STRUCTURAL MODELING OF HYDRAULIC SYSTEMS*

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Abstract:: *This paper considers the process of structural modeling, in general, and the process of structural modeling based on multiport mechanism, in particular, as base for computer added modeling. This process is illustrated on typical hydraulic control system (cylinder controlled by valve) with systematical approach.*

Keywords: structural modeling of physical systems, multiport mechanism, hydraulic control systems.

1. INTRODUCTION

The modeling process of a physical systems, in general, could be divide into three abstraction phases [1]:

- physical components phase
- physical concept phase
- mathematical phase

Each of these phases gives some view on a physical system having successful modeling process. Hierarchical structure of this process intensify level details from the level of physical components to the mathematical level. Modeling process begins with recognition of technical components and their interactions into the system to be modeled. This process is basically unique and it is base for the next step. The second step is not unique and it depends from modeling aim and physical concept. This modeling level gives qualitative description of a physical system. The last step is quantitative mathematical description of a physical system and that description can be represented by different mathematical forms.

Structural approach points at possibilite to the levels formalization in order to have base for the computer support.

Illustration of these modeling levels, using concept of multiport mechanisms, on hydraulic control systems will be subject of this work.

2. ABSTRACTION ON PHYSICAL COMPONENTS PHASE

Introduction with a system (either it is designed or to be designed) begins with establishment of the system's components and their interactions. For graphical system representation could be used non-formal notation or more often domain depended symbols, as in case of hydraulic control system shown in Fig.1.

Given hydraulic scheme represents the first abstraction modeling level (level of physical components). The system composes: hydraulic pump, valve, hydraulic two-way cylinder, reservoir and transmission lines.

This modeling level includes interface between each system's component and the outside world. This is very important because it helps designer to change any component without the structure destroying. The interfaces on this level are realized by connections (black square in Fig.1). For example, the interface of the hydraulic cylinder composes three connections (Table T1.).

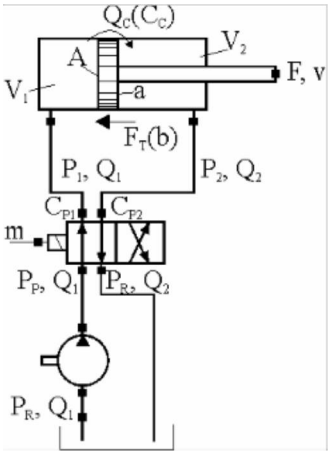

Fig.1: *Hydraulic system*

Table 1. *Hydraulic cylinder interface*

Connection		
Number	Domain	Type
1.	Hydraulic (P_1, Q_1)	Energy
2.	Mechanical (F, v)	Energy
3.	Hydraulic (P_2, Q_2)	Energy

Since, looking from outside, hydraulic cylinder we see through interface by three connections it allows substitution of this cylinder by one without interface change.

Each connection represents some kind of component interaction (energy/information) with outside world (model infrastructure). This allows that system can be considered as components net with each other interactions.

3. ABSTRACTION ON PHYSICAL CONCEPTS PHASE

Since decomposition of the system into components is ended, the second modeling level begins. Here, to the each component is associated corresponding physical concept which describes it's behavior. The process is not unique and it depends from what is the model aim, that is, it depends from what which physical mechanism going to be associated to component (friction, leakage, stiffness, etc.). Because, this modeling step is the most critical in the all modeling process. The process is very creative and not easy for automation.

For concept qualitative description on this level we use

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