INTERACTIVE EDUCATION ON SUSTAINABLE USE OF ELECTRICAL DEVICES

ORIGINAL SCIENTIFIC PAPER

Jernej Frangež✉, Marko Jesenik

DOI: 10.51558/2232-7568.2023.16.2.57

RECEIVED 2023-11-15 **ACCEPTED** 2024-04-11

University of Maribor, Faculty of Electrical Engineering and Computer Science, Koroška cesta 46, 2000 Maribor, Slovenia

✉ jernej.frangez@um.si

ABSTRACT:
Education in GREEN electrical energy and production usage is essential for young people. Every consumer can do a lot if they use electrical devices wisely. This paper will present the design, intention and use of a didactical learning exhibit for middle and high school students during technical days on faculty and faculty promotions and for educational purposes. Our main goal is to introduce students to how some everyday electrical devices work, how much energy they use and how they can save as users. The most significant emphasis will be electromagnetic devices such as elevators and devices we use daily. We will use a professional approach and design for that purpose, but we will focus on presenting it on an interactive touchscreen and small examples of those devices. The content will be in graded expertise levels, from simple picture and animation calculations to the advanced picture and mathematical model presentations. The exhibit will be designed modularly so that content or presentation can change quickly and be made from recycled or sustainable materials as much as possible.

KEYWORDS: Sustainable; Educational; Electricity; Electromagnetic devices; Interactive; Elevator; Exhibit

INTRODUCTION

Before creating a didactical learning exhibit, the most important thing is setting goals for its functionality and target population. Our leading group are younger population but as high school and faculty students. Because of that, it should be physically assembled robustly and look attractive to them. That is why we chose a capacitive touchscreen, which is robust and has no mechanical commands or buttons. With that approach, we can extend usage life because it can be programmed with actual problems in the future without changing hardware. With every part of the design, we are looking to use sustainable components and materials which are environmentally friendly. We found a teaching platform for electromagnetics [1]. Platform designed for teaching the theory of electromagnetics, our work will present teaching practical examples. We use data on elevator energy usage from the publication Advancing Elevator Energy Efficiency [2]. The paper includes three sections. The Materials and Methods section describes the conceptual idea, exhibit design, calculations and simulations. Results, screen configurations and preservations on exhibit are included in the section Results and Discussion. In the final section, Conclusion, we will discuss about further development.

MATERIAL AND METHODS

The main component of the exhibit is a touchscreen display, so we did market research. Our requirements were a size of around 10 inches, capacitive touch, colourful, integrated screen driver hardware, acceptable price, good graphic editor, and an option to connect outside microcontroller. We found Nextion display NX1060P101-011C-I with a 10.1-inch display, 1024x600 pixel resolution. It can also connect over UART communication with the microcontroller and integrated audio driver with an equalizer. In Fig. 1, is presented the selected touchscreen display.

Figure 1. Touchscreen display used for exhibit

For designing the 3D model of the exhibit, we used Designspark Mechanical software. The most straightforward solution will be to 3D print the touchscreen display housing or mount it in some electrical dose. However, there will be used plastic, which is harder to recycle. Because of that, we propose to use medium-density fiberboard (MDF) from waste material used in carpenter production. Only display will not attract the target population so much, so we should add mechanical devices. Because we are focused on presenting the working of electromagnetic devices, we add three devices of this type: direct current electrical motor, speaker and electric relay. That means we will present some smaller real devices combined with theory and working principles displayed on the touchscreen display. In Fig. 2, you can see the conceptual idea.

Figure 2. The conceptual idea of the display housing

Our faculty organizes many events, presentations and workshops on our work and education about technology to scholars and students. They are focused on teaching and transferring knowledge, but little focus is on ecology and sustainable use. We will present our two proposals and approach to include more of that part. Many people use elevators daily, especially in commercial and residential buildings. For example, exact numbers were not essential to our calculations or measurements, so we used existing data and presented it in Table 1 [2].

Table 1. Elevator energy usage in low-rise buildings [2]

	Residential apartments	Commercial office
No. of trips per day	176	589
Running power (W)	4900	8500
Idle power (W)	1326.45	208
Nonrunning power (W)	1645	409.8
Daily energy consumption (kWh)	5.35	29.68
Annual energy consumption (kWh)	1656.48	6422.88
Reduced daily energy consumption (kWh)	4.55	25.23
Reduced annual energy consumption (kWh)	1408.01	5459.45

Data shows the main difference between residential and commercial use and the type of elevator. The residential is more decorated and better looking, as well as its lighting and control panel. This impacts idle power, which is more than six times bigger than in Commercial ones. The difference is in running power because Residential elevators are mainly constructed to transport people and lighter loads.

We calculated if we lower consumption by 15 % from the presented data, which means lower usage time and less consumption in nonrunning time with more efficient lighting and control units. From equation (1)-(4) you can see calculations [2]:

$$E_{drr} = E_{dr} \cdot 0.85 = 5.35 \cdot 0.85 = 4.55\ kWh \qquad (1)$$

$$E_{arr} = E_{ar} \cdot 0.85 = 1656.48 \cdot 0.85 = 1408.01\ kWh \qquad (2)$$

$$E_{drc} = E_{dc} \cdot 0.85 = 29.68 \cdot 0.85 = 25,23\ kWh \qquad (3)$$

$$E_{arc} = E_{ac} \cdot 0.85 = 6422.88 \cdot 0.85 = 5459.45\ kWh \qquad (4)$$

Where E_{dr}, E_{dc} daily energy consumption, E_{ar}, E_{ac} annual energy consumption of the elevator system in Residential and Commercial buildings.

After considering 15% lower energy usage where E_{drr}, E_{drc} reduced daily energy consumption, E_{arr}, E_{arc} reduced annual energy consumption of the elevator system in Residential and Commercial buildings. We can see some differences where we can save energy, and users will make something for their health because they will use the staircase instead of the elevator.

For the second proposal, we will be focused on synchronous electric motors with permanent magnets. The number of applications which use that type highly increases. Also, many elevators use that type of electric motor. Its actual theme is to educate how these devices work and why they are more sustainable than other types. If we compare these types over direct current motors with carbon brushes, those devices have a longer lifespan and higher efficiency. They are also more silent and have fewer vibrations because they have no carbon brush, which is user and environmentally friendly. We make two and three-dimensional motor models of the motor used in the exhibit. Simulations and equations will be presented on display screens. For example, you can see in Fig. 3 the model and magnetic flux of the electric motor used in the exhibit.

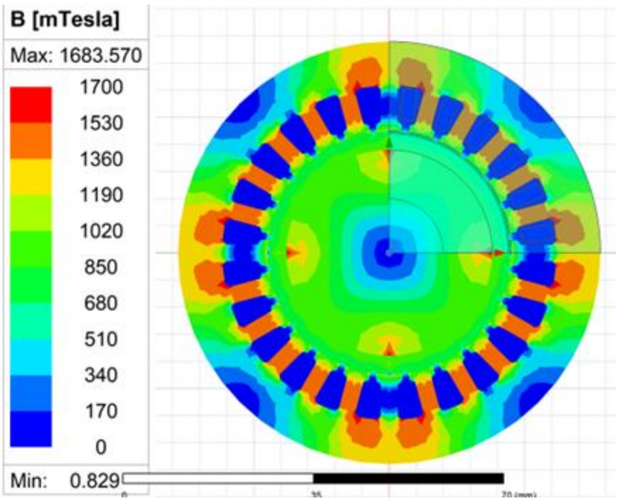

Figure 3. Simulation of magnetic flux density in exhibit electric motor

RESULTS AND DISCUSSION

In the previous section, we present our proposal, which will go into assembly. After the assembly, we will present it with the test screens below. Presented screens are for testing purposes to see how people will accept transferring information that way. After that, it will be graphically improved. The range of presented applications can be extended to more examples and proposals on how to save energy. Fig. 4 presents two screen pictures for presenting elevator energy saving. The upper screen presents an introduction, and the lower presents a calculated example.

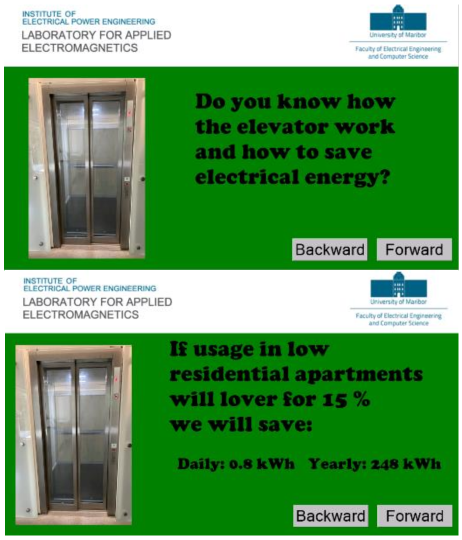

Figure 4. Example of two display screens for presentation elevator energy-saving

Continuing with the expertise level, we presented the magnetic flux density distribution in the exhibit electric motor. As mentioned, it is a permanent synchronous electric motor with permanent magnets. Fig. 5 presents two screen pictures of a computer design of a model for electromagnetic calculation. The upper screen presents a calculation of the magnetic field in the used electric motor.

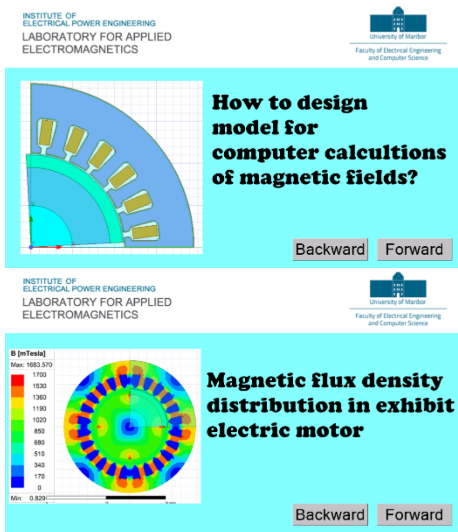

Figure 5. Example of two display screens for presentation electromagnetic calculations

CONCLUSION

Our goal will be fulfilled if we change their mind and turn them to thinking greener when using electrical devices. To educate on reducing energy usage, users must also understand the fundamental aspects of how devices work. Because natural energy resources are closely connected, if we reduce the consumption of one, we also affect others. Further development will be assembly and evaluation. The evaluation will be in two parts, testing the working of the exhibit and user's experiences.

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