

Philosophy for IT for Knowledge Management

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Abstract: For centuries, Philosophy has been a mine of ideas used to fertilize other disciplines. Being the “mother of sciences”, Philosophy addressed the notion of knowledge, the generation of knowledge, its transfer, with its prospects and limitations for quite a while. Knowledge Management, on the other hand, is gaining increasing importance in all business activities. However, the multidisciplinary nature of the approaches and the complexity of the notion of “knowledge” raise many issues that are often simply ignored or treated offhandedly. What, then, seems better than turning to and examining the potential of contributions of Philosophy to Knowledge Management and search for mutual promotion and synergy? This article tries to show two directions where Philosophy may provide help: model construction and lateral thinking.

Keywords: Philosophy, Knowledge Management

1 Introduction

Stader and Macintosh [SM99] define Knowledge Management as “*the identification and analysis of available and required knowledge assets and knowledge asset related processes, and the subsequent planning and control of actions to develop both the assets and the processes so as to fulfill organizational objectives*”. First activities labelled as Knowledge Management in this sense can be identified in the late 1970s [Leo95]. However, there is not much doubt that mankind used knowledge and, thus, somehow managed knowledge already long before (cf. [Bur02]).

Since a while, also people from a Computer Science and Artificial Intelligence background got involved into Knowledge Management. Their realm, Information Technology (IT), is regarded an enabler for many aspects of Knowledge Management solutions. IT systems are sometimes called its technical backbone.

Due to the IT background of the authors their foremost interest is the benefit of Philosophy for IT for Knowledge Management, i.e., for building and maintaining “systems” that are useful, that are built smart and actually meet a problem. Thus, the authors mainly hope to draw from Philosophy, seeking to better understand the object of their work, “knowledge”. We also suspect cases of Knowledge Management IT people who reach for the unreachable. Perhaps Philosophers could save some of them?

Maybe, we are idealizing Philosophy and hope to learn from it what Philosophy cannot provide us with. Perhaps Philosophy is too far away from practical implementation issues. But it is not our task to answer nor are we capable of answering the questions raised in this article. We are merely trying to start a dialog between Knowledge Management and Philosophy on things we deem important and which we are dealing with in our daily work.

2 Motivational issues

Throughout this article, it is assumed that there is a whole something that can be conceived of as *Philosophy* and analogically *Knowledge Management*. Then, it is not unlikely there are ideas in one discipline, Philosophy or Knowledge Management that every beginner student knows that are effectively not known by many people in the other discipline, whether experts or beginner students. [Bar00] Surely, one cannot say generally that (all) Knowledge Management individuals can profit from philosophical ideas. Depending on the circumstances, some would perhaps not profit and some others are already experts in both fields. However, even though there are some who might know ideas from the other discipline, one should consider the discipline as a whole, lacking the idea. All this said, we formulate our opinion that Philosophy as a whole, i.e. people and ideas, and Knowledge Management as a whole can probably profit from each other. (Perhaps, if this would be of use, one could even take the simplifying view of this as an issue of Knowledge Management of the knowledge in Knowledge Management and Philosophy.)

However, while thinking about bringing together the two disciplines – groups of people – one should never forget that the two are internally heterogenous. For instance, even though “mankind” was able to fly to the moon, this required a selection of some very specialized people. In IT companies, to the authors experience, software (i.e., systems) is rather often constructed by just the young and unexperienced who we found likely to prefer to start from scratch, not knowing or understanding the available status quo. Some (accidental) success provided, they easily become very resistant to changing their attitude.¹

Rephrased and with a focus on Philosophers to help IT, this becomes the following. Assumed that Philosophers can help (at all) in issues of Knowledge Management IT people, there are different situations:

1. Some IT people have concrete issues, i.e., formulated problems, that can be attacked. Perhaps Philosophers are challenged by such a problem, perhaps it can be solved with just a basic Philosophy lesson.
2. Some IT people do not see a problem, but Philosophers or other IT people diagnose some sub-optimum and can convince them that Philosophy can help them to improve.

¹Well, perhaps it is sometimes even better, if they don't change their winning strategy. E.g. Bill Gates started young (too late for the authors to copy him), with a strategy not known to that date and he was rather successful. ... But suddenly, because of so many ambivalent aspects of the story of Bill Gates' company, Microsoft, one encounters a completely different question: whether his business success is desirable, respectively for whom? But this is not a typical question for Knowledge Management IT. Perhaps Philosophers can help here?

3. A solution of Philosophers to a frequently occurring sub-optimum is more publicly “marketed” and IT people recognize it as being of value.
4. A solution of Philosophers to a frequently occurring sub-optimum succeeds to be incorporated into standard IT procedure.

We consider, for instance, the “use of ontologies in IT” belonging to the third or fourth situation above because it has probably improved, but surely changed the lives of many IT people (who did not even want their lives changed). We think, a strong barrier between Philosophy and IT was crossed here. There are surely more barriers out there.

A further consequential issue is: is it obvious about which topics Knowledge Management and Philosophy should talk? Are there open questions of IT/of Philosophy negotiated, agreed and phrased?

According to Falconer [Fal00], Knowledge Management strives for “‘solutions’ to largely unstated problems.” We do not think that the problems of KM are to a high degree unstated, but here we come back to the non-homogeneity of the KM discipline. It is not always enough that somebody has stated a problem, it is required that the problem statement is alive in the community.

Certainly, we did not yet make explicit the obvious, basic problem, the necessary fundament to be solved prior to everything else. Philosophers and IT for Knowledge Management people need to establish a basis for communication. They need to learn to talk and understand each others languages (in which they have to anticipate the others issues) and they need to develop a sense for each others cultures (without which, to our experience, humans tend to get angry quickly [DM02]).

We want to add a last observation. When we happen to read older articles, e.g. from Artificial Intelligence (for example, [MH69]), we sometimes have the impression that there are a number of issues which have been phrased and targeted already long ago, e.g. in the 1960s, but seem not to have fundamentally evolved since then. What is required to do better today?

3 The Potential

In their projects, the authors find that not many IT people have a sense for non-technical issues. Even if they cause serious difficulties, notions and ideas from Philosophy that could contribute tend to be refused right away. Thus, we suspect that there are philosophical contributions that can help in IT. Before actually going for a goal like trying to find scenarios where this could be demonstrated, now, one should try to find consensus on whether such a goal is sensible.

Hauk [Hau98] introduces Philosophy as “the quest for certainty in knowing”. This quest comprises three ingredients, phrased by Falconer [Fal00] as *being of the world*, the *universe as we perceive it*, and the *universe as we conceive it*. These three ingredients in mind, Falconer [Fal00] notes that “*it has been persuasively argued that the universe as it re-*

ally is and the universe as we conceive it are largely unknown territory". In Knowledge Management, we, as sense-making subjects², started out to chart this unknown territory by using such tools as *concepts*. It is hard to tell, how different Knowledge Management people who are using concepts, interpret their concepts, whether they consciously interpret them at all, in terms of the above three categories.

The authors understand that Philosophy somehow started in the antique, replacing step by step so-called *mythos*, introducing a kind of rationality, where rationality pertains to a certain strictness in thinking. Here, IT people, whose profession is to create such a formal artifact as software, should be naturally attracted.

Since the antique, Philosophy had quite a while to elaborate. The authors like Hauk's overview (of course simplifying), dividing philosophical development into four historical successive phases [Hau98]:

1. The search for the being of the world.
2. The supplement of this with epistemology, i.e., the consideration that human insight is confined by cognition.
3. The supplement of this with language criticism, resolving a couple of issues as mere misunderstandings.
4. The abandonment of the search for absolute knowledge, and its replacement with iterative, laborious furthering of existing assertions.

This reads as if, today, the quest for a safe and absolute fundament of knowledge came to an end: for epistemological reasons, we read, it is obvious that absolute knowledge cannot exist. This is an important issue to understand correctly, for the authors and many more in IT for Knowledge Management.

There is certainly much more to say. For the sake of brevity, we need to confine ourselves to little, with which we though aim to attract some attention of the IT reader. From an introductory book [DGSW00] we draw some statements, which are attributed to a rather recent Philosopher, Popper: "A theory does not need to be true, only successful. New theories are not necessarily accepted because of being better but because they find enthusiastic supporters, who believe in them and advocate them. Old theories sometimes die, not being falsified, but simply because their representatives die. Many irrational factors like intuition, enthusiasm and hope often play a crucial role."

IT people need skills embedded in Philosophy or, at least, based on philosophical grounds: intelligent systems for Knowledge Management are based on (formal) models of (parts of) the universe (as we perceive it) and the human conception of it. Even though these modelling aspects were just a few paragraphs above characterized as "unknown territory", still, such systems are constructed and thus also such models. Often, the authors argue, IT people are not at all conscious that they rely on models.

According to Falconer [Fal00] "*the artificial intelligence discipline, for many years, ignored the obvious fallacies in their work which their philosophical forebears bequeathed*

²<http://communication.sbs.ohio-state.edu/sense-making/>

them [...] and soldiered on uselessly. The knowledge management discipline is poised to be victim to the same fallacies [...]". It seems likely that there is some potential for improvements.

4 The Direction

The mutual consulting of two disciplines is almost always beneficial. According to Barberi [Bar00] "*... methods, notions, issues and arguments, which succeeded to practically prove their intellectual stringency and plausibility in other places, are neglected or accepted only very delayed in related sciences.*" Thus, the import of methods, notions etc. has a good chance to be a boost for a discipline. The mutual consulting of two disciplines is already rather elaborated elsewhere, e.g., in the symbiosis between Artificial Intelligence and Cognitive Science. There, the agreed part of Artificial Intelligence is the practical experimenting with Cognitive Science theories [Mit98].

In the following we try to shed light on the realm of IT for Knowledge Management and respective issues of the authors. We (boldly) state that Philosophy is the fundament of any model construction and that Philosophy enhances lateral thinking. Again, we hope to provoke appropriate response from Knowledge Management people as well as from philosophers.

4.1 Philosophy as the Fundament of Model Construction

"Finally, more than just a select few information scientists are realizing that perhaps Philosophy does have something useful to say about the objects of their work."[SW01] All tasks in Knowledge Management related to model construction, we feel, need (at least some) philosophical grounding. Once the construction of a formalized model is finished, Knowledge Management is rather experienced in what can be done with it (compare e.g. Lutz [Lut02]).

To work on a conception of things, other than variables and data structures in software, was widely not accepted for a long time in IT for Knowledge Management. The necessity was often not easy to motivate. Simple "trial and error" worked sufficiently to satisfy many demands on IT for Knowledge Management – not to mention the support of the immense growth of computer power. As long as the feeling of success dominates, as long as goals seem achieved, the general effort to improve is rather weak: why complicate things by introducing something "new", Philosophy, to the game?

The import of the notion of ontology into Knowledge Management has greatly improved the issue of modelling [CJB99]: "*Ontologies are important because ontological analysis of a domain clarifies the structure of knowledge and ontologies enable knowledge sharing*". So, today, ontologies are used to represent models conceived of domains. Not to be misunderstood: like others, e.g. Smith and Welty [SW01], we interpret the notion of ontology in its broadest sense. Relying on structural or formal features it is not hard to

distinguish between e.g.: glossary, thesaurus, taxonomy, also topic map and the like. However, these are all somehow used to denote conceptions of reality, are thus somehow of the same category. This category we label ontology.

Where IT people tend to view ontologies / models closer related to their software, Philosophers contribute to a more comprehensive understanding of modelling. Bailer-Jones [BJ00], e.g., points out drawbacks of a traditional view on scientific models in which models were exclusively hypothetical with only temporary value during knowledge acquisition, and reality was described with theories, not models. More recently, models have become mediators between theory and real world, and theories can only be applied to reality by using models.

Scientific models interpret empirical phenomena in a way that eases the understanding of the discussed phenomena. Interpretation can mean processes of idealizing, simplification, or analogical reasoning. A model provides (preprocessed) information to relate different phenomena to each other and to share them with other users of a model. [BJ00]³

Models are often imprecise, inconsistent, and aspect-focused – (negative) properties of models that were the major cause of rejecting models as describing reality. But models are useful representations of reality if one only takes three parameters into account: *function*, *selection*, and *correspondence with empirical data*. Whether a model is a good representation depends on the intended function. Not all aspects are or need to be represented by the model, some aspects of a phenomenon may even be misrepresented. The representation also depends on the amount of information available at a given time. [BJ00]

In the end, the users of a model (have to) decide about the quality of a model regarding its function, selection, and correspondence with empirical data. Absolute knowledge is impossible to reach. There will always be a multitude of coexisting models. [BJ00]

Fortunately, there are already some philosophers providing applicable guidance to IT people for model construction, e.g. Nicola Guarino, from which we like to cite a very short and crisp paper on modelling [GW02]. There is the Conference on Formal Ontology in Information Systems, to which we like to refer through Smith and Welty [SW01]. Also, this seems to us the right place to mention the workshop on “Erkenntnistheorie – Semiotik – Ontologie (ESO): Die Bedeutung philosophischer Disziplinen für die Softwaretechnik” (“Epistemology – Semiotic – Ontology: The contribution of philosophical disciplines for Software technology”) in 2001 at the annual German Informatics Society meeting, and the mini track on “Philosophical Foundations of Information Systems” at Americas Conference on Information Systems (AMCIS), since a while chaired by John Haynes.

Knowledge Management has principally accepted that a basic aspect of models is that they ought to be shared among groups of people. But the status in Knowledge Management concerning the failed strive for objective truth (of models) does not seem to be really clear. For example, Smith and Welty [SW01] do exclusively focus on the superiority of ontology

³This is of interest to IT people, in order to support not only the solution of problems, but also to support the spread, reuse and evolution of solutions and ideas. In IT sometimes technologists from slightly different areas do not even understand each other. Generally, the level and terminology on which technologists describe their solutions is not the level on which one easily transfers them to slightly varied problem situations. Model construction is thus considered by us also always a basis for communication, i.e., the transfer and negotiation of ideas.

“over the ad-hoc, case-by-case methods previously used”. Thus, at least for the moment, they do not emphasize that this may be again only temporarily and locally successful. The naive reader can be misled to the antique quest of philosophical ontology for the one and for all truth, the one correct model.

Models of different people and groups will initially differ, which raises some issues in IT for Knowledge Management, where Philosophy could possibly help out with some expertise:

1. **Ontology merging:** IT for Knowledge Management is currently heavily struggling with methods for the uncovering of ontology mismatches and their removal through negotiation.

As one special issue here, the assumption of, e.g., Smith and Welty [SW01] that the merging of two ontologies requires to have one top-level ontology, seems to us, to induce the misleading idea of one top-most “true” ontology.

2. **Ontology maintenance:** A growing practical problem in IT for Knowledge Management is the maintenance of models (represented with ontologies), i.e., their adaptation due to changes. This problem is especially complicated, as the needs for change must be coordinated with the existing formalized model.

3. **Ontology evaluation (“quality”):** After experts have installed a system, users are left alone with it. Practice shows that serious deteriorations occur because of deficits in maintenance. This is in contrast to expensive machines, where losses are immediately quantifiable and where such qualitative deterioration does not occur.

Another issue in this context is very important and is already approached by IT scientists with Philosophical expertise since years: the evaluation of the suitability of mathematical approaches like logics for modelling “reality” (and thus for Knowledge Management) [MH69].

There are some philosophical notions and methods out there, aren’t there?

4.2 Philosophy Enhances Lateral Thinking

The turning to failures of Knowledge Management are chances for detailed reviews of its methods – chances to take advantage of philosophical aid. Here, we refer to the interpretation of Peirce from an introduction in Philosophy [DGSW00]: *“As soon as acquired behaviors lead to failure, uncertainty arises, which we try to overcome, by a detailed review of our assumptions and of our behavior, to come to sensible changes, to come back to the calmness of untroubled behavior.”* Knowledge Management encounters issues which are yet unsolved. The authors hope to get the instruments from Philosophy to start to model the problems of Knowledge Management in order to solve (at least some of) them.

We regard Philosophy as a chance to extend Knowledge Management “culture” with complementing opportunities to reason and thus to progress. Only the leaving of the traditional,

prescribed paths of ones discipline allows one to see and approach traditional shortcomings of the discipline. This is what we address with “lateral thinking”.

Of course, the authors like to refer here to Kuhn [Paj98] that, “*contrary to popular conception, typical scientists are not objective and independent thinkers. Rather, they are conservative individuals who accept what they have been taught and apply their knowledge to solving the problems that their theories dictate. Most are, in essence, puzzle-solvers who aim to discover what they already know in advance.*” And, Kuhn continues: “*The man who is striving to solve a problem, defined by existing knowledge and technique, is not just looking around. He knows what he wants to achieve, and he designs his instruments and directs his thoughts accordingly.*”

Actually, it is widely demanded and practice in Knowledge Management to evaluate hypotheses quantitatively with test runs of prototypical implementations. We argue that the qualitative aspects are not enough focussed by Knowledge Management research and we hope for support of Philosophy in this concern, to clarify the use of quantitative and qualitative evaluation. “*Qualitative methods involve exploration, the first step in inquiry. Quantitative methods involve verification, the last step. Although preliminary exploration is usually necessary and always helpful, exploration requires verification. The weakness of verification alone is that since experiments and other standardized formats (such as the scale and the standardized interview) are narrow and rigid, one needs to have considerable knowledge before an adequate testing procedure can be designed.*” [Sch97]

For some further argumentation, we look at the realm of Information Retrieval, one important technique in Knowledge Management. Swanson [Swa88] provides a nice collection of observations.

Information retrieval research is traditionally strongly based on quantitative evaluation based on numerical indicators called “recall” and “precision”. But the following observations, we agree with Swanson, demand a different, more qualitative analysis of the problem and the approaches [Swa88]: “*More than thirty years ago there was good evidence to suggest that information retrieval involved conceptual problems of greater subtlety than is generally recognized. The dramatic development and growth of online services since then seems not to have been accompanied by much interest in these conceptual problems, the limits they appear to impose, or the potential for transcending such limits [...]*”

(1) Two information retrieval systems joined in a contest in 1953: 15.000 technical documents, 98 questions, and it had to be agreed before, which documents were the right answers to those 98 questions. “[...] *both teams agreed that 1390 documents were relevant to one or more of the 98 questions, but there were another 1577 documents that one team or the other, but not both, considered to be relevant – a colossal disagreement that was never resolved.*” Both competitors claimed victory; nobody cared there was a scientific issue.

(2) “*These authors [Kent, Berry, Luehrs, Perry], and hundreds of IR researchers since, seemed to accept uncritically the idea that relevance is additive. The possibility, for example, that two irrelevant documents might become relevant if put together has never been adequately considered, so far as I know.*”

(3) “[...] *Oliver Lilley at the Columbia library school was investigating the extent to*

which subject headings assigned to books was predictable by prospective users of the catalog. The results were amazing. 340 graduate students in the library school, asked to chose subject headings appropriate to six books, came up with an average of 62 headings per book, of which 61 were different from the headings actually used on the catalog card.”

(4) “John O’Connor at the University of Pennsylvania, [...] 1960 [...] noted among other things that 11 out of 23 documents properly indexed with the term “toxicity” did not contain any word at all with the stem “toxi”.”

Referring back to a citation of Falconer in the Introduction of this paper, that Knowledge Management strives for “‘solutions’ to largely unstated problems.”, one could take the following viewpoint on the above. Scientific contributions in Knowledge Management IT are always focusing on solutions. Philosophy could possibly help to first find the right questions to ask?

Can Philosophers contribute to such issues? Do they see potential for improvements? How should the situation be interpreted and how thus could it be approached? Can Philosophers help to find the right questions to ask?

A rather novel view on knowledge, called *memetics*, is described in [Hey93]: “[...] knowledge can be transmitted from one subject to another, and thereby loses its dependence on any single individual. The death of an individual carrying a certain meme (i.e., a piece of knowledge) no longer implies the elimination of that piece of knowledge [...]. As long as a meme spreads more quickly to new carriers than that its carriers die, the meme will proliferate, even though the knowledge it induces in any individual carrier may be wholly inadequate and even dangerous to survival. And, Heylighen continues, [...] a piece of knowledge may be successful (in the sense that it is common or has many carriers) even though its predictions may be totally wrong, as long as it is sufficiently “convincing” to new carriers.” But the most important change of view on knowledge is that [...] the subject of knowledge has lost his primacy, and knowledge becomes a force of its own [...]. That this is realistic can be illustrated by the many superstitions, fads, and irrational beliefs that have spread over the globe, sometimes with frightening speed.”

In the light of trends like the semantic web, this sounds very interesting. How do other Philosophers take these ideas up? How do they advice us to think about them?

5 Summary and Outlook

In this paper, we addressed some issues the authors deemed important for the further development of Knowledge Management. We tried to shed some light on open questions and links between Philosophy and IT in Knowledge Management. We hope to see some discussion start between the two disciplines.

Today, *information* is so prominently put into the center that the information-related disciplines of Philosophy and IT for Knowledge Management could be required to be combined on a larger dimension. But what would be the cost, what would be the utility? It is also possible that a re-organization of the disciplines can be achieved with some effort, so as

if a company buys some organizational consulting and both better go on to coexist more separated after that. We understood that in Norway, every student must take at least one lecture in Philosophy. Would that be an example to follow for Knowledge Management IT people?

Although our focus was on the potential benefit of Philosophy for Knowledge Management, Philosophy can, hopefully, also profit from Knowledge Management as well:

1. We think that, generally, where the experience in qualitative thinking of Philosophy could relax, i.e., enhance, the focused attention of Knowledge Management IT to quantity, the quantitative and formal experience of Knowledge Management IT are aspects that could yield new power to Philosophy.
2. Also, Knowledge Management can bring philosophical ideas to bear and give them the chance to prove successful.
3. Finally, perhaps some Philosophers would like to use Knowledge Management systems, simply to support them to master the knowledge they already have.

(Some further, more detailed suggestions are enumerated e.g. in [SW01].)

Disciplines and sciences can learn from each other if they want to. Of course, they are always implicitly constrained in the ways they foster argumentation and progress due to their respective culture. And, Dennet [Den99] states: “*What philosophers (and everyone else) have always known is that people – and no doubt all intelligent agents – can engage in swift, sensitive, risky-but-valuable ceteris paribus reasoning. How do we do it? AI may not yet have a good answer, but at least it has encountered the question.*”

However, there are trends close to Knowledge Management, where Benjamin Franklin is cited: “*in this world nothing is certain but death and taxes*”, followed with an enumeration of disciplines that seem important: Philosophy is omitted.⁴ A popular German scientific magazine writes: “*We act automatically most of the time, perhaps always.*” [Pau01] And further: “*To bridle the automatic reactions is very hard even for openminded people, as shown by quite a few experiments.*” [Pau01] If this is true, this does not leave much space for rationality, and then it seemed best to concentrate all effort into the empirical research of human behavior exclusively, and skip Philosophy. After all, maybe, those who feel Philosophy a useful partner for Knowledge Management (respectively IT), first need to discuss and explain the relevancy of Philosophy for (IT for) Knowledge Management.

References

- [Bar00] Alessandro Barberi. Historische Epistemologie und Diskursanalyse. *Österreichische Zeitschrift für Geschichtswissenschaften*, 11(4), 2000. [in German] <http://www.univie.ac.at/Wirtschaftsgeschichte/OeZG/OeZG004.html> [Last access: 2002-10-18].

⁴<http://www.mpib-berlin.mpg.de/en/forschung/abc/forschungsziele.htm>

- [BJ00] Daniela M. Bailer-Jones. Naturwissenschaftliche Modelle: Von Epistemologie zu Ontologie. In Ansgar Beckermann and Christian Nimtz, editors, *Argument und Analyse: Ausgewählte Sektionsvorträge des 4. Internationalen Kongresses der Gesellschaft Für Analytische Philosophie*, pages 1–11, Bielefeld, 2000. Gesellschaft für analytische Philosophie. <http://www.gap-im-netz.de/gap4Konf/Proceedings4/pdf/6%20WT01%20Bailer-Jones.pdf> [Last access: 2002-08-30].
- [Bur02] Peter Burke. *A Social History of Knowledge*. Polity Press / Blackwell Publishers, Cambridge, 2002.
- [CJB99] B. Chandrasekaran, John R. Josephson, and V. Richard Benjamins. What are Ontologies, and Why Do We Need Them? *IEEE Intelligent Systems*, pages 20–26, 1999.
- [Den99] Daniel C. Dennett. *Cognitive Wheels: The Frame Problem of AI*, 1999. <http://hps.elte.hu/~gk/books/cog/dennett.htm> [Last access: 2002-10-18].
- [DGSW00] Christoph Delius, Matthias Gatzemeier, Deniz Sertcan, and Kathleen Wünscher. *Geschichte der Philosophie – Von der Antike bis Heute*. Könnemann Verlagsgesellschaft mbH, Köln, 2000. [in German].
- [DM02] Jean-Claude Dunyach and Robert Moore. *Management of the Enhance Project: Lessons Learned*, 2002.
- [Fal00] James Falconer. Knowledge Management at a Branchpoint: Will We Ignore the Lessons of the AI Discipline the Way It Ignored the Lessons of Ludwig Wittgenstein? *International Journal Technology Management*, 20(5/6/7/8):601–632, 2000.
- [GW02] Nicola Guarino and Christopher Welty. Evaluating Ontological Decisions with OntoClean. *Communications of the ACM*, 45(2):61–65, 2002.
- [Hau98] Freimut Hauk. *Faszination Philosophie*. Sachbuch 60347. rororo, Reinbek, Germany, 1998.
- [Hey93] Francis Heylighen. *Epistemology, Introduction*, 1993. <http://pespmc1.vub.ac.be/epistemi.html> [Last access: 2002-10-18].
- [Leo95] Dorothy Leonard. *Wellsprings of Knowledge*. Harvard Business School Press, 1995.
- [Lut02] Carsten Lutz. Description Logics with Concrete Domains – A Survey. *Advances in Modal Logic*, 4, 2002.
- [MH69] John McCarthy and Patrick J. Hayes. Some Philosophical Problems from the Standpoint of Artificial Intelligence. *Machine Intelligence*, 4:463–502, 1969.
- [Mit98] Melanie Mitchell. A Complex-Systems Perspective on the 'Computation Vs. Dynamics' Debate in Cognitive Science. In *Proceedings of the Twentieth Annual Conference of the Cognitive Science Society*, 1998.
- [Paj98] Frank Pajares. Thomas Kuhn, 1998. <http://www.emory.edu/EDUCATION/mfp/Kuhnsnap.html> [Last access: 2002-10-18].
- [Pau01] Jochen Paulus. Unser geheimer Strippenzieher. *Bild der Wissenschaft*, (11):70–74, 2001. [In German].
- [Sch97] Thomas J. Scheff. Part/Whole Morphology: Unifying Single Case and Comparative Methods. *Sociological Research Online*, 2(3), 1997. <http://www.socresonline.org.uk/socresonline/2/3/1.html> [Last access: 2002-10-18].

- [SM99] Jussi Stader and Ann Macintosh. Capability Modelling and Knowledge Management. In *Applications and Innovations in Expert Systems VII, Proceedings of ES 99 the 19th International Conference of the BCS Specialist Group on Knowledge-Based Systems and Applied Artificial Intelligence*, pages 33–50, Berlin, 1999. Springer-Verlag.
- [SW01] Barry Smith and Chris Welty. Ontology: Towards a New Synthesis. In Chris Welty and Barry Smith, editors, *Proceedings of the Second International Conference on Formal Ontology in Information Systems*, pages iii–x, Ogunquit, Maine, 2001. ACM Press.
- [Swa88] Don R. Swanson. Historical Note: Information Retrieval and the Future of an Illusion. *Journal of the American Society for Information Science*, 39(2):92–98, 1988.