

Modeling Process of Traffic Safety Terminology with the *iglos* Software - A Methodological and Terminological Approach

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New disciplines with a specific terminology are being developed because of the increasing technical progress. On the whole, these multidisciplinary effects as well as the development of international communication problems between non-professionals and experts of a special field or between experts of different sciences. It becomes usual that technical terms are defined differently in different fields and languages. Therefore, we will present the iglos terminology management system of the Institute for Traffic Safety and Automation Engineering of the Braunschweig University of Technology as a software platform which evolves different methodological approaches for solving lexical and terminological problems between terms of different varieties (technical languages) and natural languages. First of all, these include classical semantic vagueness such as synonymy (relation of words with the same or similar meanings), antonymy (relation of words with the opposite meanings), hypernymy-hyponymy (relation between superordinates and subordinates) and ambiguity (relation of words with several meanings). For example, the German term Sicherheit has two meanings and three translations in English, namely safety, security and certainty. Whereas the first two translations define the feeling of being under protection, the third translation describes the assurance. It is the main target of iglos to avoid the multilingual misunderstanding between special languages of different fields by standardising the definitions of technical terms. In our paper, we will treat the semantic differentiation between safety-related terms as Sicherheit in German and safety and security in English with the iglos terminology modeling process on the basis of the iglos sign model as one method for solving linguistic problems.

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Introduction

With the increasing multidisciplinary and multilinguality, the linguistic and terminological communication between different disciplines grows more and more in importance. Terminology is the vocabulary of a discipline or domain (variety). There are heterogeneous definitions for *terminology* in research literature. Whereas the linguistics describes it as a system of terms in which the relations between the terms are governed (Seiffert, 1997), the standard DIN 2342:2011 defines terminology as the whole vocabulary of technical terms or as the entirety of terms and their designations or designations in a special domain (DIN 2342, 2011). The ISO 1087-1:2000 describes terminology as a “set of designations belonging to one special language” (ISO 1087-1:2000).

The disciplines which deal with terminology are the terminology work and the terminology management which “focuses on structuring, storing, exchanging, disseminating and using terminological information [...]” (Galinski & Budin, 1993). For these purposes, *iglos* (acronym for *intelligent glossary*) of the Institute for Traffic Safety and Automation Engineering of the Technische Universität Braunschweig is one example for a terminology management system.

The basic goal of *iglos* is to avoid and solve linguistic and terminological problems between technical terms of different varieties and to standardise them according to a special variety.

It is the intention of this paper to exemplify the definition and relation problems between safety-related terms – such as *safety*, *security*, *risk*, *hazard*, *danger*, *harm* and *damage* –in English common language and English traffic engineering and to avoid them by a terminological concept and a supporting process and tool for modeling.

The *iglos* Terminology Work

The idea for *iglos* resulted from an interdisciplinary cooperation between the Institute for Traffic Safety and Automation Engineering and the Department of German Linguistics in the Institute for German Studies both at Technische Universität Braunschweig. The project consistently grows in complexity and richness of perspective by our interdisciplinary dialogue with linguists, terminologists, computer scientists, engineers, translators and users on the one hand and different mother languages and international educational academies on the other hand.

In this context, we present the targets and foundations of the *iglos* terminology management system and the variety-based *iglos* sign model.

Aims and Foundations

Firstly, it is the target of *iglos* to develop a software platform based on an advanced linguistic concept. This terminology management system is intended

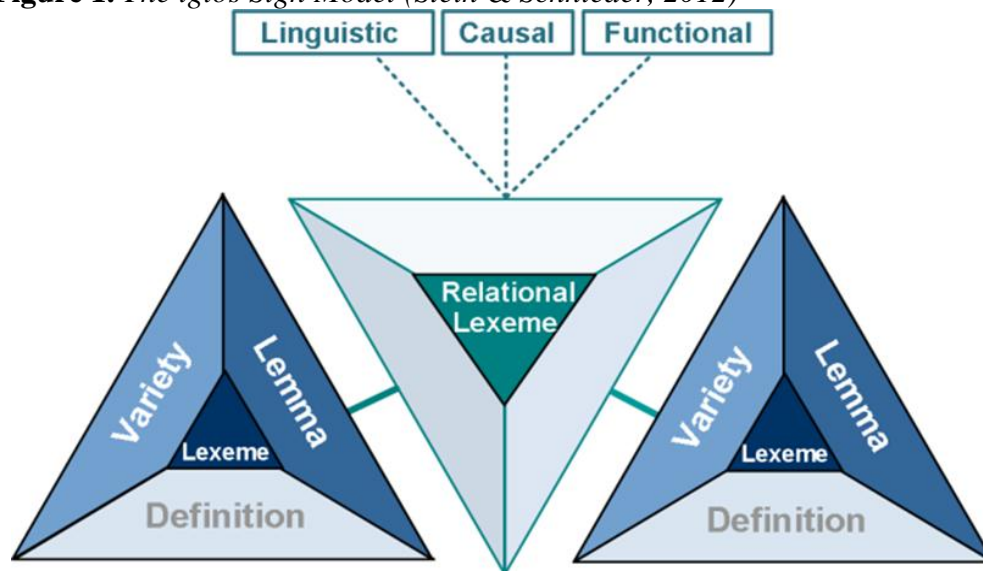
to accelerate and enable the development of a consistent, unambiguous and multilingual technical terminology for improving the scientific and commercial communication. Secondly, the foundation of the *igloos* terminology management system consists in a further development of the trilateral variety-based semiotic model which takes linguistic signs into account. These signs are determined by their linguistic context.

Therefore, the focus will be on linguistic relations such as synonymy, homonymy, meaning similarities and multiple possibilities of translation etc. (Löbner, 2003).

The iglos Sign Model and iglos Relation Types

Originally, the variety-based trilateral *iglos* sign model (figure 1) describes linguistic signs, especially lexemes as abstract morphological units which are concretised by their grammatical word forms. A lexeme consists of three constituent sides, namely the lemma (designation), the definition which is a description of the lexeme and the variety (technical language) as the context of the lexeme. In the terminology, terms are special lexemes. On the whole, there are three lexemes. A relational lexeme represents a certain relation type. It connects at least two lexemes. Some selected relation types with their predicates are mentioned in this context: risk of confusion (*isMixesUpWith*), translation (*hasTranslation*), output (*hasOutput*, *isOutputOf*), input (*hasInput*, *isInputOf*), holonymy (*hasPart*, *isPartOf*), meronymy (*isPartOf*, *hasPart*), antonymy (*hasAntonym*), synonymy (*isSynonymOf*), polysemy (*isPolysemOf*), homonymy (*hasHomonym*). Currently, there are 32 relation types in the *iglos* tool.

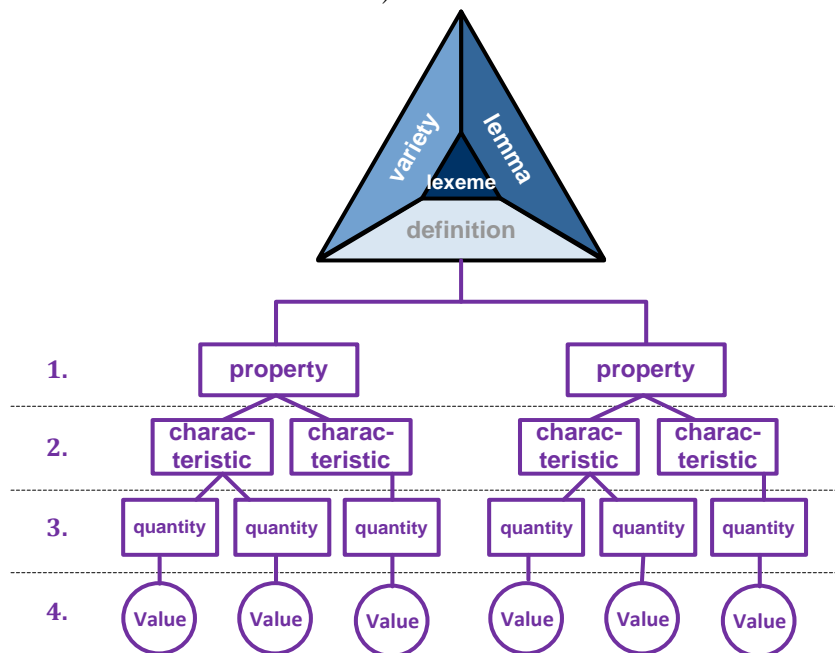
Figure 1. *The iglos Sign Model (Stein & Schnieder, 2012)*



Moreover, the *iglos* sign model contributes to the specification of terminologies by reducing or avoiding terminological haziness. This can be explicitly carried out by the consistent attribute hierarchy of attributes

(properties, characteristics, quantities and values) (see figure 2).

Figure 2. Attribute Hierarchy of Property, Characteristic, Quantity and Value (Stein; Schnieder & Schnieder 2011)



Finally, synonymy and ambiguity (disambiguation) of terms within the communication between different languages (multilingualism) and domains (multidisciplinarity) are also avoided with the trilateral *iglos* sign model.

After clarification of semantic haziness between terms, the second main merit of the *iglos* terminology work is the visualisation of term relations (formalization of terminology in a terminology building).

Terminological Approach for Solving Linguistic Problems between Safety Terms

There are many related works which are the basis for the approach of clarification of semantic vagueness between railway safety terms. Among these, there are e.g. the work of Stein & Schnieder (2012), Stein; Schnieder; Pfundmayr (2010) and Schnieder; Stein; Schielke; Pfundmayr (2011). In all these analyses, the *iglos* terminology work is presented especially with a reference to the *iglos* tool. Therefore, it is our objective to transfer the analyses of these frameworks to the analysis of railway safety terms.

On the basis of Petri nets, we want to present the dynamic relations with causal and temporal aspects of the safety concept. There are modular sub-nets (small Petri-nets) which are semantically related with each other and create a complex Petri net. In general, Petri-nets allow for abstraction and complexity (Schnieder, 2012).

The safety-terminology should be highlighted by describing the existing relations between safety-related terms. In this section, we want to present the definition problems between safety-related terms in the technical language of traffic engineering by comparing their definitions in general linguistic usage. Furthermore, we want to propose a method of resolution for these definition problems.

Safety-related terms especially refer to *safety*, *security*, *hazard*, *danger* and *risk*. This section consists of three subsections. In the first subsection, we want to introduce the important terminological problem definitions of safety-related terms. The second subsection is about the different possibilities of definitions for safety-related terms and the third subsection about the modeling of relations between safety-related terms with *iglos* for solving the semantic uncertainty.

Important Problems

Especially, our main question is the semantic vagueness between *safety* and *security*. Schnieder; Schnieder & Ständer (2009) analyse the definition of safety and security in two separate concepts. On the one hand, there is the concept of safety with its related terms *hazard*, *hazardous event*, *hazardous situation*, *harmful event*, *harm* and *risk* (figure 3). On the other hand, there is the security with its related terms *threat*, *threatening event*, *unimpaired asset*, *harm/disaster* and *unwanted incident* (figure 4). The common point of both concepts is the term *risk*.

Figure 3. Formalisation of Safety Terminology according to ISO/IEC Guide 51 (2014-04)

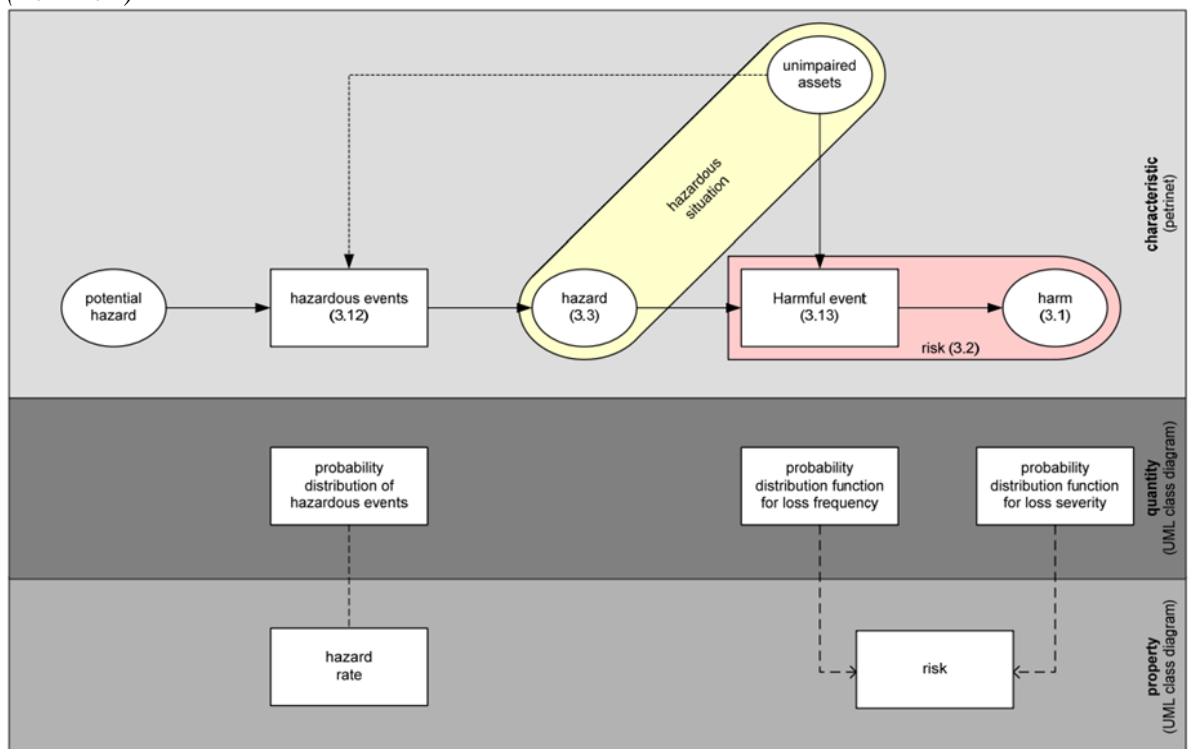
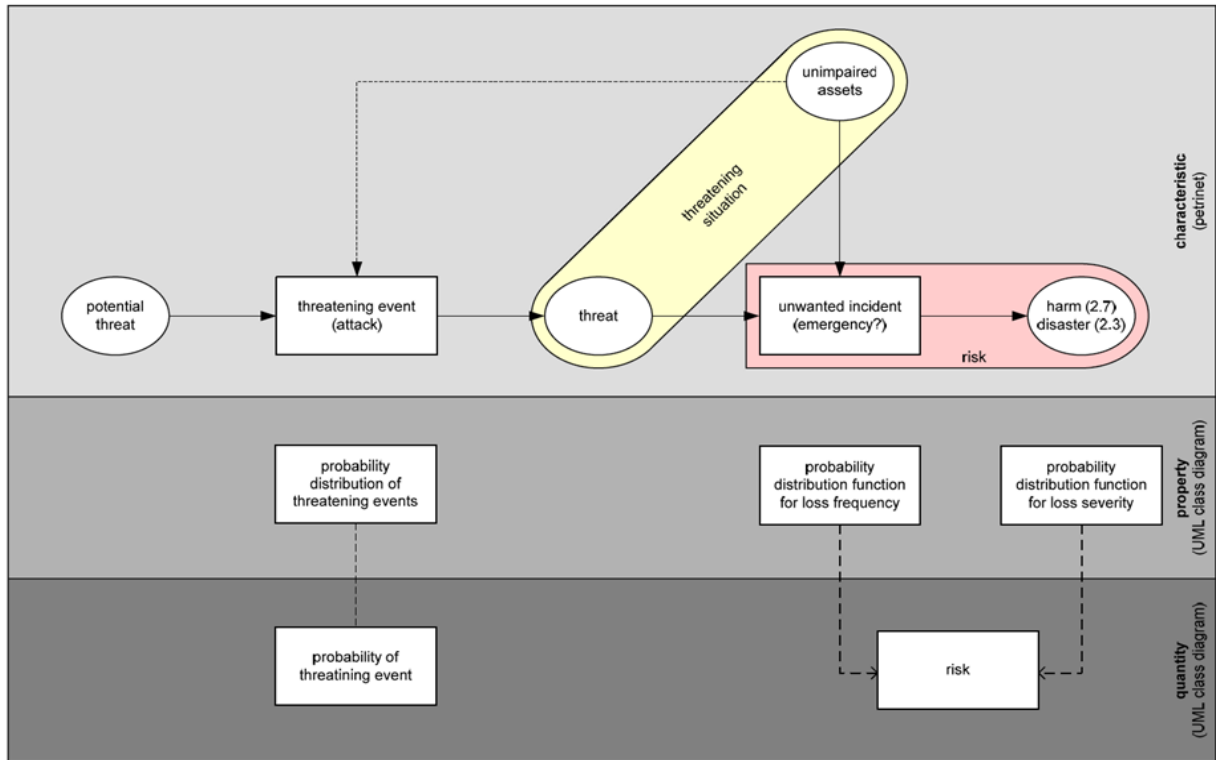


Figure 4. Formalisation of Security Terminology according to ISO/IEC SMB/3971/DC (2009)



In the present contemplation, we connect both concepts by adding terms which are in relation with safety and security.

There are the following questions according to the definitions and relations of safety-related terms in common language and in the terminology of traffic and transportation engineering:

1. What is the definitional difference between *safety* and *security*, between *risk*, *hazard* and *danger* and between *harm* and *damage*?
2. Which relations do exist between the safety-related terms mentioned above?
3. Is there semantic haziness between safety/security terms?

Modeling Process Railway Safety Terms

A modeling process is the basis of determination of semantic vagueness between terms. The DTT & DIT (2014) recommend a modeling process which consists of the following steps:

- Specification of the domain of terms
- Extraction of terms and Finding designations for terms
- Definition of terms in normative and scientific sources
- Creation of a concept system between terms

Overall, the novelty of the present paper is the *iglos* relation types between terms and their visualisation. In the present paper, we intend to expand the modeling process of the traditional terminology work of the DTT & DIT by two steps: the relation types and the visualisation of these term relations.

In summary, the special merit of the *iglos* relation types is the exact determination of semantic vagueness between terms. Furthermore, the visualisation of these relation types enables the formalisation of the terms. Finally, the result of the formalisation is a terminology building (see Stein; Schnieder; Pfundmayr, 2010).

Definitions of Safety-related Terms

Table 1 and table 2 present the definitions of the seven safety-related terms in different varieties.

Table 1. *Definition of Safety Terms in English Common Language*

Term	Definition	Source
safety	the condition of being protected from or unlikely to cause danger, risk, or injury	Oxford Dictionaries Online
security	the state of being free from danger or threat	Oxford Dictionaries Online
risk	a situation involving exposure to danger	Oxford Dictionaries Online
hazard	a potential source of danger	Oxford Dictionaries Online
danger	the possibility of suffering harm or injury	Oxford Dictionaries Online
harm	physical injury, especially that which is deliberately inflicted	Oxford Dictionaries Online
damage	physical injury, especially that which is deliberately inflicted	Oxford Dictionaries Online

Table 2. *Definition of Safety Terms in English Traffic Engineering*

Term	Definition	Source
safety	freedom from unacceptable levels of risk	EN 50128, 2001-11
security	the assurance provided by a system that any incorrect input, or unauthorized access is denied	IEC 61069-5, 1994-12
risk	the combination of the frequency, or probability, and the consequence of a specified hazardous event	EN 50128, 2001-11
hazard	a physical situation with a potential for human injury	EN 50126, 2006-09
danger	an indication given by a signal to stop	ERTMS Glossary, 2012
harm	physical injury and/or damage to health	EN 1907, 2005-04
damage	physical injury and/or damage to health	EN 1907, 2005-04

Creation of Relations between Railway Safety Terms

In the second step, the definitions from these sources are extracted and compared with each other. This comprises basically the relation between safety-related terms on the basis of the *iglos* relation types. By relating terms

with each other, the definition of each term and the differentiation between two terms are enabled.

On the whole, we have found out that

1. *safety* and *security* are converse to each other in common language and traffic engineering.
2. there are synonymy relations between *harm* and *damage* in English common language and traffic engineering.
3. there are causal/consequent relations between *harm* and *hazard*, *harm* and *danger*, *damage* and *hazard* and *damage* and *danger* in English common language and traffic engineering.
4. there is a causal/consequent relation between *hazard* and *danger* in English common language.
5. there is a risk of confusion between *hazard* and *danger* in English traffic engineering.
6. there are contextual relations between *safety* and *harm*, *safety* and *damage*, *security* and *harm*, *security* and *damage*, *risk* and *danger* and *risk* and *hazard* in English common language and traffic engineering.
7. there are part-whole relations between *risk* and *damage* and *risk* and *harm*.
8. there is an antonymy relation between *safety* and *risk*, *safety* and *danger*, *safety* and *hazard*, *security* and *risk*, *security* and *danger*, *security* and *hazard* in English common language and English traffic engineering.
9. *Safety* is related with *hazard* both in English common language and English traffic engineering terminology whereas *security* is related with *threat* in both domains (Schnieder, 2010). A threat is a “potential violation of security” according to (DIN EN ISO 24534-4, 2011-10).

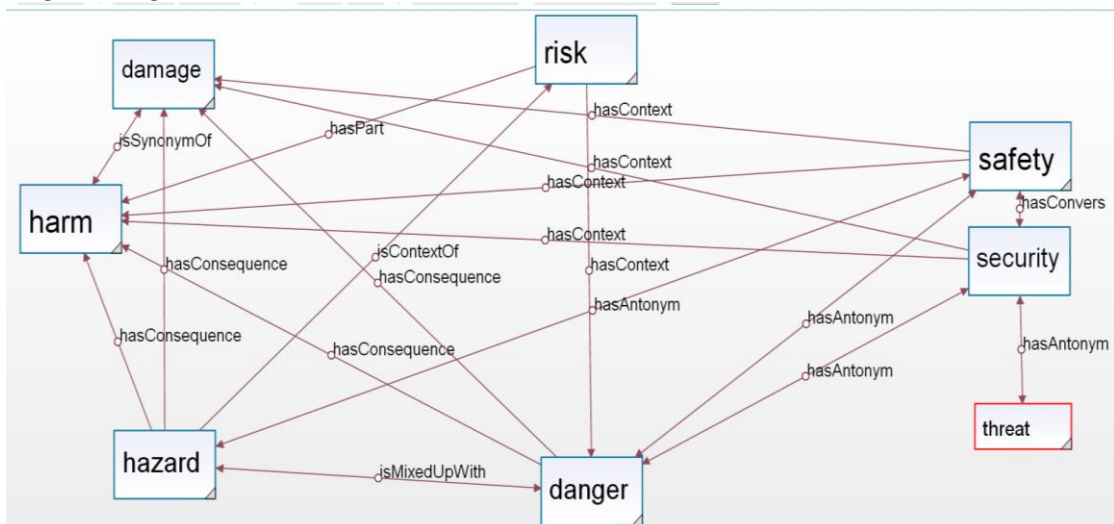
Visualisation of Relations between Safety Terms in different Domains

The last step is the visualization of term relations for a formalised terminology. Figure 5 and figure 6 present the relations between safety-related terms in English common language and in traffic and transportation engineering:

Figure 5. Visualisation of English Safety Terms and their Relations in Common Language



Figure 6. Visualisation of English Safety Terms and their Relations in Traffic Engineering



Results and Conclusions

In conclusion, there are similar definitions for safety-related terms in English common language and English traffic and transportation engineering. Therefore, there are similar possibilities for relating terms with each other. But we have verified in our contemplation that the main definitional differentiation problems in both domains exist between the safety-related terms.

It can be concluded from the results that the English safety terminology has definition and relation problems. Furthermore, it is important to define and relate terms according to the variety. That is why the *iglos* sign model with *iglos* relation types is important. On the whole, the sign model as an advanced

ontology structure with single lexemes describes the relations between technical terms.

With the aid of the methodological *iglos* terminology modeling process, we could determine linguistic problems between safety-related terms in English common language and in English traffic engineering terminology.

By defining and relating terms by unambiguous, consistent and mathematical/formal relation types, a terminology building can be constructed. This is the novelty of this approach. Therefore, the *iglos* sign model can be described as an ontology structure with single lexemes which are bound together by relations. Moreover, *iglos* is a terminology management system of the next generation which collects and integrates different (technical) languages and guides terminologists and translator to construct terminology (Yurdakul; Schnieder, 2013).

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