

## DESIGNING A SPECIALIZED AUDITORIUM AS A CENTRAL VENUE FOR APPLIED STUDIES AND RESEARCH IN PRECISION AGRICULTURE

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### ABSTRACT

The present paper focuses exclusively on the establishment of a Centre for Precision Agriculture (CPA) – a specialized facility tailored specifically for training, lectures, laboratory exercises and seminars. The project itself involves the transformation of the existing auditorium into a modern venue for applied studies and scientific research at Dobrudja College of Technology, geared towards the implementation of innovations in the field of precision agriculture. Examined carefully are the parameters that are likely to affect the construction and design of lecture halls and other educational spaces, as well as the selection of proper audio-visual systems. Thoroughly analysed are various factors including the design specifications for contemporary educational technology, which are subsequently reviewed in relation to the potential design alternatives within the existing space.

**Key words:** design, lecture hall, lighting, sound, ergonomics.

### INTRODUCTION

In order to keep up with the changing landscape of precision agriculture, it is essential for students to receive instruction in the latest techniques for monitoring and analyzing agricultural practices. This, in turn, involves training in modern advanced methods for calculating vegetation coefficients at various stages of crop growth, analyzing the effectiveness of soil treatment, and the importance of applying fertilizers and preparations (Haghighi, 2020).

The introduction of a new specialty course in Precision Agriculture at Dobrudja College of Technology based in Dobrich, has highlighted the necessity and emphasized the top priority for establishing a dedicated research centre devoted to student training.

CPA activities, in general, will primarily concentrate on meeting the technological demands of the agricultural sector, creating new products, and implementing innovative strategies and groundbreaking solutions. Given the specific characteristics of the region where the research centre will be located, namely southern Dobrudja, with the administrative centre being in the town of Dobrich, one of the country's most prosperous grain-producing areas, with a strong presence of the agrarian sector, its relevance is paramount as it will directly address the mechanization and electronization of agriculture.

The design of the auditorium will play a crucial role in ensuring the excellence of the training. It should incorporate a diverse array of features in order to provide the most effective learning environment (Shmeliiova et al, 2022).

It is even more important for all attendees to be able to engage with the presenter (Appendix, 2020).

Maintaining the optimal balance between auditorium capacity and functionality is vital to consider when planning the design of the hall. The more functional and versatile the hall is, the greater the variety and number of events it can accommodate. Through the advancement of scientific knowledge and development of innovative scientific and applied products, the CPA

aims to foster stronger collaborations with agricultural businesses on a local, national, and global scale. Additionally, the CPA offers a platform to inform and educate agricultural producers on contemporary digital solutions and sustainable approaches.

The present paper strives to propose a research project for the CPA at Dobrudja College of Technology -Dobrich, within the structure of Varna Technical University. The project reviews the possibilities for renovation (Ordinance, 2015) of an existing auditorium and its optimization for the provision of lecture courses on “Precision Agriculture”. The construction of the CPA is funded under ISP1/2023.

## MATERIALS AND METHODS

The amphitheatre layout of the hall guarantees that every student has a clear view of both the lecturer and presentation materials. The presentation area and speaker’s desk are to be strategically positioned away from the whiteboard and presentation area.

LED lighting fixtures measuring 600 x 600 mm are to be installed in the suspended ceiling to provide the required level of illumination. The auditorium illumination is computed by the following equation:

$$E \text{ (lx)} = \frac{1 \text{ lm}}{1 \text{ m}^2} \tag{1}$$

When determining how well a space is lit, it is important to consider both the incident light and light that is reflected off surfaces (Varbanov, 1999). The diffuse light is determined by the tint and texture of the surfaces. It is assumed that the reflection coefficient, including natural daylight, is 0,7. The selected LED lighting fixtures have a colour temperature of 6000K, with a power of 40W and 3200 lumens each, with a total of 12 fixtures installed. Thus, the illumination of a room of 51,6 sq/m is:

$$E = \frac{0,7 \times 12 \times 3200}{51,6} = 520,9 \text{ lx} \tag{2}$$

The illuminance level is sufficient for learning activities, providing 372 lux when no natural light is present.

Natural lighting is a key factor in enhancing productivity and comfort in any setting. There is a chance to upgrade the auditorium by installing windows measuring 4m x 4,3m on the south side and 4,3m x 1,3 m on the north one. By utilizing modern window frames and glass units with good insulation properties, the auditorium can maximize the benefits of natural lighting, ultimately improving the comfort of those working within.

Recognizing the correlation between sound pressure amplitude and distance is crucial when choosing the required sound system for the lecture hall, as delineated by the sound absorption coefficient  $\alpha_k$ , illustrating the distance at which the waves amplitude decreases by e-fold.

$$p = p_0 e^{-\alpha_k x} \tag{3}$$

The sound absorption coefficient  $\alpha$  is subject to factors such as the material of the structure, the frequency of the sound, and angle of incidence of the sound wave. It should be noted that the frequency dependence of  $\alpha$  varies among different materials. The ability of a material to absorb

sound is impacted by its capacity to convert sound energy into heat through friction within its pores, contingent on the ratio between its acoustic impedance and that of the ambient air:

$$\alpha = 1 - \left( \frac{\rho c - 413}{\rho c + 413} \right)^2 \quad (4)$$

In this context,  $\rho c$  represents the specific acoustic impedance of the sound-absorbing material in  $\text{kg/m}^2$ , while 413 denotes the specific acoustic impedance of the ambient air (Hristev, 2014).

Amplitude and loudness in sound waves are directly related– the louder the sound, the larger the amplitude.

$$L_{\text{dB}} = 10 \log_{10} \left( \frac{P_1}{P_0} \right) \quad (5)$$

where  $P$  is the power.

The acoustic design in the lecture hall is a critical factor in gauging the extent of concentration. The presence of loud background noises or concrete walls are undesirable. Establishing the need for sound absorbing panel installation should be done through testing.

The allocated workspace area per student should not be less than 600mm in width. Given the restricted depth of the levels in the amphitheatre hall, passing without lifting those sitting is not feasible. Within the current setup, the workspace width measures 500 mm tightly in a row of 12 seats. In order to maximize the space, a central pathway has been strategically designed so that only two individuals would have to be raised from their seats at a time for smooth passage. A pair of staircases, each spanning 900mm wide, can be found on the opposite sides of the auditorium, with a planned central path measuring 700mm in width. The modification entails removing a pair of seats and expanding the size of the remaining seats from 500 to 600mm.

The lecture hall is equipped with audiovisual technology and a sound system. Additionally, it is imperative to have a well-designed computer configuration to captivate and challenge students both visually and mentally.

Increased engagement and improved communication in lecture halls are made possible through the utilization of audiovisual technology, which facilitates the synchronized management of visual images and sound for effective presentation delivery.

## RESULTS AND DISCUSSION

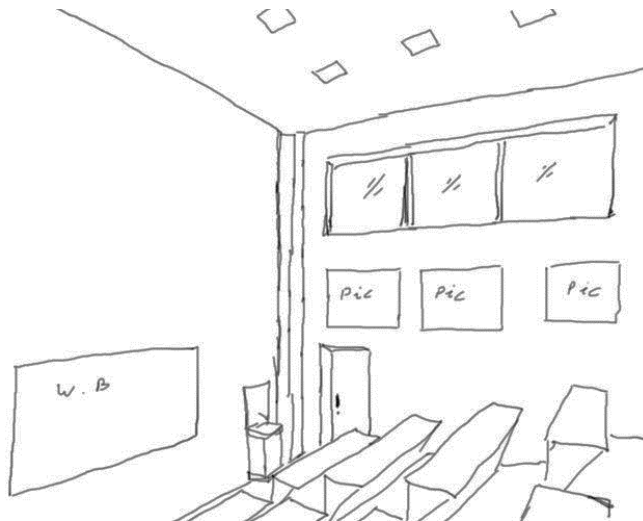
A comprehensive analysis was conducted of the existing theoretical statements regarding the nature and content of the category “digital agriculture as a model for farming development”.

The amphitheatrical structure of the auditorium prompted a more meticulous approach as to the placement of the seats for both students and the lecturer. A conceptual project has been developed in accordance with the hall’s layout, ergonomic requirements, and the seating arrangements. The creation of the project involved capturing images of the hall and then designing it digitally using a graphics tablet drawn with SketchBook software. Figures 1 and 2 illustrate the project for the south and north walls, respectively. To provide more individual space, the seating capacity of the hall was reduced from 60 to 50 studentseats. Designed, for the lecturer, is a desk complete with the relevant seating and presentation space. Arranged within the structure is a specific area for a personal computer to display and generate the material to be presented.

Allocated, within the vast expanse of the hall's walls, are specific zones for hanging boards, diagrams, and projects related to agricultural machinery in an effort to facilitate a clearer understanding of vital information.



**Figure 1: Conceptual Project 1.**



**Figure 2: Conceptual Project 2.**

The hall, subsequent to the precise measurements of all the architectural elements, is drafted with actual dimensions via AutoCAD software. The auditorium boasts internal measurements of 8,2 m x 6,3 m with a height of 5,5 m, resulting in a total area of 61,66 m<sup>2</sup> and a volume of 284 m<sup>3</sup>. To illustrate the final appearance of the hall and its furnishings, created is a detailed 3D project, as depicted in Figures 3 and 4.

The decision to use light yellow and olive-green mineral plasters on the walls was carefully chosen to complement the agricultural theme of the space. Each colour was selected to represent

different crops, such as yellow of wheat and sunflower, and the green of corn and other green plants. All in all, these colours were singled out to create a serene ambiance within the space (Raichev, 2005).



Figure 3: Visual representation 1.



Figure 4: Visual representation 2.

The furniture for the lecturer and students will feature a light wood finish, crafted from LPB material. The vinyl student seating arrangement will include a corner unit connecting three seats with a common top and front panel. Provided under the countertop will be some space for personal belongings (Kyuchukov, 2010).

The addition of a suspended ceiling is aimed at reducing sound reverberation and providing better thermal insulation.

Incorporated for presentations will be the Epson EB-685W projector, with a colour brightness of 3500 Lumens – 2900 Lumens (economy mode), contrast ratio of 14000 : 1, and power consumption of 301 Watt (Normal On-Mode), and a screen size of 60 inches – 100 inches. In order to optimize the space provided by the high ceiling height, a projector will be strategically mounted above the projection screen. A whiteboard will also be integrated into the design to facilitate writing and brainstorming sessions. The inclusion of these features is essential due to the intricate nature of the material being presented, requiring precise calculations and detailed drawings.

Selected for optimal audio performance was the FENDA F&D F770X, 2.1 channel surround system with 76-Watt (RMS) power and a frequency range of 45~90 HZ + 190 HZ~20 KHZ. Signal to Noise Ratio (dB) 75. Signal to noise ratio:  $\geq 70$  db. separation:  $\geq 40$  dB.

The background noise level in the hall is measured at 39,5 dB, which does not exceed the standards stipulated in the (Regulation, 2006) – Figure 5.

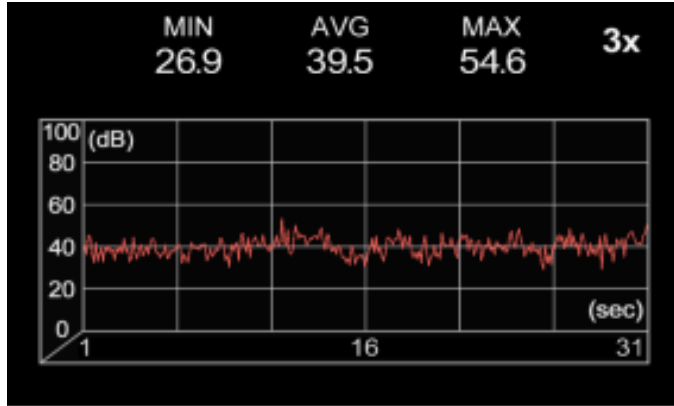


Figure 5: Level of the background noise.

The speaker’s loudness was measured at 45 dB when speaking from a distance of 1 meter. In comparison, the sound level in the last row was measured at 43,3 dB without the use of a sound system.

The hall benefits from natural lighting during daylight with 401lux because of its large windows (Figure 6).

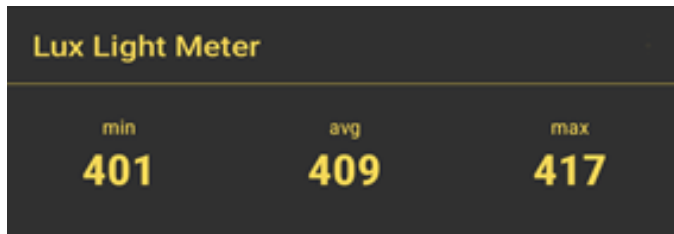


Figure 6: Natural lighting in the hall.

Window blinds are also available to adjust the natural lighting during presentations (as required).

A router will be installed in the hall to ensure internet connectivity for both lecturers and students.

A top view visualization of the hall, as depicted in Figure 7, reveals two designated stands- the first is a section for a seeder planter, and the second one – for a plough body.



**Figure 7: Visualization from above of the hall.**

The air-conditioning system in the auditorium will comprise a column air conditioner positioned in front of the windows to create a thermal curtain, as depicted in Fig.7 in the lower right corner.

Considering the climatic conditions in Bulgaria, a heating output power of 60 W per 1m<sup>3</sup> is required, while cooling demands – 50 W (vimax, 2024). An additional power reserve of 500W is appropriate for the air conditioner to operate smoothly in winter conditions. Obtained, thus, for the lecture hall is:

$$P \cdot V + 500 = P_{kl} \quad (6)$$

where: P = 60 W, V (volume of the hall) is 250 m<sup>3</sup> with the calculated volume loss due to the amphitheatre design of the hall, P<sub>kl</sub> is the power of the air conditioner.

The result is 15500 W. In this case, the power output of the air conditioner should be 16 kW, equivalent to a model with 60000 BTU. A similar standard model with cooling output power of 15.00 kW, heating output power of 19.00 kW, and noise level (indoor unit) of 47 dB is Gree GVA60AH-M3NNA5A.

The CPA flooring will feature laminate parquet with oak-coloured wood décor. The characteristics of the parquet will adhere to the standard BDS EN 13329:2016+A2:2022 (bds-bg, 2024). It is essential that the parquet will be able to withstand intense loads, and therefore, it must be Class:33-34 with Abrasion resistance of Abrasion resistance – AC5-AC6.

#### CONCLUSIONS

The present paper is designed to give a sharper focus on the project regarding the establishment of the Centre for Precision Agriculture, tailored specifically for the provision of training in precision agriculture methods and practices to both students and farmers.

The current state of the auditorium has been carefully examined, resulting in a project for essential improvements and modifications that align with CPA standards.

Accordingly, careful attention has been given to the background noise levels and natural lighting in the lecture hall. A sound system and energy-efficient lighting fixtures have been recommended to provide optimal illumination.

The selected colour palette for the interior design complements the hues commonly found in agricultural settings.

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