240n Developments in Computer-Aided Modelling

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Background Modelling is taking a central role in most engineering activities also in all aspects of operations, of which control is one of the most dominating disciplines. The generation of process models, in particular physical-chemical processes, which may be combined with biological media, are seen as an art requiring specialized knowledge for their construction. The project this group has been working on for the last two decades aims at removing the art stigma from the modelling process and make modelling a well-defined activity.

Approach The work has lead to a systematic approach to modelling. Key ingredient is thereby a system-theoretical view on the system definition and representation. It was the latter that was the es-sential part leading to a method that could be implemented in a program and is now ready to be extended beyond the physical/chemical/biological domain including any physical proc-esses. The representation builds on the conservation of the fundamental physical quantities, their transport in space and their conversion. The recognition that the fundamental physical quanti-ties form a minimal space requires all dependent quantities, which are introduced in the de-scription of the transport and conversion processes, to be the result of a mapping of this minimal space. For the field of physical/chemical/biological processes, this mapping is mostly dealt with in thermodynamics and the neighbouring fields with a rich literature to draw knowledge from.

Current Status The research has gone over three periods of PhDs with the last one having resulted in a nearly industrial-hard program called Modeller. The program has over the last two years been used in an industrial environment for the modelling of plants for the purpose of constructing train-ing simulators. Thereby did we observe an increase of efficiency of the modelling process by a factor of 10 and more. The standard demonstration we have been using, for example, gener-ates a model for a chemical reactor within 5 minutes from scratch to complete simulation in-cluding a graphical representation of the simulated results without using predefined models except than basic equations such as transformations and kinetics. Such a task requires usually in the order of an hour of work. The program also implements handling of basic time-scale assumptions, namely event dy-namics of flow, conversion and system components being the three key components in reduc-ing the dynamic domain. All three types of assumptions can be handled using singular pertur-bation thereby reducing the state space yielding models in the form of differential algebraic equation sets of index 1, thus guaranteed structurally solvable. The PhD student, who has recently started his own company and we are currently rewriting the program to adapt to the new language technologies available from the computer science community.

Plans The current program is limited to the representation of lumped systems. Thus one of the goals of the current work is to extend this to distributed systems with a in between step of repetitive structures. Assumption handling is also partially implemented. It will have to be extended and further developed to support the user in making educated choices on the granularity of the model. The second development focuses on the structuring of the equations and variables. Since physics provides a very well-defined structure it is obvious that such structure should reflect into the generation of the equation data bases, because the connection between equations and variables is not arbitrary. Thus this is also an ongoing effort. Further do we aim at opening the data base handling to the commercial level and thus ap-proach it using standard data base technology.

This Presentation will provide a overview on the methodology, the basic ideas and the implementation if time permits.