Facility management helps organizations more efficiently manage their real estate, and it’s extremely important when you’re managing historic buildings that house the offices of the Parliament of Italy. The Information Systems Development Department and the Real Estate Department of the Italian Senate manage a considerable amount of information about seven buildings containing approximately 3,000 rooms (including halls, prestige offices, and technical areas) and covering a total area of 60,000 square meters. The facility management involves maintaining accurate data about the floor plans, space utilization, asset location, and technical plants.

An efficient facilities-management information system can better support the primary organization itself, increase the building’s life expectancy and value, optimize appliance maintenance, help schedule routine maintenance activities, and improve the quality of the working environment. Unfortunately, current systems are usually vendor-specific or proprietary, and standardization attempts—such as the Industry Foundation Classes (ISO 16739), developed by the International Alliance for Interoperability (www.iai-tech.org); the Facilities Management Classes; and the Integrated Facilities Management Information System based on STEP (the Standard for Product Model Data)—have yet to overcome all the complexities involved.

So, my colleagues and I at the Information Systems Development Department and Real Estate Department developed our own Computer-Aided Facility Management (CAFM) system that combines traditional CAD software with a set of software modules. In particular, the system uses two types of data: graphical (managed by traditional CAD software) and alphanumerical (managed by modules integrated with CAD software). The graphical data, implemented through producer-defined formats and open-source model definitions (www.opendwg.org), visually represents the buildings and infrastructure. The alphanumerical data concerns information related to the buildings and their...
contents; the technical plants; and general attributes that the computer environment can store, analyze, or present. The CAFM system’s ability to link graphical elements with attributes in the form of alphanumeric data lets it extend basic GIS software to a company’s management system so that the system doesn’t present just spatial information.4

System Requirements
The first system requirement we developed outlined the project’s fundamental objective:

R1. Floor plans registry. The system must implement the real estate registry of the electronic planimetrías (in an appropriate CAD format), always having the last version available and managing the versioning and the concurrent updates.

The planimetrías contain the geometrical representation of the building’s floors.

Next, we focused on building operations, which are characterized by three main facilities-management functions: maintenance and operation management, property management, and services (see www.ifma.org). We needed not only electronic versions of the floor plans but also alphanumeric information related to each plan. We stated this requirement as

R2. Alphanumeric data registry. The system must be able to store and update building information, including the coding, typology, and occupation of the rooms; any logical models of the technical plants in the buildings; asset management and classification for technical plants; and the location of people and departments.

Our final requirement focused on safety:

R3. Compliance to safety regulation. In the context of evaluating fire risks and employee safety at the work place, the system must automate the drafting of technical documents in accordance with national regulation.

Italian regulations require employers to identify any risk factors in the company and evaluate their potential effects. Employers also must identify and implement preventative measures, monitoring their effectiveness and making improvements as needed. They usually identify such measures in a document of risk assessment prescribed by law called a DVR, which includes various detailed attachments. In fact, the regulations require employers to specify in the DVR each room’s measurements, flooring, wall type and material, ceiling type and material, door type and location, and furniture type and location. The document also must state each room’s maximum occupancy, identify emergency exit paths, and calculate the risk of fire.

System Architecture
Figure 1 shows the CAFM system architecture. The core is the relational database management system (RDBMS), which stores all objects.
version of the floor plans stored in the RDBMS, while another software component (part of which was acquired as a commercial off-the-shelf application and then customized) provides connections between each file representing a floor plan and the related attributes, also stored in the RDBMS (such as space inventory, room codes, occupation status, and asset data).

Two models exist for making the information available to users: the traditional client-server model and a Web-based model. Both have strengths and weaknesses, depending on the scenario and user. After a deep analysis, we decided to implement both models. The two environments share the same data and spatial objects, but the client software has much more functionality than the Web-based model, because CAD software can more fully exploit client resources.

After implementing the infrastructure and installing the software modules on the proper hardware, we started to feed data into the system. We focused on two main issues: integration with our central information system and security. We used the requirements as our roadmap in realizing the overall system, first developing the electronic archive for the floor plans (R1) and then structuring the system to manage the information about all plants and building assets (R2). Finally, we exploited the features offered by some technological packages (the Flash engine and XML/XSL/XSLT transformations) to introduce automatic report generation, starting from SQL queries executed on the gathered data (R3).

We converted floor plans from paper or old computer versions to the new format (the dwg format), storing all files in the RDBMS. We also defined a set of metadata associated to each dwg file to satisfy research needs. After the digitalization of the planimetcaries, we started collecting information about assets to create a sufficiently detailed taxonomy (see Figure 2).

**System Integration**

To address the integration issue, we implemented a module that links the management system for legal and personnel information with the planimetcaries to help locate employees. This reduced data duplication and kept responsibility for managing personnel information with the Human Resources (HR) department (not the Information Systems Department).

In addition, CAFM can graphically represent employee attributes—such as their title and organizational unit. Considering the entities schema and the relationships between the HR management system and the CAFM database, the integration was very straightforward. We simply linked the two database schemas—for example, we’d link a particular SQL view, defined in the HR system and readable by the CAFM system, using the employee identification number stored in both (see Figure 3).

One end the CAFM system is a consumer of information managed by the enterprise information system (EIS), while the other end of the system is the information provider itself for applications that need the real estate data. For example, consider the application that manages stationery requests (shown in the lower right corner of Figure 1): the system must know where to deliver the items—which building, floor, and room number—so to fulfil the request, the application reads the appropriate database views of the CAFM system.

The system also improves information quality by revealing data inconsistencies. For example, consider the room number—there could be a mismatch between the actual room number and the number listed in the computer system.

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**Figure 2.** An extract from the CAFM system’s information taxonomy. The taxonomy provides the proper level of specification.
System Security

For security purposes, we implemented a role-based access-control model to clearly identify the competence and responsibilities of the actors involved. The roles are classified as building engineers, plant engineers, safety managers, general operators, and so on, and an access matrix relates each role with information specifying the allowed operations and building access.

We also exploited our taxonomy to categorize the data the CAFM system manages, such as geometrical layout; rooms-floors, rooms-people, rooms-[-...]; plant-electrical, plant-hydraulic, plant-[-...]; and assets-furniture, assets-[-...]. So, for example, a building engineer might have read-write access to the geometrical layout of planimetrics associated to buildings M and G but just read permission for buildings C and K.

Application and Results

During the first year of system implementation, we focused on the digitalization task, spending a tremendous amount of time developing a reliable repository of the floor plans. Furthermore, we elicited requests for additional functions and reports, formulated by system users (the managers and technical staff in the Real Estate Department), and we organized classroom and hands-on training sessions. Then we were able to turn our attention to controlling fire risks and managing space utilization.

Evaluating Fire Risks

To reduce the risk of fire in any of the buildings, we first identified elements considered to be a fire hazard (certain types of flooring, ceiling, walls, and furniture). We also retrieved technical reports of each plant (about the electrical wiring,
The CAFM system can extensively report on the information it gathers—for example, noting when a room is about to exceed its capacity—to generate technical documents in accordance with national regulations. The system can also generate emergency exit plans as part of the DVR document.

Prior to implementing the CAFM system, an employee had to spend an entire month gathering the necessary fire-risk information to meet regulatory requirements. Now, that same employee can generate and verify the required data in just one day.

**Reassigning Rooms after Elections**

Whenever Italy has political elections, we need to provide suitable spaces for the members of Parliament and their staff. We assign the spaces according to the actual composition of each parliamentary group, taking into account room size and quality and the distance between rooms. We can generate reports through SQL queries that specify room size, attributes, and location and help us propose the new room assignments. We can then present the plan using the system's Web-based component, allowing for interaction and graphics in a Flash environment (see Figure 5).

The approval process is complex, because the politicians review the plan and request changes, leading to various iterations before assignments are final (one of the last elections involved eight iterations). The system lets us simulate space allocation in real time to quickly present new drafts for politicians to review. Prior to implementing the system, a room-allocation change took approximately one working day to represent and receive feedback. In the last election, using the new system, the same process took only one hour.

**Figure 4. Using the CAFM system to evaluate fire risks.** The real-time query console (a) shows information associated with each room and (b) attributes related to the maintenance needs of a particular asset, such as the fire extinguishers.

Efficient facilities management offers considerable cost savings. Building, plant, and infrastructure planning and construction account for only 20 percent of all costs; the maintenance phase (approximately 40 years) accounts for the other 80 percent.⁵⁻⁸ The CAFM system provides considerable economic value to Italy’s various government institutions. Recognizing this benefit, many Italian organizations have acquired facility-management services and related CAFM systems from specialized vendors for building and infrastructure maintenance. In fact, according to the International Facility Management Association (www.ifma.org), for the second half of 2009, regional agencies had contracts worth more than 10 billion euro.

A further effort is needed to address all information that daily a facility manager must consider. For example, we plan to integrate a
pervasive monitoring system into the CAFM to analyze real-time energy consumption throughout the day for each building and plant. This will help us develop short- and medium-term cost-cutting strategies through the revision of physical elements and contractual clauses with commercial providers.

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