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TECHNICAL ASSISTANCE IN CONCEPTUAL AND DATABASE DESIGN TO THE CITY OF GDANSK GIS/LIS PROGRAM

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Prepared by

Roman Pryjomko
PADCO Geo-Information Services

and

Kyler Diershaw
ICMA

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ABSTRACT

The technical assistance in GIS/LIS described under PADCO RFS 39 and ICMA RFS 70 was delivered to the City of Gdansk during a year of profound institutional and political changes within the city administration. This has caused many difficulties for the project although LIS implementation has proceeded, albeit slowly, within the broad framework of the Implementation Plan developed in August 1993. This report outlines some of the major issues addressed during the period of technical assistance. It also highlights serious organizational problems and outlines possible solutions. The problems cited in the report require complete resolution in order to ensure future progress in system development. As conditions allow, re-visiting and implementing many of the ideas outlined in the initial Implementation Plan is highly recommended. At present, the project must focus on the lengthy and critical tasks involved in database design. A technical discussion of key activities in this process and a simple "how to" guide are presented for future use by the technical staff. Having endured a period of uncertainty, the project appears to be moving into a period of greater stability and more sustained political support. With a pragmatic implementation plan in place, the opportunities for further progress and making the LIS "operational" in 1995 appear most promising. A period of overall project review and re-evaluation is required to identify priority needs and where appropriate, develop further scope for technical assistance.
EXECUTIVE SUMMARY

In the three year development period of the Gdansk LIS (land information system), the project has faced many technical obstacles which have been successfully overcome notwithstanding limited resources and expertise. However, the past year has seen the project confronting far more serious difficulties which are all too common in Poland namely, organizational and political instability. Regrettably, this disruption has had a serious impact on the LIS development process and the project now faces a period of re-assessment as stability once again, returns to the city administration.

Nevertheless, with the Implementation Plan fulfilling its function as a logical task guide and system development framework, achievements has been made in a number of important areas as described below:

1. The LIS hardware, software and communications configuration has been established in the city. This includes the physical linkage of three key sites on the LIS fiber optic network; the Voivoda Office of Documentation, Geodesy and Cartography (WODGiK), the city hall (site of the LIS unit) and the regional court of justice (the repository of deeds). These three sites manage and maintain all key data sets which constitute the "land information base" of Gdansk. Their effective activation as data nodes in the LIS network is progressing although the regional court remains stalled due to financial rather than technical difficulties. This key site should targeted for both technical and financial assistance in the future.

2. The functional requirements of the privatization and land disposition process are now more clearly defined and understood. This will be the primary focus as the priority application area(s) for the Gdansk LIS. The current database design process is concentrating on those data elements which are essential to support this process. Furthermore, by analyzing the land privatization process in detail, the city has now acquired a more detailed understanding of the strengths and flaws of this key revenue generating activity.

3. Data flow diagrams and their critical importance to the system design process has been identified during this phase of the project. As data flow analyses are completed for many departments/entities within the city government structure, the obvious weaknesses and inefficiencies in various practices are revealed. This information is not only important for various LIS database design tasks, but will also help in the identification of precisely which city agencies require organizational reform. This information should be compiled into a data flow analysis document and circulated for review.
4. Formal training in GIS/LIS related skills was delivered for the first time to the City of Gdansk. This initial training was the first in a series of training sessions that will be required to strengthen technical staff. The first training session focussed on the importance of establishing a topological data structure for the LIS. This concept is fundamental and has moved the project from a CAD (graphic) to GIS (data driven) orientation. Initial "hands on" training in some database tasks design was undertaken although this must be complemented with more formal design sessions later.

5. The completion of entity definition forms establishes the relative importance or value of each data attribute. These are being completed for every attribute that will be supported by the relational database management system (RDBMS) of the LIS. Entity definition forms allow "data scrubbing" and address important data management issues such as attribute definition and maintenance responsibility, predicted growth (update) cycles, frequency occurrence and relate status as "keys" for one-to-one and one-to-many relate: in the database structure. Completion of this task will form the basis for the physical database design.

6. Institutionally, Gdansk has re-established contacts with the Office of the Surveyor General. They will be the first self-governing gmina to receive technical support in the form of buildings and parcel management applications developed during the Lodz LIS Pilot Project. These tools constitute a massive financial investment by the Surveyor General and Gdansk will be able to quickly benefit from their important basic functionality.

   This technology transfer forms a cooperative link between the Surveyor General, who is currently mandated with coordinating a national LIS modernization program, and a local municipality. In future, self governing gminas throughout Poland will be the primary implementors and beneficiaries of LIS through various applications.

7. Information regarding the technical assistance provided to Gdansk has been informally disseminated throughout the city and voivoda, which has increased the awareness of important GIS/LIS implementation issues. Agencies in the municipality such as the WODGiK (Voivoda) and regional court of justice are now actively engaged in the LIS implementation planning process.

   These key agencies must be integrated into future technical assistance programs. This is especially important with respect to the court of justice which desperately requires assistance in organizing and automating the deed records for properties in the voivoda (region). How the Gmina, Voivoda, Court and other users will interact and use the LIS must be detailed in a comprehensive Technical Plan, which should be a coordinated and joint output from these parties.
On a national scale, Gdansk is now perceived as one of the more progressive LIS modernization programs. As a result, the city has been approached by many potential sites and is actively sharing its acquired knowledge and skills with Bydgoszcz, Szczecin, Krakow and other locations. This growing network of collaborating GIS/LIS sites is a very positive development which will over time, transfer the benefits of technical assistance beyond Gdansk itself.

8. The following technical bench marks have also been achieved:

i) The complete automation of 989 parcel maps for the city and the completion of the related cadastral (textual) database. These will be converted to a topological data structure to form the graphical "land base" for Gdansk.

ii) A land ownership map is in development which will be one of the first products from the GIS/LIS. This will show the current status of land ownership in the city by displaying which parcels are held by the municipality (communalized), the state, or those transferred into private ownership. This product will be an invaluable tool for the city government administration including various agencies responsible for the planning and privatization of land assets.

iii) The databases established to date will now be subject to the database design process. First, they will be integrated into the selected RDBMS (Informix). Then, using ARC/INFO, the data sets can be related topologically to graphical entities (parcels and buildings) and mobilized through the available buildings and parcel management applications.

These data sets include:
- A complete automated register of parcel ownership, cadastral details and land use.
- An automated buildings register.
- A partially automated (pilot) deed management system (FENIKS2).

In the future, other databases (such as deeds) will be linked to the graphic coverages maintained by the LIS and the database design will reflect this eventuality.

iv) A 1:5000 scale 2m resolution satellite image map of Gdansk (based on Russian imagery) has been produced. This has established a contemporary (1992) image backdrop for the assessment of the urban landscape, including building locations, surface infrastructure, vacant land and other features not currently shown on maps. The image has proven invaluable in identifying numerous inconsistencies between parcel (ownership) boundaries derived from maps, and actual features on the ground such as buildings. Efforts are underway to expand this image coverage for the entire voivoda where it will be used for applications such as environmental assessment and transportation planning.
This imagery provides an interim cost effective solution prior to the planned development of complete digital ortho-photography for the tri-city (Gdansk, Gdynia and Sopot) area scheduled for 1995.

v) To date, over 220 maps concerning municipal buildings, roads and water infrastructure have been automated covering approximately 2200 ha of the gmina. For each of the municipal buildings shown in this area, over 70 attributes have been collected and compiled in a database. Further information is being collected and automated on other residential buildings and districts. These data will become data elements in the database design.

9. As a technical document, the previously developed GIS/LIS Implementation Plan has been internalized by the LIS unit. This document has now become an integral component of the system planning process and will influence the development of the future Technical Plan (Plan Techniczny) for LIS.

It is obvious that previously, few if any senior decision makers in the city heeded the advice contained in the plan, especially concerning the organizational status of the LIS project. However, there are positive signs that the new administration will take a more proactive interest in some of these key issues such as a long term budget, staff compensation and organizational relationships, all of which seriously impact the project.

Outstanding Problems and Limitations

Notwithstanding this considerable progress, a number of serious problems remain unresolved. It is significant that these issues are not technical but institutional, and as noted in the past, create challenges which often prove to be the most contentious and difficult.

1. The Organizational Status of the GIS/LIS initiative

While the city's need for an effective land information management system must be met, the financial and technical burden should be shared jointly by the public and private sectors. This would recognize the inherent value of comprehensive municipal databases to agencies in the private sector such as utility companies, real estate investors and development agencies.

The proposal for an independent Public-Private Enterprise (PPE) to manage and support the LIS development process was outlined in the Implementation Plan but, rejected by the previous city council. This has had a number of serious impacts on the ability of the project to sustain itself. With no ability to directly involve the private sector and with total reliance on city support, the project has suffered from unpredictable funding, political manipulation and an inability to consolidate many important relationships with potential

8
investors. The organizational status of the LIS project in Gdansk must be effectively resolved as a matter of urgency.

2. **Human Resources and Technical Staff**

The inability of the LIS to function as a PPE has degraded any opportunities for staff to earn salaries that are competitive with the private sector and commensurate with their skill levels. This has caused a decline in morale, productivity and the loss of staff to the private sector. If the LIS has any chance of success, it must rely on the quality, knowledge and long-term dedication of adequate technical staff. This critical issue must also be resolved by the city in the immediate future.

3. **Budget and Funding LIS Operations**

The loss of potential private sector investment in the PPE and over-reliance on limited public funds has caused the project to have financial problems. Such fiscal uncertainty and budgetary restrictions are not conducive to providing guaranteed and adequate long-term funds, which are essential for sustainable system development.

It is imperative that the city recognizes the importance of establishing an LIS which will support critical revenue generating activities such as land disposition and tax assessment. A lack of adequate investment in such a system, severely jeopardizes the future prospects for growth in the land based economy. An adequate and long-term budgetary strategy which is immune to constant political manipulation, must be developed and endorsed by the city council.

This is not only a requirement for LIS implementation, but will be a sound investment in the urgently needed information infrastructure of the city.

4. **Training and Capacity Building as Foundations for an LIS**

The future prospects for LIS implementation will be governed by the abilities of the technical staff leading the project and also the capacity of potential users such as city departments, to effectively utilize the system in day to day operations. This will require continuous investment in training, capacity building and education during the system development process. Training should also occur at both the technical and management levels.

The planning and adequate funding of these activities is essential. At present, the requisite organizational, institutional and knowledge "frameworks" do not exist to support an automated (land) information system across the entire city government. Therefore, this capacity (and system) must be implemented in incremental phases over the longer term, through education, training, building awareness and the strengthening key institutions throughout the city.
In the short term, the goals must remain the development of a database (design) architecture and the implementation of specific, focussed applications that directly support key revenue generating activities such as land disposition/privatization.
CONCLUSION

Since GIS/LIS development requires sustained effort and long-term commitment, it is easy to become disillusioned with an apparent lack of progress in the short term, and seemingly continuous obstacles to implementation.

However, the entire process is cumulative and the further one progresses, essential knowledge and experience is acquired which makes future tasks more amenable. The City of Gdansk continues to follow a well established and pragmatic implementation path which has yielded some tangible results. The project remains focussed on the priority issues related to land and has effectively avoided becoming too fragmented and over ambitious. Closer integration of the gmina based LIS project with the activities of the Voivoda, and other agencies in both the public and private sectors is possible in the future. These initiatives should create a "critical mass" of human and technical resources which will drive the entire project forward.

Political instability including the lack of a viable and sustainable organizational status for the LIS unit remain serious problems. Unfortunately, these issues are beyond the scope of any external technical assistance. However, possible solutions to these problems have been suggested which can only be solved internally by the city administration. Any future technical assistance should be contingent upon these issues being resolved, and the completion of the basic database design tasks outlined in this report.

Gdansk continues to offer great hope for the implementation of a modern and functional LIS notwithstanding the difficult transitional situation in Poland. Many obstacles impede implementation but this is not surprising given the extent of the land related problems the city must resolve in order to develop its economy. There are no quick technology driven "fixes" or solutions. A long-term commitment to a comprehensive LIS implementation strategy is required. This is increasingly recognized at both the national level and in gminas throughout the country.

However, by systematically addressing the many technical, organizational and institutional issues, an essential learning process is underway. This highlights a far larger goal, namely, the importance of effective information management as the foundation for responsive government. Even though the development path is long and complex, this important mission must be pursued with a sense of urgency and commitment.
SECTION A

CHAPTER 1

Technical Assistance in Land Information Systems to the City of Gdansk (RFS 39 and 70-Phases I and II)

1.1 Introduction

This report highlights some of the major results of technical assistance delivered under the aforementioned RFS and presents a database design strategy for the LIS project in Gdansk.

The technical assistance was divided into two formal phases which have now been completed. However, Phase II activities are continuing independently in Gdansk as the technical staff undertake tasks as part of an on going database design process. In order for this report to be meaningful, it is important to refer to the GIS/LIS Implementation Plan (August 1993) developed for Gdansk with USAID sponsored assistance. This document outlines a five-year implementation process in the city with specific opportunities for focussed intervention and technical assistance. Frequent references will be made to this important document in the text.

Similar to the RFS itself, this report is divided into two distinct sections. The first section (A) presents a review of all major achievements to date in the project. In addition, problem areas and recommendations for future actions will also be presented. The second section (B) describes the database design process which is currently being implemented in the city. This section should be viewed as a "how to" manual which highlights the major tasks that must be completed in order to create a functional database for the LIS. It is necessary to emphasize that database design requires a continuum of activities over a lengthy period. Far from being generic, the methodology presented is focussed on the specific needs of the Gdansk situation and outlines achievable bench marks.

In the context of the overall implementation plan, the technical assistance provided under RFS 39 and 70 addresses the development of a GIS/LIS Conceptual Design (see page 4i of the GIS/LIS Implementation Plan for more details). This is Stage 2 of the incremental and phased implementation process outlined in Figure 1.
FIGURE 1
City of Gdansk
GIS/LIS Implementation Plan

1. Project Organization

2. Develop GIS/LIS Conceptual Design

3. Select Technology Platform

4. Implement Technology Infrastructure

5. Develop GIS/LIS Detailed Design

6. Develop Core GIS/LIS Applications

7. Define Data Conversion Procedures

8. Conduct Pilot Project

9. Implement GIS/LIS

10. Phase in Specialized GIS/LIS Applications
When the GIS/LIS Implementation Plan was initially prepared for Gdansk, an emphasis was placed on flexibility in order to have a working system development framework that would take into account the rapidly changing conditions in the city. This approach appears to have been well chosen.

In the last year, the GIS/LIS initiative in Gdansk has faced unprecedented problems and challenges. These were the direct result of a volatile and ever changing political and organizational situation in the city, which, at one point, caused the entire project to be suspended for over two months. Nevertheless, the program is again making good progress with renewed commitment to the implementation plan.

One promising signal appears to have come from the new mayor who has committed himself to support this project. Whether this verbal support is translated into positive action by the entire city government remains to be seen. Clearly, the need for an effective LIS to mobilize the land resources of the city is more urgent than ever, especially with a fiscal crisis confronting the city's government. However, to realize an integrated LIS to support these and many other functions will require long term and sustained support; financial, technical, organizational and political.

The new city administration now has a unique opportunity to move this project forward from a pilot to an operational phase, and benefit from the many products that will be forthcoming. The challenges are no longer technical, but rather a question of commitment and political will.
CHAPTER 2

Data Issues

2.1 Introduction

In addition to the formal database design (technical) chapter, related data issues will be addressed in the following sections. These describe how the information resources (to be managed by the LIS), are related to specific sectors and processes in the city administration. Furthermore, the importance of the tasks required during formal database design are also described in more detail. (Note: a detailed evaluation of existing data resources is provided in Appendix A of the GIS/LIS Implementation Plan)

2.2 The Design Process and Goals

Formal system and database design activities were initiated to ensure that the LIS in Gdansk supports the key functional requirements of the city and its various departments. Since many departments are presently in disarray while they undergo changes, only a limited number were selected for initial integration into the design process. These departments include those directly involved in the land privatization (transfer) process such as, land management, architecture and the regional court of justice. The departments that support the land disposition and privatization process, have been recognized as the priority business functions of the city (see Implementation Plan pages 8-11).

*Therefore, a key theme of the database design is the requirement for the design process to meet the needs of specific priority business function(s).*

The wider vision for an integrated city-wide information management system which supports all departments and functions is apparent within the city. However, this large scale and broad based initiative is not feasible under present conditions, although components of such a system can be addressed.

Clearly, many potential system users e.g. city departments, are not ready nor capable of playing an active role in the development of such an information infrastructure. Furthermore, the technical and financial resources are simply not available in the present economic climate. Comprehensive training and education for future system "users" is an urgent requirement.
Therefore, priorities have been established for the database design process. If successful, this will produce a database structure (and system) which first, supports the land disposition process. This should make land transfer more efficient, help stimulate an active land market and hence, generate revenues for further applications development and incremental system expansion.

2.3 Land Information—A Resource Demanding Structure and Management

Over the past two years, the City of Gdansk LIS unit has automated a large volume of data including:

- The complete automation of 989 parcel maps for the city and the completion of the related cadastral (textual) database and,.
- The automation of buildings and land records for most properties in the gmina.

The graphical data currently exists in AutoCad format while the attribute data is maintained in a proprietary database (SITy) using a format similar to Dbase tables.

While these are valuable and growing data resources, their utility can only be realized through the specific use well designed applications. This requires the formal organization of the data into structured database(s) which facilitate these applications, and continual data maintenance.

In Poland, it is all too common to find many GIS/LIS projects which focus solely on data automation and neglect addressing the vital database design and application issues. *The City of Gdansk has now reached a stage where these issues are foremost in its system implementation agenda.* Apparently, this is not the case for a related automated mapping project at the Voivoda Office of Documentation, Geodesy and Cartography (WODGiK). The details and implications of this activity will be addressed later.

For the gmina, a number of key database design activities are currently underway. The technical details of these tasks are fully described in the second chapter. However, the broader implications of these efforts must also be examined and understood.
### 2.4 Analyzing Data Flow

**Understanding the Role of an Information System in an Organizational Context**

One of the primary goals of the Gdansk LIS will be to maximize access to and sharing of relevant information resources between city departments and other users. In order to implement a system that optimizes these activities, it is essential to "map" the details of how information presently flows (or otherwise) between various "nodes" in the city structure.

For specific departments, data flow diagrams (see Figure 2) are being developed that indicate how information flows through the city government organization to future users and clients of the LIS. Note that once again, special focus is placed on those departments involved in the land management and disposition processes.

Analyzing the data (information) flow in some departments was quite revealing. In many cases, the concept of promoting and facilitating the flow of information had never been considered and was previously impossible using manual information management methods. Since this process involves a detailed survey using interview techniques, it also reveals which departments are amenable or hostile to the overall system design and development process. The survey instrument used for Data Flow Analysis is shown in Appendix A.

Initial results show that within and between many departments in the city, information flow is in most cases limited, overly complex and inefficient. These problems, once identified, should be addressed by the database design process.

The technical staff involved in assessing data flows now possess a detailed understanding of the importance of this process to system design. This awareness should also be extended to departmental managers and administrators, who must begin to promote more efficient information management practices if the city is to function as a self-sustaining organization.

In analyzing data flow, emphasis should not only be placed on those priority departments concerned with land, but also those who have existing automated information systems e.g. the "Ratusz"-city administration database. These agencies should possess a more mature appreciation of the importance of effective data flow, and their early integration into the LIS design process is highly desirable.
2.5 The Relational Database Management System (RDBMS) Environment

The Gdansk LIS database(s) will be supported using a relational data model. Therefore, the data currently stored in SiTy must be transferred and integrated into a more advanced relational database management system (RDBMS) and subsequently georeferenced or related to the corresponding graphical layers or "coverages" in the GIS/LIS.

This will require the graphics to possess topology, the implications of which are discussed more fully in the database design section. This RDBMS will offer many powerful data management, maintenance and analysis tools which can mobilize the data through different applications, both GIS oriented (spatial) and non-spatial.

The consultants assisted in the preliminary evaluation of alternative systems that could serve the needs of the LIS and integrate with existing DBMS's such as Oracle, which supports the city administrative ("Ratusz") database. A provisional decision was made towards Informix which is an industry standard, cost effective in terms of functionality, and supported in Poland. More importantly, this RDBMS is the supporting platform for two existing core applications for parcels and buildings management.

Therefore, Informix should be piloted tested and bench marked using these applications in the short term and if accepted, procured as the data platform. If Informix is chosen for the LIS RDBMS, then integration with the existing Oracle system will be required. This is possible using ARC/INFO's database integrator. The purchase and acceptance of an RDBMS is a pre-requisite to further technical assistance in database design and development.
FIGURE 2
SURVEYING DEPARTMENT

- Planning
  - Land and records management for property sales
- Construction and Permits
  - Information concerning legal aspects of properties
- Development
  - Topical Maps
- Economic Policy
  - Topical Maps
- Commerce and Services
  - Topical Maps
- City Management Municipal Utilities
  - Topical Maps
- Housing
  - Assigning numbers to properties
- "Social and Administrative"
  - Numbering and naming
- Environmental Protection
  - Topical Maps
- City Council
  - Decisions concerning street names
FIGURE 2
DEPARTMENT OF LAND MANAGEMENT

- Tender preparations (permanent and temporary zoning).

- Permits to build and demolish. Acceptance of zoning proposals.

- Legal paperwork. Assessments for tender.

- Permits to remodel for more space; adapting roof space for extra bedrooms etc.

- Farmers markets (leases). Information on pending eviction procedures.

- Queries concerning roads, parking, access to plots, "visibility triangles".

- All fees from plots, Subdividing, forgiveness of dept, accrue interest.

- The shore belt

- Access to personal ID files.
2.6 Entity Definition—The "Keys" to RDBMS Implementation

The implementation of a multi-user site for an RDBMS (such as Gdansk), requires a rationalized database design which optimizes data access, reduces redundancy and duplications, thereby lowering maintenance requirements which are substantial recurring costs in an LIS.

This involves the determination of data ownership, maintenance strategies and precise data entity definitions. The LIS unit is currently completing entity definition forms (see Appendix A) for all attributes to be entered into the RDBMS (over 100 entities). The precise procedures associated with this task are fully described in the database design chapter.

Again, this task will first focus on those entities which are critical to the land privatization process. Special attention will be placed on entities which will act as geo-referencing and/or "relate" (linkage) keys across data sets and databases. Relate keys must be unique and may include parcel, deed and/or building numbers. These "keys" will determine the exact nature of the final database structure and data element relationships.

Defining these unique identifiers is critical to ensure future integrity in one-to-one and one-to-many relates which are commonly maintained in any RDBMS environment.

Figure 3 shows the extensive database schematic developed for the Lodz LIS pilot project. This structure maintains numerous inter-related land information databases within an integrated system. Note how relationships between quite separate data sets are established and maintained using relate entities or "keys" with either the prefix ID or NR. Such relates can greatly limit data duplication while allowing users to access and navigate through the database(s) transparently and logically. The Gdansk LIS project should use this schematic as a guide to complete their own database design diagram. This database structural plan will be a key output of the design process.

Technical staff at the LIS unit have received basic training in the tasks required to construct such a database schematic. These should be applied to the priority data sets destined to be integrated into the LIS database environment.
FIGURE 3
LIS DATABASE LINKS CHART

[Diagram showing database links with labels for data base tables, geometrical layers, attribute tables, and relationships between them.]

LEGEND*

- Data base tables
- Geometrical layers
- Attribute tables
- 1:1 ratio
- 1:many ratio
- Links implemented by physical divisions of the data base
- Relations between attribute tables

ID-W Wojew
ID-R Rejon
ID-G Gmina
ID-D Precint
ID-L Dzialka
ID-B Budynek
ID-JR Jednostka Rejestrowa
ID-OS Osoba
NR-G Nr Gminy
NR-D Nr Obiektu
MSC Nr Miejscowosci
RST Nr Rejenu Statystycznego

County
District
Commune, Township
Region
Plot
Building
Cadastral Entity
Person or Corporation
Number of Townships
Number of Precints
Number of Plots
Number of Cities/Towns
Number of Statistical Regions

*TOWN, STREET and FIRST NAME are not shown on the chart. This information can be accessed from EG and EBNL data bases and from geometrical layers attribute tables.
2.7 Deed Information—Essential Components in a Land Information System (LIS)

In order to create a "land information base" for Gdansk which supports the priority process of land disposition, the LIS database(s) must contain certain essential information for properties. The required attributes must be extracted from the following data sets:

- Building records
- Parcel records
- Deed records

Precisely which entities are required will be determined during the entity definition process. However, the existing data currently automated in Gdansk mainly describes parcel and building level information. Deed records are almost entirely missing from the available data assets notwithstanding their absolute importance to many processes including land privatization.

As described in the Implementation Plan, deed records are maintained by the regional court of justice using a largely manual system and a proprietary database known as FENIKS. However, a more advanced and functional prototype system has been developed for deed management known as FENIKS2. Regrettably, this system has not been fully implemented due to a lack of funding from the Ministry of Justice. Prototype FENIKS2 is supported using the Oracle RDBMS which is fully compatible with the proposed configuration for the Gdansk GIS/LIS. Various options to facilitate the rapid automation of deeds are presented in the database design chapter.

The automation of deeds at the regional court of justice does not present technical difficulties, but rather is obstructed by financial and organizational problems. Since the existing automated parcel and building records already possess the deed number among their attributes, it is possible to "relate" these data directly to a deeds database, once the latter is integrated into an DBMS.

It is strongly recommended that the GIS/LIS program should support an effort to automate deeds, at least for the gmina. These data constitute an integral and essential component of the LIS. Without their inclusion, the prospects for LIS development are extremely limited, especially with respect to applications which support land transfer. For now, the database design process for the Gdansk LIS will proceed but must take into account the key role of deed information in future database(s).

Future technical assistance should also support the automation and integration of the regional court of justice and their deed archives into the wider LIS strategy for Gdansk. This is especially important since the court is now an active node on the city’s communication network but regrettably, has little digital data to exchange with other users on the system (see hardware, software and communications section).
2.8 Recommendations

Although data and database related issues can often be overtly technical and wide-ranging, it is vitally important to focus on a few key issues during the database design. By necessity, this is quite a lengthy process and consists of a continuum of activities punctuated by inter-related goals or benchmarks. For the Gdansk LIS project, the required immediate tasks can be summarized as follows:

1. Completion of entity definition forms for all relevant data elements concerned with land disposition.

2. Completion of detailed data flow diagrams for all relevant departments and agencies concerned with land disposition and management.

3. Initial creation of a schematic database design structure (relationship) diagram with defined relate entities.

4. Initiate integration of the regional court of justice into the database design process.

5. Complete conversion of defined data elements from existing format (SITy) to a topological (ARC/INFO) and relational (Informix) structure. Verify quality and accuracy of conversion routines.

6. Documentation of all relevant database design outputs both accurately and comprehensively. Refer to database design section for details of tasks.
CHAPTER 3

Technical Infrastructure for a Land Information System

3.1 Hardware, Software and Communication

During the period of technical assistance, a high speed fiber optic link was established and successfully tested between the city hall LIS unit, Voivoda Office (WODGiK) and the regional court of justice.

This forms the communications back bone for a distributed GIS/LIS and will allow rapid data access and transfer between users on the network. However, a distributed system and databases demand more stringent data protocols, maintenance procedures and security measures. These will be factored into the final database design document and procedures manual.

With the establishment of a wide area network (WAN), there is a natural temptation to focus immediately upon a totally distributed and decentralized information system. References by some in Gdansk to a "citywide" or even "regional" information sharing network are premature at this time. First, the functionality of the database design that is developed, must be tested in a controlled and largely centralized environment. It is conceivable that the city hall (where the LIS unit is currently located) would act as the "hub" of an initial network and control many of the database related functions e.g. security, access protocols, routine maintenance and even updating of some data sets. Subsequently, as other users come "on line," these responsibilities may be devolved from the hub outward to data nodes on the network that have developed the requisite competencies. It is important to remember that even while the system is in the process of design and development, the existing data resources still need to be continually managed and maintained. Practically, this should be handled in a centralized manner as suggested.

In summary, although the establishment of a WAN fiber optic backbone potentially facilitates distributed data management; the needs, costs and realities of the actual situation should determine the final system design. Indeed, It is irrelevant how fast the network can transmit data to users unless this is achieved in an orderly and efficient manner. A rational database design will act as the framework for the distributed access and navigation of these information resources.

As mentioned, some key clients on the fiber optic backbone are not proceeding with their data automation or database design efforts as effectively as the gmina. Especially slow is the regional court where deed records, which are essential data elements in the LIS, are still largely manual due to a lack of funds.
Nevertheless, data sharing between the City and Voivoda (WODGiK) will commence shortly. The WODGiK also has an automated mapping project underway which has output (digitized) a substantial number of technical infrastructure maps. These digital data layers which describe the water, sewer, gas, electrical, heating and telecommunications networks could act as complimentary graphical coverages to the building and parcel databases developed by the city LIS unit (see Appendix B).

However, the WODGiK initiative is experiencing problems at this time and its future potential is limited. This is due to an over-emphasis on digital mapping rather than data and applications, which actually "drive" an LIS. The WODGiK project and its relationship to the gmina LIS will be considered in more detail under the organizational issues section.

### 3.2 Hardware and Software Considerations

Basic hardware and software configurations were determined after a lengthy period of review and consultation. The LIS in the city will initially be supported by a multi-user license of ARC/INFO GIS software and Informix DBMS on a Silicon Graphics UNIX workstation/server.

This will be linked via a LAN (TCP/IP) network to the existing system of peripherals (plotters, scanner, printers) and 6 PC's which will be upgraded to support UNIX emulation. The LAN will be interconnected to the fiber optic backbone which will initially support at least two departments to be configured with workstations to allow data access. Although, this is not an optimum configuration, it should adequately support many system development functions in the medium term given financial constraints. These will include data development and conversion (to topological formats), database design, applications testing and modification, training and maintenance procedures.

The emphasis has been placed on system integration so that new hardware and software can adequately interface with the existing technical infrastructure. It must be emphasized that the above configuration does not constitute a fully operational system for the city but simply an initial technology base. Acquisitions will be necessary in the medium term as the LIS expands and develops.

Since, GIS/LIS related hardware and software are developing rapidly, it is tempting to devote an inordinate amount of time and level of effort to the consideration of these components. However, it is helpful and very important to remember a few rules regarding these assets:

1. It is simple to acquire technology but far more difficult and costly to operate and implement. Technology acquisitions must always be user needs driven and the required staff, their training, maintenance and future technical support must be determining (cost) factors.
2. GIS/LIS technology must be non-proprietary and should conform to established industry and de facto standards at the site.

3. Technology should constitute only 20% of an operational budget for any GIS/LIS. If it is more, then the site is quite probably overstocked and characterized by under utilized equipment.

4. GIS/LIS technology is only an investment if it is productive in an operational context. Otherwise, this constitutes an expensive and losing asset for any organization.

5. Technology should always be adequate to the tasks required. If the choice is between performance and usability, then the latter should be a determining factor.

A promising development is that GIS/LIS related hardware, software and communications technology is progressively decreasing in price while increasing in functionality and performance. While this will increase accessibility to the technology to a larger user community, these relative cost savings cannot off-set the increasing cost of larger system components such as the data development, personnel, training and implementation costs. Therefore, careful and pragmatic technical implementation planning and design must be a priority.

3.3 Applications—Mobilizing Data Resources and System Productivity

The choice of Informix as a DBMS and ARC/INFO as the GIS software toolbox will allow the City of Gdansk to rapidly implement existing parcel and buildings management applications. These were developed during the Lodz LIS pilot project funded by the Surveyor General of Poland. Agreements have been signed between the City and the Surveyor General which allow the first transfer and implementation of these tools outside of Lodz.

These applications (described in full detail in the Implementation Plan, Appendix B) will boost the productivity of the Gdansk LIS. They provide a graphic user interface to the GIS software and essential tools for parcel and building data management. These core applications represent over two years of technical development effort and large scale financial investment, from which Gdansk can benefit in the medium term. Adaptation and customization of these applications will be necessary and the database design process must ensure effective integration between the (LIS) databases and these core applications. This is discussed in more detail under "Fit Analysis" in the Database Design Section. It must be emphasized that the core applications from Lodz do not offer any "solutions" per se. At present, they are simply basic application platforms which should be tested and further developed as required.
CHAPTER 4

Organizational Issues

4.1 The Requirement for a Public/Private Partnership for LIS Development

During the development of the GIS/LIS Implementation Plan for Gdansk, it was quickly determined that:

1. The City did not possess the necessary technical, human and financial resources to unilaterally implement an LIS;

2. Given the experiences of numerous GIS/LIS sites elsewhere, it was desirable to examine the concept of public-private sector partnership(s), and

3. The LIS unit in Gdansk should operate as a cost/profit center and service enterprise for the city. This would facilitate the adoption of a private sector approach to LIS and allow the unit to support the city's information management needs more effectively.

An organizational arrangement was developed (Figure 6 in the Implementation Plan) which outlined the proposed organizational relationships for the GIS/LIS project in Gdansk. At the head of the structure was proposed an independent steering committee with members from the city government and key private investors in the system. Management and technical support services for the LIS would be provided by a Public-Private Enterprise (PPE) which would coordinate all activities and relationships with system users, service providers and investors (funding sources) from both the public and private sector. A key strategy was the formation of a "profit oriented" entity which could attract the required system development funds from those sectors with a direct interest in the implementation of an LIS, e.g. lending banks, land developers, utility companies, contractors and real estate entities. From an operational stand point, the pivotal coordinating element in the entire organizational structure would be the PPE.

It is important to note that many municipal GIS/LIS operations in the U.S., for example, the cities of Miami and Phoenix, operate as cost/profit centers and have strong private sector participation in system development and even management. This approach has proven to be very beneficial and cost effective. However, the legal basis for such relationships must be clearly established to ensure all parties benefit equitably from this arrangement.
The recommendation to move the LIS unit "outside" of the city government structure and adopt a semi autonomous public-private status is not only made for operational and/or financial reasons.

GIS/LIS development and implementation requires long-term stability and therefore, protection from the vagaries of political changes and upheavals. Regrettably, this institutional arrangement and the formation of the PPE has not occurred due to objections from some members of the city council who seemingly object to the establishment of an effective LIS in the city.

One can only speculate that these objections are based on the fear that an automated LIS will expose gross inefficiency, mismanagement and corruption of land information and assets, which can otherwise be "hidden" within the current chaotic manual system. Since the LIS unit remained within the city government structure, it has been subject to both political attacks and manipulation.

Such incidents are a most serious threat to the Gdansk LIS unit and have had a serious impact on staff morale, productivity, funding and system development. The hope is that sense will prevail within the newly elected city government and the LIS modernization program will be allowed to continue given the substantial level of effort and financial resources (over $1m) committed to date. The issue of a public-private sector partnership for LIS development remains outstanding and must be addressed if the project is to proceed. Clearly, if the city cannot make an adequate long term commitment of all the resources required to implement an LIS, then this alternate institutional arrangement is the only viable option.

The USAID Technical Assistance to the Gdansk LIS initiative has indirectly provided important support to the project, by enhancing its credibility and stature through external sponsorship. Representatives of national government, the Surveyor General and many cities throughout Poland (including Szczecin and Krakow) now recognize Gdansk as one of the more progressive sites for LIS modernization.

As a result of the wider influence of this LIS project, technical assistance and guidance provided to the city is now being transferred to other sites who have similar needs and requirements. Conversely, technology transfer is occurring back to the city in the form of core applications from the Surveyor General and assistance from international private sector groups wishing to support this innovative project. Nevertheless, these positive developments will prove to be irrelevant unless the serious organizational issues described above are quickly resolved.
4.2 Technical Partnerships and Collaboration--
The Key to Successful LIS Implementation

While the LIS project in the gmina continues, a related automated mapping project is underway at the voivoda (WODGiK) level. This effort is primarily focussed on the automation (digitizing) of technical infrastructure maps (1:500 scale) for the voivoda region. These maps show the infrastructure details of water, sewer, electrical and other networks (see appendix B), and are complimentary to the land (parcel) base being developed by the gmina.

Having completed the automation of a pilot area, this project is presently in a period of re-evaluation. Similar to many projects in Poland, the WODGiK have focussed almost entirely on the automation of graphical information while neglecting the importance of related attribute data including applications design and development. Of even greater concern, is the absence of any implementation plan (general or technical) that outlines the future course and goals of the entire project.

Since the gmina LIS is currently addressing the database design and applications issues, it would seem beneficial for the WODGiK to actively participate in these efforts. While the generation of large volumes of digital data is relatively easy, the resolution of database design and applications oriented problems is far more complex. Without addressing these critical issues, any information system is destined to fail since the fundamental questions related to effective information delivery to users are unanswered.

In Gdansk, the time is appropriate for the development of a comprehensive technical plan (Plan Techniczny) for the GIS/LIS which will outline in detail, the requirements and needs of multiple users including the gmina, WODGiK, regional court of justice and other priority users. This document would also address the database design and applications requirements for all defined users. These tasks are outlined in more detail in Stages E and F of the Gdansk GIS/LIS Implementation Plan (see pages 53-56).

The development of an integrated technical plan will require a formidable effort and investment in time, financial and human resources. While this is certainly beyond the means of any single initiative currently underway in Gdansk, it could be accomplished through a joint effort. Furthermore, the project to create such a plan must be led by a private independent contractor with technical skills in this domain. While no single company in Poland has all the necessary capabilities, experience gained by NeoKart GIS Ltd. (Warsaw) during the Lodz pilot LIS project would be most valuable.
Many uninformed GIS/LIS advocates criticize or shy away from investing in the creation of a multi-user GIS/LIS technical implementation plan. Apparently, these parties wish to proceed blindly with massive data automation efforts anticipating that issues such database design and applications development will resolve themselves over time. This lack of technical implementation planning is always a foundation for failure, and the cause of massive financial waste.

It is imperative to understand that the proposed multi-user, city-wide LIS in Gdansk is in fact, a complex technical and organizational infrastructure for information management. This will be required to serve the growing needs of the city and other information users for decades to come. The implementation of any technical infrastructure be it a road system, water distribution or telecommunications network demands comprehensive technical planning. If this is an accepted practice for these types of projects; then it must also be recognized as a pre-requisite for GIS/LIS (infrastructure) development and implementation.
CHAPTER 5

Human Resources and Training

5.1 Technical Staff Issues

It is universally recognized that the implementation of an LIS demands both technical and management skills which must be addressed by competent professional staff. However, personnel possessing the requisite technical knowledge are difficult to find and even harder to retain especially in the low paying public sector in Poland. Therefore, required skills must be developed through continuous training and education.

This is a major concern within the Gdansk LIS unit which helped promote the idea of a public-private sector approach. It is envisaged that this would create an environment where technical staff could not only support the LIS initiative, but also generate revenues in a private sector enterprise. This would facilitate increased base salaries and help retain key technical staff within the unit.

As earlier described, the public-private sector LIS enterprise was regrettably rejected by the previous city administration. This has had a direct impact on the LIS project with the loss of key members of the technical staff to the private sector; where salaries are far more competitive.

The loss of GIS/LIS qualified technical staff constitutes a significant financial loss to the city and its future development prospects. Obviously, such staff take with them all their experience and technical expertise which can only be replaced through lengthy training and staff development, both of which incur additional costs to the city.

If the LIS project is to proceed, the city must adopt a more progressive policy towards the technical staff that are required for system development. Clearly, the city cannot compete with the salaries offered by the expanding private sector. Therefore, they must adopt a more private sector approach to the LIS in order to maintain its important human resources. The diverse skills and demanding responsibilities of GIS/LIS technical staff require special recognition and attention. This is essential for continuity of system development and maintenance.

5.2 Staff Profiles

The Implementation Plan previously outlined the profiles of core staff that will be required to develop and implement the LIS in the city. While staffing has been severely disrupted and limited by political and financial upheavals, the following roles must be
assigned, especially during the more technical development phases which address database design and applications.

These defined roles include:
- An Operations Manager
- Database Administrator
- Network/Systems Manager
- Data Quality Control Specialist
- Application Specialist

These core staff are in addition to the technical staff who handle daily responsibilities such as data automation, update and maintenance. In order to develop the personnel and skills required for LIS implementation, training and education will be ongoing, essential requirements. This important issue is addressed in the following sections.

5.3 Training and Staff Development

Phase I of technical assistance to the city delivered a basic GIS training course in the use of the ARC/INFO GIS software package. ARC/INFO will provide all the basic tools, functionality and topological data model for the municipal LIS. This was the first formal training in GIS received by the city.

Seven technical staff participated in the five-day training including representatives from the Gdansk LIS project, the voivoda and the private sector (Polish Telecommunications Company). Students received theoretical training and undertook "hands on" exercises using the software, and also received an extensive training manual for future reference. It must be emphasized that although this was only introductory training, some fundamental GIS concepts were covered including the importance of topology. These will form the basis for future implementation tasks and more advanced training.

The majority of the training course was conducted by a certified GIS trainer from Neokart GIS Ltd., Warsaw. The trainer demonstrated detailed knowledge of complex technical subjects and delivered the material most effectively. The use and support of such competent local technical staff for GIS/LIS projects in Poland should be encouraged. This provides a cost effective mechanism for delivering training which will be increasingly required to compliment other forms of external technical assistance in the future.
5.4 Future Training Needs

The gmina LIS unit will shortly have to invest in more formal training of staff in a number of important technical skill areas. The training each member of staff should receive will be dictated by their designated roles and responsibilities. The following training requirements are priorities:

1. Advanced GIS

In conjunction with the installation of the system hardware and GIS software, training should be provided in advanced ARC/INFO, which will develop existing basic user competency in this software. Training should be customized to address the immediate needs of the site and project. This should include the conversion of CAD files to topological coverages and their update/maintenance.

2. Training in RDBMS

This should address the theory and practical applications of these systems e.g., Oracle, Informix, for the management of large, urban databases in an LIS environment. This must include the creation of relational databases with topological coverages, definition of "relate" fields, and conceptual and physical database design processes, which are currently in progress.

3. Applications Development

Since Gdansk intends to adopt the existing parcel and buildings management applications from Lodz, training in this process will be required. This should involve the actual implementation of these applications, their operation, functional requirements and possibilities for future customization, as required. Subsequently, training in actual applications design and development will be necessary in the medium term.

4. Training in Management Issues

Training in GIS/LIS related management issues has long been ignored but is as important as any technical training. Participants can include senior technicians but more usually involves, higher level managers, administrators, decision makers, and even politicians. The emphasis of this training is the effective management of spatial information resources and supporting systems; namely, how to increase productivity by making spatial information "work" to solve real problems. A primary objective is to provide participants with practical and theoretical training in process/problem analysis, information flow and related management skills.

Acquiring combined skills in business practices, communication and information management techniques optimize the financial and operational effectiveness of the LIS facility.
Expected management benefits from this training include:

- an ability to accurately assess operational requirements
- strategies for more effective information flow within and between organizations
- reduced costs in establishing systems
- less time spent in evaluating technical options
- quicker implementation of operational systems
- less duplication of effort and data
- more effective strategic planning of resources

This training highlights the capabilities of a modern LIS as an effective management tool which both increases productivity and strengthens institutional capacity. If the Gdansk LIS is to be locally sustained over the long term, then developing a competent management capacity in the region is essential.

In addition to the formal training outlined above, the LIS unit should attempt to conduct frequent and targeted sensitization events for key decision makers in the city, and offer on-the-job training to external staff who are willing to participate in the system development process.

In Gdansk and many sites in Poland, the current cadre of capable, trained technical (GIS/LIS) staff is very limited and far exceeded by growing demands from both the public and private sectors. This large "knowledge gap" is a severe problem, given the increasing numbers of sites attempting to implement GIS/LIS. The lack of staff with adequate training, technical expertise and overall project management skills in the public and private sectors is a national problem which has been recognized by the Surveyor General and other LIS modernization advocates.

Inevitably, GIS/LIS projects are suffering unduly and are strained by the burden of trying to provide adequate training and technical skill development using resources which are both fragmented and immature. In Poland, there is an urgent need to concentrate these capabilities in a facility(s) which is capable of offering comprehensive technical support to multiple user sites.

This need has been recognized by the City of Gdansk and an initiative (see below) has been launched with the potential to positively impact LIS development in not only the gmina, but throughout the region.
5.5 GIS/LIS Implementation Support through Building an Institutional Capacity

As outlined in the GIS/LIS Implementation Plan, the diverse resources required to establish an LIS in a municipality such as Gdansk are formidable. In most cases, a critical mass of technical expertise and support is required to move these projects forward over the long term from an implementation to an operational status.

Recognizing this need, the City of Gdansk, in association with a number of public and private sector sponsors has developed a proposal to establish a center provisionally named the Institute of Strategic and Spatial Studies (ISSS).

The broad aims of this center are:

1. To recognize the strategic importance of various planning processes to urban development and expand competency in this field;

2. Manage and promote an education and training facility which promotes the use of appropriate planning tools and technologies such as GIS;

3. To facilitate and support the implementation of LIS in the Gdansk metropolitan region and other cities in Poland; and

4. To share knowledge and expertise in the above using a number of networks including: The Baltic Cities Union, Eurocities and Union of Metropolitan Cities in Poland.

The idea of an independent facility which can concentrate and offer a diversity of technical support activities to GIS/LIS programs is very attractive. Indeed, access to such a "learning" and "technical support" entity could positively impact the prospects of many LIS projects in Poland. While the logistical details of the ISSS are unclear, the number of potential supporting agencies continues to grow. Certainly, this combination of Polish and international resources from both the public and private sectors will have the capacity to make a significant impact on the many needs of GIS/LIS projects in Poland. However, the level of effort required to establish and operate such a facility should not be underestimated. This important initiative must not detract focus or resources from the more immediate tasks which must be completed by the Gdansk project. The progress of this center will be monitored closely given its potential impact on the Gdansk LIS.
CHAPTER 6

Budgetary Issues

6.1 The Financial Requirements of GIS/LIS Implementation

In gminas across Poland, the funding of LIS implementation is extremely difficult given a number of severe financial restrictions. Many of these problems stem from a simple reality. While many sectoral responsibilities are being devolved from central government to the self governing gminas, the funds required to support many of these activities are not forthcoming. This is certainly relevant to the LIS issue. While laws have been passed which allow gminas to manage and maintain their own land information, the resources are simply not available to enable this process.

The situation is further complicated by a simple truth: while most municipalities are lacking adequate funds for LIS development, they also cannot afford to ignore their obvious need for an effective LIS required to support key "business" processes such as land management, disposition and privatization.

Figure 4 summarizes the estimated value of property parcels (in zlotys) in various sub-divisions or obrebs in Gdansk. The data were obtained from the city's geodesy and surveying department. The columns show the average value of parcels, obreb area and finally, the combined value of all parcels in each obreb. Since the primary function of the Gdansk LIS will be to mobilize the land resources through a privatization process, the amounts in the last column clearly express the possible (estimated) revenues that are presently unrealized. These figures must be seriously considered by the city administration when establishing investment levels in LIS development.

Certainly, the private sector including banks, real estate investors and developers are more than aware of the huge financial potential of land in the Gdansk municipality. However, their participation in creating a land market is contingent upon access to accurate, timely information regarding the land and this information can only be effectively delivered by an integrated LIS.

In the course of the technical assistance provided to the Gdansk LIS, the consultants have avoided direct intervention in any budgetary issues and related debates. Advice and guidance has only been provided to ensure that any technical implementation activities are first prioritized, and then executed as effectively as possible within the framework presented by the implementation plan.

Clearly in the last year, the Gdansk LIS project has faced unprecedented financial pressures as a result of political upheavals in the city. Had an autonomous public-private sector enterprise been established to manage the LIS (as recommended), then the project
<table>
<thead>
<tr>
<th>LP</th>
<th>District</th>
<th>Group</th>
<th>Avg. Parcel Value</th>
<th>District Area</th>
<th>Total Land Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
<td>VI</td>
<td>452 000 zł</td>
<td>129 3528 ha</td>
<td>555 440 923 200 zł</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>VI</td>
<td>452 000 zł</td>
<td>120 1599 ha</td>
<td>515 966 610 600 zł</td>
</tr>
<tr>
<td>3</td>
<td>11</td>
<td>XXIV</td>
<td>185 000 zł</td>
<td>706 6079 ha</td>
<td>1 241 863 384 250 zł</td>
</tr>
<tr>
<td>4</td>
<td>12</td>
<td>VI</td>
<td>452 000 zł</td>
<td>114 6192 ha</td>
<td>492 174 844 800 zł</td>
</tr>
<tr>
<td>5</td>
<td>13</td>
<td>VI</td>
<td>452 000 zł</td>
<td>84 4354 ha</td>
<td>362 565 607 600 zł</td>
</tr>
<tr>
<td>6</td>
<td>30</td>
<td>VI</td>
<td>452 000 zł</td>
<td>48 5191 ha</td>
<td>208 341 015 400 zł</td>
</tr>
<tr>
<td>7</td>
<td>29</td>
<td>VI</td>
<td>452 000 zł</td>
<td>107 1980 ha</td>
<td>460 308 212 000 zł</td>
</tr>
<tr>
<td>8</td>
<td>28</td>
<td>XXIV</td>
<td>80 000 zł</td>
<td>70 7202 ha</td>
<td>53 747 352 000 zł</td>
</tr>
<tr>
<td>9</td>
<td>26</td>
<td>XXIV</td>
<td>80 000 zł</td>
<td>164 7640 ha</td>
<td>125 220 540 000 zł</td>
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<tr>
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<td>27</td>
<td>XXIV</td>
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<td>122 9517 ha</td>
<td>621 397 851 100 zł</td>
</tr>
<tr>
<td>17</td>
<td>54</td>
<td>III</td>
<td>532 000 zł</td>
<td>130 9410 ha</td>
<td>661 775 814 000 zł</td>
</tr>
<tr>
<td>18</td>
<td>66</td>
<td>III</td>
<td>532 000 zł</td>
<td>109 7360 ha</td>
<td>554 605 744 000 zł</td>
</tr>
<tr>
<td>19</td>
<td>67</td>
<td>III</td>
<td>532 000 zł</td>
<td>234 1994 ha</td>
<td>1 183 643 767 600 zł</td>
</tr>
<tr>
<td>20</td>
<td>79</td>
<td>IV</td>
<td>424 000 zł</td>
<td>97 9108 ha</td>
<td>394 384 702 400 zł</td>
</tr>
<tr>
<td>21</td>
<td>78</td>
<td>IV</td>
<td>424 000 zł</td>
<td>114 6907 ha</td>
<td>461 974 139 600 zł</td>
</tr>
<tr>
<td>22</td>
<td>77</td>
<td>IV</td>
<td>424 000 zł</td>
<td>109 1114 ha</td>
<td>439 500 719 200 zł</td>
</tr>
<tr>
<td>23</td>
<td>50</td>
<td>XIV</td>
<td>274 000 zł</td>
<td>77 0039 ha</td>
<td>200 441 151 700 zł</td>
</tr>
<tr>
<td>24</td>
<td>64</td>
<td>IV</td>
<td>424 000 zł</td>
<td>156 7011 ha</td>
<td>631 192 080 800 zł</td>
</tr>
<tr>
<td>25</td>
<td>34a</td>
<td>IV</td>
<td>424 000 zł</td>
<td>0 ha</td>
<td>0 zł</td>
</tr>
<tr>
<td>26</td>
<td>279</td>
<td></td>
<td>648 000 zł</td>
<td>161 0000 ha</td>
<td>991 116 000 000 zł</td>
</tr>
</tbody>
</table>

Based on the assumption that 95% of a precinct's surface is communal ground.
(Data from Survey Dept. in Gdansk City Hall, prepared by B. Koczot)

* 20,000 zł is approximately equal to $1.00
may not be so dependent upon public funding, which continues to be inadequate. If private sector interests and investors remain marginalized from the citys' LIS development process, then budgetary problems will continue.

Various funding issues and option were discussed in detail in the Implementation Plan. The most important deserve re-stating since they are of critical importance to the future development of the LIS.

1. Any budget for GIS/LIS implementation must be long term and include guaranteed funds for initial "start up" costs and future operations. These budget line items must include hardware, software, staff, training, database development and management, system and data maintenance costs and system upgrades.

2. Sustained investments in an LIS project are required over a period of between 3-5 years before derived benefits exceed expenditures and operational expenses. This is a key concept for LIS budgetary planning where standard cost/benefit models are usually not relevant to the GIS/LIS development process. However, it is important to note that incremental benefits from the implementation of such a system are usually derived far quicker than any financial model would suggest.

3. Since GIS/LIS implementation is a continuous process consisting of a number of inter-dependent stages, budgetary stability is essential. If funding is unpredictable and/or inadequate, then this will not only severely impact future planning, but can also erode any progress from previous investments in system development.

4. Finally, the most successful and sustainable GIS/LIS budgetary strategies are those which rely upon a diversity of investment partners and a well developed financial plan. Above all, funding should always be adequate to the tasks required of the system. If necessary funds cannot be secured, then activities must be prioritized and scaled down to more achievable levels. This requires a degree of pragmatism which is often missing in the more technical individuals who are usually involved in managing GIS/LIS initiatives.

Clearly in Gdansk, the LIS budgetary issue remains uncertain and largely unresolved. A concerted effort must be made by the LIS unit and the city government to ensure that an adequate and long-term budget is secured and guaranteed. This is obviously dependent upon the organizational status of the LIS project, which must move towards a more public-private sector orientation as soon as possible.
In conditions where GIS/LIS implementation faces numerous constraints including financial, technical, political and organizational obstacles, alternate strategies must be actively sought and/or developed. The experiences of LIS projects in similarly restrictive conditions must be examined for lessons learned and possible solutions to problems such as those encountered in Poland.

A most common trend among many GIS/LIS sites in Poland today is the almost exclusive pre-dominance of surveyors as the lead professionals managing and implementing these projects. As a consequence, many so called "GIS/LIS" sites are actually automated mapping and surveying enterprises with little or no focus on other land based information, beyond geodetic field measurements.

Historically, surveyors have been important custodians and practitioners using some land based information in their daily work. In particular, they are focussed on the cadastral features of properties, namely the geodetic boundaries, legal description and accuracy of these defined parcel limits.

While these elements are important aspects of any LIS and especially a true automated cadastre, the priorities of the surveying community must not dictate the parameters within which a modern LIS must develop in a municipal setting such as Gdansk. The requirements for establishing an LIS do not equal those of an automated cadastre. In particular, survey accuracy for parcel information is not required.

It is clear that in the development of an integrated LIS which supports many processes or "business" functions, the relevant data requirements, rather than the absolute accuracy of survey information is of far greater importance. However, in many LIS programs such as Gdansk and Lodz, the level of effort expended to collect and automate accurate survey level information has been large, costly, time consuming, and a labor intensive component of the implementation process. As a consequence, many other LIS development tasks such as database design and applications development have been constrained by the apparent need to determine the exact location of each property PRIOR to its integration into the LIS. This approach to LIS implementation must be radically re-evaluated and revised.

Many land management applications which could be supported by an automated LIS including; land disposition, zoning, land use planning, zoning, property appraisal and evaluation, property tax collection, do NOT require that survey accuracy parcel boundaries be entered into the system.
Clearly, an LIS should always be a data driven system where the contents and structure of relevant attributes in the database(s) are of foremost importance. This being the case, an alternate approach to LIS development is presented in Appendix C.

This methodology has been implemented and tested worldwide with positive results at a fraction of the cost of traditional LIS projects, which unnecessarily strive for survey accuracies. Since data collection is the most costly element of LIS development, the Gdansk LIS project is advised to carefully examine and re-assess all current data acquisition/collection activities, especially with respect to parcel boundaries.

With very limited financial resources for system development, more focus should be placed upon automating deed information, structuring databases and designing applications that will rapidly support the priority process(es) for revenue generation. The subject of data “accuracy” in an LIS is examined further in the database design section (B), which also details specific design tasks and related procedures.
CHAPTER 8

Database Design:  
A Critical Component in the GIS/LIS Implementation Process

8.1 Introduction

A critical component in GIS/LIS implementation is the development of a database design that will directly support the priority business functions identified earlier in the process. Database design, like system implementation is itself a logical process, which must be executed in an orderly and comprehensive manner. Figure 5 illustrates the logical sequence of conceptual design tasks, as well as the first stages of the database design process.

In developing a database design for the Gdansk LIS, decisions must be made as to what graphic and tabular data elements will be included in the relational database(s), as well as the graphics data library, and how these elements are accessed and maintained relative to each another.

Since GIS functionality allows for processes and analysis that are not possible using manual methods, the participants in the database design process must also consider how business practices might be changed or enhanced in the future. This will help to avoid duplicating any existing manual methods without taking advantage of powerful GIS capabilities. An example of this may be the display of the parcel identifier numbers on obreb maps. Since this identifier can be stored as a tabular database attribute, there is no longer a need to maintain it as a graphic annotation on the map. All text attributes can be displayed on the map at any time without having them placed as an annotation string. This moving of map annotation elements to internal text attributes can simplify map maintenance while producing maps that possess label features based on the requirements of the individual departments. This avoids the additional effort required to develop and design a "universal" map product that attempts to encompass every need in one generic view.
Benchmarks and Key Tasks in Conceptual Design Process
A Framework for Activities

- Identify User - Assess overall data needs and resources

Assess Priority Process(es) and Related Data Requirements

Determine Data Flows with Diagrams

Assess Specific Data Requirements (i.e. elements and entities)

Feedback & Revise

Develop Data Dictionary

Initiate Normalization

Complete Physical Database Matrix

Complete Entity Definition forms Attention to Relate "Keys"

Document All Stages, Problems and Results

OUTPUTS

- Compiled Entity Definition Forms
- Completed Database Matrix
- Compiled Data Flow Diagrams
- Complete Data Dictionary
- Preliminary Database Structure Schematic

REVIEW ASSESS MODIFY

Proceed with Physical Database Design
In addition, the requirement for strict Arc-Node topology supports many spatial analyses such as a proximity query e.g. identify all properties valued over 500,000 Zlotys within 500m of this retail location? Such a query may be needed to generate an address file from the database for a property survey. These examples illustrate the importance of a process focussed database design during the implementation of an operational GIS/LIS.

It is important to remember that this chapter is only an initial primer for database design with is a lengthy, multi-stage process. Further training, technical documentation and assistance will be needed. However, completion of the tasks outlined below represents a significant contribution to the overall database design effort. Appendix contains a "quick look" database design reference manual which summarizes many of the tasks described in the text.

8.2 GIS and CAD-Complimentary or Conflicting Approaches to Database Development?

Because the City of Gdansk and other regional agencies (e.g. the WODGiK, and similar agencies throughout Poland), already have a significant investment in CAD software, it is important to understand the different functional capabilities and roles each technology should play in the development of a municipal Land Information System (LIS).

The database design process relates directly to this discussion because the dissimilar data models inherent to these software technologies ensures that the LIS database design can be optimized for only one software type.

CAD software was developed to produce digital or computer-generated drawings of almost any kind of design, sketch, plan or map document. The tools available are optimized for this capability (primarily drawing and graphics automation) and are efficient for maintaining these types of documents in a digital format. The ability to change and/or update documents is efficient and precludes manual redrafting of complete documents as is frequently done for alterations on hand drafted maps.

Some vendors and private groups also have added the ability to link CAD graphics to tabular attributes stored in extended databases. However CAD systems do not have a topological data model as is inherent to most GIS software.

8.3 The Importance of Topology in GIS/LIS Implementation

Topological data models greatly extend the capability of GIS software in that it gives graphic elements in the GIS database spatial "awareness" of neighboring graphic
elements. For example, electrical lines on an infrastructure map "know" what other lines connect to them and at which intersections (switches) thereby allowing the software to support network, flow and load distribution applications across an entire city or regional network. Parcels or other polygon type data "know" who their neighbors are, as well as what types of lines (boundaries) separate them. This allows for a myriad of applications from proximity or nearest neighbor analysis, census studies, city-wide land valuation and property taxation evaluations. All of these applications and many more used by municipal government rely on a GIS/LIS utilizing a topological data structure.

Other topology based urban applications include:

- Emergency response dispatch
- Fire dispatch optimization
- Crime Analysis
- Noise abatement
- Electrical network load analysis
- Water and sewer capacity analysis
- Garbage truck routing
- Surface and storm water runoff analysis
- Facility or siting optimization
- Utility inventory
- Utility customer complaint response systems
- Streets inventory and maintenance tracking
- Site planning
- Land use planning
- License qualification analysis
- Property assessment
- and many others...

Although topologically based GIS is clearly the tool of choice for the Gdansk LIS, the city's previous investment in AutoCad and the data stored in that format are not wasted. Translation from AutoCad (or Intergraph) to Arc/Info format is an inherent capability of the GIS software. However, because of the lack of enforced structure in CAD software, the translated data would have to be passed through an edit and quality assurance/control process to insure it meets the topological requirements of the GIS package.

Any tabular attributes stored in that system could also be moved to a multi-user relational database that would interface with the GIS. This reformatting and transfer of data will more easily meet the needs of the distributed, network based multi-agency LIS system proposed for the Gdansk metropolitan region.
Graphics data could continue to be maintained in Autocad and moved across as needed to the LIS until a GIS based maintenance system with relevant applications is implemented. However, it is clearly preferable not to manage two distinct systems and the data translation process. Although, a CAD maintenance strategy that insures "clean" data translation to topological formats could be devised.
CHAPTER 9

Phased Implementation and Database Design
Global vs. Phased Approaches

The task of completing the GIS/LIS database design for the City of Gdansk, and implementing applications to support the priority process of land privatization is composed of several steps, which are inter-dependent and in accordance with the outline provided in this report.

Beyond these tasks, a decision must be made whether to use a global design and implementation approach or a phased implementation process.

The nature of database design tasks are often repetitive. Furthermore, file design, data dictionary, item descriptions, and relate or key items can change over time as a system grows to encompass new elements or requirements that were not included in the original design. This can happen more readily when using a phased approach to developing a GIS. Addressing all possible elements in the initial design helps to eliminate the cyclical re-design process and is one of the main reasons that the global design methodology is taught by many database software vendors.

The drawback to a global approach is that for large database design efforts, it requires a large commitment of time and resources and frequently delays actual implementation of end user applications. Because the City of Gdansk needs to implement a working GIS/LIS solution that will support the land privatization process in the near future, a phased design and implementation process should be utilized focusing on the LIS requirements.

The advantages of a phased approach as suggested above includes a shorter implementation cycle where design is focussed on a limited set of requirements (which support clearly identified priority processes) using a smaller set of database elements. Any disadvantages of a cyclical re-design effort associated with the phased approach can be eliminated by following a few design guidelines, and by taking advantage of design restrictions imposed by the graphic elements of the database. Put simply, every effort must be made to divide graphic elements into separate layers or coverages which logically groups the textual attributes associated with them.

This data normalization also helps insure that new database elements can either be added to new tables or are added to existing tables without disrupting the structure of existing database elements. Careful design of the core database will insure that later phased development/design efforts are an easy addition to the existing system, without requiring significant changes in the existing database design or applications.
Because of the availability of existing core applications developed for the Lodz pilot project that utilize the Arc/Info GIS software and the recent transfer of these applications to Gdansk, the database design can be further accelerated by designing more directly towards the database interfaces provided by these existing application(s). This allows the database design effort to encompass the conceptual database design while also developing many components of the physical database design. This will accelerate the LIS development process while not requiring significant changes should any future decision be made to use any alternative GIS software package.

9.1 Data Requirements and Priorities--Decisions about Data

Effectively assessing the data requirements for a GIS/LIS first requires the determination of end users' "business" requirements. These are the basis for determining not only what graphic and tabular data will comprise the LIS, but also the spatial and attribute accuracy required.

Since the City of Gdansk will be implementing a land information system first, with other functions such as utility management added in later phases, it is this precise requirement which must be addressed.

The departments and agencies that participate in land management and specifically privatization include:

- Department of Land Management
- Department of Architecture
- Department of Surveys
- Department of Development
- Court of Justice
- Regional (Voivoda) Surveyor

Large and/or more complex developments or land transactions may also involve the mayor and city board as well as the Department of Economic policy. Note that the Regional Surveyor (Voivoda) and Court of Justice are state agencies not under city jurisdiction.

The minimum data sets used by these departments in the disposition of land in the city that should be included in the LIS database(s) are:

- The parcel history data (Appendix D)
- Obreb level parcel maps showing property boundaries
All the data elements listed below are part of an automated system already linking these data to the digitized obreb maps. Many of the listed data groups include multiple data elements that currently includes:

- Synoptic parcel data
- Land Use data
- Register unit data
- Owners data
- Corners coordinate data
- Administrative decision data
- Synoptic Building data
- Building Construction data
- Utility (Installations) data
- Building Restoration data
- Building Use (functions) data
- Units data
- Unit description data
- Other Information (text) data
- Deed number

Other data that should be included but are not as critical to land disposition are the city planning maps and the utility data maintained by utilities and regional surveyor (WODGiK). Since a large percentage of the land use planning maps are being developed under contract with private firms, this data should be included only after ratification by the city, and after the existing parcel land database has been created.

Also, since the utility networks (technical infrastructure) is viewed as an integral part of the "land base," it is appropriate to minimize duplication of effort by making the city parcel information available to the regional surveyor or utilities, as a "base map" for the utilities infrastructure data. The fiber optic link available between these agencies would make it possible to readily share these data sets. The future availability of utility data registered to the land (parcel) base could allow the city to use the utility information together with the overall planning and development plan approval process. This is currently not occurring but should be a future goal.

9.2 Access to Deed Information--The Keystone to Land Disposition

Although deed data is registered and maintained by the Regional Court of Justice, it contains information vital to several city departments involved in the disposition and privatization of land. Since these data are used by the city but the legal version is maintained by the Court of Justice, there are a range of options that could make this data available to the city LIS.
An optimum solution would be the complete development and implementation of the Oracle-based relational database (FENIKS2) system which has been pilot tested and can effectively manage deed information. This could be accessed using the fiber optic backbone that connects the city and court. Depending upon agreements between the city and court, the LIS could either have access to a deed data retrieval system (like FENIKS2), or access the deeds directly. Direct access would require a city developed application for retrieval and display of deed data. In either case, the court would be able to use various tools inherent to an RDBMS such as Oracle, to control access and security to data by limiting both group and individual access to the deed database(s).

Another option would require the city to build an internal city-owned deed database by automating relevant deed data internally. This could be done should the city and court fail to reach agreement on a shared database. This is also an option should the city find that the functionality of the courts' database does not meet city requirements as is the case with many shared database systems. Additionally, the city's deed requirements are less than those of the court. While the court is required to keep the entire legal deed on record, the city only needs to "view" elements relevant to land privatization or other land transactions. This may allow the city to pursue a third option.

The third option would be a document imaging system which could store scanned deeds similar to attribute tables in an RDBMS. This would require the city to automate copies of the deeds by scanning. With the simultaneous automation of the appropriate keys or identifiers (i.e. the unique deed number), the scanned deeds could be used as an attribute of the LIS and retrieved both graphically as well as through tabular search operations.

The main drawback to this system would be continual maintenance as well as the requirement that all access terminals have graphics capability. Scanned images also have significantly higher storage requirements than textual databases. Their advantage is that scanned document databases can usually be built more quickly and at a lower cost than tabular systems. With all the above options, cost versus functionality, and maintenance issues must be factored into any development decision. A hybrid technical solution may be appropriate. Notwithstanding, there is widespread agreement in the city that the deed information must be integrated into the LIS in the near term.

9.3 Accuracy Requirements

The accuracy of data to be managed by a LIS must always be addressed during the database design because this relates directly to the business functions or processes the system will support. These required or priority functions in turn, determine exactly which data will be stored in the LIS. Gdansk's LIS will primarily support land information management and the privatization process. Therefore, the LIS "land base" should be constructed to meet these application requirements.
Since this LIS database will be shared among several departments and agencies, spatial accuracy should meet the requirements of the department with the most stringent spatial accuracy requirements. In Gdansk, this is the land survey group. Survey accuracies for the current obreb maps have a stated accuracy of plus or minus 10 centimeters based on registration to the system of large survey coordinates presently in use. The present digitized obreb maps in the city however are only registered to this land net using three or four coordinates per map. Manual digitizing also introduces additional spatial error that degrades the accuracy of these data to about plus or minus 0.5 meters. The ongoing project to resurvey the entire metropolitan land base will yield coordinates that could provide a parcel base map with increased spatial accuracy.

However, as mentioned in the earlier chapter, the city's LIS does not require this level of accuracy to support many valuable applications. In fact, a land base with the accuracy of the current digitized base will adequately meet the requirements of over 80% of all future applications that would ever be developed for the municipality. With this in mind, the city should utilize the current digitized land (parcel) base in the initial LIS implementation or consider approaches such as point based systems (Appendix C).

As field surveys are slowly completed and the resurveyed parcel coordinates become progressively available, the digitized land base can be "rubber-sheeted" or warped to these new coordinates, thereby raising the spatial accuracy of the spatial data using surveyed coordinates. This allows the system implementation to proceed with applications to support the land transfer business requirements, without reliance on the laborious resurveying process. Warping of coverages (data layers) in the future should cause little or no disruption to any existing LIS applications.
CHAPTER 10

Database Design Tasks

The development of a conceptual and physical database design is now underway in Gdansk. The completion of the tasks outlined below is critical for the conceptual design and in order to move directly towards completion of the physical database design. Additional formal training will also be a pre-requisite to successful completion of these tasks.

The tasks remaining to be completed by the LIS unit include:

1. Completion of the Entity Definition Forms
2. Complete initial populating of physical database matrix spreadsheet
3. Initial Normalization
4. Completion of a schematic database structure diagram (as in Figure 3)

10.1 Completion of the Entity Definition Forms

The completion of the Entity Definition Forms (EDF's) is the first task to complete. Training and procedural instructions were provided to the technical staff. The elements on the sheet (Appendix A) include:

COMPLETED BY:
This is the name of the person completing the entity sheet. It is important to fill in this field because changes may occur to the entity that require re-interviewing the person completing the sheet or the end user who provided the information. This allows the same people to address any changes without reeducating new participants in the process.

DATE:
This is the date the entity sheet was completed

ENTITY:
This is the common name e.g. ULICA that is often used by users when addressing a particular data element or entity. Different groups may use the same entity name to describe different pieces of data. This must be eliminated to avoid confusion and accidental access to the wrong elements in a database search or query.

SYNONYMS:
This is an alternate name for the data element. This is also known as the "short name" because it is the name under which the element will be most often accessed by in the
database. Remember no two elements can have the same name in a database. This reduces confusion and accidental access to the wrong elements in a database search.

ENTITY DEFINITION.
The entity definition is a two part field. The first part describes the item type and storage requirements. For Arc/Info the main item types include C character, B binary, I integer, F floating point, and D date. For graphic entities, enter the word graphic and describe its graphic type i.e. line, point, polygon or text. A typical non graphic description might be 40,40,C. The first "40" describes internal storage requirements, the second describes display requirements, while the character describe the item type. Remember that floating point descriptor field widths include one space for the decimal and the number of spaces required after the decimal, i.e. 4,12,F,3. Check with the particular extended database vendor for supported item types which accommodate items that will be kept in Oracle, Ingres, or other external databases.

The second part of the definition is a verbal description of what data the field will contain. A description for a field called "ADDRESS" might contain this description; "Mailing address for parcel owner not street or mailing address for occupant." It is important to include valid values or allowed value ranges where applicable. These can be placed in the notes section below or attached to another sheet if they occupy too much space.

FREQ. OF OCCURRENCE:
The total number of elements expected for this field in the database. This is important because dissimilar frequencies for tabular elements help define what entities go into which table. It is undesirable to create tables with two fields, one with a high number of occurrences and the other with just a few.

GROWTH RATE:
How many occurrences of this entity will be added to the database over days, weeks, months, or years? This is used to help with capacity and maintenance planning.

FEATURE ACCESS OR EDIT RESTRICTIONS:
Describes which individuals or groups should have the ability to access the data entity. This must describe who will have read access to the data as well as who will have write or edit privileges. This is used to set up database and system level security for all data access.

GRAPHIC MAINTENANCE RESPONSIBILITY:
What person, group, or department will have maintenance responsibility for the graphics layer to which this data entity belongs. This also includes maintenance responsibility for the related attribute data. Groups supporting tabular applications only (e.g. the court of justic) may also be listed here because they include data that may be related to the graphics for analytical or display purposes.
NOTES:
The notes section may include anything the analyst believes is important to the design or maintenance of the database that was not included under any of the other entity definition forms headings.

Complete one sheet for each entity that is a candidate for inclusion in the LIS. Be sure that items are defined in the most rigid structure possible. This is defined by the likelihood of an individual item being used for retrieval of data, or the inclusion of a repeating field. An example is an address field entity that is defined as a 40,40,C and contains all elements of an address. In reality, this field is comprised of several fields including street name, street type, address number, and other components. Since many database retrievals will be performed by one or more of these component entities, they should be defined as individual entities and not defined together.

In addition, the item street name would be repeated for all the addresses associated with that street. This element should then be listed as a separate entity since it is a candidate for movement to a street names file where all the street names are listed only once. Furthermore, a one to many relate with a short relate key will allow full addresses to be reconstructed "on the fly" when desired.

10.2 Completion of the Physical Database Matrix Spreadsheet

The physical database matrix (Appendix E) provides a summary of all the graphic and tabular data entities that will be in the LIS and many pertinent facts that will aid in the completion of the physical database design. As this matrix is refined and data is grouped and further defined, the categorization of the data will reflect the actual table names and contents defined by the physical database design.

A copy of the matrix complete with entities collected during the initial design sessions completed in April 94 is included in the appendices. A digital copy of this spreadsheet and contents were also made available to technical personnel. Although this data reflects many of the final database candidate elements, it is not complete. All the entities from the completed EDF's must be entered into the matrix.

It is common to find the same elements under different names or maintained by more than one group. Maintenance responsibility must be agreed upon by the participating departments. If items must be maintained by more than one group for update periodicity or other constraints, the items should be given different names. The goal is to eliminate maintenance redundancy and insure database integrity by having only one group or individual maintain each of the database entities. This often requires that business practices and maintenance responsibilities be altered to achieve this goal. The fields in the matrix include:
Layer, Cov, DBMS or Loc.

This field contains the layer or coverage name containing the graphical data entities. For tabular attribute entities this field contains the database management system (location) of the entity. Graphic entities are grouped together by maintenance responsibility and Arc/Info coverage name. Choose a coverage name that reflects the data it contains. The land base coverage might be called "Land." Make sure that coverages don't contain conflicting data types. Polygons and points features cannot be stored in the same coverage. Separate logical data layers into different coverages. This means that utility data should be on separate coverages from the land base. The ability to show these two coverages together as one map product is not impaired by separating them into different coverages. They become analogous to different "layers" in an Autocad drawing file. If the tabular data will reside in an Oracle database put the word "Oracle" in this field. Conversely, if it is a related "Info" database file then enter "Info" in the field.

Fields #2

Field 2 contains no header in the matrix spreadsheet because the field is too narrow. This field contains a single alpha-character signifying the type of graphic or tabular entity. Enter "O" or "I" for Oracle and/or Info tabular entities. If using Informix or another database, add unique codes as needed. For Arc/Info graphic elements enter a "P" for polygon features, "X" for point features, "L" for line features, or "A" for annotation features. These codes extend to all Info attributes that reside in each of the Feature Attribute Tables (FAT). Deciding if the attribute should reside directly in the feature attribute table or in an extended database file should be done using these initial criteria:

1. If the entity exists only to support display or representation of a graphic feature then it belongs in the FAT.

2. If the attribute has exactly one instance for each graphic element in its related feature class (line, point, etc...), and meets criteria (1) then it belongs in the FAT.

3. If the attribute is not used in any tabular based applications separate from the graphics based applications, and meets the preceding criteria then it belongs in the FAT.

4. If cross map (tile) calculations or summation reports are not required and it meets the other criteria, then it belongs in the FAT. This requirement will not be needed by Autumn of '94 due to advances in the Arc/Info data storage system (ArcStorm).

Data entities are candidates for storage in related Info or other DBMS if they fail the above criteria. If they need multi-user access, especially update, then they most likely belong in the extended DBMS and not in Info files.
Fields #3

This field lists file names. Entities contained in each file are listed immediately below this entry since it is entered only once as a sub header for all entities that belong in the named file. For coverage FAT files, do not include the coverage name since it is already stated in the first column. Enter only the FAT type i.e. PAT, AAT, XAT, etc... Each annotation type receives its own insert in this column describing the annotation group i.e. "lot boundary dimensions." For extended database files insert the full file name.

Feature/Attribute
This field contains the entity name. Initially this may contain the long or common name for the entities. These should be replaced with the database synonym or short name by which the element will be commonly accessed.

Base
Sys.
This field contains "yes" or "no" describing if this element will be included in the first phase of the GIS/LIS implementation.

Maint.
Respon.
What group or individuals will maintain the entity.

Convert
or New
Is the entity one that previously existed or is it newly created in support of the planned LIS. A system-wide unique identifier or relate key item are examples of data entities that would be "new."

Conversion
Responsibility
What group or vendor is responsible for initially entering the data entity into the planned system.

Conversion
Source
What is the current entity source that will be used as the conversion source document or map.
Conv.
Method
How will the data initially be loaded into the GIS. Possible methods include key entry, digitize, COGO input, derive, or import. Derived data is generated through manipulation of other previously entered entities. Imported data comes from another previously automated source e.g. GPS.

The physical database spreadsheet, data dictionary and physical database design diagrams are closely related to one another and modification in one of these documents will frequently cause the others to be altered to reflect this change. Completing the physical database matrix spreadsheet will provide the starting point for developing the data dictionary and database design diagrams that will complete the physical database design. Having this document finished will allow the physical database design sessions to be completed more quickly.

It is recommended that the final physical design be completed in conjunction with staff and/or a contractor who is intimately familiar with the Arc/Info software. This task should be completed with Arc/Info experts because the software provides for many system specific functions like key files, symbol look-up tables, and other software peculiarities that directly alter the database design process from a standard relational database design effort.

Database vendor staff and training would be appropriate only for the design of related non-graphic tabular based systems. If for any reason, another GIS software package is used, the completion of the physical design should occur with staff or appropriate system developers familiar with the selected software.

After completion of the entity forms and the first completion of the physical matrix, the data dictionary and the physical database design diagrams can be started. At this time there are certainly fields in the physical database matrix that are not completed. When the physical database design diagrams are constructed and attribute inter-relationships are more clearly defined, entities may be moved around in the matrix to reflect these changes.

Since entities grouped together in a single file usually are maintained by a single group or individual, this process may help to fill in missing values for the maintenance group or conversion responsibility matrix fields.
10.3 Initial Normalization

In following the rules stated for filling in field #2, some normalization of data has occurred. It was stated by city personnel that they already had experience with developing normalized relational database structures. The non FAT (AAT's, PAT's, XAT's) that are listed as Oracle, Info or Informix files should be reviewed and normalized to third normal form where possible.

If any review is needed on this process use James Martin's books on data base development. "COMPUTER DATA-BASE ORGANIZATION", section on creating third normal form structures beginning on page 23.

Many database vendors also teach short courses on this topic. The current data files entered into the matrix are already fairly well, although not completely normalized. If this task should prove difficult it can be done in conjunction with the final physical database sessions mentioned above.

10.4 Creating the Data Dictionary

Although the data dictionary, entity forms, and physical database matrix contain many common elements, each reflects a different view of the data as well as serving a different end use. The data dictionary is a source document maintained for end user evaluation of potential data sources available in the GIS. It is used as a constant reference document during the development of end user applications. A good data dictionary is also a valuable reference document in communicating with users concerning their data and applications.

A data dictionary can have many forms. In its purest form it contains the descriptive data contained on the entity definition forms plus a description of all the files or coverages in which it occurs. A modified data dictionary based on coverages, related files and entities is more useful for end users as well as application developers. Although an on-line data dictionary application is even more useful, the time spent in its implementation can encroach upon other application development which will be a critical factor for Gdansk.

For a quick and very useful manually produced data dictionary-database design document, a word processor is the only tool required without need to actually access a GIS. A chapter is usually devoted to each of the graphics coverages or groups of coverages that comprise a logical data unit. For the City of Gdansk, the initial
implementation will comprise a chapter describing the "land base" and any coverages that are defined therein. Future chapters may include one for the land use planning maps and a chapter for each of the discrete utility layers. An example of a typical data dictionary entry is shown in Appendix E.

The "land base" chapter will include the physical database design diagrams where they are completed. This will yield a complete physical database design document with the data dictionary descriptions inserted under the file headings in which they occur.

The preliminary work for the data dictionary should involve making one entry in a word processing document for each of the entities in the database. A header line should be entered containing the entity name, followed by a list of all the files in which the entity will reside. A line should then be omitted followed by an entry which includes the verbal description portion of the definition field from the entity definition forms (EDF's). Omit another line and enter any valid value information gathered on the entity definition form.

One of these entries should be made for each attribute that resides anywhere in the GIS/LIS database. This will complete the initial development of the data dictionary. When the physical database design session is completed, these descriptions can be combined with the database design diagrams and files description text developed during those sessions, to produce a complete physical database design document.
CHAPTER 11

Fit Analysis for the Lodz Parcel and Buildings Management Applications

At the time of this report, a complete translation of the database design report for the Lodz LIS applications had not been completed. However, this document is an excellent transferable model for the database design exercise to be completed in Gdansk. Some of the primary entities and file descriptors have been translated allowing a preliminary comparison of these two projects and applications.

The Lodz application is a complete parcel and building data maintenance system that allows for synchronized graphic and tabular attribute updates for parcel splits, combinations and other such transactions. This is the same core functionality required by the City of Gdansk for their LIS implementation. These applications even possesses database design elements for the inclusion of utility data. This will be a future requirement for the City of Gdansk and/or the WODGiK, who are currently engaged in the automation of the technical infrastructure data for the region. However, in the Lodz applications, it appears that this utility management function is only designed for at this time. This means there are no actual maintenance applications currently available for utilities. These may be a future consideration for development during a later phase of the Gdansk LIS implementation project.

An important aspect of the current Gdansk LIS database includes a number of fields for buildings, including many for building history maintenance purposes. The Lodz database design appears to contain a similar subset of those fields needed by Gdansk. The City of Gdansk also requires deed data to be available on-line. The Lodz application (database design) appears to have a deed file (attribute) that contains only a deed reference number without a deed management application which will require development in due course.

If this field is populated by the unique deed identifier number used by the Court of Justice, then this may be all that is required to link any GIS driven application with the courts deed database once it is on-line. Accessing this record would allow the court database to be searched (even remotely across the WAN) using this key, so that the full deed information could be accessed by the city LIS using the Lodz applications (with some modifications).

Additional building and parcel fields maintained by the City of Gdansk would have to be added to the Lodz system to have on-line access to this data. This appears necessary because local land transaction decisions must be in compliance with city regulations concerning historic buildings etc. This could be accomplished in a number of different ways.
The data could be implemented as a separate sub-system with relate items to the core maintenance and viewing applications. This would allow use of the maintenance application(s) as soon as data are translated and loaded into the Lodz system. Only minor modifications would be needed to link the two systems. The Gdansk building sub-system could then be built separately and integrated into the LIS at a later date.

The second method would require that all missing fields and/or files be added immediately to the Lodz applications. This would delay full implementation but would provide a more immediately integrated solution. It appears that the Lodz applications could be utilized as a core maintenance component for the Gdansk LIS. Their implementation could save as much as 6 months to a year of intense applications development effort which would only replicate many of the tools and functions already developed in Lodz.

The Lodz application is currently designed to operate with an Informix database. The database integration tools included in Arc/Info can integrate with Oracle, Ingres, and Informix equally well. Any call/query from Arc/Info to the databases should use the same syntax allowing one database to be easily substituted for another.

Unfortunately, the tabular portions of the Lodz application are built with specific Informix forms tools. Translation of these forms to another package could require rewriting and re-design unless translation capabilities are available for this task. This issue could be answered by the DBMS vendor regarding translation of Informix to Oracle forms.

However, using the Database Integrator, Arc/Info can communicate with most (Oracle, Informix, Info and other) database packages simultaneously. So, even if the decision is made to utilize Informix with these specific applications, other databases using another DBMS package (such as the "Ratusz" under Oracle) could still be fully accessed through Arc/Info.

11.1 Database Development Constraints

During the conceptual design meetings help in April '94, it became apparent that there were constraints to implementing a city-wide LIS in Gdansk.

1. The first constraint encountered was both processes and departments involved in land transactions (privatization) are in a serious state of transition. This makes it very difficult to develop meaningful departmental business and data flow documents. Indeed, the details of the completed land transaction diagram may already need to be changed!! Therefore, because of this dynamic situation, the design process must focus more on the required data itself. If the correct elements are precisely accounted for in the database design, then functionality can be extended at a later date to whichever users and/or departments are designated as responsible for fulfilling these task(s).
2. The second constraint is a lack of in-house expertise in either development or use of GIS software. Usually a core group has some experience working with the hardware and software technologies involved. A possible solution to these constraints would involve training existing staff who are most familiar with these technologies (currently the Autocad group) and developing them as the core LIS implementation team. Other city and departmental staff could also work collaboratively with this team to implement the core system in a single physical location. As core implementation issues are resolved, then specific functions could be migrated out to the departments when appropriate. This allows for close association and on the job training of less experienced staff with those most familiar with the system. It also avoids having to resolve all the technical issues of a more distributed system simultaneously, while applications are still to be implemented.

The Gdansk LIS group must take advantage of the indigenous skills available in Poland to overcome many of the tasks assigned for the immediate future. With respect to database design and adapting the Lodz applications, the city must utilize the considerable expertise of NeoKart GIS Ltd., who engineered the Lodz applications, and have completed both database design and technical project documents. Attempting to train the Gdansk staff up to this contractor's level of experience would take years, and is neither a practical nor cost effective proposition.

However, the Gdansk LIS unit must acquire some formal training which will increase the staff skill base and will allow for the effective operation and maintenance of the system in the future. Database design and applications development tasks should be sub-contracted where possible, and developed in conjunction with experienced groups such as Neokart. This is the only time and cost effective solution available to the city during these next critical stages of system development.
CONCLUSION

In the short term, the LIS unit in Gdansk should work towards addressing the essential tasks outlined in this chapter. It is important to remember that all tasks should be completed accurately and comprehensively. Documenting results and any problem areas that arise is also vitally important. In combination, the outputs from these tasks will make a major contribution to the physical database design which is the next major stage in the LIS implementation process. The tasks involved in this subsequent stage should be reviewed and are outlined in the GIS/LIS Implementation Plan (pages 53-57).

The tasks outlined for completion in this report represent important benchmarks. Their successful completion will determine whether external technical assistance of the type sponsored by USAID is appropriate in the future. After a most difficult and challenging year, the Gdansk LIS project appears to have crossed over a major watershed. With equal determination and commitment, the challenges posed by database design will also be overcome.
APPENDIX A

Entity Definition Forms and Data Flow Analysis Survey Forms

These standard data collection instruments should be used routinely in the completion of these important components of database design. Original forms must be compiled and safely archived for future use and reference.
PROCESS/INFORMATION WORKFLOW QUESTIONNAIRE

INTERVIEWER: __________________________
INTERVIEWEES: ________________________
______________________________________
______________________________________
DATE: __________________________

1. PROCESS NAME:

2. ORIGINATING SOURCE (WHO & HOW IS THE PROCESS INITIATED?):

3. RESPONSIBLE PROCESSING AGENCY:

4. INTERAGENCY COORDINATION:
   - WHAT INFORMATION IS PROVIDED TO WHICH AGENCIES?:
   - WHAT INPUT DOES EACH AGENCY PROVIDE?:

PAGE 1
5. WHAT KEY INFORMATION IS INVOLVED IN THE PROCESS?:

6. WHO MAINTAINS THE INFORMATION?:

7. WHAT REPORTS, MAPS OR DOCUMENTS ARE PRODUCED IN THE PROCESS?:

8. MAINTENANCE INTERVAL (DESCRIBE FOR EACH INFORMATION GROUP, REPORT, DOCUMENT OR MAP):

9. FILE/STORAGE DOCUMENT LOCATION(S):

10. LAWS OR ORDINANCES GOVERNING SCHEDULE, TIMING, OR OTHER RELEVANT ITEMS AFFECTING WORKFLOWS:

11. CURRENT WORKFLOW PROBLEMS/ISSUES:
12. RECOMMENDATIONS (SEE ABOVE):

13. PLEASE DIAGRAM WORKFLOWS ASSOCIATED WITH THE ABOVE KEY TASKS INCLUDING TIMING AND INVOLVEMENT OF OTHER AGENCIES/DECISION MAKERS. (FEEL FREE TO USE THE BACK SIDE OF THIS PAGE IF NECESSARY):
APPENDIX B

Example of WODGIK Technical Infrastructure Maps and Parcel Map

Both of these data sets are now available in digital formats—the infrastructure map in CAD format and the parcel coverage in a topological data structure. Efforts must be made to develop a common geo-reference base which will allow the full integration of these complementary data sets.
Wybrany fragment cyfrowej mapy podstawowej
w skali 1:500

TREŚĆ:
Sytuacyjno-wysokościowa • Uzbrojenie terenu

Wydział Geodezji i Gospodarki Gruntami
URZĄDU WOJEWÓDZKIEGO GÓ "Gdańsku"
APPENDIX C

Alternative approaches to implementing LIS

The approaches outlined in these articles have been implemented and tested with positive results in many locations worldwide. At sites experiencing various constraints, it is important to seek alternative solutions to the problems posed by LIS implementation. These approaches should be investigated for Gdansk and other sites in Poland.
Modern Methods in Land Use Planning

USAID Takes an Innovative Approach to GIS

Acute strains on urban land supplies in this age of rapid urbanization make effective land use planning essential in the cities of developing countries. Traditional approaches to Geographic Information Systems (GIS), however, involve lengthy time frames and large amounts of money. To meet the need for more practical, timely, and cost effective approaches to GIS, USAID applies a technique developed by Planning and Development Collaborative International (PADCO).

The procedure incorporates key issues and data into a land registration structure, subsequently transferring them into a fully automated information system (Lots by Dots™). A single point is used to define a property parcel, as opposed to the traditional polygon methodology. Lots by Dots™ facilitates the rapid development of a comprehensive land database containing environmental indicators, physical characteristics of the land, the geographic position of each land parcel, and all pertinent cadastral information.

Application in Honduras Saves Time and Money

Application of this point-based GIS system was implemented under an Inter-American Development Bank funded project in San Pedro Sula, Honduras, an area with a total of 130,000 property parcels (both urban and rural). In three and a half months, using local resources, 30,000 of these properties were entered into a pc-based GIS at a total inclusive cost (training, software, hardware, data collection, and output) of less than $120,000. The estimated time and cost for the traditional polygon-based approach for these same 30,000 parcels is three years and $1.2 million.

Presently, USAID supports the use of GIS technology throughout the developing world from Jamaica to the Philippines. (See News pp. 11 and 13).

Rapid Land Use Assessment

An additional methodology that USAID is utilizing is PADCO's Rapid Land Use Assessment (RLA™) which assesses and quantifies land use through a combination of satellite imagery, local field knowledge and resources, and simple GIS techniques. In only three weeks, using satellite data and local staff, the RLA™ methodology enabled the municipality of San Pedro Sula to determine and quantify by area 18 categories of land use for a 900 square kilometer area. The satellite data were processed in the U.S. and taken to Honduras to be used as a black and white image map for interpretation. Utilizing simple aerial photographic techniques, field surveys, and local knowledge of the Sula Valley, municipal staff constructed a land use database. Once the data had been interpreted, it was digitally transferred by trained, local municipal staff into a simple, pc-based GIS.

Presently, USAID is sponsoring similar studies in the municipalities of Cebu and Davao in the Philippines, which utilize Russian two-meter resolution satellite data to inventory land use patterns over large areas and integrate this information into a GIS.

Peter Rabley (PADCO) and Peter Gonzales contributed to this article.
A NEW APPROACH TO LAND INFORMATION SYSTEMS

PROBLEM

Traditional approaches to Land Information Systems (LIS) involve lengthy time frames and large amounts of money. Experiences in Thailand (20 years and over $20 million USD), Indonesia (5 years $12 million USD), and Australia (15 years more than $20 million USD), illustrate the need for a more practical, timely and cost effective approaches to support land privatization initiatives.

PADCO has developed a streamlined approach to LIS for both urban and rural land that rapidly incorporates the key issues and data into a land registration and titling structure and transfers them into an automated information system (Lots by Dots™).

KEY CONCEPT

Under PADCO's Lots by Dots™ or point-based approach, a land parcel is not stored as a polygon or area in the LIS and hence is not used as the base framework for the related database. Instead, a single point feature representing each property is used as the identifier and geographic locator. Figure 1 below illustrates this concept.

Figure 1 Point based LIS (Lots by Dots™)

This is a critical difference from the polygon-based approach which attempts to compile all land parcels together into a logical, contiguous base of properties according to a polygon framework. The polygon-based approach is practically impossible to achieve, even in the United States because individual surveys of land parcels or 'lots' are often, not entirely accurate and do not actually reconcile with one another. In developing regions, property boundaries for land parcels are almost always ill-defined with no accurate survey information for the polygon boundary. However, the individual properties can be rapidly located in the field and in a LIS as a point. Subsequently, the legally binding document, the title or deed for the land parcel, can be associated to the point. In this way, the related plot survey information describes the boundaries of the property - not the boundary polygon.
By focusing on a single point to define a property parcel, the question of a single property’s boundary and its adjustment to other surrounding parcels becomes irrelevant in the LIS. As indicated, area information is still maintained within the database by storing the actual surveyed lot area with each property point. Additionally, the shape and form of the property parcel can also be incorporated within the database by rapidly scanning the individual surveyor field diagram and then relating this information as a data record to the property point.

The benefits of PADCO’s point-based LIS versus a polygon-based system include:

- Reduced time for input (90% savings)
- Reduced processing overhead as the databases are smaller and faster to manage, analyze, update, and use (40-60% savings)
- All relevant and pertinent information is stored within the database just as it would be with a polygon-based system, only no resources are expended on resolving land geometry problems in database development.

The final component to the point-based approach is one of data collection. In many countries one of the greatest problems is the absence of timely, accurate data. PADCO has developed an approach that is particularly suited to rural environments which combines local resources and Global Positioning Systems (GPS). The GPS is a small hand-held receiver which receives geographic positions information every 2 seconds within an accuracy of +/- 20 meters. As many rural land parcels are significantly larger than this, property locations can be identified/recorded quickly and cost-effectively for a large number of parcels. As the field person collects the geographic (point) position of each land parcel, the property identifier number as well as the physical characteristics of the land such as: land cover, crop type, soil condition, number of structures can also be logged. This effectively allows an LIS database to be built in the field during the survey process. Additional complimentary data can be integrated subsequently into the LIS database.

EXAMPLE

PADCO is currently applying a point-based LIS system in San Pedro Sula, Honduras and will be utilizing a similar approach in the Philippines and Indonesia for rapid land inventory and LIS development.

In San Pedro Sula, Honduras there are a total of 130,000 property parcels (both urban and rural). In 3.5 months using local resources, 30,000 of these properties have been entered into a pc-based LIS at a total, inclusive cost (training, software, hardware, data collection, and output) of less than $120,000 USD. The estimated time and cost for the traditional polygon-based approach for these same 30,000 parcels is 3 years and $1.2 million USD.

Figure 2 below illustrates a small portion of the database collected to date. Data attributes contained in the relational database include cadastral and ownership (title) information. This figure illustrates a particular property point that has been selected graphically; the and related tabular data is displayed in the lower-left corner.
The point-based approach is fully supported by a pc-based workstation configuration consisting generally of: a 486 computer with 8 MB Ram, a 340 MB hard drive, SVGA color monitor, uninterrupt power supply, A1 digitizer, 8 pen plotter, local software, and one GPS field unit. The approximate cost for such a configuration is $25,000 USD. This configuration can be mobilized and implemented with local staff in the field within a few weeks, establishing a functioning LIS office or resource site.

Finally, the entire design of the point-based approach is flexible and allows for the eventual transfer of all collated data to a polygon-based system, should geometrically accurate and contiguous surveys be developed and automated. Thus, there is no data redundancy or duplication associated with the point-based approach eventually evolving into a polygon parcel orientated system.

In summary, a point-based Lots by Dots™ methodology represents a rapid, cost effective means to develop a functional and flexible LIS capable of supporting land management, title development and privatization activities.
RAPID LAND USE ASSESSMENT

The Rapid Land Use Assessment (RLA™), developed by PADCO, represents another cost-effective and timely methodology to assess and quantify land uses through a combination of satellite imagery, local field knowledge/expertise and resources, and simple GIS techniques. This methodology has been (or is being) utilized by PADCO in Indonesia, Pakistan, the Philippines, and Honduras. In the case of the Philippines, USAID is sponsoring a study that will utilize Russian 2 meter satellite data to inventory land use patterns over large areas and integrate this information in a GIS. This Russian data will be acquired and processed by PADCO's Russian joint venture partner - Kiberso.

In Honduras the RLA™ methodology allowed the municipality of San Pedro Sula to determine and quantify, by area 18 categories of land uses for a 900 square kilometer area in three weeks using SPOT 10-meter satellite data and local, cadastral staff. Image maps of the satellite data were processed in the US and taken to Honduras to be used as a black and white image maps for interpretation. Utilizing simple aerial photographic techniques, field surveys, and local knowledge of the Sula Valley, the land use database was constructed. Once the data had been interpreted it was then transferred digitally (through a process known as digitizing) by trained local municipal staff into a simple, pc based GIS. Figure 3 below shows a small portion of the entire land use database. This information supplements existing point (parcel) data concerning cadastral/ownership features of the land area and is used to assist numerous government planning functions.

Figure 3 Example of digital output from the RLA™ methodology in San Pedro Sula, Honduras.
APPENDIX D

Parcel History

A listing of the data elements which make up the parcel history. These elements will be subject to the data base design process. Attributes will be prioritized to determine which are most critical to the land disposition process.

Parcel History
- Register Number
- Previous Register Number
- Previous Register Name
- Owner(s) First Name
- Owner(s) Last Name
- Parents First Name
- Parents Last Name
- Res. Address Street Name
- Res. Address Street Type
- Res. Address Number
- Res. Address Appendices
- Res. Address City
- Ownership Type
- Number of Obreb Map
- Lot Number
- Deed Number
- Landuse Types
- Landuse Type Area
- Total Lot Area
- Total Area Register Unit
- Verbal Area Description
- Street Address

Synoptic Data Parcel
- OBREB_NUMBER
- MAP_NUMBER
- PARCEL_ID
- REGISTRY_UNIT
- STREET_NAME
- ADDRESS_NUMBER
- DIGITIZED_AREA
<table>
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<td>UTILITIES_PRESENT</td>
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<tr>
<td>HISTORICAL LANDMARK</td>
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</tr>
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<tr>
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</tr>
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</tr>
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<td></td>
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<tr>
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</tr>
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</tr>
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<td></td>
</tr>
<tr>
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</tr>
<tr>
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<tr>
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<tr>
<td>VALUE_PER_METER</td>
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<tr>
<td>BUILDING_PRICE</td>
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<tr>
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<td>---------------------</td>
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<td>REST_TEXT</td>
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FUNCTIONS
  AREA_OF_USE
  NUMBER_OF_ROOMS
  NUMBER_OF_USE

UNITS
  NUMBER_OF_APARTMENTS
  NUMBER_OF_FAMILIES
  NUMBER_OF_ROOMS
  TOTAL_AREA_FUNCTION
  NUMBER_OF_TENANTS
  CEILING_HEIGHT

UNIT DESCRIPTION
  UNIT_NUMBER
  UNIT_TYPE
  DECISION_NUMBER
  AREA_OF_UNIT
  USAGE_AREA
  NUMBER_OF_ROOMS
  TOTAL_NUM_OF_ROOMS
  NUMBER_OF_TENANTS
  WATER_CLOSET
  BATHROOM
  CENTRAL_HEAT
  HOT_WATER

OTHER INFO
  TECHNICAL_CONDITION
  FIRE_RESISTANCE_CLASS
  FIRE_DANGER_CLASS
  CONSERVATORY
  OTHER_TEXT
APPENDIX E

Physical Database Matrix and Database Dictionary

The matrix is in the process of completion for Gdansk and contains information which is essential to data normalization and the physical database design process. Also attached is an example of an entry from a Database Dictionary which is another important output from database design activities.
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<td>Key/Import</td>
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<td>Key/Import</td>
</tr>
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<td></td>
<td>Convert</td>
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This table contains various attributes related to a dataset.
**THEME:** Drainage  
**COVERAGE NAME:** DNNET  
**FEATURE CLASS:** line, polygon  
**DESCRIPTION:** Drainage network including perennial and non-perennial streams and rivers, lakes, and canals  
**DATA SOURCE:** DCW  
**SOURCE SCALE:** 1:1,000,000

### Polygon Attribute Table

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**DNPYTYPE code definition**

1. Perennial inland water. Includes perennial lakes and streams, estuaries, lagoons, unsurveyed perennial streams, reservoirs, and navigable canals.
2. Nonperennial inland water. Includes nonperennial and seasonally fluctuating lakes and streams and abandoned navigable canals.
3. Wet sand. Includes wet sand and sand deposits in and along riverbeds.
4. Snowfield, glacier, ice field or ice caps.
9. None. This code is used for any area that is not a Drainage feature. Polygons within this code include the background polygon, islands within inland water or ice areas, land areas enclosed by stream or river courses, or ocean areas.

### Arc Attribute Table

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** These lines were derived from the border between the shade for inland water (dark blue) and open ocean or ocean ice (light blue) on the ONC sheets.

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**ANNOTATION**

Geographic names of selected rivers, streams, lakes, reservoirs.

**NOTES**

- The political boundary was used to clip all layers except for hydrology (DNNET). In clipping hydrology, a 1 km buffer of the political boundary was used, in order to include rivers which lie along the national border, and those which inaccurately fall outside the border.
- Drainage has some rivers which were taken from tile or ONC sheet boundaries to maintain connectivity among features.
Base Map Data Sets

THEME: Airports
COVERAGE NAME: AEPOINT
FEATURE CLASS: point
DESCRIPTION: Airport locations with airport type, name, and elevation
DATA SOURCE: DCW
SOURCE SCALE: 1:1,000,000

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<td>*Decimal degrees longitude</td>
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<tr>
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<td>LAT</td>
<td>13</td>
<td>N</td>
<td>6</td>
<td>*Decimal degrees latitude</td>
</tr>
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</table>

AEPTYPE
code  definition
1      Active civil
2      Active civil and military
3      Active military
4      Other
5      Added from ONC when not available from DAFIF

ANNOTATION
None.
APPENDIX F

Database Design "Quick View" Manual

Summarizes key procedures and concepts for stages in the database design process. This should be referred to regularly as a useful guide to tasks which must be undertaken both accurately and completely.
COMPUTER SYSTEM:

DATA: Things known or assumed (Webster).

DATABASE: A mechanized, shared formally defined and centrally controlled collection of data used in an organization (Everest, 1986).


DATABASE SYSTEM: An integrated, user-machine system for providing information to support operations, management, analysis and decision making functions in an organization (Everest, 1986).
Basic Definitions - VOLUME AND DETAIL OF INFORMATION REQUIRED IN A SYSTEM IS DEPENDENT UPON FUNCTION AND LEVEL OF ORGANIZATION
Definitions - A TRADITIONAL ARC/INFO GIS ENVIRONMENT

WORKSPACE DEFINITION FOR USERS

SOFTWARE

DATA

INPUT UPDATE WORKSPACE

DISPLAY WORKSPACE

ANALYSIS WORKSPACE

MANAGEMENT WORKSPACE

MAP LIBRARY DATA DICTIONARY

DATA MANAGEMENT SOFTWARE

GIS ARC/INFO

TABULAR DATA

OTHER DATA TYPES (E.G., IMAGERY, SCANNED DOCUMENT)
MANAGING LARGE VS. SMALL GIS DATABASES

LARGE GIS DATABASES

EXAMPLES

- LARGE SUBJECT THEMES

SMART GIS DATABASES (OR CAD ENVIRONMENT)

- SINGLE THEME MAP COVERAGES
  SOILS MAPS, LANDUSE MAP

GRAPHICS

ATTRIBUTES

ATTRIBUTES

GRAPHICS
WHAT ARE THE GOALS OF DATABASE MANAGEMENT?

- Efficient, stable database
  Prevents frequent database redesign
  Prevents major rewrites of application software
  Allows compact, efficient, and nonredundant storage of data items

- Flexibility of user views

- Quick and efficient data entry and update

- Flexible data retrievals and report generation (GIS)

HOW DO YOU ACCOMPLISH THIS IS A GIS DATABASE USING A RELATIONAL DATABASE MANAGEMENT SYSTEM?

- Move data out of the feature attribute tables (FAT's).

- Establish a unique identifier as a link between the data and the FAT's.

- Break down the file structure using normalization rules and optimize it for the DMBS and the type of database usage.

- Establish a data element dictionary defining all data elements rigorously, both in content and type.

- Test the resulting design and then repeat the process.
Design Overview

Key Questions that Must Be Answered By The Design Process

A large number of questions need to be answered in an organized way.

**USERS:**

- Who are the users?
- How will they interact with the system?
- How often will they interact?
- What will they use the system for?
- How will the database be maintained?

**DATA:**

- What data will need to be utilized?
- What data must be stored?
- How will the data be stored?
- How will the data be maintained?
- Who will be allowed to see or use data (security)?

**OUTPUTS:**

- What kind of outputs will be generated?
- How often?
- What format?
Detailed Designs

OBJECTIVES:

1. DEVELOP COOPERATION & SUPPORT FOR THE DATABASE
2. UNDERSTAND USER OPERATIONS & ACTIONS
3. REVIEW ENTITIES & ATTRIBUTES AND IDENTIFY ADDITIONAL ATTRIBUTES / CODES / RELATIONS
4. RELATE USER ACTIONS & DATA
5. DESIGN STABLE DATA STRUCTURES & SOFTWARE
6. TEST ACTIONS & DATA STRUCTURES
7. DEVELOP PLAN FOR IMPLEMENTATION

 STEPS:

1. ORIENTATION
2. USER ASSESSMENTS / DATA INVENTORIES
3. CONCEPTUAL MODEL
4. PHYSICAL MODEL
5. PILOT STUDY
6. IMPLEMENTATION PLAN
Main Goals of Orientation

WHY:

BUILD SUPPORT AND COOPERATION
DEVELOP LINES OF COMMUNICATION

HOW:

SEMINAR
-GIS CONCEPTS
-SYSTEM OVERVIEW
-EXAMPLES
-DESCRIBE CAPABILITIES
-PROTOTYPES
-GENERAL IMPLEMENTATION PLAN

WHO:

MANAGEMENT
USERS

DOCUMENTATION:

ORGANIZATIONAL STRUCTURE (FLOW CHART)
OVERALL GOALS
A GENERAL SYSTEM DESCRIPTION
A GENERAL LIST OF EXISTING SYSTEMS
A GENERAL LIST OF USERS (PARTICIPANTS)
STEPS REQUIRED FOR THE DESIGN (LIST)
TIME LINE
Main Goals of User Assessment

WHY:

UNDERSTAND USERS OPERATIONS
IDENTIFY DATA SOURCES

HOW:

INTERVIEWS/SURVEYS/USER GROUPS
- REVIEW AVAILABLE MANUALS
- REVIEW ANY EXAMPLES
- INTERVIEW USERS
- IDENTIFY USER OPERATIONS
- IDENTIFY DATA-OPERATION RELATIONSHIPS

WHO:

USERS
INTERVIEW TEAM
MANAGEMENT

DOCUMENTATION:

NAMES (INTERVIEWER, INTERVIEWEE, ORGANIZATION, ETC.)
ORGANIZATION GOALS AND OBJECTIVES
DATE OF INTERVIEW
PROCESSES USED TO ACCOMPLISH OBJECTIVES
OUTCOME OF PROCESSES
FREQUENCY
DATA USED (EXAMPLES)
DATA ELEMENTS (ENTITIES)
SENSITIVITY AND ACCURACY OF DATA
HOW AND HOW OFTEN IS DATA USED
WHAT KIND OF DATA IS IT
HOW IS DATA MAINTAINED
WHAT PRODUCTS ARE REQUIRED
FREQUENCY OF GENERATION
FUTURE NEEDS
Main Goals of Conceptual Design

WHY:

DEVELOP LOGICAL MODEL OR VIEW OF DATABASE
DEVELOP LOGICAL PLAN FOR DEVELOPMENT

HOW:

FUNCTIONAL ANALYSIS

TASKS - PERFORMED TO MEET PRIORITY GOALS
PROCESS - PERFORMED TO MEET PRIORITY OBJECTIVES WHICH
ACCOMPLISH GOALS
OPERATIONS - PERFORMED TO ACCOMPLISH PROCESSES
ACTIONS - PERFORMED TO COMPLETE OPERATIONS

ENTITY/ATTRIBUTE ANALYSIS:

ENTITY - DATA ELEMENT THAT HAS BEEN DETERMINED AS REQUIRED
ATTRIBUTE - A QUALITY THAT DESCRIBES AN ENTITY
RELATION - A TIE OR AFFINITY BETWEEN ENTITIES. A RELATION CAN
ALSO BE VIEWED AS A FILE OR TABLE.

WHO:

TECHNICAL STAFF
USER GROUP
Main Goals of Physical Design

WHY:

EFFICIENCY, INTEGRITY, SECURITY, CHANGE

HOW:

CONVERT FUNCTIONAL ANALYSIS INTO SYSTEM ACTIONS
- GROUP ACTIONS INTO ROUTINES
- IDENTIFY WHICH COMMANDS ARE REQUIRED
- IDENTIFY MODE OF OPERATION

CONVERT CONCEPTUAL DATA MODEL INTO A PHYSICAL ONE
- IDENTIFY WHICH ENTITIES SHOULD BE IN THE SAME LAYER
- IDENTIFY ALL ATTRIBUTES FOR EACH ENTITY
- BUILD TABLES (FILES) FOR ATTRIBUTES (NORMALIZATION)
- CONSIDER ARC/INFO CONSTRAINTS
- TEST AGAINST ACTIONS

WHO:

TECHNICAL STAFF
PROGRAMMERS / ANALYSTS / DATA ADMINISTRATORS

NOTE: THERE IS A CONTINUUM BETWEEN PHYSICAL & CONCEPTUAL DESIGNS
Main Goals of Pilot Study

WHY:

TEST DATA STRUCTURES
TEST IDENTIFIED ACTIONS
VIEW DATABASE DESIGN AS AN ART

HOW:

IDENTIFY TWO STUDY AREAS
CONCEPTUALLY IDENTIFY ALTERNATIVES FOR PERFORMING ACTIONS
SELECT A SINGLE ALTERNATIVE FOR DATA ENTRY
SELECT A REASONABLE NUMBER OF ACTIONS TO TEST
ADDRESS, DISPLAY, ANALYSIS AND MAINTENANCE ISSUES
TEST THE SIZE OF THE DATA STRUCTURES
REVIEW ACTIONS
REVIEW OTHER ALTERNATIVES

WHO:

USERS & TECHNICAL STAFF

DOCUMENTATION:

ACTIONS - CONCEPTUAL ALTERNATIVES
TESTED ALTERNATIVES
(ACTION/TIME/USER EASE/COMPUTER)
PRODUCTS - MAPS & REPORTS
RESULTS & RECOMMENDATIONS
DATA - STORAGE/SIZE/MACHINE/ACCESS

REMEMBER:

GENERATE EXCITEMENT & SUPPORT
REMAIN REALISTIC - SIZE
- PRODUCTS
OBTAIN USABLE RESULTS & USE THEM
DOCUMENT THE RESULTS - DATA STRUCTURES
- ACTIONS
- LIMITATIONS
- UNIQUE PROBLEMS
FORCE RECOMMENDATIONS & REVIEW
REMEMBER, THE PILOT STUDY IS ANOTHER TOOL!!!!
Main Goals of Implementation Plan

WHY:
- ESTABLISH CONTINUITY FOR SYSTEM
- CREATE AN "OVERALL OR BIG PLAN"
- INVOLVE MANAGERS (DECISION MAKERS)
- IMPLIES APPROVAL

HOW:
- DEVELOP USER GROUPS
- PRIORITIZE GROUPS & SYSTEMS
- IDENTIFY DEVELOPMENT TEAM
- DOCUMENT PLAN
- DEVELOP A DETAILED TIME LINE AND BUDGET

WHO:
- MANAGEMENT
- USERS
- DEVELOPMENT TEAM

DOCUMENTATION:
- LIST OF DESIGN GOALS & OBJECTIVES (PRIORITIES)
- LIST OF DELIVERABLES
- LIST OF PERSONNEL
- FLOW CHARTS & DIAGRAMS
- TIME LINES
Detailed Implementation Plan

WHY:

DEVELOP PLAN TO STAY FOCUSED ON ORIGINAL GOALS & OBJECTIVES

HOW:

REVIEW PILOT STUDY
IDENTIFY EXPENSES & COMMITMENTS
IDENTIFY DELIVERABLES & TIMES
DEVELOP TIME LINE
REVIEW & APPROVE

WHO:

USERS & TECHNICAL STAFF
MANAGEMENT

DOCUMENTATION:

SOFTWARE/HARDWARE
- COMMITMENTS
- TIMES (TIME LINES)
DETAILED BUDGETS & STAFF RESOURCES
DATA
  DATA STRUCTURES
COMMITMENTS FOR ENTRY & MAINTENANCE
AVAILABILITY FOR ANALYSIS & DISPLAY
DATA ADMINISTRATOR
Basic Documentation Requirements & Checklist

HARDWARE:
REFERENCE MANUALS
USER MANUALS
LEGAL PAPERS

DATABASE:

MAP BIBLIOGRAPHY
SCALES
SOURCES
CONTACT PEOPLE

DATA LOCATIONS (MAP LIBRARY)
STATUS
LOCATIONS

DATA DICTIONARIES
ENTITY/ATTRIBUTE DEFINITIONS
LAYER DEFINITIONS
FILE DEFINITIONS
ITEM DEFINITIONS
CODES
RELATIONSHIPS
Documentation

SOFTWARE

VENDOR
REFERENCE MANUALS
USER GUIDES
LEGAL PAPERS

IN-HOUSE SOFTWARE (DEVELOPED OR CUSTOMIZED)
PROGRAMMER/APPLICATIONS GUIDE
USER MANUAL
DESIGN DOCUMENTS
DEVELOPMENT

SYSTEM

DESIGN DOCUMENT:
JUSTIFICATION & EXPLANATIONS
WHO
DATES
FLOWS
ETC.

DEVELOPMENT & IMPLEMENTATION PLANS

USER OVERVIEWS AND SUMMARIES