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CONCEPTUAL DESIGN APPROACH FOR MECHATRONIC SYSTEMS CONTROLLED BY A PROGRAMMABLE LOGIC CONTROLLER (PLC)

J Bathelt, A Jönsson, C Bacs, A M Kunz and M Meier

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Proposed development process

The overall layout for the proposed interdisciplinary design process is shown in Figure 1.

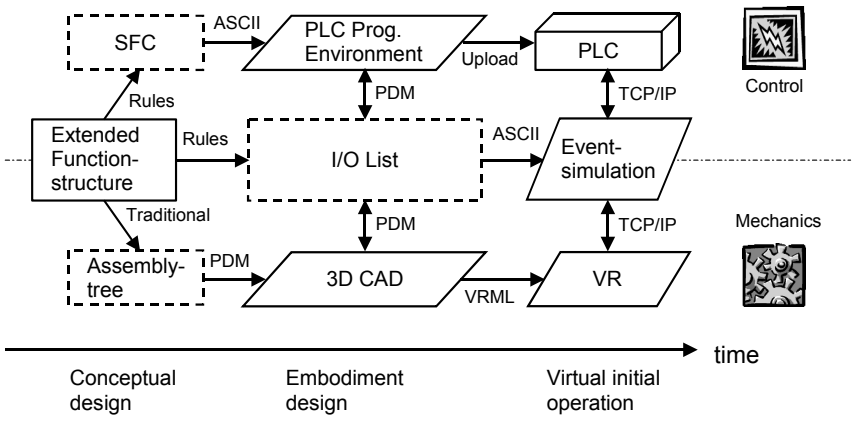

Figure 1. Proposed development process.

Today, it is common to formulate a rough assembly tree inside a PDM system. The assembly tree is then used to initiate a concurrent workflow for the embodiment of CAD geometry.

A similar mechanism exists for the development of PLC code. The graphical programming language SFC (Sequential Function Chart) is intended to initiate the programming of the PLC [1]. SFC is one out of five standardised programming languages specified in IEC1131-3. It can be mixed or translated to the other languages during the coding phase.

In this work a new *extended function structure* is presented in order to be able to derive the assembly tree, SFC and the I/O list as shown in [1]. The I/O list is a flat list containing a description of all sensors (inputs) and actuators (outputs). Since the actuators and sensors are located on the electromechanical borderline (Figure 1), this widespread used list is helpful when establishing a bridge between mechanics and control.

The bi-directional connection between the PLC and the geometry generated using CAD, visualised in a virtual reality environment, allows the virtual initial operation (Figure 1).

The extended function structure

The function structure is widely accepted as a bridge between analysis and synthesis. It is describing the overall functional behaviour supported by the concepts of hierarchy and sequence. Three flows: material, energy and signal can be assigned to the sequence in order to specify the in- and outputs of the functions. In this work a fourth flow: *logic* is introduced in order to differ between signals transmitted via wires and the control logic inside of a PLC.

The use of a PLC controlling the mechatronic system implies sequential behaviour including time-delayed steps and (transition) conditions before the next step may occur. As shown in [1] and in the example in this work, this PLC related information is already available when building the function structure.

The look and feel of the proposed extended function structure is a mix of existent solutions and SFC. For instance the hierarchy is symbolised by drawing sub functions inside of their main functions as in SFC, FAST (Function Analysis System Technique) or SADT (Structured Analysis and Design Technique). Transition conditions could be drawn as a function in a box. Since they often imply a sensor, they are drawn as a border, which has to been passed after the condition is fulfilled like in SFC or Petri nets. The following list is summarising the extension of the function structure:

- Transition conditions
- Time aspect
- Logic flow

The usage and appearance of the extended function structure is illustrated in this work by an example.

References

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Jens Bathelt, Christian Bacs, Andreas M Kunz, Prof. Dr. Markus Meier
Federal Institute of Technology, Institute of Mechanics, CH-8092 Zurich, Switzerland
Tel: +41 1 632 35 15, Fax: +41 1 632 11 81, E-mail: bathelt@imes.mavt.ethz.ch
URL: http://www.zpeportal.ethz.ch

Anders Jönsson
Blekinge Institute of Technology, Department of Mechanical Engineering, SE-371 79 Karlskrona, Sweden
Tel: +46 455 38 55 12, Fax: +46 455 38 55 07, E-mail: anders.jonsson@bth.se
URL: http://www.bth.se/ima