

# The Implementation of E-Commerce Ontology

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## **Abstract**

*Business Ontology can enable the successful development of enterprises system. This is being achieved through knowledge sharing and the ease of communication between every entity in the organization. There are many researches that focus on the construction of business ontology. Most of these studies try to develop a general ontology for every business in the world. However, the practice of the theory of business ontology in real business is quite a few especially in the field of e-commerce.*

*In this research, we will try to apply some of these theoretical concepts and methodology of IDEF 5 and Ontolingua to develop a tangible ontology for a small business on the net.*

## **1.Introduction**

### **Ontology and Business ontology**

Historically, ontologies arose from the branch of philosophy known as metaphysics,

which deals with the nature of reality--of what exists. The traditional goal of ontological inquiry, in particular, is to divide the world "at its joints," to discover those fundamental categories or kinds that define the objects of the world. So viewed, natural science provides an excellent example of ontological inquiry. For example, a goal of subatomic physics is to develop a taxonomy of the most basic kinds of objects that exist within the physical world (e.g., protons, electrons, muons). Similarly, the biological sciences seek to categorize and describe the various kinds of living organisms that populate the planet.[1]

Enterprise Ontology (EO) is a collection of terms and definitions relevant to business enterprises.[2] To develop enterprise ontology, we need to concern all the terms in this business and define them clearly. This includes its intended purposes, the process and everything that happen in the business. We use our experiences in converting these into formal definitions and the collection of these definitions is ontologies for business.

## **Why do we need Enterprise Ontology in E-Commerce?**

From the research of AIAI (Artificial Intelligence Applications Institute in the University of Edinburgh) the main uses for the Enterprise Ontology includes:[3]

- Enhance communication between humans, for the benefit of integration
- Serve as stable basis for understanding and specifying the requirements for end-user applications using the Tool Set which in turn leads to more flexibility in an organization;
- To achieve interoperability among disparate tools in an enterprise modelling environment using the EO as an interchange format.

Ontologies can enable the successful development of enterprises system. This is being achieved through domain knowledge sharing and reuse based on commitments to domain ontologies that structure and define the data terms, attributes and relations ensuring its consistency. Ontologies provide the logical connections for integrating a domain's data and the databases they reside in.[4]

It is clearly that to develop an ontology for a business can improve its communication and understanding. The advantage of ontology is especially important for an E-Commerce information system. In E-Commerce, everything is running on the net. It is extremely important to have a strong information and business system. Therefore, to develop ontologies for an e-commerce can improve the whole process of the business.

## **2. Methodology**

To develop ontologies in E-Commerce, we need to choose a tool to analyse the case that we want to study. In this research we chose the tool of IDEF 5 and Ontolingua to develop our ontologies. Here, we will introduce the basis of these two methods as below:

### **Ontolingua**

In the first stage, we will use Ontolingua as the building block to develop our business ontology. The original Ontolingua language was designed to support the design and specification of ontologies with a clear logical semantics. To accomplish this, Ontolingua is a monotonic first order logic with a simple syntax and some minor extensions to support reasoning about relations. Ontolingua can capture intuitive bundling of axioms into definitional forms with ontological significance. [5] Some of the key words form the basis of Ontolingua. Here we give the definitions of these terms: [6]

- **Class**

A class is a representation for a conceptual grouping of similar terms. For example, a computer could be represented as a class which would have many subclasses such as personal computers, mainframes, workstations, etc. Each class is described by a definition which specifies the slots and values that describe the class itself (not the members of the class), slots and values that describe the instances of that class, and logical statements (called axioms) that describe the class but can't be represented using slots and values.

- **Instance**

All of the terms in an ontology that have an associated definition (i.e., classes, slots, relations, functions, facets) are an instance of some class. Classes are instances of Class, functions are instances of Function, etc. An instance should not be confused with an Individual because an instance may be a class whereas an Individual cannot be a class.

- **Slot**

A slot is used to describe a relationship between two terms. The first term must be an instance of the class that is the Domain of the slot and the second must be an instance of the class that is the Range of the slot. For example, brother could be represented as a slot such that its Domain was Animal and its Range was Male-Animal.

- **Instance Slot**

An instance slot is a slot on a class that is used to describe a property of the instances of a class rather than the class itself. For example, mass would be an instance slot because it is used to describe how much a particular instance weighs rather than what the class weighs (obviously a class doesn't have mass since it is an abstract concept). Whereas, subclass-of is an own slot because it is used to describe the class itself.

- **Domain**

The domain of a slot is a class that restricts the terms on which the slot can be added. A slot can only be added to terms which are an instance-of its domain.

- **Function**

A function is a special type of relation which relates some number of terms to exactly one other term. That is, a function is a

relation such that no two relationships of n terms in the relation have the same first n-1 terms. For example, mother is a function that relates an animal to exactly one female animal.

A function may also be referred to as a slot if it relates only two terms.

- **Axiom**

An axiom is a sentence in first order logic that is assumed to be true without proof. In practice, we use axioms to refer to the sentences that cannot be represented using only slots and values on a frame.

## **The Method of IDEF 5**

### **IDEF5**

The IDEF5 ontology development process consists of the following five activities.

- **Organizing and Scoping.** The organizing and scoping activity establishes the purpose, viewpoint, and context for the ontology development project, and assigns roles to the team members.
- **Data Collection.** During data collection, raw data needed for ontology development is acquired.
- **Data Analysis.** Data analysis involves analyzing the data to facilitate ontology extraction.
- **Initial Ontology Development.** The initial ontology development activity develops a preliminary ontology from the data gathered.
- **Ontology Refinement and Validation.**

The ontology is refined and validated the ontology to complete the development process.

### IDEF5 Ontology Languages

Supporting the ontology development process are IDEF5's ontology languages. There are two such languages: the IDEF5 schematic language and the IDEF5 elaboration language. The schematic

language is a graphical language, specifically tailored to enable domain experts to express the most common forms of ontological information (see Figure 1). This enables average users both to input the basic information needed for a first-cut ontology and to augment or revise existing ontologies with new information. The other language is the IDEF5 elaboration language, a structured textual language that allows detailed characterization of the elements in the ontology.[7]

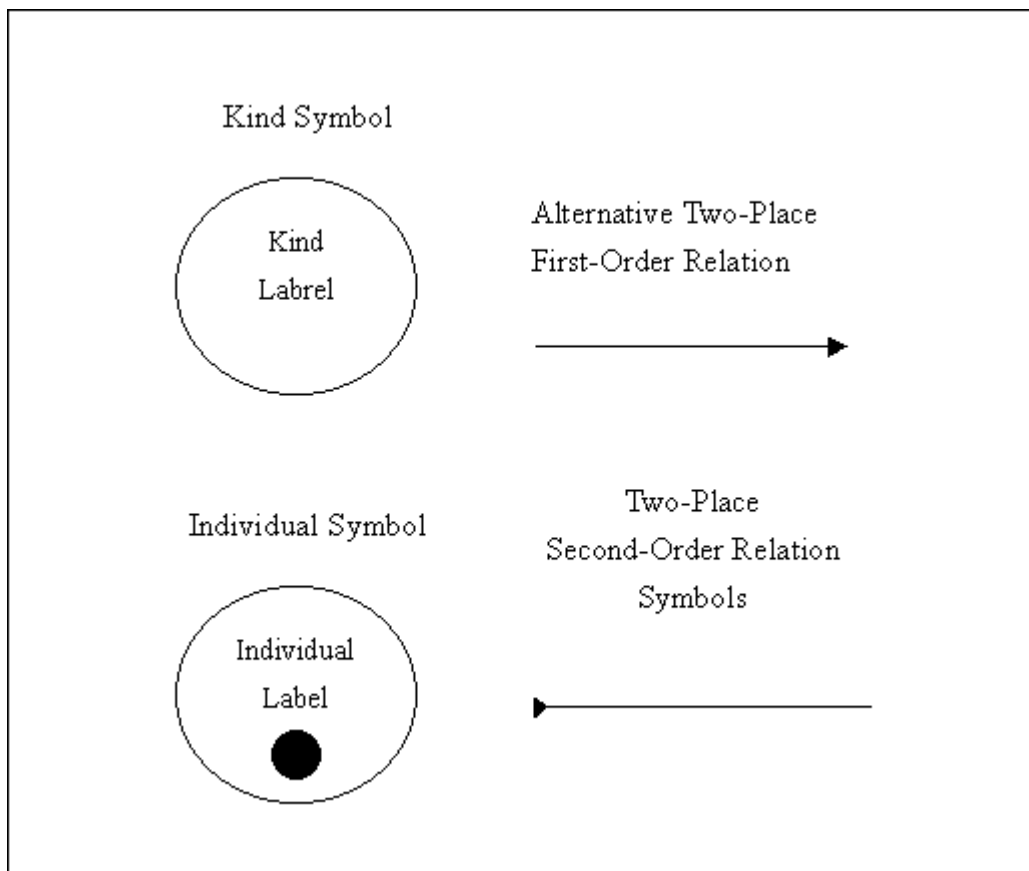


Fig 1. Basic IDEF5 Schematic Language Symbols[8]

Various diagram types, or schematics, can be constructed in the IDEF5 Schematic Language. The purpose of these schematics, like that of any representation, is to represent information visually. Thus, semantic rules must be provided for interpreting every

possible schematic. These rules are provided by outlining the rules for interpreting the most basic constructs of the language, then applying them recursively to more complex constructs.

However, the character of the semantics for the Schematic Language differs from the

character of the semantics for other graphical languages. Specifically, each basic schematic is provided only with a default semantics that can be overridden in the Elaboration Language. The reason for this is that the chief purpose of the Schematic Language is to serve as an aid for the construction of ontologies; they are not the primary representational medium for storing them. That task falls to the Elaboration Language. The Schematic Language is, however, useful for constructing first-cut ontologies in which the central concern is to record, in a rough way, the basic elements that exist in a domain, their characteristic properties, and the salient relations that can be obtained among objects of those kinds and among the kinds themselves. Consequently, the basic constructs of the Schematic Language are designed specifically to capture this type of information. Generally speaking, the IDEF5 method is used to construct ontologies by capturing assertions about real-world objects, their properties, and their interrelationships. [9]

### 3. Literature Review

Ontological engineering is a new engineering discipline that aims at defining shared terminologies for different fields and purposes. This method can be used in different field of knowledge domain. Many works are progressing in different fields at this time.

In this paper, we focus on the field of business modeling. In the development of enterprise ontologies, the Edinburgh University and University of Toronto have done a great job. The Artificial Intelligence Applications Institute (AIAI) in the Edinburgh University has developed the Enterprise Ontology with the support of UK's government. [10] In AIAI's paper, they give a comprehensive description of the Enterprise

Ontology, a collection of terms and definitions relevant to business enterprises. Then they converting these terms and definitions into the formal language: Ontolingua. Finally, they give a detailed account of how to use the Enterprise Ontology, including an evaluation which compares the actual uses with original purposes.

The study of the University of Toronto focuses on the TOVE (TOronto Virtual Enterprise) project. They have created a data model that has the following characteristics.

- Providing a shared terminology for the enterprise that each agent can jointly understand and use.
- Defining the meaning of each term (aka semantics) in a precise and as unambiguous manner as possible,
- Implementing the semantics in a set of axioms that will enable TOVE to automatically deduce the answer to many "common sense" questions about the enterprise,
- Defining a symbology for depicting a term or the concept constructed thereof in a graphical context.[11]

In the Helsinki University of Technology, the researchers also used the theories of Enterprise Ontology to develop their ontology of strategic business planning. It is called the BTT project. The BPTT Ontology can be used in the internal activities of a company, to support the information gathering and provide a basis for building a corporate memory. [12]

There are many different applications of the methodology of ontology. They focus on different knowledge domains that include biology, business management, science etc.

All of these studies were tried to construct a communicating interface in their area. This also can be used as a major part of their information system.

#### 4. Case Study-Business ontology of MOMO Auto Accessories

In this thesis we want to use the website of MOMO Auto Accessories to apply the concept of business ontology to an actual business case. The reason that we chose this case is it is a typical style of e-commerce--e-shop. Interactions between e-commerce and information system are plenty. And the scale of this case just fit this study.

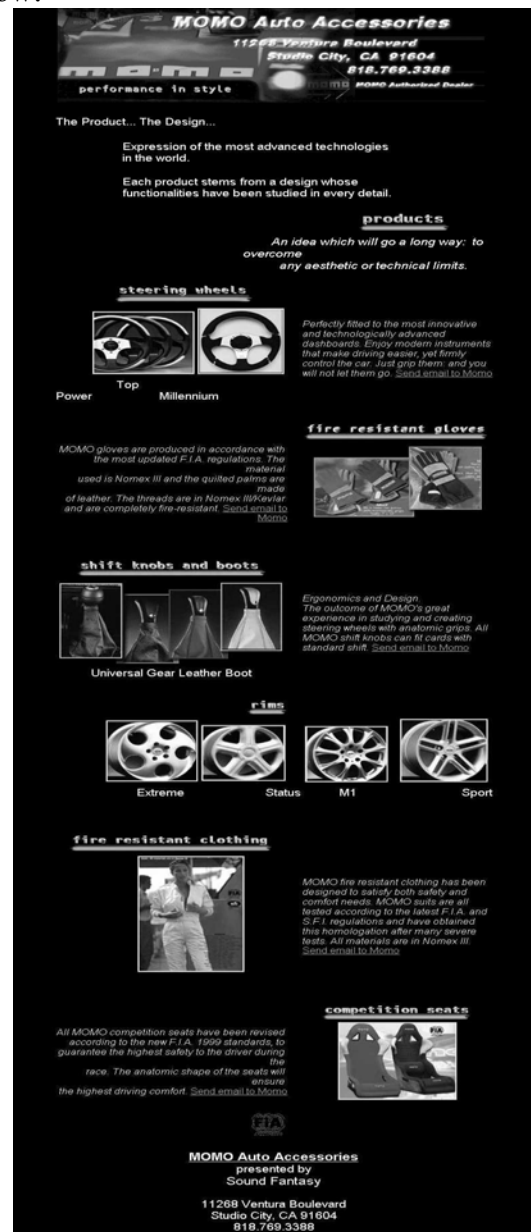
#### MOMO Auto Accessories

MOMO, based on Italy, is one of leaders in the car-accessory market. Since 1960, MOMO's story is a legend of the creative, imaginative entrepreneurship. It all began with a passion for motor racing. One day Giampiero Moretti, a politics student at the University of Pavia, Italy and amateur racing driver, had a friend of his make a very special steering-wheel for his racing car. It was smaller than the normal one used, but what was most original about it was the handgrip, a very large handgrip that gave a much better hold, making the car easier to handle and drive. This odd steering wheel attracted the attention of many racing drivers, among them John Surtees of Ferrari. The English driver tried it and had it mounted on his single-seat Formula One race car. That was a happy year for Surtees and Ferrari, who won the F1 championship, and for Morretti's steering wheel which had its share in the glory. Requests for it began to pour in, and what had begun the passion grew into a business. [13]

#### Develop the Ontology for the MOMO Auto Accessories



MOMO Auto Accessories is an authorized Dealer of MOMO Co. Ltd.. This dealer has its own web site on the net to sell its product to the customer. In this case, we will analyse its web site and develop a specific ontology for this site. Ontolingua and IDEF5 schematics will be used in this case. The web site of the company can be seen below:



To develop the ontology for the MoMo

Auto Accessories, the content of its web site will be analysed. We will use both the Description Summary Form and the Term Description Form as our tools to complete this job.

Description Summary Form		
Project: MOMO Auto Accessories Ontology	Analyst: George, Tsou	Reviewer: J.C. Tsou; M.J. Huang
Version: 2.0	Review Starting Date:	Review completion Date:
Purpose: To develop an ontology for the web page of MOMO Auto Accessories		
Context: The information acquired must be enough to describe the content of the web page of MOMO Auto Accessories		
Viewpoint: Web page visitor		

Term Description Form		
Project: MOMO Auto Accessories Ontology		Analyst: J.C. Tsou; M.J. Huang
Term#	Term	Description
1	MOMO Auto Accessories	The authorized dealer of MOMO Co. Ltd.
2	MOMO Co. Ltd.	Professional Auto Accessories manufacturer
3	Products	The product that is sold by MOMO Auto Accessories.
4	Steering Wheel	An Auto Accessory--Steering Wheel
5	Top Power(Steering Wheel)	A specific steering wheel model
6	Millennium(Steering Wheel)	A specific model of steering wheel
7	Fire resistant glove	A glove that can resist fire and be produced by MOMO Co..
8	MOMO gloves	A glove that is produced by MOMO Co..
9	F.I.A. regulations	F.I.A stands for FEDERATION INTERNATIONALE DE L'AUTOMOBILE. Every year FIA will organise the FIA Formula One World Championship and F.I.A. Regulation is the rules in this contest.
10	1.F.I.A. regulations of	The F.I.A. regulations for specific thing.
11	2.Qualify F.I.A. regulations	Something that satisfy F.I.A. regulations
12	Quilted palms	The quilted palms of Glove
13	Threads	The thread of Glove.
14	Material	The material that use to produce the product.
15	Nomex III	A kind of material that can resist fire.
16	Leather	A material that is made by animal's skin.
17	Made by Nomex III	Something that is made by Nomex III
18	Made by leather	The thing that is made by leather

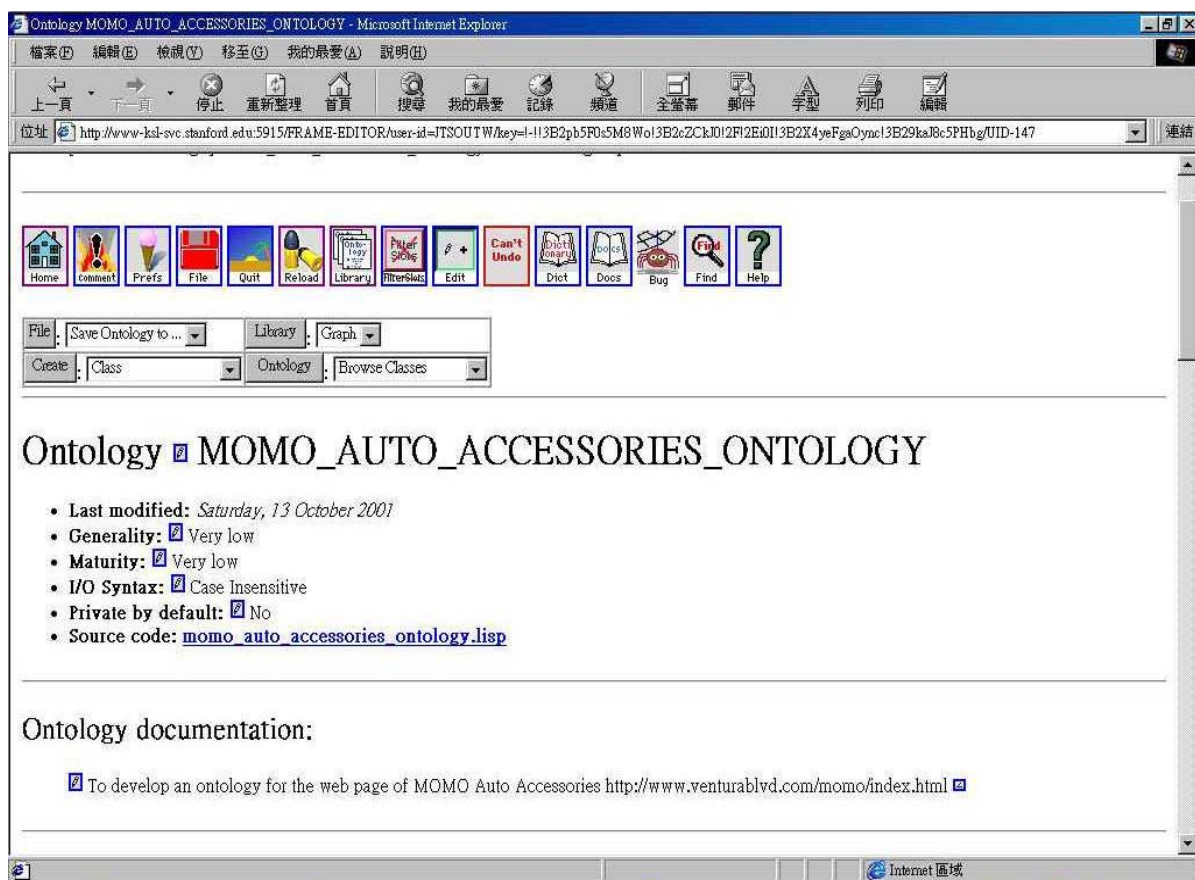
19	Shift Knobs	Shift Knobs that produced by MOMO Co. Ltd.
20	Boots	The Universal Gear Leather Boot that produced by MOMO Co. Ltd.
21	Rims	The rims that produced by MOMO Co. Ltd. for Auto's wheel.
22	Extreme_Rims	MOMO's rims Type-- Extreme
23	Status_Rims	MOMO's rims Type-- Status
24	M1_Rims	MOMO's rims Type-- M1
25	Sport_Rims	MOMO's rims Type-- Sport
26	Fire resistant clothing	A clothes that can resist fire and be produced by MOMO Co..
27	Driver	The people who drive a car
28	Driver's safety needs	The need that driver needs to feel safe.
29	Driver's comfort needs	The need that driver needs to feel comfortable.
30	Satisfy Driver's safety needs	Satisfy Driver's safety needs
31	Satisfy Driver's comfort needs	Satisfy Driver's comfort needs
32	S.F.I. regulations	This is a spec. about safety.
33	F.I.A. regulations	F.I.A stands for FEDERATION INTERNATIONALE DE L'AUTOMOBILE. Every year FIA will organise the FIA Formula One World Championship and F.I.A. Regulation is the rules in this contest.
34	Nomex III	A kind of material that can resist fire.
35	Competition seats	The seat that produced by MOMO Co. Ltd. for Auto's wheel and be used in a racing car.
36	F.I.A. regulations	F.I.A stands for FEDERATION INTERNATIONALE DE L'AUTOMOBILE. Every year FIA will organise the FIA Formula One World Championship and F.I.A. Regulation is the rules in this contest.



## The Ontology for the MOMO Auto Accessories (Use Ontolingua)

To develop ontology, we will use the Ontolingua Ontology Editor provided by the Stanford KSL Network Services. The Knowledge Systems Lab (KSL) belongs to the Department of Computer Science at Stanford University. The lab conducts research in the core Artificial Intelligence areas of knowledge representation and reasoning. Current work focuses on design

and development of knowledge servers; multi-use ontologies, knowledge bases and knowledge system modules; computational environments for modeling the structure, behavior and functionality of physical devices; compositional modeling; architectures for adaptive intelligent systems; and knowledge-based systems for science, engineering and defense applications. The Ontolingua Ontology Editor is the tool that they develop to compose domain ontology. The layout of this editor is shown below.



We use the ontology editor to develop the ontology of MOMO Auto Accessories, then translate the result into Ontolingua. Here is ontology of MoMo Auto Accessories that be presented by Ontolingua.

```
*****
(In-Package "ONTOLINGUA-USER")
;;; Written by user Jtsoutw from session "Session name not supplied
[Saturday, 13 October 2001, 06:37:50]" owned by group JUST-ME
;;; Date: Oct 13, 2001 10:07
;;; Definitions: 33
(Define-Ontology
Momo_Auto_Accessories_Ontology
(Vehicles)
"To develop an ontology for the web page of MOMO Auto Accessories
http://www.venturablvd.com/momo/index.html"
:Io-Package
"ONTOLINGUA-USER")
(In-Ontology (Quote Momo_Auto_Accessories_Ontology))
;;; ----- Classes -----
;;; Boots
(Define-Class Boots
(?X)
"The Universal Gear Leather Boot that produced by MOMO
Co. Ltd."
:Def
(And (Product ?X)))
;;; Competition_Seats
(Define-Class Competition_Seats
(?X)
"The seat that produced by MOMO Co. Ltd. for Auto's wheel
and be used in a racing car."
:Def
(And (Product ?X)))
;;; Driver
(Define-Class Driver (?X) "The people who drive a car" :Def (Thing
?X))
;;; Driver_Comfort_Needs
(Define-Class Driver_Comfort_Needs
(?X)
"The need that driver needs to feel comfortable."
:Def
(And (Driver ?X)))
;;; Driver_Safety_Needs
(Define-Class Driver_Safety_Needs
(?X)
```

```

"The need that driver needs to feel safe."
:Def
(And (Driver ?X))
;;; F.I.A_Regulation
(Define-Class F.I.A_Regulation
(?X)
"F.I.A stands for FEDERATION INTERNATIONALE DE
L'AUTOMOBILE. Every year FIA will organise the FIA Formula One World
Championship
and F.I.A. Regulation is the rules in this contest. "
:Def
(And (Thing ?X))
;;; Fire_Resistant_Clothing
(Define-Okbc-Frame Fire_Resistant_Clothing
:Frame-Type
:Class
:Direct-Superclasses
(Product)
:Direct-Types
(Class Primitive)
:Own-Slots
((Qualify_F.I.A_Regulation) (Arity 1)))
;;; Fire_Resistant_Glove
(Define-Class Fire_Resistant_Glove
(?X)
"A glove that can resist fire and be produced by MOMO
Co.."
:Def
(And (Product ?X))
;;; Leather
(Define-Class Leather
(?X)
"A material that is made by animal's skin."
:Def
(And (Material ?X))
;;; Material
(Define-Class Material
(?X)
"The material that use to produce the product."
:Def
(And (Thing ?X))
;;; Momo_Auto_Accessories
(Define-Class Momo_Auto_Accessories
(?X)
"The authorized dealer of MOMO Co. Ltd."
:Def
(And (Momo_Co_Ltd. ?X) (Simple-Set ?X)))

```

```
;;; Momo_Co._Ltd.
(Define-Class Momo_Co._Ltd.
(?X)
"Professional Auto Accessories manufactory"
:Def
(And (Thing ?X)))
;;; Nomex_Iii
(Define-Class Nomex_Iii
(?X)
"A kind of material that can resist fire."
:Def
(And (Material ?X)))
;;; Product
(Define-Class Product
(?X)
"The product that is sold by MOMO Auto Accessories."
:Def
(And (Momo_Auto_Accessories ?X)))
;;; Rims
(Define-Class Rims
(?X)
"The rims that produced by MOMO Co. Ltd. for Auto's
wheel."
:Def
(And (Product ?X)))
;;; S.F.I._Regulation
(Define-Class S.F.I._Regulation
(?X)
"This is a spec. about safety."
:Def
(And (Thing ?X)))
;;; Shift_Knobs
(Define-Class Shift_Knobs
(?X)
"Shift Knobs that produced by MOMO Co. Ltd."
:Def
(And (Product ?X)))
;;; Steering_Wheel
(Define-Class Steering_Wheel
(?X)
"An Auto Accessory--Steering Wheel"
:Def
(And (Product ?X)))
;;; ----- Relations -----
;;; F.I.A._Regulation_Of
(Define-Okbc-Frame F.I.A._Regulation_Of
:Frame-Type
```

```

:Slot
:Direct-Types
(Binary-Relation Relation Slot)
:Own-Slots
((Range F.I.A_Regulation) (Arity 2) (Domain Thing)
(Inverse Qualify_F.I.A._Regulation)))
;;; Made_By_Leather
(Define-Relation Made_By_Leather
(?Frame ?Value)
"The thing that is made by leather"
:Def
(And (Thing ?Frame) (Leather ?Value)))
;;; Made_By_Nomex_Iii
(Define-Relation Made_By_Nomex_Iii
(?Frame ?Value)
"Something that is made by Nomex III"
:Def
(And (Thing ?Frame) (Nomex_Iii ?Value)))
;;; Qualify_F.I.A._Regulation
(Define-Okbc-Frame Qualify_F.I.A._Regulation
:Frame-Type
:Slot
:Direct-Types
(Binary-Relation Relation Slot)
:Own-Slots
((Range F.I.A_Regulation) (Arity 2) (Domain Thing)
(Inverse F.I.A._Regulation_Of)))
;;; Qualify_S.F.I._Regulation
(Define-Relation Qualify_S.F.I._Regulation
(?Frame ?Value)
"Thing that satisfy the spec. of S.F.I. regulation"
:Def
(And (Thing ?Frame) (S.F.I._Regulation ?Value)))
;;; Satisfy_Driver_Comfort_Needs
(Define-Relation Satisfy_Driver_Comfort_Needs
(?Frame ?Value)
"The need that driver needs to feel comfortable."
:Def
(And (Thing ?Frame) (Driver_Comfort_Needs ?Value)))
;;; Satisfy_Driver_Safety_Needs
(Define-Okbc-Frame Satisfy_Driver_Safety_Needs
:Frame-Type
:Slot
:Direct-Types
(Binary-Relation Relation Slot)
:Own-Slots
((Domain Thing) (Arity 2) (Range

```

```

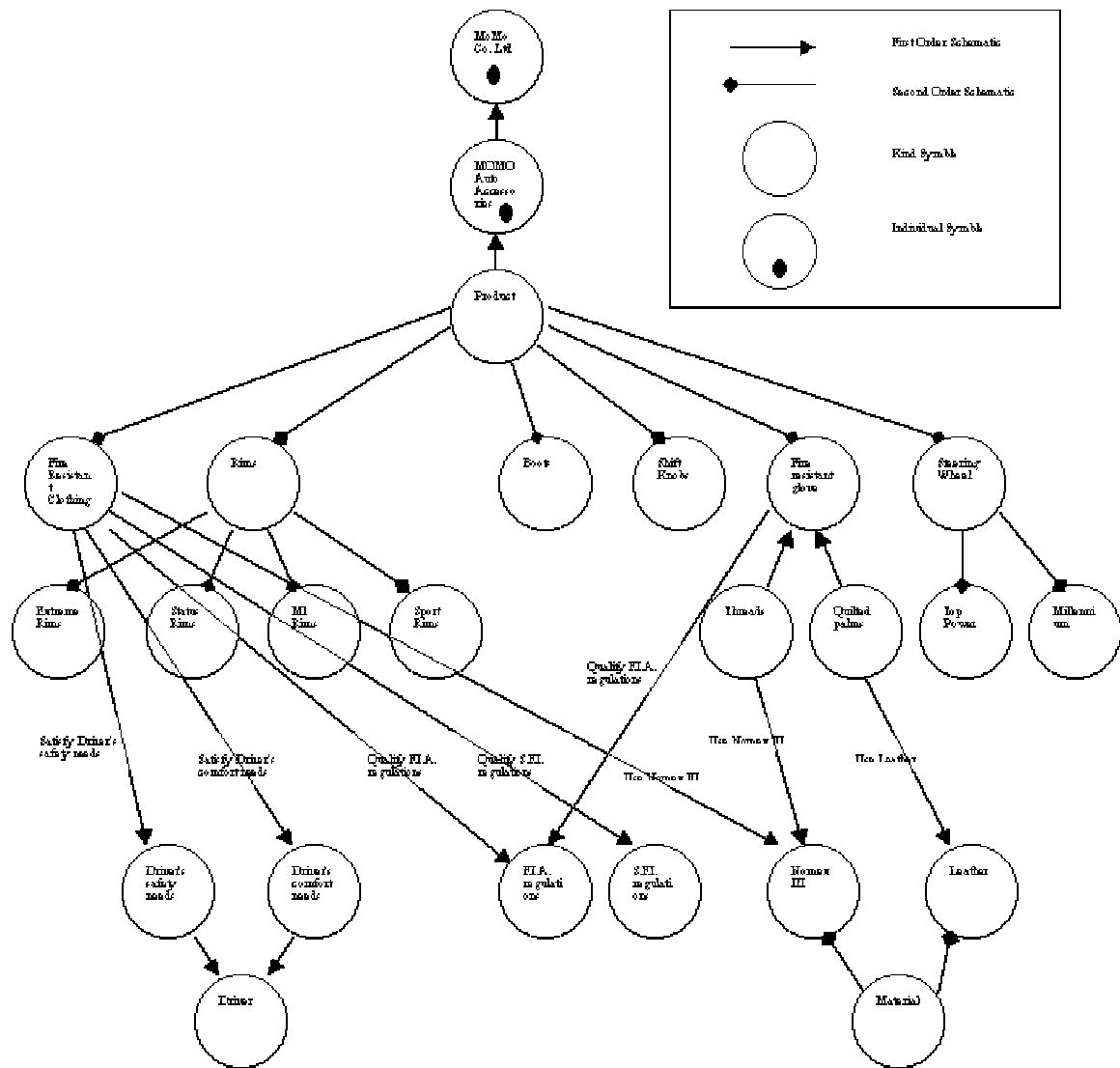
Driver_Safety_Needs)))
;;; ----- Functions -----
;;; ----- Instance -----
;;; Extreme_Rims
(Define-Individual Extreme_Rims (Rims) "MOMO's rims Type-- Extreme")
;;; Gloves_Threads
(Define-Okbc-Frame Gloves_Threads
:Frame-Type
:Individual
:Direct-Types
(Fire_Resistant_Glove)
:Own-Slots
((Made_By_Nomex_Iii)))
;;; M1_Rims
(Define-Individual M1_Rims (Rims) "MOMO's rims Type-- M1")
;;; Millennium_Steering_Wheel
(Define-Individual Millennium_Steering_Wheel
(Steering_Wheel)
"A specific model of steering wheel")
;;; Quilted_Palms
(Define-Okbc-Frame Quilted_Palms
:Frame-Type
:Individual
:Direct-Types
(Fire_Resistant_Glove)
:Own-Slots
((Made_By_Leather)))
;;; Sport_Rims
(Define-Individual Sport_Rims (Rims) "MOMO's rims Type-- Sport")
;;; Status_Rims
(Define-Individual Status_Rims (Rims) "MOMO's rims Type-- Status")
;;; Top_Power_Steering_Wheel
(Define-Individual Top_Power_Steering_Wheel
(Steering_Wheel)
"A specific steering wheel model")
;;; ----- Axiom -----
;;; ----- Other -----
*****

```

**The Ontology for the MOMO Auto Accessories (Use IDEF5 Schematics)**

In this section, we will use the IDEF5 schematics to present the Ontology of

MoMo Auto Accessories. The content of this ontology is completely the same as the ontology that is presented in the previous section. The only difference is the method that we use to present it.



Use IDEF5 Schematics to present the Ontology of MOMO Auto Accessories

## 5. Conclusions

In this paper, a business ontology has been developed for a typical B2C e-commerce company. The model that we develop business ontologies for MOMO Auto accessory can also be used to develop business ontology for most of the small and

medium enterprises on the net. In this experimental study, some theoretical methodologies proposed by previous researchers have been verified. Further study in this field can focus on the tangible study of companies like Yahoo.com, Amazon.com etc. These studies can really solve the problem to develop ERP system.

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