one part as the quality of research data generated in universities would be greatly improved.

Problem 7. Surveillance and control procedures for various human and animal diseases. Diseases of man and animal have been here for centuries and will continue to be. Loss of life, suffering, and economic losses, are a result disease. Considerable effort is being expended to control and/or prevent disease in man and animal. In order to develop efficient and feasible surveillance procedures for a disease requires considerable cooperation between the statistician, the biologist, and medical experts. It may be necessary to develop different procedures for each disease. For example, procedures for the cattle diseases *Bovine leucosis* and blue tongue require very different methods (see Federer, *et al.*, 1985, Clark *et al.*, 1985). Each disease should initially be treated as something unique, but it should be realized that a single procedure may be useful for several to many diseases. Once the procedures for surveillance have been developed, control procedures may be instituted to eliminate or greatly reduce the incidence of a disease.

Problem 8. Correlated observations. The assumption of independence among experimental and/or sampling units is an untenable one for many situations. Since statistical theory is considerably easier for independent observations, we statisticians hide in our i.i.d. world. In many experiments in agriculture, biology, medicine, ecology, and other areas, the experimental units are not independent. There may be competition, memory, carry-over, etc., between adjacent units. It is felt that the phenomenon of competition between adjacent units is present in most agricultural, biological and ecological experiments. Statistical analyses for independent observations is universal but incorrect for these data. Thus, incorrect or inappropriate analyses are being conducted on thousands of experiments each year. To rectify this, additional theory is required. Some developments needed are:

i) an extension of the Geisser and Greenhouse (1958) paper to handle many types of relationships,

ii) a single-degree-of-freedom test for competition between adjacent units,

iii) development of specific models and analyses for specific competitive effects for treatments in an experiment and to bring these analyses up to the level of procedures for nonadditivity,

iv) further development in nearest-neighbor analyses for trends in data,

v) a study of econometric methods to ascertain their usefulness in other areas,

vi) presentation of developments in i) to v) at a level (Snedecor-Cochran) readable by investigators, and probably very important,

vii) development of procedures to eliminate competitive effects.

Problem 9. Teaching of survey techniques If one peruses the offerings of universities on survey techniques, it is appalling to note that some statistics departments may give only one course on survey sampling design and analyses (mostly the latter) and nothing else. It should be noted that the majority of the world's statisticians make their living working in the survey design area. There are few, if any, sampling experts in most university statistics departments. I would not classify a person as an expert whose sole claim to expertise in survey design was the ability to teach a course from Cochran's "Sampling Techniques," no matter how well it could be taught. I have also been told by a statistics department head that a course on sampling did not belong in a statistics department. I have also been told by several survey organization personnel that they had to train their own survey statisticians because universities for the most part (Iowa State University being an exception) were not graduating statisticians with any expertise in surveys.

To meet the needs for real world problems, universities should develop a curriculum for sampling and surveys. This includes courses on

i) interviewing and interviewer techniques,

ii) planning a survey,

iii) sampling and control procedures in industry, in the laboratory, and in medical studies, and

iv) practical experience in planning, conducting, and analyzing the results from a survey.

Problem 10. Dissemination of statistical research results. Previously it was stated that only a small fraction of statistical research results was used by an investigator or by a teacher of statistics. Is this because the results are not useful to these groups or is it because it is obscured by mathematical jargon at a level beyond the user's comprehension? The answer is yes to both questions. In order to remedy the part due to the second question, procedures are needed to educate the mass of statisticians about research results. One way to do this is to have clear and understandable expository articles for all topics researched in statistics. One of the key features of these articles should be a detailed explanation of areas where these procedures could be used. To illustrate from two areas of research in which I have been heavily involved, i.e. fractional replication and orthogonal F-rectangles, there is no problem in documenting a large number of areas in which the former is useful and in some cases a necessity. However, for orthogonal F-rectangle theory, there is relatively little statistical documentation for its research; that is, it is useful in constructing new experiment designs. The theory for orthogonal sets of F-rectangles will be more useful in Coding Theory than in statistical applications (see Federer and Mandeli, 1986). The contribution of this research is not so much in Statistics *per se* but in Mathematics and Coding Theory. In an expository article, comments such as the above should be included so that the reader will be informed of the usefulness of the results obtained.

Journals of review and expository articles at the Snedecor-Cochran level are sorely needed in Statistics. Will the new review journal "Statistical Science" fill a part or all of this need? Only time will tell. It is well-known that it is extremely difficult to obtain such articles even if the writer is assured that article will be published regardless of the reviews, as S.R. Searle did years ago for *Biometrics.* One of the main reasons is that writing such articles is a very difficult and time-consuming task. A second reason is that rehashing known material may not be as exciting as writing a research paper. In order to obtain well-written expository articles, it is suggested that

i) an authority on a subject with excellent writing skills be selected,

ii) the writer be assured of publication and he has sole responsibility of how to handle reviewers comments,

iii) only the most recent results (last five to ten years) be included,

iv) a specific set of instructions on what to include be formulated as a matter of policy,

v) one of the instructions in iv) be a demonstration of where and how the results are useful in statistical applications,

vi) doctoral graduates together with their chairman be considered as a source for some of these articles as a literature review is usually required for the dissertation, and

vii) the possibility of having one or more sessions at statistical meetings where the proposed author presents his expository or review paper.

One could continue and list many more important problems in Statistics. The above should be sufficient to indicate that much work is required to keep Statistics a dynamic and useful field. Statisticians are faced with many challenges. They should heed these. If they do not, Statistics will *wither*. By facing our challenges, we can determine whether it is "wither" or "whither"! I have great hopes that we will direct the course of statistical research to meet the challenges.

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