Education and research to promote Land Information Systems

Andrew U. Frank
University of Maine at Orono,
Surveying Program, Civil Engineering Departement
Orono, ME 04669

Abstract
The realisation of integrated, multi-purpose Land Information Systems is presently hindered by a number of theoretical problems, for which solutions are not yet known, and by an extreme shortage of manpower to realize systems where they are planned. Only three universities offer presently series of courses related to LIS (UW-Madison, UNB, UMO).
It is proposed, to strengthen those programs so that they will become true center of excellence in Land Information Studies (as proposed in the Academy of Science report). MOLDS recently estimated that funded research in the amount of $500,000 per university per year for the next five to ten years is needed to build excellent groups of researchers and help to develop courses to educate the needed manpower in the field.
This proposal would solve both of the named hindrances as it would produce the theoretical knowledge as well the professionals to apply it.
Action in this area should be taken immediately, as it can be seen that other professions are moving and the surveyor might be degraded to a mere data collector for others planning and operating Land Information Systems.

1. Goal

Presently there are many efforts to install Land Information Systems, or systems to manage space related data with somewhat limited goals. Unfortunately many of these endevaours are going on without participation of the surveying profession.
We assume, that properly trained surveyors are best qualified to plan, implement and operate systems to manage space related data. They have traditionally a feeling for land and an understanding of geometrical data. We would find it deplorable, if surveyors would become mere data collectors for others, who operate systems to manage space related data. However, we see very strong indications, that such systems are planned now without including the surveying profession.

Our goal must therefore be, to strengthen the surveyors position in this area. We have to act soon or it will be too late.

2. Present situation

We do not understand today how to build truly integrated multi-purpose cadastres as they are described in the Academy of Science report. There are a number of problems, where fundamental, theoretical research must be done. Equally hindering the realization of systems is the nearly complete absence of educated surveyors, knowledgable in database management and computer cartography to design such systems.
It is feasible today, to build systems which less functionality, providing highly improved services over present level, manual systems. There is not enough evidence, to decide, if and when such systems are economically advantageous. Typically such systems manipulate graphical data and provide graphical overlay capabilities; they are usually intended for a single user or a group of users with very similar needs.
There is a number of theoretical questions of technical, economic and organizational nature which prevent us from implementing large, fully integrated system, which handle geometric data of all kinds and allow many different uses of the same data.

2.1 Technical problems

- Coordinate systems: Coordinate values are not 'estimables' in the statistical sense. Terms describing the inevitable measuring errors can not be compared for coordinate values from different sources (the so called 'datum problem'). It is necessary to find theoretically sound solutions in order to combine geometric data from different sources.
- Represenation of geometry in vector form: there are proposals, but there is not a complete, convincing solution of how operations on points and lines (connecting points, intersecting lines etc.) should be designed. This is of great importance, as property information systems must deal with boundary lines.
- Spatial relationships: There are no clearly identified categories of spatial relationships and how they apply to a query language for space related data [Tomlinson 1984] [Frank1982].
- Data management systems for spatial data: There is little knowledge about statistical spatial distribution of data in the urban environment and only a few studies dealing with storage structures for large amounts of space related data are available [Gutman 1984] [Hinrichs 1983] [Frank 1983] [Tamminen 1983].
- Database management systems for geometric data: Only recently have

investigations been started to look into requirements for 'non-standard' database management systems [Frank 1984] [Lum 1983].
- Transaction of long duration: In databases long periods of time may elaps between the start of a changing transaction and its completion. There are no theoretically sound concepts available to deal with such situations.
- Database schema: there are no simple procedures known to describe the data necessary for the operations of a unit of an organization. With present methods it is very difficult, to list all data and their relations used by several units.
- Analyse of operations in an office, especially in a technical service. Methods to analyze operations in offices are much lacking and only recently research has focused on this problem.

2.2 Managerial and operational problems
- Sharing of data: no concepts to deal with sharing of data between several units are known.
- Economics of maintaining geodetic control or base maps: a single study has recently been done [Duchesnau & Epstein 1984].

This incomplete list reflects to a certain extent my personal experience and could be extended to include other aspects. It was discussed with other experienced researchers in the field during the recent International Symposium for Spatial Data Handling [Marble 1984], and the amount of agreement was surprising. The prevalent optimism of a few years ago has changed to a better understanding of the problems involved with a integrated, multi-purpose Land Information System.

3. Education and Research
Only few institutions worldwide pursue research in this area and very few universities in North America provide education. From the few universities offering degrees in surveying, to my knowledge only three have extended course series in topics related to Land Information Systems (University of Wisconsin at Madison, University of New Brunswick, Frederiction and University of Maine at Orono). All these programs lack funding to pursue specific Land Information Systems topics and faculty is often forced to concentrate on other subjects, where funding is available. As a consequence, not enough students are leaving these programs to go out and work on the practical realisation. Even worse, not even enough students with advanced degrees are graduating to fill faculty position in new programs (University of Edmonton, which plans to start a specific undergraduate degree program for Land Information Systems, encounters

problems, in finding faculty with experience in the area).
In a recent effort, MOLDS followed a proposal in the Academy of Science report and selected three universities (UW-Madison, UNB, UMO) as centers of excellence in Land Information Studies.
In a number of departements of geography interesting work on spatial data management for Geographic Information Systems is carried out. Many of these results directly carry over to Land Information Systems; nevertheless there is a difference in the approach that makes independent curricula and specific research necessary.

4. Proposed solutions
We perceive an imminent need for research to clarify certain problems critical for the timely and effective realization of integrated, mult-purpose Land Information Systems. This research should be carried out at universities with an extended series of courses dedicated to problems related to Land Information Systems. MOLDS estimated recently, that funded research in the order of $500,000 per year per university over the next five to ten years would enable these centers of excellence to build groups of experienced researchers and faculty. This will lead to the development of good, practically founded courses and programs, which in turn will produce the graduates with expertise, needed to realize Land Information Systems. It is important, to work on this research in universities, because only universities can use such funds for education of graduate students. Not all this must be new money, as part of it may come from present research done in-house in federal or state agencies and private firms (in fact, NOAA is already funding a second research effort at UMO to determine economic values related to spatial data).
A sustained flow of funded research will (hopefully) find solutions to problems that today make the implementation of LIS very expensive and complex programs, and will at the same time produce the educated and experienced manpower to realise such systems.