Don't design - configure!
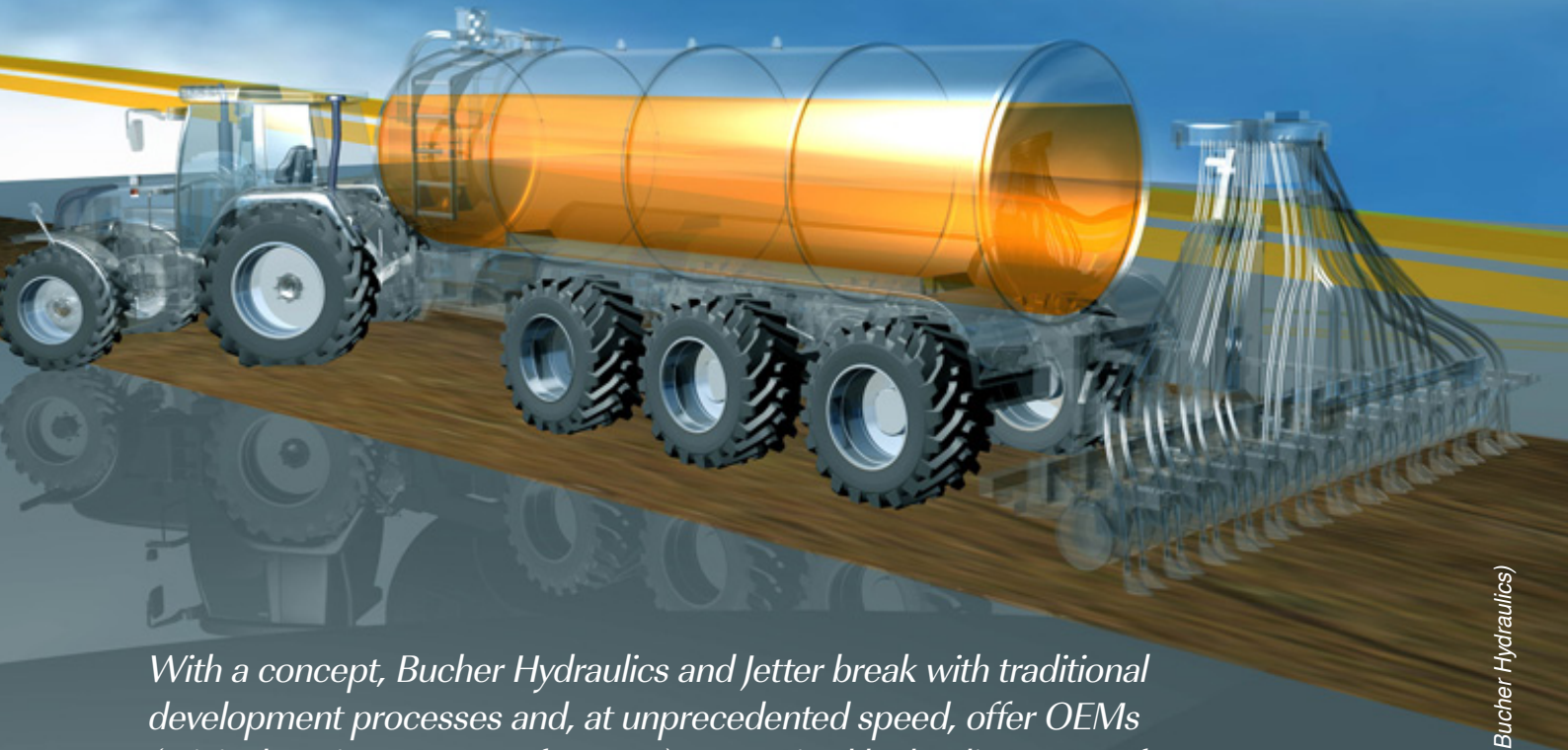

With a concept, Bucher Hydraulics and Jetter break with traditional development processes and, at unprecedented speed, offer OEMs (original equipment manufacturers) customized hydraulic systems for slurry tankers.

Precision farming is generally regarded as the ideal way for the targeted cultivation of agricultural land. For manufacturers of vehicles and implements, however, precision farming also means an increasing number of electronic components, the integration of new sensor technologies, and a number of variants and functions in their range of vehicles. Slurry tankers in particular, both as self-propelled and towed versions, represent a major challenge in terms of development costs and time. This is because a large number of possible options in the chassis, steering system, and slurry tank, as well as different distribution devices, must be catered for. The Nitrates Directive 91/676/EEC on groundwater protection and its German implementation in the form of the Fertiliser Ordinance (DüV) are also hovering over the industry as a constant worry. It is uncertain how long this will remain just a matter of stricter documentation obligations and tighter rules for determining fertilizer requirements, as well as longer 'no fertilizing' freeze periods. The industry is therefore facing the additional challenge of being able to react quickly to statutory regulations at the same time that the number of variants for slurry tanker subsystems is increasing. Significantly shorter development cycles for hydraulic systems and their control, as well as retrofit solutions, are currently very important for slurry tanker manufacturers.

Generic modular development

The approach of Bucher Hydraulics and Jetter has been to completely end the "serial" development process that starts with requirements specifications, then project planning, engineering, prototype procurement, test phase, and initial sampling: The design of the system solution was broken down into a number of individual modular solutions, taking into account all common variants and technologies on the market. This was true for both the hardware and the software aspects. For this purpose, an interdisciplinary team of Bucher and Jetter engineers defined more than 40 hydraulic subfunctions for the slurry tanker. For each subfunction (e.g. suction hose), the corresponding variants (e.g. multi-jointed suction arm) were assigned to it and the hardware and software elements for each of these variants were then developed and tested. A good 1,5 man-years was invested just in the source code for all the options. The "generic system solution for slurry tankers" contains around 1 400 parameters. Each specific overall system for a particular slurry tanker now consists of a combination of selected and previously tested and optimized subsystems.

Bucher Hydraulics has the right portfolio for a modular configuration of the hydraulic system, because the control blocks feature a sectional design. With up to 22 sections, ▷

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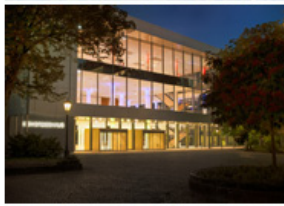
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Tuesday, March 17, 2020		
09:30 - 09:45	Holger Zeltwanger (CiA)	Conference opening
Keynote session **Chairperson: Holger Zeltwanger (CiA)**		
09:45 - 11:00	Carsten Schanze (VW)	Future of CAN from the prospective of an OEM
Session I: Physical layer **Chairperson: Carsten Schanze (VW)**		
11:00 - 11:30	Magnus-Maria Hell (Infineon)	The physical layer in the CAN XL world
11:30 - 12:00	Patrick Isensee (C&S Group)	The challenge of future 10-Mbit/s in-vehicle networks
12:00 - 12:30	Johnnie Hancock (Keysight)	Characterizing the physical layer of CAN FD
12:30 - 14:00		*Lunch break*
Session II: CAN XL data link layer **Chairperson: Reiner Zitzmann (CiA)**		
14:00 - 14:30	Florian Hartwich (Robert Bosch)	Introducing CAN XL into CAN networks
14:30 - 15:00	Dr. Arthur Mutter (Robert Bosch)	CAN XL error detection capabilities
15:00 - 15:30	Dr. Christian Senger (University of Stuttgart)	CRC error detection for CAN XL
15:30 - 16:00		*Coffee break*
Session III: CANopen testing **Chairperson: Uwe Koppe (Microcontrol)**		
16:00 - 16:30	Mark Schwager (Vector)	A new approach for simulating and testing of CANopen devices
16:30 - 17:00	Oskar Kaplun (CiA)	CANopen FD conformance testing – today and tomorrow
Session IV: CANopen FD **Chairperson: Christian Schlegel**		
17:00 - 17:30	Uwe Wilhelm (Peak), Christian Keydel (Emsa)	A simplified classic CANopen-to-CANopen FD migration path using smart bridges
17:30 - 18:00	Alexander Philipp (Emotas)	A theoretical approach for node-ID negotiation in CANopen networks
18:00 - 18:30	Yao Yao (CiA)	CANopen FD devices identification via new layer setting services (LSS)

Wednesday, March 18, 2020		
Session V: CAN FD lower layers **Chairperson: Dr. Frank Deicke (Fraunhofer IPMS)**		
09:00 - 09:30	Tony Adamson (NXP)	CAN signal improvement and designing 5-Mbit/s networks
19:30 - 10:00	Fred Rennig (ST Microelectronics)	A lightweight communication bus based on CAN FD for data exchange with small monolithic actuators and sensors
10:00 - 10:30	Kent Lennartsson (Kvaser)	Improved CAN-driver
10:30 - 11:00		*Coffee break*
Session VI: Engineering **Chairperson: Kent Lennartsson (Kvaser)**		
11:00 - 11:30	Nikos Zervas (Cast)	Designing a CAN-to-TSN Ethernet gateway
11:30 - 12:00	Dr. Heikki Saha (TKE)	Automated workflow for generation of CANopen system monitoring graphical user interface (GUI)
12:00 - 12:30	Dr. Christopher Quigley (Warwick)	Benchmarking of CAN systems using the physical layer – car, truck, and, marine case studies
12:30 - 14:00		*Lunch break*
Session VII: Security **Chairperson: Torsten Gedenk (Emotas)**		
14:00 - 14:30	Thilo Schumann (CiA)	Embedded security recap
14:30 - 15:00	Prof. Dr. Axel Sikora (Hochschule Offenburg), Georg Olma (NXP), Olaf Pfeiffer (Emsa)	Achieving multi-level CAN (FD) security by complementing available technologies
15:00 - 15:30	Vivin Richards, Allimuthu Elavarasu (Infineon)	CAN XL made secure
15:30 - 16:00		*Coffee break*
Session VIII: CAN XL higher layers **Chairperson: Dr. Arthur Mutter (Robert Bosch)**		
16:00 - 16:30	Peter Decker (Vector)	IP concepts on CAN XL
16:30 - 17:00	Holger Zeltwanger (CiA)	Multi-PDU concept for heterogeneous backbone networks

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Figure 1: With the LVS hydraulic valve, designers can now create those implement control systems that, so far, have been difficult to master. LVS valve blocks can be configured for both fixed displacement and LS pumps. (Source: Bucher Hydraulics)

all the functions can be incorporated in one block. Alternatively, it is possible to distribute the functions over several blocks, e.g. on the drawbar, distributor or suction boom. The valves with functions specific to the slurry tanker also have a sectional design. They operate load-independently thanks to the pressure compensator that is connected downstream of the proportional directional control valve (flow-sharing principle). A very large selection of valves is available for special functions in the areas of steering, chassis, hitch, top cylinder, etc., which can be combined modularly in a variety of forms in the inlet or intermediate sections.

Table 1: A selection of some already implemented functions (Source: Bucher Hydraulics)

Chassis functions	Steering system	Distribution attachments
Articulated drawbar	Tire pressure control system	Disc harrow
Articulated drawbar	Compressor prerun and overrun, intervals	Baffle plate
Hitch control	Compressor fan overrun	Strip tillage
Hydraulic suspension	Top cylinder	Drag shoe
Centralized lubrication system		Drag hose

The proportional valves, e.g. for steering or for controlling the application rate, can be combined as required in the block. Therefore no particular priority needs to be allocated when arranging the valve positions. This makes variant management much easier. System solutions that include downstream pressure compensators prevent subsystems from stopping in the event of undersupply. This ensures trouble-free, continuous operation even in critical areas such as the headland or when filling the slurry tank. In developing the "generic system solution for slurry tankers", Bucher Hydraulics concentrated primarily on optimizing the control of the valves by the Jetter electronics.

The special feature of the generic system solution: customers can themselves select all the hydraulic and electrical subfunctions in a configuration file (text file). All subfunctions are pre-programmed and customers only have to compile the configuration file for their vehicle or attachment. All standard filling and docking systems, pump and distribution systems, even the NIR (near-infrared spectroscopy) sensor and the Piadin admixture are available as options and can be parameterized. The visualization software for the Isobus terminal and the control software are compiled from the configuration file. For the visualization of the partial functions, the guideline was to use self-explanatory pictograms and to supplement them with relevant data, such as the partial width of the injector, the fill level of the slurry barrel or the height of the hitch, etc. Custom layout options for the display are possible via freely placeable softkeys. This, too, is defined in the configuration file. All precision farming functions based on the Isobus, such as Virtual Terminal, the integration of a tractor ECU (electronic control unit), a freely configurable joystick, Task Controller BAS, the application rate specific to a particular sub-area using Task Controller Section Control, and Task Controller Geo are "on board". The integral user management is particularly important for contractors. Using this function, the jobs that have been loaded from the Task Controller can be assigned to the respective driver. The job data can be transferred to the task controller via telemetry or a USB stick.

Wiring harness

Each valve block is controlled via an I/O node and the data is looped from I/O node to I/O node via CANopen. The ▷
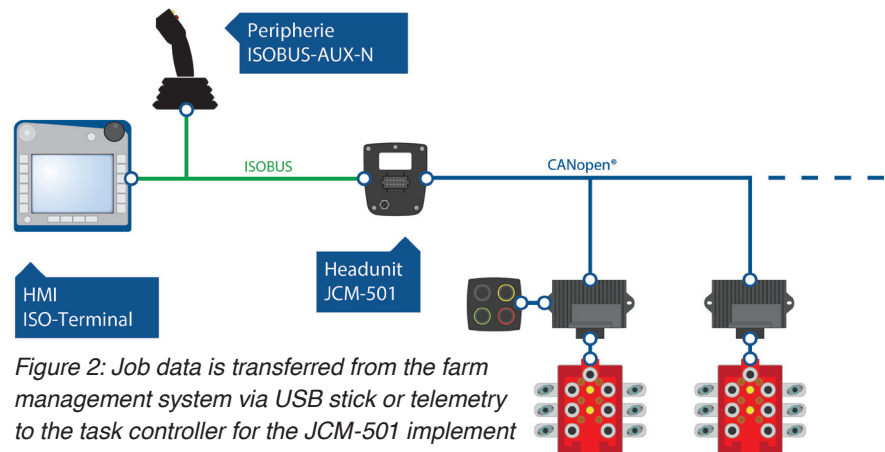

Figure 2: Job data is transferred from the farm management system via USB stick or telemetry to the task controller for the JCM-501 implement ECU (Source: Bucher Hydraulics)
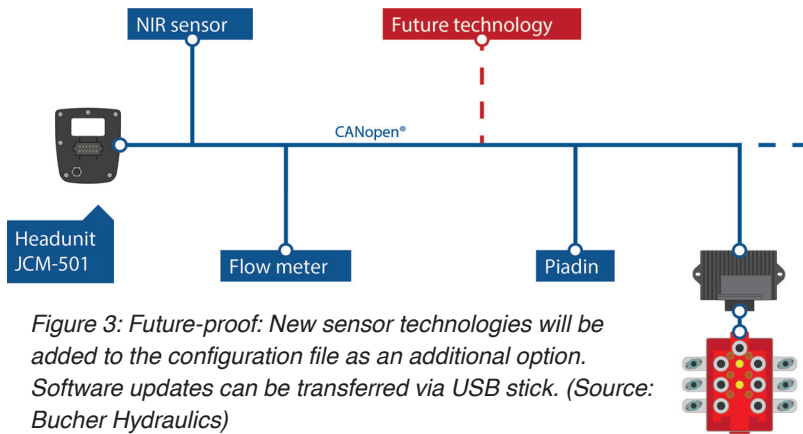
Figure 3: Future-proof: New sensor technologies will be added to the configuration file as an additional option. Software updates can be transferred via USB stick. (Source: Bucher Hydraulics)

classic cable harness is not a practicable solution for such a freely configurable system with its numerous options. With a central electrical system and cable distributors, flexible and plug & play cabling with high-quality connector systems is offered (cable distributors: IP67 unplugged, IP69K plugged in, IP65 central electrical system with cable glands).

During commissioning, the cabling, plug connections, sensors, and switches are checked by an input and output test at the terminal. In the event of a fault in the field, integral diagnostics make it easier to locate electrical faults such as cable breaks, faulty plug connections, and short circuits.

Some German states have recently also approved the use of an NIR sensor to determine the slurry dosage via nutrient amounts. The NIR sensor is connected to the controller via CAN network and provides the nitrate, phosphate, and potassium content in the slurry. The correct application rate is controlled by the nitrogen value measured in the slurry, and the phosphate and potassium values during application (geo-referenced) are recorded in the Task Controller.

For OEMs, this generic system solution for slurry tankers means a radical change in development and in the communication with their suppliers of hydraulics and control systems. In the beginning phase we no longer have the sometimes tedious preparation of a requirements specification, instead we have a configuration tool for the hardware and software. This covers all the important functions

of the slurry tanker. The OEM can concentrate on the placement of the hydraulic components and their piping, the connection of the central electrical system, and the linking of the I/O nodes, sensors, and switches. The plug & play cables are supplied with the system. Future sensor technologies will be implemented as a new option in the relevant module in the control software and visualization. The NIR sensor and the Piadin admixture have already been included in this way. OEMs can now face any future tightening of the Fertiliser Ordinance with composure.

Bucher Hydraulics stated: "Our contribution to precision farming is to bring together into a system all the components ranging from hydraulics, through solenoids, sensors, controls, display, visualization, and programming all the way to diagnostics in a highly flexible, customer-specific manner and with maximum speed-to-market. This enables OEMs to react quickly and flexibly to customer requests and new legal requirements." "We took Isaac Newton as our role model and systematically divided the complex problem into small, easily solvable subproblems and then brought those together again to form the overall solution." ◄
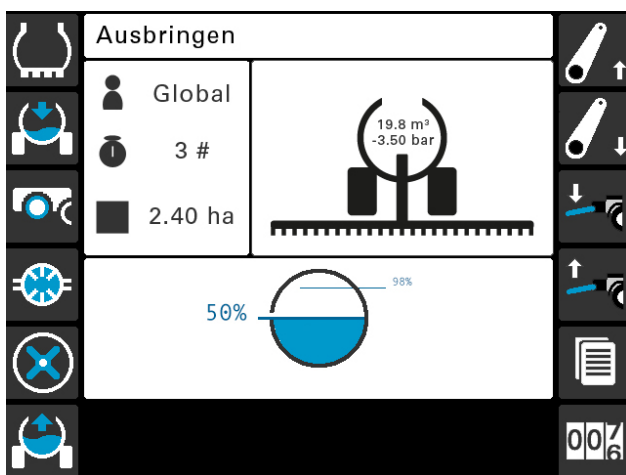

Figure 4: All active functions at a glance – visualization at the terminal (Source: Bucher Hydraulics)

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