Facilities Management IT Tools:
Building Model, Basic Information and Graphics

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ABSTRACT:

The need for small easy to use Facilities Management IT tools for the existing building stock has led to the development of lokalEjdInFo a windows based management/information system with graphical navigation. The first version is in use in public institutions and the second version is under consideration among a broad group of FM experts in DK.

lokalEjdInFo has been implemented as a database system with graphics/CAD added on.

The paper will discuss the building model used in the system, the sufficient model for FM in comparison with the necessary CAD model for building and the possibilities for extracting the FM building model from the *CAD* model.

Basic information on the property is extracted from public databases and is used for automated generation of part of the objects in the building model.

Graphic information is extracted from *CAD* models of the building or created from scanned drawings by the means of simple CAD tools added to the database tool as extensions. Graphics are used for graphic navigation in the model, for extracting quantities and for presentation of information. The paper discuss strategies for FM and *CAD*.

1. THE BUILDING MODEL FOR FACILITIES MANAGEMENT

Designing a building data model suited for Facilities Management -FM- means that many different issues has to be considered. In the first place the FM model should be suited to receive data from the building project model if it is a new building. Existing buildings can at least in Denmark benefit from receiving data from public real estate databases, and in the future there will be a transfer of key figures on expenses between public databases and local administrations. The building description for FM has to be very flexible in the sense of level of detailing. And last: the user interface and the FM model has to be co-ordinated, so that it is possible to implement a system with a modern window based graphic interface, where object can be picked in lists or on drawings.

The following elaborate these themes.

1.1 Building Project Modelling and Facilities Management Modelling

The structure and format of the database suited for planning and production of the building **is** so that the **CAD** floor plan is showing the placement and dimensions **of** the building objects, whereas the description of the objects specifies the materials.

The floor plan with its building objects are the most important carrier of information in the project database. The objects on the floor plan are related to the specifications and if necessary for the detailed geometrical description or the exact placement to section drawings, elevations and/or 3D models. In the project database the main focus is on building objects: building parts, installations or inventory.

In the database for facilities management the focus is shifted a little, so that it is the surfaces of the terrain and surfaces of the exterior and interior building objects, that is of main interest, besides the components of the installations.

When moving from designing and constructing to managing the building focus change from focus on building components to focus on the outdoor and indoor spaces of the estate.

The FM activities: managing area tenancy or monitoring supply is based on areas of room floors, storey areas and areas on the terrain. Effective maintenance of building components are about regular inspection and preventive maintenance of the surfaces of building components inside, outside and on the terrain. The same holds for cleaning.

The **CIS-CAD structure** (CIS -Co-ordinated Integrated System- by the Ministry of Housing) is a proposal for an exchange format for transfer of data from the building project database to the FM database and to public real estate databases.

The format specifies sub formats for graphical and alpha-numeric describing so called themes, that is: the site, the building, stories and rooms in the building and all the building components.

The information is structured so that the building components are related to the site or storey where they are placed.
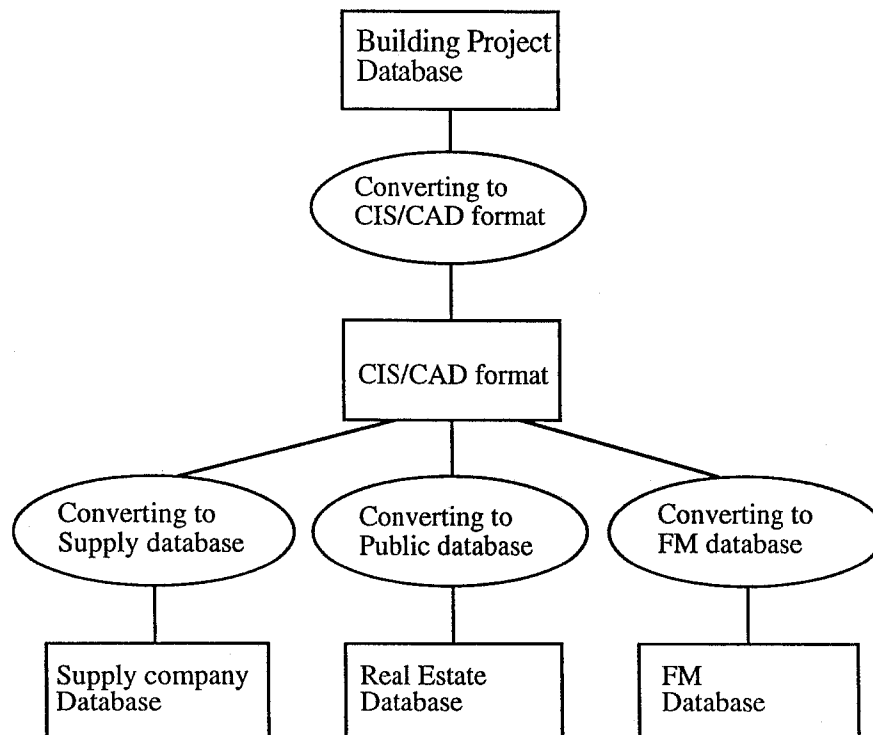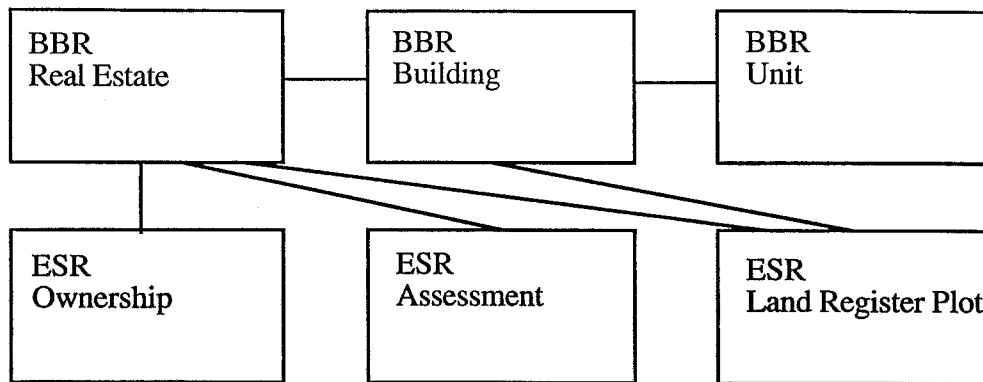

Figure 1 **CIS-CAD Structure**

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┌─────────────────┐   ┌─────────────────┐   ┌─────────────────┐
│ BBR             │   │ BBR             │   │ BBR             │
│ Real Estate     ├───┤ Building        ├───┤ Unit            │
│                 │   │                 │   │                 │
└─────────────────┘   └─────────────────┘   └─────────────────┘
┌─────────────────┐   ┌─────────────────┐   ┌─────────────────┐
│ ESR             │   │ ESR             │   │ ESR             │
│ Ownership       │   │ Assessment      │   │ Land Register Plot│
│                 │   │                 │   │                 │
└─────────────────┘   └─────────────────┘   └─────────────────┘
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Figure 2. **Public Real Estate Databases**

1.2 Public Real Estate Database

The public registration of real estate data in Denmark is organised in two databases, BBR -Bygge- og Bolig Registeret- and ESR -Ejendoms Stam Registeret-.

BBR contains information on: Real Estate, (identification, supply, summary of areas), Buildings (identification, code for use, construction/materials/installations, stories, areas) and in some cases (apartments) Units (identification, use, areas, installations).

ESR contains information on Ownership, Assessment and Land Register Plot(s).

BBR is structured so that Units belongs to Buildings and Buildings belong to Real Estates.

ESR Ownership and Assessment is related to BBR Real Estate and ESR Land Register Plots are related both to BBR Real Estate and to Building.

Information in ESR and BBR is made available to property owners/managers through the CIS format. (An extract from the database delivered on diskette.

If the FM database is structured in accordance with the BBR structure, there is a possibility to use the BBR data for automatic creation of the FM objects: real estates, buildings and sections (stories). This is of value when the case is that a new FM database has to be established for an existing building stock.

In all cases the information in BBR and ESR is important for FM, and the other way round the correctness and updating of the public property registers are depending on their use.

1.3 Building Description. Level of Detailing

It is very important, that the facilities manager can choose a level of detailing in the FM building modelling, that is suited to the need and resources of the administration at a given time. And the level of detailing should be allowed to vary in accordance to the different building types.

The FM system should be able to operate with a low level of detailing in the beginning and gradually build up to a full and detailed building description, with all the localities and parts of the building and the site registered.

As an example it should be possible to manage all the roofs or all the windows of the buildings of the property as one single object, and at a later stage when it is needed as a single object for each window or roof.

1.4 Key Figures

The FM database must be suited for producing key figures, maintenance expenses per square meter etc.. Average key figures for different building types can be very useful in setting a goal for and measuring the effectiveness of FM.

A well accepted norm in Denmark -DK- is to split maintenance and cleaning expenses on three localities: out on the site, outside the Building, and inside the building.

There is this year in DK an ongoing project collecting a row of key figures for different properties, with the goal to produce average key figures. There will be special key figures for each type of real estate in accordance to usage and building construction. The goal is to be able to produce key figures for each building type, but it seams that the FM systems in use are not able to produce key figures on building level. One other outcome from this key figure project is a proper set of definitions of areas.

1.5 User Interface

A modern FM system must have graphic-window-mouse based user interface. That means, that access to objects in the database should be through picking in drawings or lists rather than through typing object names.

A hierarchical ordering of the objects will facilitate the access through list, in that the number of object in each list can be kept reasonable small.

Drawings in the FM database shows, the placing and the dimension of building objects. But the drawings has also the function that they are a "window" into the database. Picking a component on the drawing gives access to the component information. And the drawing can be used to give an overview of components with particular characteristics.

1.6 Graphics

There is at least three different strategies to follow when it comes to graphics in FM systems.

One is to implement the FM system in the CAD system, using the programming tools that follows with many CAD systems.

Another strategy is to implement the FM system with database tools and holding the graphics in the CAD system. The objects in the database has then to be related to their graphic description in the CAD system.

The third strategy is to transfer the graphics from the CAD system and hold them in the FM database. In this case the database tools has to be extended to be able to show active graphic objects that can be picked.

The strategy to follow is dependent on the situation. If the buildings change constantly to fit to the need of new users it may be best to hold the graphics in the CAD system.

In all three cases the graphic data, can and should be simplified in comparison with the level of detail that is need in the project database.

In the third case the graphic data can be simplified drastically. All objects can, if they are shown on top of a detailed non active background drawing, be simplified to a line, a polygon or a symbol, together with a label. This will satisfy the need to be able to se the object and to pick it. The details of the object, and its relation to other object is shown in the background drawing, which is the normal floor or site plan, with a level of detailing as say scale 1:100. This strategy has been adopted in lokal**EjdInFo**.

2. lokalEjdInFo A LOW COST GRAPHICAL FM IT SYSTEM

lokalEjdInFo has been initiated by the Ministry and Housing in DK and has been implemented by the Datacentre at Aarhus School of Architecture.

The main goal has been to make FM in public institutions more effective by:

• Use of existing data (public real estate databases).

• Uniformed management methods.

• Shared experiences (key figures).

The design of the system is, where it has been possible based on well established FM principles and methods. That is in the design of the database, in methods for systematic maintenance, and method for monitoring supply of energy and water.

But the system has also added new possibilities to FM:

• Hierarchical list based object navigation.

• Creation of building objects from public database data.

• Graphical object navigation and area measurement.

The following is a brief description of lokalEjdInFo: an overview, its User interface with facilities for navigation, the structure of the database and the creation of the building description database, and as an example a description of the FM tool for maintenance.

2.1 Overview

lokalEjdInFo is implemented with OMNIS 7 a database tool, that has made it possible to develop an FM system with a modern user friendly and self instructing user interface. The system run on Macintosh with full graphics and under Windows only with non active graphics.

Navigation in the hierarchical object structure is done by selecting objects in lists or by picking objects graphically at site plans or floor plans.

In lokalEjdInFo version 1.1 there has been implemented FM tools for creating and updating the FM database, tools for systematic maintenance, and for monitoring energy and water supply. Besides that lokalEjdInFo comprise an effective information system.

The structure of the database has been designed so that it is well suited for implementing all kind of FM tools, planning and managing cleaning, managing area tenancy etc. The structure fit to the structure of BBR, so that parts of the database can be created automatically. Graphics in the form of back ground drawings with active polygons superimposed are stored directly in the database.

The tools for building maintenance support the yearly inspection of the building parts, and the following work on the yearly maintenance plan.

In monitoring the supply of electricity, heath and water can be registered and compared with estimates for consumption. The heath consumption can be calibrated to a "standard year", for climate independent comparison.

As an information system, lokalEjdInFo can deal with public real estate data, and with text and picture documents. The system can read and store the CIS extract from BBR and ESR, and give access to these data, and all data objects in it can have text and picture documents attached.
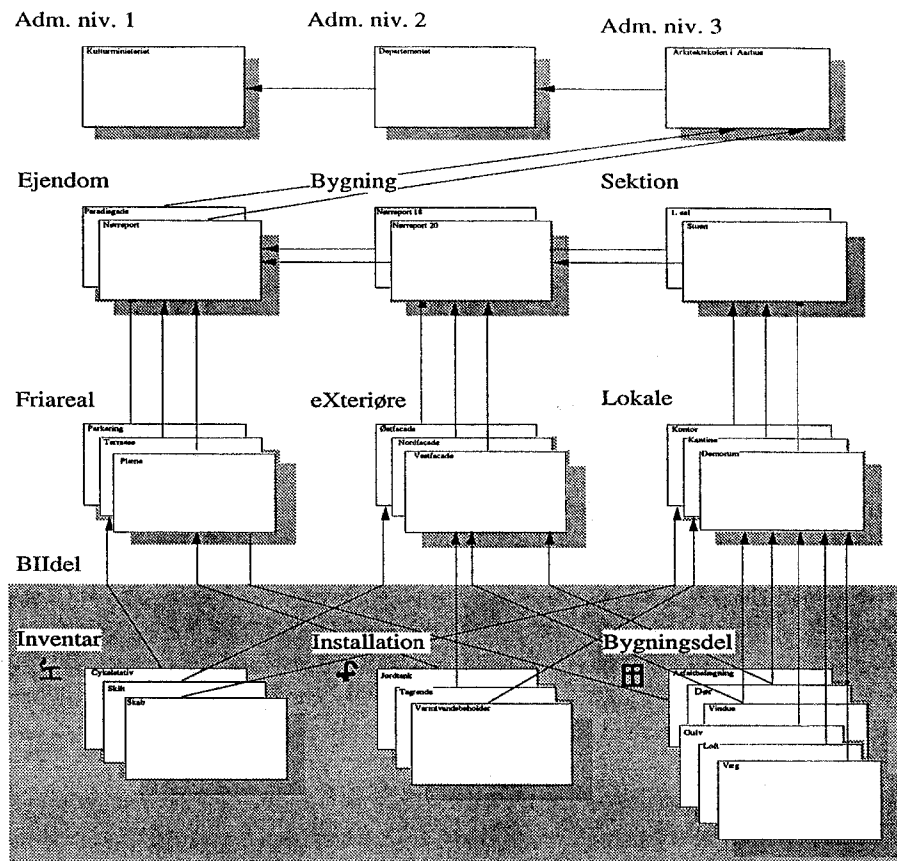
Figure 3. lokalEjdlnFo Hierarchical Object Structure

2.2 Basic Building Description. Data Structure

The data kernel in lokalEjdInFo comprise the relatively static description of the property, that is designed to be the basic information for all the different tasks of FM.

In FM the focus is on the surfaces of the spaces, as said before. And spaces naturally divides in three object types namely: Free areas (with no building) on the site, Exteriors, roofs, facades etc. and Rooms, interior locales.

Building elements, Inventory and Installation parts, all treated equally in the structure as a so-called BII object, is connected to one ore possibly two (in the case of windows and doors) of the space objects.

It is also natural to group Rooms in the object type Section (a storey or part of a storey) and to connect Sections and eXteriors to the object type Building. Buildings and Free Areas are then connected to objects of the type Real Estate to finish the building description.

On top of that there is three levels, serving only as a possibility to divide the database administratively, as reports only sums up to the level connected to the Real Estates.

Through special space objects pointing directly to the Real Estate ore say Building above and created automatically it is possible to connect BII objects at a low detailing level without forcing the structure. It could be all the windows of a property managed as one object.
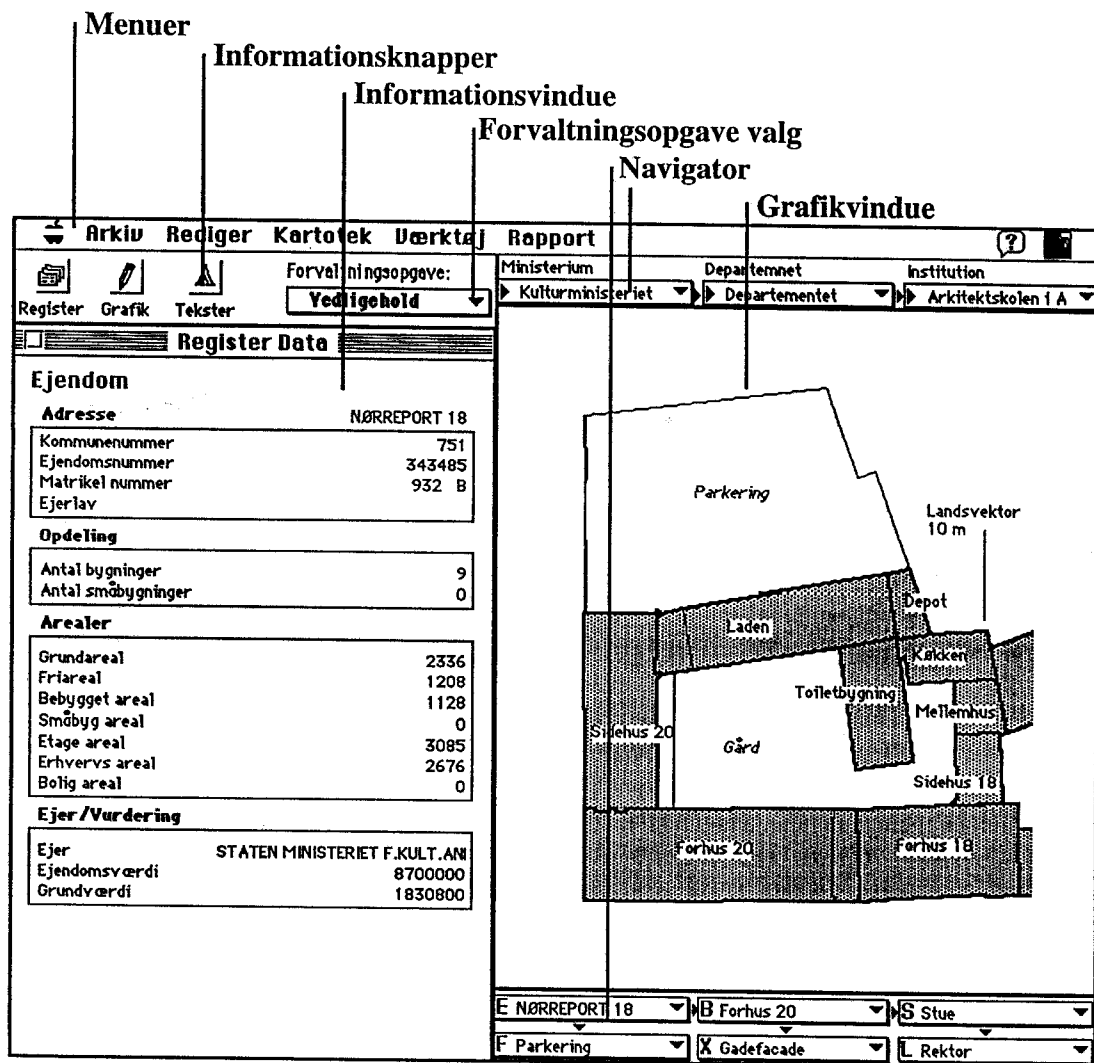
Menuer
Informationsknapper
Informationsvindue
Forvaltningsopgave valg
Navigator
Grafikvindue

Arkiv Rediger Kartotek Værktøj Rapport (?)

Register Grafik Tekster   Forvaltningsopgave: Ministerium   Departemnet   Institution
                             Vedligehold   ▶ Kulturministeriet ▼ ▶ Departementet ▼ ▶ Arkitektskolen 1 A ▼

Register Data

Ejendom

Adresse   NØRREPORT 18

Kommunenummer   751
Ejendomsnummer   343485
Matrikel nummer   932 B
Ejerlav

Opdeling

Antal bygninger   9
Antal småbygninger   0

Arealer

Grundareal   2336
Friareal   1208
Bebygget areal   1128
Småbyg areal   0
Etage areal   3085
Erhvervs areal   2676
Bolig areal   0

Ejer/Vurdering

Ejer   STATEN MINISTERIET F.KULT.AN
Ejendomsværdi   8700000
Grundværdi   1830800

Parkering
Landsvektor
10 m
Depot
Laden
Køkken
Toiletbygning
Mellemhus
Sidehus 20
Gård
Sidehus 18
Forhus 20
Forhus 18

E NØRREPORT 18 ▼ ▶ B Forhus 20 ▼ ▶ S Stue ▼
F Parkering ▼ X Gadefacade ▼ L Rektor ▼

Figure 4. lokalEjdInFo Main Screen

2.3 User interface. Graphical and List based Navigation

lokalEjdInFo is implemented in a modern window environment, with a graphical user interface that is user friendly and self instructing.

Selecting a FM tool: Database updating, Maintenance or Supply, course the menus and the information window, showing data on the active object to adjust.

The active object is made active in the Navigator or for some object types on graphics.

The Navigator is a set of hierarchical buttons, one for each object type. Behind the button is an object list. Selecting/making active say a Real Estate in the button marked "E", course the content of the underlying buttons ("F", "B", "X", "S" and "L") change to objects belonging the active Real Estate object. The information window shows data of that object and the site plan is shown in the graphics window.

Active graphics are only for the Real Estate objects where the objects Free Areas and Buildings can be picked on the site plan and for Section objects, where Rooms can be picked on the floor plan.

Figure 5 screenshot:

```
┌─ Opretlelse med BBR    Institution: Arkitektskolen I Aarhus ─────┐
│ Ejendom                        antal bygn. antal småbygn.   BBRejendomme
│ +AARHUS      KALØGADE 5              1    0              ⬆
│ +AARHUS      HEJLGADE 39             2    0
│ +AARHUS      NØRREBROGADE 28         2    0                [ Slet ]
│ +AARHUS      NØRREPORT 16            2    0
│ +AARHUS      NØRREPORT 18            9    0                [ Opret ]
│ +AARHUS      NØRREPORT 22            1    0
│ +AARHUS      PARADISGADE 4           3    0                ["Under"]
│ +AARHUS      STUDSGADE 33            4    0
│                                                           ⬇
│ Bygning         etager bolig erhverv bebyg. taget. kælder anvend   BBRbygninger
│ *Nørreport 18 BYG1   3   0   693  186  135  294 Undervisning  ⬆
│ *Nørreport 18 BYG2   3   0   148   42   22    0 Undervisning
│ *Nørreport 18 BYG3   1   0    30   30    0    0 Undervisning  [ Slet ]
│ *Nørreport 18 BYG4   1   0    56   56    0    0 Undervisning
│ *Nørreport 20 BYG5   2   0   674  324  226  176 Undervisning  [ Opret ]
│ *Nørreport 20 BYG6   2   0   526  184  158  238 Undervisning
│ *Nørreport 20 BYG7   1   0   164  189    0    0 Undervisning  ["Under"]
│ *Nørreport 20 BYG8   1   0   161   93   68    0 Undervisning
│ *Nørreport 20 BYG9   1   0    24   24    0    0 Undervisning  ⬇
│ Sektion              anvend                      Etager og BBRenheder
│ Nørreport 18 Kælder    Uoplyst                             ⬆
│ Nørreport 18 Stue      Uoplyst
│ Nørreport 18 1.sal     Uoplyst                             [ Slet ]
│ Nørreport 18 2.sal     Uoplyst
│ Nørreport 18 Tagetage  Uoplyst                             [ Opret ]
│
│                                                            ⬇
└──────────────────────────────────────────────────────────┘
```

Figure 5. **Automatic object creation from CIS / BBR data**

2.4 Basic Building Description. Creation of Objects

All objects can be created manually from the object above in the hierarchical structure.

Objects of the type Real Estate, Building and Section can be created automatically from CIS BBR data. This process starts with reading in the CIS data and store them in the database. Next step is to look at the Real Estate one by one and decide which Buildings and Sections (Storeys) in that building should be created. Often all Buildings and all Sections are created. Sections are derived from information on storeys in the BBR Building data.

Objects of the type Free Area and Room are created manually, or in the process of making active graphics.

Exteriors are created totally manually in this version of lokal**EjdInFo**.

BII objects are created manually and are classified with CIB/Sfb and product type. There is information to support cyclic inspection and quantities stored with the BII object.

In future versions of lokal**EjdInFo** it will be possible for new building to create all object from the building project database via the CIS-CAD exchange format.

```
┌──────────────────────────────────────────────┐
│ BIIdel.        Bygningsdel. Installation. Inventar │
├──────────────────────────────────────────────┤
│ Betegnelse             Skydedørl Kantine      │
│                                                │
│ Sfb ................  Innervægge Komplettering │
│                                                │
│ Prototype ...........................  Skydedør │
│ Type/fabrikat ............  Håndværksfremstillet │
├──────────────────────────────────────────────┤
│ Anskaf. år  1857 Besigt.år  1993 -interval  1  │
├──────────────────────────────────────────────┤
│ Mængde   4.00 Enhed  m2 Suppl. antal       1   │
├──────────────────────────────────────────────┤
│ Relation 1 ...         Kantine   ┌──────┐      │
│ Evt relation 2     Kantineudsalg │ vælg │      │
│                                  └──────┘      │
│              ( Annuller ) [  OK  ]             │
└──────────────────────────────────────────────┘
```

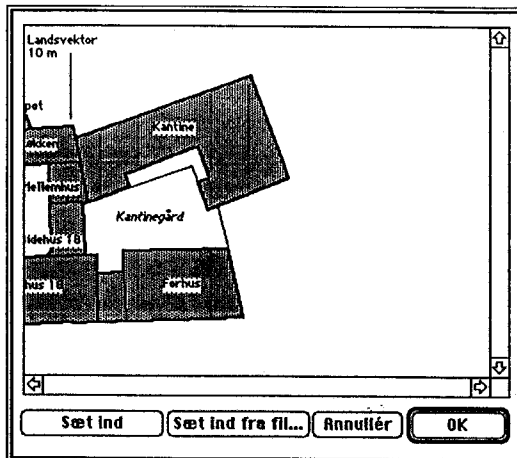Figure 6. **BII object information**

Figure 7. **Setting in the background drawing**

2.5 Basic Building Description. Active Graphics

In this first version of lokalEjdInFo there are only active graphics for objects of the types Real Estate and Section.

Graphics are based on background drawings, a CAD drawn or scanned site plan or floor plan in Mac PICT format, with polygons drawn upon with a simple drawing tool implemented with the use of Apple Quick Draw as an extension to OMNIS 7.

Polygon co-ordinates are stored in the database and the area and the perimeter are calculated. Free Areas and Rooms can be created in the process of tracing the polygon.

The scale of the site plans are found by tracing a vector with known UTM co-ordinates on the background drawing. The scale of the floor plans are derived from a reference vector traced on the building in both plans. The inaccuracy is easily kept below ±5%.

It will be possible in the next version of lokalEjdInFo to read background drawings and polygons in the AutoCAD DXF format. In ver. 1.1 the editing facilities are poor.
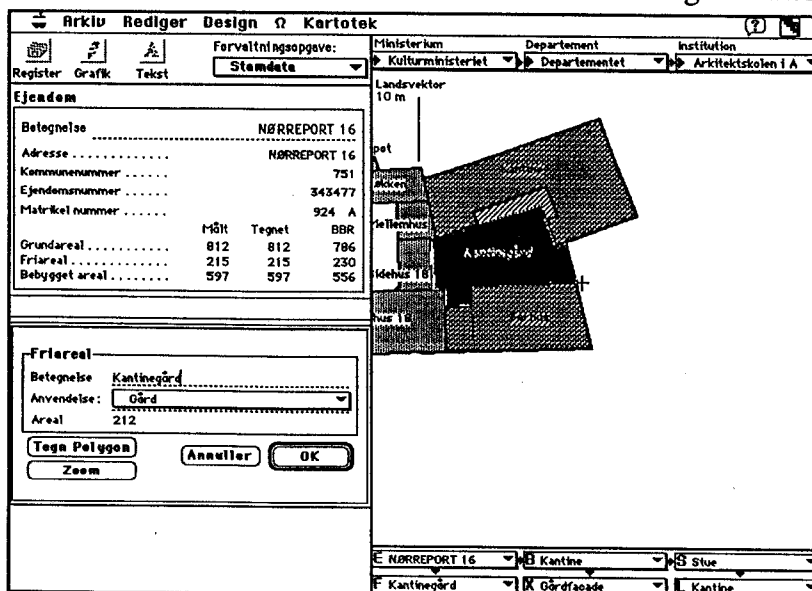
Figure 8. **Creating a Free Area and polygon**

2.6 Maintenance. FM Tool Example

The method of systematic maintenance adopted in lokalEjdlnFo is cyclic in an one year cycle. The activities in this process are:

• Inspection a systematic control of the condition of BII objects: building parts, inventory and installations, to se if there is a need for maintenance activities or to check if already planed activities has to be adjusted.

• Planning next years maintenance activities, in the scope of a 4-10 years budget.

• Conducting the maintenance enterprises. (no tools for that in version 1.1)

Inspection is supported by lists of BII objects and planed maintenance activities that has to be checked. BII objects are put on the list in accordance with their last data of inspection and inspection interval.

In the following planning process new maintenance activities are created and existing activities eventually adjusted.

Maintenance activity data is: Description of enterprise, date for last and next execution and interval between execution if the activity is cyclic, statistical information (priority, kind (preservation, repair, renewal), course), quantity, price etc.

The activity planning process is facilitated by a budget tool that gives immediate 4 year budget control.

The maintenance plan is reported with expenses split on site, exterior an interior. There is a 4 year and a 10 year report, as well as key figure report and priority report.

As mentioned there are no tools for conducting the execution in version 1.1.

Figure 9 **Maintenance activity**

3. FUTURE

lokal**EjdInFo** version 1.1 is small and in no way a full FM IT system. But it shows ways to build a low cost system with a modern window based user interface and with a graphical building model.

Low cost graphic has been possible by simplifying the graphical information, in comparison with that of a CAD project database. The simplification has been obtained by using simple active pickable polygons on top of non active detailed background drawings, and means that graphics can be stored directly in the FM database. This seems to be a good strategy at least for buildings that are not changed too often. Future systems should be able to read and update background drawings and the simplified object graphic from CAD.

The data structure that has been adopted reflects in many ways the typical way of describing buildings on drawings, the site plan and the floor plans. And the list based and graphical navigation is designed in accordance with that structure. But from a FM point of view it is really the spatial objects that is of main interest. The grouping in sections or buildings often do not correspond with administrative groupings as: the occupation of a department or a rented area. So there has to be ways to make alternative groupings of spaces and ways to navigate in this groupings. The same holds for building elements, inventory and installations. It should be possible to work with a selected group of BII objects and maintenance activities. So in the future the hierarchy has to be "looser" and there should be more ways to look into and use the object information.

Simple graphics integrated in the database seams to be a good solution today. But the day where where there exisst an effective Building Modelling System with fully Integrated Database Capability this will be the best environment for Facilities Management.
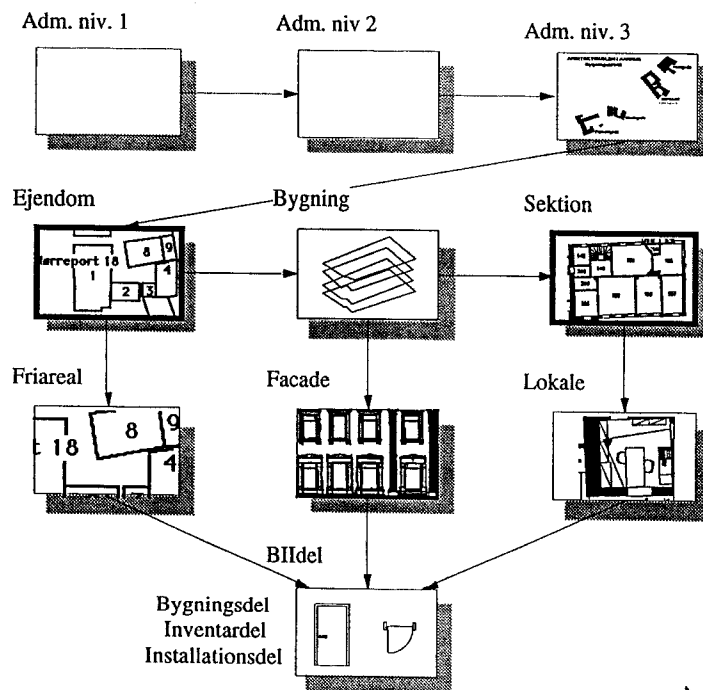

Figure 10. **Planned graphics**

APPENDIX 1.

Glossary

Text on illustrations has not always been translated to English. So this brief glossary serves to make it more readable. Note: in Danish it is OK to form "new" words by putting existing words together.

Boligministeriet	Ministry of Housing
Bygning	Building
Del	Part / Element / Component / Object
Ejendom	Real Estate / Property
Forvaltning	Management
Friareal	Free Area (with no building) on the site
Grafikvindue	Window showing graphics
Knapper	Buttons
Lokale	Locale / Room
Nøgletal	Key Figure
Opgave	Task
Sektion	Section: Storey or part of storey
Vedligehold	Maintenance
Vindue	Window

APPENDIX 2

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