MECHATRONICS AND CURRICULUM DEVELOPMENT

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1.0 INTRODUCTION :

With the course of time, because of the advancements in technology, each branch of engineering began to have offshoot(s) and made their presence felt as a distinct discipline. We find that 'production technology' separated from mechanical engineering discipline, 'electronics' discipline from electrical engineering discipline, 'computer technology' from electronics discipline, 'concrete technology' is now emerging from civil engineering discipline and so on. Mechatronics is one such emerging technology. This paper is an effort to highlight the salient features of this discipline and discuss a strategy for its curriculum development based on the competency approach.

2.0 RISE OF MECHATRONICS :

By the time a new discipline percolates down from institutions like the IIT to craftsman courses at the ITI level, the manpower requirement in the industry for the new technology changes. Hence, the Technical Education system has to gear up to respond quickly. Otherwise, it will pave the way to the mushroom growth of 'overnight technology shops' churning out passouts which the industry has to employ as they are the only ones available.

The inventions of robots and the control of various mechanical equipment using electronics saw the emergence of this new discipline called MECHATRONICS - i.e. MECHAnical + elecTRONICS. In other words, we say that this discipline has emerged as a result of the marriage between mechanical and electronics engineering disciplines.

Looking at the present Indian scenario we find that Mechatronics has made inroads in the fields of defence, manufacturing, process industries, electronic communication, videography and materials handling.

Mechatronics as a discipline has emerged in the Universities of Arkansas, Kentucky, Louisiana state, Penn State and Rensselaer Polytechnic Institute in the USA. the University of California at Berkeley has developed a Masters Programme in Mechatronics. IEEE transactions on 'Components, Hybrids and Manufacturing Technology' and 'Mecha tronics' journal which is published 8

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times a year from Elsevier Science Ltd., Oxford, England, contain many papers on the subject of mechatronics.

3.0 WHAT IS MECHATRONICS ?

Mechatronics is a way of designing subsystems of electromechanical products to ensure Optimum System Performance. Twenty years ago, the Japanese had recognised this merger of mechanical engineering and electronics engineering and christened it Mechatronics. This name was coined by Ko-Kikuchi, presently the president of Yaskawa Electric Co., Chiyoda-Ku, Tokyo.

The 'Technical Committee on Mechatronics' formed by the 'International Federation for the Theory of Machines and Mechanism' at Prague, Czech Republic, has defined Mechatronics as, 'A synergistic combination of precision mechanical engineering, electronic control and system thinking in the design of products and manufacturing processes.'

Another discipline that is closely associated with Mechatronics is Concurrent engineering. In this, the groups that make up the project team develop parts of a system in tandem, work separately, but share the overall results of their group efforts. But in this paper we will be concerned only with mechatronics. This emerging area is better explained by the following example.

3.1 A MECHATRONICS SYSTEM :

Fig. 1 depicts the schematic diagram of an automotive braking system. This consists of mechanical, hydraulic and electric systems. Many of its components criss-cross disciplines the electric motor is both electrical and mechanical, the valves are both mechanical and hydraulic. Mechatronics is a discipline which permits simulation of many elements - mechanical, electronics and hydraulic systems.

A battery powered d.c. motor runs a pump to pressurize the hydraulic system. The midpoint of the braking pressure is set by a check valve in series with a solenoid controlled two way valve. A damping orifice provides pressure feedback on the valve's spool as an internal control mechanism. In addition to this inner feedback loop, an outer feedback loop uses an electronic pressure sensor to set pressure level.

In the second loop, the armature of the solenoid controls the valve speed to which it is rigidly connected. The output of the electronic sensor is a voltage proportional to the actual hydraulic pressure in the line. The voltage is fed to a difference (or error) amplifier where it is compared with a reference voltage (V ref). This reference voltage is either derived from the force exerted by the brake pedal or generated by a wheel-speed control processor.

The position of the solenoid armature is controlled by the difference between the two voltages, amplified by a dual transistor drive circuit. The sensor thus gives a direct feedback on the state of the hydraulic pressure which can therefore be directly controlled.

The pressure applied to the assembly through a brake line consists of a rigid line and a flexible hose. The brake assembly is itself modeled as a brake cylinder with spring return attached to a load mass and a mechanical travel limit.

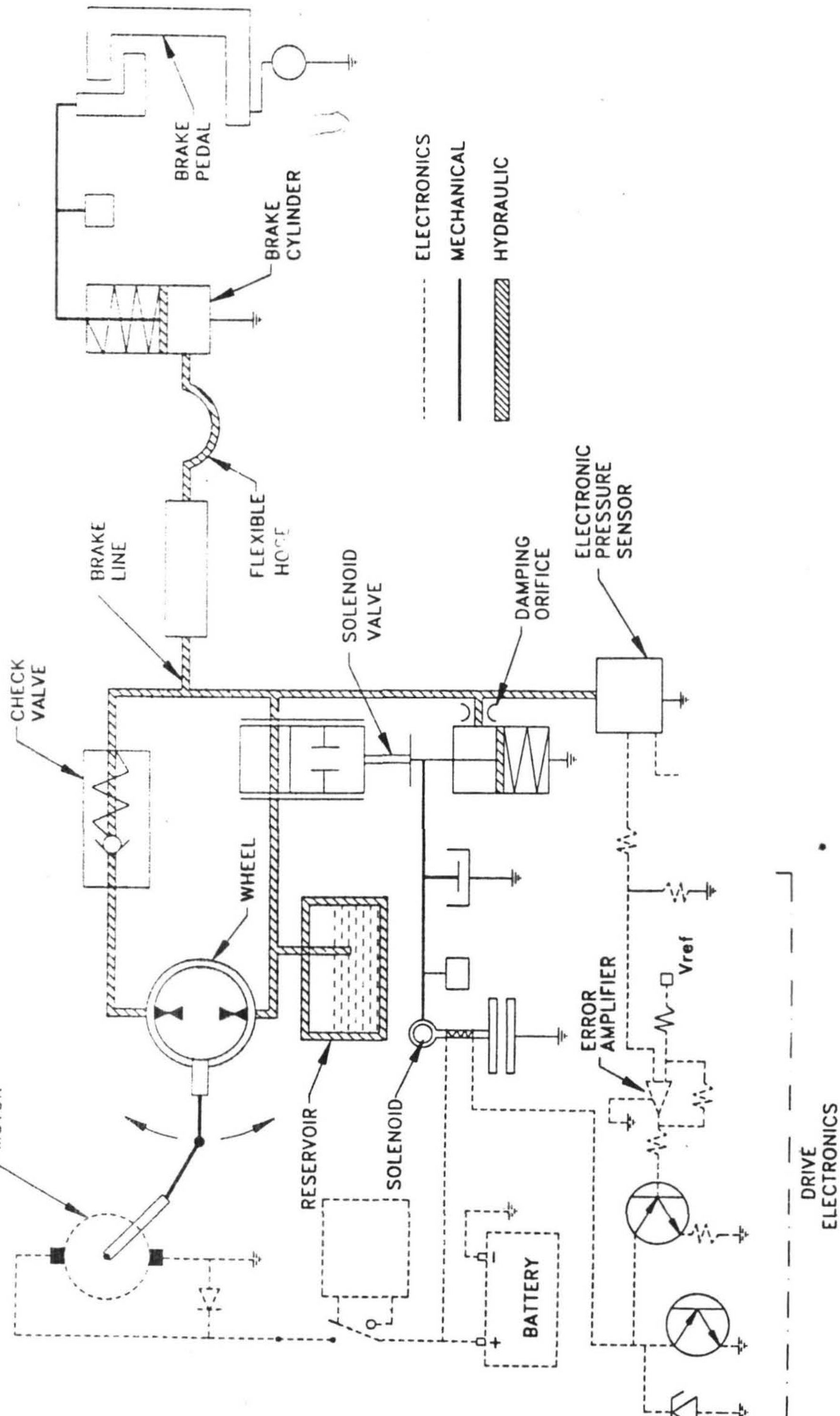

FIG. 1 AUTOMOTIVE BRAKING SYSTEM

4.0 CURRICULUM DEVELOPMENT IN MECHATRONICS :

'Technical Teachers' Training Institute, Bhopal, which has been a pioneer and visionary in the field need-based curriculum development, has been quick to react to the needs of the industry. Presently, a curriculum has been developed by this institute for the Mechatronics Technician. One distinguishing feature of this curriculum is that, this curriculum development has been done in collaboration with the industries in the Western Region of India.

Now let us examine the competency approach in curriculum development of an emerging area such as Mechatronics.

Firstly, to develop a curriculum in an emerging area, one has to become aware of it. This can only happen by being in close liaison with the industry. The industry's cooperation is essential, as they are going to be the direct employers of the passouts of the new discipline. So, the Technical Education System has to be close to the industry.

In a way, the 'womb to tomb philosophy' holds good for the curriculum development process too. The industry's involvement in the curriculum development process right from the beginning in identifying the emerging area, till the final detailing of the curriculum, will help the Technical Education System in implementing the curriculum successfully. This exercise will help the industry in owning the curriculum as well. The partnership with the industry starts right from idetifying the emerging discipline through a series of dialogues and workshops at various levels of industrial personnel. This will help in corroborating the distinguishing features of the emerging area and also identify the manpower requirement, say, for the next 5 to 10 years for all categories of personnel at different hierarchies.

Secondly, a curriculum development task group is to formed to be identify the minimum number of competencies required of a specific kind of industrial workforce, say, Mechatronics Technicians in this case. This strategy is one of the recent approaches in curriculum development. A competency, can be defined as 'cluster of skills required of a technician (or an engineer or craftsman) to perform a particular job successfully.' Hence a mechatronics (or any other emerging area) technician will require at least some minimum number of competencies to perform his / her job successfully. These are arrived at, through a series of interviews and dialogues, oral and / or written with the industry personnel and other documentary data. The output of this exercise is a list of competencies.

Thirdly, each of the identified competencies consist of many Macro skills each of which can further be broken down into a number of micro skills. The Micro skills thus derived have to be validated by the task group in partnership with the industry, again through workshops / dialogues.

All these identified micro skills are to be achieved by the students / trainees during their formal programme of study, when they undergo through varied methods of instruction in the classroom, laboratory, field and / or industry.

Fourthly, each of these micro skills are analysed for their content matter and practical exercises. This content matter and practical exercises are then clustered, taking into account various factors such as an organised body of knowledge, time available, entry level of the students etc. and other resources. This clustering gives rise to the various Courses that will form a branch of engineering, say for a diploma programme, degree programme, or for that matter any programme, which can be as short as 1 week or as long as 3 to 4 years duration.

The total process has been diagramatically represented in Fig. 2.

5.0 AN ILLUSTRATION :

To bring in more clarity, one of the several competencies required of a mechatronics technician is detailed out.

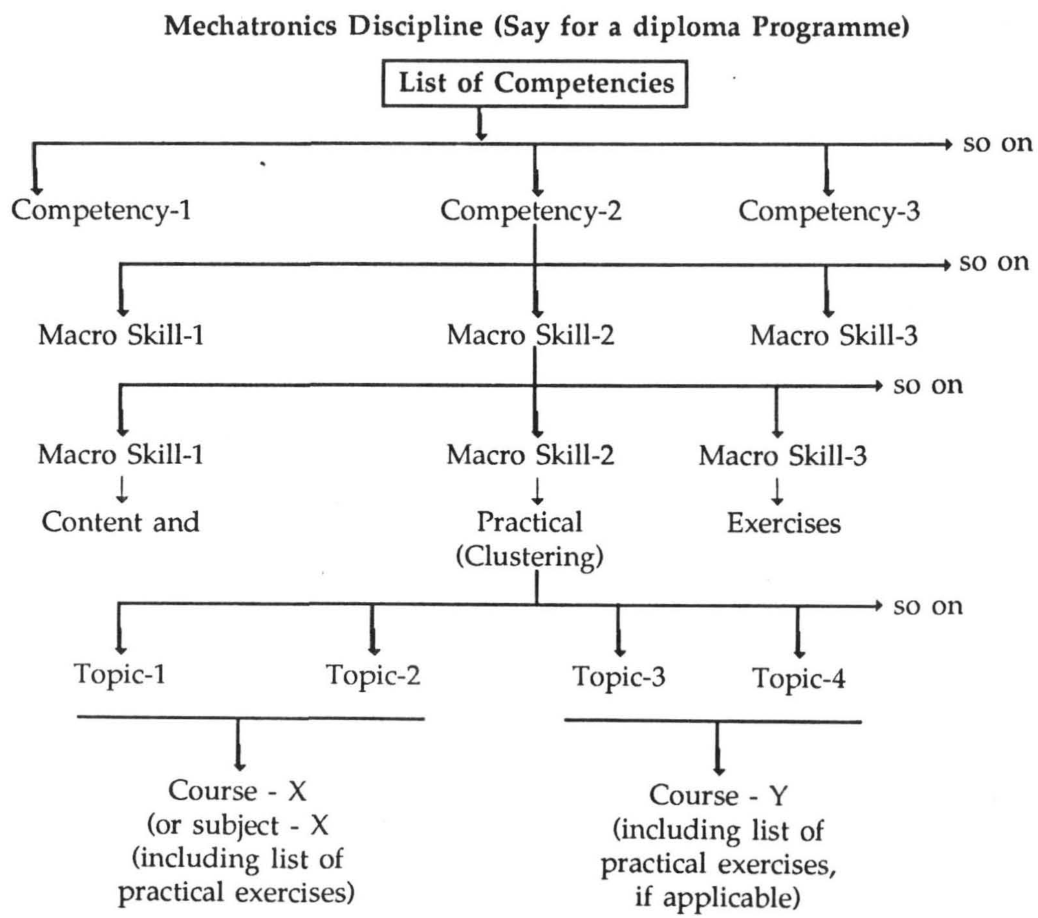

Fig. 2 MODEL FOR CURRICULUM DEVELOPMENT

TABLE - I

FORMAT FOR DEVELOPING COMPETENCY BASED CURRICULUM

S. No.	Competency Statement	Macro skills	Micro skills	Content Matter	Practical Exercises
1.	Trouble Shoot a CNC machine →	(a) Trouble Shoot the electronic circuit of a CNC machine → (b)	(i) Read electronic circuit diagrams → (ii) Conduct electronic tests → (iii) .... →	electronic symbols, CRO, multimeter, electronic components etc. → - - - - →	* Right way of soldering * using test instrument

The total process hitherto should be well documented

The technician should troubleshoot a CNC machine'

A few of the Macro Skills that make up this competency are as follows.

(a) 'The technician is able to trouble shoot the electronic circuit of the CNC machine.'

(b) 'The technician is able to trouble shoot the mechanical parts of a CNC machine.'

Next step is to derive the Micro-skills for each of the macro skills outlined above. Two sample micro-skills have been derived from the first macro skill.

- 'The technician is able to read the electronic circuit diagrams.'
- 'The technician is to conduct tests on electronic circuits as specified by the manufacture.'
- .... more micro skills could be derived.

The content that could be derived from these micro skills as :

- Standard electronic symbols, I.S. Codes, trouble shooting instruments like CROs, multimeters, electronic components,........ etc.

The practical exercises are :

- electronic engineering drawing
- reading the values of electronic components
- right way of soldering and de-soldering
- using test instruments like CROs, multimeters etc.

After the contents and practical experiences of all the competencies related to a particular target group are derived, the curriculum development task group should cluster the contents and practical experiences. These clusters will be formed, based on an 'organised body of knowledge', time available and other resources. These clusters will lead to the formation of different topics. When the relevant topics are clubbed together courses take shape, like - Course X, Course Y, etc. Such different courses put together can constitute a particular programme that can be offered by in any technical institution or training department.

A sample format detailing out the curriculum is illustrated in Table- I.

6.0 CONCLUSION :

In conclusion, it can be said that the basic premise is that the Technical Education System should be very sensitive to the changing technologies and emerging disciplines. This sensitivity, leading to the quick development of need-based curricula in emerging areas, will be helpful to the industry and relevant to the society at large.

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