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Computer Aided Facility Management (CAFM) interface between photogrammetry, civil engineering and architecture

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ABSTRACT

This article wants to show the connection that exists between photogrammetry, civil engineering and architecture and GIS. The point where these domains meet is the building. Information on the building are collected by all. But the information is in different data bases and in different formats. How can these different information sources be linked? Which method for data collection can be used? The similarity between GIS and CAFM will be pointed out and future applications based on CAFM information will be described. What is the potential for other applications than "only managing" building? Research in GIS have lead to the method of object-relational (object-oriented) modeling in GIS. Is this modelling method also suitable for CAFM? Why not use a GIS instead of a new product to manage the building information? Many Questions arise with this new topic. Not all questions can be answered in one right way. There are always different solutions for special applications. But general questions like the right architecture and a generalistic data model can be answered. Why is facility management so important? In industry and big organisations facility management has become a managing tool of growing importance. In times of decreasing profit rates and harder competition, every company is forced to develop better strategies for resource and facility management.

1. INTRODUCTION

CAFM offers the chance to combine all information on buildings and facilities. This information of a building is collected by different specialists and different data collection methods. Photogrammetry takes images that show the building from outside. In "classic" photogrammetry, a sensor (airborne or spaceborn) takes the images and with these images digital terrain models, or virtual reality representations of the outside of a building can be calculated. When this is done for a whole city, we talk about virtual city models. The civil engineer is interested in the construction of a building. The structural analysis of a building like the static component is very important for the use during the whole lifetime of the building. This information can not be collected by photogrammetry. Other information e.g. architecture plans, workflows, or which climate control system is in the building is also information which is needed in order to run an efficient facility management. Another view on a building is that of an architect. In general he sees the shape of the building and the front design.

All these different views on the same object and same information raise the demand for accurate building information. This demand and the knowledge of the high costs of running a building lead to the fact that many companies are forced to implement an efficient management tool for building information. (Braun H.-P., Oesterle E., Haller P., 1996) A CAFM is the tool to manage all the different data that have to be stored. Different information such as graphic, attribute, management, and routine maintenance have to be stored, analyzed, managed and presented. This is very similar to the way GIS Systems handle geographic information. The paradigm of import, processing, analyzing and presentation of geographic information is well known in the GIS domain. With this paradigm we can see that on the inquiry side the similarity between GIS and CAFM is obvious.

The following is about CAFM as interface between different applications that deal with building information. The Stuttgart University will introduce a CAFM system to manage all the buildings of the University. For this introduction the IFP did a benchmark between 6 CAFM systems. Based on the experiences in GIS at the institute a data model and an object relational system architecture was developed. In order to estimate the cost for data collection a virtual 3D model of one building was made.

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2. THE INTERFACE FUNCTION OF A CAFM

CAFM is nothing completely new. All buildings in the world are already managed. But this management is not always efficient and transparent. In companies state of the art is a wide spread responsibility for different parts of the building. The financial department is responsible for all monetary affairs. The service of the climate control system is done by another department. The room management and occupancy planning lies in another responsibility. You can continue by counting all the departments that have to do with management of buildings. Every department must have plans and alphanumeric data to do this work. These plans are normally paper plans, copied from the original building plans; in most cases they are outdated. If a building is 10 years old, the age of the plan is also 10 years or even 11 years. On these plans the different thematic information is "color hand painted". Figure 1 is an example for such a thematic plan. The colours (here different pattern) show rooms, a specific institute occupies on floor 9 of a building of Stuttgart University.

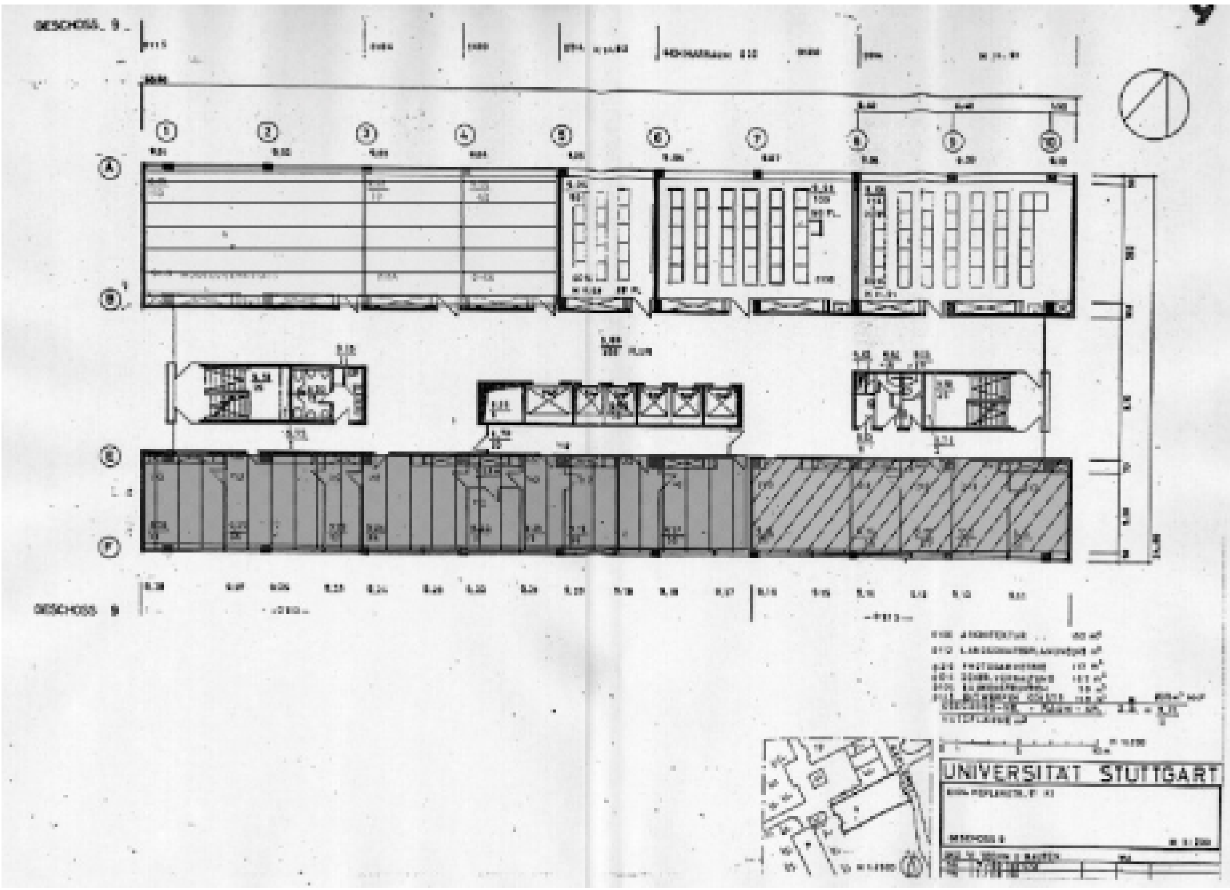

Figure 1: Paper plan.

Every department has its own plan. To see all the information that is in graphical form, it would be necessarily to search them on minimum 10 different paper plans. These plans are from different sources (architecture plans, structural analysis plans, plans for heating, ventilation and air conditioning) and are from different date during the construction of the building. This example shows that most of the graphic information in a organisation is not consistent, not up to date and different departments that are responsible for the management of the building decide on different basic information. The consequence of this information chaos are incorrect decisions, communication problems in and between the departments. The high redundancy of information and the problems with this are clear in this situation.

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CAFM offers the possibility to store and manage all the different information in one database and all the different departments work on the same data (Scheib R., 1998). In one step it is possible to reduce the redundancy to a minimum. Reality shows that every department develops its own strategy to manage the information chaos, so that Island-systems arise. The task in order to implement a CAFM is not just to install a new program and say now we do CAFM. The task is to integrate all the information in one system. The Island–systems are in most cases special programs for a special application. The functionality of all these systems cannot be taken over by the CAFM, some functionality can be replaced. For the remaining applications CAFM must be the data source. This is meant by CAFM as interface between photogrammetry, GIS, civil engineering and architecture (figure 2).

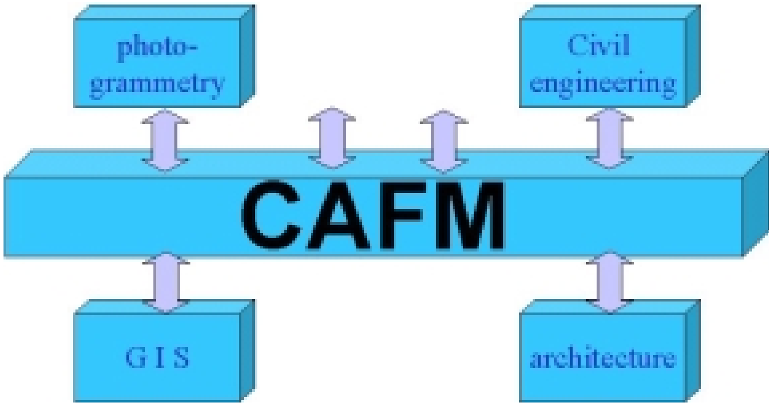

Figure 2: CAFM as interface.

3. CAFM: THE LOGICAL CONTINUATION OF PHOTOGRAMMETRY

CAFM is the logical continuation of photogrammetry. Close range photogrammetry and laser scanners are developed to examine rooms with high accuracy in buildings. These applications are at the moment mostly for historical buildings because of the amount of data that have to be managed. Data collection of room equipment is of crucial importance for a CAFM. Why not use a camera to capture the equipment of a room like detecting a roof of a building?
Car Navigation Systems help the driver to find the way through a complex street network. The street information for the map database is combined by using aerial images and other data sources. With this systems one can find the destination but what happens after reaching this destination? How can one find a particular room in a 50 floor building or a gift shop and what is currently on sale? To answer these questions, you need a system that offers this information and generates a walking guide to navigate in the city or in a big mall. Customers of photogrammetry don't want to stop in front the building. They want to virtually and physically walk inside. In order to do this the inside of buildings must be captured and stored in 3D (Runne H., 1993). Even time is of big importance. 4D databases will be the future for buildings to fit the need of the information society. As part of a benchmark for the introduction of a CAFM at Stuttgart University (CAFMUS) a Virtual Reality Model of one building is derived from a CAD data set. In this benchmark 6 different CAFM systems have been tested. (Weller R., 1997) The public sector is forced to manage all the facilities in accordance to management principles. The use of a CAFM is therefore unpreventable. (Frutig D., Messerli T., 1998)

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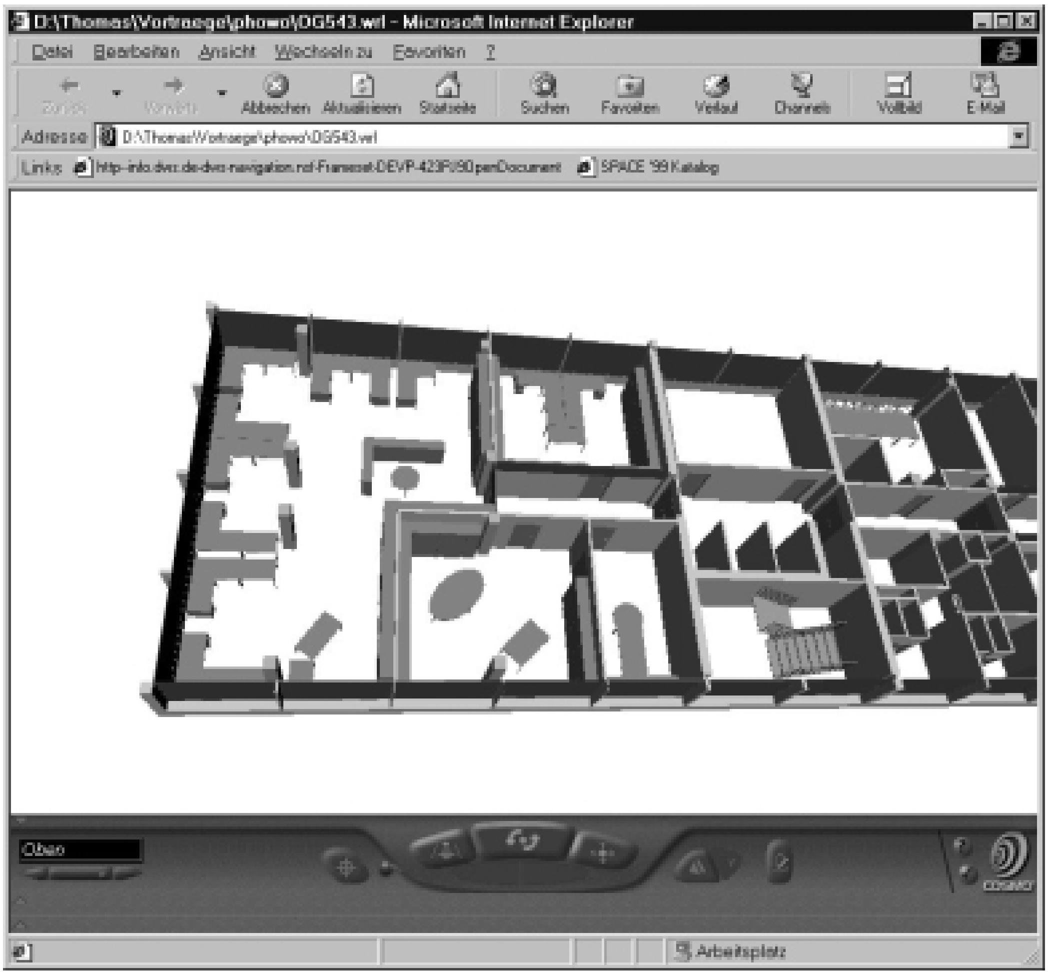

Figure 3: Virtual building information (testsite ifp).

All the graphical Data are collected either from architecture plans or direct measurements in the building. The aim of this work was to get an impression on data collection time and costs. Stuttgart University will introduce a CAFM System to manage all rooms and equipment of the University. The total amount is 700 000 square meters in Stuttgart. This virtual Building model is not the main aim, but it is a nice by-product of this collection. The main point in this effort is to get a complete, consistent information database in a unified architecture. The problem here is, like in GIS, the combination of graphical and alphanumeric information.

4. SIMILARITIES BETWEEN CAFM AND GIS

Why not use a GIS for Facility Management? (Ulmer F. 1996) The point is that GIS software is very good in managing, analyzing and presenting geographic information. Doing facility management, time relevant information, workflows, special information on switchgears, climate control and for maintenance also have to be stored (Braschel R. 1995). A GIS is not designed to handle all this information. In order to use a GIS, the necessity to implement a lot of special information and analysis tools would bring a lot of implementation work with it. Geometrical analysis, a main topic in GIS, is only a small part of a CAFM. Some mathematical analysis developed for GIS will be implemented in CAFM Systems in the near future. In order to create interactively special maps e.g. for handicapped people to find the way to a particular room without stairs the shortest way with constraints must be found. GIS and CAFM systems both have their own special functions and must exchange information with each other. A meta model for this information exchange must be found.

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Figure 4 shows the system architecture of a CAFM. This architecture is comparable to a GIS architecture. (Schürle T., Boy A., Fritsch D. 1998) The system is based on a object relational database. A object-oriented database is at the moment not ready for an application with this amount of data. In future the object relational database will be replaced with an object-oriented database. The use of intranet and internet is very important for an implementation into the workflows of the employees.

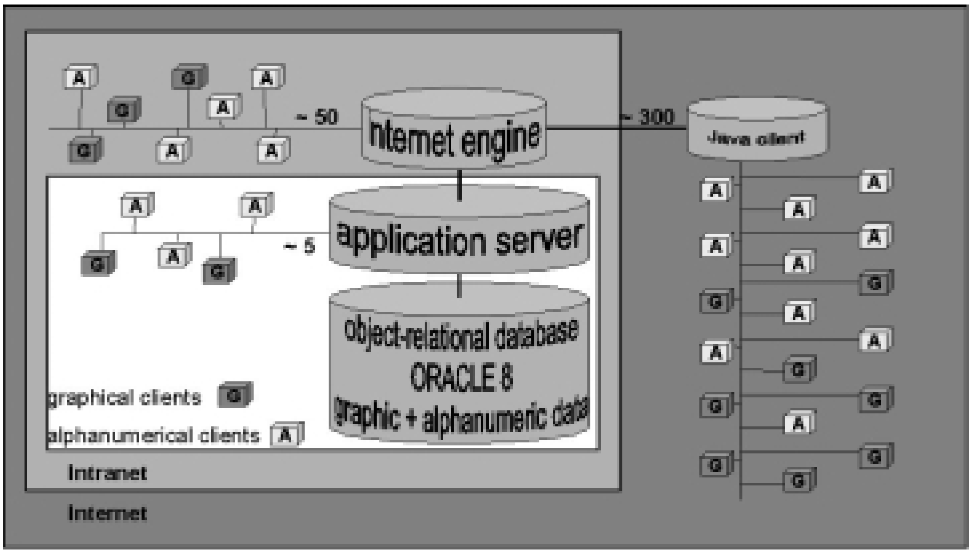

Figure 4: System architecture of a CAFM.

The user interface for CAFM can be a standard internet browser with a JAVA application (Kreuer B., 1998). Information can be updated with this JAVA Client. The security of this system must allow special rights for different users. E.g. if one logs on, it depends on his personal rights whether one is allowed to change, or see all data. Stuttgart University plans to give the Institutes the right to see only their own information. Another similarity between GIS and CAFM is the principle of Input Management Analysis and Presentation (IMAP) of geometric and alphanumeric information. Figure 5 shows a synopsis of the IMAP principle for GIS and CAFM. (Bill R., Fritsch D. 1994)

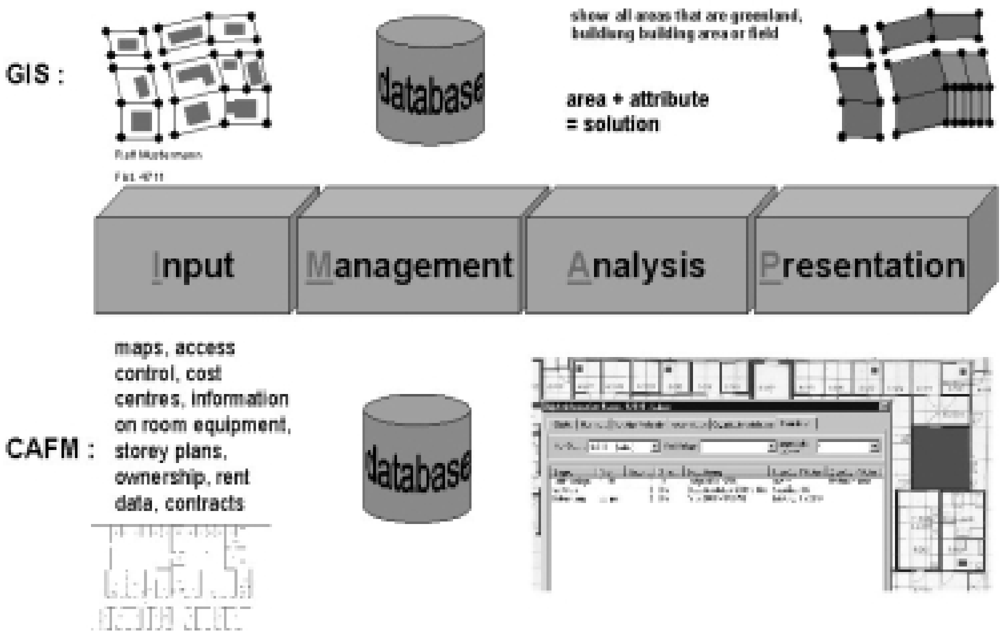

Figure 5: IMAP principle.

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Many companies already use GIS to store information on their properties and for environmental analysis. These systems must be integrated in CAFM. The special functionality of the GIS can not be rebuilt by CAFM but the same data should be used. Here, also the object relational approach offers the possibility to store the data in one database and export the information to the GIS, do the GIS analysis and then re-import the solution.

5. DATAMODEL FOR CAFM

A sample of a data model is given in figure 6. It shows the complexity of relations and dependencies between the objects. It was modeled using UML (Unified Modeling Language). The static sight of the data model is designed to help defining the information content of the database. It is not intended to implement this model in a self made CAFM. The data model helped us to define criterias for potential candidates of commercial CAFM suppliers. A benchmark between 6 systems was made. The object-relational system architecture which represents the architecture best, and the data model was one of the reasons for the technical choice for a special system.

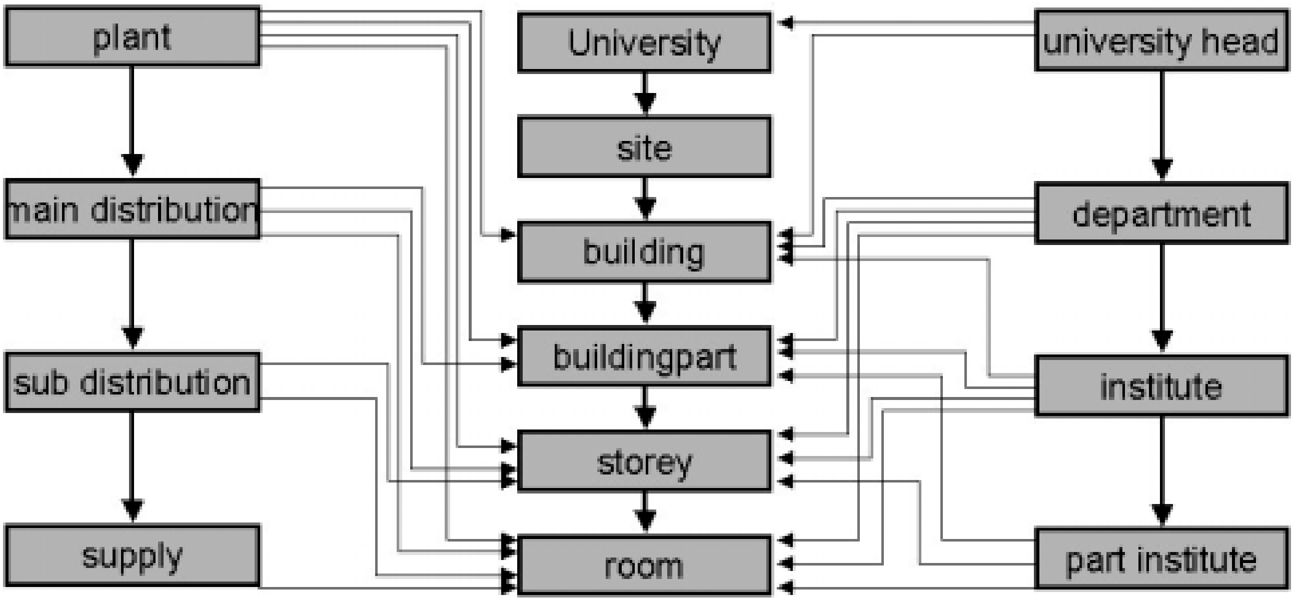

Figure 6: Data model for CAFM.

This is a coarse level of the data model. Here the three main topics of CAFM are represented. On the left side the technical management of technical units. In the middle the main part of every CAFM the infrastructure with room management and on the right side the administration part. One step deeper in this data model the three main parts split into five. The whole structure in management and in building and supply must be represented by the data model. The big advantage by building this model is to learn who is responsible for what data and how they are managed and collected. Learning form this static data model the customizing of a CAFM system can be accelerated. The main information that is necessary is captured by the data model. Additional information that come with the customizing can easily be attached to this data model. The next step in this model is to integrate the dynamic part. The objects shown in figure 7 are only the static objects. The dynamic objects that interact with this static objects must be defined. These objects will be modeled at the time they are introduced to the CAFM. It is impossible to find all dynamic objects before working with the system.

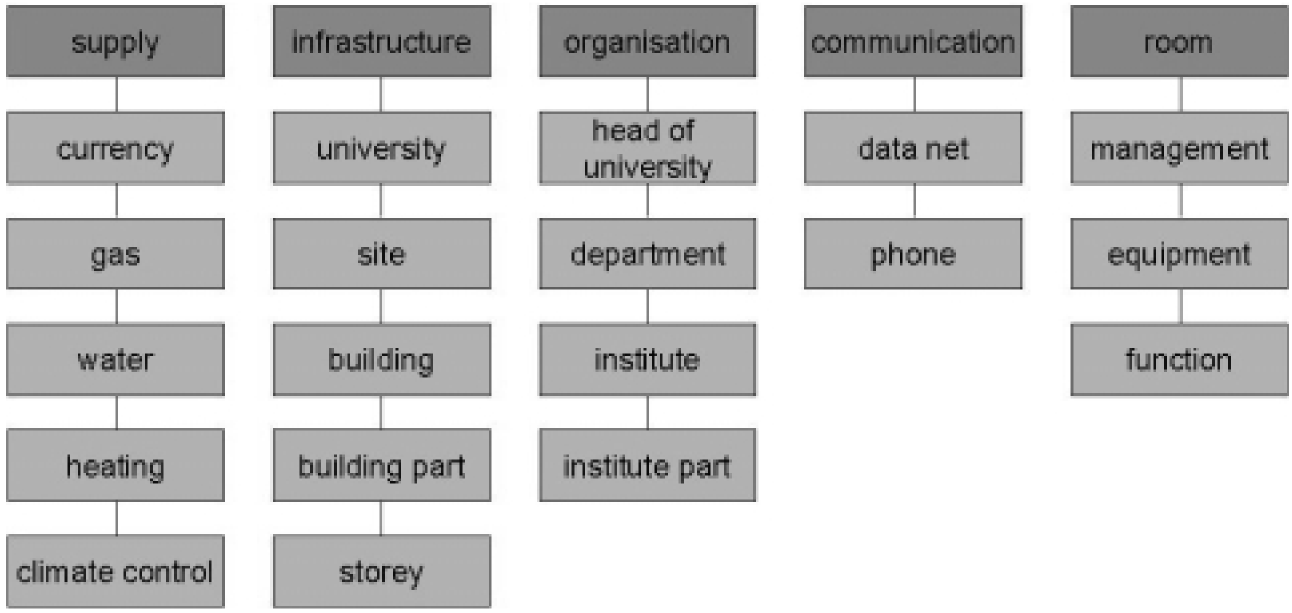

Figure 7: Level 2 of the CAFM data model.

6. BENEFITS OF CAFM INFORMATION FOR FURTHER APPLICATIONS

As indicated in the beginning, CAFM data can also be used for other purposes. The biggest challenge in this field will be a navigation assistant for pedestrians, and the combination of all information that are currently being collected. The information society will demand all the information to virtually visit a mall or a colleague in his or her room. Another application is also the virtual city model for urban planners. The basic data for them will be the CAD plan and the information on the shape of the roof of the building. These data and for example the material of the roof of the building will be stored in CAFM Systems and can be used to build the City models.

7. CONCLUSION AND OUTLOOK

The potential of CAFM Systems and the interface role between GIS, photogrammetry, and civil engineering cannot be underestimated. The main advantage with such a system is the transparent data management and the unique data source for all users in a company. The demand for real 3 D data will increase by implementing such systems. Some of these systems are already capable of managing these data. Time aspects such as control of maintenance and quality of data are getting more and more importance because the cost intensive management of building is no longer possible. In literature the cost for building is only 5 to 20 % of the total cost of a building in its life.
In order to fulfil the demand on 3D information, new data collection tools and methods must be developed. New methods for storing and management of these data must be developed. Photogrammetry must go inside the building otherwise other branches such as civil engineers will take over these fields. The co-working with other experts is very important for a facility management. A facility manager must be a generalist.

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