

Development of complex Mechatronic Systems - Computer aided Conceptual Design

ICCME 09 Salzburg, May 26-26 2009

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Agenda

- Motivation
- Approach
- Summary and Outlook

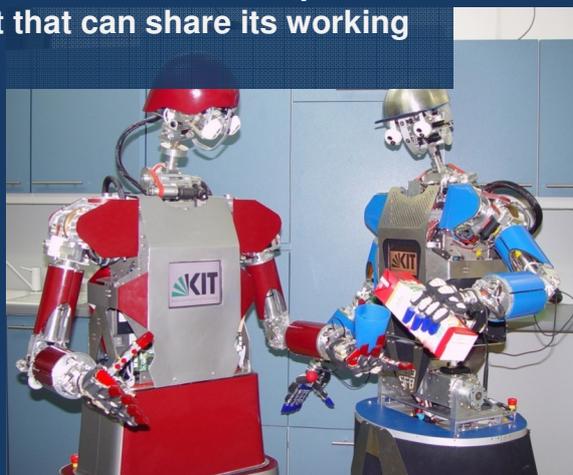
agenda

- motivation
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- summary and outlook

SFB588 – Humanoid Robots in Karlsruhe

- Objective of SFB588: Development of concepts, methods and concrete mechatronic components for a humanoid robot that can share its working space with humans

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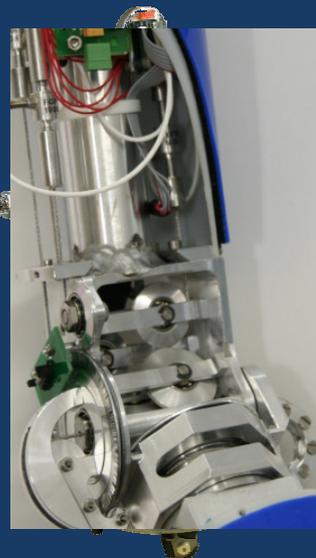
SFB588 – Humanoid Robots

- Objective of SFB588: Concepts, methods and mechatronic components for a humanoid robot that shares its working space with humans

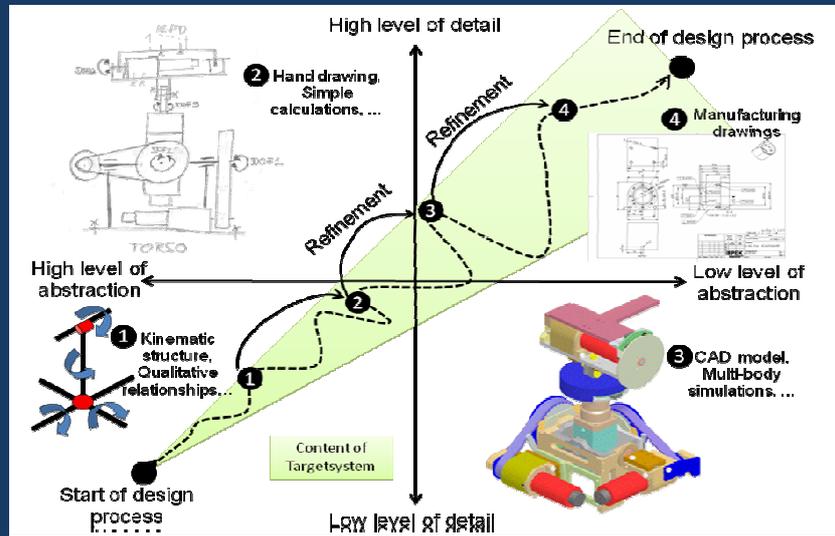


Example

- Development of ARMAR IV-V
- no evolution but revolution (e.g. elbow)
- Application of approved components
- Multidomain development
→ high complexity
- How do we determine an “optimal” configuration?
- Additional Challenge:
→ fast determination of new optimal configurations after changed boundary conditions



Motivation: Typical Development-Process

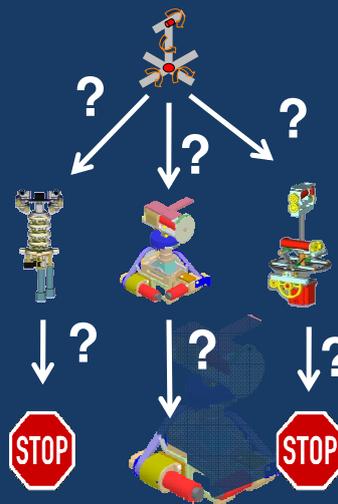


Motivation 2: Many possible Solutions

Development processes often include divergencies and iterations (fluctuating BCs)

Aims:

- (semi-) automatic configuration and weighting of (sub-) systems
- computer-aided optimization of generated configurations

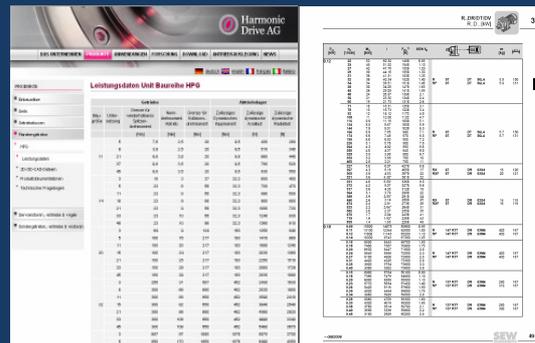


Motivation 3: Find suitable Components

Challenge:

- big number of catalogues with diverse structures
- selection of suitable and foremost compatible components difficult
 - diversity of solution hard to oversee
 - Which one is the “optimal” configuration?

The Idea:
 Computer-aided finding components and generation of suitable and compatible subsystems.



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State of Technology


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Types:
 Power rating (W):
 Ø (mm):
 max. length (mm):
 Nominal torque up to (Nm):

10 Results per page Results: 1 to 10 of 1230 hits 1/123

Order No.	Program	Max. Ø (mm) ±	P [W] ±	U _n [V] ±	n ₀ [min ⁻¹] ±	M _n [Nm] ±	Downloads	Combine with	Price EUR 1 pcs	Quantity
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200939	A-max: 12 Ø12 mm, Precious Metal Brushes CLL, 0.5 Watt, CE approved	12	0.5	3	13700	0.866			31.27	<input type="text" value="1"/>
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Stock program
 Standard program
 Special program

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Conceptional Verification


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- Are there any existing configurations for subsystems, with which the requirements can be fulfilled?
- Are there configurations of subsystems, that are compatible to each other?
- **precondition:**
All component parameters must be stored in a proper classification.

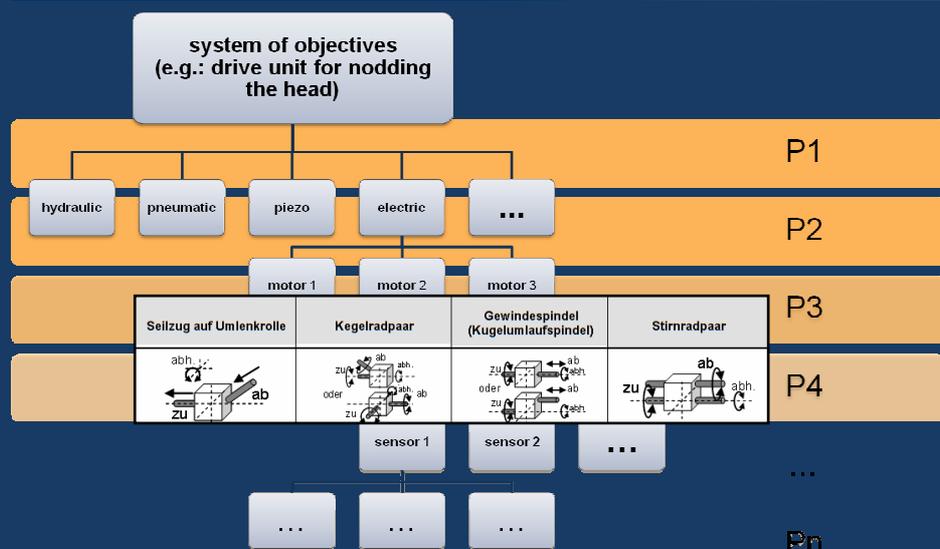
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Approach

Two-stage method:

- **phase 1 – configuration phase**
computer-aided **selection of suitable configurations** (not only components!) using standardized component libraries
- **phase 2 – optimization phase**
computer-aided **determination of free parameters** (search of optimal configuration, placement of configurations within design space, ...)

Phase 1: Configuration



configuration phase – library

■ precondition :

All component parameters must be stored in a proper classification: Excel-Sheet → XML

manufacturer	product id	torque	efficiency factor	dimension x	dimension y	dimension z	diameter	voltage
SEW	S/00102	10	0.91	45	90	177	4	24
SEW	S/00103	15	0.91	35	85	185	6	12
SEW	S/00104	20	0.89	34	93	105	6	12
SEW	S/00105	25	0.90	33	81	100	11	12
SEW	S/00106	30	0.85	31	99	193	12	24
SEW	S/00107	35	0.92	31	100	184	5	12
SEW	S/00108	40	0.93	35	84	106	6	12
Maxon	m-33541	35	0.82	31	85	178	10	24
Maxon	m-33542	20	0.86	45	88	137	8	12
Maxon	m-33543	15	0.85	32	100	150	2	12
Maxon	m-33544	10	0.87	38	94	181	10	24
Faulhaber	F14235	20	0.83	30	86	194	4	12
Faulhaber	F14236	23	0.79	32	94	137	9	12
Faulhaber	F14237	27	0.81	42	99	192	5	12
Faulhaber	F14238	32	0.81	31	95	175	7	12
Parker	512p	15	0.81	40	100	187	7	12
Parker	513p	12	0.76	43	87	196	5	12

Configuration Phase – Library

■ Precondition :

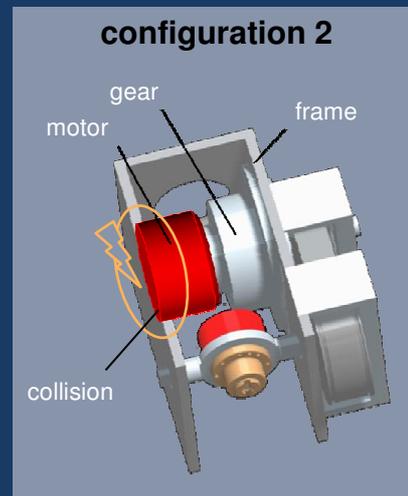
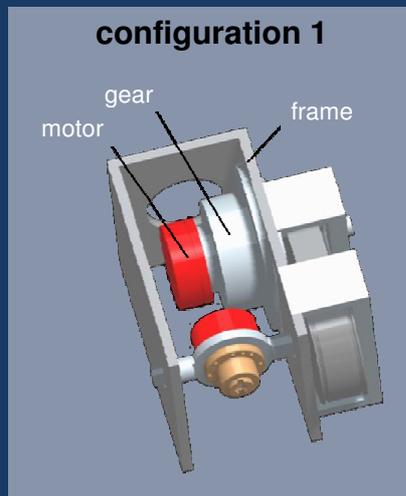
All component parameters must be stored in a proper classification: Excel-Sheet → XML

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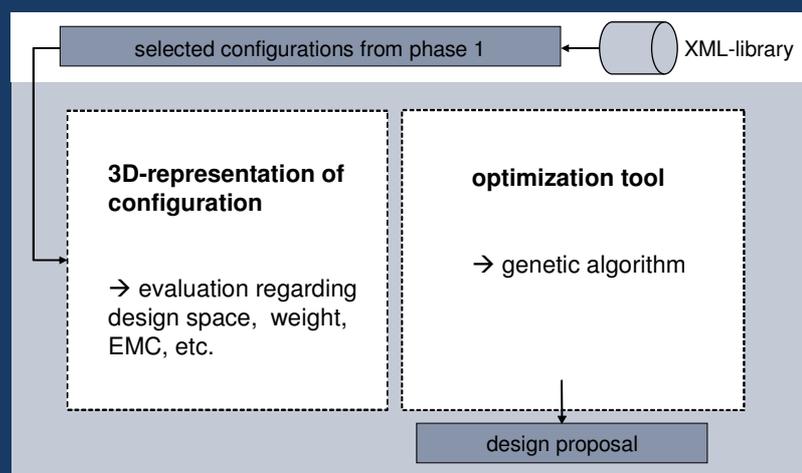
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  < parameter >
    <label> voltage [V]</label>
    <value> 24 </value>
  </ parameter >
  ...
</root>

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Example: Elbow Joint



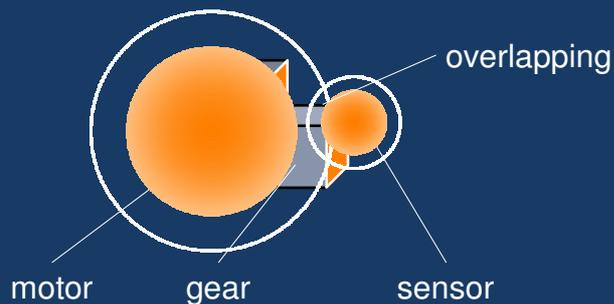
Phase 2: Optimization



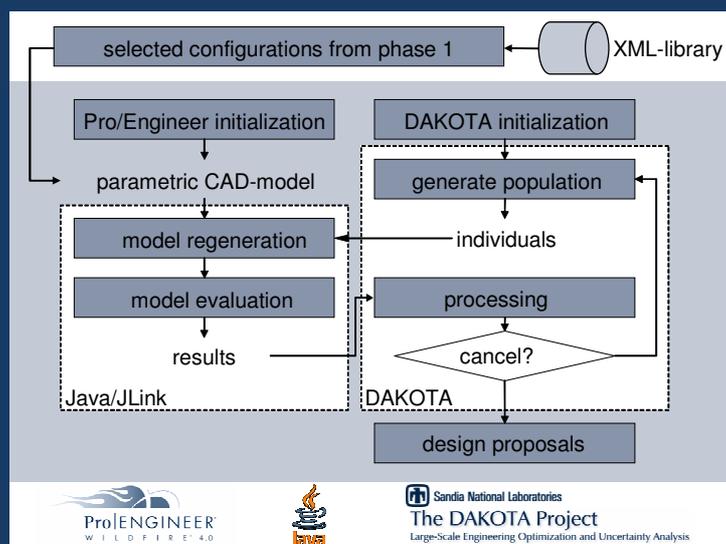
configuration phase / optimization phase

■ example: electromagnetic compatibility

- based on CAD-models including information regarding mechanical interfaces
- automatic checking of diverse constraints
 - evaluation of configurations resp. concept



Implementation



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Summary and Outlook

- **Summary:**
 - Support configuration process using computer-aided methods
 - Reduce risk to forget possible solutions
 - Make sure to find optimal configurations
 - - Implementation still under progress!
- **Outlook:**
 - Integration of other software tools like Matlab/Simulink:
 - simulation and evaluation of dynamic behavior of entire system
 - exchange of CAD-Data between ProE Simulink via XML
 - Implementation as a completely automated process
 - Refeeding of already know solutions - integration in PDM-System

Thank you for your attention