GUEST EDITORIAL

Inclusion of Six Sigma in ChE Curricula

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All repetitive activities produce outcomes by which their performance may be assessed. The outcomes of these processes have specifications imposed on them by the customers they serve. This is true of dynamic manufacturing processes, common in chemical engineering, which respond to changes in the inputs after a time lag, or static transactional processes, abundant in commerce, which respond to changes in the inputs instantaneously. The notion of variation in the outcomes of all processes and transactions arises because uncontrollable and unknown causes are always present. Perfection therefore is not in the plan of nature. Minimum variance is that state beyond which further improvement is not possible because the causes responsible for the residual variation are unknown or uncontrollable. Thus, minimum variance in static and dynamic processes is a theoretical standard against which the performance of practical approaches may be assessed. For dynamic processes, it is possible to design minimum variance control laws but doing so dramatically escalates the cost of control and the system becomes extremely sensitive to modeling errors. Operational strategies for complex dynamic processes therefore aim at achieving a good compromise between the speed of response and system stability in the presence of modeling errors. These optimizing strategies go by the name constrained model predictive control (CMPC) which remains the state of the art today.

The foregoing ideas are well-known to chemical engineers. This editorial suggests that minimum variance control has far greater significance. When applied to static processes the minimum variance methodology goes by the name six sigma created at Motorola about the time when CMPC made its debut in the late seventies and early eighties. Six sigma is the static equivalent of CMPC. Over forty percent of US corporations have adopted six sigma. Since static processes and transactions, encountered in virtually every activity of life, vastly outnumber dynamic processes, six sigma should be in the toolkit of every chemical engineering graduate. Six sigma training will make ChE graduates better control engineers, and help them with job prospects and career advancement.

The author taught a senior/graduate-level six sigma elective in the chemical engineering department for several years prior to retirement. He continues to teach the course elsewhere along with an online version of the course. He introduced mandatory six sigma green belt training in the MBA program of the University of Kentucky and has been teaching the course to their MBA students in Athens, Greece for the past nine years.

Chemical engineering departments should require six sigma training of all graduates and the best way to do this is to include it in their curricula at both the senior and graduate levels. The author equates process control and six sigma training to teaching ChE students the wherewithal of how to achieve the best possible performance in diverse endeavors and for this reason six sigma should not be an option. In addition, many campus recruiters will enthusiastically endorse ChE plans to include six sigma training in the ChE curriculum.

There is so much one-to-one correspondence between process control and six sigma concepts that it might be advantageous to combine the two courses into one new four-credit course. Some topics such as Laplace transforms and the solution of differential equations could be shifted from the process control course to the math courses to make room for six sigma concepts. Some process control concepts could also be shifted to a ChE laboratory where software packages such as MATLAB and MAPLE could be used to reinforce process control concepts. Since six sigma heavily relies on statistics, statistics should be a prerequisite for the course. By coordinating with the instructor of statistics, the necessity of spending time on statistical review can be avoided. The use of statistical software (e.g., SPSS or MINITAB) will avoid the drudgery of repetitive computations and help with the pace.

Instructors interested in including six sigma training as a separate course or as part of their process control offering may contact the author (pradeep@sixsigmaquality.com) for a course outline, syllabus, and a set of MINITAB and MAPLE exercises. ❐