My dictionary defines algorithm broadly as a step-by-step procedure for solving a problem or accomplishing some end and thus supports what I thought was a misuse of the term in the subtitle of this book. The authors, both faculty members at the University of Waterloo, got a lot more than that right in this extraordinary book devoted to the systematic reduction in variability.

The book is an outgrowth of the authors’ work as participants in the University’s Institute for Improvement in Quality and Productivity (IIQP). They acknowledge the support and participation of nearly 30 companies as diverse as GM Canada and Campbell soup. I learned from the website that IIQP has since been renamed The Business and Industrial Statistics Research Group and that Professor Steiner is the Director. The book is used as the text in a course in Productivity Improvement at the University and comes with a CD containing 109 data sets in both Excel and Minitab formats that came from actual variance reduction projects described in the text. The CD also contains 356 pages of additional material including exercises and their solution, supplementary material for 11 of the book’s 21 chapter and six appendixes devoted to the use of Minitab.

The book is a bonanza for those searching for relevant examples for a short course for a manufacturing staff or to enliven a course in Engineering Statistics.

The book is targeted at chronic, as opposed to sporadic, problems of excessive variability met in manufacturing and assembly, in medium to high volume production environments. The implementation of the algorithm is presumed to be delegated to a team possessing in its members, process and statistical know-how.

The authors enumerate 7 ways, of varying complexity, in which process variability may be reduced. The algorithm itself is set forth in flow chart format. The first step is to Define a Focused Problem. The next step is to Check the adequacy of the Measurement System. Following this step the team proceeds to select one of the 7 ways to reduce variation. These divide into three ways requiring the identification of a dominant cause and 4 ways which do not. The authors’ experience teaches that in most cases the team will decide to search for a dominant cause. The algorithm loops until a choice of variation reduction method is shown to be feasible whereupon a plan for implementation is developed. The last step comprises three elements: i) implementing the solution ii) validating the solution and iii) holding the gains, i.e., putting monitoring techniques in place so the reduction in variability is maintained over time.

In Chapter 1, Introduction, the authors describe seven real world problems such as a case of excessive variability in a crankshaft diameter and a problem with Engine block leaks. They present what they call the baseline data, typically histograms or scatter plots and summary statistics that define the situation as the team found it. These same problems are frequently referred to in subsequent chapters as the algorithm is applied to them. Chapters 2 to 5 constitute the book’s Part I, entitled Setting the Stage. Chapter 2 is called Describing Processes. Chapter 3, called Seven Approaches to Variation Reduction, describes and illustrates, with examples, each of the seven ways to reduce variability. Chapter 4 describes the algorithm itself. Chapter 5, Obtaining Process Knowledge Empirically, gives a framework for learning about a process, to which the authors apply the acronym QPDAC, standing for
Question, Plan, Data, Analysis and Conclusion. Two examples illustrate the QPDAC procedure, one involving a piston diameter measurement system and the other involving an unwanted residual pattern in a two color laminating process.

Chapters 6, 7 and 8 amplify respectively on the first three steps of the algorithm and comprise Part II of the book captioned Getting Started. Chapter 6 addresses the conduct of the baseline investigation and contains some straight talk on sample size requirements. The authors advocate samples large enough that sampling error is negligible which means “hundreds of units if the output characteristic is continuous and thousands if the output is binary”. They also suggest for this reason, that binary variables be converted to continuous where possible substituting for example, the measured thickness of a engine wall for the binary “leaks or doesn’t”.

Part III, called Finding a Dominant Cause of Variation comprises Chapters 9-13. The idea of Families of causes of variation are considered such as variation that occurs over time and variation that occurs either before or after a certain point in the process. A deductive elimination method worthy of Sherlock Holmes is used to nail the culprit. Statistical techniques appearing in these chapters include histograms, scatter plots, box plots, regression and, in chapter 13, a $2^3$ factorial experiment, with a Pareto chart to assess the relative magnitude of effects. Statistical orthodoxy is subservient to practical results so there is no obsession with using random samples, hypothesis tests, confidence limits or tests of normality. Process knowledge and a few statistical tools wisely applied, are combined in the common goal of finding and eliminating variation.

Part IV, entitled Assessing Feasibility and Implementing a Variation Reduction Approach, comprises Chapters 14 to 21. Moving a Process Center by finding an input that acts as an “adjuster” is dealt with as is Desensitizing a Process to Variation and its close relative, Making a Process Robust. Feedforward control, feedback control and 100% inspection round out the options.

One refreshing thing about the book is that not every project described was a success. Usually every project described has valuable lessons for ultimate success. In one case a team ran an experiment to find the combination of six variables that would result in the smallest variability. When implemented there was no improvement because the short term variability seen in the experiment was a small component of the longer term variability shown in the baseline data. In other cases the only possible cure was too expensive to implement and the project was abandoned.

In summary, this book offers systematic guidance for practitioners and practical illustrative material for teachers. It had its genesis in a most salutary collaboration of those two groups.