# Extensible Models and Templates for Sustainable Land Information Management – Intent and Purpose

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## INTRODUCTION

To arrive at a pragmatic core cadastral content standard and ontology and a comparative model of the related functions and processes, we have to share some understanding of the world we live and work in. We have to make some assumptions of what the future may be and ensure that the models we design will easily adapt to remain relevant in the future. We have to understand the characteristics, needs, and wants of users if our models and standards are to contribute to a better society.

This paper draws a parallel between the major motivations for the development of the Standardized Core Cadastral Domain Model and the FGDC Cadastral Data Content Standard. In Section 4 of this paper, I propose that the Standardized Core Cadastral Domain Model be renamed to the Standardized Core Cadastral Data Dictionary.

Cadastre 2014 provided a glimpse of what the future may hold for land information management land administration. We see global trends in the information and communication technologies (ICT) market. Notice that GIS is not called out separately in the previous sentence. In this context, what was formerly known as GIS – now more commonly called geospatial information processing – is a subset of mainstream information technology. Section 1 of this paper briefly reviews some pertinent ICT trends and futures.

Technology is crucial to effective land administration and a real estate market, and efficient property transactions require efficient processes for clear and timely communication between organizations that are geographically distributed using heterogeneous computing environments. It is thus necessary to critically review and understand each of the inexorably linked components – and the flows and interactions between them, as well as technological and societal trends – to arrive at templates and standards that will enable sustainable land administration infrastructures and affordable real property transactions.

Property registration provides a foundation for the real estate market, which in turn, requires a trustworthy banking and financial infrastructure. It is interesting to observe that property registration infrastructures remain mainly regional/local, while banking infrastructures are global. The real estate market has, at least for a subset of society, become global as well. In Section 2, discussion includes the information exchange models deployed or in development by mortgage banking associations, real estate agencies, and the land title insurance industry and provides an overview of how cadastral information is used these commercial environments.

The COST G9 and FIG Commission 7 Conference on Standardization in the Cadastral Domain will focus on the development of a shared set of concepts and terminology for the cadastral domain and consider international standardization of these concepts in the support of meaningful exchange of information between organizations, or component-based system development through applying standardized models.[1] A survey[2] of the previous work by COST/G9 and FIG Commission 7 on the subject matter leading up to this conference focuses on the development of core content standards, definition of the object and class relationships in the cadastral domain, and description of selected processes from specific European countries. The previous reports also identify the difficulties that exist in comparing processes and their cost and efficiencies across countries.

Section 3 provides an overview of a comparative model for property transaction costs based on ongoing work in the development of indicators for global comparison of real property transactions.

## 1. INFORMATION AND COMMUNICATION TECHNOLOGIES – TRENDS AND FUTURE

### 1.1 Simplicity Looms Large

Every computer user has struggled with computer problems. When a system suddenly crashes, when months of research data is corrupted, and we toil many hours to repair the damage, we have probably all wondered whether technology or the user is in charge. This is a simple example of what may be the IT industry's greatest challenge – conquering complexity.

It is safe to say that technology has made life more complex – true also in the cadastral domain. End-users in all industries are searching for solutions and applications to simplify their daily tasks.

In an October 30, 2004, survey on information technology published by *The Economist*[3], Donald Norman is quoted, "Today's technology is obtrusive and overbearing. It leaves us with no moments of silence, with less time to ourselves, with a sense of diminished control over our lives"[4] and "…. it is time for human-centered technology, a humane technology."[5]

Research from the IDC quoted in *The Economist*[6] leads to the conclusion that ICT complexity – and, by implication, complexity in the ICT infrastructures that support cadastral systems and real estate markets – will continue to haunt the operators and owners of ICT infrastructures. The IDC figures show that the ratio of expenditure on fixing existing systems vs. buying new systems (75 percent vs. 25 percent) has reversed from 15 years ago. A recent

[1] http://www.kinf.wiai.uni-bamberg.de/SICD/
[2] Survey of reports and presentations published on the COST G9 Web site. http://costg9.plan.aau.dk
[3] *The Economist*. October 28,2004. http://www.economist.com/surveys/PrinterFriendly.cfm?Story_ID=3307363
[4] D. A. Norman, The Invisible Computer (Cambridge, MA: MIT Press, 1998).
[5] Ibid.
[6] http://www.economist.com/surveys/PrinterFriendly.cfm?Story_ID=3307363

sample of firms surveyed by the IDC shows that 70 to 80 percent of their IT budget now goes toward fixing old systems. This leaves only 20 to 30 percent available for new purchases.

These IDC statistics have a direct impact on land information management infrastructures around the world. The figures validate investments that technology companies, such as Intergraph, Oracle, MapInfo, AutoDesk and LaserScan, have been making in standards and technologies for interoperability.[7]

In the context of the management of geospatial information some database vendors, such as Oracle, have addressed the simplification challenge and ensured that all Oracle databases are geospatially enabled by treating geospatial data simply as another data type, accessible through SQL and XML Query.

There should be no technical reason why property transactions or maintenance of data in a land information system should be more complicated than online home banking – after all, telecommuting is here to stay.

To achieve affordable, effective production and delivery of the appropriate information to the right place at the right time, land information management agencies (which are still very much government centered) continue to drive solution providers toward sustainable solutions that also simplify life for employees.

Google.com presents a very good example of simplicity. The user interface consists of approximately 31 words, a textbox, and two command buttons. This extremely simple interface hides some very complex logic and operations – a concept that we should seek to provide in land administration and real estate management.

### 1.2 Building Sustainable Infrastructures on Legacy IT Environments

In September 2003, the United Nations Economic Commission for Europe's Working Party on Land Administration (UN-ECE WPLA) reported that "Land administration reforms across the world during the past decades have focused on building or rebuilding land title registration and cadastral systems. Grants or loans that supported capacity building concentrated on providing the necessary skills to operate the new technologies. However, strategies for long-term sustainability were rarely built into these programs. The development of business skills and a business ethic has not always been regarded as a priority. Today the beneficiaries of many of these programs are facing difficulties since much of the technology of the 1990s is obsolete. It needs to be replaced but how can this be achieved? Who will pay for what some call a 'technology refresh'?"[8]

A sustainable land information management infrastructure can be achieved by designing it to remain functional and operational given the certainty that there will be variations and changes

[7] http://imgs.intergraph.com/interop/
[8] Report from Workshop on Spatial Information Management for a Sustainable Real Estate Market. Economic Commission for Europe. Working Party on Land Administration 3rd Session. Geneva, 17-18 November 2003. http://www.unece.org/env/hs/wpla/3Session.htm

in environmental factors such as ideology, political priorities and goals, government, legislation, technology, and resource availability.

There is evidence[9] that agencies with legacy systems are applying resources to improve internal operations using existing systems before replacing systems. To this end the technologies and services being sought are those that would help agencies integrate and simplify the once leading-edge, now legacy, systems using non-invasive integration methodologies.

To provide a robust and sustainable land information management infrastructure, in the context of a dynamic business environment, requires that certain foundation components exist to allow the infrastructure to rapidly adjust, adapt, and respond to influences while maintaining continuity in operations and service delivery.

Three of these components are:

- Continuity in the availability of skilled human resources
- Continuity in financial and logistical resources
- Information and information management Infrastructure

To optimize the odds of a land information management infrastructure's sustainability, it must be designed so that it can be maintained at length without interruption, weakening, or loss of efficiency, functionality, or quality, given the following:

- There is a real possibility that the first two components above will – from an in-house availability point of view – change for the worse in the future.
- The technologies underlying the information management infrastructure will change rapidly and continuously.

Studies have shown the data component of land information management systems to be one of the major cost items. Figures of between 50 and 75 percent of related total cost have been quoted. The data component includes items such as data modeling, database design, data capture, and data conversion and migration. This suggests the following:

- Operators of land information management systems would be well advised to ensure that the investment in the data component of the system or infrastructure is optimized and "future proofed."
- Land information management infrastructures must be designed so that the beneficial use of information will optimize cost/benefit ratio of the system across the land information value chain.

As mentioned in the UN-ECE WPLA quote above, the strategies for long-term sustainability were not built into these programs. Organizations must be realizing by now that they will forever be in a state of IT migration – legacy components will always exist in their IT infrastructure and in those of organizations they interact with. Organizational and industry

[9] Various international requests for proposals and implementation specifications.

strategies must take this reality into account and enable profitable and sustainable operations under these conditions. So must the designers of core-cadastral templates and the related operational and functional processes.

## 2. REAL PROPERTY INFORMATION EXCHANGE IN THE COMMERCIAL SECTOR

Commercial participants in the real estate market, such as mortgage banks, credit reporting agencies, title insurance companies, and real estate agents have a vested interest in the efficient exchange of transaction-related information and the improvement of transaction and approval processing times. Their quest for efficiency and speed is driven by customer satisfaction, the time value of money, and profitability.

Included in the information these companies exchange and reference is land information, such as property location or identification, property rights, value, and related title information. In developing data content standards and process templates for cadastral information, it is important to recognize early on in the development cycle that public agencies such as cadastral offices, land registration offices, and tax agencies are linked to the business processes required for property transactions. It is in this context that public agencies must be prepared for active participation in electronic commerce and electronic integration into the e-commerce value chains.

The UN-ECE WPLA recognizes the impact of electronic commerce (in the form of electronic conveyancing) in the following extract from their September 24, 2003, Report on Spatial Information Management for a Sustainable Real Estate Market:

> The emerging use of the Internet will impact heavily on land administration organizations. At the same time, it provides opportunities for better customer satisfaction and a reduction in operating costs, for example, in the submission of official documents concerning the establishment, transfer, or deletion of rights to land. There is no difference whether these documents are submitted by notaries, solicitors, or the parties involved in a transaction themselves. Increasing use of personal computers, text processing software and electronic signatures creates a demand for the electronic submission of deeds or civil agreements. The development of systems for electronic conveyancing in, for instance, the United Kingdom, Canada, and Lithuania, and the electronic submission of deeds in, for instance, the Netherlands are the result of this understanding.[10]

In the same report, the WPLA also comments that "The combined access to the cadastral archives and to other public archives, either locally or centrally maintained, can rapidly improve the way authorities at all levels can inform businesses or individuals. The interconnection with the online banking system offers significant benefits for the risk management of loans and mortgages. It could also reduce the overall cost of real estate

[10] http://www.unece.org/env/documents/2003/hbp/wp.7/hbp.wp.7.2003.4.e.pdf

investments and enhance land market activities with reliable rules for land and construction valuation."

To provide a brief insight into what the e-commerce impact to a public agency may be, the data exchange standards of the U.S. Mortgage Industry Standards Maintenance Organization (MISMO)[11] are briefly reviewed.

### 2.1 The MISMO Commercial Mortgage Data Standards Initiative[12]

MISMO is developing a commercial mortgage origination data standard that provides both the content and format for borrowers and originators to transfer critical data to lenders. The data standard will use XML Schema to define the structure and format for moving data between parties involved in a mortgage origination transaction. These parties typically include the borrower, the lender, third-party report providers, due diligence providers, rating agencies, and, if appropriate, investors.

As is the case with the FIG Commission 7 Standardized Core Cadastral Content Standard, MISMO expects that users of the standard may have additional data requirements, and that some of additional data will be incremental to the standard. This MISMO standard is thus designed to be extensible, so that each participant can supplement the standard with its own unique requirements. It is also anticipated that not all the data in the standard would be applicable for all loans, and, therefore, there may be more data defined than would actually be used in originating a particular loan.

It is interesting to note that MISMO explicitly states that "the intent of the standard is only to provide guidelines for the data to be collected in the commercial mortgage origination process, and does not recommend underwriting methodology or computations. The standard assumes that each participant has its own methods for originating and underwriting." [p. ii]

In the development of this standard, the importance of workflow and process management in the origination process is recognized. The MISMO Working Group states that it "recognizes that the commercial mortgage lending process does not stop at origination. Clearly, the ultimate goal is seamless movement of data from the borrower through the lender to the servicer and investors." [p. ii]

Table 1: Property Identification Attributes

| Data Field Name | Definition |
|---|---|
| Number of Collateral Properties | The number of separate properties that serve as collateral for the subject mortgage |
| Property Name | The name of the property that serves as mortgage collateral or its street address |

[11] http://www.mismo.org
[12] Commercial Mortgage Data Standards Initiative Originations Data Dictionary. http://www.mismo.org/mismo/docs/C-MISMO%20Originations%20Dictionary%20Exposure%20Draft1.pdf

| Data Field Name | Definition |
|---|---|
| Attributes Description of Property | A narrative description of the physical characteristics of the collateral property including its general use and amenities, size and massing, construction methods and materials, age, and other attributes |
| Address 1 | The street address of the property that serves as mortgage collateral |
| Address 2 | Additional information provided to identify the property's location |
| City | The city in which the property that serves as mortgage collateral is located |
| Property County | The county in which the property that serves as mortgage collateral is located |
| Property Postal Code | The postal or ZIP code for the collateral property (in the United States, expressed as 5+4; for other countries, an alphanumeric combination) |
| Property Country | The country in which the property that serves as mortgage collateral is located |
| Property Area | An indication of the basic nature or character of the sub-market in which the property serving as mortgagee collateral is located |
| Property Type – Primary Use | A description of the primary function of the collateral property |
| Property Type - Secondary Use | A description of the secondary function of the collateral property |

Table 1 lists the property identification elements specified in the data dictionary. It is interesting to note that there are no provisions for cadastral identifiers – which may be an artifact of the nature of the cadastral infrastructure in the United States.

Although MISMO is a U.S.-based organization, note that they do provide mortgage loans wherein non-U.S. property serves as collateral. This is evidence of the global nature of the property investment market.

MISMO's Specification for Title Request and Response V2.1[13], which is an XML-based specification, does, however, provide for an "AssessorsParcelIdentifier" as well as a physical property address:

```
<PROPERTY _StreetAddress="100 Broadway" _City="San Diego" _State="CA"
_County="San Diego" _PostalCode="92101" _TitleCategoryType="SingleFamily"
AssessorsParcelIdentifier="558996987" _SalesAmount="400000">
                        <_LEGAL_DESCRIPTION _TextDescription="Would contain
the legal description of the property." _Type="MetesAndBounds"/>
```

[13] http://webster.mismo.org/mismo/specs_21.cfm

</PROPERTY>

Cadastral domain experts from countries with more formal cadastral infrastructures may be surprised by the fact that MISMO seemingly allows for a "loose" or non-cadastral reference to the real property collateral. There is however food for thought in this "discovery," which is elaborated upon in the conclusion to this paper.

As suggested in Section 1 of this paper, the future IT landscape will be shaped by those who succeed in simplifying a complex world. This challenge extends into the cadastral domain as well – cadastral systems must become user friendly for citizens, property owners, and small and large investors. Formally adopting common property identifiers into the cadastral domain and content standard is one way we can simplify the system, increase its acceptability and usage, and improve its sustainability.

### 2.1 Workflow Interoperability

Executing a real property investment transaction, mortgage application, or a parcel subdivision transaction requires the completion of a process that transcends organizational boundaries. Section 1 suggests that legacy systems will remain part of every organization's IT infrastructure – this means that organizations may have internal process and workflow management solutions that could hinder the realization of the benefits of fully automated cadastral transaction processing or property transaction systems.

In an electronic conveyancing environment, the value chains that must be implemented to deliver on an e-conveyancing transaction could be implemented using a set of workflow definitions that have been created to support discrete segments of the entire process. This would, however, result in the creation of islands of automation in the end-to-end process.

To avoid or circumvent the efficiency barriers presented by these islands of automation, the workflow interoperability must be possible, enabling different workflow products to communicate with another by exchanging messages that control process interoperation and integration. This is analogous to the Oracle Interoperability Initiative[14] whereby major GIS software vendors, such as AutoDesk, Intergraph, Laser-Scan, and MapInfo, are cooperating to enable smooth interoperable access to an organization's geospatial data.

Figure 1 shows (cadastral or property) information and its relationship to process and organization.[15] The current modeling activities by FIG Commission 7 and COST G9 have so far focused mainly on the information component and are working toward specifications that would support the transport of information between the process and information components. Other organizations, such as the World Bank, the UN-ECE WPLA, and various commercial companies, are working to understand process and organizational issues.

Although some land administration service providers in Canada, United Kingdom, New Zealand, Denmark and the Netherlands in particular, have implemented electronic

[14] http://imgs.intergraph.com/interop/oracle.asp
[15] http://www.wfmc.org/standards/docs/Ref_Model_10_years_on_Hollingsworth.pdf

conveyancing and cadastral transaction processing, a large body of work and research remains to assimilate the workflow interoperability knowledge into the cadastral domain.

This paper includes the proposal for FIG to consider making the assimilation of this knowledge into cadastral domain a priority, and that participation in the activities of workflow standards organizations such as the Organization for the Advancement of Structured Information Standards (OASIS)[16] be considered.

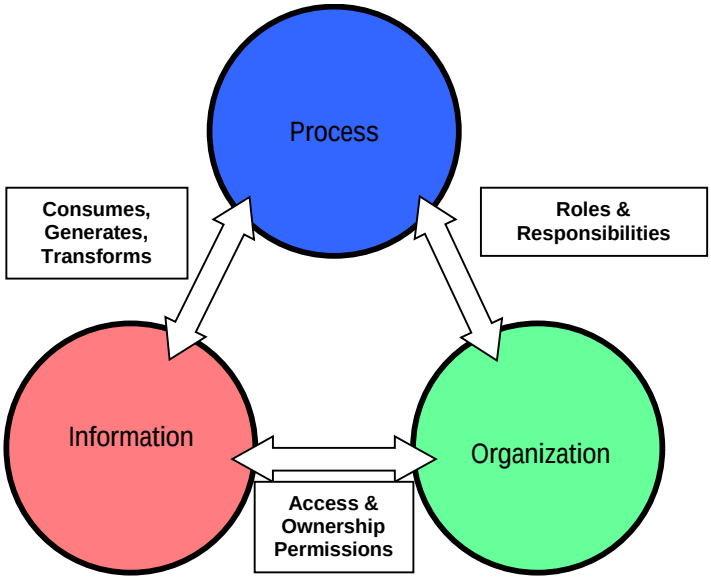


Figure 1

## 3. A COMPARATIVE MODEL FOR PROPERTY TRANSACTION COSTS

The main objective of Action G9 is " … to improve the transparency of real property markets and to provide a stronger basis for the reduction of costs of real property transactions by preparing a set of models of real property transactions, which is correct, formalized, and complete according to stated criteria, and then assessing the economic efficiency of these transactions."[17]

Determining costs for a property transaction in a single country has proven to be a difficult endeavor.[18] Because of the differences in infrastructure and legal, social, and economic conditions between countries, it would be even more difficult to establish an absolute norm or cost for property transactions.

[16] http://www.oasis-open.org
[17] Draft memorandum of Understanding for the Implementation of a European Concerted Research Action designated as COST Action G9 "Modeling Real Property Transactions." Brussels. 29 January 2001. http://cost.cordis.lu/src/pdf/G9-e.pdf and also at http://costg9.plan.aau.dk/CostG9Main.html.
[18] Zeverbergen comments on this difficulty in his "**Sale and subdivision in the Netherlands"** presentation at the WG2 Meeting in Hungary, September 2-3, 2004.

To meet the G9 objective as quoted above, optimum cost parameters for property transactions have to be established to determine if property transaction costs in a specific country are high and whether any adjustments or reforms are necessary.

International lenders and development aid agencies have long needed a comparative model that would support comparative analyses and measurement of country costs and efficiencies, including property transaction costs and efficiencies in different jurisdictions. To this end, the World Bank and the International Finance Corporation established the Rapid Response Knowledge Service (RRKS)[19] to provide policy advice on business environment reform and privatization policy in developing countries.

The RRKS compiles comprehensive assessments of the business environment in developing countries, through country-specific reports as well as comparative data used for benchmarking purposes. The comparative data is made available through the RRKS Doing Business database. One of the latest topics added to this database is property registration.

The database now includes indicators related to property registration, benchmarked to January 2004, indicating the ease with which property is registered in 145 countries representing the following regions and economies:

- East Asia and Pacific
- Europe and Central Asia
- Latin America and Caribbean
- Middle East and North Africa
- OECD High Income
- South Asia
- Sub-Saharan Africa

The property registration study[20] for the Doing Business database attempted to cover the complete sequence of procedures necessary to transfer the property title from a willing seller to a willing buyer when a business purchases land and a building in a peri-urban area of the country's most populous city.

To arrive at a result that would support comparative analyses across countries, specific assumptions about the property, the actors, and procedures were made. These assumptions are published on the RRKS Web site[21].

Some of the property registration indicators included in the database have a direct relevance to the COST G9 main objective. These key indicators include:

- The number of procedures required to legally register property

[19] http://rru.worldbank.org/Main/About.aspx
[20] The study methodology is developed in "Property," a forthcoming research project by Simeon Djankov, Facundo Martin, and Caralee McLiesh.
[21] http://rru.worldbank.org/DoingBusiness/Methodology/RegisteringProperty.aspx

- The time[22] required to complete the legally required procedures

Official costs such as fees, transfer taxes, stamp duties, and payments to the property registry, notaries, public agencies or lawyers[23]

Members of the COST G9 research team should review the methodology and results of the RRKS's Property Registration Study to determine whether it should be used to achieve the G9 activity objective of " … assessing the economic efficiency" of property transactions.

## 4. INTENT AND PURPOSE OF THE STANDARDIZED CORE CADASTRAL DOMAIN MODEL

Experiences from around the globe have led to the conclusion that models such as the core cadastral domain model can be misinterpreted as an approved or proposed data model, rather than an extensible content template or ontology. This is especially true if the model or standard is endorsed by an international organization such as FIG.

In an attempt to avoid any such misinterpretation or misapplication of the FGDC Cadastral Data Content Standard in the United States, the following wording was introduced into the latest revision (v1.3) of the FGDC Cadastral Content Standard:

> 1.4 Applicability and Intended Uses of Standard
>
> The Cadastral Data Content Standard is intended to support the automation and integration of publicly available land records information. It is intended to be useable by all levels of government and the private sector. The standard contains the standardization of the definition of entities and objects related to cadastral information including survey measurements, transactions related to interests in land, general property descriptions, and boundary and corner evidence data. Any or all of these applications are intended to be supported by the standard.
>
> The intended geographic scope of the standard is all fifty states of the United States including all onshore cadastral as well as marine cadastral information. Applicability of this standard in other geographic areas and business processes, such as the Insular Areas of the United States has not been determined. ……
>
> The standard is not intended to reflect an implementation design. An implementation design requires adapting the structure and form of these definitions to meet application requirements. …."[24]

It is as important to state in clear and concise terms what the intent and purpose of the Standardized Core Cadastral Domain Model **is not**, as it is to state what it is.

[22] Time is measured in calendar days.
[23] The cost is expressed as a percentage of the property value, calculated assuming a property value of 50 times income per capita.
[24] http://www.nationalcad.org/data/documents/CADSTAND.v.1.3.pdf

The Brno paper[25] on the 3rd Version of the Standardized Core Cadastral Domain Model states the two primary purposes of the model as "enable effective and efficient implementation of flexible (and generic) cadastral information systems based on a model driven architecture…," and to "provide the common ground for data exchange between different systems in the cadastral domain."

The Brno paper recognizes data exchange (the second purpose) as the major motivator for the development of the model. This motivation parallels the motivation for the development of the FGDC Cadastral Content Standard.

It is in this context that these proposals are made:

1. Rename the Standardized Core Cadastral Domain Model to "Standardized Core Cadastral Data Dictionary" to reflect its primary purpose and development driver.
2. Add wording similar to that quoted from the FGDC Cadastral Content Standard to the next version of what will now perhaps be known as the "Standardized Core Cadastral Data Dictionary"

The proposals above will contribute to the correct application and use of the standard. Further reference to the FIG Core Cadastral Model in this paper will be using the new name proposed above.

## CONCLUSIONS

The US mortgage industry's "loose" or non-cadastral reference to real property highlighted the following about society's awareness and knowledge of the cadastral domain:

- People unfamiliar with the cadastral domain do not share the same reverence for unique parcel identifiers as cadastral domain practitioners.
- Most people have no idea what their cadastral parcel identifier is. They do know their property addresses though.

As suggested in Section 1 of this paper, the future IT landscape will be shaped by those who succeed in simplifying a complex world. This challenge extends into the cadastral domain as well – cadastral systems must become user friendly for citizens, property owners, and small and large investors. Formally adopting common property identifiers into the cadastral domain and content standard is one of the ways we can simplify the system, increase its acceptability and usage, and improve its sustainability.

In the early 1990's , while in the African veldt in the Pilanesberg in what was then the Republic of Bophuthatswana (now South Africa), University of New Brunswick's John McLaughlin remarked about the future of cadastral surveying and land information management, stating that "rules and tools will be automated."

[25] Christiaan Lemmen, Paul van der Molen, Peter van Oosterom, Hendrick Ploeger, Wilko Quak, Jantien Stoter, Jaap Zevenbergen. A Modular Standard for the Cadastral Domain. 2003.

Our challenge remains to understand and represent these rules and tools in a sufficiently timely manner and format to those who need to know. To achieve this task in a timely manner, both researchers and industry have to be willing to co-opt existing and functioning non-proprietary standards and conventions.

## REFERENCES


H. Stuckenschmidt, E. Stubkjær & Ch. Schlieder: Modelling Land Transactions: Legal Ontologies in Context Second International Workshop on Legal Ontologies, 13 December 2001, University of Amsterdam, Netherlands.

Erik Stubkjær, Denmark: Modelling Real Property Transactions. Paper presented at the XXII FIG International Congress, Washington, D.C. USA, April 19-26 2002.

Intergraph Mapping and Geospatial Solutions: Enterprise Land Information Management Data Content Template.

Norman, D. A. 1998. The invisible computer. Cambridge, MA: MIT Press.

University of California, San Diego - Department of Cognitive Science Web Site. http://cogsci.ucsd.edu/~norman/DNMss/TamingTech.html.

Workflow Management Coalition: Reference Model Interface 4 for Workflow Interoperability, 28th October 2004 Edition of the Economist

Uhlrich, William M. 2002. Legacy Systems: Transformation Strategies. Prentice Hall PTR, Upper Saddle River NJ.

Drucker, P. F. (1998): "Management's New Paradigms." Forbes, October 5, 1998. pp. 152 – 176.

Hay, David C. 2003. Requirements Analysis: From Business Views to Architecture. Upper Saddle River, New Jersey: Prentice Hall PTR.

Christiaan Lemmen, Paul van der Molen, Peter van Oosterom, Hendrick Ploeger, Wilko Quak, Jantien Stoter, Jaap Zevenbergen (2003): A Modular Standard for the Cadastral Domain, The 3rd International Symposium on Digital Earth, 21-25 September 2003, Brno, Czech Republic

le Roux, Pierre (2003): Advances in Technology: Capabilities of non-proprietary commercially available databases in support of sustainable land information management infrastructures., Second Cadastral Congress, Crakow, Poland 2003

le Roux, Pierre. 2000. “International Trade in Technology, Services and Knowledge in support of the Establishment of Efficient Land Markets.” (Unpublished). Paper presented at Management of Technology Seminar at the University of Alabama in Huntsville. April 2000.

le Roux, Pierre (1996): Appropriate Information Management Technology in Support of the Establishment, Development and Maintenance of Land Management and Administration Infrastructure, International Land Tenure Conference, Orlando, Florida, November 1996

le Roux, Z. P. (1993): Land and Cadastral Reform in the Republic of Bophuthatswana, Tenth Conference of Southern African Surveyors, Sun City, Bophuthatswana ( now South Africa ), 23-25 May 1993

Lopez, Xavier R. and others. 2003. “Oracle Database 10G: A Spatial VLDB Case Study.” Paper presented at OracleWorld 2003 in San Francisco.

Porter, M. E. (1980): Competitive Strategy: Techniques for Analyzing Industries and Competitors. New York Free Press, 1980.

Ulrich, William M. 2002. Legacy Systems Transformation Strategies. Upper Saddle River, New Jersey: Prentice Hall PTR.

van der Molen, P. (1998): Trends in Land Registry and Cadastre, Proceedings of FIG XXI International Congress - Commission 7, Brighton, United Kingdom, July 1998.

Wetherbe, James. 1988. Systems Analysis and Design: Traditional, Structured, and Advanced Concepts and Techniques, 3rd Ed. St. Paul, Minn.: West, p. 114.

Economic Commission for Europe, Working Party on Land Administration (WPLA), Third session, (Geneva, 17-18 November 2003), (Item 4 (a) of the provisional agenda), Workshop on Spatial Information Management for a Sustainable Real Estate Market, Report prepared by the delegation of Greece in cooperation with the secretariat. http://ods-dds-ny.un.org/doc/UNDOC/GEN/G03/322/05/PDF/G0332205.pdf?OpenElement

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