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This Week's Citation Classic

Davison E J. A method for simplifying linear dynamic systems. *IEEE Trans. Automat. Contr.* **AC-11**:93-101, 1966. [Department of Electrical Engineering, University of Toronto, Ontario, Canada]

The behaviour of a multi-input, multi-output dynamic system is often described in terms of a linear, time-invariant model, and for large complex systems, the order of such a model is generally excessively large. This paper deals with the problem of obtaining a simplified model which approximately describes the behaviour of the original system. [The *SCI*® indicates that this paper has been cited in over 165 publications since 1966.]

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"At the time this paper was written, I was in the middle of my PhD thesis dealing with the control of large-scale systems, and the above paper was completed as a by-product of this thesis study. The topic itself was suggested by my supervisors, Harold Nicholson and Howard Rosenbrock, who, at that time, were also carrying out research at Cambridge University in control system analysis and design. Although I thought the paper was important, it, in fact, was not included as part of my final PhD thesis.

"The problem which the paper studies can be expressed in a very simple way. Given that the behaviour of a multi-input, multi-output system is described in terms of the linear, time-invariant model of order n: $x=Ax+Bu$, $y=Cx+Du$ where $u \varepsilon R^m$ are the inputs, $y \varepsilon R^r$ are the outputs, and $x \varepsilon R^n$ are the states, can one obtain a simplified model of order n^*, where $n^* << n$, which approximately describes the behaviour of the original system? This problem is now called the model reduction problem and is of immense importance for the purpose of analysis, synthesis, and simulation studies of many complex systems which typically arise in modern industrial society.

"As is often the case, the problem formulation and solution obtained in this paper were not obtained in a formal research environment, but rather, in this case, on a ski slope in Austria. Of course, a number of unsuccessful attempts at the problem had previously been made, and a good deal of frustration had already been accumulated before this solution occurred. On completing the paper in 1963, I do recall feeling disappointed that the paper did not tell the whole story about model simplification at that time. As it turns out, some 20 years later, the whole story is still not understood!

"The paper is important because it was one of the first papers dealing with the simplification of multivariable models and had the following features: (I) In itself, it could be immediately applied to important practical application problems, e.g., to the simplification of power system equivalent models, the simplification of chemical process control models, etc. (II) It served as a stimulus for further research into the general area of model simplification. There have now been literally hundreds of papers written on the topic since the paper was published. In addition, there are sessions at annual conferences regularly dedicated to the general topic of model simplification.

"A survey, now outdated, of some 137 papers dealing with the model simplification problem is given in reference 1."

1. **Genesb R & Milanese M.** A note on the derivation and use of reduced order models. *IEEE Trans. Automat. Contr.* **AC-21**:118-22, 1976.