Backward simulation - A tool for designing more efficient mechatronic systems

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This paper uses the method of backward simulation or inverse system simulation as a tool to optimize system configurations or to size components for hydraulic drives. Backward simulation (understood as inverse system simulation) means that input and output of the simulation are switched. The direction of computation goes backward from the physical outputs to required control inputs. The main benefit of backward simulation is the fact that a control is not necessary. In fact, one can say that perfect control is assumed, because the required output is given as input to the simulation. Another benefit is, that implemented with Modelica, the backward simulation approach can be used with the same models and with the same simulation tool that is used for the forward simulation approach. This leads to a better communication between design and control engineers which can use the same simulation model in different stages of the product development process.

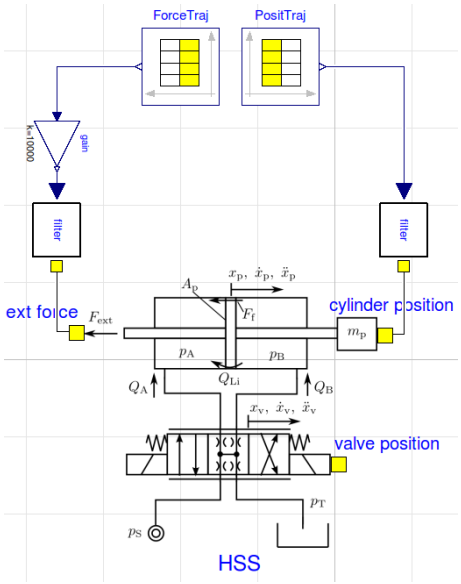

Figure 1: Dymola backward simulation of hydraulic servo system

Figure 1 shows the simulation model of a simple hydraulic drive. For simulation of such a system, usually the valve input signal has to be provided by a control. Using the backward simulation approach with Modelica, the valve input can be calculated from boundary conditions, which are the cylinder motion and force inputs.

The paper explains the backward simulation approach using simple examples. The benefit for the product development process is explained and illustrated at the example of a hydraulic drive. Using the backward simulation approach, resizing of the components can be done without a need to change the control. Through resizing of the components the energy consumption of this drive can be reduced by nearly 40%.