

Cadastral Modeling - Grasping the objectives

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SUMMARY

Modeling is a term that refers to a variety of efforts, including data and process modeling. The domain to be modeled may be a department, an organization, or even an industrial sector. E-business presupposes the modeling of an industrial sector, a substantial task.

Cadastral modeling compares to the modeling of an industrial sector, as it aims at rendering the basic concepts that relate to the domain of real estate and the pertinent human activities. The palpable objects are pieces of land and buildings, documents, data stores and archives, as well as persons in their diverse roles as owners, holders of assets, experts, and holders of authority. More subtle objects are rights and restrictions, which relate persons through enforceable rules and commitments. The objective of this fabric of complex relations is to provide a stable and yet flexible frame for legal-economic dispositions that are related to land.

The paper advances the position that cadastral modeling has to include not only the physical objects, agents, and information sets of the domain, but also the objectives or requirements of cadastral systems.

Cadastral Modeling - Grasping the objectives

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1. INTRODUCTION

A Cadastral System is conceived, as the call for paper proposes, as the combination of a cadastre with its spatial focus, and a land register with its legal focus, cf. the motivation for this conceptualization in (Silva, Stubkjær, 2002). A fairly high level of abstraction is needed in order to provide for a set of models, which is complete and consistent and at the same time relevant for practice and applicable across jurisdictions within e.g. the European Union.

The COST G9 research activity has achieved some progress in modeling real property transactions. The emphasis has been on stating the activities performed: the actors, the sequence of activities, and the outcome, using UML modeling as the reference (e.g. Vaskovich, 2004). The level of abstraction made it possible to compare the performance of activities across countries. It appeared, however, that it was difficult to explicitly state the goals of the diverse activities, and/or phrase the activities in a way that emphasized the objective of the activity. To illustrate the problem by an example:

Subdivision includes a number of steps, including boundary measurements, and the approval by the Cadastral Agency. What is the objective of this activity? One of the objectives is to make available a cadastral identifier, which unambiguously names a specific parcel on the cadastral map. Another is to specify a the boundaries on the cadastral map in accordance with the legal reality on location, and a third is to specify a property unit, which then makes the base for sale and mortgaging. Who wants or requires this identifier? The geodetic engineer, who made the boundary measurements, and initially defines the parcel? The owner, who requested the cadastral service, because the law requires it? The purchaser, who could not mortgage his property unit without recording in the Land Registry, which again could not be accomplished without the cadastral identifier?

The example demonstrates that to a certain extent, it is a matter of choice to which actor the request should be attributed. The impact of this vagueness may be reduced by stating the requirements of 'all' actors within the domain, and then check, whether requirements are missing or better could be attributed to another actor.

The above mentioned limitations of standard UML modeling has been realized by knowledge engineers as well. The following section 2 refers to recent outcomes of their research, which suggests a more rigorous statement of requirements. Section 3 provides an answer to that call by presenting for each of 10 actors a listing of their supposed requirements from the other actors. Research within the domain has so far stated objectives, functions or features on a more general level. Section 4 analyses these often cited objectives, etc., and relates them to the requirements at actor level. Section 5 presents similar efforts in stating objectives and user needs, section 6 provides a discussion, among others of the idealized government, which was introduced in section 3, and the conclusion in section 7 closes the paper.

2. REQUIREMENT SPECIFICATIONS

2.1 The domain

Cadastral Systems are, world-wide, integrated in societal life in a way that makes it difficult to specify the domain in a way that points out the essentials. By taking a point of departure outside Europe, you might get a better basis for stating, what otherwise would be left unnoticed as truisms.

Hernando de Soto has established the fact that the humbler strata of each of a number of developing countries are in possession of houses, the value of which taken together far exceeds the holdings of the respective government, the local stock exchanges and foreign direct investments, and which is many times greater than the aid from advanced nations (De Soto, 2000). From this perspective he presents a number of effects, which characterize the property rights of the West: They are formalized, written on paper according to rules and norms, through the support of competent professionals and civil servants, who are generally available to owners and prospective purchasers, and the rights are abstracted in carefully maintained databases and archives.

The subsequent statement of requirements is, however, made in the intension to cover the situation only in Europe. This restriction is needed, because some of the main actors described below, the professionals and the public services, are not available, physically or economically, for the transacting parties of the developing countries (BRM, 2001, note 47). The initial adjudication of the country concerned is thus assumed to be completed, and the legislation, expertise, information systems, and practices are taken to be in place. The following may render the cadastral domain in terms of UML 'packages' in a compact way.

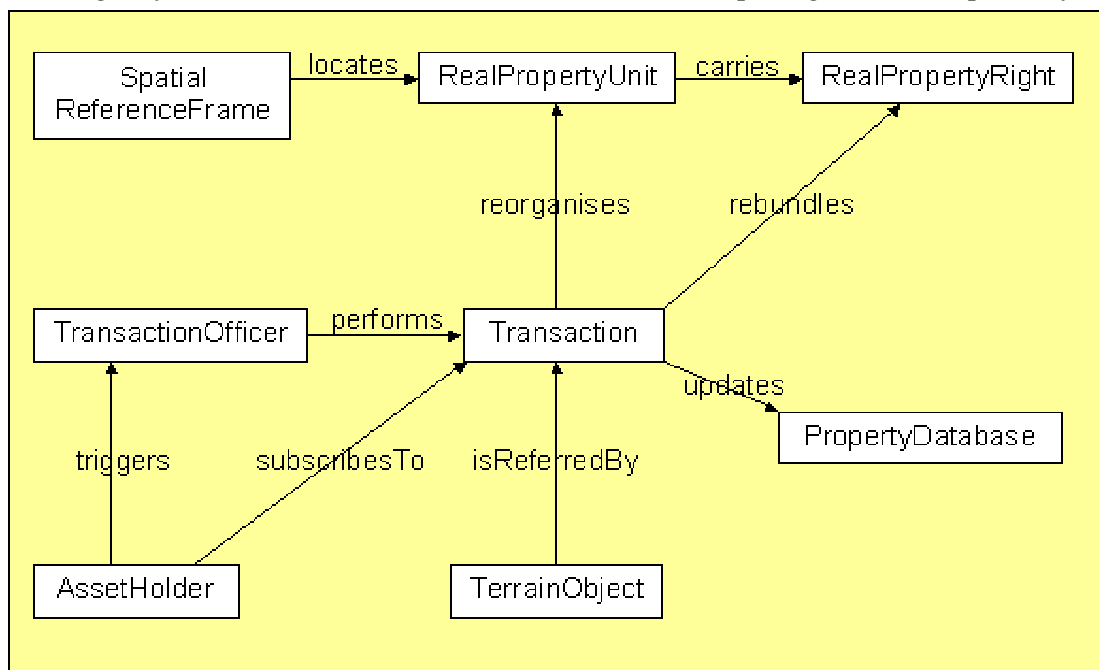


Figure 1: Cadastral Core Packages. Source: Stubkjær, 2003b

The assumption that the Cadastral System is largely established perhaps implies that a requirement analysis at actor level cannot be used to motivate the establishment of the Cadastral System as such. The statement of requirements at actor level does however contribute to the identification of requirements. The relative importance of the requirements is subject to further studies. The reason for that being that a certain level of, for example legal security in property transactions, may be achieved by a host of combinations of services and measures, which means that the ‘most relevant’ requirement cannot easily be established.

2.2 The methodology

The limitations of standard UML modeling have recently been realized by knowledge engineers. A framework for requirements engineering is proposed, providing primitive concepts like actors, goals, and actor dependencies (Yu, 2001). The proposal is developed into a specific software development methodology, *Tropos*. The system-to-be is represented as another actor and is related to stakeholder actors in terms of actor dependencies. (‘Agent’ is a term that includes stakeholder actors, software, as well as other resources. Consequently, ‘multi-agent system’ is a relevant keyword). The stakeholder actors may draw upon resources or agents, available in their environment as well (Giunchiglia, et al, 2002).

Perini et al (2002) further focuses attention to the interaction amongst stakeholder actors: - behavior may be characterized as lying between extremes of competition and cooperation depending on, to what extent actors try to achieve common goals, or whether their goals are conflicting. Consequently, modeling should reflect the dependency between pairs of actors. Only by modeling this interaction firstly, it becomes possible to keep track of the *why*, the objective of the activities.

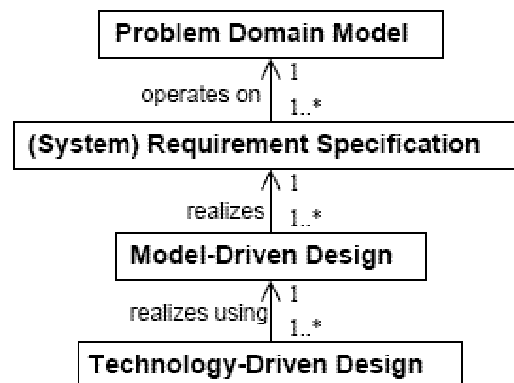


Figure 2: Requirement Specification in context. Source: Astesiano, 2002, Fig 1.

Finally, mention is made of the important suggestion by Astesiano and Reggio (2002) to discern between a Problem Domain Model, the Requirement Specification, and the System, respectively. The latter is specified through Model- and Technology-driven design, as illustrated in Figure 2. This conception of the modeling effort allows for a more explicit description of the system and its boundaries.

3. THE MAIN ACTORS AND THEIR POTENTIAL REQUIREMENTS

The actors charted below are ideal types, fictional models that never the less help us to understand the real world. What is common to the 10 actors is that they are supposed to act in a rational, but not necessarily law conformant, way, maintaining their interests and aiming at reducing their individual costs.

Perhaps, the requirements will be specified in a way, which mentions a specific plan or procedure, rather than stating a goal. This is against the idea of requirement analysis, which should allow for independent treatment of requirements and the subsequent design of plans, respectively. However, the scientific vocabulary of the cadastral domain is yet not developed to an extent, which allows for such 'pure' statement of requirements.

3.1 The Seller

The seller requires from the *Purchaser* an appropriate payment for the sold property unit. Furthermore, as valuable assets are at stake, the trading of ownership rights against money, etc. has to be performed in a way that protects the asset of the seller.

The seller requires from the *Real Estate Agent* to introduce, within reasonable time, of one or more Purchasers, who are able to pay the appropriate sum. Furthermore, the preparation of a sales offer, which accounts for the relevant attributes of the property unit and states a price, as well as guidance on how to market the property unit in an attractive way, and how to establish a mix of cash payment and mortgages that potentially increases the cash sales price.

The seller (and/or Purchaser) requires from the *Legal Advisor* to provide a written evidence of the transaction, have it recorded in the Land Registry, and monitor the related cash flow. Furthermore, to handle the details of receipts and expenditure of the property unit, relative to the day of entering into possession, and to advice on insurances and other appropriate measures to reduce the disturbing impacts of unexpected events of physical or legal nature.

The seller requires from the *Financial Institute* (or the Legal Advisor) the handling of the cash-flow of the transaction in a secure way, and assistance in the possible termination of existing mortgages.

From either of the previous, the seller may require guidance on, how the property transaction might be performed to reduce impact on taxation, as well as advice on the investment of the available capital to maximize rent and accommodate to the future cash-flow needs of the seller.

In case of change of size or shape of the unit and/or change of use category of the property unit, the Purchaser may request a *Geodetic Engineer* to establish the units' new boundaries, and arrange that the unit is functionally viable, e.g. legal access to a public road. The Purchaser then requests from the *Cadastral Agency* an official, unique identifier of the property unit(s).

3.2 The Purchaser

The Purchaser requests from the *Seller* a complete title in the property unit, as well as a fair account of the physical defects and the encumbrances of the unit. The purchaser may request that a part of the purchase amount is settled in terms of a Seller's mortgage in the property unit.

The Purchaser requests from the *Legal Advisor* assistance in specifying all relevant details of the transaction, and recording it in the *Land Registry* as mentioned above. Furthermore, the Purchaser requests from the *Legal Advisor* (and the other professions) that they offer professional indemnity.

The Purchaser requests from the *Land Registry* the provision of correct information on the rightful owner, as well as an account of all encumbrances but the most obvious, e.g. taxes and utility fees.

The purchaser requests from the *Financial Institute* a prompt offer for mortgage, and advice on the various lending options available.

The Purchaser requests information (through *Seller* or professionals) from the *Cadastral Agency* on the location, identification, and boundaries of the property unit.

The Purchaser may request a *Building Survey* in order to reduce the risk in assessing the physical qualities of constructions, etc.

3.3 Real Estate Agent

The Real Estate Agent (and other professionals) requests from the *Seller* (and other clients) to be paid for the service offered, and to be informed on the wishes of *Seller* as regards the conditions of sale, including price.

The Real Estate Agent requests from *Financial Institutes* and/or from *National Statistics* gross information on the real estate market, e.g. the number of transactions of different estate categories within administrative areas, and similar on the mortgage market.

3.4 The Legal Advisor

The Legal Advisor requests from the *Land Registry* an account of the present recordings, in order to assess the validity of the details of the deed.

The Legal Advisor requests from the *Client* to be paid for the service offered, and from the *Real Estate Agent* an agreement on the distribution of tasks as regards the scrutinizing of the conditions of sale, the establishing of rights, the financing of the transaction, and the transfer of money.

3.5 The Financial institute

The Financial Institute (bank) requests from the *Purchaser* that s/he repays the loan(s) and pays interest and charges as agreed.

In case of default, the bank requests from the *Land Registry/Court* that foreclosure action is performed within a predictable period of time.

3.6 The Land registry

The Land Registry requests from *Government* the provision of salaries, office space and equipment, as well as job applicants with sufficient education.

The Land Registry requests from the *Legal Advisor* (on behalf of the *Purchaser*) the settlement of stamp duties, etc, and the provision of deeds, which precisely identify the parties and the property unit transferred, which moreover specify the future owner(s) and the encumbrances and their mutual priority, and which finally state the sale price. The Land Registry furthermore requests that deeds are supplemented with evidence as needed, e.g. to witness the powers of a party.

The Land Registry requests from the *Cadastral Agency* the provision of unique identifiers of all property units, and information on changed (updated) property units.

3.7 The Geodetic Engineer

The Geodetic Engineer requests from the *Seller* (and other *Clients*) to be paid for the service offered, and to be informed on the wishes as regards future boundaries.

The Geodetic Engineer (or other responsible) requests from the *Municipality* (and/or other local authorities) the approval of intended changes of the property unit within a reasonable elapse of time.

The Geodetic Engineer requests from the *Cadastral Agency* relevant maps, including previously prepared boundary map sheets, as well as the documentation and monumentation of a geodetic network.

3.8 The Cadastral Agency

The Cadastral Agency requests from *Government* the provision of basic resources cf. similarly the Land Registry.

The Cadastral Agency requests from the *Geodetic Engineer* a specification of new and existing property units and their boundaries, the remedy of discrepancies between what is recorded and what is the legal situation on location, the recording of previous omissions, as well as the settlement of subdivision duties and fees.

3.9 The Citizen

The Citizen, as a potential buyer, requests from the *Government* a general education in reading and writing, including the use of writing while committing oneself. Furthermore is requested a formation, which enables the Citizen to reflect her assets and other potentials, and invest them in purposeful action. Finally the Citizen requests from the *Government* “to any person within its jurisdiction the equal protection of the laws” (cf. Fourteenth Amendment of the Constitution of the USA, 1868), but also that government and upper strata of society obeys to the law in the same way as the citizens are supposed to do (no dual standards in legal and economic affairs, cf. Collins, 2000: 105f).

3.10 The Government

The Government requests from *Land Registry* and from *Cadastral Agency* a complete and reliable coverage of the jurisdiction, and a reasonably joint conception of the recorded property units, including the use of same or mutually referenced identifiers, and mutual assistance for correction of inconsistencies. Furthermore, that property registration and related procedures contributes to a transparent market in real estate, i.e. that it is accessible to the public, and managed in a technically reliable, timely, and efficient way.

The Government requests from civil servants: *Land Registry*, *Cadastral Agency*, to behave according to bureaucratic norms of the Weberian, not the pejorative sense. This implies also the monitoring of rules and procedures with a view of reducing complexity and enhancing consistency. Government requests from professionals: *Real Estate Agent*, *Legal Advisor*, and *Geodetic Engineer*, to provide professional indemnity, and behave according to a professional ethics.

The Government requests from *Citizen* the payment of taxes, and from *Buyer* and *Seller* the payment of duties and fees related to the transaction.

The above description of Government may be more idealized than the descriptions of other actors of this section. As announced in the introduction, a discussion is deferred to section 6.

4. REQUIREMENTS IN TERMS OF OVERALL PRINCIPLES AND FEATURES

The cadastral system operates as a whole, while in the previous section we applied the point of view of the diverse actors. In order to complement the above requirement investigation, the following refers to statements on the goals, functions, or features of the system as a whole. It is based on the overview provided by Zevenbergen (2002), which also provides reference details on literature before 1995.

Kurandt (1957), and Henssen (1995) mention the following principles pertaining to the Land Registry (LR) of German tradition:

- The booking principle, that conveyance is effected through recording in LR only
- The consent principle, that only the authorized according to the LR may request change
- The principle of publicity, including that recorded facts enjoy public credibility, and
- The principle of specialty, that the parties and the unit(s) of property are unambiguously identified.

Except for the third principle (enjoy public credibility), the others are means to achieve the overall goal of legal security. The German law demands preconditions and establishes legal effects, which in complex ways relate to the overall goal. The consent principle tends to support the accordance of the recorded with the reality. However, it presupposes a well organized registration system, that is: the principle of specialty must be realized. This principle again depends on the Government's means for identification of persons and on the operation and coverage of a Cadastral Agency, which provide the identification of property units.

Ruoff (1957) mentions three principles often quoted in literature in English:

- The mirror principle, that the recording in LR accurately and completely mirrors the facts that are material to title,
- The curtain principle, that purchasers, etc. need not to investigate legal facts beyond what is recorded in the LR, and
- The insurance principle, that a deficient LR recording triggers compensation to those, who suffered a loss by trusting it in good faith.

The mirror principle is supported by the above mentioned consent principle, and presupposes the specialty principle. Together, the realization of the three principles of Ruoff substantially reduces what in New Institutional Economics is dubbed the measurement costs of transactions. The notion of the mirror principle allow us to restate the request by the Land Registry to the Legal Advisor: The Advisor shall provide the Land Registry with the information needed to maintain the mirror principle.

Fortescue-Brickdale (1914), Kurandt (1957), and the FIG Statement on the Cadastre (1995) offer related sets of features of a (well-functioning) registration system.

Of those, 'legal security' mentioned by all covers the three above-mentioned principles of Ruoff.

'Simplicity' or 'understandability' of registration is mentioned by all as well. The mentioning of this feature seems not weighted against the complexity of the transactions, which suggest the use of professionals, at least until multi-agent systems support the able citizens in a comparable way, cf Arrunada (2004), who states that intervention by lawyers and notaries has become unnecessary for supporting much of private contracting in real property. Anyhow, (a well-meaning) government should strive for reducing the complexity of legislation.

Equitable access, Fairness, and Low cost are mentioned by the FIG Statement. Except for 'legal security', the features mentioned are also requested by the idealized government, which was described above, part 3.10.

Concluding, 'legal security', 'public credibility', and, proposed by Zevenbergen: 'trustworthiness' seems best to capture the overall objective of cadastral systems, while the 'mirror principle' with the 'insurance principle' best explains why credibility is achieved.

5. RELATED RESEARCH: STATEMENTS ON USER NEEDS

5.1 Requirements in the field of artificial intelligence and law

The Dutch Tax and Customs Administration conducts a research program POWER in which methods and tools are developed that support a systematic translation of (new) legislation into the customs' processes. The methods and tools developed are reported to help improving the quality of (new) legislation. Also, the methods support the codifying of the knowledge used in the translation processes in which legislation and regulations are transformed into procedures, computer programs and other designs. To illustrate the aspect of requirement specification, mention is made of a definition of the quality of law enforcement, which is offered by Engers et al (2001): "Quality of law enforcement is defined as the satisfaction of the constituency with the adoption of equality before law, predictability of law enforcement and proper use of law by law enforcing agencies". Here the constituency is taken as the actor, which eventually requests the requirements.

5.2 Requirements in the field of geographic information

A report on Users needs for reference data, (ETeMII, 2001) noted the ETeMII objective to enable better access to geographic information, and consequently stated the intension to tackle the users' needs for reference data (p.3). The report goes on to specify that "Stakeholders are users, data producers, data owners and GI service handlers. For a successful outcome, a European GI infrastructure must involve all of them...". Unfortunately, the user needs are not specified in much detail: "When the question, 'what do you need?' is posed to a specific user, the answer is classically, 'what do you have?' ... Nowadays, final users demand much higher data quality and better documentation" (p. 5).

The main ETeMII report includes an Annex C, the purpose of which is to examine existing user requirements (or 'customer requirements') as determined by a wide range of studies and reports from across Europe and the globe. "However, to provide such an analysis has proved to be beyond the scope of this annex ... due to the very large number of competing data requirements arising from GI user groups/sectors". The Annex, however provides economic data, which may be combined with the report's highly relevant structuring of geographic information to provide the following figure:

Visible objects: 33%	Socio-economic Units: 29%
Selected topographical themes: <ul style="list-style-type: none"> • Transport: 5 • Elevation: 7 • Hydrography: 5 • Other environmental: 16 	<ul style="list-style-type: none"> • Units of administration: 2 • Units of property rights: 27 • Addresses: ?
Other: 38% Geodetic framework: 4; Utilities 19; Maritime navigation: 15;	

Figure 3: Geodata groups and their relative economic weight

Source: ANCLIZ Benefit Study, 1995, as quoted by ETeMII, 2001, Annex C

The figures are surely debatable, but no better evidence appears available. The figures point to the relative importance of the units of property rights, i.e. land registry and cadastre. This may be further illustrated with data from the Danish National Survey and Cadastre (KMS,

Årsrapport, 2003). The report reveals that the degree of cost recovery amounts to about 60 pCt on the cadastral activity proper, while only 34 pCt in general for the agency.

An interpretation of the above might be that the agency (and other European agencies?) faces user requirements, which are more determined regarding data on property units, than other, e.g. topographic data.

5.3 Requirements motivating the Lemmen et al standard for the cadastral domain

Governments need instruments to facilitate the implementation of a proper land policy in the broadest sense (Lemmen et al, 2003: 400). The main functions of every cadastral system are 1) to keep the content of the relationships between man, right, and land stored in a database, updated by drawing on legal transactions, and 2) to provide information from this database . The information may be hard to understand. By referring the information to an underlying ontology, expressed as a standardized cadastral core model, the information and communication between parties will be enhanced. This applies especially to communication across jurisdictions.

Open markets and globalisation ask for further standardization. The technology push, as well as the market pull for new services put demands on organisations for change. Cadastral modelling facilitates this development by providing standardized modules . These unspecified references to actors are supplemented with more concrete, namely that GIS suppliers like ESRI similarly offer models for several domains, and the cadastral domain is within its scope.

6. DISCUSSION

The role of government is remarkable. In the countries, which were mentioned by De Soto (2000), governments either have not realized the need for land administration instruments, or have not been able to establish them. Reversely, both the requirements specification of section 3 and section 5.3 above assumes the presence of a (strong) state, in order to make the property market and the implementation of land policy operate.

This is consistent with Giunchiglia (2002) who state that the stakeholder actors may draw upon resources or agents, available in their environment as well. However, the reliance on resources in the environment makes it problematic to transfer a standardized core to other jurisdictions, where the environment may be different, and important resources missing.

The requirement specification of section 3 may well be in need of further development. On the other hand, the specification allows for accumulation of knowledge in a more integrated way than has been possible so far. The statement of section 5.3 on the first function of a cadastral system compares fairly well with the ‘mirror principle’ of section 4. This is not to say that only one way of expression is appropriate. Rather, the various expressions are more easily compared.

7. CONCLUSION

Standardization of the cadastral domain supports the meaningful exchange of information between organizations and parties, in their dealing with rights in land and other real estate. Standardization is here conceived in the proactive sense, as a kind of legislation or regulation, which is imposed on actors and their future activities within the cadastral domain. Regulation needs to be legitimized. The Parliamentary process is essential in the legitimating of general prescripts, while the legitimating of standards appears to be a more open issue. Nebulous references to ‘user needs’ may be found.

The relevance of a Cadastral System in its totality is established, not with reference to user requirements, but rather with reference to the historical fact that such infrastructure is needed to enable a market in real estate.

The paper suggests that rational requirement analysis provides the legitimacy in cases, where users are not able themselves to specify the requirements. The approach draws upon recent developments in software engineering methodology, in an effort to state user needs in a way, which is specific enough to allow for empirical testing, and which facilitates a subsequent systems analysis.

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BIOGRAPHICAL NOTES

Erik Stubkjær is professor of cadastral science at the Department of Development and Planning, Aalborg University, Denmark, since 1977.

He has written numerous research articles and conference contributions with a view to elicit theoretical foundations of cadastral systems.

He is former chairman and member of the Programme Committee of the conference series: Scandinavian Research Conference on Geographical Information Science (ScanGIS), and member of the Scientific Committee of the COSIT series of conferences. During 1996-99, he was co-ordinator of the EU's Phare/ TEMPUS project: Improved Education on Environment and Infrastructure. The project regarded the restructuring of the study programme of the Department of Geodesy, Faculty of Civil and Geodetic Engineering, University of Ljubljana,

Slovenia, and resulted in a formally agreed renewal of the study programmes. 1999-2001, he was co-ordinator of a Nordic-Baltic Network on Land Management in Geodetic University Programmes, NorBalt.

Since November 2001, he is elected chairman of the Management Committee of a research project, Modelling Real Property Transactions, which co-ordinates research in 12 European countries, supported by the EU's COST scheme (G9).

In May 2003, he organised a PhD-course in the context of the International Doctoral School of Aalborg University. The course 'Cadastral Development – The Contribution of Scientific Enquiry' attracted 10 participants from 8 countries.

Erik Stubkjær is member of the Danish Association of Chartered Surveyors, and of the IT-section of the Society of Danish Engineers.

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