Emergency Lighting Cabinet for Fire Safety Learning

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César Martín-Gómez, Javier Bermejo-Busto, Natalia Mambrilla-Herrero.

1. Introduction.

Education in a School of Architecture (for both architects and building engineers in Spain) has to cover all fields involved in construction, from design theories to technical areas [1], also incorporating new pedagogical theories [2] [3] [4] [5] [6]. (Fig. 1)

Within this context, the School of Architecture where this prototype has been created, has developed a very important activity related to fire safety inside the technical sphere [7]. The technical cabinet described in this article fulfills other laboratory activities focused on increasing the practical knowledge of these aspects to architects, not to fire engineers.

There are other simulators for engineering learning and, of course, for future fire engineers [8] [9], but it is supposed that they are not as practical as this one. (Fig. 2)

2. Background

The goal of the Building Services and Energy Section of the School of Architecture where this experience has been carried out, is that newly-graduated students will have been trained to design, calculate and integrate the various Building-related Services, including fire safety parameters.

Although it is unusual for an architect to receive such intense training in Building Services over four years [10] [11], it was intended to offer the students further practical knowledge by bringing simplified real building services elements closer to the lecture-room.

The three technical cabinets contain the most common facilities in buildings of a certain size: fire safety, electricity and a heating/cooling system [12].

In this School of Architecture, the teaching of fire safety facilities starts at the second academic year. During the last course students have to design and integrate all facilities into their projects. Then, most questions and problems arise and the previous technical cabinets are used in order to solve the students doubts in a practical way.

After having explored all the existent solutions available on the market and checked that none of them fulfilled the teachers necessities, it was decided to design and build a specific technical cabinet to transfer the knowledge related to emergency lighting.

It is important to note that students learn the general principles of these types of systems in the theoretical sessions before watching the cabinets. Therefore, they are not learning specific software/equipment, but the solutions that market offers today in a similar way that they will find when starting their professional careers. In fact, cabinet is ready to assume changes for fixtures or fittings every year with minimal maintenance work. Due to all these reasons is why this experience is intended as a novel means of making building services more attractive to students through hands-on learning.

3. Methodology

Taking the dimensions of the original technical cabinets, two companies were contacted in order to explain to them the teachers staff requirements.

Both the high number of students and the anticipated mobility of the cabinets have led to their construction with solid and durable materials, which ensures low maintenance costs and high reliability despite intensive use.

Both companies seemed to be very interested because, apart from the publicity of its execution, it was a big opportunity to develop a new product that did not exist on the market.

These triangular collaborations (University + technical cabinet manufacturer + emergency lighting manufacturer) were focused on two aspects to achieve the final result:

- Definition of the physical elements and concepts that wanted to be shown.
- Definition of the software which managed the different actions that could be done.

Acadademical Quality System of the University undertakes to carry out polls to 100 students of the subject every year. To really know the effects of this cabinet on students learning, it was compared the numerical ratings of students and their comments in the polls in the year prior to their implementation and after. Numerical ratings were better and written comments from students are explicitly related to the improvement and importance of these elements learned in the laboratory and not just theoretically.

4. Components description

Fire protection is, unfortunately, one of the least discussed technological elements at Schools of Architecture. That is why in addition to theoretical teaching, practical instruction, with technical cabinets (as this case), is of the greatest importance.

The elements used in this cabinet are the following: (Fig. 3)

a. Connection. Supplies all elements of the cabinet.

b. Electric control panel. Allows to switch on and off all the lights of the cabinet. It is composed of one main switch and four partial differentials.

c. Isolator ST-200. Allows to check that the communication between the cabinet and the computer is correct. There are two of them installed. One receives the data of three luminaires. The other one receives the status of the battery and the other two lights.

Isolating switch of the BUS for connecting a maximum of 200 luminaires. Enables checking of the secondary BUS lines used for communication between the TMA control central and the TCA series luminaries. The isolating switch optocouples the bus signal between the main line and the secondary line, thus protecting the installation from potential errors and making it easier to detect errors.

d. Power unit PBL-2402 TCA. Centralized battery that supplies energy to the VIR light and the beaconing system. It communicates directly with the computer software.

Rectangular polycarbonate box, prepared to supply 24 V DC voltage. Designed to be installed on a symmetrical DIN 46277/3, EN 50022 rail of an electrical panel, taking up a width of 12 single magneto-thermal switches (140+70 mm). Equipment specially adapted to power beacons uninterruptedly (with mains power on or off). Power supply unit with batteries with permanent output of 24 V, 0.2 A. Ni-MH battery included. Provides 1 hour of autonomy at maximum output consumption. Provided with over-current and output short circuit protection with automatic reset. Includes a microprocessor for functioning with a Daisatest Centralised System.

e. Beaconing direction switch DIR.

Directional switch powered at 24 V AC/DC that enables one out of every four beacons in a system to be switched on sequentially to indicate a direction.

f. LENS N30 TCA luminaire.

Provides LED light source that illuminates on power failure. An internal microprocessor checks the status of the device and periodically performs functionality and autonomy tests and reports the status. If the luminaire connects to a Central TEV, data on its status is sent directly to a control computer via this module where the status of the entire emergency luminaire installation can be monitored. This luminaire, like all those that follow, were selected after discussions work among teachers, builders cabinet and lighting manufacturers, gathering the features that are required in academic terms, attending the physical space of the cabinet and they must exist in the manufacturer catalog. And of course, being a School of Architecture, the aesthetic value became very important.

g. LENS P30 TCA (AD) luminaire.

Provides LED light source that illuminates whether or not there is mains power supply. An internal microprocessor checks the status of the device and periodically performs functionality and autonomy tests and reports the status. If the luminaire connects to a Central TEV, data on its status is sent directly to a control computer via this module where the status of the entire emergency luminaire installation can be monitored.

h. LENS P30 TCA (S) luminaire.

Provides LED light source that illuminates whether or not there is mains power supply. An internal microprocessor checks the status of the device and periodically performs functionality and autonomy tests and reports the status. If the luminaire connects to a Central TEV, data on its status is sent directly to a control computer via this module where the status of the entire emergency luminaire installation can be monitored.

i. BLOCK P30 TCA luminaire.

Not commercialized luminaire while writing this article. It can be considered as a normal light in terms of funcion but with a high emphasis in its design.

j. GALIA LD P3 TCA luminaire.

Rectangular body with pronounced edges, comprising a polycarbonate housing and diffuser. They supply permanent lighting or signalling using LED technology. An internal microprocessor checks the status of the device and periodically performs tests of functionality and autonomy and informs of the status. If the luminaire connects to a TEV Control unit, data on its status is sent directly to a control computer via this module where the status of the entire emergency luminaire installation can be monitored.

k. VIR2121-P P luminaire.

Square methacrylate plate measuring 210x210 mm with an engraved emergency sign adhered to the back and a thin decorative aluminium contour on the top so that it blends perfectly with the surroundings. Wall-fitting system. Methacrylate signs, with a maintained lighting module with batteries.

l. ALZIR-C luminaire. Beaconing light.

Small recessed unit comprising a square Zamak embellisher and a square diffuser of tempered glass. Mains voltage power supply 230V AC or 24V AC/DC. Lights up by LEDs. Has accessories to also operate when mains power is off (PBL units) or with a low safety voltage (TL transformer).

m. ALZIR-R luminaire. Beaconing light.

Small recessed unit comprising a round Zamak embellisher and a round diffuser of tempered glass. Mains voltage power supply 230V AC or 24V AC/DC. Lights up by LEDs. Has accessories to also operate when mains power is off (PBL units) or with a low safety voltage (TL transformer).

n. Software installed on the computer.

DaisaTest System is a type of emergency lighting facility with capacity to monitor the status of all luminaires on a control computer and to optimise their maintenance. To achieve this the DaisaTest System checks that all luminaires are working properly and displays the result of the test in graphic form on signal indicators on the computer monitor or by means of the emergency lighting system Status Reports.

5. Tests

To ensure students understanding of the content, as well as the maintenance of the cabinets, operational protocols in both Spanish and English have been written. It was included both languages because it is expected to achieve the widest possible distribution of this tool, which is intended for use by non-experts and is open to continuous improvement from other working groups with similar concerns. Thus, the tests always follow the same specific logical order, both for student practice and for anyone else who uses them.

To ensure the learn through hands-on experience the groups are of less than eight, therefore, everyone can practice following the guidelines of the protocols.

Every time, before testing, the different components of the cabinets are explained.

Learning tests to be performed are divided in two blocks (Fig. 4-5). The first three tests are designed for students in order to understand the basic functions of the cabinet and the software. The other ones, are willing for professionals and other researchers deeping into complex functionalities and trials.

-Test 1. Recognize all the elements and luminaires installed. Differences among permanent luminaires (LENS P30, GALIA and BLOCK), non permanent ones (LENS N30), batteries (PBL power unit) and beaconing system (ALZIR-R. ALZIR-C).

-Test 2. Initialize the trials with all the lights switched on. Afterwards, switch off and on the luminaires LENS P30 and GALIA from the DaisaTest software. Activate the ecopermanence sensor in the luminaires LENS P30 and BLOCK. This sensor recognize the amount of light around it and switchs off the luminaire if there is daylight. Disable the ecopermanence option in the software. Force battery and BUS faillure in LENS N30 with the switches available above the light. The software will show both errors inside the battery and BUS squares, and a small orange LED placed at the bottom of the luminaire will pulse three times. Restore switches to its original position. Force 'Lighting faillure' in GALIA luminaire. The lighting box in the software will show an error, and the LED placed in the front of the luminaire, will pulse twice. Restore switch. Switch off one LENS P30 and GALIA lights in software.

-Test 3. Force a power faillure with the 'Power Faillure' switch. Check that all the lights are turned on. Turn up and down beaconing speed with the power unit wheel (DIR). Afterwards change the direction of the beaconing with the software. Restore the 'Power Faillure' switch and press it again in order to implement the change. Turn off 'Power Faillure' switch.

The next tests are designed for professionals. They are advanced tests about complex functions:

-Test 4. Check the connection between the cabinet and the computer. In order to do this test, the TestBUS button in the isolators and the central unit must be pressed. The LED in the isolator must blink in orange to check that the connection is correct.

-Test 5. The LENS N30 can be forced also to have a lighting faillure. However, because it is a non-permanent luminaire, the faillure will not be recognized if a power faillure is not forced. Though, after having turned down the 'Lighting faillure' switch, the 'Power faillure' one must also be switched. Then, the LED placed at the bottom will pulse twice in orange.

-Test 6. Automatic switches could be created in the DaisaTest software. This function allows to automatically switch on and off permanent lights and those which depend on centralized power units. Thanks to this option, lights can be switched on when desired according to the necessities of the building or the necessities of the property.

-Test 7. The DaisaTest software controls all the installation constantly. Moreover, two specialized tests can be programmed. The first one simulates an emergency situation during 20 seconds in order to check that everything works correctly. The second one forces an emergency lighting to download all its battery to measure and check their durability. Both tests can be programmed in the DaisaTest software to avoid disturbing the users of the installation while the building is not in use.

-Test 8. When a faillure is found in the installation, the software automatically shows a proposal for maintenance. To access to this proposal, the blue wrech must be clicked. It will show the model reference of the luminaire in case it is a lighting problem or how to check the faillure to restore it. All these reports can also be sent through e-mail to the desired adresses: maintenance service, users of the building, etc.

6. Discussion and conclussions

The conclussions drawn from the design and operation of the cabinets can be summarized as follows:

- The cabinet has shown that the advanced knowledge can be transferred to future architects with regard to the concepts of emergency lighting, the possibilities available on the market and the importance of the associated software in the buildings management.
- The cabinet will not become out of date, because the luminaires are easily substituted by the brand new models that will be developed.

- Versatility of the final solution, because a big amount of tests can be conducted according to the user: architecture student, engineer, building designer or even emergency services workers of the government administration.
- All data presented allow the experience to be replicated by others, with particular interest in those Technical Schools which make their research at the boundaries between architecture, engineering and fire safety [13] [14].

The connection with the fire safety installation cabinet is expected in the foreseeable future. This will allow the users of the technical cabinets to understand even better the relationship among the different components of a fire safety equipment.

As this experience has been so successful authors will intend to create a new cabinet, to show students conventional lighting concepts.

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