9c Issues on the Operability of Multivariable Non-Square Systems

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Non-square systems in the process control sense with fewer degrees of freedom are quite common in chemical processes. In these systems, it is impossible to control all measured variables at specific set points. This is because the number of degrees of freedom available, or manipulated variables, is smaller than the number of outputs. As a consequence, many of the outputs are controlled within an interval, between an upper and lower bound. If the interval is chosen to be very narrow, there might be no solution for the available values of the input variables. On the other hand, if the interval for these output variables is quite wide, then the tightness of control achieved might not be satisfactory.

The objectives of this presentation are: 1) the systematic demonstration of the need to properly design the output bounds on non-square Model Predictive Controllers (DMC/MPC); 2) the development of a multivariable non-square Operability methodology for linear systems;

The first objective will be achieved by simulating an example of a non-square chemical process, a Steam Methane Reformer (SMR), which has 4 manipulated, 1 disturbance and 9 controlled variables. These simulations will be performed through the DMCplus™ controller of AspenTech and the MATLAB MPC Toolbox (Mathworks™, Inc) controller. Furthermore, convergence characteristics of the MPC algorithm will be analyzed as a function of the output window specified.

Concerning the second objective, in order to extend the Operability methodology for multivariable non-square linear systems, some modifications on the definitions proposed initially by Vinson and Georgakis (2000) for square systems are required. The new definition of Operability should recognize the necessity to control some outputs at ranges rather than at a given point of the Desired Output Space (DOS). As a starting point for the development of this methodology, we are examining some simple non-square systems to motivate the new concepts. We are also examining some application examples involving the multivariable control system of the SMR process. Finally, through the proposed operability methodology, it is possible to verify the effectiveness of the controller design before implementation.

Reference: Vinson, D. R.; Georgakis, C. *Journal of Process Control* 2000, 10, 185-194.