Cultures in Information Systems Development

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Abstract. Modelling is an essential part of information systems development. Models are used for communication between interest groups and inside development teams. Models are also used for transferring baseline artefacts between development phases. Models are mainly developed by humans, which represent certain cultures - national, enterprise, professional, team, project etc. Because of that we claim that models, as well as many other information systems related artefacts are culture dependent. The models are born in certain context and these must be also interpreted by taking the original context into account. In our earlier studies we have analysed the effect of culture in information systems development: culture related aspects in general level, in information search and interaction and in web information systems. We focus now on modelling. Because of that we shortly answer to the question "How cultures differ from each other". This reviews and synthesis generally accepted frameworks for cultural analysis. In addition we shortly open the results of our earlier studies. Because modelling is a human activity, as well as information systems are used by humans, we integrate the use context into information systems development. The findings of culture analysis are transferred to modelling practices via our framework that defines model as an instrument transferring elements of its development context to the models - we discuss the roles of normal models, deep models and modelling matrix. Finally we will concentrate on the problems of cross-cultural modelling using selected national cultures as an example.

Keywords. culture-dependence of modelling; deep model, modelling matrix; multi-cultural system development;

1. Cultural Differences

1.1. The Layered and Dimensions Approaches

G. Hofstede [12] defines culture adapting the layered structure of Maslov pyramide (Figure 1). He uses the term "mental program" to describe the characteristics of each layer. The lowest level - operating system - is common for all humans. The second layer - collective program - is learned and remains same in a collective group of people and indicates the culture. The "onion model" on the right side of the Figure 1 describes the

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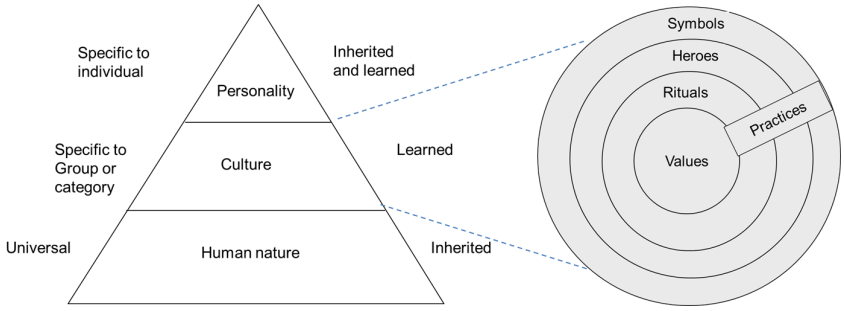

Figure 1. The layered structure of culture

main elements of the culture. Values are the core of the culture. Rituals are collective activities that are essential in a culture and indicate the membership of the group. Heroes are highly prized examples in a culture and indicate positive values of it. Symbols are words, gestures and objects that are common for those share the culture. Practices are manifestations of all other elements of a culture.

R. Lewis [21,22] applies the pyramid model in his culture analysis (Figure 2). As seen in the Figure the culture layers between Finland and Germany are different. Both countries in Lewis' classification (discussed later in this paper) are close to each other and belong to the group of linear-active and data-oriented cultures. In spite of that, the values and core beliefs - the core of the culture - are different.

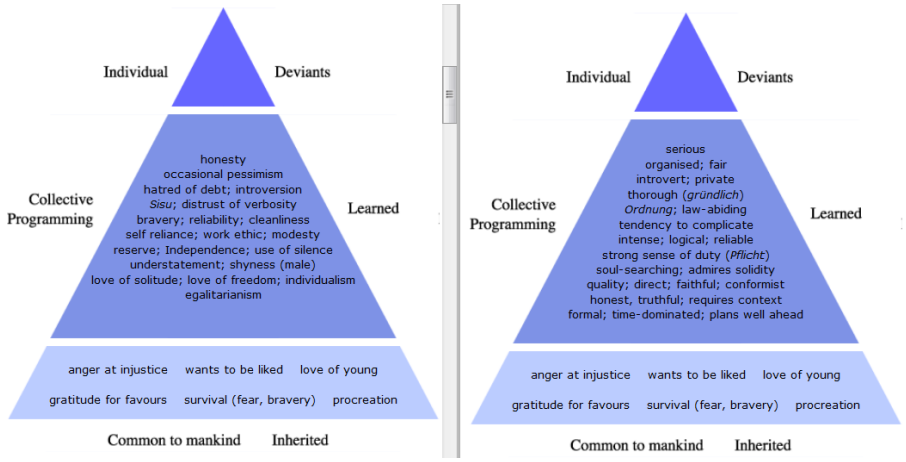

Figure 2. Values and core beliefs of Finland and Germany according to [22]

In our paper [17] we have introduced three methods to be used in recognizing cultural differences: the 6D model of Hofstede, Lewis "triangle model" and Hall's high/low context culture model. In addition to these there are several other ones; most of these overlap with the former ones and do not provide additional value to the analysis. Figure 3 illustrates the classification principles of Hofstede's model.

The model of Hofstede bases on the analysis of six cultural dimensions [11,12]:

- Power Distance (PDI): the extent to which power differences are accepted.

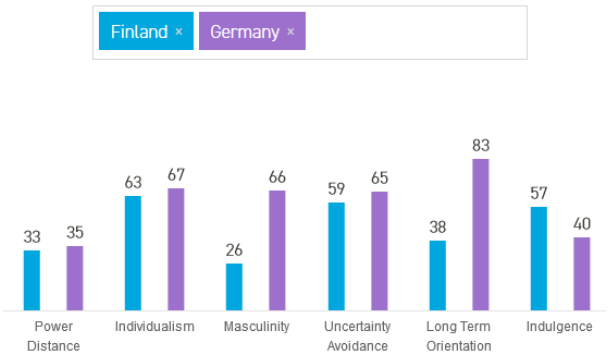

Figure 3. The Hofstede 6D model [11]

- Individualism / Collectivism (IDV): the extent to which a society emphasises the individual or the group.
- Masculinity / Femininity (MAS): refers to the general values in the society - hard/ soft values.
- Uncertainty avoidance (UAI): refers to the extent that individuals in a culture are comfortable (or uncomfortable) with unstructured situations.
- Long-term / Short term orientation (LTO): refers to the extent to which the delayed grati?cation of material, social, and emotional needs are accepted.
- Indulgence / Restraint (IVR): acceptance of enjoying life and having fun vs. controlling the life by strict social norms.

The country comparison tool[3] provides access to the database collected by Hofstede during the decades. The data covers culture values of most countries in the world. The left side of Figure 3 indicates the similarity of Finland and Germany. Meaningful difference is in LTO and MAS values, slight difference in IDG. The German work to reach results, which are more long-range than the Finns (LTO). They appreciate material values more than Finns (MAS) and live in the atmosphere, which is more puritan than in Finland (IVR).

1.2. Interaction and Collaboration

The Lewis' model [21,22] focuses in analyzing interaction and collaboration activities of people. The nationalities locate in the corners and sides of a triangle. The corners represent the basic stereotypes: linear-active, multi-active and reactive. Linear-active cultures are data oriented (decisions are based on facts and official sources) and can be described by terms cool, factual and decisive planners. Reactive cultures are "listeners" - they base their behavior in more rich base of information sources (oral information from social networks, family, friends, ...) than people in data oriented cultures do. In communication they are not active members of the interaction; listening and reacting is typical to them in dialogues. Terms courteous, amiable, accommodating, compromiser and good listener describe people in reactive cultures. They are also usually members of collective cultures in Hofstede's classification. Multi-active cultures are dialogue oriented. Like

[3] https://www.hofstede-insights.com/product/compare-countries/

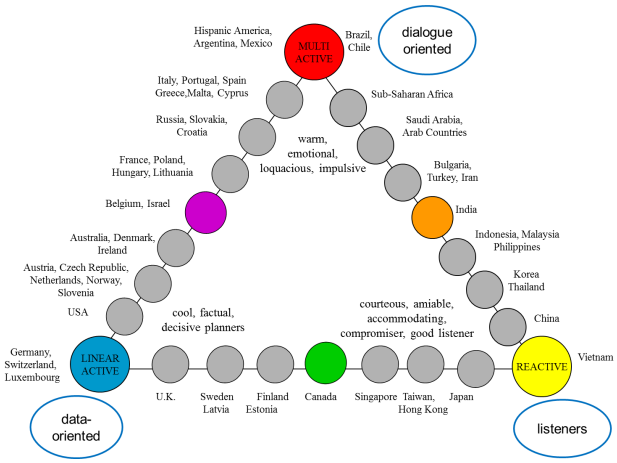

Figure 4. The Lewis' triangle model (modified from [21])

people in reactive cultures they use rich set of information sources, but especially prefer oral information. Multi-active characteristic means doing several things at once, being extrovert and being active member of dialogues. Terms warm, emotional, loquacious and impulsive describes them.

1.3. Context Dependence

The Hall's [9] model divides cultures according to the importance of context recognition in communication. Context means the extent of "wordless" communication included in the messages. High importance of context in communication indicates the importance of the membership in a collective group - i.e. collectivistic group culture in Hofstede's classification. In high context cultures, the meaning of the message relates to the context in which it is presented. The group members know a variety of details included in the message without explicit messaging. The low context cultures are opposite. These cultures prefer punctual and clear messaging. All information is clearly included in the message and need for knowing the context is minimal. Low importance of context indicates highly individualistic society in Hofstede's classification. Finland, as well as all Scandinavian countries, and Germany belong to the category of low context cultures; Japan and Arab countries instead are typical high context cultures. Somewhere in the middle of the continuum are USA and England, in which it is also typical to use words and sentences with hidden meaning.

1.4. The Storyline of the Paper

In this paper we start with an investigation whether cultures have an impact on models, i.e. on model development and model utilisation. Models can, for instance, be used as a means for communication. A hypothesis could be that models are a stability kernel among different people. The opposite hypothesis states that models are culture dependent. Section 2 discusses the relationship between modelling and cultures. Section 3 introduces a general model notion and a separation between the normal model and the deep model. We illustrate the cultural dependence for different kinds of schemata. Section 4

investigates the cultural differences for modelling styles. It is shown that the models developed in different cultures might also be different although the application is the same. Culture thus determines how models are developed and how models are used.

2. Cultures Influence Human Modelling Activities

2.1. Modelling is Different Worldwide

While zapping through textbooks from different countries on database analysis, design, and development we observe that the same topics and the same application tasks result in rather different database schemata. So, what causes these differences? What styles are preferred where? Under which circumstances one model is better than the other? Which detailedness is the best? Shall we concentrate on typical structures only? How exceptional cases are handled?

We observe also different modelling pattern and styles beside language differences (ER-like, UML. ORM, NIAM, IDEF, etc.). Students who got first lectures in object-orientation develop completely different schemata than those who got introduced to functional or procedural paradigms. Some companies like Ploenzke or SAP have a completely different way of representing the same application.

Moreover, the same language paradigm is often modified and extended. For instance, there are more than 50 extensions of the entity-relationship approach. Most of them are actually incompatible. Many modelling languages exist in a large variety of dialects what makes knowledge transfer and communication difficult. One reason might be that the ways of thinking, of modelling, of controlling, of working, and of supporting are different in different communities and thus result in different environments and thus in different cultures. Another reason might be the insufficiency of a language. In this case, we can use language pluralism and develop model suites [29].

Modelling might also follow different paradigms and postulates. It might use different not combinable theories. Modelling is biased by the developers and their educational and professional background [33]. It is typically laden[4] by concepts that are to be represented, by its community, by the context into which the model is set, and by the way of utilising a model. If we compare these factors influencing modelling with the culture notion then we realise that all these factors are culture-driven.

So, we may conclude that organisation, professional, educational, and finally national cultures influence the outlook, the content, the adequacy and dependability of a model. It is not only the behaviour of people that is governed by the cultures but also the development and utilisation of tools that is governed by the culture. Models are instruments that are used in utilisation scenarios. Communication is one of the main scenarios. Models are used similar to utterances in natural languages in this scenario.

2.2. Culture Sensitivity in Information Systems Development

We have handled the topics related to information systems (IS) development in multicultural context in several papers. The papers handle information systems development from different points of view. Culture related aspects affect in both the development and

[4]This concept has been considered in detail by H. Kangassalo (and J. Palomäki) in the EJC'15 keynote "Definitional conceptual schema - The core for thinking, learning, and communication" at June 11, 2015.

the use of IS. The development work is made in multi-cultural distributed teams, in which it is important to recognize the dynamics of the team in decisions related organizing the work, leading the team and managing the development project. Transfer towards cloud based ecosystems and web information systems (WIS) makes recognition of the end-user base more difficult. In requirements engineering phase we have more and more often "faceless" clients from different cultures and from different parts of the world that must be served by the WIS [15].

Our earlier studies cover general aspects in IS development [14], information and query-answer related aspects [17] and web information systems design related aspects including database design and conceptual modelling [16]. These papers provide a "handbook" type list of findings to support IS development in multi-cultural context. Our analysis applies the interpretations of human behavior using Hofstede's dimensions and Lewis analysis. It also acts as an evidence to the applicability of culture analysis and stereotyping methods to guide IS development for multi-cultural context. The realization of the findings is included in the requirements engineering phase, which transfers them to non-functional requirements in the requirements specification of the IS.

We have approached the topic via Hofstede's and Lewis' models. Hall's model provides some new aspects to the analysis, which are worth of more studies. Low context cultures are tended to demand exact communication. Our hypothesis is that IS development in such cultures indicate clear and unambiguous user interface, whereas high context cultures are tended to accept some ambiguities and complexity in it. Low context indicates linearity, high context multi-activity.

2.3. Information Systems Modelling and Culture

In IS projects models are means for communication - transferring duties and work items trough the life cycle of the IS and supporting interaction between the interest groups. We defined modelling to be a kind of solution to the problems of communication. Modelling languages are culture independent unlike natural languages. However, our hypothesis is that the use of them and the structure of the models indicates culture of its user. In IS development models transfer system related knowledge between interest groups. Because most of the modelling techniques used in practical work are semi-formal, the lacking exactness opens door for misunderstandings. In addition the sender's and receiver's ability to interpret the model may vary; one of the reasons is culture. Interpretation of the models is also context sensitive (i.e. in different contexts the interpretation may vary). The model itself is a construction of concepts and individuals according to their internal concept handling mechanism interpret it. In our paper [13] we introduced a hypothesis that also this mechanism is culture dependent - that what a Finn finds in a (conceptual) model would be different to the findings of a German or Japanese. In the same paper we have listed problems related to communication and collaboration in multi-cultural context: (1) behavioral patterns of people are different, (2) concept creation and handling is different, (3) language of communication is different, (4) communication includes opportunity to serious misunderstandings and (5) transformations (transferring the message from one language to other) may change the meaning of the message. All these problems fit to IS modelling, too.

2.4. Modelling of a Human Being, Team Dynamics and Organization Culture

In culture adaptable information systems development context there have been efforts to model its user. In adaptable IS the system includes a model of the user. If this "user model" is equal to the real behavior of the user, the system may adapt its operations according to the expectations of different users. In culture adaptable IS this model includes culture related factors.

One of the best-known model is MOCCA environment developed by K. Reinecke [27]. MOCCA is an application that can adapt ten different aspects of its UI with 39366 combination possibilities altogether. MOCCA acts also as an example of the technical implementation of the flexible user interface in information systems design. The user model takes into account the cultural background of the user including user's cultural adaptation because of the influence of foreign cultures. The user profile basis on the following parameter: MAS, UAI, PDI, LTO, IDV, year of birth, political orientation, social structure, religion, education level, familiarity to certain form of education, computer literacy and gender. External dependencies cover nationality of the person, his/her mother's and father's nationality and language skills (mother tongue, foreign languages). Dynamics of the model basis on the former length of stay under the effect of the foreign culture.

M. Phaedra and M. Permanand [26] have introduced a student model that takes into account his/her demographic factor values. The person (student) has simple arguments: identification, age and gender. The dimensions of the model fall into five categories that describe particular contextual categories: geographical aspects, religion, ethnic background, education level (including school - note the importance of school as a root of an important source of information in dialogue oriented and reactive cultures), and particular physical environment settings and terrains. External properties cover - as in MOCCA - parent data including their occupation (social group) and native language. The model does not include any aspects creating dynamics, if changes in the parameter values not counted. The model neither includes any cultural factors derived from stereotype models.

G. Dafoulas and L. Macaulay [6] have modelled the dynamics of multi-cultural virtual software development teams. The model lists a variety of factors that to take into account in management of the team and organizing the work in it. They emphasize that each individual is a member of multiple cultures (*Cultural profile* category): one or more national/ethnic cultures, one or more professional cultures, a functional culture, a corporate culture, and a team culture, among others combined to individual (personal) characteristics. They have seen, especially in multi-cultural distributed teamwork the importance of professional and functional culture: "software professionals worldwide belong the computing subculture, which is stronger than any other culture". A Russian software engineer (professional culture) would be more similar to an American peer than to a Russian marketing manager (functional culture).The model of cultural dimensions in virtual software teams does not specify the properties of an individual (professional) but a roadmap to manage the team. *Human resources* category includes PDI, UAI, IDV, time difference between members, trust level between team members, concept of space (Lewis) and material power (goods that create or indicate power). The required skills interact with human resources. The required skills category covers communication skills, participation activity, leadership, conflict resolution, problem solving, decision-making, goal setting and motivation. *Team development* category covers the improvement of required skills by taking into account first the team profile (diversity level), the role profile

(preferences) and finally task profile (requirements); the improvement is a continuous iterative process. Although this model belongs more into the category of "management and leadership models" it points out important aspects that indicate personal properties to be included in the model of a software engineer.

Our paper [14] includes a simple user model structured as a mind map. This model indicates the important factors of an individual to be taken into account in developing adaptive information systems. The personal properties category of the model covers personality profile (nine general factors and three dialogue preference related factors), work profile (six factors) and education profile (three factors). The portfolio category includes task related parameters, user involvement description, type of collaboration and restrictions to take into account.

E.G. Blanchard et al. [5] use very similar approach in their conference paper related to intercultural communication. They have found a remarkable (literature based) evidence which shows that the way people interpret and react to their environment significantly differs from one culture to another and that wide range of human activities and situations influenced by culture. In spite of that, the human-related technologies have not accounted for culture. Western context dominates in design and solutions, which are tested and validated on Western samples. In their paper Blanchard et al. (2013) introduce a simplified conceptual model of intercultural communication. Cultural elements concept class in the model covers cognitive cultural elements and cultural non-verbal communication (body language) related aspects. Non-cultural (innate) elements concept class includes behavioral primitives (gestures, postures, facial expressions) and some innate non-verbal communication elements. Additional concept classes cover the role of context, culture and cultural group, enculturated individual aspects, cultural group cohesion and a variety of descriptors.

B.S. Parumasur [25] handles the problems related to organizational development (OD). The paper states that American and European consultants have developed most of the OD practices. Because of that, cultures collide in different cultures. Contextualized and customized approach is needed: The skills readiness acquired at school varies (abstract thinking, team skills, entrepreneurship, technical, language, ...), motivation factors vary between cultures (emergent/mature), gap to the welfare plays an important role. In all change and improvement processes gap between local values and proposed interventions must be recognized. However, the evolution of the political and economic climate changes the values rapidly; globalisation leads to adoption of foreign influence (see [27]). The paper concludes to a model, which indicates organisation's readiness to changes; the model applies Hofstede's 6D model in the following way. PDI: High PDI indicates acceptance of social and economic gaps, acceptance of inequality, acceptance of centralization, valuation and respect to authorities and hierarchical relationships. In high PDI cultures close supervision is needed. PDI indicates also suitability of participative / non-participative decision making. Large PDI is associated with collectivism and (lower national wealth), small to individualism (and greater national wealth). UAI: High UAI indicates resistance to changes. Combined with high PDI it reflects the responsibility of an organization instead of individuals. UAI links to formalization, the need for formal rules and specialization. IDV: IDV indicates the acceptance of person level benefits (salary differentiation based on productivity) and the importance of interpersonal relationships. High IDV leads to a need to explain every act in terms of self-interest. IDV relates also to the directness / informality of feedback (performance improvement vs. de-

stroying the harmony in certain conflict situations) and the aim to avoid face loosing (in a group. MAS: Masculinity relates to career advancement and salary vs. social aspects of work. It indicates also differentiation of gender roles. Relatively high MAS and Weak UAI justifies the high level of achievement motivation.

2.5. Revisiting Cultural Studies

The different approaches to dimensions of cultures have been combined, systematised, and generalised in [17]. The result is a 11-dimensional Kiviat graph in Figure 5. The dimensions could be used to derive guidelines for web information system development what has been illustrated by the dimension values for Finland, Germany, and Japan.

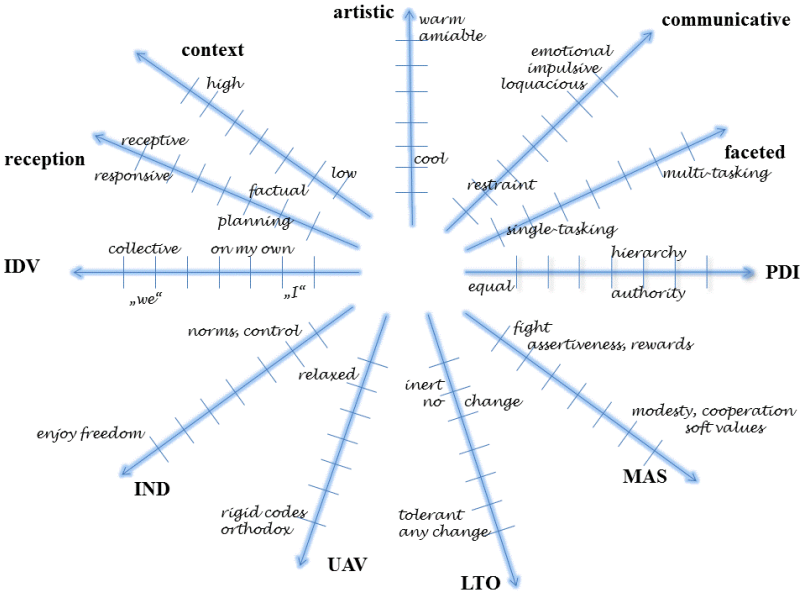

Figure 5. The Kiviat graph of the cultural dimensions of people

The graph can be extended by dimensions from other culture models. Instead we can use this combination also for derivation of other properties. The models by Hall, Hofstede, and Lewis cannot be solely considered. Additionally, combined properties cannot be derived. For instance, the triangle model [21] does not allow to reason on the cultural distance. The cultural distance is classically the differences of cultural values and is expressed as a function of differences in values of some of these dimensions, e.g. Euclidian or Mahalanobis distances. The triangle model also mixes three dimensions in Figure 5: the kind of being active, the kind of reacting on the partner and the way how tasks are performed. If we compare the distances between German and Japan people from one side and between Japan and European Russian people then first one is small in the triangle Lewis model whereas it is larger in Figure 6. The distances between Northern German and Japan people and between Japan and European Russian people in Figure 6 match far better with observations in normal life.

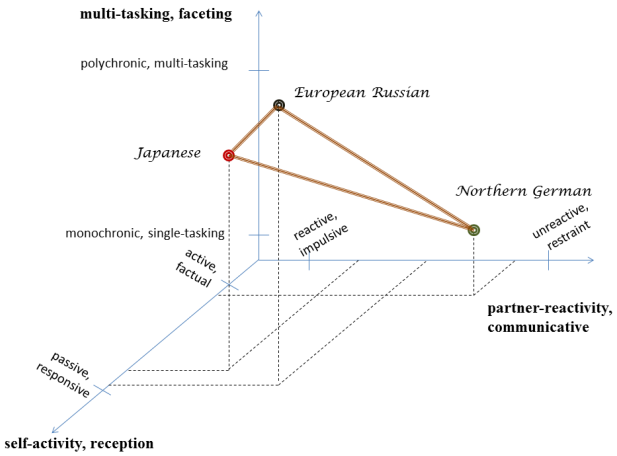

Figure 6. Three-parameter space of cultural dimensions with distances

So, the eleven dimensions in Figure 5 provide a better means for supporting also cross cultures. They can be easily extended by Victor's model [23]. Since some of the dimensions are important for some aspects and not relevant for others, we can use views for these aspects. For instance, if we concentrate on the communication and interaction level then the Lewis triangle or the three-dimensional characterisation together with high and low contexts should be taken into account. Models are also developed for communication scenario. Therefore, we can abstract from Hofstede's approach in this case. If we consider however the modelling activities then Hofstede's dimensions become more central.

3. Models and Modelling

3.1. A Model is an Adequate and Dependable Instrument

Modelling is a topic that has already been in the center of research in computer engineering since its beginnings. It is an old subdiscipline of most natural sciences with a history of more than 2.500 years. It is often restricted to Mathematics and mathematical models what is however to much limiting the focus and the scope.
A **model** *is a well-formed, adequate, and dependable instrument that represents origins* [31,32]. Its criteria of well-formedness, adequacy, and dependability must be commonly accepted by its *community of practice* within some *context* and correspond to the *functions* that a model fulfills in *utilisation scenarios*.

As an instrument or more specifically an artifact a model comes with its *background*, e.g. paradigms, assumptions, postulates, language, thought community, etc. The background its often given only in an implicit form. The background is often implicit and hidden.

A well-formed instrument is *adequate* for a collection of origins if it is *analogous* to the origins to be represented according to some analogy criterion, it is more *focused* (e.g. simpler, truncated, more abstract or reduced) than the origins being modelled, and

it sufficiently satisfies its *purpose*. Well-formedness enables an instrument to be *justified* by an empirical corroboration according to its objectives, by rational coherence and conformity explicitly stated through conformity formulas or statements, by falsifiability or validation, and by stability and plasticity within a collection of origins. The instrument is *sufficient* by its *quality* characterisation for internal quality, external quality and quality in use or through quality characteristics such as correctness, generality, usefulness, comprehensibility, parsimony, robustness, novelty etc. Sufficiency is typically combined with some assurance evaluation (tolerance, modality, confidence, and restrictions). A well-formed instrument is called *dependable* if it is sufficient and is justified for some of the justification properties and some of the sufficiency characteristics. Models are used in

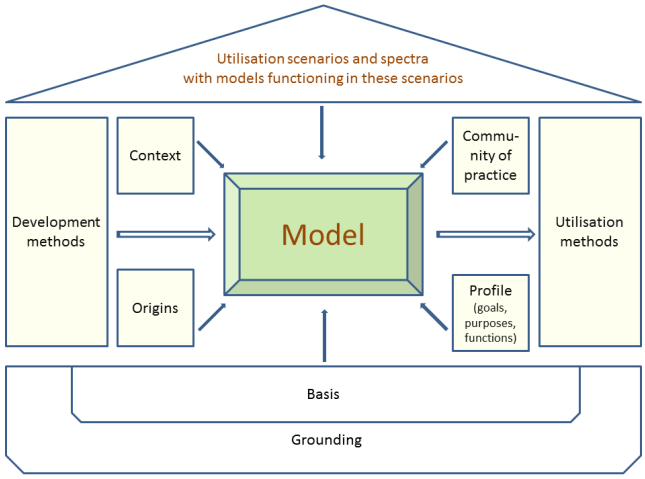

Figure 7. The model as an instrument that is adequate and dependable for its driving directives (origins, profile (functions, purposes, goals), community of practice, context) within its background (grounding, basis) and that properly functions in utilisation scenarios as a deputy of its origins

various scenarios, e.g. *communication*, perception, system construction, analysis, forecasting, documentation, system modernisation and optimisation, control, management, and simulation. Let us in the sequel concentrate on the first scenario.

3.2. Database Modelling and Cultures

We already developed a number of *stereotypes for database schemata* [15]:

(a) strictly hierarchical (ER-like) database schemata,
(b) schemata with local viewpoints that reflect the needs of some stakeholders (local-as-view approach),
(c) variants of XML-schemata, Bachman diagrams,
(d) sets of local database schemata with the requirement that the corresponding database schemata is simply the union of the set (global-as-view based on local viewpoints),
(e) sets of personalised views based on local database schemata with some kind of coherence constraint among all views (rigid global-as-view) etc.

These schema stereotypes ca directly be associated with stereotypes as shown in table 1.

Table 1. Cultural stereotypes, kinds of database schemata that are potentially preferred, and potentially useful database schema stereotypes [15]

Cultural stereotype	Preferences	Schema
High Power Distance	completely specified and well-formed, easy to understand and persistent database schema	(a)
Low Power Distance	freely configurable database schemata that is adaptable to current needs and preferences	(d)
Individualism	my own database schema according to my and only my preferences (work profile, education profile, personality profile, security profile)	(e)
Collectivism	commonly agreed database schema reflecting all elements within a group according to the collaboration style	(b)
Masculinity	restriction to essential elements and only those, strict structuring	(a)
Femininity	schema with additional and optional elements, with exploration opportunities, personalised schemata	(e)
Uncertainty avoidance	complete schema with all elements, hierarchical structuring, more linear, well-scoped sub-schemata with simple reference to main schema	(a),(d)
Uncertainty tolerance	extensible schema, flexible schema style, web-like schemata	(c),(e)
Long-term culture	all potential elements are reflected as well as all viewpoints, focused (oil stain) schemata	(a), (b)
Short term culture	handy schemata depending on current use and smooth integration of them, decomposable schemata	(e)
Indulgence	schema with a central part containing all necessary elements and further elements that might of use in future	(e),(c)
Restraint	puritanical schemata without any non-essential elements	(a)
Linear-active culture	schemata with step-wise exploration of all its aspects	(b)
Multi-active culture	different variants of the global schema for parallel integrated work	(d),(c)
Reactive culture	completely fledged schemata with all details and views for later work	(d)

3.3. The Normal Model, the Deep Model, and the Modelling Matrix

Model development is typically based on an explicit and rather quick description of the 'surface' or normal model and on the mostly unconditional acceptance of a deep model [18]. The latter one directs the modelling process and the surface or normal model. Modelling itself is often understood as development and design of the normal model. The deep model is taken for granted and accepted for a number of normal models.

The *deep model* can be understood as the common basis for a number of models. It consists of the grounding for modelling (paradigms, postulates, restrictions, theories, culture, foundations, conventions, authorities), the outer directives (context and community of practice), and basis (assumptions, general concept space, practices, language as carrier, thought community and thought style, methodology, pattern, routines, commonsense) of modelling. It uses a collection of undisputable elements of the background as grounding and additionally a disputable and adjustable basis which is commonly accepted in the given context by the community of practice. Education on modelling starts, for instance, directly with the deep model. In this case, the deep model has to be accepted and is thus hidden and latent.

This separation into normal model and deep model provides a means to distinguish two different logical theories behind: entailment or logical consequence for normal models and semantic presupposition for deep models. The pragmatic presupposition additionally consider the relation between a model developer or user and the appropriateness

of a model in a context. Inferences become then context- and scenario-dependent. Models are thus also evaluated based on their added value and not mainly evaluated based on their validity or correctness[5].

A (modelling) *matrix* is something within or from which something else originates, develops, or takes from. The matrix is assumed to be correct for normal models. It consists of the deep model and the modelling scenarios. The modelling agenda is derived from the modelling scenario and the utilization scenarios. The modelling scenario and the deep model serve as a part of the definitional frame within a model development process. They define also the capacity and potential of a model whenever it is utilized. Deep models and the modelling matrix also define some frame for adequacy and dependability. This frame is enhanced for specific normal models. It is then used

3.4. Why Conceptual Modelling is (Not) Acceptable

A *conceptual model* is an adequate and dependable artifact or instrument that

- is enhanced by concepts from a concept(ion) space,
- is formulated in a language that allows well-structured formulations,
- is based on mental/perception/situation models with their embedded concept(ion)s, and
- is oriented on a matrix that is commonly accepted.

The conceptual model of an information system consists of a conceptual schema and of a collection of conceptual views that are associated (in most cases tightly by a mapping facility) to the conceptual schema [35]. Conceptual modelling is either the activity of developing a conceptual model or the systematic and coherent collection of approaches to model, to utilise models, etc.

Conceptual modelling is not in the center of development activities in all countries. Observing the history of the ER-conferences on conceptual modelling for three decades, we discover that it is still a central and attracting topic in Europe with a movement from North to South over three decades, did not change in Middle East, lost its attraction in Northern America and partially also Southern America, and has not been a central issue in the rest of Asia. So, one might ask why this attention and changes happened. One answer could be the loosing interest and importance in this approach. Another answer could be however that development is based on rather different styles in different countries, i.e. is culture-dependent. A third answer might be that models are latent and not explicitly stated what is also culture-dependent.

4. Cultures in Modelling

4.1. Models, Languages, and the Background

P.P. Chen [3] made the observation that the entity-relationship modelling language follows specific construction rules of the Old Egyptian and the Chinese language. This modelling language can only represent simple English sentences. Later, [10] could show that the extended ER modelling language HERM [28] covers the main categories in the English language. So, languages enable and hinder modelling.

[5] "All models are wrong. But some of them are useful." (often cited as a phrase by G.E.P. Box [2])

The background and especially the grounding are often incorporated into the deep model that is not explicitly communicated. For instance, the grounding for information system models includes DBMS and CE paradigms and postulates, set semantics, database theory, DBMS solution layering, DBMS technology (theory and culture), graphics and diagrammed canonical representation, ER canon, data-first-methods-second paradigm, database-approach-as-guide, etc. The basis of the model house in Figure 7 includes also a number of specific assumptions and commonly accepted practices. For instance, database modelling can be based on specific extended ER language, hidden basic types, views as derived (algebra) expressions, concept fields, extended ER thought style, parametric generic concept field, Indo-European utterance composition, extended ER development methods, extended ER heuristic rules, transformation techniques to other deep models, and extended ER tools. Additional assumptions are Salami slice tactics, the believe that functionality comes later, a rigid separation into firstness of syntax and secondness of semantics, visualisation, well-formedness (including lazy normalisation), extended ER pattern, reuse of experienced solutions (as exemplars), and flat two-dimensional schema representation. Global-as-design is commonly accepted in the database community. The global schema is the main result. Views are then defined on top of the schema by algebraic expressions in oder to cope with user viewpoints. Global-as-design has its limitations. The combination with local-as-design, e.g. for BPMN diagram suites, becomes rather difficult.

The language as an essential part of the basis, the grounding and also the other choices in the basis are acceptable in one community of practice and might be completely unacceptable for others. So, the deep model and partially also the matrix are part of the cultural setting. It is often claimed that the organisation and education cultures rule this setting. The other dimensions of culture [14] are, however, not less important.

4.2. Models as a Sufficient and Necessary Means of Communication

Communication or exchange of data/knowledge/information is one of the main scenarios where models function as a content that is communicated. Models support learning, description, prescription, prognosis scenarios as well. Communication involves several partners with their own background and culture and is based on a relationship between these partners. Each of these partners also interprets the model in a specific way based on hidden background and the specific treatment of the four directives, i.e. presupposes a specific conditional framework against which the model makes sense. The explicit part of the model is the normal model. The implicit or pragmatic part is the deep model. The matrix of the model combines the deep model and the specific ways of model usage according to the considered scenarios. We shall see in the sequel that the pragmatic part is interwoven with the culture.

Models for communication must follow felicity resp. appropriateness conditions, i.e. conditions on well-formedness. Models and especially representation models must be developed on the principles of visual communication, of visual cognition and of visual design [15,24,30]. The culture of modelling is based on a clear and well-defined design, on visual features, on ordering, effect, and delivery, and on familiarity within a user community.

The meaning of models is typically combining four parts: (1) the literal model meaning (“what is said”), (2) the conveyed model developer meaning, (3) the model user meaning, and (4) and the implicated meaning (“what is implicated”). The implicated

meaning might be conventional or non-conventional. Non-conventionality of models includes what is the implicated content within the model and what has been left aside (non-conversationally). The first one can be general or particular. These different kinds of model content influence the *model informativeness*. The first part is triggered by the meaning of the model constructs and the model design as a statement. The second, third and fourth meanings are human related and thus depend on the culture of the people involved. The model itself should have a holistic interpretation.

Models in communication scenarios have to follow general principles and a set of rules called ***maxims of model communication***. They are, in general, communication implicatures from [7,8].

Cooperative principle: Make your model such as is required, at the stage at which it occurs, by the accepted purpose of the model within the communication scenarios in which it is are deployed. This general principle has several sub-principles called "Maxims of Model Communication"

- **Maxim of quantity:** Make the model as informative as is required for the current purpose of the model do not make the model more informative than is required.
- **Maxim of quality:** Try to make model as valid as possible do not incorporate aspect that are invalid. All constructs need an adequate evidence.
- **Maxim of relation/relevance:** The model and all its elements must be relevant.
- **Maxim of manner:** The model should be parsimonious and perspicuous, i.e. economic and well-formed. Any obscurity of expression and ambiguity are avoided.

Implicated maxim of efficiency: The maxim of quantity requires that a model should be sufficient for an understanding by the model user (I(nformation)-principle [20]. From the other side it requires that the model should contain all necessary elements for an understanding by the model user (R(elevance)-principle). The model represents as much as the modeller can and must. The M(odality)-principle assumes that non-normal, non-stereotypical situations by the model that contrast to normal situations are given in an explicit and understandable form. The P(recision)-principle requires that a model is only at a precision level according to purposefulness. The B(revity)-principle prefers smaller models over longer, complex ones even though it has to be interpreted in a vague way. In some cases, vague models might serve better its function.

These maxims are explicitly stated by the sufficiency characteristics which allow to evaluate the quality in use, the external quality and the internal quality. Based on the modelling style we are able to reason on negation. A typical, however, often impractical approach with the strongest interpretation is the closed-world assumption in modelling that allows to conclude about the meaning of missing parts in the model. This assumption follows [4] ("Dire et ne pas dire"). The maxim of efficiency is often based on 'hidden' sub-models (called in the sequel 'deep model') which are taken for granted within a context and background by a community of practice.

We observe that these maxims are accepted in different cultures in a different way. So, the pragmatics of models depends on the culture. Moreover the deep model is governed by this pragmatics. The principles cannot be satisfied at the same time. Which principle is preferred also depends on the community of practice and thus on their culture imprinting.

4.3. Cross-Culture in Modelling

The adequacy of models has been handled in a strict or flexible way. Some model notions require a mapping property as a strict form of analogy. At the same time truncation or abstraction is required instead of focus. Also well-formedness is often taken more tolerant. Purposefulness is however commonly accepted. A similar observation can be made for dependability of models which is often only implicitly assumed. All model notions analysed in [34] use an implicit deep model that is undisputable. A rather surprising difference is the explicit statement on quality characteristics which have to be satisfied. At the first glance it seems that the list is random.

Let us, however, analyse[6] the German database or information system books which are often used for teaching and papers and books from US where the first are published in the ER conferences since 1992 [7]. We observe that there are common properties applicable to both. There are also properties than can be only observed for one side. some properties are out of scope or out of style although they are important for information systems.

To make these different style more clear we shall use Lewis' horizons of communication [21] in Figure 8. There are general properties that are commonly accepted by the two communities. There are also properties that are out of style or out of scope. There are also typical German and US properties that can only be observed for one of the communities. For instance, the US approach to development is often based on an 80:20 principle, i.e. the schema is left open for further development. The normal case is mainly considered. The opposite is observable for the German style. The schema must be complete. Whatever is not explicitly stated in the schema is not relevant in the application.

Therefore, cross-culture projects often result in a complete mismatch although the orientation to global-as-design and the deep model are commonly accepted. In oder to come to a common solution, the principles to modelling must be agreed in advance. This agreement may start with an agreement of the maxims (of quantity, quality, relevance, manner) and on the R-, I-, M-, B-principles. According to [1], the choice of the language is influenced by effectiveness (cost-effectiveness, representation effectiveness), infrastructure (especially tools), resource availability, knowledge capitalisation, and - what she calls - political factors. The latter are cultural factors.

4.4. Deep Models are Governed by Culture

The deep model combines the unchangeable part of a model and is determined by the *grounding for modelling* (paradigms, postulates, restrictions, theories, culture, foundations, conventions, authorities), the *outer directives* (context and community of practice), and the *basis* (assumptions, general concept space, practices, language as carrier, thought community and thought style, methodology, pattern, routines, commonsense) of modelling.

Let us consider information systems development: The grounding includes DBMS and Computer Engineering paradigms and postulates, set semantics, database theory,

[6] These observations only cover partially the specific styles and should be extended with other material as well. Since we are interested in the general culture-dependence of modelling and not in a complete empirical study we restrict ourselves.

[7] A similar observation has been made by M. Bjeković [1] for selection of enterprise modelling languages. She investigated the role of the purpose in modelling, the choice of modelling languages, and the factors for preferring one language above the other.

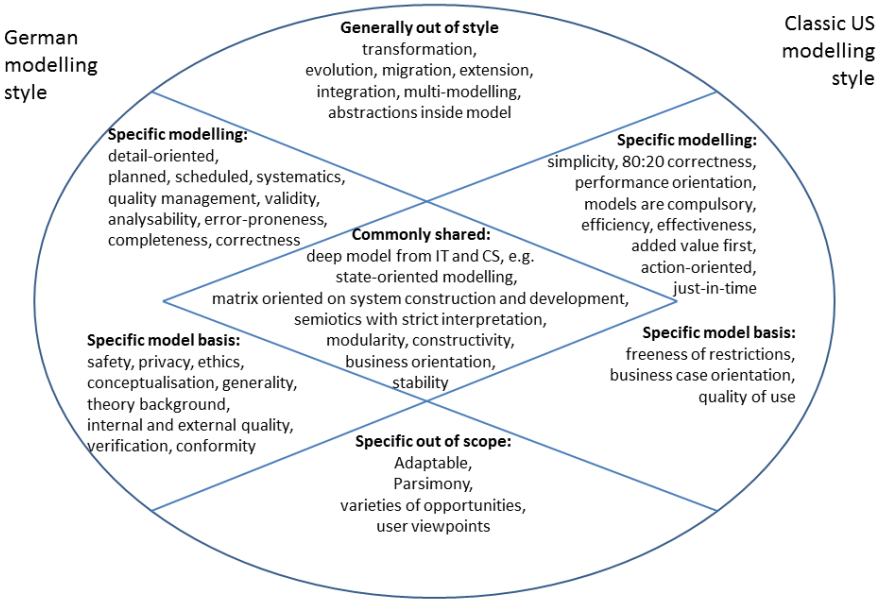

Figure 8. Modelling styles in two cultures

DBMS solution layering, DBMS technology (theory and culture), graphics and diagrammed canonical representation, ER canon, data-first-methods-second paradigm, and DBS guiding question. The basis can be build on specific an extended ER language, on hidden basic types, on views as derived (algebra) expressions, on concept fields, on a specific extended ER thought style, on parametric generic concept field, on Indo-European utterance composition, on extended ER development methods, on extended ER heuristic rules, on transformation techniques to other deep models, and on ER tools. Typical commonsense and common practices that are applied are: global-as-design, Salami slice, functionality comes later, rigid separation into firstness syntax and secondness semantics, visualisation, well-formedness (lazy normalisation), ER pattern, experienced solutions (as exemplars), and an orientation on flat schemata. Deep adequacy uses a specific analogy, specific focus, specific purpose. Deep dependability is based on arguments from the origins, on coherence inherited, on a rigid stability, and on sufficiency on the basis of extended ER quality criteria. The deep model is extended by the four directives: (i) Perception and situation models with lexicology and lexicography (e.g. an ontology as cut-out in the concept fields); (ii) a specific communication-oriented profile; (iii) the context typical for current IT or Business Informatics; (iv) the ER community of practice. The deep model provides the interpretation and the make of the normal model.

We realise that all components of the deep model are governed by the culture of the community of practice. This culture must be accepted and is the basis for a smooth communication within this community. The culture includes the acceptance of several principles: (1) the community uses a common vocabulary (*Helsinki principle*); (2) the 'what' and 'why' of modelling is agreed (*principled universe of discourse, environment,*

and information system); (3) an individual can have more than one viewpoint, one for each subject in which he is interested or has to deal with (*searchlight principle*); (4) all relevant general static and dynamic aspects, i.e., all rules, laws, etc., of the universe of discourse should be described in the conceptual schema (*100 % principle*); (5) a conceptual schema should only include conceptually relevant aspects, both static and dynamic, of the universe of discourse, thus excluding all aspects of (external or internal) data representation, physical data organization and access, as well as all aspects of particular external user representation such as message formats, data structures, etc. (*conceptualisation principle*); (6) the conceptual schema for an information system in practice can be perceived as being built up like some sort of onion the inner layer of the onion being formed by the minimal conceptual schema based on the fundamentals of logic, the extensions representing the layers of the onion (*onion principle*); (7) development is concentrated on the *what about what* with paying attention to the *how with what* we do it (e.g. conceptual level, external level, internal level) (*x-level architecture principle*).

4.5. Model Matrices are Driven by Culture

According to [19], a disciplinary matrix consists of (I) symbolic generalizations as formal or readily formalisable components or laws or law schemata, (II) beliefs in particular heuristic and ontological models or analogies supplying the group with preferred or permissible analogies and metaphors, (III) values shared by the community of practice as an integral part and supporting the choice between incompatible ways of practicing their discipline, and (IV) exemplars for concrete problem solutions similar to Polya's theory for puzzle-solving (see also Wittgenstein 'Game' [36]). Additionally we consider (V) a guiding question as a principal concern or scientific interest that motivates the development of a theory, and (VI) techniques as the methods an developer uses to persuade the members of the community of practice to his point of view. So, the modelling matrix includes the deep model ((I),(II),(III)) which already culture-governed and additionally.

The modelling matrix is a specific disciplinary matrix and consists of the deep model and the modelling scenarios with specific stereotypes. So it governs the development of the 'rest' of the model development and model utilisation. The agenda is derived from the modelling scenario and the utilisation scenarios.The modelling matrix thus provides also a specific understanding of adequacy and dependability of models.

We may now derive specific modelling matrices for information system models — mainly for the development of the normal model. The matrix is assumed to be correct for normal models. Normal modelling involves showing how systems and their models can be fitted into the elements the matrix provides. Most of this work is detail-oriented. The matrix itself is thus driven by the culture accepted by the community of practice within the given context.

5. Conclusion

The aim of this paper was to analyse the culture sensitivity of modelling and models. We see modelling as a human activity and because of that it is as culture sensitive as human behavior in general. Worldwide we use same modelling techniques and tools, which for their part unify modelling practices and models. There are also several studies that criticize the use of tools and practices developed in powerful cultures in foreign

culture context. The kernel of the criticism is that these tools and techniques transfer the elements of the origin to the culture where these are used. Big gap can be seen between Western and Eastern cultures, as well as between mature (welfare) and emergent (more poor) cultures.

In our paper we have approached the topic from the direction of culture analysis in general level and applying the results of our findings in (cross-cultural) modelling context. A modelling framework — "the model house" — is used as a basic structure. The role of normal and deep models, as well as the role of modelling matrix are parts of this framework. Culture dependent aspects in conceptual modelling provide and comparison of modelling styles of two cultures are used as applications.

Our conclusion is that we found a lot of culture sensitive aspects in modelling. Models include a lot of "wordless" information that have source in modelling languages. In this context we want to make analogy to Hall's high and low context cultures discussed in section 1 of this paper. Modelling languages — because of the semi-formal character — leave a lot of gaps to exact specification. This gap includes always some amount of culture related aspects. In addition normal information system requirements specification includes a lot of non-functional features that are defined by still less formal language, like natural language. These features are culture sensitive and also in most cases impossible to test by normal testing practices and verification; instead of tests human validation is used - again one culture sensitive step more.

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