A BRIEF REVIEW ON MECHATRONICS RESEARCH AND OPPORTUNITIES

Dinesh Kumar[1], Sanjay Kumar Mirania[2], Shailendra Kumar Bohidar[3]

[1,2]Lecturer, Electronics and Tele.Comm. Kirodimal Institute of Technology, Raigarh, Chhattisgarh, (India)

[3] Lecturer, Mechanical Engg. Kirodimal Institute of Technology, Raigarh, Chhattisgarh, (India)

ABSTRACT

The aim of the paper is not to attempt to address about the subject of mechatronics and its current and future standing as an approach to engineering design and development, the paper initiate, provoke and stimulate debate and discussion on a range of mechatronics related issues, without necessarily attempting to provide new methods or approaches, relating to the future potential of and directions for mechatronics. In this respect therefore, while containing an element of review, the paper is intended as a discussion document structured around the author's personal experience and perspective of mechatronics Research.

I INTRODUCTION

Mechatronics is defined as "The synergistic integration of mechanical engineering with electronics and intelligent computer control in the design and manufacture of products and processes [1]. Over many years of involvement with mechatronics it has become increasingly challenging at a personal level to reconcile the various different and differing arguments as to what it is that defines, constitutes and differentiates mechatronics with respect to related engineering disciplines such as systems engineering, control engineering, design engineering and manufacturing systems as well as identifying its continuing role in education [4].

Mechatronics is a discipline that combines elements from mechanical engineering, electrical engineering, and computer science. Given its cross disciplinary nature, it is typically reserved for graduate or upper-level undergraduate courses [2].

One subject in which mechatronics naturally serves as a vehicle for course material is mechanical design. Students can be taught traditional mechanical design techniques, such as planning tools, evaluation matrices, and functional decomposition through the use of mechatronic examples and projects. The inclusion of mechatronic projects benefits students, who are able to practice the design concepts that they have been taught, while forming a strong foundation in mechatronics principles. The projects are also rewarding, as they often afford the students their first opportunity to design and build a computer-controlled machine. However, the integration of mechatronics projects into the course poses significant challenges for the faculty. For example, the basic mechatronic concepts, such as electric

motor operation and control system programming, must be taught in addition to the mechanical design material. Table 1 provides an indication of the topics that have been and are associated with Mechatronics, [4]

Automation and robotics	Machine vision
Automotive engineering	Mechatronics systems
Computer aided and integrated manufacturing systems	Medical systems
Computer Numerically Controlled machines	Packaging
Consumer Products	Sensing and control systems
Diagnostic, reliability, and control system techniques	Servo-mechanics
Engineering design	Structural dynamic systems
Engineering and manufacturing systems	Systems engineering

Table.1 Some mechatronics applications areas.

II MODERN MECHATRONIC SYSTEM AND RESEARCH OPPORTUNITIES

Fig. 1 shows a block diagram of modern mechatronic systems. It looks like a typical block diagram found in control textbooks with the two additional blocks human–machine interfaces and link to other systems.

Note that we have placed the computation block in the middle to emphasize that the computer plays the central role in modern mechatronic systems. This block may represent a variety of hardware devices such as programmable logic controllers, DSPs, embedded microcontrollers and their combinations as well as software that realizes decision-making algorithms. Mechatronics research should start with a clear idea on the target physical system. In other words, mechatronics research should not be methodology driven.

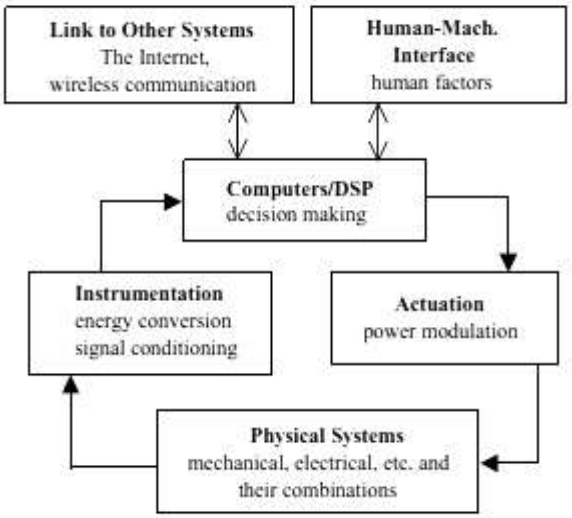


Fig.1. Modern Mechatronic system

A technical paper on a new control methodology with an illustrative example may be a fine contribution to technical journals on controls, but most likely will not be appropriate for Mechatronics journals. Having said this, many research topics addressed by researchers in the area of dynamic systems and control are relevant to and of critical importance to mechatronics. For example, the following research topics address important aspects in the development of engineering systems and are relevant to mechatronics.

- Robust control without high-gain nature for prolonged actuator life and minimized vibration.
- Control with low-frequency output measurements.
- Simultaneous design of control algorithms and fault detection algorithms. [3]
- Modeling and identification of dynamic systems.
- Simple yet reliable tuning of robust controllers.
- Comparison of various control methods in terms of performance and implementation costs including complexity.

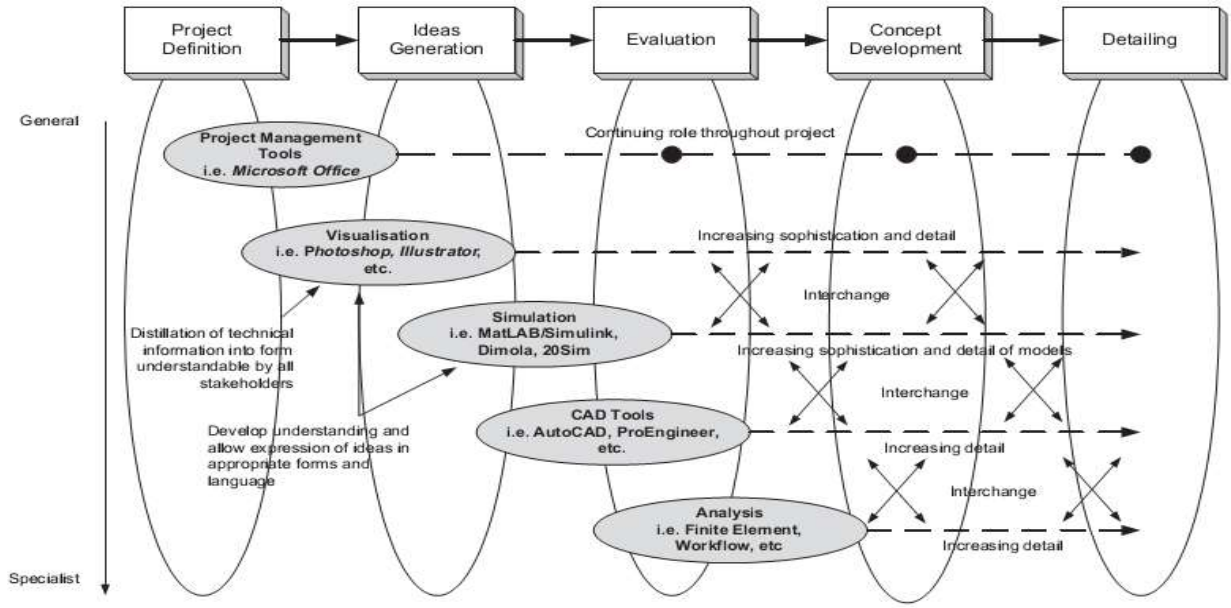
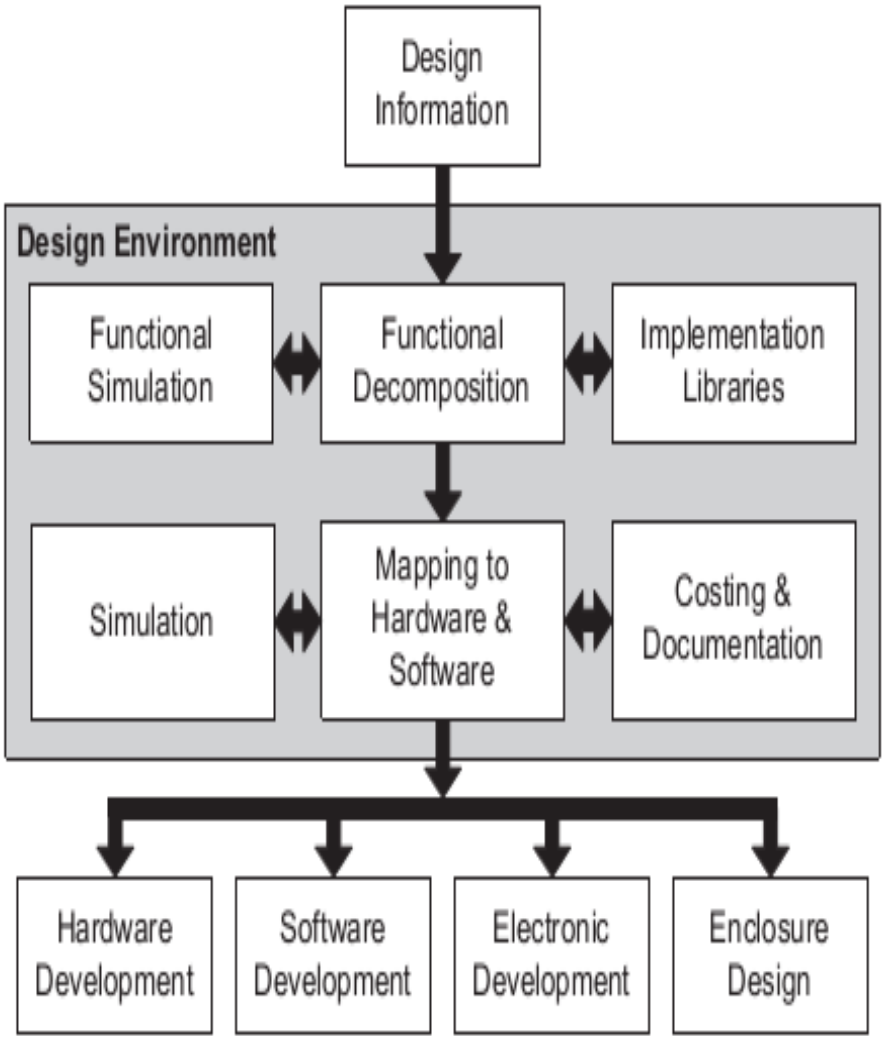


Fig.2 Design Support Tools.[8]

III. ARTIFICIAL INTELLIGENCE AND MECHATRONICS DESIGN

Despite the availability of a wide range of tools to support de-sign thinking as was suggested earlier by Fig.2, the basic problem of managing communications between domain specialists remains in place. There is a specific need to support specialists from one domain in the early identification of potential solutions from other domains in a way that then enables the relevant domain expert to provide effective input. One approach to achieving this has been through the use of a case based reasoning approach [5,6] in which the system guides the user towards either existing solutions, the cases, or to the generation of outline solutions which can then be taken to the domain expert for refinement.



Consider also the design environment of Fig. 3 in which functional decomposition tools are used to support the mapping of the decomposed system onto the relevant hardware. For instance, take the filter hierarchy of Fig.4. The top level of this hierarchy contains information common to all filters while the progressive lower levels then contain more detailed information specific to the retrieval category. The bottom level is then the instantiation of the specific filter. Each instance thus inherits information from the top level ‘‘filter” along with features from the associated subclasses. This structure can be decomposed as shown in Fig. 5, establishing the major high level processes and their relationships.

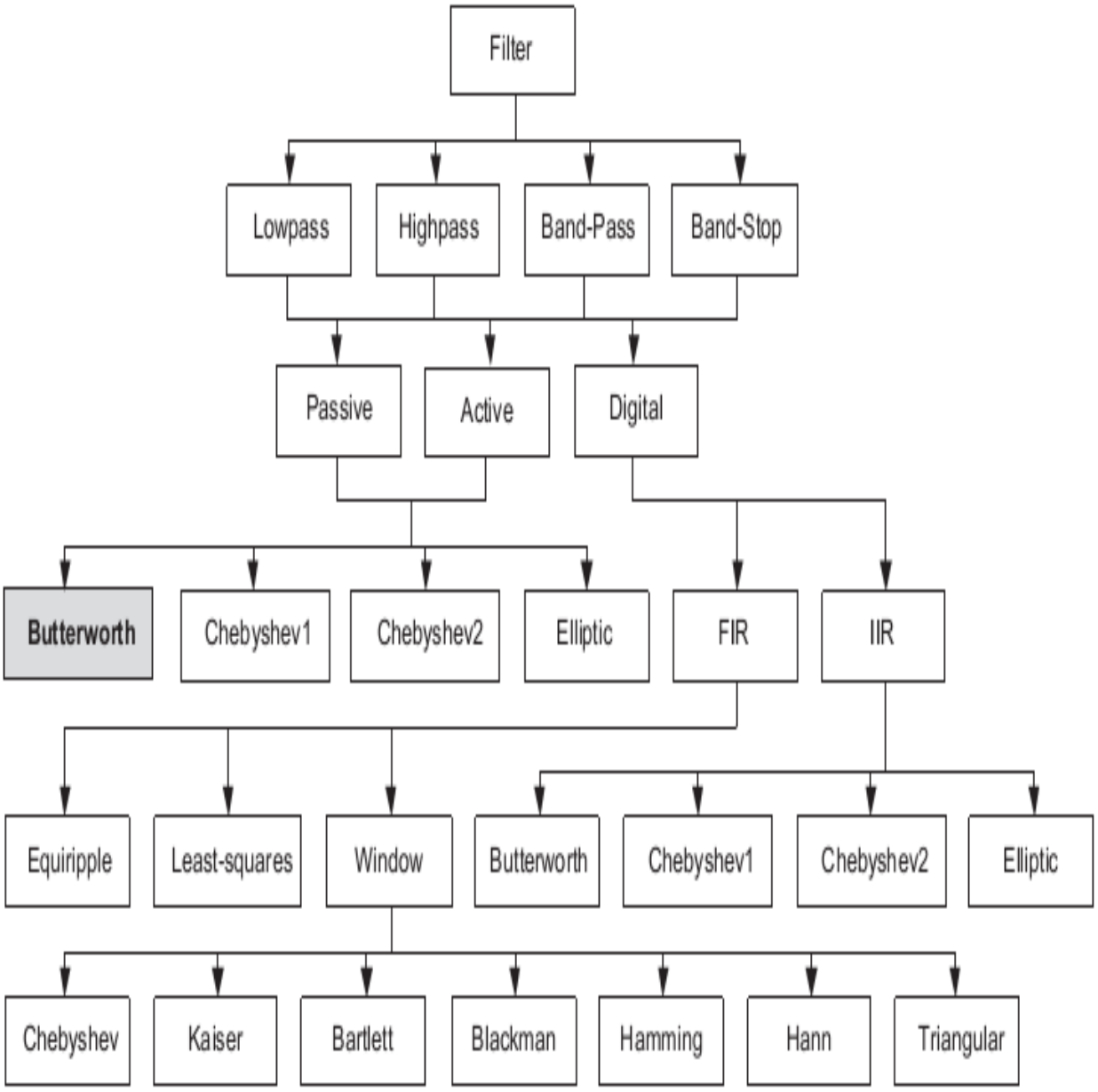


Fig.4 Filter Hierarchy, Butterworth block is shaded. [8]

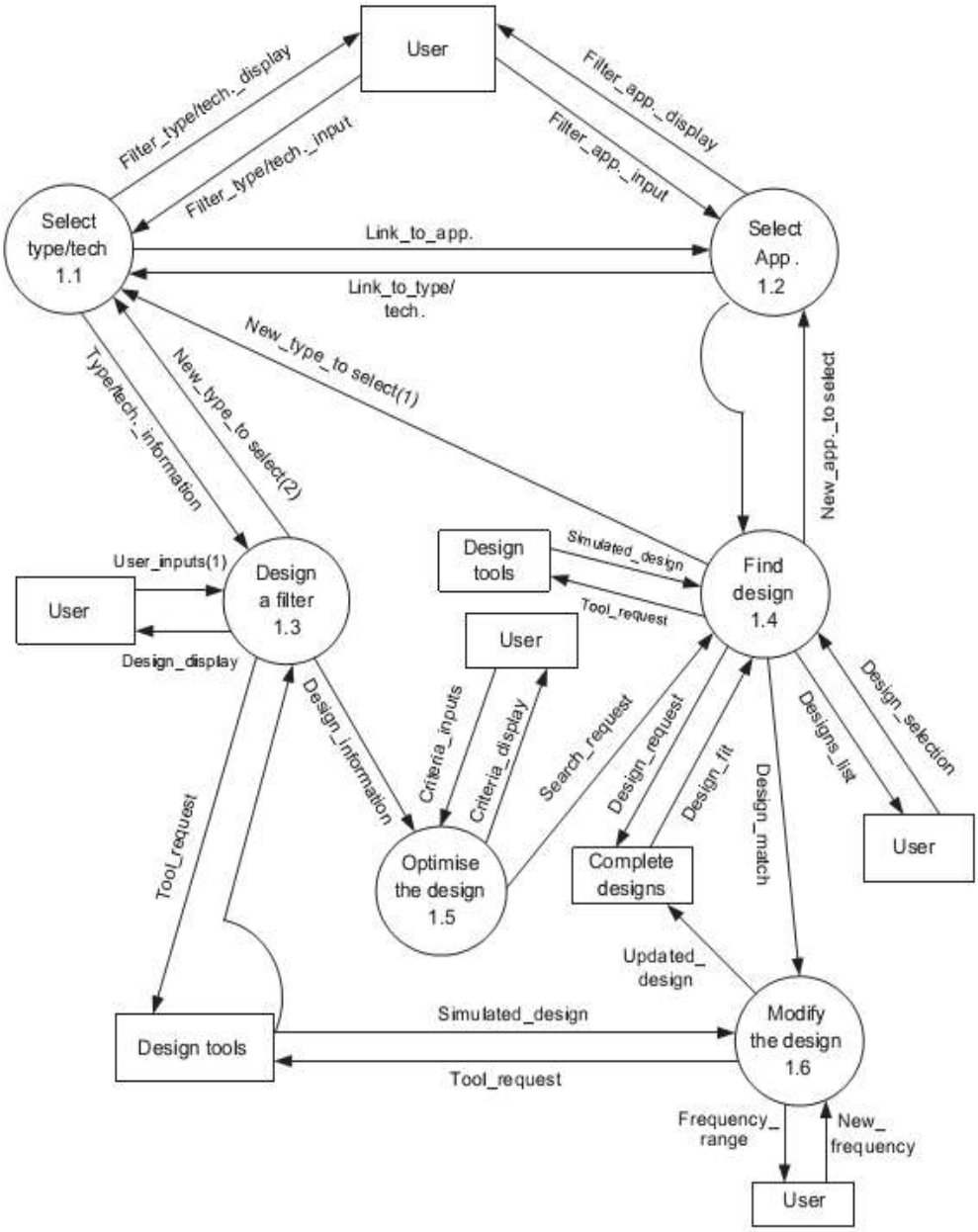


Fig .5 First Level Decomposition Of the filter Design System [8]

IV. CONCLUSIONS

The paper emphasized the evolution of mechatronics and described the opportunities and challenges in mechatronics research . Mechatronics is essential as the best industrial practice in today's global and competitive market. At the

same time, mechatronics thinking forms the basics of the modern engineering. The mechatronics approach is particularly relevant in mechanical engineering and electronics engineering. The Paper Reviews on artificial Intelligence and Mechatronics Design and hope it will be beneficial to everyone involved in Mechatronics.

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