

The Hazardous Situation Ontology Design Pattern

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Abstract. This extended abstract describes an ontology design pattern for modeling hazardous situations. We build upon state-of-art models for hazards and hazardous events, and on existing standards in the domain of occupational safety. We also present an example of the application of the pattern in the occupational safety and health domain.

Key words: ontology design pattern, ODP, hazards, occupational safety and health

1 Introduction

Hazard is a *potential* source of harm on someone or something. It is a *threat* that may be caused by source, situation, or act with a potential for harm. The need for ontological modeling of hazards and related concepts such as risks, causes and consequences has been identified in several domains.

The Risk base ontology from the EU project RISCOSS [1] uses the concepts of Event and Situation from the foundational ontology Dolce Lite Plus [2] to define the concepts of Risk, Risk Event, Goal, Activity, Cause, Consequence, Impact, and Measure for software component selection. It re-uses concepts from another risk ontology, defined in the EU project Musing and definitions from standards such as ISO 31000. It does not include, however, a concept of hazard. Threat is modeled in Cyber Security ontology [3]. Also a hackathon at Ontology Summit 2014¹ has recently been devoted to modeling hazard and risk related concepts in travel domain. The report uses the term hazard as of an event. Furthermore, RiskEvent is a superclass of accidents in this view. In this case, Factor (such as EnvironmentalFactor, e.g. Limited_Sight) is closest to our interpretation of the meaning of the term hazard.

In this work, we describe the Hazardous Situation Ontology Design Pattern². We take a step towards a clarification and consolidation of some of these terms. This pattern was inspired by a dependency scheme of terminology concerning hazards in EU norm OHSAS 18001:2007 (hazard → hazardous situation → occupational risk), but is generic.

¹ <http://ontolog.cim3.net/OntologySummit/2014/>

² <http://ontologydesignpatterns.org/wiki/Submissions:HazardousSituation>

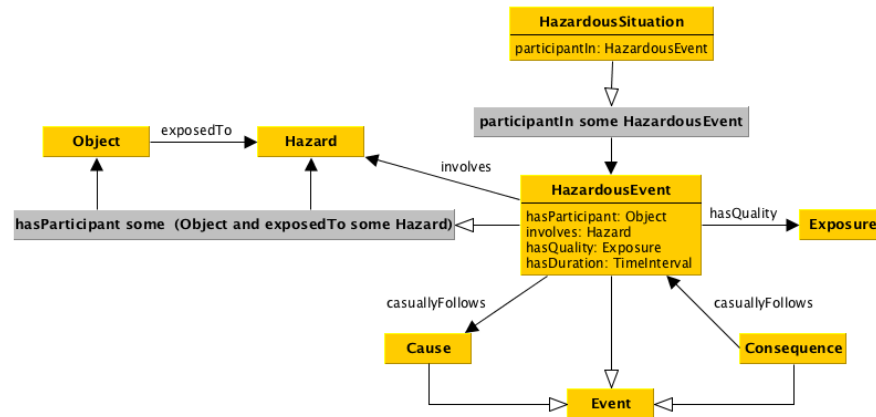


Fig. 1. The Hazardous Situation Ontology Design Pattern

2 The Hazardous Situation Ontology Design Pattern

The Hazardous Situation Ontology Design Pattern is depicted in Figure 1. *HazardousSituation* is a situation that participates in one or more *HazardousEvents*. *HazardousSituation* represents a kind of snapshot, a context, a setting or a state. The meaning of 'situation' is similar to that of the class *situation* in the Descriptions & Situations (DnS) extension [4] of the DOLCE ontology [5], also similar to that of the *DuringState* in the Event and Situation Ontology (ESO) ontology [6, 7], or a discrete state (a fluent) in the PSL ontology [8, 9].

HazardousEvent is defined as an event where at least one participating *Object* is exposed to a *Hazard*. Already the exposure of an object (e.g. a person) to a hazard suffices for the event to be called *HazardousEvent*, an emergence of any consequence is not a condition. Any *HazardousEvent* also has some duration (of the type of *TimeInterval*³).

HazardousEvent may casually follow some *Cause* and may cause one or more *Consequences*. A *Cause* may be an unsafe act, such as spilling oil and not clearing it up. This results in an unsafe condition of a pool of oil on the floor. A *HazardousEvent* is triggered when somebody enters this part of the floor and as a consequence may lead to an accident such as someone slipping on the oil, falling and breaking his/her leg.

Exposure is a measure of the extent (a *dose*) to which an *Object* is exposed to – or may be influenced by – the *Hazard*.

2.1 Intent

The intent of a pattern is to provide a building block for modeling hazardous situations. Those situations are the situations where one or more objects is ex-

³ <http://ontologydesignpatterns.org/wiki/Submissions:TimeInterval>

posed to one or more hazards to some extent (exposure value). Such situations have some cause that triggered the enactment of a hazard. They also result in some consequences.

2.2 Competency Questions

The list of competency questions for the pattern is as follows:

- What object (person, organization, equipment etc.) is exposed to a hazard?
- To which hazard is exposed an object (person, organization, equipment etc.)?
- Which hazardous events are associated with a hazardous situation?
- What is the cause of a hazardous event?
- What is the consequence of a hazardous event?
- What is the value of exposure of an object being exposed to a hazard?

2.3 Pattern Formalization

Below we provide the formalization of the pattern in the Web Ontology Language (OWL) [10], expressed in description logic (DL) [11]:

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HazardousSituation ⊆ ∃participantIn.HazardousEvent
HazardousEvent ≡ ∃hasParticipant.(Object ⊓ ∃exposedTo.Hazard)
HazardousEvent ⊆ ∃hasQuality.Exposure
HazardousEvent ⊆ ∃hasDuration.TimeInterval
HazardousEvent ⊆ ∃casuallyFollows.Cause
Consequence ⊆ ∃casuallyFollows.HazardousEvent
Cause ⊆ Event
HazardousEvent ⊆ Event
Consequence ⊆ Event
```

2.4 Example Usage: Occupational Safety and Health

Occupational safety and health is defined as the scientific domain dealing with the anticipation, identification, evaluation and control of *hazards* that emerge in or from the *workplace* and that may negatively impact the *health* and well-being of *workers* [12].

Consider the following scenario: *"The farmer is spraying pesticides on the fields. He asked a student working on a farm for help in carrying pesticide sprayers and storage containers. In this situation, neither the farmer nor the student is wearing any personal protective equipment such as gloves or using any respirators. After 4 hours of spraying, they student developed skin irritation."*

In this scenario, the Objects are Farmer and Student that are both Workers. The Workplace is the field. HazardousSituation is associated with at least two HazardousEvents both defined as a Worker (Farmer and Student) being exposed to an OccupationalHazard (pesticides). The Cause of this exposure is lack of personal protective equipment, and the immediate Consequence is HealthDeterioration (skin irritation).

3 Summary

In this paper, we have presented an ontology design pattern for modeling hazardous situations.

In future work, we will further investigate the use of a suitable event model, including a spatio-temporal dimension. We will also investigate in more detail the modeling of causality. Next steps of the future work agenda include re-using the pattern for modeling the occupational safety and health domain.

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