2008

Reconstructing and Educating Interdisciplinarity

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ABSTRACT

Interdisciplinarity is required: from those in charge at universities, policy-makers and leading researchers globally. It is essential, however, that interdisciplinarity be founded on a unified scientific theory so it is not a mere catchword but filled with substance of its own. This paper presents a conceptual framework, which allows the need-based reconstruction of interdisciplinary content. This is done using an example: the creation of a language-critical organization theory as part of Computer Science (CS), which seems to have entered the global discussion of the topics “Web Science”, “Enterprise Computer Science” or "Services Science. Nowadays, because of “ubiquitous computing”, it is modeling in almost every scientific or business area and not programming, that is in the focus of a world-spanning System and Applied Computer Science.

Keywords: Interdisciplinarity, Organizational Informatics, Organizational Computer Science, Service-oriented Architecture, Workflow-Management-Systems, Modeling Languages, Software Engineering, Philosophy of Science.

I. MOTIVATION

Service-orientation has long become more than a mere buzz word that starts as hype and heats the discussions in the IT-community, cools down after a while due to unsatisfactory technical feasibility and finally disappears altogether to give way to the next fad.

At present, due to innovation and technical invention, service-orientation is discussed everywhere in the context of service-oriented architectures and is much more than just another technology [Bieberstein et al., 2008]. It is at the same time interdisciplinary science and practice. A SOA can only be implemented in enterprises successfully if it is understood entirely. Collaboration between technology, organization and human beings can only succeed in an organization if they are understood in a holistic way. The catch phrase “Total Application System Science” is already going the circuit internationally. But: Not the *Internet of things* but the *Internet of events* in the sense of – as far as possible – schematically organized, controlled processes, such as important events, represents a central challenge to all enterprises, administrations and even to our private lives (*Figure 1*).

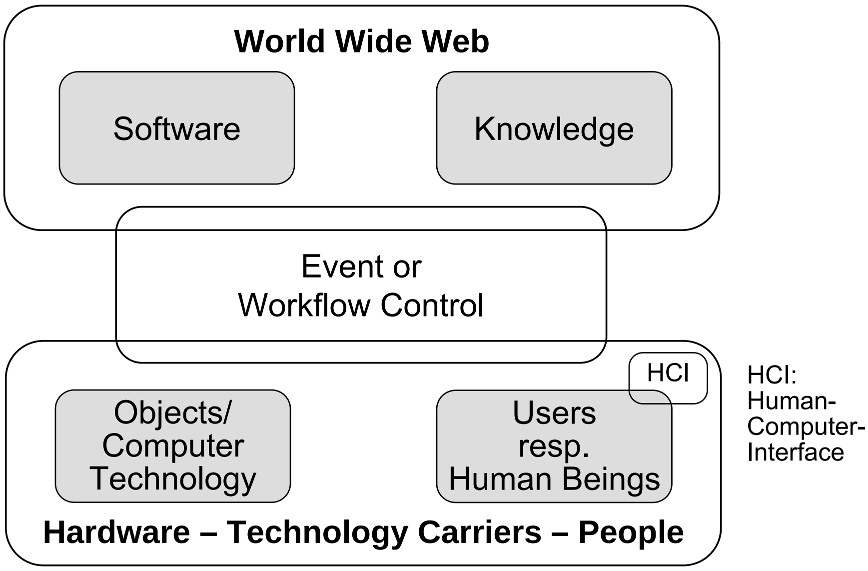

Figure 1. From an "Internet of things" to an "Internet of events" for people’s private and business lifes

Enterprises need to analyze, document, (re)construct and optimize their (work) processes as best the can to be able to turn them into “business services” accordingly. It is, therefore, vital to return to the two pillars of classic organization theory, i.e. *operational and organizational structure.* But especially the example of operational structure shows that classic organization theory is not sufficient to achieve an enterprise model [Ortner et al., 2008] that is necessary for implementing effective and efficient processes, or services. What is needed here is a theory-stabilized (language-critical) *informatical (Computer Science)* *organization theory*. Its relevant conceptual aspects including organizational structure will be presented in the section III.

The interdisciplinarity that is theoretically and practically inherent to all enterprises constitutes the bridge between classical organization theory and a language-critical and informatical organization theory – the much-required interdisciplinarity for future educational concepts in computer sciences [Ortner and Heinemann, 2007]. “Enterprise” here is meant in broader terms namely as a private or public economic entity as well as a family or a single individual and its planned activities.

II. INTERDISCIPLINARITY AS A BRIDGE

With good reason, Jürgen Mittelstraß reminds us: “Who (even in a disciplinary framework) has not learned in an interdisciplinary way, will not be able to do research in an interdisciplinary way” [Mittelstraβ, 1997] and one is inclined to add: Neither will they be able to teach in an interdisciplinary way [Ortner and Heinemann, 2007].

Obviously, interdisciplinarity constitutes an important pillar in science as well as in practice today, in particular when we look at science at universities or education in our schools.

DEFINITION AND DELIMITATION

Interdisciplinarity today is – after the phenomenal advances in numerous scientific and technical disciplines – a concept that is rightly the subject of animated discussions. Before proceeding, we want to look at the term more closely and provide a clear definition for our further usage of the term in this text. For ubiquitous computing purposes we can distinguish two areas of interdisciplinarity:

1. Mathematics, Informatics (Computer Science), Natural Sciences, and Technical Sciences (e.g. Mechanical Engineering, Electrical Engineering

and Information Technology, Civil Engineering) as so called *MINT-Studies*.

2. Mathematics, Informatics (Computer Science), Business Sciences, Social Sciences, and Technical Sciences as so called *MIBST-Studies*.

Seen from an informatical perspective the MINT-Studies are dominated by “number crunching” and algorithmic theory, the MIBST-Studies on the other hand by “data crunching” and a language-based Computer Science. But in the meantime both categories are also specifically oriented towards organizational processes and not only towards computing data. There was a paradigm shift from data to organization [Ortner and Heinemann, 2007] in Computer Science.

Of course, one of the “classics” among all the interdisciplinary courses of study is Business Informatics whose graduates can (or should be able to) work with economists and computer scientists equally well. Their focus depends on the students themselves as well as on their university.

Nevertheless: This example shows that interdisciplinarity means to move *between* different disciplines substantially. But this definition will not suffice, as the term *multidisciplinarity* could apply as well. Multidisciplinarity, however, refers to an often misunderstood “pragmatic” aspect of interdisciplinarity, namely the mere result of different disciplines working together. Here, methodological or even terminological and conceptual questions play only a minor role in achieving results. *Interdisciplinarity* is quite different. Clearly, the results of its interdisciplinary object of research are of interest as well, but it particularly focuses on the methods used (e.g. ways) and the ways of thinking (e.g. languages), as well as their integration into a common (constructive) philosophy of science for all participating disciplines. This is also true for *transdisciplinarity*, but which for Mittelstraß is more. It reinstates the “original unity of science – here understood as the unity of scientific rationality, not of the scientific systems with respect to its intentions and their justification“ [Mittelstraβ, 1997]. The last term we want to introduce is *infra-interdisciplinarity*. It “merely” means the communication within and outside a discipline, i.e. a common language base (e.g. within computer sciences itself as well as the disciplines that apply computer sciences). Already "infradisciplinarity" is being downgraded to a specific (disciplinary) theory abstraction (e.g. formal logic or axiomatic mathematics).

Thus, interdisciplinarity is productive mainly because it integrates different competences (methods, ways of thinking, etc.). This integration enables a holistic understanding of an object (field) and shifts the focus on the correlations (in the sense of "understanding what something has become") instead of on the applicability of isolated results. Interdisciplinarity is a term that integrates scientific methods of different disciplines, provided that there is mutual respect and understanding. It is an indispensable prerequisite for enterprise or organizational engineering in the sense of a practiced interdisciplinarity and shall be understood as an integrated theory in the following. Enterprise modeling with its languages and methods can serve as an example, as it is undoubtedly substantial and interdisciplinary due to the advances in information technology (ubiquitous computing).

In addition to the so-defined interdisciplinarity, we further need its fundamentals, i.e. a kind of *basic interdisciplinarity* such as logic [Wedekind et al., 2004-2005]. These fundamentals – as mentioned before – are covered by *infra-interdisciplinarity*. The introduction of certain parameters equally relevant for all disciplines is useful as well. Basically, we are looking at a *meta-interdisciplinarity* here, covered by the term *trans-interdisciplinarity* we want to introduce for the field of goals and their justification, in addition to the general conditions for the means. Now, we possess the three important elements for developing an informatical organization theory:

- Fundamentals (infra-interdisciplinarity),
- Theories (interdisciplinarity and infradisciplinarity), and
- General conditions (trans-interdisciplinarity)

By informatical organization theory or organizational computer science we understand a (new) organization tenet, which has arisen as a result of schematization requirements and the use of information technology in organizations (enterprises) for their operational and organizational structure. In practice, it is already represented in the most impressive way by the new modeling languages UML (Unified Modeling Language), BPMN (Business Process Modeling Notation), OSM (Organizational Structure Metamodel), BMM (Business Motivation Model) or SBVR (Semantics of Business Vocabulary and Business Roles). It is essential to use them methodically. The results must not only be verified but also justified by the goals an enterprise aims at. This situation has developed globally due to ubiquitous computing and applies to all spheres of human life. It is therefore justified to call it “new organizational tenet” or “organizational computer science” (Enterprise Computer Science).

INTERDISCIPLINARITY AS A SCIENTIFIC APPROACH TO “SOA”

Service-oriented architectures (SOA) are the cutting-edge state of development of business-informational objects in enterprises. In addition to an IT-infrastructure and an (application) service architecture, the enterprise-SOA requires a complete reconstruction and optimization of the enterprise's operational and organizational structure. SOA-governance, as a further organizational element, can be seen as another management component of the approach by which an enterprise as a whole (Total Application System Architecture), advances to be a research field and subject area of interdisciplinary courses of study such as “Business Informatics”, “Enterprise Engineering” or even “Enterprise Computer Science”. In addition to the various structure category levels, *figure 2* contains the idea of a component-based, dynamic enterprise orchestration for the best possible pursuit of marketing goals. Additionally, it shows two central tasks: the permanent (re)construction and documentation of work processes using informatical languages such as UML (Unified Modeling Languages).

The interdisciplinary character of the task fields in *figure 2* becomes apparent if we look at the model of an accountancy service, for example, and ask ourselves what knowledge is the basis of this work.

- The accounts structure of this service is based on either the principle of double-entry or governmental accounting.
- The accountancy workflows of an enterprise shall be reconstructed and optimized using BPMN-diagrams or use cases.
- The software market is to be searched for adequate "services" and these must be evaluated.
- The enterprise's IT-infrastructure (software and devices) may have to be modernized.
- etc.

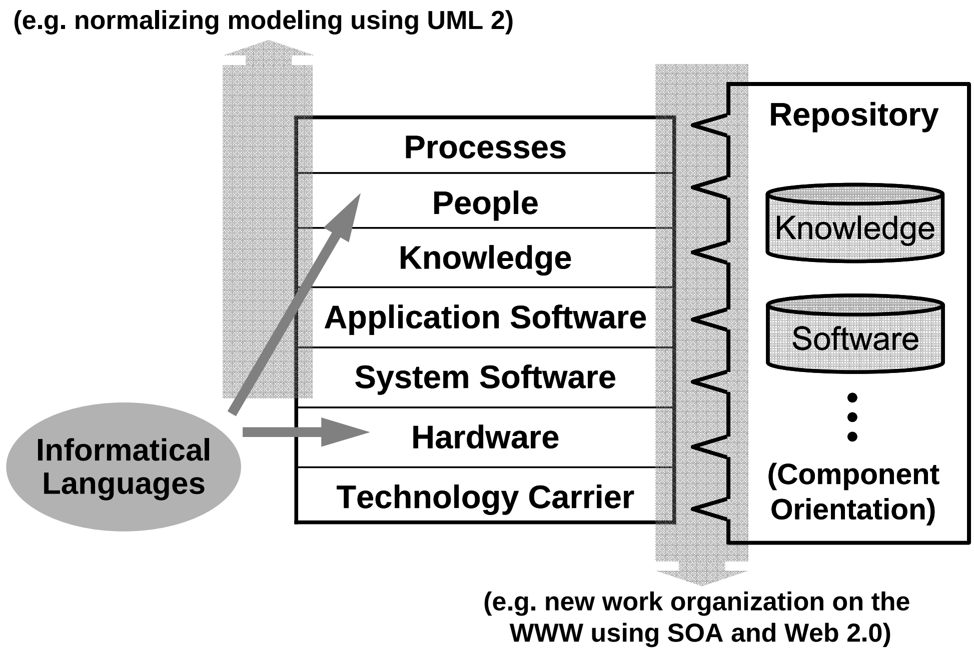

Figure 2. Comprehensive list of the architecture components as well as the tasks in research and study of an "Enterprise Computer Science" as an interdisciplinary subject

Interdisciplinary knowledge is essential and indispensable in each situation, and solely crucial for success. Due to the advances in (Business-) Informatics, “programming” is considered easy (industrializable) while “modeling” is classified rather as difficult (but can be supported by methods). But the greatest challenge still is the communication (“argumentation”) with the users that is based on a “language logic

THE NETWORK-METAPHOR AND ITS CONSEQUENCES

As we have seen before, interdisciplinarity is a result of linking different faculties. This does not mean that each discipline enters a “liaison” with every other discipline but, metaphorically speaking, a kind of *network* is formed (comp. *figure 3*) whose nodes are the “pure”, i.e. original basic disciplines, while the edges are what results from the connection of interdisciplinary fields of study.

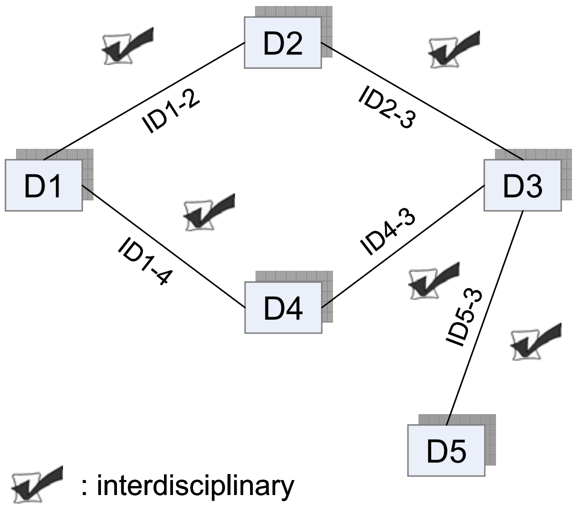

Figure 3. Network-metaphor

Looking at the example-network in figure 3 we realize that here it is not possible to state anything about the focal points of potential interdisciplinarity. For example, interdisciplinarity between D3 and D4 can be interpreted as ID3-4 as well as ID4-3. Figure 4 exemplifies this using the following grammatical preliminary considerations:

The compound	comprising the nouns	is
fish soup	fish-*soup*	a particular soup
scapegoat	scape-goat	neither a particular cape, nor a particular goat → metaphorical
Bergriese* (mountain giant)	*Berg*-Riese (*mountain*-giant)	a particular mountain

* *The third example is presented in German language as nothing similar is known in English.*

Figure 4. Grammatical preliminary considerations for the design of interdisciplinary designators

Thus, the direction matters: from which original discipline to which other discipline an interdisciplinary connection and, therefore, a new discipline will be created. Here, we restrict our representation and our further considerations to the connection between two disciplines (whereby this can be done in several steps). The following matrix derives as a consequence:

„To"-nodes / „From"-nodes	1 Logic	2 Informatics	3 Organization	4 Language	
1 Logic	***D1***	Logic-Informatics	Logic-Organization	Logic-Language	
2 Informatics	Informatics-Logic	***D2***	Informatics-Organization	Informatics-Language	
3 Organization	Organization-Logic	Org.-Inf.	***D3***	Organization-Language	
4 Language	Language-Logic	Language-Informatics	Language-Organization	***D4***	

Figure 5. Interdisciplinarity matrix

The *interdisciplinarity matrix* shows that, based on the original disciplines D1, ..., Dn, which still serve as the foundation for all interdisciplinary disciplines, further disciplines may evolve possibly based on existing connections. They may in some cases be considered fields in their own right. The connection between organization and computer sciences may serve as an example here. The variant *organization-computer sciences* shall mean the computer sciences that deal with organizational questions (similar to Business Informatics) and, therefore, represent a specific computer science. Vice versa, the combination *computer science-organization* as a specific organization theory makes the organization of computer sciences and its elements as subject matter for research. It is interesting to know that from the point of view of organizational structure, some enterprises call their IT-department simply “Informatics”.

This correlation, together with the definitions in section II, shall now be used to lead up to an informatical organization theory. With such a “conceptual framework” of “science production” it seems natural that some disciplines may “die” after some time while others should not be created in the first place.

III. CONCEPTUAL FRAMEWORK FOR THE RECONSTRUCTION OF INTERDISCIPLINARY CONTENT

Interdisciplinary research must be based on theory. As discussed in the first section of this paper, classical organization theory is not sufficient as a foundation of interdisciplinarity for SOA. In the following, relevant aspects of informatical organization theory as a continuation, or modification of classical organization theory, will be demonstrated step-by-step using the example of *organizational informatics.* We will use the term “organizational informatics” as a synonym for *language-critical informatic-based* (with the modeling languages of computer science) *organization theory*, that is currently developing [Lehmann, 1999].

Here, the levels of interdisciplinarity as introduced in section II are used (comp. *figure 6*). The “equations” are to be read from bottom to top. For example, the following is true formal logic + language = language logic

or

organizational logic + informatics = organizational informatics.

The Formal Logic on *level -1* provides us with an *infradisciplinarity* that focuses on axioms (in accordance with Hilbert's axiom systems) as well as on the pure *form*. It is therefore not yet useful for an informatical organization theory and especially not for the aspect of interdisciplinary "content". What we need, from a constructivistic point of view, is *form and content*, as applies form level 1 upwards. Section IV of this paper will describe *level -1* in greater detail.

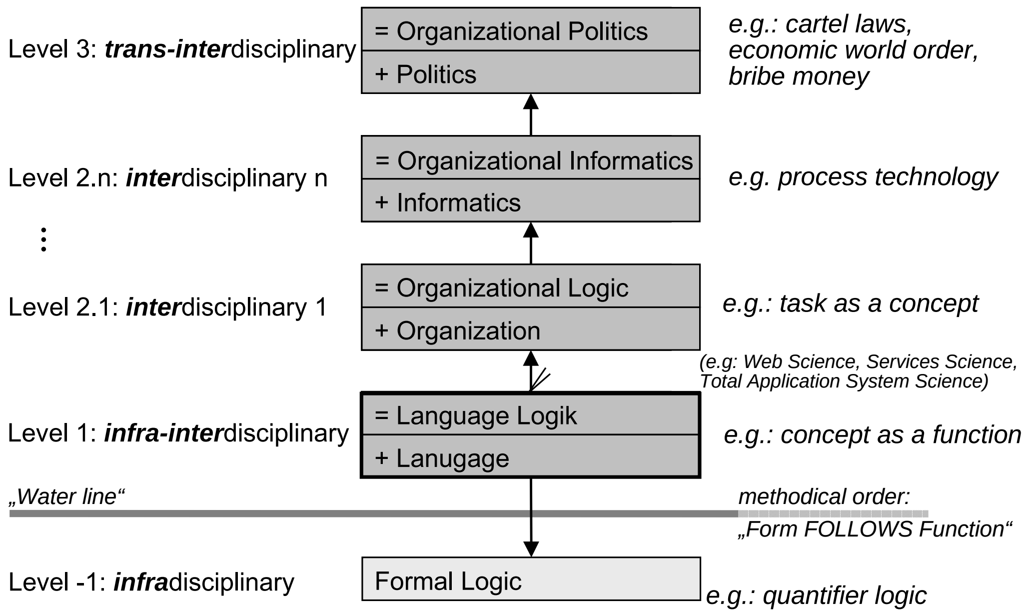

Figure 6. Reconstructing parts of the curriculum
of an interdisciplinary organization theory (Services Computing)

The Services Computing as shown in figure 6 is currently becoming a cross-discipline covering both: the science and the technology bridging the gap between Business Services and IT Services by using web services and SOA, business consulting methodology and utilities, business process modeling, transformation and integration. In fact Services Computing has become the default discipline in our modern services industry by striving for the goal to enable IT services and computing technology to perform business services more efficiently and effectively.

FUNDAMENTALS OF LANGUAGE LOGIC

First, it is necessary to define the foundation for each kind of interdisciplinarity, i.e. for *infra-interdisciplinarity*. For level 1, this is achieved by the supplementation of formal logic with (material) languages. In the beginning, there is always the object of the language artifacts we want to (re)construct. This object is defined more closely through a rational classification of objects (e. g. by classifying the objects into things and events. Here, rational means that the objects of a language we look at can be (re)constructed from different angles or categorical approaches. This must be possible for all scientific fields equally, as "only using language we can distinguish objects from other objects" [Kamlah and Lorenzen, 1996]. And these objects can, depending on the categorical approach chosen (e.g. thing language or event language) be structured in different ways.

As already presented in [Wedekind and Ortner, 1980], we can disassemble propositions made in ordinary language – in order to obtain pieces of language (words, particles) from these structures - and structure them in an elementary way to use them for our further work. This way, "Paris is a city" becomes

{is a city} {Paris}

"Paris" shall be understood as an argument and must accordingly be represented by the variable "x". In this way, we obtain the *propositional form*:

{is a city} {x}

We replace the braces by capital letters

CITY (x)

and allow this open sentence, which now resembles a mathematical function f (x), to be extended by different arguments, one after the other, such as "Paris", "Frankfurt", "Vienna" instead of the placeholder "x". As a result, we no longer have an open sentence but a *propositional function* that is true if the inserted argument really is a city. This brings us back to Frege's logic of terms, by which a term is a function if “its value is always a truth-value”. [Frege, 2002].

$$\text{CITY (x)} \rightarrow \{\text{is true, is not true}\}$$

This procedure is fundamental and, therefore, avoids vagueness, because each proposition can be reduced to one truth-value in informatical modeling [Kamlah and Lorenzen, 1996]. “Paris”, “Frankfurt” and “Vienna” are subsumed under the term CITY, i.e. for them, the value of the propositional function is “true”. Because of the existence of such a set of *singular things*, Frege speaks of the meaning; whereas today we speak of the *extension* of the term. To fully understand the term, we further need Frege's “sense” (Sinn) that is the term's content, or the *intension*. It can be determined by adding further predicators to our term. In our example, CITY is the first predicator, the category predicator. All others belong to the terms already introduced.

CITY (x)	(NAME,	COUNTRY,	RESIDENT)
	Paris	France	2.167.994
	Frankfurt	Germany	659.021
	Vienna	Austria	1.680.447

Intensional, this is a so-called *thing schema*. Now we have clarified what a term respectively a concept is from the point of view of language logic on *level 1*, and how a discipline-transcending rational language (infra-interdisciplinary) for all participating disciplines to use is (re)constructed, for instance via a rational classification of things, step-by-step, cycle-free and making everything explicit. In the next step, we shall apply this conceptual model to task and process modeling.

FROM CLASSICAL ORGANIZATION THEORY TO ORGANIZATIONAL LOGIC

Using the conceptual logic respectively the logic of terms introduced in the previous section, it is now possible to apply it to particular subject areas. Thus, we have reached level 2.1 in figure 6, of the first interdisciplinarity-level. Here, language logic is supplemented by organizational content (terms) such as job, staff or work, which consistently leads to *organizational logic*. Enterprise organization and the important distinction of task and work in Kosiol [Kosiol, 1972] provides a sound example.

For work organization in the sense of Frederick Winslow Taylor's Scientific Management, the separation of planning and execution of work, precise task descriptions, the division of labor, incentives and motivation, etc. are recognized and at the same time established organization-theoretical principles. A task is performed by somebody or “something” (machine, computer, etc.). This fulfillment can again be described as “true” or “false”, “done” or “open”, etc. Also, a task is a (propositional) function whose value is always a truth-value. In informatical modeling (modeling with languages from CS), *tasks* lead to language-logical *schemas*, which on the intentional level consist of terms (concepts), and *work* that leads to *instances* of this schemas. Instances must be described in the form of singular propositions to “understand” them linguistically as extensional. Here, it is vital that task be reconstructed logically as an event term not as a thing term.

In accordance with our procedures in the previous section, we obtain the following example:

ENTERtransaction (z) $\rightarrow$ {is being executed, will not be executed}

The argument “z” can be replaced with the different executions, in the sense of the amount of singular events (extension) for which the value “is being executed” is true. From an intentional point of view, this results in an *event schema*, which can be used to model task and process schemas that are founded in science and theory. Use case diagrams, BPMN diagrams and basically all the diagrams categorized under “behavior” in UML [Hitz et al., 2005], are language-logically based on event terms and can thus be used for modeling an enterprise's process organization. Diagrams of the category “structure” can lead to an informatical modeling of an enterprise's organization structure as they are founded primarily on the language-logical thing terms and therefore must belong in the category "thing languages".

INTERDISCIPLINARY USE OF PROCESS TECHNOLOGIES

Language-theoretically, process modeling follows a different categorical approach than for example, the organization of data. And for this – from the point of language logic – relevant for these are thing languages (e.g. “4711 is an employee”) while for process modeling, event languages are relevant (e.g. “This machine preparation is taking place now”). Accordingly, for the implementation of the modeling results, database management systems (DBMS) can be used for data and workflow management systems (WfMS) for organizational processes. DBMS as well as WfMS are so-called *universal systems* (Universal Services). They can be used in enterprises only after an application based on them has been developed.

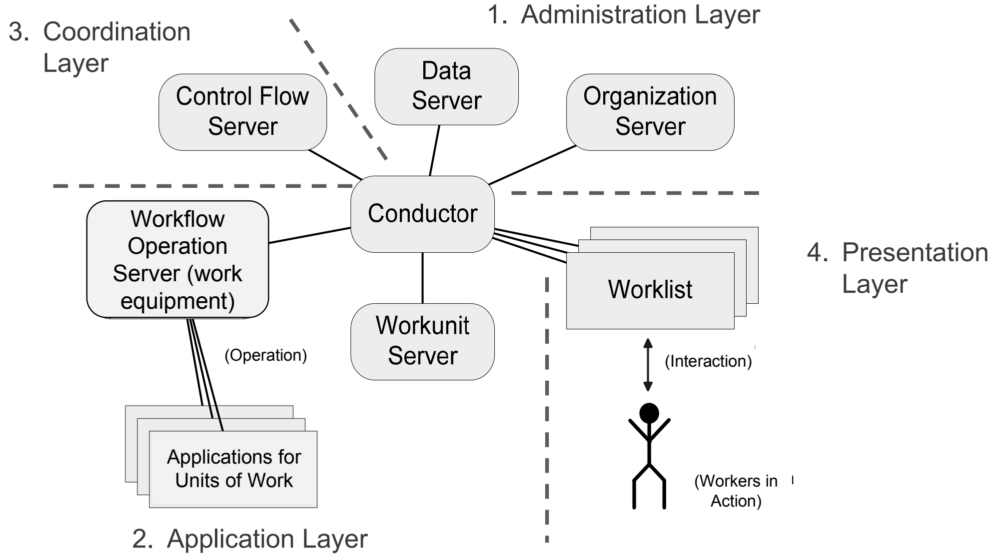

Figure 7. Architecture of a WfMS application system

While a paradigmatic separation of the organization of data and their maintenance takes place for DBMS-applications as well as the application programs on the other side, with WfMS-applications there is a conceptual separation of process control and process execution (by human beings and/or application software). WfMS-applications are usually modeled in an aspect-oriented way and even implemented using this structure [Jablonski and Petrov, 2005]. Figure 7 shows the architecture of such a WfMS application system. It is overlaid by a level-architecture as can be found in many SOAs on the software side, which was described in detail in [Ortner, 2008].

As shown in figure 1, we can organize the entire Internet including all its users as a global WfMS application system. It is more realistic, however, if we realize the potential to implement particular “parts” (e.g. functional areas) of enterprises or enterprise networks as WfMS application systems. The suitable sub-areas result from the degree of detail by which we are able to describe work processes on the task-level (event term) and schematize or model them before their execution.

It is clear that from the point of view of computer sciences the development and operation of WfMS application systems is on a far higher level of interdisciplinarity than ubiquitous computing promises on other application fields (e.g. in natural science). It seems a new interdisciplinary subject of study “Organisational Computer Science” as called for in [Ortner and Heinemann, 2007] is necessary – and justified. With respect to the Internet, since [Hendler et al., 2008] even a “Web Science” is under consideration in this interdisciplinary context. But also, a “Services Science”[1] cannot deny the interdisciplinary content of an “Organizational Computer Science”. Internationally, from the point of view of an extended *Business-Informatics* or *Information Systems Science*, if resources are allocated for this, we could at the same time talk about an "Enterprise Computer Science".

GENERAL CONDITIONS

In addition to the means-related requirements, for an interdisciplinary (means) science further general conditions are the goals pursued and their substantiation,

[1] First International Symposium, March 23.-25., 2009 in Leipzig, Germany.

or “ethical and political” justification, respectively. Computer Science is based on the language artifacts we create, "language engineering" [Ortner, 2005] so to speak. Arguing language-critically, clearly we are concerned with the constructive organization (i.e. step-by-step, circle-free and making explicit) of a *goal language* on the transdisciplinary level of our conceptual framework (figure 6), as well as the enterprise-specific language artifacts of this language that represent the entrepreneurial goals or motivation, that is, the objectives. This “goal language” justifies the results of using *means languages* (e.g. thing language or event language) in the application domains of IT. This is the highest quality assurance level in a (language) engineering field.

How constructivistic the methodical organization of a goal language can be presented in detail repeatedly, last in [Lorenzen, 1987], by Paul Lorenzen and is easily to understand for anybody who is open-minded. The organization aims at a plurality of compatible norms for human action. It is characterized by the requirement for trans-subjectivity and for overcoming our own subjectivity, thus for achieving common and compatible norms (e.g. goals).

In the context of the reconstruction of enterprise goals (*figure 8*), the OMG (Object Management Group) recommends the use of BMM (Business Motivation Model). Other developments in this field combine procedures such as Goal Analysis and Balanced Scorecards to an approach called “Balanced Goalcards” [Siena et al., 2008] to make management of enterprise ends successful: step-by-step, circle-free and, ethically and politically “correct”.

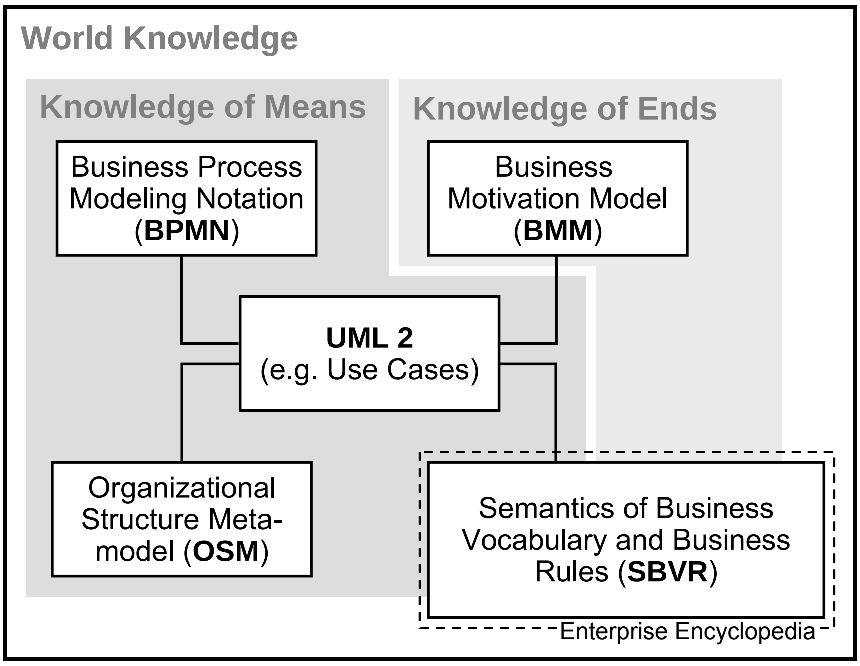

Figure 8. Administration of interdisciplinary knowledge by means of the UML and its extensions

According to Lorenzen, “Children need fairy tales, grown-ups need ideals” is a practical and indispensable requirement to us human beings for creating a goal order “this side of idealism and realism” [Lorenzen, 1992]. Of course, the question remains, whether a global economic system can be created this way, whether cartel laws will work or bribe money will no longer be paid. There will always be people on the other side of “normal-mindedness and willingness”. To be language constructivist is only using a method, not an ideology that wants to help “by force”. The (language) constructs that can be obtained using this method are, however, characterized by high quality and precision. Also stated in [Hendler et al., 2008] is that in our time such a common goal language (e.g. an world-order of economy) is needed.

IV. INTERDISCIPLINARIZATION, INSTITUTIONALIZATION, AND INTERNATIONALIZATION

So far we have focused on interdisciplinarity and in parts on institutionalization with regards to curricula of universities. Of course we also have to two look at schools that are responsible for literacy as well. Figure 9 shows the different implications of logic and technologies for human mankind.

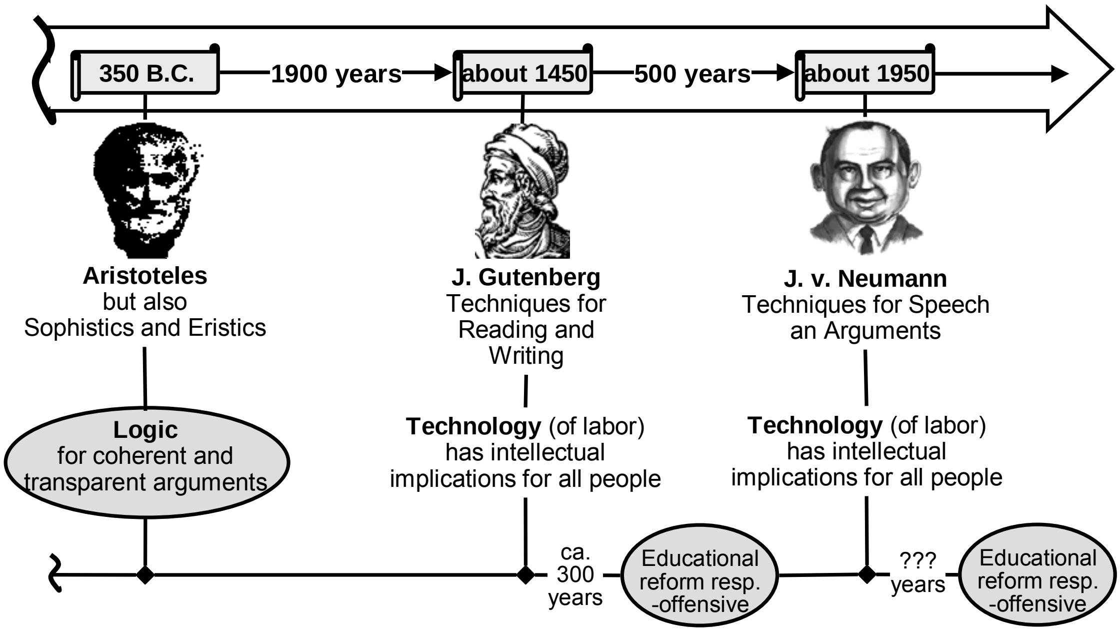

Figure 9. Institutionalization of basic interdisciplinary literacy

Interdisciplinarity as described in this text and shown in figure 10 means the importance of linking expert knowledge of different disciplines. Institutionalization is needed to spread and anchor this interdisciplinary basic knowledge among the society, and internationalization stands for the global industrialization of knowledge production.

How the future with regards to those three aspects should look like is forecasted and illustrated in figure 10. But for this it is indispensable that policy, economy, and science work hand in hand regarding interdisciplinary sciences like Services Computing or Enterprise Engineering.

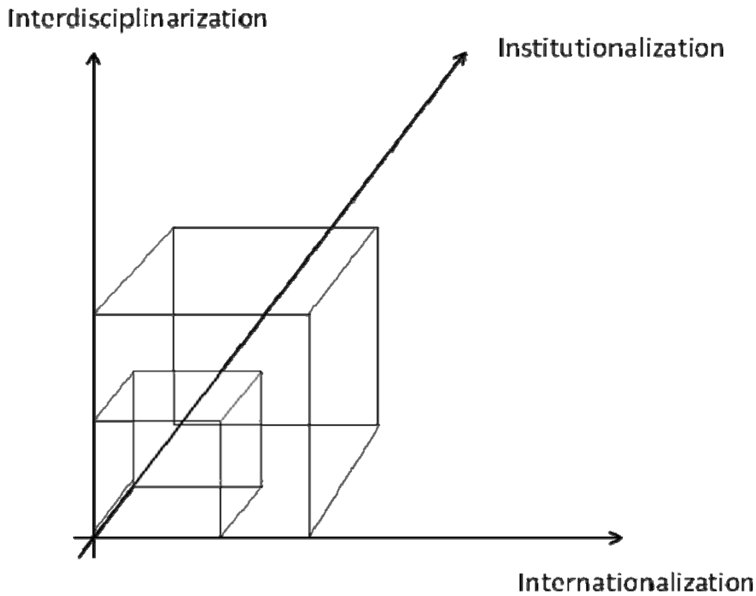

Figure 10. Interdisciplinarization, Institutionalization, and Internationalization

The small cube in figure 10 shows how much those three aspects are placed in our society so far whereas the huge cube should be the next reachable goal but by far not the limit of our efforts to spread interdisciplinarity, institutionalization, and internationalization.

V. OUTLOOK

The subject of interdisciplinarity is increasingly becoming an issue at universities in Germany and elsewhere. It seems, decision-makers around the world have realized that there is a need for it. In fact, the current situation in education and on the job market can be described as follows: Only the one who learned something that is interdisciplinary and cultural invariant, has a chance to be successful in business on nowadays' global labor market. This is not an easy task for politicians and those in charge of educational objectives, but as Bertrand Russell stated [Russell, 2001], it is possible: "Applying this philosophical method has resulted in a critical habit of mind that can be extended to all human activity. It causes fanaticism to cease and promotes the willingness to treat each other with sympathy and understanding." In other words: The solution to this dilemma and therefore the “ticket” to interdisciplinarity is precision on the part of the participating subject areas, for example when new interdisciplinary disciplines are created and introduced, that is based on the pillars of constructivism [Lorenzen, 1994].

Many a first-year student has realized that interdisciplinarity is a skill needed for a successful career. Looking at the enrolment numbers, applied computer sciences, especially Business Informatics – are about to outstrip the core computer sciences. In Germany, interdisciplinarity, especially with respect to a contructivistically-founded informatical organization theory, will lead to the establishment of new disciplines (e.g. “Enterprise Computer Science”), new job profiles (e.g. “Enterprise Engineer”) and new, or rediscovered, content in education (e.g. classical logic taught at school as part of learning the mother tongue) in the medium or long term. But there is a lot still to do on the part of science as well as on the part of policy-makers, to provide information and take the necessary steps.

VI. REFERENCES

Bieberstein, N.; et al. (2008) *Executing SOA – A Practical Guide for the Service-Oriented Architect, IBM Press*.

Frege, G. (2002) *Funktion, Begriff, Bedeutung*.

Heinemann, E. (2008) *Berufsfähigkeit und Anwendungsinformatik, Proceedings der Multikonferenz Wirtschaftsinformatik (MKWI).*

Hendler, J et al. (2008) *Web Science: An Interdisciplinary Approach to Understanding the Web,* in: Comm. of the ACM, Vol. 51, No. 7, pp. 60-69.

Hermann, H. D. and Schrammen, G. (2005) *Reden und Widerreden – Argumente für die deutsche Sprache, 2. Auflage*.

Hitz, M. et al. (2005) *UML@Work – Objektorientierte Modellierung mit UML 2, 3. aktualisierte und überarbeitete Auflage*.

Jablonski, S. et al. (2005) *Guide to Web Application and Platform Architectures.*

Kamlah, W. and Lorenzen, P. (1996) *Logische Propädeutik, 3. Auflage*.

Kosiol, E. (1972) *Die Unternehmung als wirtschaftliches Aktionszentrum, Reinbek bei*.

Lehmann, F.R. (1999) *Fachlicher Entwurf von Workflow-Management-Anwendungen*.

Lorenzen, P. (1987) *Lehrbuch der konstruktiven Wissenschaftstheorie*.

Lorenzen, P. (1992) *Diesseits von Idealismus und Realismus, in: JANICH, P. (Hrsg): Entwicklungen der methodischen Philosophie*, pp. 207-217.

Lorenzen, P. (1994) *Konstruktivismus*: Journal for General Philosophy of Science, 25 (1), pp- 125-133.

Mittelstraß, J. (1997) *Der Flug der Eule: Von der Vernunft der Wissenschaft und der Aufgabe der Philosophie.*

Ortner, E. (2005) *Sprachbasierte Informatik – Wie man mit Wörtern die Cyber-Welt bewegt*.

Ortner, E. (2008) *Language-critical Enterprise and Software-Engineering, Proceedings of the* 14 th American Conference on Information Systems.

Ortner, E., Eller, B. and Elzenheimer, M. (2008) *Das elastische Unternehmen – Wie die heutige Informationstechnologie von dynamischen Unternehmen eingesetzt werden könnte, Arbeitsbericht des FG „Entwicklung von Anwendungssystemen"*.

Ortner, E. and Heinemann, E (2007). *Memorandum zum Verhältnis von System- und Anwendungsinformatik: Diskussionspapier sieht Organisationsprozesse als das Fundament einer Neuausrichtung der Informatik*,: Computerzeitung Online vom 16. Juli 2007.

Russell, B. (2001) *Philosophie des Abendlandes*.

Siena, A. Bonetti, A. and Giorgini, P. (2008) Balanced Goalcards – Combining Goal Analysis and Balanced Scorecards, *Proceedings of ENASE, 3rd Inernational Conference on Evaluation of Novel Approaches to Software Engineering*, *Madeira (Portugal).* p. 107-114.

Wedekind, H., Inhetveen, R. and Ortner, E. (2005) Informatik als Grundbildung, 6 Aufsätze in: *Informatik-Spektrum, Heft 2 (2004) bis Heft 1 (2005).*

Wedekind, H. and Ortner, E. (1980) *Systematisches Konstruieren von Datenbankanwendungen-Zur Methodologie der Angewandten Informatik*.

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