XII Conference on Transport Engineering, CIT 2016, 7-9 June 2016, Valencia, Spain

Databases for highway inventories. Proposal for a new model

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Abstract

Database models for road inventories are based on classical schemes for relational databases: many related tables, in which the database designer establishes, a priori, every detail that they consider relevant for inventory management. This kind of database presents several problems. First, adapting the model and its applications when new database features appear is difficult. In addition, the different needs of different sets of road inventory users are difficult to fulfil with these schemes. For example, maintenance management services, road authorities and emergency services have different needs. In addition, this kind of database cannot be adapted to new scenarios, such as other countries and regions (that may classify roads or name certain elements differently). The problem is more complex if the language used in these scenarios is not the same as that used in the database design. In addition, technicians need a long time to learn to use the database efficiently. This paper proposes a flexible, multi-language and multipurpose database model, which gives an effective and simple solution to the aforementioned problems.

Keywords: Road ; Inventory ; Maintenance ; Geometric Design

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1. Introduction

A highway inventory is an ordered set of data about a road network, its elements and characteristics. It is a basic element for good highway management and maintenance. Different agents are interested in highway inventories and each one has different needs. Highway administration authorities or road design and construction companies do not have the same information needs as road maintenance companies or emergency and civil protection services.

Three levels of information could be considered in highway inventories:

- *Geometry and topology:* information about the road itself, what roads there are, where the beginning and end of the road is, the identification and denomination of roads, their horizontal and vertical alignment, their nodes (intersections or interchanges).
- *Roadway characteristics*: for example, number of lanes, lane width, kind of pavement and slopes.
- *Highway elements*: auxiliary works and accessories (e.g. highway drainage, traffic signals, guard-rails, noise barriers) and structures (e.g. retaining walls, bridges, tunnels).

There are two kinds of data models for road inventories. On the one hand, there are data models whose purpose is information exchange between different software applications. These use standards such as LandXML (LandXML, 2016), GML (Geographic Markup Language) (OGC, 2004), and several European initiatives inside the INSPIRE directive (European Commission, 2016), EuroRoadS (Svärd, 2006; Euroroads Forum 2016) and INSPIRE Specification on Transport Networks (INSPIRE, 2014). In Spain, nowadays, the National Geographic Institute is redefining its road network data model in order to adapt it to the Data Specification on Transport Networks from the INSPIRE directive (IGN, 2015). The main problem with these standards is that it is necessary to set the complete list of features and specific characteristics needed beforehand, and this results in excessive complexity. Developing applications that implement these standards is a very complex task and most developers do not use them.

The second group is made up of data models independent of standards and developed ad hoc for a specific project or software. This is the case, for example, of the Spanish Highway Inventory (Ministerio de Fomento, 2009) and also of several types of commercial inventory software (Rebolj et al., 2008). They usually employ commercial relational database software and the information about the data model is usually limited. This kind of inventory and data model cannot be used for other purposes than those for which they were conceived. If any criteria or inventory element requirements change, these applications often become obsolete. The problem is more complex if the language used in these scenarios is not the same as that used in the database design. In addition, technicians need a long time to learn to use the database efficiently.

This paper proposes a flexible, multi-language and multipurpose database model, which gives an effective and simple solution to the aforementioned problems.

2. Model proposal

The data model that will be proposed is based on a non-SQL database and it does not require a previous design or the previous listing of inventory elements and their characteristics. It starts with a straightforward model, and users build and adapt it to their needs in an incremental way. This data model provides a good tool for any schema of any kind of highway inventory and for solving the information needs of any user.

A road inventory is, basically, a geographic information database. Existing real world highway features are depicted as geographic information features stored in a database. Olaya (2012) indicates that geographic information consists of two main components:

- *Spatial component*: refers to position inside an established reference system. It provides location and geometric information on features.
- *Thematic component*: establishes the nature and specific characteristics of features.