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Standards for Electronic Data Exchange in Agricultural Applications

Mechanical and electronic compatibility between tractors and implements is taken for granted by farmers purchasing new machinery. Modern agriculture and its approach to optimise farming processes by means of electronic devices also requires electronic compatibility between tractors, implements and the software installed in the farmer's PC. It is hard to answer the question on why working with electronic data is still so difficult, 15 years after initial standardisation approaches began. Partially the answer could be that standardisation is a tedious process, but it also seems that manufacturers only have a slight interest in implementing these norms.

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Standards are an essential part of our lives and they help to make many things much easier.

The best example is language. By social agreement, sequences of letters and sounds have been assigned with a meaning. This convention has been consolidated over centuries and is today settled in detail as a standard in fundamental publications on grammar and orthography.

Yet another example: you are reading a magazine printed on A4 paper. If you intend to forward this magazine to another person, any paper store can provide you an envelope without knowing its precise dimensions. This was not so easy until the A4 format was fixed in the DIN 476 standard in 1922.

Windows and Word are a de facto Standard

Manufacturers of microprocessors have been following their individual strategies for a long time. Until the early 80's most applications have been developed for specific processor platforms. In the meantime, the operating system Microsoft Windows has been established as a de facto standard. It allows to execute applications independently of the processor type. Likewise the convenience of being able to edit all kinds of text documents – mostly in Microsoft Word format – with different editors is today being taken for granted.

Standards for Position Measurements and Maps

Geographic Information Systems (GIS) are common in agriculture when it comes to precision farming applications. The company ESRI has established with its Shape format the de facto standard for exchanging geographical information. GI systems, which cannot at least read this format, are practically of no use. The advantage for the end user is obvious: geodata in vector format can easily be opened with different software packages, independently of which software package had been used in the first place to create the data.

A standard output format for position data (NMEA 0183) from satellite navigation systems has already been defined in 1983 by the National Marine Electronics Association (NMEA). The output of this ASCII protocol is supported by all GPS receivers and facilitates compatibility with all software and hardware using the position information independent of model and manufacturer. NMEA has also published a protocol for transmitting data on CAN Buses (NMEA 2000) already a couple of years ago.

Standards in Agriculture

Standards also play an important role in agriculture. ISO 11001 defines the shape of three-point hitch couplers and thus facilitates the mechanical compatibility between tractors and implements independently of model and manufacturer. The German standard DIN 10050-8 (Testing of butter wrappers - Part 8: Determination of water insoluble sodium chloride free ash) is a good example for how sophisticated and detailed some processes related to food production and agriculture have been defined in standards in order to maintain food quality and safety.

The CAN standard in automotive engineering

In the early 80s the automotive industry increasingly integrated electronic components in cars and trucks. The necessity to effectively exchange data between electronic components was driven by the demand to develop new features and optimise open and closed loop control processes. Bosch presented the concept of a Controller Area Network (CAN) in 1986. CAN is a protocol, which facilitates fast and secure communication between controllers in a vehicle, alike the communication between computers in the internet.

The concept attained broad acceptance and in 1993 the specification for CAN was implemented as ISO 11898. Without CAN the development of complex functions such as ABS and traction control systems (TCS) would have taken much longer.

CAN for tractors

In the mid 80s, a task force within the German association of plant and machinery manufacturers (VDMA-LAV) started to develop a standard for CAN based communication between electronic components in agricultural machinery. The agricultural bus system (LBS, DIN 9684) was not only designed to specify a protocol for the communication between controllers within a vehicle. It was supposed to define the communication between tractors and implements as well as data formats for exchanging process and prescription information between the tractor and a management information system installed on a PC.

Before the work on DIN 9684 could be finished, ISO (International Organization for Standardisation) adopted the issue of agricultural data exchange. ISO decided to develop an international standard (ISO 11783), based on the existing SAE J1939 standard for the CAN communication on buses and trucks. The basic framework for ISO 11783 was only finalized a couple of weeks ago (June, 20th 2007). Subordinated standards on data formats (ISO 11783-11) and the design of the user interface (ISO 11783-6) had already been fixed before.

Data exchange formats

A fair amount of the data provided by controllers on the CAN Bus is of significant interest to the driver and the owner of the machine. Ground speed, fuel consumption, PTO speed, the position of the three point hitch or the mass flow and moisture content of grain on combine harvesters - this information is available on a CAN bus system. Some of this data can be displayed and manipulated on a virtual terminal (according to ISO 11783-6). Storing such data for further analysis definitely helps to improve management processes, especially when activity values are stored along with information on position and time from a GPS receiver.

In order to process the data and to create maps, data must be transferred to a PC. The software used for processing needs to know the data structure. At best, the data format is independent of make and model of the machine so that data from different machines can be processed with a single application. A unique data format had already been layed out by VDMA in DIN 9684-5 and is now to be defined in ISO 11783-11. KTBL, a German association involved in agricultural technology, is working on a standard that allows to present different kinds of agricultural processes in a structured manner. agroXML relies on the international XML standard. The work on describing the essential elements of plant production has already been finalized.

Standards in practice

The mechanical interfaces between tractors and implements have largely been standardized. However, farmers trying to reap the benefits of electronics in tractors and implements are still struggling with difficulties due to the lack of implemented standards

and the resulting diversity of file formats and protocols. Processing yield data from different yield monitoring systems collected on the same field is a challenge that only specialists can cope with. Merging yield data from different sources requires several intermediate steps and different conversion tools or programmes. Even importing yield data, collected with a new yield monitoring system, into a software tool that was provided with another yield monitoring system that has been already in use for a couple of years may turn out to be impossible. Many farmers have frustratedly abandoned the concept of local yield measurement due to the above mentioned limitations.

Farmers sharing machinery would find it convenient to be able to record data from a CAN bus. This would make balancing fuel consumption and machine hours an easy task and costs due to maloperation of the machine or the implement could clearly be assigned to an operator.

Appropriate solutions meeting these demands are only available for single tractor models. The devices used for data recording and the file formats are not compatible. This is why recording process data - despite its apparent advantages - has not been adapted by machinery rings and contractors.

Recording process data and yield monitoring information is also fundamental for transborder farming, an approach to farm several small fields belonging to different farmers as a single management unit. After harvest, yield and costs are being balanced by spatially assigning process data (consumption and operating hours) as well as yield data to the original field boundaries and their owners. Besides psychological barriers, the lack of standards for recording yield and process data has been the main restraint to a broader acceptance of the concept of transborder farming in areas with small field sizes.

Besides recording data, electronic devices on tractors and implements also allow for controlling the rate and intensity of an operation. Precision farming aims at adapting and optimising management on a subfield level. One important process within precision farming is the creation of prescription maps with varying rates of application for different management zones within a field. In the field a terminal determines the position of the implement and controls its application rate according to the underlying information in the prescription map.

Again, the lack of standards or their implementation substantially complicates the creation of prescription maps. Normally more than one software tool is needed to handle the input data required for deriving the prescription values within the management zones. Controlling an implement in practice still requires different terminals and job controllers on the machine to be properly connected and setup for seamless operation. This approach is vulnerable to failure. The introduction and implementation of standardized formats and protocols would substantially help to facilitate the implementation of precision farming techniques.

New technology - such as process data recording and precision farming - have already been widely adopted in the United States. This is mainly due to the fact that farmers mainly source their farming equipment from one company or supplier. All the more, farmers in Germany and Europe rely on further development and implementation of standards until they know the true promise of the advantages of electronics in agriculture.