FROM COMPUTER CALCULATIONS TO A COMPUTERIZED REPORTING SYSTEM

Miles E. Byers, Engineer of Materials and Physical Research, Illinois Department of Transportation

In working with computers to handle the data generated in a comprehensive study for statistically based specifications Illinois became aware of their potential for reporting purposes. This presentation provides information on MISTIC, the Materials Integrated System for Test Information and Communications developed as a spin-off of developing end result specifications. Input will be through video tube terminals and output through the tubes or hard copy reports. A description is given of the file categories and the functional services involved. In addition, examples are given of inquiries that might be made from the Resident Engineer to the Bureau Chief level in order to obtain information necessary for engineering or management decisions.

Illinois' involvement with statistics related to quality control, acceptance sampling, and specifications writing began in the mid 1960's. By 1966 we were actively engaged in experimental studies of bituminous concrete mixtures and embankment densities. The necessity for separating Statistical Quality Control and Statistical Quality Assurance soon became obvious and educational efforts had been slowly succeeding with contractors, suppliers and Department personnel. No universal demand for statistical based, or end result, specifications has been made in Illinois to date. This situation may be changing as available engineering manpower decreases and overall understanding increases.

There have been many successful applications arising from the need for computerized data to develop statistical information. The move towards a computerized reporting system is one spin-off from this work in compiling data. The advantages of a computer in making calculations and analysing data gathered in the early experimental studies lead to laboratory uses for computation and data processing applications necessary for engineering reports.

Materials' personnel have long seen the need for, and the possibility of, an inspection information system which would provide Construction personnel with Go-No Go information on the suitability of materials delivered to the job site. The computer capability for rapid calculation and programmed decision making were seen to provide possibilities for implementation of this idea.

About 1972 the Bureau of Computer Science and Information also became interested in this program and provided financial support for a feasibility study. Possible benefits of an inspection reporting system were found to far outweigh the cost, and a request for proposal was issued to locate a consultant capable of developing a computerized reporting system. Three firms indicated both capability and interest. From these, one was selected and an agreement was signed early in 1974, with a scheduled date of June, 1976, for implementation of the system.

The agreement includes several milestones for status reports and decision points allowing change in scope, or abandonment if later work finds it to be impractical. The agreement also provides for a Steering Committee of Department personnel to become intimately involved in program development. The proper use of this Steering Committee is the key to successful implementation of this program. Through it, we assure input from the eventual users and commitment to the concept.

The acronym of MISTIC has been chosen. MISTIC means Materials Integrated System for Test Information and Communications. Frankly, the program cannot do anything that currently cannot be done manually. It will just do these things faster and allow us to do other things that are not done now due to the time element involved.

Before explaining the system itself, a few comments on the environment in which it will operate are in order. Illinois uses a Central Bureau to coordinate field and laboratory testing with the nine districts which also possess Material Bureaus. Centralized testing is done in the Springfield laboratory of the Bureau of Materials and Physical Research. Materials generating in the Chicago area are tested at the Branch Laboratory in that area. Each district also has a laboratory and is responsible for field sampling and inspection. Materials records are currently retained at the project, district and Central Bureau levels. Problems are most commonly encountered in the matter of timeliness of communication of test information. Manpower restrictions due to the budgetary

situation are also beginning to cause problems. Use of the computer has the potential of alleviating both of these problems.

The MISTIC system involves use of a central data base of test and inspection information. This data will be used to provide scheduled, automatic, and demand reports through the use of video tubes or hard copy.

The video tubes will be available in the districts and the Central Bureau for both input and output uses. The districts will be able to enter sample identification and appropriate field data. The laboratories will enter test information. Information will be available to both the districts and Central Bureau and to management from the same file.

Detailed files will contain information on all current projects. Summary data will be maintained in four categories. Contract files will contain appropriate information on current projects. Certification information will be consolidated by project. Producer/supplier history will also be retained. Operational statistics, such as backlog, sampling frequencies, test cycles, etc., will also be provided at least for the Central Bureau laboratory.

The previous mentioned reports will be available either on line through the video tubes or through hard copy which will normally be generated through batch operations and available overnight. In addition to providing the input previously mentioned, the video tubes will allow instant inquiry and provide instant display capabilities. They will also provide prompt availability of data generated at one location to all districts and the Central Bureau. Managers will also be able to obtain instant information on sample status or laboratory operation status. Hard copy reports may be scheduled to meet legal requirements and provide necessary manual files. Automatic reports will serve as reminders or provide notice of necessary action. Demand reports will provide test data statistics of our performance trends.

The computer basically is providing three functional services. It will collect test results, perform calculations, compare results with appropriate specifications and provide notification of necessary action. It will answer status inquiries from Materials, Construction and Management personnel. It will also maintain historical experience records.

After such a detailed explanation the usual question is, "What can it do for me?" The answer obviously depends on who you are.

If you are a Central Bureau Chief, you might be faced with this situation. One of the laboratories has finally reduced its backlog after it borrowed a man from another section. You could ask, "What has been our output at the two staffing level and what does historical data indicate what the next quarter work load will be compared to the last quarter work load?" The program will provide this information to aid your decision to return the required man or recommend that he remain as assigned.

If you were a Central Bureau Laboratory Chief, you might be faced with a situation in which a new technician is to be assigned (obviously these are hypothetical situations). You could ask, "Which tests are taking the most time and which are causing the most backlog?" This information would be useful in considering assignment and training of the new technician.

If you are a District Materials Engineer, you might find out that a resident engineer is going to be married next week. You could then want to ask, "What is the status of quantities inspected vs. quantities used on this resident engineer's project?" The information could be provided the next day so that you could proceed to get the inspection updated, if necessary, before the honeymoon started and the resident engineer lost interest in paper work.

If you were a Resident Engineer (not on a honeymoon) you might receive material at the project site with no evidence of inspection. You should logically ask, "Can I use this material?" Initially, communication with the computer must be conducted through the District Materials Engineer, but eventually each resident engineer may have his own little black box. The District Materials Engineer may inquire with identification of the material, quantity, source, shipment date, or other information and obtain an immediate display of inspection status and appropriate test data.

If you are a lab technician or a field inspector, with a lot of test data on hand, you may very well want to ask, "MISTIC, can you run the necessary calculations, compare the data with the specifications and let me know if everything is O.I.?" The answer is sure, and you won't even miss coffee break waiting for the answer. If that kind of response won't sell this system, I don't know what will.

Just two problems now remain. We must maintain credibility and restrain our enthusiasm. The answer to the first lies in the second. There are continued temptations to either oversell the program when we talk about it, and to expand it as we work on the

detailed design. This could lead to unrealistic expectations of the eventual users because of practical and fiscal limitations to the program. A product that doesn't live up to the promotional campaign will destroy the credibility of both the producer and advertising agency.

Since I am speaking as a representative of both the producer and the advertiser, I have to be especially careful of my credibility. In this case I am sure that this spin-off from developing statistically based specifications will deliver as advertised. You will be hearing a lot more about MISTIC in the future.

CALIFORNIA'S EXPERIENCE WITH THE USE OF STATISTICAL SPECIFICATIONS

Wallace H. Ames, Supervising Materials and Research Engineer, and Carl R. Sundquist, Senior Materials and Research Engineer, California Department of Transportation

This paper presents a summary of California's experience with the use of statistical specifications for the control of highway construction quality. The paper outlines the research, initiated in early 1965, emphasizing the need for statistically based specifications. The early development of a moving average specification, the problems resulting from its implementation, and later revisions to the original specification are discussed. A subsequent study, initiated in 1972, comparing materials quality control under the original moving average specification with that derived from the previous finite limit specifications is also discussed, and the findings of the investigation are summarized. The conclusions of these studies are: The moving average specifications work well and are thought to be practical, and that administrative problems preclude the use of purely statistical based specifications.
Key Words: Moving Average, Statistical Specifications, Quality Control, Mean, Standard Deviation, Normal Distribution, Research, Implementation, Material Quality.

Developing practical and reliable specifications for highway construction has always been one of California's goals. Specifications that are unnecessarily restrictive or arbitrary tend to raise costs, create delays, and strain relations between construction engineers and contractors. Conversely, excessively broad specifications lead to significant variations in quality, inordinate maintenance costs, and reduced public convenience and safety. Rapid evolution in construction methods and materials has made it necessary to constantly review and update specifications.

Prior to 1969, in California, our specifications generally had finite limits outside of which material was theoretically rejected. In many cases, however, it was often difficult and costly to reject material.

About 1964, the Federal Highway Administration began encouraging state highway agencies to develop specifications that recognize and allow for normal testing and materials variation. We initiated a research project in early 1965 to evaluate what some of these variations were (1). As an example, this research indicated that we had purchased material with a relative compaction ranging from 90 to 100 percent under a specification requiring a relative compaction of 95 percent. Between 1965 and 1968 a series of reports were released presenting the findings of this research (1-9).

The results of these studies indicated that we were accepting material that was represented by a normal distribution curve and that the test results ranged from slightly below or outside to varying amounts above or within the specification limits. This evaluation indicated two things: we were accepting material that was not one hundred percent