

# Development of interactive materials by engineering students using the Descartes applet

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- **Introduction**
- **Materials and Methods**
- **Results and Conclusions**

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## INTRODUCTION

The primary objective of the first year of Mechanics in a degree course such as Forestry Engineering should be to develop the students' capacity to analyse any proposed mechanical situation by applying basic principles which have been correctly assimilated.

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## INTRODUCTION

**But there are significant difficulties in teaching this subject due to:**

- **students' lack of motivation**
- **insufficient prior preparation for the topic**
- **discipline's inherent complexity**
- **the students' preconceptions about the subject**

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## INTRODUCTION

**Didactic activities have been introduced sequentially in the teaching of this subject:**

➤ **Teaching methodologies:**

1. **Creation of interactive applets as a teaching methodology (2002/03 academic year).**

➤ **Knowledge assessment**

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## INTRODUCTION

### Didactic activities

#### ➤ Knowledge assessment:

2. Incorporation of a module on prior knowledge of Mechanics (2003/04 academic year).
3. Assessment of preconceptions regarding the concept of force (2004/05).
4. Development of a work project in groups using Descartes software (2006/07).
5. Incorporation of the subject onto the Moodle platform (2008/09).

## MATERIALS AND METHODS

The average results for the subject of Mechanics and Mechanisms obtained by the students in the last five years are far from satisfactory:

- 26% pass
- 26% fail
- 48% no show

## MATERIALS AND METHODS

### Teaching methodologies:

#### 1. Creation of interactive applets as a teaching methodology.

Programs for mathematical calculations and for simulating phenomena are the most useful for improving students' understanding of the underlying concepts of mechanics.

Since the 2002-2003 academic course, a series of applets were designed and have been integrated into the teaching programme for the subject.



## MATERIALS AND METHODS

### Teaching methodologies:

#### 3. Assessment of preconceptions regarding the concept of force.

In order to detect preconceptions about the concept of force, Force Concept Inventory (FCI) has been carried out on all students since the 2004-05 academic year, before starting the specific teaching of this subject.

## MATERIALS AND METHODS

**Specifically, the most common preconceptions when approaching the study of planar kinematics are:**

- **failure to differentiate between position and velocity**
- **failure to understand the vectorial nature of velocity and acceleration.**

## MATERIALS AND METHODS

### Teaching methodologies:

#### 4. Development of a work project in groups using Descartes software

Regarding the assessment of knowledge, in the 2006-07 academic course we introduced a supervised work project to be carried out in groups (2 students) as an obligatory and evaluable activity in the kinematics module.

## MATERIALS AND METHODS

### Descartes project

Created for the purpose of exploiting the advantages of computers and the Internet to offer teachers and students in primary and secondary education a new way of teaching and learning. Descartes nippe is a program developed in the Java language (applets) which enables the creation of interactive scenes similar to electronic blackboards.

## MATERIALS AND METHODS

### Methodology of a work project in groups using Descartes software (i):

1. Preliminary session: in order to demonstrate the features of the tool.
2. The students are divided into groups to solve a problem involving the kinematic analysis of a basic mechanism (slider-crank four-bar).

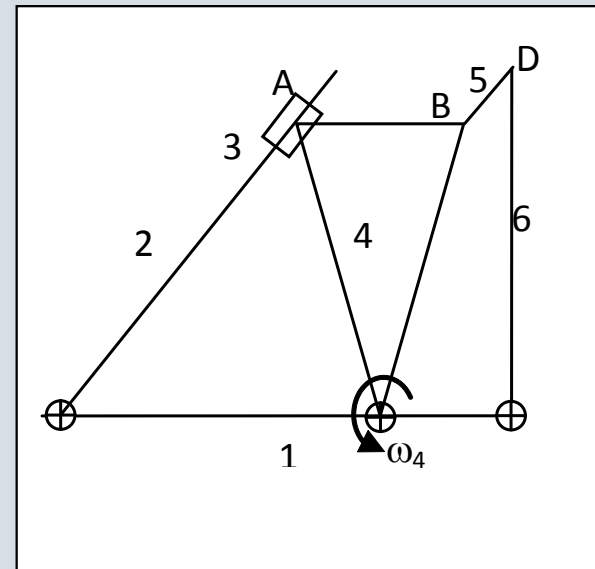
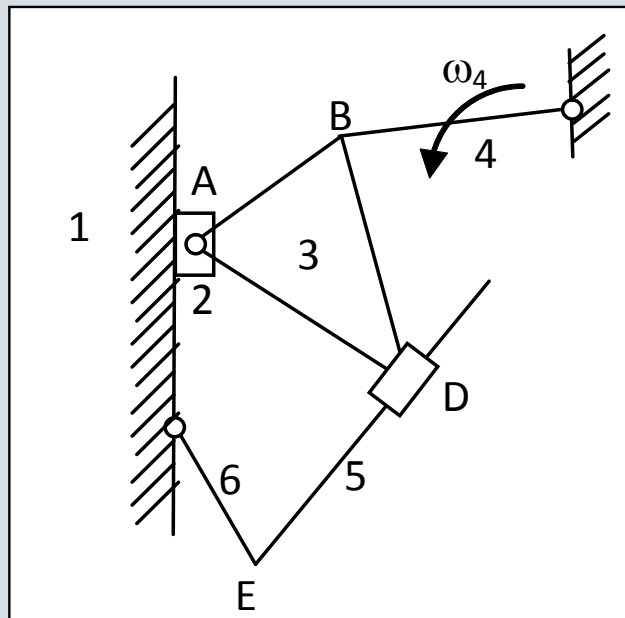
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## MATERIALS AND METHODS

### Methodology of a work project in groups using Descartes software (ii):

2. In this same session each group is given a collection of mechanisms (an assortment of about 20), from which they must select one

## MATERIALS AND METHODS



Examples of possible mechanisms for selection

## MATERIALS AND METHODS

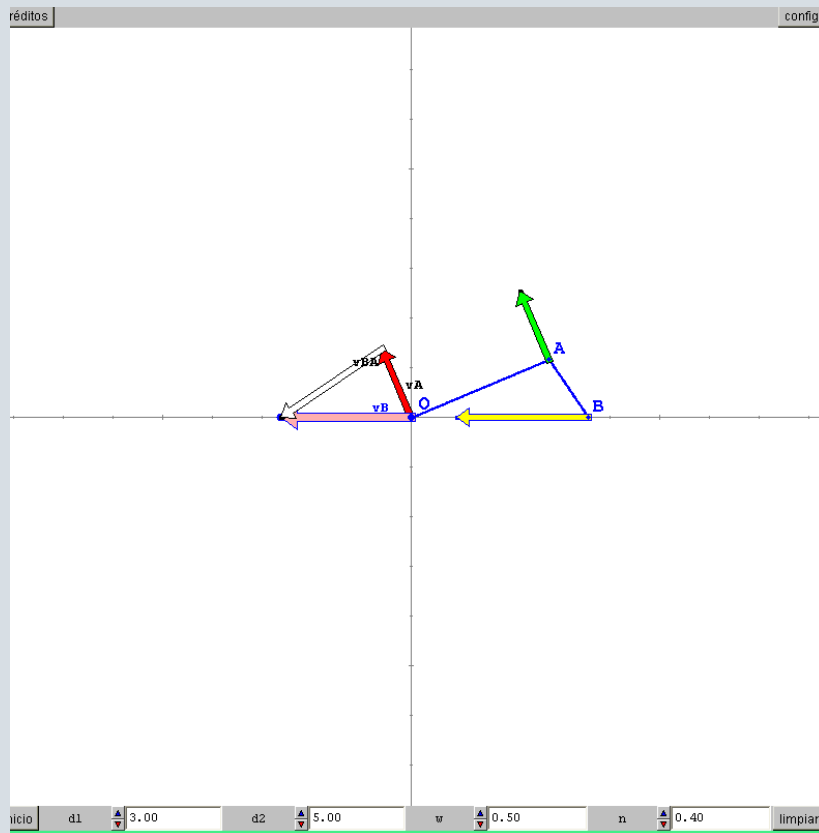
### Methodology of a work project in groups using Descartes software (iii):

3. The groups carry out their work project in eight two-hour sessions in the computer classroom, under the supervision of professors.



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## MATERIALS AND METHODS: procedure for calculating velocities for the basic slider-crank four-bar mechanism (i)

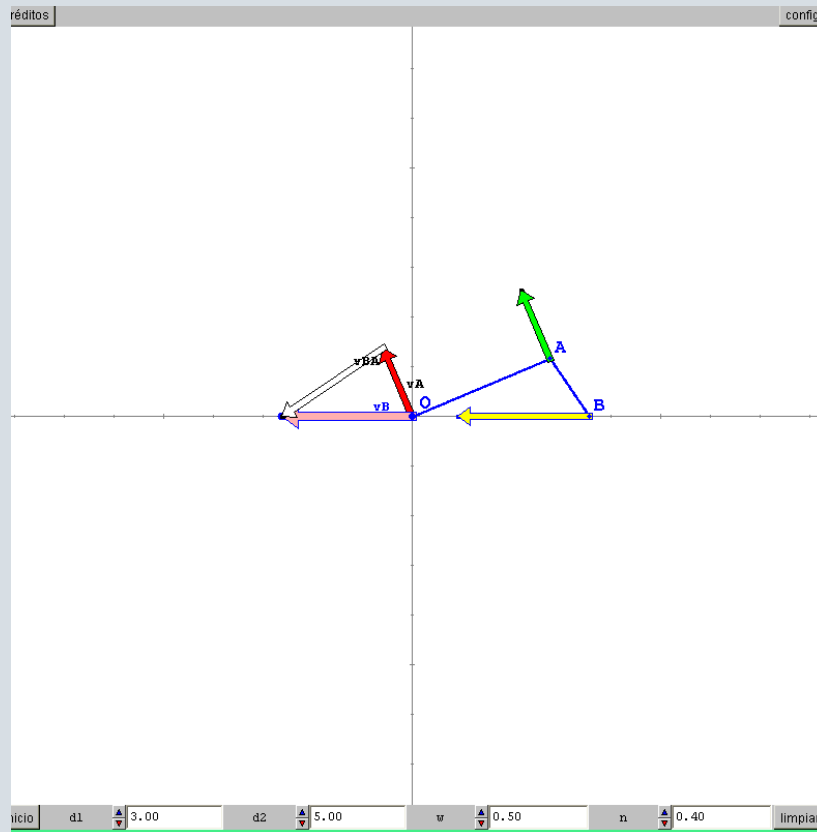


Slider-crank four-bar

- The angular velocity of the crank (OA)  $\omega$  is the starting figure.
- The coordinates of end A ( $A_x, A_y$ ) coincide with the components of vector OA. These components expressed in three-dimensional space ( $A_x, A_y, 0$ ) and multiplied vectorially by the vector  $(0,0,\omega)$  allow us to obtain the components of the velocity ( $v_A$ ).
- The velocity of the other end of the connecting rod (B) is obtained by means of the vectorial equation which relates the velocities of two points on the same element:

$$v_B = v_A + \omega \wedge BA$$

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**Slider-crank four-bar**

**MATERIALS AND METHODS:**  
procedure for calculating velocities  
for the basic slider-crank four-bar  
mechanism (ii):

- The velocity vector  $v_B$  is determined graphically at the origin of the coordinates by calculating the intersection of two straight lines. One of them has the direction of  $v_B$  (horizontal) and passes through the origin, and the other is perpendicular to  $BA$  and passes through the end of  $v_A$ .
- The velocity obtained must be transferred from the origin to the application point B.

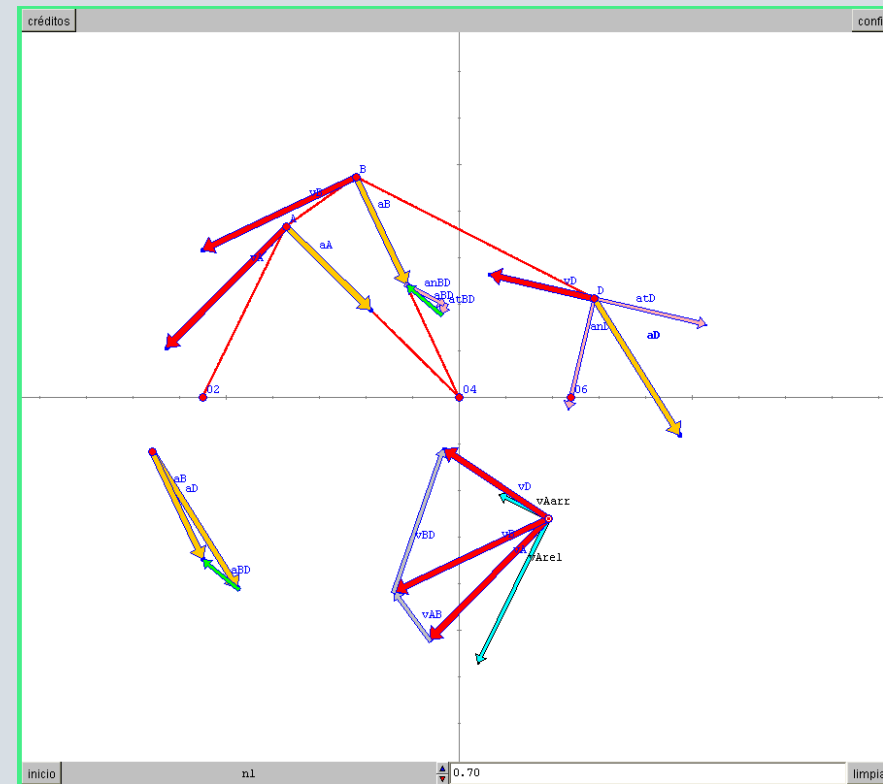
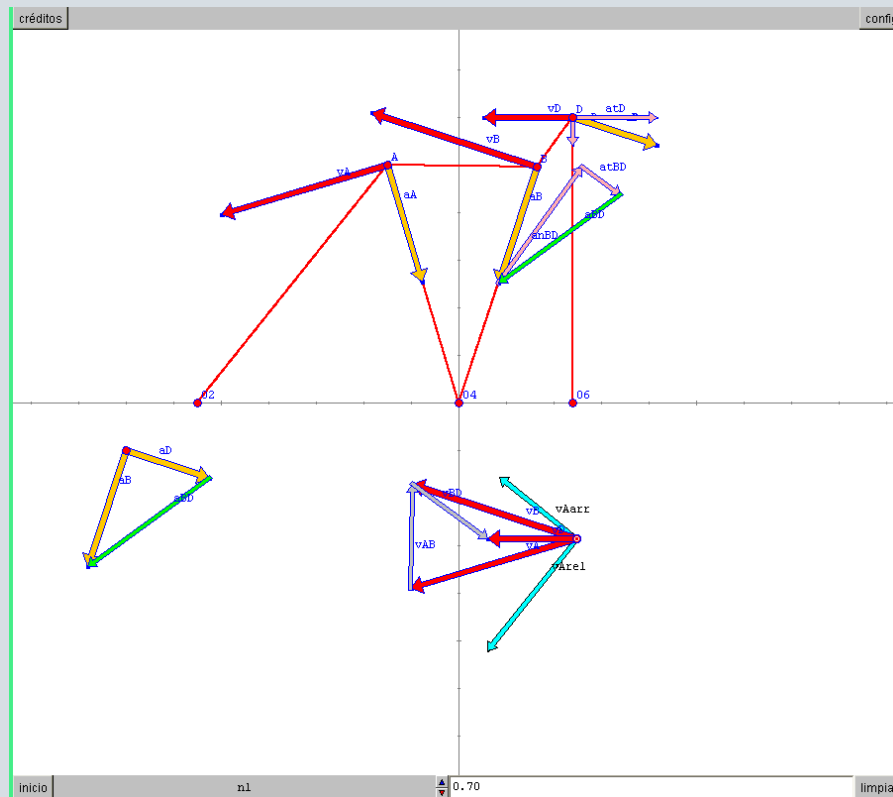
## MATERIALS AND METHODS

### Criteria for evaluating the work:

- Degree of difficulty of the mechanism
- Correctness of the calculations
- Clarity of resolution and presentation
- Use of auxiliary variables
- Control points in articulations and sliders
- Operations and calculations presented in a separate document

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# MATERIALS AND METHODS



Configurations of a mechanism

## RESULTS

### Distribution of projects by academic year

Year	Num. matriculated	Num. projects	% students
2006/07	133	20	30
2007/08	139	22	31.6
2008/09	129	33	51.2
2009/10	100	26	52
2010/11	133	45	67.7

## RESULTS

- It is helpful to use this method in order to modify the position of the elements without having to undertake the calculation of the simulation of the movement.
- The velocities can thus still be obtained correctly as the configuration is not modified. In addition, by moving the CP, it is possible to check that the velocities have been correctly calculated for any position.
- The use of this software by engineering students makes it possible to develop new skills and abilities. When the students create the material themselves, they have to analyse the problem in depth and at the same time graphically visualise their corrected calculations on the screen.

## CONCLUSIONS

- Some critical preconceptions for learning the subject (vectorial dimension of velocities and accelerations) can be corrected.
- The tutoring process in the classroom leads to improved teacher-student communication.
- Since its implementation, the number of students taking part each year has increased, and this group demonstrates the highest percentage of passing scores.

# Thank you for your attention!!

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