CONSTRUCTION OF A BALL`S MILL: AN EXAMPLE OF INTEGRATION BETWEEN THE BASIC CYCLE AND THE PROFESSIONAL CYCLE IN THE COURSE OF FOOD ENGINEERING OF THE CENTRO UNIVERSITÁRIO DE BELO HORIZONTE

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***Abstract*.** In a historical moment of rapid scientific and technological changes a constant reflection about an engineering course curricula structure and the extra curricular activities has been necessary. In this contest the focus of this reflection comes through the following questions: What does this institution desire for its graduation? What do companies want from their engineers? It is known that there are institutions that valorize a solid scientific knowledge, others a more applicable one. Also in the companies' universe there is a necessity of engineers capable of having the domain over all types of knowledge: from those which favor the creation of new products (a more scientific profile) to those that aim the production it self, the maintenance and the client's bringing and support (a more applicable profile). Attempting to answer those questions, we believe in a graduation that brings an equilibrium between knowing to think, knowing to do and knowing to be. Our proposal was to make a scientific initiation which would make the integration between Physics and Unit Operations in our course. This integration was made by the building of a low cost ball's mill, because the buildings of equipment makes possible the application of the theoretical knowledge acquired in these disciplines, besides it also stimulate their creativity towards engineering problems resolutions. This work will show relevant aspects of the impacts of the equipment' building in learning, in students graduation and in the teaching methodology.

***Keywords**:* methodology of education, engineering education, ball's mill

1. Introduction

In the contemporary world's dynamic the engineering teaching must use methodologies which approach and balance the learning of how to think, to do things and to be, "(Silva)". Knowing how to think is associated with the subjects such as mathematics, physics, chemistry and the engineering sciences. Knowing how to do things is associated with subjects that make the integration of knowing to how to think and knowing of how to be, allowing the development of processes to satisfy specific necessities such as the conception of machine elements. And at last, knowing how to be, referring to engineering students is related to the history of the techniques' science – it's perception that the scientific and technological science is not associated with the political, social and economic factors. It is believed that the equipment's buildings made by students and the study of the project variables are capable of finding the equilibrium among the knowings (a pedagogical boarding based on projects`s methodology: a new paradigm of engineering), "(Cardoso and Menezes, 2003)". Even with the constant engineering curricula actualization, few interdisciplinary subjects in between the college bases and the professional teaching, it might be because of the small desire of the university's docent party so that these bonded works happen, as well as the lack of the institutions' initiative of feeding such integration projects. This essay intends to show that it is possible to increase the fusion between knowledge acquired during the college bases and professional teaching through the buildings of equipment.

2. Materials and methods

The project was initiated with classes of theoretical physics applied to machine elements and Unit Operations related to milling processes: a pedagogical enrichment towards the development of this

research and the use of different concepts in between physics and unity operations in order to solve engineering problems. A proposal which encourages the active participation of students along with the introduction of students into the art/science of formulation and resolution of engineering problems. In this process, great emphases was given to creation and experimentation. It`s necessary to learn how to do, to understand how things work instead of just reading how it had been done.

The equipment's construction was initiated by the reuse of recyclable material found in the institution: An old machine proper to stretch pasta was turned into a ball mill. A stainless steel budge entirely covered with wheel inner tub rubber was used. The budge dimensions are: 0.2 m height and a 0.1 m radius. The machine's pulley was replaced in order to allow the mill's rotation frequency to be of 1.23 Hertz, "equation (1)", "(Ribeiro e Abrantes ,2001)".

$$\text{Operation frequency} = 0.53 \,/\, (\text{mill's diameter})^{1/2} \quad (1)$$

A motor of 248.57 W and two different sized balls were used: carbon steel and billiard`s balls. The choice of using two types of balls was due to the fact that the milling's income was tested in function of the milling balls' density to a constant volume. We also considered their low cost. The number of balls for the mill was calculated through the "equation (2)", " (Ribeiro e Abrantes , 2001)".

$$\text{Number of balls} = (\text{ball density})\,(\text{budge volume})\,(\text{occupation percent}).\ 0.5 \,/\, (\text{ball mass}) \quad (2)$$

The material chosen for the milling was maize flour. For both ball types millings with the following timings were performed: 300 s, 1800 s, 3600 s, 5400 s and 7200 s. For each timing measures of the process's efficiency (grain size reduction) were made through grinding and optical microscopy. In the case of microscopy optics, one technique of low cost was also elaborated: a magnifying glass of microbiological counting together with a digital camera was used to get the images of grains in scale. Such photos had been analyzed in the software Sizemeter.

Results

The "Figure 1" shows the ball's mill constructed in the laboratory of Engineering by the group.

Figure 1 - Ball's Mill

The “Figure 2” shows the bulge and the billiards’balls .

Figure 2 - Bulge with the balls

The “Figure 3” shows analysis for microscopy optics before the milling.

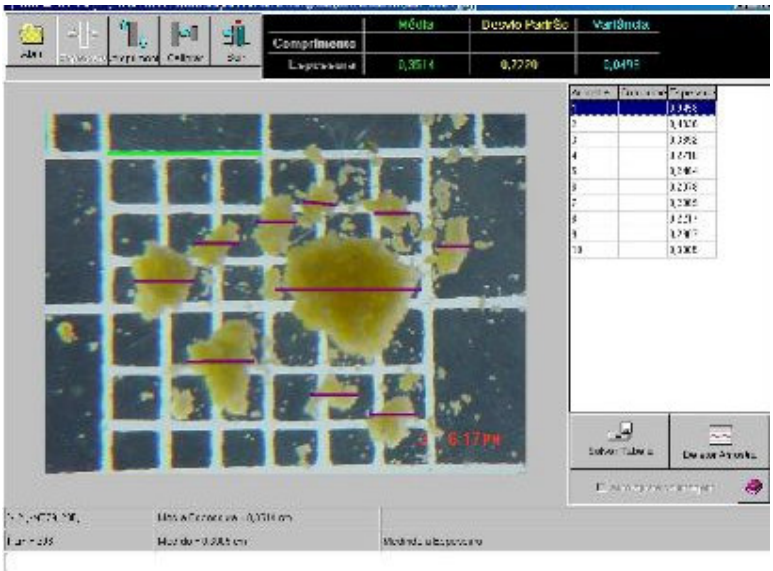

Figure 3 - Analysis of microscopy optics before the milling

The “Figure 4” shows the image of analysis of the microscopy optics of the maize flour after been milled by billiard`s balls per 300 seconds.

Figure 4 - Analysis of microscopy optics of the maize flour after been submitted to the milling process with billiards`s balls per 5 minutes

The “Figure 5” shows the image of the maize flour after been submitted to the milling process with carbon steel balls per 300 seconds.

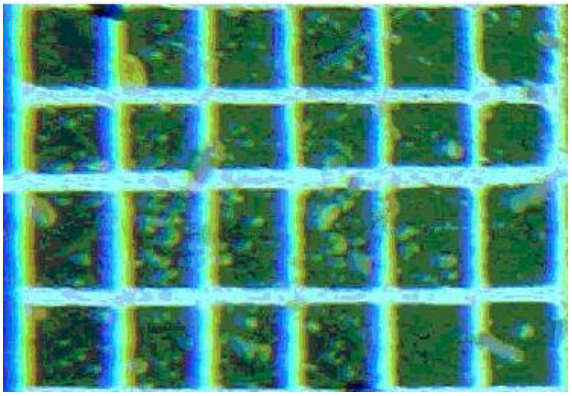

Figure 5 - Image of the maize flour after been submitted to the milling process with carbon steel balls per 300 seconds.

The "Table 1” shows some results of milling with maize flour.

Table 1 – Some results of milling with maize flour

Milling time (seconds)	Medium diameter of system (m) Milling with billiard`s balls	Medium diameter of system (m) Milling with carbon steel balls
0	0.00334	0.00334
300	------	0.00259
1800	0.00023	0.00014

As a pedagogical result obtained through the project`s methodology it has been observed that the students acted in a more active way on the process of knowledge`s construction. It was verified that the students`s active position during the investigation process and the surpass of the problems during the mill`s building lead to a greater engagement to the project.

Conclusion

It can be concluded that it is interesting to search for new methods and improve the present ones that are focused in the exact sciences searching for a education which increases the relation between teaching and learning aiming the graduation of competent professionals as well as conscientious citizens. This essay showed that a pedagogical effort in order to mix in grater proportions the acknowledgements acquired in the college bases and the professional teaching (a interdisciplinary boarding) through the buildings of equipments (a pedagogy focused in projects methodology) is valid. The mill's construction converged to the understanding of teaching as a process which gives capability, builds and develops abilities.

3. Acknowledgements

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4. References

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