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### **TIDYING UP DESIGN METHODS – AN APPROACH USING ELEMENTARY DESIGN METHODS**

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This contribution presents an innovative approach to defining elementary design methods to “tidy up” the obscure body of prescriptive procedures for design work. The key concept to overcome this was the analogy to the system of chemical elements. Adapting this concept to design methods it reduces them to elementary ones, which cannot be divided further semantically. These elementary methods are traced back to elements like objects, functions or properties linked with operations like assign, merge or connect. Analysing about 100 design methods only 8 elements and 5 operations were found. First tests demonstrate fascinating perspectives for a convincing structuring of design methods and for improved performance in teaching and learning.

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### **THE ISSUES AND BENEFITS OF AN INTELLIGENT DESIGN OBSERVATORY**

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In order to support today’s digital, knowledge-driven and highly distributed design activities there is a fundamental requirement to improve the means by which design researchers observe industry practice, evaluate tools and methods, and assesses the state-of-the-art. A prerequisite for this is the ability to undertake more holistic investigation, perform controlled experiments, and capture, analyse and organise experimental data. To begin to address these issues the creation of an intelligent design observatory is proposed and the issues associated with designing the environment, monitoring and recording design activities, data processing and analysis, observation and measurement, and an appropriate experimental methodology are discussed.

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### **HOW TO DERIVE APPLICATION-SPECIFIC DESIGN METHODOLOGIES**

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Engineering Design Theory and Methodology is often criticised as being too general, too broad, too rigid/inflexible, too time-consuming for industrial practice. Not all of the criticism is justified, but the basic message must be taken serious. The aim of this paper is to introduce a novel approach of how to transform a “general” Design Theory and Methodology into an application-specific methodology for a particular branch of industry or even company. Base is the author’s general approach of Characteristics-Properties Modelling (CPM) and Property-Driven Development (PDD). The concept is then illustrated by a small example and conclusions are drawn.

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### **METHODICAL DESIGN 1972 – INTEGRAL DESIGN METHODOLOGY 2007: MORPHOLOGIC REFLECTION**

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To support multidisciplinary building design an Integral Design method is developed by combining a prescriptive approach, Methodical Design, with a descriptive approach, Reflective practice. The use of Integral Design within the design process results in transparency of the design steps and the design decisions. Within the design process, the prescriptive methodology of Integral Design is used as a framework for reflection on the design process itself. To ensure good information exchange between different disciplines during the conceptual phase of design a functional structuring technique can be used for reflecting: Morphological Overviews, to give an overview of the functions and aspects considered and their alternative solutions.

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### **A MODEL OF CK DESIGN THEORY BASED ON TERM LOGIC: A FORMAL CK BACKGROUND FOR A CLASS OF DESIGN ASSISTANTS**

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The paper addresses concept-knowledge (C-K) design theory. C-K theory explains design as the interaction between available knowledge (K space) and concepts (C space - propositions that are neither true, nor false in K space). We give a model of K space based on a term logic, NAL, and we describe how to interpret the key notions of C-K theory within the framework of NAL. It is then discussed how NAL can be used to capture fundamental notions of C-K theory. Some related issues including design assistants based on C-K theory are discussed.

### **USING PARAMETAR ANALYSIS FOR INCORPORATING DESIGN PRINCIPLES DURING CONCEPTUAL DESIGN**

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Design principles capture the essence of design knowledge. They can aid in synthesizing and evaluating design concepts. Opportunities to incorporate the principles often go unattended, due to the absence of methodologies for the systematic application of the principles. This paper presents parameter analysis as a tool to create configurations incorporating design principles in general, and the principle of direct and short load transmission path in particular. It places a magnifying glass over a portion of the conceptual design process of a running tool for offshore oil field drilling application. The methodology presented in the paper will enable expert and novice designers to effectively incorporate design principles in their designs.

### **INTEGRAL BUILDING DESIGN WORKSHOPS; COMPARING STUDENTS AND PROFESSIONALS**

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Following the developments in (Dutch) building practice, where besides specialist skills a integral design approach is increasingly being asked, the Building Services chair of the Faculty of Architecture, Building and Planning of Technische Universiteit Eindhoven (TU/e) initiated a multidisciplinary masters project 'Integral Design'. As basis for this project served a learning-by-doing workshop approach, developed and tested with/on experienced practitioners from the Royal Institute of Dutch Architects (BNA) and the Dutch Association of Consulting Engineers (ONRI). In this paper the results of the first two multidisciplinary masters project editions are discussed. A comparison with BNA-ONRI workshops for practitioners is made.

### **PHYSICAL NATURE OF TECHNICAL SYSTEMS**

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The article presents a systematic approach to synthesis of a conceptual technical system (TS). The starting point for creating the structure of conceptual TS are physical laws, which are required to fulfil the desired function. In order to enable connections between individual physical laws and TS structure, basic schemata (BS) are introduced. Basic schemata consist of geometrical elements and physical quantities. They represent the necessary structure for realization of the complementary physical laws. BS are applied for embodiment of the parts and they enable their assembly into complex TS. Connections between BS reveal physical nature of TS.

### **THEORY OF TECHNICAL SYSTEMS AND ENGINEERING DESIGN SCIENCE - LEGACY OF VLADIMIR HUBKA**

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The personal and professional history of Vladimir Hubka is outlined. The scope of science leads to typical research methods for design, and the triad 'theory – subject – method' connects a scientific or informal theory to a recommended method. Hubka initiated a body of formal scientific theory about technical systems, transformation processes, and engineering design processes. As a typical example, the development over time of the model of a transformation system is traced. The role of information is outlined, dividing it into object information and design process information, each with its theory and its applicable methods and heuristics. Engineering design science is placed into a hierarchy of sciences, the only developed design science.