Pump example specification

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Contents

1. Introduction

This PDF is automatically generated based on an ESL specification of a pumping system.

2. System specification decomposition level 1

This chapters describes the system of interest at the first decomposition level. That is, it describes 2 components which play a role within the environment in which the system of interest must operate and the (functional) interactions between those components. In Figure 2.1 the associated design-structure-matrix (DSM) is shown. The DSM shows the dependencies between the elements that are relevant to this decomposition level.
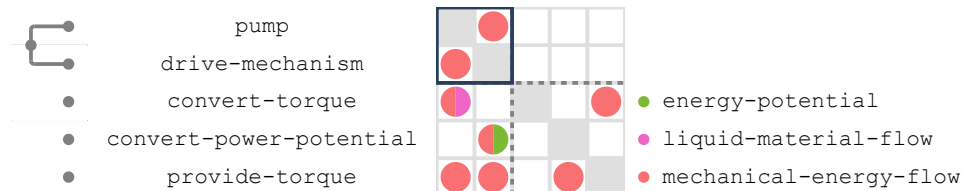
Figure 2.1.: component – function spec dependency matrix of decomposition level 1.

2.1. Drive-mechanism

This section describes **drive-mechanism**.

The following properties are specified for drive-mechanism:

- drive-length

2.1.1. Goal function requirements

provide-torque

Drive-mechanism must provide torque to pump.

2.1.2. Transformation function requirements

drive-mechanism → convert-power-potential

Drive-mechanism must convert power-potential into torque.

Subordinate function specifications

drive-mechanism → convert-power-potential

drive-mechanism → provide-power drive-mechanism → motor → convert-power drive-mechanism → power-source → convert-potential

2.1.3. Quantitative design constraints

dc-drive-length

Drive-length must be equal to pump-length .

2.1.4. Qualitative design requirements

IP68

Drive-mechanism must be IP68 compliant.

2.1.5. External models

drive-mechanism → power-source → efficiency-model

model definition name

Battery-efficiency-model

related variables

drive-mechanism → power-potential
drive-mechanism → power

2.1.6. Sub-components

Drive-mechanism is composed of the following sub-components:

- motor
- power-Switch
- power-source

2.2. Pump

This section describes **pump**. Can be sourced by manufacturer XYZ. Part number CFG.PMP.0.1

The following properties are specified for pump:

- pump-length

2.2.1. Transformation function requirements

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pump → convert-torque

Pump must convert torque into water-flow.

2.2.2. Quantitative design requirements

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min-water-flow

Water-flow must be at least 1.0 [L/s].

2.2.3. Quantitative design constraints

---

dc-drive-length

Drive-length must be equal to pump-length .

---

3. System specification decomposition level 2

This chapters describes the system of interest at decomposition level 2 and introduces 3 additional components. In Figure 3.1 the associated design-structure-matrix (DSM) is shown. The DSM shows the dependencies between the elements that are relevant to this decomposition level.
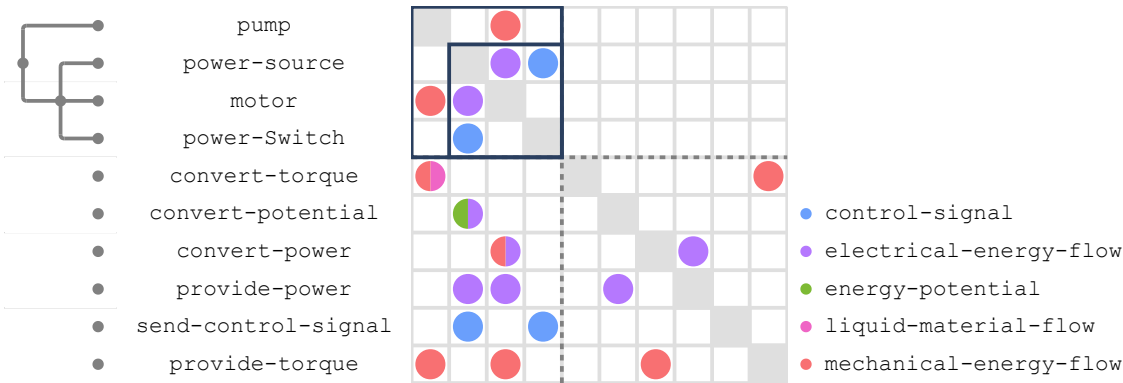

Figure 3.1.: component – function spec dependency matrix of decomposition level 2.

3.1. Power-source

This section describes **power-source**. This component is a sub-component of *drive-mechanism*.

3.1.1. Goal function requirements

drive-mechanism → provide-power

Power-source must provide power to motor.

3.1.2. Transformation function constraints

drive-mechanism → power-source → convert-potential

Power-source does convert power-potential into power.

3.1.3. Behavior requirements

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drive-mechanism → toggle-power

Case *on*:
when:

- motor-control-signal is equal to True [-] then:

- power must be at least 300 [W] Case *default*:

when no other case applies, then:

- power must be equal to 0 [W]

3.1.4. External models

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drive-mechanism → power-source → efficiency-model

---

model definition name

Battery-efficiency-model

related variables

drive-mechanism → power-potential
drive-mechanism → power

3.2. Motor

This section describes **motor**. This component is a sub-component of *drive-mechanism*.

3.2.1. Goal function requirements

---

provide-torque

Motor must provide torque to pump.

Clarification

This goal function requirement automatically migrated from *drive-mechanism*.

3.2.2. Transformation function requirements

---

drive-mechanism → motor → convert-power

Motor must convert power into torque, with subclauses:

- conversion must be at least 0.8

3.2.3. External models

---

drive-mechanism → power-source → efficiency-model

---

model definition name

Battery-efficiency-model

related variables

drive-mechanism → power-potential
drive-mechanism → power

3.3. Power-Switch

This section describes **power-Switch**. This component is a sub-component of *drive-mechanism*.

3.3.1. Goal function requirements

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drive-mechanism → send-control-signal

Power-Switch must send motor-control-signal to power-source.

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4. Conclusion

For more information on system specification and architecture modelling. Please contact Ratio Computer Aided Systems Engineering B.V.

Appendices

A. List of variables

A.1. Definitions

Variable	Type	Domain	Units	Clarification
drive-length	Spatial-measure	0.0 [m] $\leq$ x		
drive-mechanism → motor → conversion	Efficiency	0.0 $\leq$ x$\leq$ 1.0		
drive-mechanism → motor-control-signal	Control-signal			
drive-mechanism → power	Electrical-energy-flow		W	
drive-mechanism → power-potential	Energy-potential		Wh	
pump-length	Spatial-measure	0.0 [m] $\leq$ x		
torque	Mechanical-energy-flow		Nm	Comments on variable t
water-flow	Liquid-material-flow		L/s	