# Preface

The contents of this book are, for the most part, the result of the experience I gained during the five years I spent as a researcher at the Centre for Systems Engineering and Applied Mechanics (CESAME), Université catholique de Louvain, Belgium, from September 1995 to June 2000. I am very grateful to Michel Gevers, Brian D.O. Anderson, Xavier Bombois and Franky De Bruyne for the good times we spent, the great ideas we had and the good work we did together. I also want to give credit to Pascale Bendotti and Clément-Marc Falinower of Électricité de France for their support and collaboration in the elaboration of the case study in Chapter 6.

After completion of my Ph.D. thesis (Codrons, 2000), I landed in an industrial R&D laboratory, fully loaded with scientific knowledge but with almost no practical experience. This was the real beginning of the genesis of this book. As I have spent the last four years discovering the industrial reality and trying to put my theoretical knowledge into practice, I have also discovered the gap that often separates both worlds. For instance, when the issue is the realisation of identification tests on an industrial system in order to design or tune some controller, in a rather amusing way, both the scientist and the plant operator will recommend making the tests in closed loop. The latter, because it is often more comfortable for him and less risky for plant operation than open-loop tests; the former, for the reasons exposed in this book. In spite of this, however, the usual practice consists of opening the loop, applying a step on the input on the process, and measuring the output response from which essential values like the dominant time constant and the gain of the process can be determined. What is the problem, then? Who is right? Is it the scientist and his closed-loop... whim? Or is it the control or process engineer, with his rules of good practice or her pragmatic approach? To be fair, both are probably right. The open-loop approach is satisfactory most of the time when the objective is to tune PID controllers. *grosso modo*, those only require knowledge of the process time constant and gain for their tuning. However, this approach deprives the engineer of the necessary knowledge of the process dynamics that would help him to design more sophisticated control structures, especially in the case of coupled subsystems that would require a global handling with multivariable control solutions in lieu of monovariable but interacting (and mutually disturbing) PID loops.

The problem is even worse when the objective is to design a controller that has to be simultaneously *optimal* (with respect to some performance indicator, *e.g.*, the variance of the output or an LQG criterion), *robust* (with respect to modelling errors, disturbances, changes in operating conditions, *etc.*) and *implementable* in an industrial control system (which will generally put a constraint on its order and/or complexity). Most of the time, suboptimal solutions are worked out on the basis of, again, monovariable control loops and sometimes indecipherable logic programming aimed at managing the working status of the various PID controllers in function of the process conditions. This results, generally, from a lack of knowledge of the existing modelling and control design tools, or of the way they can be used in industrial practice.

Actually, one of the most critical and badly tuned loops I have been faced with is probably the learning loop between industry and the academic world. Without pretentiousness, my intention when starting to write of this book was to make some of the most recent results in process modelling for control available to the industrial community. The objective is twofold: firstly, it is to provide the control engineer with the necessary theory on modelling for control using some chosen specific black-box techniques in a linear, time-invariant framework (it sounds a reasonable first step before nonlinear techniques can be addressed); secondly, and this is perhaps the most important issue, it is to initiate a change is the way modelling and control problems are perceived and tackled in industrial practice. This is just a small part of what a feed-forward action from University to Industry might be. Also very important is the feedback from Industry to Academia that happens essentially through collaborations.

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