MECHATRONICS TEACHING IN PREPARING AGRICULTURAL ENGINEERS FOR PRECISION FARMING TECHNOLOGY DEVELOPMENT

Ph.D [1]**Navitski P.,** [2]**Norton T.,** [2]**Clare D.,** [2]**Peets S.**

[1]*EE «Belarusian State Agricultural Academy», Gorki, Belarus*
[2]*Harper Adams University, Newport, Sropshire, Great Britain*

Introduction

Farming represents the coupling of mechanical, chemical, biological technologies with plant/animal growing methods in order to optimize profitable outputs while minimizing environmental pollution. Smart Farming can be considered as the use of computer-based and satellite technologies to improve productivity, quality, environmental impact, energy efficiency, reduce operator error during agricultural operations. Information and Communications Technology (ICT) is emerging as an important enabler in achieving these objectives efficiently.

The concepts of ―Smart Farming‖ or ―Intelligent Agriculture" are growing in importance for modern agriculture and novel agricultural technologies that effectively optimize farm management operations are rapidly emerging. This trend in agricultural technology is the next step in the development of conventional precision farming systems but at a higher technological level. Engineering is core to these developments, with mechatronic systems, robotics, drones, modern agricultural machines, farm management with telematic systems now being central to recent innovations.

Considering the strategies of computer technologies in agricultural business processes, it should be noted the advantages of an integrated approach to automation of technological processes and production compared with point or "patchwork" activities. An integrated approach to intelligent agriculture begins not only with the planning of agricultural production, including the collection and analysis of information, decision-making, improving manufacturing operations, but also to the teaching of agricultural specialists. Mechatronic engineering is an increasingly important discipline as most modern vehicles and machinery incorporate multiple mechatronic systems.

Various machines are used in Belarus agriculture now. To create and maintain these machines and mechanisms function perfectly highly qualified engineers are needed. Belarusian State Agricultural Academy (BSAA) is the leading agricultural higher establishment in Belarus. Mechanical engineering faculty of the BSAA trains agricultural mechanical engineers and engineers for mechanisation of land reclamation work. Students study such special subjects as agricultural machines, mechanisation of agricultural farms, theory of machines and mechanisms, resistance of materials, engines and their parts and others. The laboratories of the faculty are equipped with modern machinery. There are practical classes at the machine testing range. Therefore, learning to intelligent agricultural technique is very necessary.

Overview of Harper Adams University

Harper Adams University was founded in 1901 and has had a long and proud tradition of working closely with rural and land-based industries. The university has been acknowledged widely for its quality of education, being short-listed in the 10th annual Times Higher Education Awards, in recognition of its work during the 2012-13 academic year, during which Harper Adams secured university title, recruited its highest ever undergraduate intake, took research student numbers to a record high, and saw 100 per cent growth in

research income. For teaching and research HAU has facilities including an Engineering Complex, Soil Hall, Machinery Demonstration Hall, Off-road Vehicle Test Track, Engineering Design Centre and Agricultural Engineering Innovation Centre.

The Agricultural Engineering Innovation Centre (Fig. 1 a), home to the National Centre for Precision Farming, is a new building which opened in October 2013 and provides provide 'clean' engineering facilities including: electronics/mechatronics lab, hydraulic lab, research lab for tractors and machines, accommodation for staff, rooms for continuing professional development, a state-of-the-art lecture theatre with space for a tractor.

The large covered Soil Hall (Fig. 1 b) measures 60m x 30m and provides facility for carrying out practical demonstrations and research into the behaviour and performance of off-highway vehicles and field machinery without the influence of the weather and uses irrigation to change soil conditions. A machinery demonstration hall provides storage and demonstration facilities for off-highway and agricultural machines. Off-road Vehicle Test Track if for demonstrating all sorts of off-road vehicles.

Fig. 1c shows some the electronic communications teaching equipment designed and constructed by the Mechatronics teaching team at HAU (Dr Peets; Mr Clare). CAN bus is a message-based protocol, which is widely used in automotive applications and the equipment acts as a primary teaching aid in demonstrating the fundamental aspects of the of this protocol to Agricultural and Off-Road Vehicle Design Engineers.
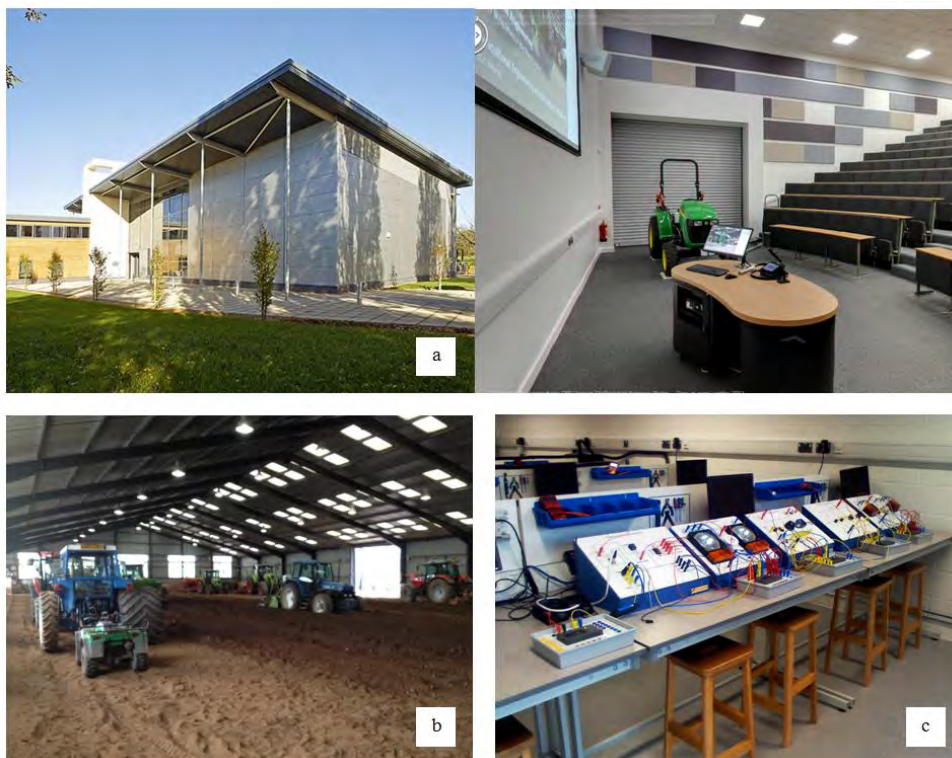

Figure 1. – Harper Adams University Engineering Complex facilities

Related areas are the National Centre for Precision Farming and Academic Departments. One of the academic Departments is Engineering Department. It is responsible for teaching a range of undergraduate and postgraduate engineering courses, with core subjects in mechanical engineering, mechanical science, materials, electronics and mechatronics, engineering design and maths. Students can also study a number of specialist modules, depending on the route chosen, which include off-road vehicle design, terramechanics, agricultural engineering principles, soil and water and hydraulic system design and control. One of them is the MSc course on Applied Mechatronic Engineering.

Mechatronics teaching at Harper Adams University

The course of Applied Mechatronic Engineering at Harper Adams is designed for students with a strong academic background but limited industrial experience. It is intended to expedite the experiential development of these engineers through a series of industrially linked projects. Students will complete the course with a view to taking leading positions in manufacturing companies designing innovative machinery and equipment by employing new and emerging technologies to develop mechatronic systems, machinery and solutions.

The final award is MSc and the intermediate awards are PgC and PgD. The course Applied Mechatronic Engineering has the following duration: MSc takes one year full-time and PgC/PgD takes one year full-time or two-three years part-time.

This course builds on the Engineering Department's long history of working closely with industry teaching students how to apply engineering science to industrial product design. Mechatronics is a multi-disciplinary field of engineering that combines with mechanical, electronic, computer, software, control and systems design engineering in the design and manufacture of useful products. It is an increasingly important discipline as most modern vehicles and machinery incorporate multiple mechatronic systems.

Some of the technologies that mechatronics encompasses include: robotics, vision systems, satellite navigation systems, communications technology, and biometric and other new advanced sensors. Introduction of these new technologies means that engineers cannot rely upon prior knowledge when designing machinery. As a consequence it has become normal practice for new highly technical equipment to be developed by specialist manufacturers, either through subcontract subsystem devolution or commercial partnership.

When developing new products, much of the work of the engineer involves the recombination or reapplication of previously un-combined technologies to solve new problems or enable new functionalities. Engineers therefore need to develop the greatest possible body of knowledge as a resource to call upon during the resolution of novel challenges in new or different environments.

This course provides an understanding of the practical application of engineering science and mathematics to the development of mechatronic systems. It is designed to aid students with good engineering qualifications, but limited applied industrial experience, learn the skills to take leading positions in manufacturing companies designing innovative machinery and equipment by employing new and emerging technologies to develop mechatronic systems, machinery and solutions.

This is quite innovative and progressive course. That is why there are specific requirements for candidates. For example, they must have an honours degree in a relevant engineering discipline, with either a first or an upper-second class honours classification or an equivalent award. But if some candidates already have a postgraduate diploma in a relevant engineering discipline or an equivalent award, they can enter this course. This postgraduate programme builds upon students' existing engineering skills and knowledge developed through prior education and focuses them into a more specific and applied area of study. This approach is designed to allow students to expand their applied knowledge and develop the necessary powers of analysis required to solve complex design problems. Learning largely takes place through a series of individual and group engineering projects intended to enable students to apply their existing academic skills and knowledge to the design, fabrication and testing of new products or systems. Where applicable, projects will be sponsored and supported by engineering companies and will focus on the development of mechatronic systems, machinery and equipment.

Future collaboration between BSAA and HAU

There is strong necessity of teaching mechatronic engineering in Belarus agricultural education system. And there are possibilities for doing it. One of them is to build education

collaboration of BSAA and HAU in Erasmus project on BSAA ag-engineering course improvement to provide BSAA engineering students with the skills to develop Precision and Smart Farming technologies. There are number of core disciplines could be used in this process, based on mechatronics, robotics, modern agricultural machines and development, Farm Management.

SUMMARY

Smart Farming integrates the use of machines, computers, satellite and sensor technologies to improve efficiency of agricultural operations. This paper considers the problems of preparing mechanical agricultural engineers and carried out necessary teaching mechatronics and gives an introduction to Harper Adams University (HAU), along with an outline on the current education in Mechatronic Engineering. It finishes by defining some actions for future collaboration activities between Belarusian State Agricultural Academy and HAU through European programmes.

ЛИТЕРАТУРА

1. Инновации в механизации земледелия и защиты растений на agritechnica-2013 / А. В. Клочков, П.М. Новицкий, А.Е. Маркевич // Земледелие и защите растений. – 2014. – № 1. – С. 75.
2. Materials website http://www.harper-adams.ac.uk/.
3. Materials website http://www.BAA.by

РЕЗЮМЕ

Smart Farming объединяет использование машин, компьютеров, спутниковых и сенсорных технологий для повышения эффективности сельскохозяйственных операций. В статье рассмотрены проблемы подготовки инженеров-механиков для агропромышленного комплекса и обоснована необходимость преподавания мехатроники, рассмотрен опыт Университета Харпер Адамс в преподавании мехатроники в соответствии с существующим учебным планом. В заключении определены возможности для будущего сотрудничества между Белорусской государственной сельскохозяйственной академией и Университетом Харпер Адамс через европейские программы.

E-mail: *Navitski_Pavel@tut.by*