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Seminar

**Advanced Design Theories and Technology for  
Complex Systems (3):  
Similarity Theory and Design Methodology for Complex  
Engineering Systems**

- 1. Similarity Theory: Foundations**  
September 21, 2012, 9.30 am
- 2. Similarity Theory: Applications in Design**  
September 24, 2012, 3,00pm
- 3. Design Theory and Methodology Engineering Complex Systems**  
September 26, 2012, 7.20 pm
- 4. Design Languages for Engineering Complex Systems**  
October 10, 2012, 7.20 pm

**Lecturer**

Priv.-Doz. Dr.-Ing. Stephan Rudolph University of Stuttgart, Germany

**Sponsor**

International Collaboration Innovation Team Project of Tsinghua University  
(重点学科高水平国际合作创新团队支持项目)

**Organizer**

Institute of Design Engineering  
Tsinghua University  
<http://adcp2012.com>

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## Introduction to the lecturer



**Priv.-Doz. Dr.-Ing. Stephan Rudolph**

**University of Stuttgart**

Privatdozent

Similarity Mechanics Group Head

Institute for Statics and Dynamics of Aerospace Structures, University of Stuttgart

Stephan Rudolph graduated in 1990 with a German Diploma of Aerospace Engineering from the University of Stuttgart, including studies and thesis work abroad at a French Aerospace Grande Ecole (ENSICA) in Toulouse, France, as well as at the Massachusetts Institute of Technology (MIT) in Cambridge, USA. After obtaining his PhD from Stuttgart University in 1995 on Design Evaluation he was a PostDoc in the Systems and Design Group at the Massachusetts Institute of Technology (MIT). German Habilitation in the area of Design Methodology at the Faculty of Aerospace Engineering and Geodesy in 2001. The publication record consists of more than 100 entries (conference and journal papers and book chapters).

Stephan's research interests include the search for a unified theory of design and design methods, applications of similarity theory to design synthesis and analysis and design evaluation methods as well as development of graph-based design languages for the computer-assisted exploration of design in the context of engineering complex and multi-disciplinary systems such as satellites, cars and aircrafts. Stephan heads currently a group of 8 PhD students and teaches courses on programming, algorithms and data structures, including topics from artificial intelligence such as knowledge representation and knowledge processing and applications of these methods to digital engineering.

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## Selected Publications

- [1] Kröplin, B. and Rudolph, S.:  
Entwurfsgrammatiken – Ein Paradigmenwechsel?.  
Der Prüferingenieur, 26, 34–43, 2005.
- [2] Schaefer J. and Rudolph S.: Satellite Design by Design Grammars.  
Aerospace Science and Technology (AST), 9, 81–91, 2005.
- [3] Rudolph, S. and Bölling, M.: Constraint-based conceptual design and automated  
sensitivity analysis for airship concept studies.  
Aerospace Science and Technology (AST), 8, 333–345, 2004.
- [4] Rudolph, S.: Übertragung von Ähnlichkeitsbegriffen.  
Habilitationsschrift, Fakultät Luft- und Raumfahrttechnik und Geodäsie,  
Universität Stuttgart, 2002.
- [5] Rudolph, S.: Eine Methodik zur systematischen Bewertung von Konstruktionen.  
VDI Fortschrittsberichte Reihe 1, Nummer 251, VDI-Verlag, Düsseldorf,  
zugl. Dissertation, Universität Stuttgart, 1995.



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## Program

### Lecture 1: **Similarity Theory (Part 1) Foundations.**

September 21, Friday, 2012, 9.30-12.00 am (including discussion and break)

Meeting room 4304, Precision Instrument & Mechanology Department,

### Lecture 2: **Similarity Theory (Part 2): Application in Design.**

September 24, Monday, 2012, 3.00-5.00 pm (including discussion and break)

Meeting room 4304, Precision Instrument & Mechanology Department,

### Lecture 3: **Design Theory and Methodology for Engineering Complex Systems**

September 26, Wednesday, 2012, 7.20-21.55 pm (including discussion and break)

Teaching building 6B106

### Lecture 4: **4. Design Languages for Engineering Complex Systems**

October 10, Wednesday, 2012, 7.20-21.55 pm (including discussion and break)

Teaching building 6B106



## References

### Lecture 1 and 2:

Rudolph, S.: Mathematical Foundations of Non-Classical Extensions of Similarity Theory. In: Borodich, F.M. (ed.): IUTAM Symposium on Scaling in Solid Mechanics, Proceedings of the IUTAM Symposium, Cardiff, UK, June 25-29, 2007. Springer, New York, 2009.

Rudolph, S.: On the Context of Dimensional Analysis in Artificial Intelligence. Proceedings of International Workshop on Similarity Methods, University of Stuttgart, Germany, November 26-27, 147-161, 1998.

Rudolph, S.: On Topology, Size and Generalization of Non-linear Feed-Forward Neural Networks, in: Neurocomputing, 16, 1 (July 1997), 1-22.

Rudolph, S.: On A Genetic Algorithm for the Selection of Optimally Generalizing Neural Network Topologies, Proceedings of the 2nd International Conference on Adaptive Computing in Engineering Design and Control'96, I.C.Parmee (ed.), University of Plymouth, March 26th-28, Plymouth, United Kingdom, 79-86, 1996.

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### Lecture 3 and 4 :

Rudolph, S.: On A Mathematical Foundation of Axiomatic Design, Proceedings of the 8th ASME Design Theory and Methodology Conference in Irvine, California, August 18-22, 1996, 1-8.

Rudolph, S.: Upper and Lower Limits for “The Principles of Design”, Research in Engineering Design (1996) 8: 207-216.

Rudolph, S.: A Semantic Validation Scheme for Graph-Based Engineering Design Grammars. In: Gero, John (ed): Proceedings Design Computing and Cognition (DCC'06), Springer, Dordrecht, 541–560, 2006.

Rudolph, S.: Know-How Reuse in the Conceptual Design Phase of Complex Engineering Products – Or: ‘Are you still constructing manually or do you already generate automatically’? In: Tichkiewitch, S., Tollenaere, M. and Ray, P. (Eds): Proceedings Conference on Integrated Design and Manufacture in Mechanical Engineering 2006 (IDMME 2006), Grenoble, France, May 17-19, 2006.

Rudolph, S.: On design process modelling aspects in complex systems. 13th NASA-ESA Workshop on Product Data Exchange (PDE 2011), May 11–12, Cypress, California, USA.

Rudolph, S., Fuhr, J.-P. and Beilstein, L.: A validation method using design languages for weight approximation formulae in the early aircraft design phase. EUCOMAS 2010 Conference, Berlin, June 7–8, 2010.

Arnold, P. and Rudolph, S.: “Bridging the gap between product design and product manufacturing by means of graph-based design languages.” TMCE 2012, Karlsruhe, Germany, May 7-11, 2012.

Groß, J. and Rudolph, S.: “Generating SimulationModels from UML – A FireSat Example.” 2nd Workshop on Model-driven Approaches for Simulation Engineering (Mod4Sim 2012), Orlando, FL, USA, March 26-29, 2012.

Groß, J. and Rudolph, S.: “Dependency Analysis in Complex System Design using the FireSat example.” INCOSE International Symposium 2012 (IS 2012), Rome, Italy, July 9-12, 2012.

Gross, J., Reichwein, A., Rudolph, S., Bock, D. and Laufer, R.: An Executable Unified Product Model Based on UML to Support Satellite Design. AIAA SPACE 2009 Conference and Exposition, Paper AIAA 2009-6642, September 14–17, 2009, Pasadena, California.

Böhnke, D., Reichwein A. and Rudolph, S.: Design Language for Airplane Geometries using the Unified Modeling Language. ASME Proceedings of Design Engineering Technical Conferences, San Diego, CA, August 30 - September 2, 2009.