THE SACS SYSTEM FOR THE ANALYSIS OF STRUCTURAL AND TECHNOLOGICAL ELEMENTS IN HEALTHCARE

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ABSTRACT

This article shows an informative tool which manages CAD digital maps in order to feed a database that provides structural, technological and organizational information of about 15,000 rooms of Careggi Polyclinic – AOUC (one of the largest Italian hospital which stands on an area of 74 hectares). The system has been developed by the Monitoring Laboratory (MonLAB) of Florence University (an autonomous office made by personnel of Department of Electronics and Telecommunications together with Department of Architectural Technologies) within an extensive restructuring process of the hospital itself. This strategic programme of transformation called "New Careggi" includes demolition, rebuilding and renovation works. The system called SACS (System for the Analysis of Hospital Equipment) is a custom Visual Basic software that drives Autocad to manage and analyse digital plans of buildings coded on specific layers. The software maps Departments and relative Operative Units, Destinations of Use, healthcare technologies and environmental comforts grouping info by single room and homogeneous areas, giving quantitative and qualitative results (such as surfaces, heights and volumes, Key Performance Indicators, etc.). The particularity of SACS is the "everything inside DWG" approach: all data is stored inside the digital maps allowing anytime to rebuild the whole information having nothing but the DWG files. This allows a great flexibility of the system that offers the possibility to elaborate pre-existing and not specifically SACS-designed plans.

Key words: hospital, management, monitoring, tools, GIS

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1. INTRODUCTION

The modern hospital organization is based upon a huge amount of data and people and the main problem is to organize and to make functional relations among them. In fact hospitals must now undergo a numerous quantity of requirements in order to fulfill their clinical and medical duties. These requirements are set by national and international institutions which force structures to respect given parameters to grant sufficient hygienic, qualitative and organizational standards (accreditation process). The university hospital campus of Careggi (Florence) is a pavilion hospital and it is hence made by 52 buildings over a 317,850 m^2 with 1,796 beds. Its inner organization has been reviewed over the years and it is now structured in Departments, Activities Area and Operative Units. Departments (or Integrated Activity Department – IAD) are functional macrostructures associated with the clinical and technical supplied offer: they are 20 and many of them works among many buildings, using different structures, technologies and rooms throughout the whole hospital area. For each IAD there are functional substructures with a lower level of aggregation: Activity Areas (AA) and Operative Units (OU). The first ones join together physical spaces in relation to the carried out activity; the second ones join together medical staffs in relation to the medical activity they are assigned to. Therefore it is possible to have one OU operating in different rooms associated with different AAs: so a single room is assigned to only one Activity Area but it can be used by many medical staffs, hence by many OUs (for example ambulatories and surgery rooms are used in many cross-specialties, but assigned to only one AA). The 20 IADs, together with the 276 Activity Areas and 181 OUs made a three-dimensional matrix and each cell identifies a single medical center.

2. METHODS

This work comes from the need to have a tool which monitors the whole hospital and give unbiased data to assess the building/technological estate and assigns priorities to necessary interventions by whomever is responsible. The developed system is special hospital GIS linked to the inner Hospital Information System (HIS) designed in Microsoft Visual Basic. The software is used to monitor the *status-quo* of the buildings (in terms of beds, square meters, destination of use, functional area and many other features for every room) by driving DWG maps in Autocad.

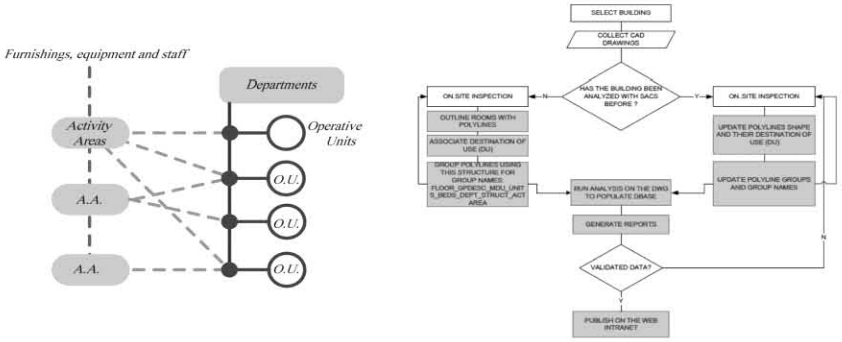

Figure 1. Organization of AOUC and SACS Process Flowchart

The system is "special" because of its singular approach to storing, analyzing and managing steps compared to a common GIS which is described as "everything inside DWG" and that will be discuss later in the article. The idea behind SACS is to bring the knowledge-sharing to its maximum allowing hospital staff to potentially comes to know of everything about the building estate (spreading of Operative Units, Activity Areas and Departments, beds, detailed destination of use and environmental comforts of each room). The informative system is composed by the core-engine software, which drives CAD maps and makes automations on them, a data-entering module and a SQL Server database that contains the tables used to decode the data stored inside the DWG files. This is the great potential of the system: all info is stored inside the maps (and also backed-up on the database for emergency recovery) so that they are self-sufficient and the information can be always rebuilt using nothing but the CAD files: this is what has been previously mentioned as the "everything inside DWG" approach. The current release of the software (SACS v4.0) electronically analyzes the plan of the hospital and outputs statistics on dimensions and aggregation of spaces, subdivided by 42 Main Destination of Use (MDU) and their 246 sub-classes (SDU – Secondary Destination of Use) in order to give a description as real as possible of the hospital organization. Data is collected using techniques which have reference to Post Occupational Evaluation (POE) through on-site surveys and personnel interviews. Spaces are classified by their "real" usage and by customer's waiting in terms of environmental comforts. Survey information is data-entered into the SACS and linked to the DWG "polyline objects", each one of them outlines the perimeter of a room. Moreover every single space is associated to an unique "talking" code that identifies it inside the hospital, letting the user immediately knows the examined position. The room code is formatted according to the following rule: *BLD_LEVELROOM, where BLD is the code of the building, LEVEL is the number of the floor mapped by the linked DWG file, and ROOM is a 3-digit formatted increasing number. Besides the above mentioned data (room-code, MDU, SDU, IAD, AA and UO), the following room-linked info is also managed by SACS: height of the room; room square and volume; square-light ratio; typology of users (medical and technical staff, students and suppliers) number of beds; code of the Air Treatment Unit (ATU) that feeds the*

room; Electrical Group (EG) for the medical rooms as described by the Italian Electrical Committee; number of medical gasses connections detailed for air, oxygen, dinitrogen monoxide and void terminals; room-afferent assets; room-afferent occupants. This information is a powerful data source the Hospital Information System (HIS) can be linked to and is needed to compute a set of structural Key Performance Indicators (number of beds per ward square, square per destination of use, type of services and facilities per destination of use, operating rooms per day-surgery beds, etc.).

2.1 Reporting

Autocad hyperlink property of the polyline is used to associate a hypertext to every single entity. Because of the heterogeneous available amount of data, it is useful to access them from intranet consulting too. Therefore SACS automatically publishes all the gathered attributes together with those stored in the DWG files embedded in a html page accessible via web: this allows everyone to access the inner information recorded in the maps, even without having the SACS engine installed on his computer but only with a common web-browser. Before publishing SACS is able to make some automation on the CAD maps like generating hatches coloured according to the MDU's RGB colour or texts of the attributes for the single room centered in the polyline that outlines it. From the hospital intranet SACS main page the user accesses to a list of available floors for the selected building and then to the related maps or PDF reports by clicking on the desired floor. Here the previously described hyperlink gives an instantaneous information of highlighted room attributes that can be deepened by clicking on it. The structure of the reports is arranged by buildings or by departments (useful to study the scattering of an IAD in the hospital estate and to plan possible improvements). Plus the reports shows the set of KPIs calculated for 3 levels of aggregation: floor, building and hospital. SACS is also able to automatically produce door-plates with info about the room (afferent IAD, OUs and AA, room-code, names of the staff).

Figure 2. SACS-Destinations of use, classes, colors and relative icons.

3. RESULTS

The software is flexible and allows queries on rooms and gives numerical and graphical reports. Hence it is very useful as support tool for the healthcare planning. A list of few examples grouped for users follow: *Medical staff use SACS to know the "spreading" of their units/departments and which ones they eventually have to coexist with. Firemen query SACS to know the escaping pathways along the buildings, where the fire-escapes and fire-stairs are and which places are more sensible and thus ask for more attention. Technical staff uses SACS almost every day to retrieve parameters for hospital like quality of service indicators or accreditation requirements. Everybody inside the hospital can query SACS to know building code and name, floor, any medical or non-medical activities carried out inside a given room or as a tool for people-finding.*
The software is used for many purposes and in really different scenarios like space management, transfer management, accreditation requirements assessment, electro-medical devices management (through the interface with the Clinical Engineering database) and general designing and remodeling.

3.1 Transfer Management

The first problem which SACS solved was about the transfer management. Careggi has been being remodeled for about the last 10 years: during this process a lot of transfers have been made following the demolition and the re-building of many areas of the hospital. SACS is able to answer the main question in a transfer process: does the target room meet the requirements of the new use it has to fulfill? By

consulting all the data stored along the room-representing polyline it is possible to know that and then easily answer the previous question. Thus SACS gives a prevision of which transfers are more or less complex to manage or generally not allowed at all.

3.2 Accreditation Requirements Assessment

Accreditation is based upon 4 main clusters: plant, technological, architectural and organizational. By using SACS and its reporting features it is possible to determinate which requirements (especially plant and structural ones) are already satisfied and which not: KPIs give a relevant, strong and very useful information about that. Obviously not all the requirements can be assessed by using the system so that on-site surveys need to be done and other HIS databases must be consulted in order to satisfy all the necessities. However there is no denying the huge save of time that SACS brings in a so massive process of evaluation. Plus SACS is recorded in the inner organization paper as the official hospital tool used to verify the possession of the accreditation requirements. Accreditation is one of the tools for environment quality assessment and it also includes accessibility, safety and comfort factors: for this reason SACS has a distinct module used to classify this type of data.

3.3 Space Management

SACS is used in hospital space management since it is able to link every single univocal room-code to the staff and furniture/equipment registers. As mentioned above SACS automatically produces room's door-plate with logistic information useful for facility management and governance activities like staff space-allocation, destinations of use verification and cost and space analysis of OUs. SACS offers a complete database with multifunctional data which allows many typologies of aggregation and enquiries by different categories of users, with the possibility to make more complex studies like cost-benefit analysis or comparative analysis.

4. CONCLUSIONS

Modern hospital organization is based on a large amount of data and people that must interact with each other in order to ensure adequate qualitative parameters. Thus informative management tools are even more necessary. SACS is one of these and it not only offers quality control functions, but results in a true user-friendly service for people throughout the hospital (staff, patients, visitors and students). SACS is always under continuous evolution due to its own nature and its development follows 2 main streams: one is focused to enlarge the management skill of the system (even by linking it to other hospital tools), the other concerns on support people along the hospital sanitary pathways. MonLAB is developing a new software release with more data stored in. Information about typologies of the Cleaning Facility Macro-Area to evaluate the price of every room in terms of cleaning operations, sound/data systems management and an intranet search engine are just a part of the future available features.

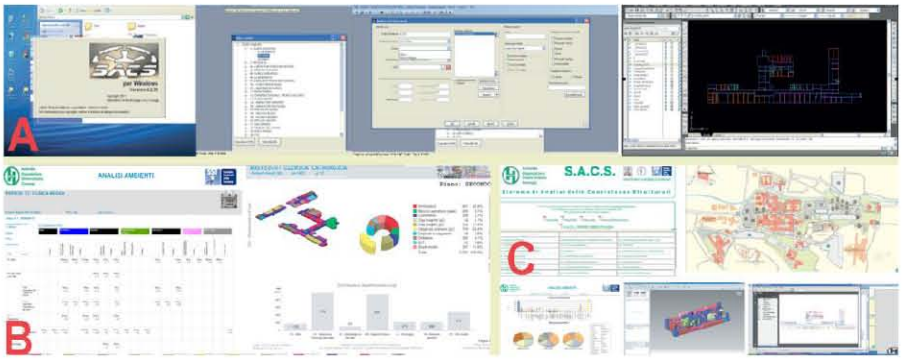

Figure 3. SACS: phases of use. A) data entry. B) PDF reporting. C) WEB reporting.

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