

An Incremental Approach to Teach Mechatronics Design at the Sophomore Level of Mechatronics Engineering Education

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Introduction

- ▶ Mechatronics engineering - design of innovative interdisciplinary engineering systems
- ▶ Need for hands-on skills as well as a strong theoretical background
- ▶ Project-based learning - incorporation of vertical (i.e., abstract and procedural) and lateral (i.e., search and brainstorming) thinking
- ▶ Capstone design courses at senior level integrate vast amount of knowledge and skills acquired by the students throughout their education
- ▶ A different perspective in teaching mechatronics design - hands-on skills on a design project at sophomore level

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Introduction

- ▶ Students at sophomore level have limited background on engineering science and almost no background on advanced topics
- ▶ Teaching sophomore students to gain an ability of thinking on a system level
- ▶ Design a simple but complete system to accomplish predefined tasks with their limited engineering knowledge
- ▶ They can better grasp the connections between topics in the rest of their curriculum and as a result, gain a much richer and deeper understanding of the discipline as a whole

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Course Overview

- ▶ MECE 202 Principles of Mechatronic Design”
- ▶ A spring semester course **with lectures and laboratory hours**
- ▶ Laboratory hours are reserved for working on the **design projects**.
- ▶ Projects are assigned to **individuals and/or groups of students** depending on the amount of funding available from the department.
- ▶ Typical grading:
 - ▶ Design Performance 30%
 - ▶ Weekly Reports 10%
 - ▶ Final Report 20%
 - ▶ Individual Progress
 - ▶ Final Exam

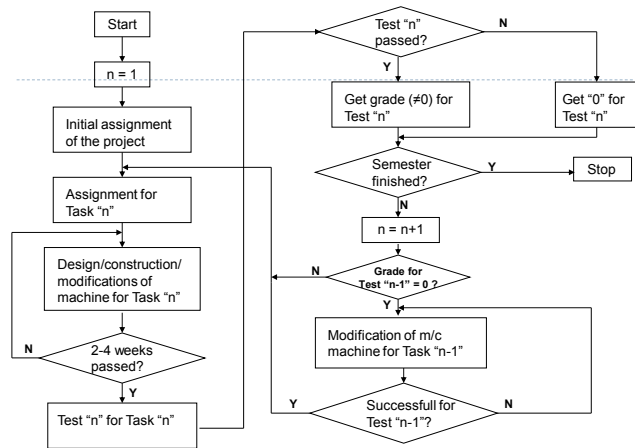


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Incremental Design Approach(IDA): Motivation

- ▶ **Incremental Design Approach (IDA)** is a sequence of design steps which are partly dependent on outcome of the prerequisite design steps.
- ▶ **3-6 incremental design steps** are implemented in a semester. In this approach, the first design project is assigned at the beginning of the semester with the regular associated design criteria and specifications.
- ▶ Students design and manufacture their machines to perform the assigned initial task within **2-4 weeks of design period**.
- ▶ After the finished period of the incremental design, **a test competition** is performed to evaluate design performance of all projects based on the predefined design criteria.

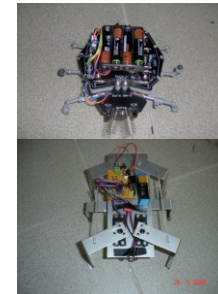
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Example Design Projects

Academic Year	Project Topic
2004-2005	Design and manufacturing of a machine to collect randomly located table-tennis balls on a floor area.
2005-2006	Design and manufacturing of a machine to move on the floor without any wheels or wheel-like elements in contact with the floor.
2006-2007	Design and manufacturing of a machine to move over a freely hanging catenary rope.
2009-2010	Design of a wide vehicle to move straight in a predefined path, to stop at a black line and to climb up an inclination.
2010-2011	Design of a moving and line following platform that stops when there is an obstacle on the way.



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IDA Design Case (2010-2011 Academic Year)

Task 1 (Design period: 4 weeks):

- Start motion at a "START" position,
- Move straight in a path (width= 60 cm, length= 3 m)
- Stop when a black line (4 cm in width) on the floor is sensed
- The vehicle should move in the path. If the vehicle goes out of the path, the test is not successful and students' period grade is failure.
- The vehicle should stop before it passes the black line. If the vehicle does not stop or if it stops after it passes the black line, the test is not successful and students' period grade is failure.
- Distance between the stop line and the vehicle's measured stop position should be minimized. The best grade for this period is given to the minimum distance from the defined stop position.



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IDA Design Case

Task 2 (Design period: 3 weeks):

- First, the vehicle is required to perform Task 1.
- At the end of the path, it is expected to sense the black line and starts following a curved path on the floor.
- When the vehicle meets an obstacle on its way, it should sense the obstacle and stop. When the obstacle is removed, the vehicle should continue following the curved path.

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IDA Design Case

Task 3 (Design period: 3 weeks):

- A tunnel is placed on the line. The vehicle is required to turn its lights on while it is passing through the tunnel and turn it off when it goes out of the tunnel.
- The vehicle will continue following the path and should stop when it senses another obstacle at the end of the path.



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Discussion

- One of the most popular courses studied by mechatronics undergraduate students of Atılım University.
- Design and construction of a real mechatronic system is a high motivation for the second year students.
- Although they do not know the underlying theory behind some of the important mechanical/mechatronic components such as gears, sensors etc., they get familiar with the practical use of these elements and it is observed that this increases their success at junior and senior level courses.
- Incremental design approach has proved greatly beneficial in terms of exciting sophomore students to work on design problems.

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Discussion

- The design topics must be carefully selected, considering the limitations on the academic background of students, duration of design periods, availability of materials, components and/or manufacturing processes.
- Although the basic design idea is the same for most of the projects, the design details are widely diversified.
- Continuous faculty interest and guidance is essential for the motivation of students all through the semester.
- The incremental design project approach is understood to be useful for maintaining students' interest on the project and for guiding inexperienced students throughout a complex design process.

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Concluding Remarks

- As a result, sophomore students live through a complete design procedure on a simple mechatronic system starting from abstract design ideas up to manufacturing of physical design products.
- They develop their design under true competitive physical conditions.
- Innovative talent of the students is improved and better understanding of the design process is now possible.

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Thank you...
Questions/comments?

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