# A THEORETICAL BASIS FOR CADASTRAL DEVELOPMENT

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## ABSTRACT

The European cadastres developed - through more than a century - each in its own national and legal context. The international discussion on the 'multi-purpose cadastre' and ·on Land Information Systems presupposes the understanding that the national practices and conceptions can be conceived as variations of a common theme or phenomenon: the Land Information System, or - more specifically - the cadastre.

This paper presents a related collection of concept sets which name various components of the mentioned phenomenon in its abstract, generalized form. These concept sets are largely borrowed from adjacent disciplines: geodesy, geography, political science, and linguistics. The disciplines' different methods of scientific enquiry are briefly discussed.

Cadastral development is due to able professionals, as well as to political support, among other things. The paper discusses the role of theory and the cadastral academic in this societal context.

## 1. INTRODUCTION

The purpose of the paper is to bring together elements of theory which were presented at diverse conferences during the last 5-7 years. The conferences addressed topics which are related to the field of the land surveyor in one way or another. However, it was characteristic of the structure and discussion at these conferences that no paradigm in the sense of Thomas S Kuhn (Kuhn, 1962) could be perceived.

This assessment is hardly surprising: the surveying profession is influenced by the technology applied for measurement. The change of this technology has been dramatic during the last decades: From surveying and photogrammetric instruments, which are in fact sophisticated machines, to computers and GPS, which have machine-like traits, but are better conceived as message processors.

This change in hardware is accompanied by a change in culture: the 'old' surveying tradition was to a large extent dominated by companies and research of German speaking origin, while the 'new' wave is dominated by Anglo-Americans. This relates not only to the developers and vendors of computer equipment: research and development is intertwined with industry and government, and as the European governmental institutions differ considerably from the North American institutions, the approach and

values of research have changed profoundly, also. These changes make old bases of research disappear, and some philosophers of science (e.g. Michel Focault: The Order of Things. 1966) seem to maintain that in a sense no basis is possible at all.

The teaching of land surveying students, including PhD students, demands selection and ordering of the vast amount of literature. Some argue, that it is the task of the student - during his or her academic learning process - to bring about this order. The position of this paper is, however, that by providing the student with an ordered and possibly consistent set of information the student will have a more informed basis for individual judgement. The aim of the paper is thus to promote a scientific ordering of information related to the cadastral surveyor.

### A note on terminology: LIS, GIS and cadastre

The notion of the 'multi-purpose cadastre' of the 1970s was, in the early 1980s, replaced by the term 'Land Information Systems'. The Commission on Land Information Systems of the International Federation of Surveyors suggested the following definition:

- "A land information system is a tool for legal, administrative and economic decision-making and an aid for planning and development, which consists on the one hand of a data base containing spatially referenced land-related data for a defined area, and on the other hand, of procedures and techniques for the systematic collection, updating, processing and distribution of the data. The base of a land information system is a uniform spatial referencing system for the data in the system, which also facilitates the linking of data within the system with other land-related data" (FIG, 1981).

The term of LIS has been substantiated by textbooks, e.g by Peter Dale and John McLaughlin (Dale & McLaughlin, 1988). However, the term Geographic Information Systems has been applied in Europe (cf. Burrough, 1986) as well as in North America, which brought confusion about the meanings of the terms. In the late 1980s the American Society for Photogrammetry and Remote Sensing and the American Congress on Surveying and Mapping made efforts to reach a consensus, and the following definitions were published:

- Geographic Information System (GIS): "A system of hardware, software, data, people, organizations, and institutional arrangements for collecting, storing, analyzing, and disseminating information about areas of the earth."
- Land Information System (LIS): "A geographic information system having, as its main focus, data concerning land records" (Dueker & Kjerne, 1989, as cited in Vonderohe et al, 1991).

The (American) vendors of computer systems, and influential publications, e.g the two volume standard work: Geographical Information Systems - Principles and applications (Maguire, Goodchild & Rhind, 1991) have made GIS the name of the game, not only among geographers, but among land surveyors and photogrammetrists as well. As the content of the present paper addresses more the dominating concept which LIS delimits, and as the author does not belong to the profession of geographers, the notion of the cadastre is taken up again. Following the recent definition of GIS, you may say that a cadastre is a geographical information system which is applied by government.

This definition implies that the 'institutional arrangements' of the Dueker & Kjerne

definition are substantially related to legislation by Parliament, besides technical standards, professional codes of conduct, and other institutional arrangements. GIS's applied for governmental (land use) planning and environmental control are included; this extension of the scope of the term cadastre is motivated by the fact that these information systems are used by public administration and must be evaluated accordingly. Government here includes local government; the information systems of the utilities and other regulated companies are, on the other hand, not considered cadastres. However, the activities of these companies concerning mapping, etc. are considered important for the understanding of cadastral development.

**The point of view of the paper**
The focus of the 'old' conception of the land surveyor was on surveying and mapping. Cadastral law and related legislation was part of the curriculum, and at universities with a strong faculty in planning social theory might be included as well. Generally, the task of the surveying faculties was (and is) to research the potential and implications of new technology in collaboration with the providers of the equipment and the larger user enterprises in government and the mapping business.

This paper advocates a view which is less occupied with the technology as such, however important that technology in fact is. The focus is on **the cadastre in its societal context**.

Cadastral agencies emanated as technical bureaucracies with the task of handling cases on subdivision, etc. according to law. The concern for just treatment of every case, has met competition from a more management-oriented conception of public administration. The cadastral agencies have, to an increasing extent, taken on obligations concerning national coordination of spatial data. Recently, cost recovery is demanded, too (Rhind, 1992). The management of cadastral agencies, thus, must be based on an understanding of the political processes which influences the provision of resources for the cadastre.

One may have the view that management is a profession in its own right, and that you should stick to your trade as a surveyor. The position taken in this paper is that to exploit the opportunities of the markets of technology and of administrative-political alliances, among others, you need a deep understanding of the cadastre. You need a balanced imagination of what are the potentials of the cadastre, and a prudent view of what restrictions have to be observed to maintain a sufficient quality of data and confidence in the cadastral institutions. Therefore, scientific information in its abstract, generalized form must be organised to serve this understanding. As Machiavelli and others presented a 'Speculum regale', a reflection on the tasks of a prince, it is proposed to provide, through continued research, a 'Speculum cadastrale', not only addressed to managers of the cadastral agencies, but to those who care for the cadastre.

## 2. THE CADASTRAL SUBJECT AREA

The following names what are considered the elements of the subject area of the cadastral surveyor: the objects, their images and the related activities. The exposition proceeds from the most palpable to the abstract. The naming of the subject area applies mapping as a structuring principle, as can be seen from the following.

**First level**
Nature, the environment, the terrain, and a territory are names with different connotations, but all address the surface of the Earth. The basic concern of the cadastre is the **boundaries** of territories: national states, administrative regions, or property boundaries. However, the boundaries constitute only one set of **terrain objects** which are mapped and registered to serve the needs of society at large.
**Cadastral maps and records** render an image of the terrain objects: their position, shape and other geometric and non-geometric attributes. To be useful in the public debate on land use and property regulation, and for taxation and cases with a judicial dimension, the maps and records need to be reliable.
The activities of this level are **definition, naming, and mapping (in the widest sense) of terrain objects and boundaries.**

The **tools** applied for these tasks (surveying instruments, computers) count among the basic items, too.

**Second level**
The main objects on the next level of abstraction are the **owners** and others who have the disposal of land and natural resources, their professional **advisers**, and the **authorities** with whom they communicate. Their **rights and liabilities** of the owners, and the **authority** of the governmental units are the most interesting attributes. The legal dispositions of the owners and the authorities, etc. are 'mapped' into **documents.**
The activities at this level are **agreements** on land, on rights in land, or on activities related to land, and the **granting of permission** (e.g on building or subdivision), or other **public decisions** (e.g. on development plans, or on the filing of a deed in the legal cadastre). Generally, these activities are regulated by law, so that they follow prescribed **administrative procedures**.

**Third level**
The main objects, or **actors**, of the third level are the organisations who issue and maintain the prescripts of level two. **The Parliament** is the actor par excellence, but, as research has evidenced (e.g. Schneider, 1988), neither the only nor the most influential. Ministries, local government representatives, utilities, larger companies (e.g. GIS vendors), professional organisations, and interest groups (e.g 'green' organisations) all interact to maintain and develop their position in society, and to solve what is agreed to be 'societal problems'. The important attributes of the actors are the **resources** they have at their disposal for this interaction, and the **relations** among the actors in terms of mutual agreements, formalized practices of interaction, etc.
The activities at this level are conceived as a **trade with resources of a societal nature.**
The 'mapping' or outcome of this trade is new or revised prescripts of any kind, e.g. laws, by-laws, or technical standards.
These prescripts surely address real world problems. These problems may relate to level one, e.g. pollution or inequality among groups of the population, or to level two: needs or malfunctions at the level of administrative procedures, but it is assumed that the prescripts may be read, also, as a 'mapping' of the powers who shaped the prescripts, who moulded the conception of the societal problem at hand, and who influenced the timing of the solution.

## The structure of level one through three

In the preceding sections, three levels have been mentioned and the main **objects** and the most interesting **attributes** of the levels have been outlined. The literal mapping at level one has been applied as a metaphor to structure the elements of level two and three.

The activities at the three levels: **Mapping, administrative procedures, and exchange of societal resources**, respectively, may be conceived as communication processes. This is hardly surprising: Cartography has been conceived as communication for years, and the research issue is now revived as 'spatial language' (Frank & Mark, 1991; Mark & Frank, 1991). Administrative procedures prescribe rather formalized communications between owners, developers, professionals, authorities, and the general public. At the third level the exchange of resources is achieved through a variety of communicative practices: negotiation, establishment of working groups or task forces, voting, arbitration, etc.

The three levels of the cadastral subject area have thus been structured by the metaphor of mapping, and the abstract concept of communication.

A **fourth level** may be identified as well: the level of **philosophy and of scientific and moral norms**.

The cadastral subject area includes activities within the realm of natural science, but within the realm of social science as well. The question whether science is describing 'reality' or some imagination, and similar questions, must be answered according to the different objects of study of the natural and the social sciences.

To support this view, mention is made of the different observation process: When the objects of level two and three above, i.e. persons and organisational units, are the object of a scientific study, they react to inquiries ('observations') in a double way: They answer to the questions, but at the same time the questioning process create reflections which are likely to change the object being investigated, so that the observation cannot be repeated and confirmed. Also, the conceptions and values of persons are in a sense unpredictable, due to the creativity and freedom of man.

If one would take the position that natural science is the only 'valid' science, then one would leave democracy to 'dealers', 'gamblers', and poor people, and deprive the political (and judicial) processes of the contributions of scientific enquiry, however vulnerable it may be to criticism.

Of course, every cadastral academic has to make up his or her opinion on these issues as they relate to scientific, as well as to moral norms. However, this kind of discussion is mentioned in most accounts of the philosophy of science, and a conscious stand is necessary for the scientific investigation of the three above-mentioned levels.

By including philosophy of science in the subject area of cadastral studies you, furthermore, gain a position from which you can discuss some of the long term trends of the discipline. The land surveying studies are subject to change, due to changes in technology and due to the changing needs of society. The idea of an information society is one example. To grasp a 'unity in the variety' you may have recourse to basic conceptions like machine, organism, or text. However, this issue is not pursued here, as theory is presented as a more basic means to organize information on cadastral issues in a compact and stable form (cf. Ziman, 1992, p. 28).

## I. Elements of a cadastral theory

The following outline of elements of cadastral theory takes its point of departure from geography. In the classifications of scientific libraries, cadastre may be conceived as a subdiscipline of geodesy, or related to land conceived as an economic entity, or arranged with other tasks of government within public administration, e.g concerning agriculture or housing.

Geography was selected because geography, like geodesy, is concerned with objects and issues related to the surface of the Earth, but geography also includes social science issues (human geography, social geography) as well as natural science issues (physical geography). Furthermore, the relations between land information systems and geographical information systems which were mentioned at the outset of this article, make geography a natural choice.

### A. The basis: observations, theory, and mathematics

About 30 years ago William Bunge presented a methodology "which leaves geography no excuse for not reaching full maturity as a science" (Bunge, 1962: p. 36). Applying a "classical arrangement which other sciences have found useful", he presented branches of geography within three headings:

### Facts - Theory - Logic,

where Logic included "Cartography, Words or Mathematics" (p. 37). An evaluation of the relative potentials of maps and mathematics is concluded as follows: "Mathematics is the broader and more flexible medium for geography. In general, ... maps are a subset of mathematics" (p. 71, cf. p. 197). In addition to **geometry**, including projective geometry, Bunge mentions **graph theory** (p. 127), and discusses **topology** in theoretical geography (p. 183ff).

In 1969 David Harvey presented a further developed treatise on the role of scientific method in geography (Harvey, 1979). A scientific **theory** is considered as a **"set of sentences expressed in terms of a specific vocabulary"** (p. 88). In the case of Euclidean geometry, terms such as 'point', 'line', 'plane' form the primitive terms collected together in an initial set of (axiomatic) sentences from which the whole structure of Euclidean geometry is derived. A theory is useful in the empirical science only if it gives some interpretation with reference to empirical phenomena. The Euclidean point may thus be interpreted by a dot on a map, or by the marked center of a boundary mark in the terrain. This interpretation is guided by a 'text for the theory' or a set of 'correspondence rules' (Harvey, 1979: p. 88-89).

It is interesting to note that the schemes presented are recognizable, also, in a recent textbook on knowledge representation (Davis, 1990). Ernest Davis considers the field of study as a micro-world: a restricted, idealized model of the world containing only those relations and entities of interest in the particular (reasoning) system being designed. The definition of the micro-world: its entities, relations, and the rules that govern them, is called the 'ontology' of the domain. The characteristics of the domain model are expressed in an 'axiomatic system' through a formal language. The statements of the formal language is connected to the ontology by a 'semantics' or **'domain**

**theory'**, which specifies how sentences in the formal language are interpreted as facts about the micro-world. Davis develops, also, the implementation of the statements in data structures, etc, but this aspect is omitted there.

In comparing the three texts it seems that Bunge's 'logic' relates to Harvey's 'theory' with axiomatic sentences, and Davis' 'axiomatic system' is expressed in a formal language. Davis' 'domain theory' relates clearly to Harvey's 'correspondence rules'. It appears that Bunge and Harvey apply the term 'theory' differently. While Harvey seems to restrict the term to the abstract world of mathematics, Bunge seems to apply 'theory' in the same sense as Davis, i.e. as 'domain theory'.

In the following 'theory' is conceived as 'domain theory', i.e. as sentences which relate mathematical constructs to the field of study. The **mathematical constructs** may be borrowed from any mathematical sub-discipline: **set theory, topology, graph theory, functional analysis, etc.**
For example, linear algebra and mathematical statistics may be considered mathematical tools available, e.g. for the analysis of measurement errors. The domain specific theory, i.e. the statements which relate the mathematical formalism to the real world of the surveyor, are the equations of observation, and the coordinate systems applied: For pedagogical and historical reasons the distinction between 'domain theory' and 'axiomatic system' is generally not spelled out in textbooks on adjustment, but the distinction is considered necessary for the following.

For every level, one through three of the subject area of cadastral studies, there are suggested corresponding (domain) theoretical elements or models. Due to obvious limits the presentation must be rather superficial, and reference is made to previous articles or other pertinent literature. The subject area relates to natural science as well as to social science. The problems due to the different methods of scientific enquiry are not discussed here.
The method for distinguishing one topic from another is: What is specific for this knowledge area, and does not belong to either the mathematical-axiomatic realm, nor to the realm of observations or empirical phenomena.

**B.  Spatial reference frames (Einstein, Piaget, ..)**
The Danish DSFL format for exchange of digital map data has been in use since 1982. The users have demanded revisions of the format. It is, therefore, interesting to note the way terrain objects are spatially referenced within this format.
From the outset different map projections were discerned by an appropriate coding, i.a. a Danish national projection called System 1934, and the UTM. Later, the need of the utility companies resulted in the concept of 'reference points', 'reference lines' and 'reference areas'. This means, that you may refer to the centerline of a road, as an alternative to the national coordinate system, and that the topology of a network may be transmitted through the format. A further update allows you to transfer data without referring terrain object codes to coordinates. Instead the localization is provided by reference to the national coding of streets (postal address coding).

Generally, spatial reference frames relate to some physical body. The list of potential physical bodies is quite comprehensive, cf. Fig. 1. It seems that Einstein was the first

| Human body | Terrain element | Earth |
| Vehicle | (road, landmark, | Sun (inertial) system |
| Instrument | town, etc.) | |

*Figure 1: Physical bodies which may provide the basis for spatial reference frames.*
*Source: Stubkjær, 1991: 217*

to relate a reference frame not to a celestial body as is the standard in geodesy, but to a vehicle (cf. Schwartz J & McGuinness M, 1979). The human body is applied in connection with the identification of Danish premises since 1978 (Stubkjær, 1992). The human body also provides the point of departure for spatial learning as investigated by J. Piaget and others in the 1940s. A recent survey of research on spatial knowledge structures refer to coordinate and non-coordinate reference frames as well (Davis, 1990, chapter 6).

In a previous article (Stubkjær, 1992) it has been demonstrated that a number of non-coordinate spatial reference frames have a certain practical importance.

A spatial reference frame is a mathematical construct which relate to a physical body (Stubkjær, 1992: 217). The mathematical construct may have different properties: It may be of zero, one, two, or three dimensions. Michael M Worboys distinguishes the following four structures: Set theoretic, topological, metric (admitting measurements of distances, but not necessarily bearings), and Euclidean (Worboys, 1994: 392)

Spatial reference frames are considered the basic theoretical element of level one of the cadastral subject area. In 1981, the FIG-resolution 301 emphasized "a uniform spatial referencing system for the data in the system". The position taken in the present paper is that the restriction to "a (single?) uniform .. system" ought to be lifted, and the full variety of spatial reference frames taken into consideration for cadastral development, depending on the circumstances in the country concerned.

C. Communication theory (Roman Jakobson)

In a review on geographical information science Michael F Goodchild calls for "generic models of uncertainty, analogous to the role played by Gaussian distribution in the theory of measurement error" (Goodchild, 1992: 41, cf. 35+). The following section refers to articles which suggest a linguistic model of communication as a basis for the analysis of errors related to communication, i.e. to the second level of the cadastral subject area.

The linguist Roman Jakobson has developed a communication model for the analysis of poetic texts (Jakobson, 1960). The communication model has been recognized in mainstream communication studies (see e.g. Fiske, 1982). While cartographic research by Arthur H Robinson and Barbara Bartz Petchenik, (The nature of maps, 1976)

frequently compared the communication models of Shannon, Kolacny, and others (cf. Head 1991; Stubkjær, 1991a), the communication model of Roman Jakobson has not aroused interest in the context of cartographic or GIS research so far.

Shannon's communication theory lies behind the notion that the value of information is measured by the reduction of the uncertainty of the user (Dale & McLaughlin, 1988:171). It is thus not novel to apply communication theory to the issue of quality, and recently Shannon's model has gained renewed interest (Lindholm & Sarjakoski, 1992). However, Shannon's model lacks the important aspect of meaning in the communication which is represented in Roman Jakobson's conception.

**The communication model of Roman Jakobson**
Jakobson's model is a double one. He starts by modelling the constitutive factors in an act of communication. These are the six factors that must be present to make communication possible. He then models the functions that this act of communication performs for each factor.

The basic line of thought is thus the same as the well-known communication model by Shannon: An 'addresser' sends a 'message' to an 'addressee'. Jakobson recognizes, however, that the 'message' has to refer to something other than itself. This he calls the 'context'. The 'message' has to be transmitted from 'addresser' to 'addressee'. This he calls the 'contact', by which he means the physical channel as well as the psychological connections between 'addresser' and 'addressee'. The final factor is the 'code', a shared meaning system by which the message is structured. In computer science 'code' has a rather narrow meaning, referring to code tables and binary digits. Here 'code' is used in a broader, linguistic sense.

The constitutive elements of the model are visualized by Jakobson as follows:

$$\begin{matrix} & \text{Context} & \\ \text{Addresser} & \text{Message} & \text{Addressee} \\ & \text{- - - -} & \\ & \text{Contact} & \\ & \text{Code} & \end{matrix}$$

This scheme serves as a structuring principle for six functions of communication. Each of these functions is related to one of the six constitutive elements:

$$\begin{matrix} & \text{Referential} & \\ \text{Emotive} & \text{Poetic} & \text{Conative} \\ & \text{- - - -} & \\ & \text{Phatic} & \\ & \text{Metalingual} & \end{matrix}$$
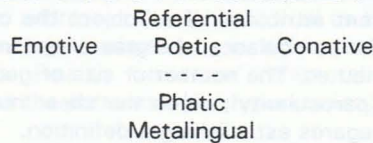
For a full treatment of these functions the reader is referred to Jakobson (Jakobson, 1960) or John Fiske (Fiske, 1982). The core of Jakobson's communication theory is that the six constitutive elements are necessary and sufficient for the performance of a communication.

**Roman Jakobson's model and the quality of geographic information**
In geodesy and surveying, measurement theory plays an important role. The data in spatial information systems are not all measured, and classical error theory applies only to a limited degree to the different quality measures which are necessary for a full

quality assessment of information systems. In a previous presentation of this issue, a review was made of the treatment of quality issues in textbooks on LIS and GIS, and a comprehensive ordering of quality measures was presented (Stubkjær, 1990). This line of research has been further developed (Stubkjær, 1994).

A selection of quality measures are cited from the mentioned papers:
**Completeness** is a measure of the degree to which the 'message' portrays all instances of the selected entity types of the 'context' or, with Davis' terms: 'micro-world'. In a certain sense a complete description is impossible. Completeness is assessed according to the set of entity types which are specified for the message at hand. An example: A map shows street lamps. The map is said to be complete, if all street lamps in the field are also portrayed in the map.
The **density of observations** (sample size) is a measure which is an alternative to 'completeness' and which applies to geostatistical analysis (cf. Burrough, 1986).
**Accuracy** is a measure of the variance of measurements, well-known from measurement theory. Frequently, LIS/GIS textbooks restrict themselves to **positional accuracy**.
**Reliability** is a measure of the number of detected errors per number of observations. If you do not have detected errors, your measurement is likely to be unreliable, since experienced observers have an error rate in the order of 2 per cent. Reliability is achieved through independent checks. Burrough uses 'reliability' in connection with 'density of observations' (1986:105).
**Validity** is here taken as a measure of the recording's accordance with the allowed domain of the variable or attribute concerned. The domain for 'number of floors' may be 1, 2, and 3 for detached houses, and 1..20 for other buildings. The term validity has a wider meaning in the context of epistemology (cf. e.g. Ziman, 1992: 34+).

**The quality of the code**
**Consistency** is a measure of the extent to which the concepts of the message are explicitly related and without mutual contradictions. This measure presupposes that the concepts are defined. The measure may include the quality of the definitions: how complete the definitions are, if they specify a domain for valid recordings of the object or attribute, etc.
**Particularity** is a measure of the potential information content of a message: The more different objects or different attributes of an object the code provides, the higher the particularity. The higher the particularity, the greater the importance of the definition of the different types or attributes. The number or size of geographic units of a GIS is not included in the concept 'particularity', since the sheer number of the same unit does not present problems as regards establishing a definition.
**Compatibility** is a measure of the congruence of the codes (or systems of standards, as Burrough terms it (:104)) of two data collections.

**Quality measure related to the 'addresser'**
One may consider **authority** as a quality measure, a measure of the degree to which the 'addresser' is able to defend the 'message' in terms of money and social status. Yvan Bédard qualifies this measure in pointing out that certain 'addressers' are in a position to guarantee the quality of information, and to compensate user losses: "Uncertainty absorption takes place when a model maker guarantees a model of the reality and compensates users damaged by poor data" (Bédard, 1986: 157). The financial conse-
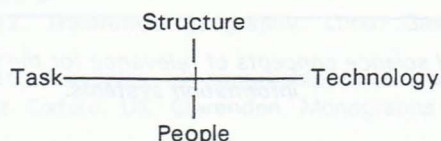
quence of this uncertainty absorption is that deficits in the technical quality of data is covered by the 'social quality' of data. This may be achieved by legislation, say as a component of a public registration of title to land, but also by a professional society which requests its members to sign insurances and compensate clients for damages due to bad conduct.

Concluding this section it is noted that the mathematical tools which may be relevant for this linguistic error analysis are not specified. This may be the subject of further studies.

### D. Technology and organisations (H J Leavitt)

The following section on technology theory addresses the objects of several levels of the cadastral subject area: Surveying instruments and computers (level one) are here considered the technical tools of an organization. Persons and organisational units may be considered the senders and receivers of information at level two, but they may act, also, as the 'actors' of level three, e.g. when unionists fight against management for better working conditions, or when one department rivals another. Persons and organisational units make up the social component of an organization.

In the context of a review of research on organizational development, Harold J Leavitt structured the research into four aspects or variables: task variables, structural variables, technological variables, and human variables (Leavitt, 1965). The four aspects are considered mutually dependent so that a change of one aspect generally induces a change in the three other aspects (Leavitt, 1965: p. 1145). Schematically, Leavitt presents his conception as follows (four lines: Task-Structure-Tech.. are to be added):

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                         Structure
                            |
            Task————————————+————————————Technology
                            |
                         People
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'Task' refers to the products or services which are delivered according to the purpose of the organization. 'People' addresses the skills as well as the attitudes of the working force at all levels. 'Technology' refers to machinery and equipment, but also to procedures and techniques. Finally, 'structure' refers to the division of work and distribution of power, and to the patterns of communication, materials and work flow.

This scheme names the basic components of an organization. It provides a basis for many system design methods, and even if it appears rather simplistic compared to a full treatment of the issue of information technology and organisational change (cf. e.g. Eason, 1988), it may provide a backbone for further refinement. Reference is made, also, to a 'Model of key functions in a production organisation for map and geo-information..' which was presented by F. Amer at the first ELIS seminar (Amer, 1992), and which may be interpreted as a refinement of Leavitt's model.

## E. Political Science: Implementation

Cadastral development may be conceived as the development of any other technical system. However, evidence seems to indicate that the development of national land information systems affects the political powers (Stubkjær, 1991), and that, according-ly, the relevant theory must be taken into account. Based on an empirical and theoreti-cal work by Volker Schneider (Schneider, 1988) it has been suggested that a similar approach may be taken for the analysis of cadastral development (Stubkjær, 1992a; Stubkjær, 1992b).

Schneider demonstrates in his study how industry, scientific bodies, and international organizations interacted with the well-known political actors in the law-making process. You may be used to thinking of administration and administrative development in terms of a hierarchy. To explain the course and outcome of such a political process you cannot, however, refer to a single decision hierarchy, Schneider maintains. The actors consti-tute a **political network**, the nodes of which are **actors**. The actors exchange **resources in terms of organizational strength, image and technical knowledge,** among others.

Schneider's concepts and research design seem highly relevant, if you want to explain the development of the Danish Registration of Buildings and Premises during 1973-77. Elements of this theory are presented below:

| | |
|---|---|
| Political network | Actor |
| Arena | Actor's goal structure |
| Agenda | Actor's resources |
| Exchange of resources | |

*Figure 2: Political science concepts of relevance for the development of national information systems.*

Concluding, it must be noted that even if Schneider's research is clearly within the field of social sciences he performs a rigorous analysis of his observations by applying multi-dimensional scaling, and several graph theoretical measures, e.g. centrality as regards the political network, which is determined according to the reported exchange of information.

The boundaries of the cadastral map are frequently conceived as a network (level one of the cadastral subject area). The procedures which are needed to obtain a building permit, or a subdivision grant, may be conceived as a (communication) network (level two). Volker Schneider has demonstrated the feasibility of applying the network concept on political issues (level three). Taken together, there seems to be some support for the arrangement suggested by Bunge and others: By treating mathematics independent of the domain theory you may re-use the mathematical tools at different levels, and you can prepare a more distinct exposition of the theoretical elements of the subject area.

## II. Concluding remarks: Mixing detachment and engagement

The paper may be seen as an attempt to reach at a 'unified' view of the world. However, no claim is made that the world 'is' what the theory states, and nothing more. The purpose of the effort has been to structure the subject area of cadastral studies by applying a minimum set of conceptual patterns (specifically: mapping, communication, and network). The time available for education is short, and, therefore, the presentation of knowledge must be compact, clear, and based on re-use as far as possible. The land surveying candidate and cadastral academic ought to be provided with a 'speculum cadastrale', an imperfect, but hopefully gradually improving reference for scientific inquiries.

Natural science frequently claims to be objective, free from all subjective influences (Ziman, 1992: 36+). The more one moves from the first to the second and third level of cadastral objects, the more impossible it is to avoid a subjective note in the research. The remedy is to accept this fact: to state, as far as possible, the purpose of the research, and the values of the researcher, e.g. to use one's resources to improve cadastral systems.

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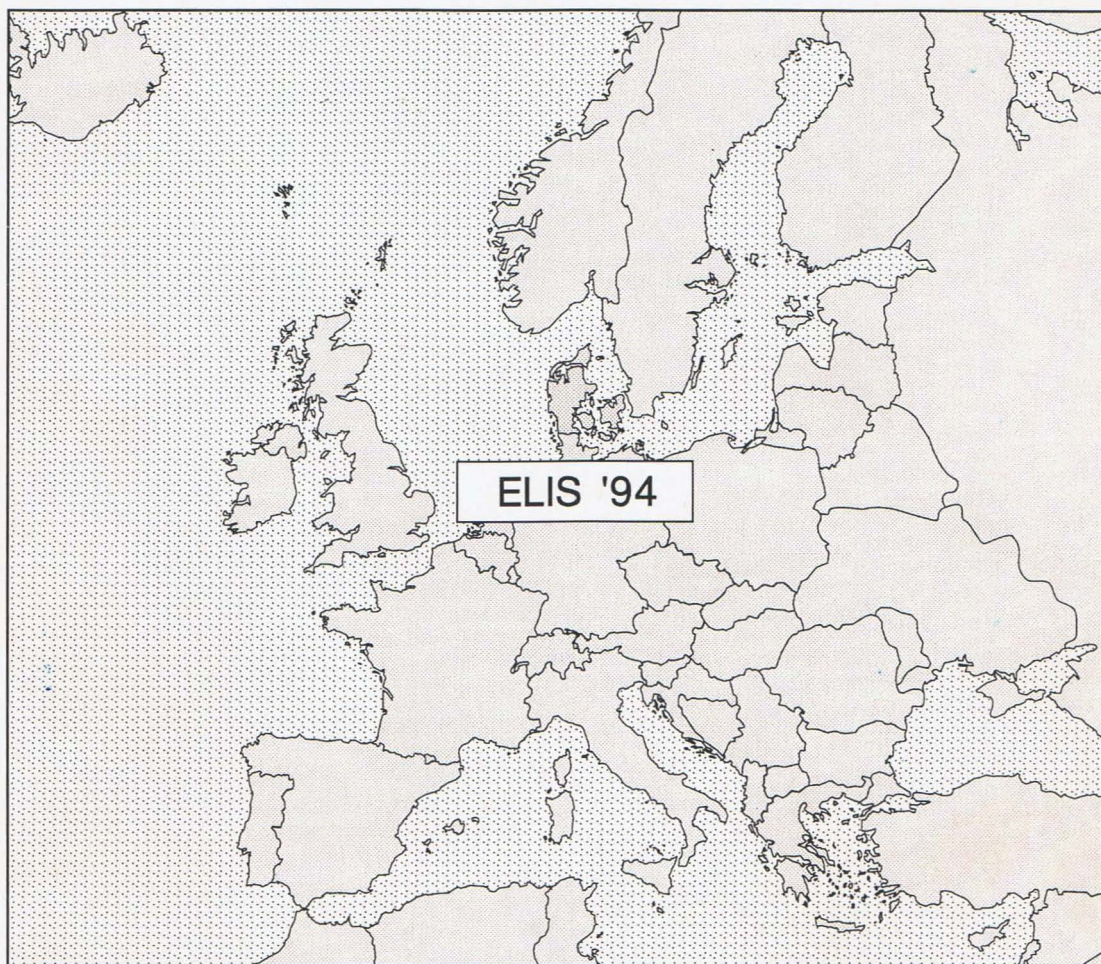
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# PREFACE

The Third Seminar ELIS '94 was held in Delft on September 12 and 13, 1994 as an activity of EUROLIS. It preceded the official opening and the first summer course of the ITC-TUD Centre for Cadastral Studies.

EUROLIS is a network of universities co-operating in the field of LIS education and research, and is co-ordinated by the Delft University of Technology.
The Centre for Cadastral Studies is a follow-up of a LIS Course, which was successfully organized by ITC and TU Delft.

An outcome of the Seminar is this volume of papers reproduced or retyped with minor editing corrections.


Prof.dr. M.J.M. Bogaerts/prof.dr. J. Gaździcki                        Delft, May 1996

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