MECHANICAL PROJECTS WITH PRACTICAL CASES

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Abstract. *The study of mechanical engineering in the "Project of Mechanical System" discipline involves theory that is difficult for students to get motivated and pay attention. Topics like creativity, models, product and society, classification of project, planning of production and execution, structure of project, economic project, design, project for easy maintenance, patent, brainstorming, etc, are difficult for students to get motivated since they are almost an engineer and are interested in constructed cases. In this article, two practical cases are presented to students from department of Mechanical Engineering of Unesp-Ilha Solteira to solve. The projects presented are an elevator for a manipulation's pharmacy, with some equipment already acquired by the owner, and an Off Road car for student competition. The students were asked to present alternatives, to discuss preliminary project, to work in groups and to fabricate the elevator and the vehicle. The elevator was constructed and is working satisfactorily. The vehicle has participated in some competitions and has got some satisfactory results. Details of the development and student discussion are presented in this article.*

Keywords*: Engineering, design, autoca.d*

1. INTRODUCTION

In the early 1950's a committee on evaluation of engineering education of the American Society for Engineering Education stated that Training for the creative and practical phases of economics design, involving analysis, synthesis, development, and engineering research, is the most distinctive feature of professional engineering education (Shigley, 2002).

Although these goals were stated nearly 50 years ago, they are valid today. Since diagnosis is required for many problems, particularly in upper-division courses, most students become reasonably proficient at it also.

The guideline approved by Brazilian Education Ministry, in the Resolution number 11/2002 for engineering courses was intensively discussed before being approved. It was elaborated based on giving a humanistic formation to Mechanical Engineer beyond the preoccupation on environment and the Ethic. All of it with the necessity of a solid basic formation capable to make the trainee absorb news technologies that continuously appears.

Engineering education focuses heavily on problem solving, but many professors teach content and then expect students to solve problems automatically without being shown the process involved. In our opinion an explicit discussion of problem-solving methods and problem-solving hints should be included in every engineering class.

2. MOTIVATION OF THIS WORK

In a research Gore and Gitlin (2004) asked teachers to respond to questionnaires and interviews regarding their views of educational research. They found that these teachers dismissed educational research because they did not find it practically applicable to their classroom situations, and they felt that the researchers did not take into account the specific contexts in which their findings would be applied. Teachers in this study also believed that educational researchers lack credibility because they are divorced from the real work of teaching, and that research is inaccessible to them because of the overly technical format in which it is presented. Rose (2002) notes that for the majority of teachers, their research remains a process that appears removed from their everyday practice.

According to Simon [3] experts have about 50,000 chunks of specialized knowledge and patterns stored in their brain in a readily accessible fashion. The expert has the knowledge linked in some form and does not store disconnected facts. Exercises, which require students to develop trees or networks, can help then form appropriate linkages (Straiger, 1884). Accumulation of this linked knowledge requires a lot of years. Since it is not feasible to accumulate this much information in four or five years, producing experts is not a realistic goal for engineering education. How the novices who start college differ from experts has been the topic of some studies like in Mayer (2002) and in Yokomoto and Ware (1990).

Cognitive psychologists are in general agreement that there are generalizable problem-solving skills, but that problem solving is also very dependent upon the knowledge required to solve the problem (kurfiss, 2003). Of all prerequisites, knowledge and motivation are the most important.

Confidence is also important, so professor should encourage students and serve as models of persistence in solving problems.

Teaching engineering is very difficult because students are interested in practical cases, especially those in the last year of the course. The discipline “Project of Mechanical System” faces this problem since it involves theoretical topics. In our opinion, ways must be found to involve the engineering student in genuine design experience.

In working problems, students need to practice defining problems and drawing sketches. The differences between a student’s sketch and that of an expert should be delineated, and the student should be required to redraw the sketch. Students also need to practice paraphrasing the problem statement and looking at different ways to interpret the problem.

As a Teacher of Mechanical course program we think that the program must be elaborated in order to give the engineer some ability. Among those abilities are notions of order of greatness, high general culture to realize the solution of engineering in the global context and enough knowledge linked to actual reality.

Learning topics like creativity, models, Product and Society, Classification of project, Planning of production and execution, structure of project, economic project, design, project for easy maintenance, patent, brainstorming, etc, are difficult to students to get involved since they are almost an engineer and are interested in practical cases. We notice some lack of interest in theoretical topics and the need of some practical project to motivate the students. We are used to giving them some machine, machine element, or some device to be projected. This part gets their attention more than the theoretical topics, but they can not see the result of their project. As a pharmacist was constructing a second floor in a pharmacy of manipulation in our town, and asked us to help him to project and construct that, we decided to delegate the job to students from department of Mechanical Engineering of Unesp-Ilha Solteira. We also gave them the task of projecting and constructing an off road vehicle to a Brazilian National Student Competition.

The group got very involved in the project and the discipline had the best results since we teach it. The group could see the result of their work in the end of the course and the theoretical topics could be showed as they projected the elevator and the vehicle.

3. EARLY EXPERIENCE

All the students, during the mechanical course, learn about Gauss, Newton, Leinniz, Hooke, Galileo, Pythagoras, Sadi, Carnot e Joule among others. Drawing the “Time – Line” and locate those people is very important and interesting to student to get inspired and to situate a discovery event with its author in the History.

Before giving the student a task, we also talked about the human evolution, the fire and wheel discovery, the Greek civilization, the renaissance, the motor history, etc.

One of the theoretical task gave to student in the past was to project a Submarine. As they claimed for practical case, we decided to present them two tasks. One was to project and construct a vehicle for Off Road Student Competition. We presented the Rules and Laws of the Competition and encouraged them to give solution and to construct that. Among a lot of project we chose one. Bellow it is presented the students involvement in the vehicle construction.

Figure 1. Construction of the vehicle. On the left students curving a tube for the structure, on the right the mounted structure.

In one Semester we discussed the project and construction of the vehicle. In the other semester we discussed the project and construction of the Elevator. Bellow it is presented the second semester discussion of our experience in the discipline “Project of Mechanical System” with the Practical Cases and some results of the first semester too.

4. THE ELEVATOR PROJECT

The owner of the pharmacy had bought a motor with a small reducer according to miss information. The motor was 1/8 CV with a nominal rotation of 1620 rpm and 110/220 V. The reducer had a transversal axis with a reduction of 1:60.

We explained that in a project the final product should be the response or the solution of an individual or collective necessity. The client can declare his necessity in terms of product that desire to buy; although his real necessity is, normally, the service that the product can render.

Before beginning the study of solution it is necessary that the problem to be solved by the product (elevator) be totally identified and stated.

The necessity of our client was, then, an elevator for a manipulation's pharmacy that should work in a clean ambient, without noise, not expensive, with easy maintenance, with some equipment already acquired by him. The charging box should pass by a hole of 360x320mm let in the corner of wall when the second floor was constructed.

So, they should work according to the need of the client and the need of the client could not be the best solution by an elevator for this purpose.

4.1 – Working in group

According to Hueter (1990), the creativity increases in elementary school up to an age of about eight and then steadily decreases with further schooling. At about eight years old children become very aware of the opinions of other people. It becomes important for them to fit in and to use objects for "what they are supposed to be used for". The result is a decline of creativity that continues through college.

A complexity science sensibility calls the attention to the need to allow for improvisation; a readiness to genuinely entertain new ideas and alternative approaches. Too often teachers willingly submit to being told what to do. However, this is not the sort of learning that should be expected from professionals, and should not be the sort of learning one accepts from the teachers. If inquiry is a defining feature of professional practice (Clarke, Erickson, 2003), then the generative space created by improvisation is essential for the emergence of complexity.

According to Naidoo (2004), improvisation is often used to help solve problems where conventional thinking particularly within a creative context is not working. It is also used to develop new ways of working that can be spontaneous and innovative. Through improvisation we create relationships with other improvisers that utilize our imagination and explore the differences that exist in relating that leads to creative emergence.

Working with the Assimow (1968) model, that is, study of execution process, preliminary project and detailed project, we tried to show them that as engineer they would work in-group because most of the time, factories let the responsibility of solutions to a group of people and not to a person. At this case it is necessary a procedure in order to have the best individual creativity process. We talked about project technique like Brainstorming, Synectics, artificial intelligence, analogy and others.

We divided them in small group of five people and we asked them to project the elevator without researching anything and anywhere. They should project without any previous knowledge and any previous start point. There was no previous existing elevator, like the one we intended to project, in their brain.

We motivated each group to present preliminary solutions. One of those solutions is showed in Fig. 2 where we decided not to translate the notations.

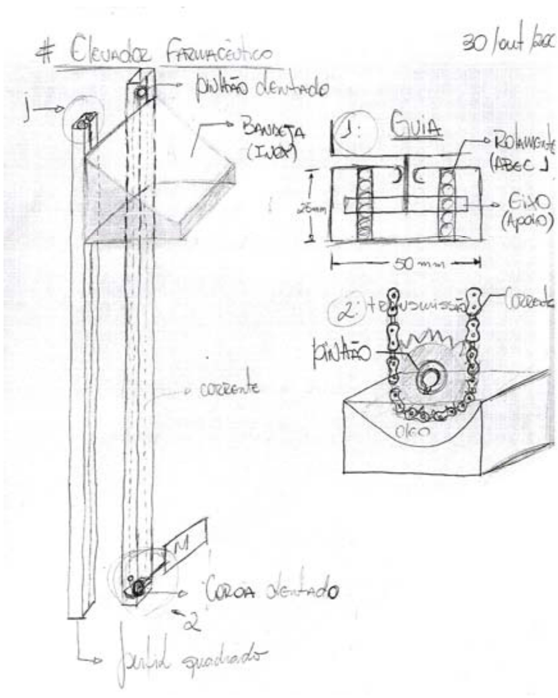

Figure 2. Sketch of first preliminary project presented

That solution was presented by one of the group and we raffled one to make a Brainstorming on that. Problem like noise, dirty and difficulty of maintenance were pointed and the preliminary projected was modified.

Everybody gave opinions and the first idea was rejected. It was adopted an assembly with steel cable instead of a belt or chain drive transmission.

As the steel cable pulls the charging box up or down the small weight of the empty charging box could let the steel not stretched and not winded correctly on the drum. So the drive pulley transmits the movement to steel cable by friction, and the adequate tensile happens. To keep this tensile there is a regulation in the inferior pulley system, assembled together a spring that avoid the cable loosening when the temperature give up or excessive tensile in cold days.

The transmission system by friction together the spring also work as an emergency system since in case of obstruction of the elevator there would be a sliding of the steel cable on the pulley that would avoid excessive load on steel cable and on the motor-reducer.

4.2 - Design

Lave and Wenger (1991) argue for a focus on the whole person, within the social context and the sociocultural community, where learning is seen as a process of participation in ‘‘communities of practice’’. In mentoring the relation between the mentor and the mentee comes into focus.

After the Brainstorming everybody agreed that the best solution was nearest a solution presented by the group three. The preliminary solution of this group was modified not substantially. Figure 3 and Figure 4 present some draw of the elevator.

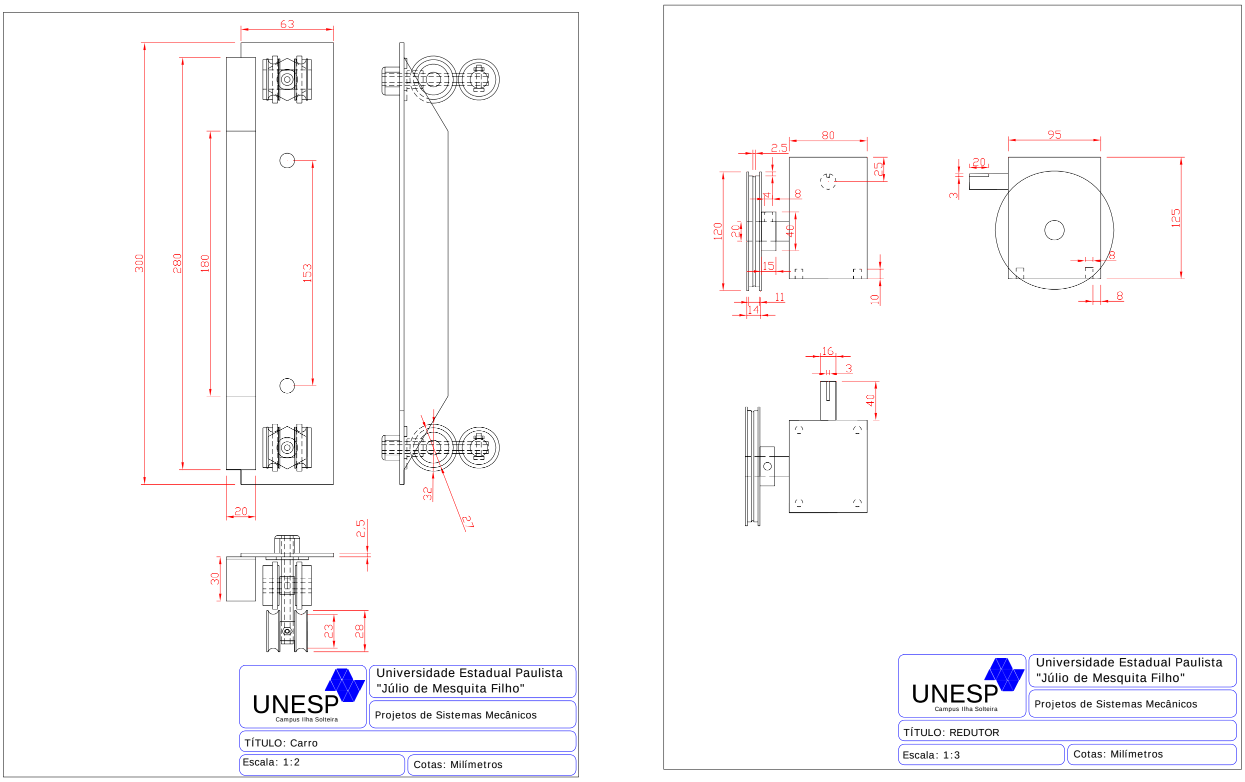

Figure 3. Mechanical drawing of elevator. Car on the left, reducer on the right.

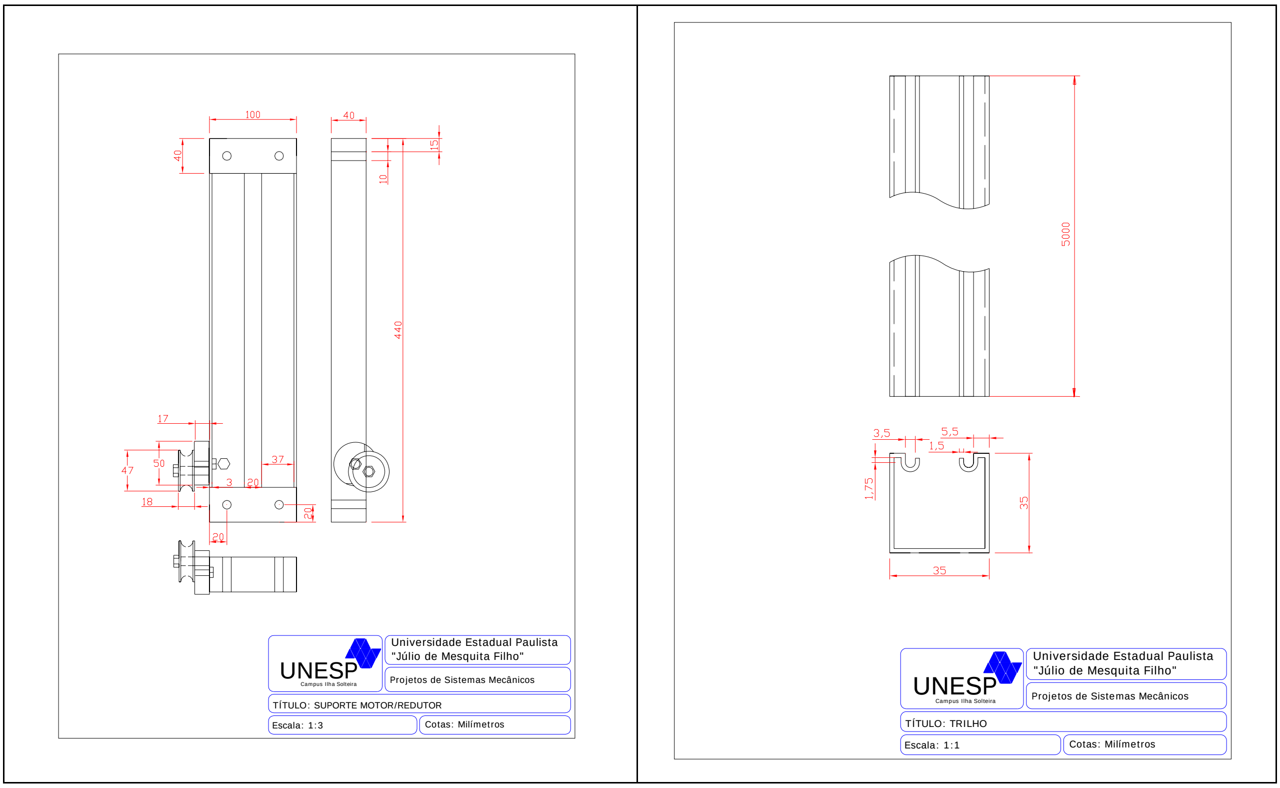

Figure 4. Mechanical drawing of elevator. Support of the Motoreducer on the left, Rail on the right.

Every piece was drawn in detail, including the electrical parts, and a Report was generated. Everybody was responsible for at least one draw. Every draw was corrected by at least one student. Every wrong draw was pointed, discussed and corrected. A maintenance manual and an elevator catalog were also generated. They had to plan the production.

In the project they made the following consideration:

Q = charging capacity = charge +charge box weight = 25 Kg;
Class I = class according norm NBR-8400 (1984) (motored machinery for occasional services, low speed, 6 operation per hour at most;
V_e = Elevation speed = 10 m/min;
η = Total performance of system = 0.8

It was used the following equations:

$$d_c = k\, Q^{1/2} \qquad (1)$$

where d_c is the minimal diameter of cable and K is a coefficient according to norm NBR 8400.

Solving that equations they got to:

$d_c = 0.31 \times 25^{1/2} = 1.55$ mm,

A cable of 2.5 mm in diameter was chosen with a security coefficient of 1.8.

As the motor already existed, they only verified if it was adequate applying the equation 2 and 3 bellow.

$$N_R = \frac{Q.V_e}{\eta.60.75}, \qquad (2)$$

$$N_n = 1{,}6\, N_R \qquad (3)$$

where, N_n is the nominal power and N_R is the regime power.

Solving those equations, they got to

$$N_R = \frac{25.10}{0,8.60.75} = 0,0694CV \ ,$$

N_n = 1,6 x 0,0694 = 0,11 CV

So, according the calculation above the motor acquired was enough.

5- RESULTS

Every body was involved in the construction of the elevator. To avoid a big number of people inside the pharmacy we divided again the student in small group. One group was responsible to go to the pharmacy to take some measurement, other to construct, another to assembly the elevator, other to buy some piece, etc. They had to remember some discipline to do the electrical parts. During the construction they also remembered discipline like machinery, welding and maintenance, beyond others. They had to specify roller bearing, learn how to make a maintenance manual, how to make a product catalog and how to make a project report.

The elevator is constructed since the end of 2005 and until today presented no problem. The ambient inside the pharmacy is clean; there is no contamination with oil and no noise.

In Fig.5 and Fig.6 some pictures of the elevator are presented.

Figure 5. Panel on the left. Panel mounting on the right.

Figure 6. Elevator Box on the first floor, on the left. Elevator on the ground floor, with the inferior part without protection, on the right.

Given in the same discipline the constructed vehicle, on one Competition is presented bellow.

Figure 7. Constructed Vehicle on a Competition. On the left, a group of motivated student mounting the vehicle for the competition. On the Right, the vehicle on an endurance.

7- CONCLUSION

During the project phase, once the problem has been completed, students should be required to check their results and evaluate them versus internal and external criteria. After the problem has been graded, some mechanism for ensuring that students learn from their mistakes is required.

In this experience with the practical cases, we noted that an individual can get impressed by the knowledge or judgment of others and fail in exercising your own creativity. Some students are afraid of giving opinion. The tendency of getting satisfied with one idea makes them think that the idea is the real solution of the problem.

Everybody was very involved in that idea and they felt like engineers projecting, discussing, constructing and seeing their job done. The evaluation of the course by the students and by us was excellent. We had to keep a big control in order to avoiding them to spend more time then enough in the discipline. We had to remember that other discipline was very important, as project of mechanical system, to their carrier.

8- ACKNOWLEDGEMNT

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