Statistical Process Control for Surface Mount Technology

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This book is the outgrowth of 5 years consulting experience in the applications of statistical methods to Surface Mount Technology (SMT). This book provides the reader with the methodology of applying Statistical Process Control (SPC) on the manufacturing line. This methodology is called data sleuthing. The book is divided into two parts. Part I provides an overview of the methods of data sleuthing. Part II provides a case study approach to the implementation of SPC throughout the whole SMT manufacturing line. It starts with how to qualify the raw material from the supplier to the implementation of SPC for final test of the printed circuit board. In Part I, we discuss in detail the tools and methods of data sleuthing. Chapter 1 presents the concept of data sleuthing. Data sleuthing is the practice of employing statistical methods and strategies to detect, identify, and eliminate "excessive variation" in SMT. Data sleuthing has three components: statistical tools, strategies for implementation, and the axioms of deductive reasoning and logic. It is the synergistic relationship of the three that allows us to solve cases of excessive variation. In chapters 2 through 6, we provide the reader with the basic tools to summarize the data, employ control charts on-line, conduct process capability studies, and design experiments to obtain process knowledge about what input variables in the process affect the process output variable(s) in question. We also provide ways to optimize the process through the application of response surface methodology. We show ways to develop relationships between process characteristics through regression analysis. In Part II of the book, the casebook of data sleuthing, we provide the reader with 11 cases on how to implement data sleuthing in practice. One of the key components of solving each of these cases is the axioms of data sleuthing. These axioms are quotations on deductive reasoning and logic from Sherlock Holmes. The names of the case studies are based on actual story names from Sherlock Holmes to reflect the importance of these axioms in practice. At the start of each case study is listed the tools, strategies, and axioms applied to solve the case. Data Sleuthing is the practice of employing statistical methods and strategies to detect, identify, and eliminate "excessive variation" in Surface Mount Technology (SMT) processes. In this definition there are two key concepts which are delineated in this monograph: (1) Statistical Methods, and (2) Excessive Variation. Data Sleuthing is based on the principles of deductive reasoning and logic. The most famous practitioner of these principles is the legendary fictional detective, Mr. Sherlock Holmes, created by Sir Arthur Conan Doyle (1986) .We take the approach of Mr. Sherlock Holmes in this treatise by developing a case study approach to solve situations where excessive variation is encountered. This is accomplished through the use of tools and methods that reflect deductive reasoning and logic. This book is divided in two parts. Part I provides the reader with an overview of the tools necessary to employ in practice to solve Cases of Excessive Variation. Part II of the book provides 11 case studies which gives the reader practical examples of how to employ these tools in real-life situations to solve cases of excessive variation throughout the SMT process. The axioms of Data Sleuthing are employed to remind the practitioner that the basis of solving the case of excessive variation is deductive reasoning and logic. The scientific approach to studying variation indicates that there are two classifications for process variation namely common (sometimes called random) and special (sometimes called assignable) causes of variation. Before providing an example from an SMT process, we ask the reader to conduct a simple exercise. Write your name three times. Next write your name with the opposite hand. Examination of the signatures from writing it three times with your usually signature hand shows that slight differences can occur. These are examples of common cause of variation . The differences between the two hands reflect assignable causes of variation. It is helpful to demonstrate the difference between the two with an example taken from a component placement process. In this operation the process engineer has identified the following four sources of variation: (1) Feeders, (2) Heads, (3) Nozzles, and (4) Component Placement Machine. Example 1.1 gives the details. EXAMPLE 1.1 In this

example, the component placement process is specified to produce no more than 50 parts per million (PPM) defect level . In this operation, the process engineer has identified the following four sources of variation: (1) Feeders, (2) Heads, (3) Nozzles, and (4) Component placement machine itself. Table 1-4 gives the breakdown of what causes of variation is attributed to each type. The process engineer chooses to attribute the feeder, nozzle, and head sources of variation to special causes of variation. The reason is that in each case, the failure was easily identifiable, were easy to eliminate by referring to the machine maintenance manual, and they were fixed by the maintenance organization. The reason that the component placement machine was attributed to common cause was due to the fact it was already performing to its theoretical capabilities. The team could not perform any corrective action to make it perform more efficiently. The only way for this operation of component placement equipment to perform more efficiently is to replace the existing equipment with new equipment that is capable of performing at a theoretical defect level of 50 PPM or better instead of at the current machines capability of 100 PPM. As stated earlier in Table 1-2, it is the responsibility of management to make this type of decision. The reason for this is, it is a capital expenditure, which is the responsibility of management to make. This is at the crux of the problem when trying to implement SPC in practice. After the "low hanging fruit" is harvested from the program, experts estimate that 85-94% of problems is the responsibility of management to fix! We address this situation in more detail in Part II in Case Study Number 11- The Final Problem. Table 1-4: Causes of Variation Attribtued to Placement Equipment

Sources of Variation: Reason for Failure: Type of Cause Feeder:

Wrong Part Number: Special Nozzle: Can't Hold Part: Special Head: Doesn't Move to Pick-Up Part: Special Machine: Failure Rate of 100 PPM at Machine Theortical Design Guideline: Common

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