## *Process Dynamics and Control, 2nd Ed.*

by Dale Seborg, Tom Edgar, and Duncan Mellichamp

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***Reviewed by***

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First, I want to applaud the authors for making a substantial, well-thought-out revision to their textbook. I have used the book to teach my introductory process control course but had not really read the additional material in the new chapters until this review. I was very impressed with the depth and breadth of the material. I am amazed that the authors were able to eliminate so much material and yet not dilute the critical topics that are important to a first course. I know that it was a struggle to decide what to eliminate and what to keep, just due to the fact that three personalities were involved. They did an excellent job.

Since the authors did eliminate so much material, especially on digital control, I see the two versions being more like Volume 1 and Volume 1.5 (not quite two volumes) and working to complement each other in advanced courses in process control. I see potentially three semester courses (at least this is the way I would do it) from this text. The first one is a general process control course for all undergraduate chemical engineering students covering Chapters 1-9, 11-12, and 15-16; a course in advanced methods covering Chapters 13-14, 18-21 (bringing in material from the first edition); and an application toward plantwide control and plant design covering Chapters 10, 22-24, and all the Appendices.

For those working in the process control field the book is a good textbook as well as a good reference manual. Faculty that are not, however, yet are teaching process control might find the text intimidating and too complex. I asked a faculty member in my department who fits this category and is currently using the text and that was his feeling. I kept this in mind while reviewing the text and I could understand his feeling of insecurity with it. One way the text could be improved is to revisit the chapters I mentioned for an introductory course and work to rewrite it in such a way that faculty in this category could feel more comfortable with the material.

My comments on specific chapters are as follows. Chapter 1 needs more problems. I am disappointed that they took the block diagram out of this chapter. I have used it to tell students where we are going and why we need Chapters 2-7 and how each block represents certain chapters that we will tie back together in Chapter 11 (what used to be Chapter 10). Chapter 2 is essentially the same as before just with some new problems (I particularly like the additional application on bioprocesses and the exercises). Chapter 3 is essentially the same but the authors should have left Exercises 3.16 and 3.20 in this edition. These were two of my most popular problems for homework. Chapter 4 also did not change much but could be made shorter by giving a general method using Section 4.3 material, which covers all cases. I like the addition of state-space formulation. Chapter 5 has been basically untouched, which I applaud, but it does have more good problems—something faculty always appreciate. Section 6.3.1 is a good addition to Chapter 6 and is explained well. I have always appreciated this chapter and I am glad to see it is even better. The problems are good, especially the ones reflecting new material and bio-systems engineering. For Chapter 7, I feel that all the emphasis on graphical methods should be removed and replaced with regression. In illustrating regression techniques I think it is more important to show how software packages would do this rather than to give the mathematical equations on how they are done. Although they give Matlab and Excel examples they do not show, step by step, how this is exactly done. I think professors and students would appreciate this detail.

Example 7.4 needs to be revised or removed. Who would fit Models 3 and 4 to that response? In addition, a better ARX or ARMAX model should give a better fit by the fact that Model 1 fit so well.

Chapter 8 is basically the same but this chapter has always needed, as it does now, more problems. Chapter 9 is done well but needs more explanation of hardware and more problems.

Other textbooks are much stronger in this material such as Riggs (2001). I just skipped the material in Chapter 10 and went straight to Chapter 11. It is good material but out of step with how I do my course. It is important for the material on plantwide control and design. I do not like the way the material in the new Chapter 11 has combined Chapters 10 and 11 from the first edition. I like to keep stability analysis separate. There are, however, plenty of good exercises in this chapter. Chapter 12 is done well and has excellent problems. Chapters 13 and 14 are a good condensation of the three chapters on frequency response from the first edition. This material needs to remain but not be overemphasized, in my opinion. Chapter 15 is an excellent chapter with good problems.

For Chapter 16, the addition of Fuzzy Logic Control is an excellent improvement but I couldn't find any exercises on this topic. In Chapter 17 I am glad that they left the material on filtering in this edition. I know that it was difficult to remove much of the material on z-transforms and sample data-control systems, but the first addition could supplement

these eliminations if necessary. It would help to actually have an example for obtaining the poles and zeros. Also, what happened to $C_0U_z$ in Eq. 17-46? The $C_0$ is there but where is $U_z$? I appreciate the addition of Section 17.6 and I am glad they did not go into a lot of detail [it would be hard to match the material of Ogunnaike and Ray (1994) on the topic]. There are a lot of good problems in the exercises.

I did not find many errors or typos in this edition, which is commendable considering the amount of new material and reorganization. In Chapter 18, however, "n!" on page 477 should be "$n^2$." Also, on page 479, "hidden" is mistakenly printed as, "hidd en." On page 492, just below Eq. 18-58, "4" should be "w." I commend the authors for adding the SVD material and updating this chapter. It may be the most important chapter for the control design engineer in terms of theory.

I am glad that they shortened the material in Chapter 19 since optimization is a course in itself and only an overview is critical to any process control course. Chapter 20 is a substantial and critical improvement over the first edition. All the basic fundamentals and concepts of model predictive control (MPC) appear to be present. At least it gives a good overview and introduction on the subject. Although I have not taught from this chapter yet, the exercises appear to be excellent.

The authors did an excellent job on Chapter 21. They did it just right and the critical material is here in just the right amount. These topics include the following: X bar chart, S chart, Cusum, EWMA, Cpk, Six Sigma, and multivariate MPC. They need, however, to point out which ones detect a "mean shift" vs. a "variance shift." For example, there is no statement in this regard for the X bar chart. I suggest that they add the use of Minitab in this chapter as they did Mathlab and Simulink for chapters exploiting their use. Finally, Chapters 22-24 appear to be done quite well and I look forward to using them in future courses.

Overall, the authors' have made a timely and significant improvement to this textbook by bringing it up to date with current practices and needs, and enhancing its use as a textbook in process control for undergraduate as well as graduate students. I have used the earlier book since 1991, and with the improvements they have made in the second edition, this text will be useful in the courses I teach for many years to come. ❐