INTERNATIONAL DESIGN CONFERENCE - DESIGN 2006
Dubrovnik - Croatia, May 15 - 18, 2006.

DESIGN 2006

AN INTEGRATED INFORMATION AND TYPE SHEET SYSTEM FOR RAIL VEHICLES

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Keywords: design engineering, engineering design, information, evaluation, type sheets, competitiveness, rail vehicles

1. Introduction

The need for information about comparable technical products and the evaluation of their competitiveness is as old as the competitive market. The respective information and evaluation differ according to their aims. If a company aims to address and attract potential direct users/customers to its product, this information and evaluation is focused mostly on attractive product properties concerning e.g. functions, price, safety, operational cost, delivery time, etc. Demands on the systematic arrangement of these criteria are not high due to their prevailing low number – their attractiveness/importance for the addressed direct user is a simple driver for solving this task. Demands on the objectivity of comparison and evaluation according to these criteria are mostly "political", i.e. to stress first of all the advantages of the company's product, and not obviously "under evaluate" other competitive products – otherwise loss of customer trust would result.
The users of the more neutral information about comparable technical products available on the market and evaluation of their competitiveness, called e.g. benchmarking, are also mostly their potential direct customers. Thus the scope of monitored properties is not significantly increased, and only demands on the objectivity of their evaluation become higher. Consequently demands on the arrangement of the criteria remain relatively low, and the general importance of the involved user properties is mostly also the main driver for their order. In addition the stress is put mostly on the final statement about the (relative) competitiveness of the respective compared products.

2. Product information and evaluation for engineering designers

An engineering designer needs a substantially more comprehensive information and evaluation tool. He or she needs to know, evaluate and mutually compare values of a large number of different property characteristics of both the company's previously designed and competitive products. These characteristics concern not only their future direct customers but also more 'soon' and more 'remote' customers. The first group includes, for example, engineering designers who will elaborate and detail the proposed constructional structure of the designed product, those who will perform its technological and organizational preparation of production, who will produce, assemble, test, pack, store, distribute, sell, install the designed product, and so on. Among the more remote customers belong, for example, those who will maintain, repair, disassemble, recycle and dispose of it, and even, in general, more or less all society, nature and space, which will be affected by all the necessary inputs and outputs during the life cycle of the designed product. The problem is that most of these properties are not explicitly stated in contracts or regulations, but are often generally implied as 'obvious' [ISO 9000:2000]. However, an engineering designer must be aware of this because all properties influence, in general,

the future competitiveness of the designed product. However, these depend significantly on its constructional structure, for which engineering designers are responsible.
From this follows that an engineering designer needs also to know and compare by which values of "inner" property characteristics, (for example by which values of characteristics of technological principle, functional principle, TS structures, forms, dimensions, materials, tolerances, however also strengths, stiffness, wear resistance and so on) the above values of "outer" property characteristics have been achieved.

3. Theoretical background

There are a large number of characteristics describing the above properties of technical products. In the past it was believed that there were an infinite number of them, and that they had nothing in common with different products. In any case it is not simple to find a comprehensive and at the same time concise, transparent and simple system to capture the whole complexity, diversity and variety of characteristics which define the respective properties of technical products. We have decided to solve this problem for the task stated in the title of this paper using the theory of life cycle properties and quality of technical products [Hubka 1996, Hosnedl 2001 and 2004], which has been elaborated on the basis of the Theory of Technical Systems, which is a constituent of Engineering Design Science [Hubka 1996].
Our hypothesis was to derive classes of the so called external TS life cycle properties objectively using the model/'map' of TS life cycle phases and to add to them the three classes of so called internal TS properties axiomatically defined in [Hubka 1996]. The chosen method for the development of a theoretical model/'map' of TS life cycle using models from [8] and [22] is depicted in Fig. 1.

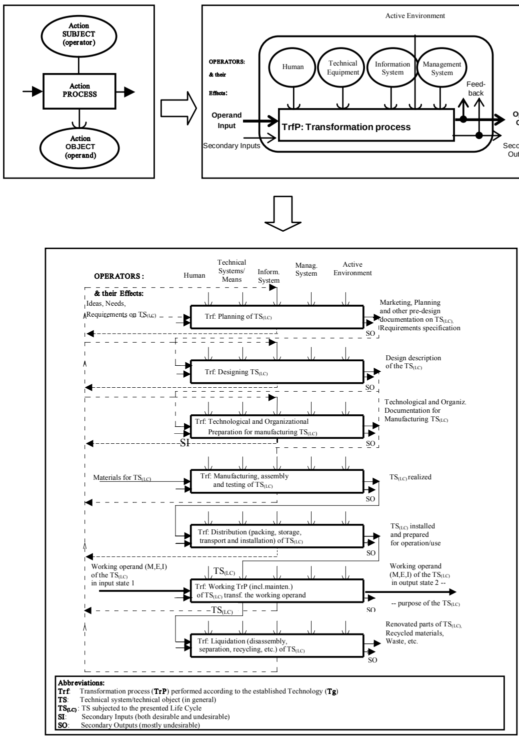

Figure 1. Model of TS Life Cycle (bottom) composed from the Models of Transformation Systems [Hubka 1996] (top right), paradigm of which creates a Model of Action [Eekels 2000] (top left)

The resulting system of classes of both external and internal TS properties/characteristics has the simple table form shown in Fig. 2. Considering both general and actual priorities of classes of the TS properties/characteristics (mostly the operational and safety related classes have the highest priorities - see Fig. 2) this system/‘map’ can effectively serve as a reference for the establishment of a systematic list of requirements on designed TS and for all other related design engineering tasks including the system arrangement of TS properties/characteristics for their recording and evaluation, which has been our task in this case.

DOMAIN OF EXTERNAL TS PROPERTIES & their CHARACTERISTICS
TS PROPERTIES RELATED TO TS LIFE CYCLE (LC) PHASES / PROCESSES Planning → Design Engineering →Tg&Org. Prep.of Production → Distribution → Operation (Usage.Process)→Liquidation *(numbers in the brackets show rough simplified general priorities of the respective property classes during design engineering)*
(3) Properties for Origination Phases: – constructional suitability for the planning, design engineering, technological and organisational preparation of manufact., manufacturing (incl. co-operations, purchasing, assembly and testing), etc.
(4) Properties for Distribution – constructional suitability for packaging, storage, transport, etc.
(1) Operational Function or (more generally) Effect Properties on the transformed operand – constructional suitability for required e.g. clamping, moving, heating, etc. (including their functional properties/parameters– constructional suitability for required power, speed, rpm, etc.)
(2) Other Operational Properties – constructional suitability for operational safety, space and energy needs, service life, reliability, etc.
(5) Properties for Liquidation – constructional suitability for disassembly, separation, recycling, etc.
TS PROPERTIES RELATED TO OPERATORS OF THE RESPECTIVE TS LC TRANSF. PROC. Humans & other Living Beings – Technical means (TS) –Environment – Information System – Management System Note that requirements on the following properties differ for the respective phases of the TS life cycle! *(numbers in the brackets show rough simplified general priorities of the respective property classes during design engineering)*
(2) Properties for Humans & other Living Beings in the respective TS LC phases: – constructional suitability for operator safety, ergonomics, agreeability to humans, including aesthetic appearance, low noise, etc.
(5) Properties for Technical Means (other TS) in the respective TS LC phases: – construct. Suitability for use of easily accessible TS, few demands on needed new technical means/TS, etc.
(3) Properties for Environmental Material and Energy in the respective TS LC phases: – constructional suitability for required ecology, i.e. society, nature and space, etc., compatibility
(4) Properties for Environmental Information in the respective TS LC phases: – constructional suitability for keeping laws, regulations, licences, patents, culture, customs, etc.
(6) Properties for Professional Information (Information System) in the respective TS LC phases: – constructional suitability for needs of easily accessible/provided professional information/ knowledge, etc.
(1) Properties for Object Management (Management System) in the respective TS LC phases: - constructional suitability for company’s product, production, human, technical, information/ knowledge, license, market, sales, service, etc. policy, constraints and identity
(7) Properties for Economic and Time Management (Management System) in the resp. TS LC ph.: – constructional suitability for required production, operational cost/price, effectiveness, etc., for keeping required deadlines (including delivery time), duration of processes/operations, etc.

DOMAIN OF INTERNAL TS DESIGN PROPERTIES & their CHARACTERISTICS *(numbers in the brackets show rough simplified general priorities of the respective property classes during design engineering)*
(1) Engineering Design Characteristics – TS technological principle, functional principle, crucial functions, features, etc.
(2) Elementary Engineering Design Properties – TS structure, and shapes, dimensions, materials, types of manufact., surface quality, tolerances, etc. of its elements
(3) General Engineering Design Properties – TS strength, stiffness, hardness, corrosion resist., etc.

Figure 2. System Classes of properties of a Tech. System (TS) derived from the life cycle of the TS: [Hubka 1988, Andreasen 2000, Pahl 1996, Breeing 1993, Cross 1991, Dieter 1991, Ehrlenspiel 1998, Hales 1993, Hundal 1997, Roozenburg 1995 aj. => Hosnedl 2004]

4. Application and implementation

The integrated Information and Type Sheet System for Regional Rail Vehicles (RRV), developed and implemented in MS Excel, currently covers 179 comparable characteristics (values for 81 can be retrieved in or derived according to [Regional]) for each of 49 variants of 20 RRV types of 10 leading European competitors of Czech producers. The 136 characteristics of external properties are split into 30 properties structured into 12 classes derived from transformation systems corresponding to 7 crucial processes of product life phases according to [Hosnedl 2004]. The 43 remaining characteristics of internal properties are split into 3 axiomatically defined classes [Hubka 1996].

The characteristics are arranged in matrix form, and entered into the first sheet of MS Excel. A section of this large matrix is depicted in Fig. 3. Illustrative comparative diagrams of values for crucial characteristics of variants of RRV are automatically displayed, as the example in Fig. 4 shows.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1			INFORMATION AND EVALUATION SYSTEM FOR REGIONAL RAILWAY VEHICLES																	
2			Type:		CORADIA LINT - 2 segments			CORADIA LINT - 3 segments			CORADIA LINT - 4 segments			INTEGRAL (5 segments)			DESIRO 5002 - 2 segments			DESIRO 5002 - 3 segments
3			Company:		ALSTOM			ALSTOM			ALSTOM			JENBACHEI			SIEMENS			SIEMENS
20				Weight (0 - 4)		Evaluation (0 - 4)	Weighted value		Evaluation (0 - 4)	Weighted value		Evaluation (0 - 4)	Weighted value		Evaluation (0 - 4)	Weighted value		Evaluation (0 - 4)	Weighted value	
21			EXTERNAL PROPERTIES																	
22			TS PROPERTIES RELATED TO TS LIFE CYCLE (LC) PHASES / PROCESSES																	
23			Planning→Design Engineering→Tg&Org. Prep.of Production →Production→Distribution→ Operation (Work.Process)→Liquidation																	
24			**(1) Operational Functions** *(including their functional properties/parameters) :*																	
25	1		LOADING CAPACITY Weight (0 - 4):	2																
26		1	Places for sitting - 2nd class		120			180			240			150			107			180
27		2	Places for sitting - 1nd class		8			12			16			14			0			12
28		3	Places for sitting - additional e.g. hinged		24			36			48			0			10			36
29		4	Places for sitting alltogether		152			228			304			164			117			228
30		5	Places for standing - 4 passengers/m^2		142			113			284			200			109			113
31		6	Max. number og passengers		294			341			588			364			226			341

RegVoz / GrPar / CorLint / Integral / ET22 / FLIRT

Figure 3. Section of the recorded characteristics on RRV

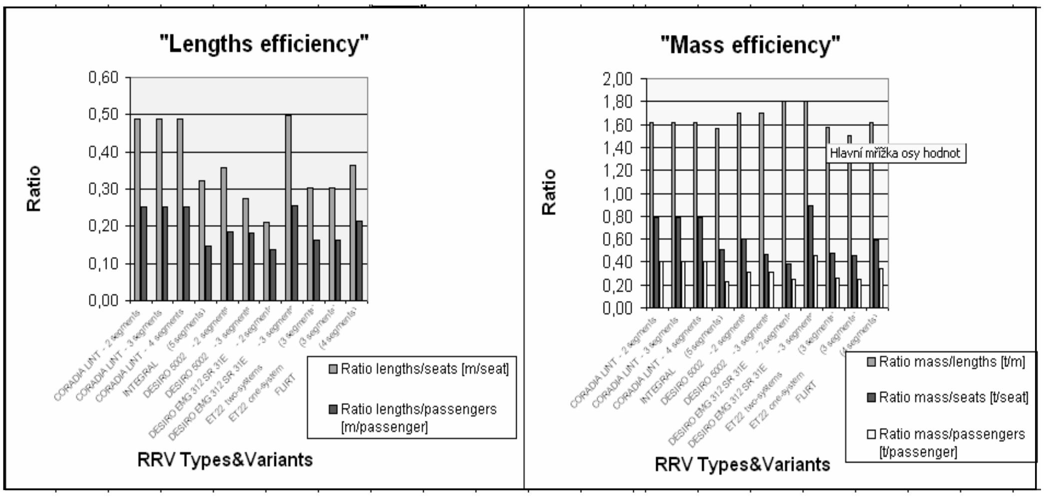

Figure 4. An example of comparative diagrams for the recorded RRV types and variants

The importance of each external property can be weighted (1-4) and the value (either numerical or verbal) of each characteristic classified (1-4). An overall weighted evaluation for each property and for crucial clusters of properties (e.g. for quality, cost, etc.) are automatically calculated. Illustrative comparative evaluation diagrams for crucial characteristics and of the total evaluation of respective variants of RRV are automatically displayed.

The structure of the first sheet together with relevant selected data is automatically transmitted to other MS Excel sheets belonging to the respective RRV types and their variants. Each of these additional sheets is only supplemented by a relevant conceptual scheme and a coloured photo of the respective RRV type. Consistent “RRV Type sheets” are automatically generated in this way. An example of the section of a Type sheet is depicted in Fig. 5

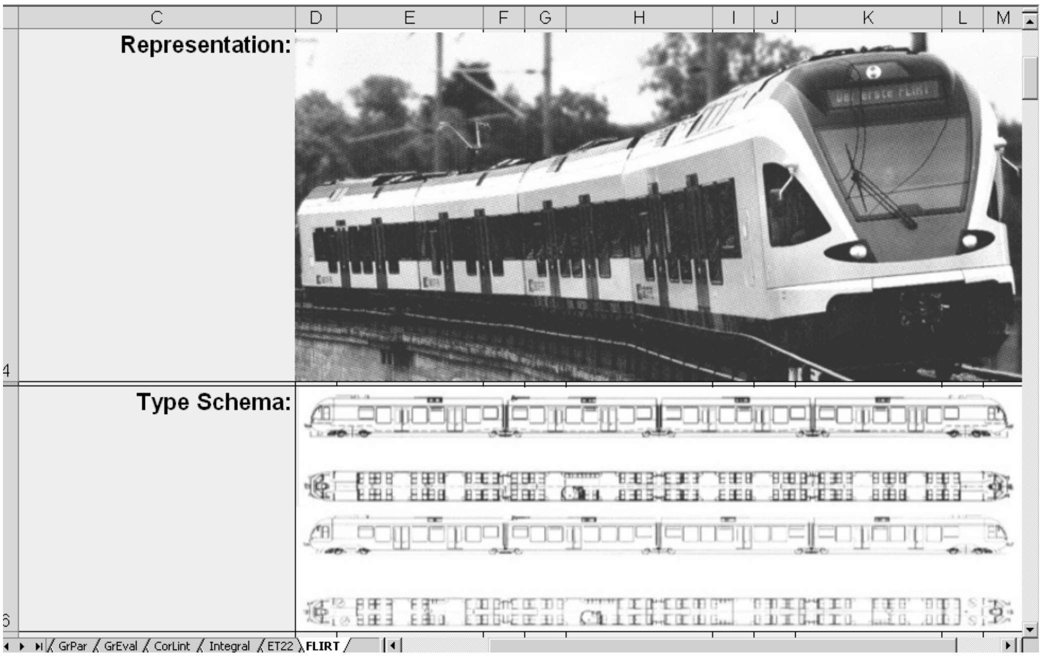

Figure 5. Section of the RRV Type sheet

5. Conclusion

A comprehensive Integrated Information and Type Sheet System for Regional Rail Vehicles RRV based on the theory of properties of technical products [Hubka 1996, Hosnedl 2001 and 2004] has been developed and implemented on MS Excel. The system enables user friendly modifications and systematic extensions both of the number of characteristics and RRV types. It enables easy conversion for any class and type of technical product. The next aim is to search especially for information which is not generally available, for example, accessible only at users, repair shops, and so on, to provide engineering designers and engineering designer managers with even more effective support for their demanding and responsible conceptual decisions.

Acknowledgement

This paper includes results of the project of the Research Centre of Rail Vehicles, ID 1M0519, No. 1M4977751302 at the University of West Bohemia in Pilsen subsidised by the Czech Ministry of Education.

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ISO 9000:2000, "Quality management systems

Regional Train Vehicles. Alstom, Bombardier, ČKD Vagonka, Jenbacher, Metrovagonmaš, Pars, Pesa, Siemens Stadler Vrutky and Stadler - Company Information Materials

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