Mechatronics Conception: Integration, Unification and Universality

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Current development of the world industry makes new demands for integration, unification and universality. This covers the demands for the equipment used in manufacturing process. The manufacturing equipment should be flexible and adaptable to implementing different tasks.

Perhaps, the top goal to achieve in this direction is to create a new type of equipment, which should be enough versatile to be easily transformed to suit various manufacturing systems and to permit the implementation of various technological tasks.

This trend can be seen with personal computers. Many PCs having the same structure are used in various environments and for various purposes: from educational equipment at home up to a base of control system for controlling production processes.

Another forthcoming example of such all-usability is Mechatronics.

The term of Mechatronics first appeared in 1969 [7] and was introduced by Yaskawa Electric as a portmanteau word of Mechanics and Electronics. At first under Mechatronics there was understood such type of production as any smartly regulated electric drive. During the 70's the term was applied to automatic doors, vending-machines. The 80's came to include in the Mechatronics production group NC machines, industrial robots, automotive control systems, various home appliances. The 90's supplied Mechatronics with teleoperated industrial and robotic systems, micro machines, advanced medical appliances.

It is worth noting that the term of Mechatronics and its subject area originated from industrial engineers, and not from basic research workers. In the general motion of Technology, if one refers to T^3 - Technology Transfer Tree [3], that corresponds to the trunk of the tree.

This caused the science of Mechatronics work tightly with industry [1]. In Russia this trend led to the formation of "Mechatronics Association", which linked both industrial enterprises and scientific institutions and universities, making them enter a permanent exchange of ideas, conceptions and technologies.

Historically speaking, Mechatronics is tightly connected with Robotics [5], because many of the Mechatronics tasks have been on the agenda of Robotics. So far many of the Mechatronics research groups around the world have had Robotics research as their predecessor.

According to the officially recognised definition by IFTMM [8]: "*MECHATRONICS is the synergetic combination of precision mechanical engineering, electronic control and system thinking in design of products and manufacturing processes.*"

Currently, this definition associates many other definitions, with some variation in text, but with keywords about synergy of Mechanics, Electronics and Computer Control [4][7].

Nowadays, in industry the term of Mechatronics can refer every kind of equipment which provides intelligently controlled motion.

As an example, one can refer to Hexapod [1] - a new type of metal-cutting equipment, which combines the precision of traditional metal-tools with the flexibility and manoeuvrability of industrial robots. (Such an equipment is produced by "Siberia-Mechatronics Corp.", Russia). On the emergence of this type of equipment, researchers could not agree on how to classify hexapods. Traditional Machine-tool building did not accept them, because the hexapod supposed many tasks, not related with Machine-tool building (e.g. the influence of different degrees -of -freedom). On the other hand, Robotics did not consider such problems of hexapods as metal-cutting action as being a Robotics problem. Finally, all agreed that it could be referred to the field of Mechatronics.

Today Mechatronics in industry is first of all advanced manufacturing machines (like hexapod), motion control equipment, mobile equipment and industrial robotics. In everyday life Mechatronics has found itself in civil engineering equipment, intelligent agriculture machines, medical appliances, automotive systems, various home appliances.

If we are to summarise the main advantages of Mechatronics, one can mention for the beginning the following:

- Closed Module Architecture for the User - User is no longer frightened with the necessity to spend enormous time on wiring, connecting, assembling the whole system;
- Integrated Control System - the integrated control system allows to use various algorithms and methods of advanced control, which are the most convenient for the module;
- Unified Elements Base and Design - Unified Elements base and unified design allow to preliminarily select the best fitting each other components of the whole module.
- Open Architecture for the Multi-Modules Systems - the similarity of modules allows to easily connect and gather them in a unified multi-module structure. Their unification will considerably diminish the repair and service costs of such structure;
- Unified Interfaces - the unified interfaces (internal and external) will allow to quickly adopt the system for the new tasks performance and for coordinative work with other equipment;
- Universality in Application - the Integration and Unification of mechatronic systems will eventually bring about their Universalisation. Thus the same modules will be possible to assign for the performance of different tasks. This is extremely important for many industrial end-users, with relatively low production volume or for test production, especially for SMEs.

As one can see, the most crucial for Mechatronics are the properties of Integration, Unification and Universalisation. Hereby are presented the main problems in these directions [2], [6].

Mechatronics problems in Integration:

- Architecture of Mechatronic Module;
- Internal Interfaces problem;
- Integration of Smart Sensorics;
- Software & Hardware Integration.

Mechatronics problems in Unification:

- Unified Mathematical-ware;
- Unified Advanced Control Methods and Algorithms;
- Drawing up of Standardized technical Features;
- Unified elements base (in components);
- Unification of internal interfaces.

Mechatronics problems in Universalisation:

- Standard input interface;
- Standard output interface;
- Standardised mass-dimension features;
- Wide range of working modes;
- Man-machine interfaces.

Considering the directions of perspective research in Mechatronics, the authors consider the necessity for concentrating on the most emerging:

- Formulation of unified Theory of Mechatronics;
- Formulation of unified mathematical approach;
- Creation of database of engineering solutions.

Further development of Mechatronics can be seen as dissemination through mass media [9], dissemination through industrial products, dissemination through science and education and dissemination through various co-operative works [1].

The latter might be realised through the setting up of the European Working Group on Mechatronics. Such working group could carry out their activities in the main directions of:

- Advanced Control in Mechatronics;
- Hierarchical Mechatronic Systems;
- Integration in Mechatronics;
- Education in Mechatronics;
- Standardisation in Mechatronics.

This could motivate industry and research to get together, to discuss achievements and work out the directions of perspective research in Mechatronics - Technology of Integration, Unification and Universality.

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