Hermann Auernhammer, Markus Demmel, Achim Spangler and Markus Ehrl, Freising

The IMI electrical implement indicator

Real data regarding machinery and implement utilisation remain the weak point in farm management. Now, a new situation can be created through LBS and GPS. For this, all machines and implements on the farm have to have an electronic identification unit and be equipped with flash-memory. A lasting and unmistakable data storage can then allow utilisation data to be identified and then processed for many management decisions.

Prof. Dr. Hermann Auernhammer is manager of the special area Technology in Plant Production in the special sector for Biological Raw Materials and Technology in Land Utilisation, TU Munich. Dr. Markus Demmel is assistant, Dipl.-Inform. Achim Spangler and Dipl.-Ing. (FH) MSc. Markus Ehrl are studying for their doctorates in the same department, Am Staudengarten 2, D-85354 Freising; e-mail: *auernhammer@tec.agrar.tu-muenchen.de.*

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Machine costs represent an over-dimensional proportion of production costs although the investigation and determining of the former are based largely on assumptions and imputations because real operational data are not available. The situation is even more difficult with used machinery or where implements are applied on several farms on a common use or leasing basis with, in-part, completely different utilisation intensity.

The idea

LBS and GPS represent a standardised communication and positioning technique for agricultural use. Up to now, however, both components could only be applied in application machines for fertilising and spraying and, more recently, for drilling and precision seeding. Thus the majority of farm machines and implements were left out because an electronic system identification was not available. This, however, is easy to realise in LBS, when:

- every implement gets its own electronic identification card
- is included in the system initialising
- makes available current data
- and guarantees a continuation of data recording in its own memory.

This type of implement identifier (Implement Indicator „IMI®“) must belong to the implement as an implement-specific unit and contain implement-specific data and information. It can be directly linked into the implement (when further implements follow and the Bus has to be conducted further) or integrated in the LBS plug with fixation on the implement (no additional Bus connection required).

Realisation concept

A first realisation took place on the basis of an available STW processor/computer (ESX®, Sensortechnik Wiedemann Kaufbeuren) end of 1999 as project study with multiple tests in a specific LBS test environment (*fig. 1*).

For the realisation towards field application, the processor/computer family ESX-DIOS®, which had then become available from STW, was used. Programming took place with Open Source Program Library LBSlib (see Landtechnik 3/2001, p. 138) in the following configurations (*table 1*):

Type 1 (electronic typecard)
In the IMI® the implement data was stored in unchangeable form. These could be: implement/machine, sort, year of manufacture, type, working width/payload, mounting position, ...

Type 1	Type 2	Type 3
Group specification unit Implement details Manufacturer Type Production year [mmjj] Working width/ Payload [m/t]	Group specification unit Implement details Manufacturer Type Production year [mmjj] Working width/ Payload [m/t]	Group specification unit Implement details Manufacturer Type Production year [mmjj] Working width/ Payload [m/t]
	Farm data Farm number MR number LU number Cost data Cost attribution Fieldwork data Working time in field [h] Distance for work in field [km]	Farm data Farm number MR number LU number Cost data Cost attribution Fieldwork data Working time in field [h] Distance for work in field [km]
		Operational data Total time in field [h] Total distance in field [km] Working time in field [h] Mounting/demounting time[h] Driving time [h] Driving distance [km] Sensor 1 [...] Sensor 2 [...] Sensor 3 [...] Sensor n [...] Service data
Electronic type sign **Manufacturer**	Farm data recording **Farm**	Machinery exploitation **ÜMV**

Table 1: Development stages of the electronic implement indicator IMI®

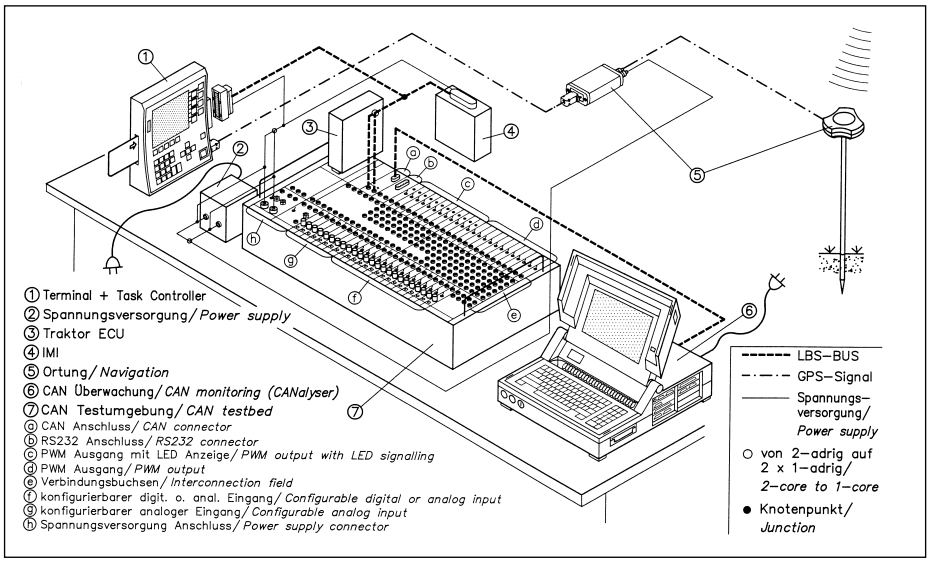

Fig. 1: LBS test facility for system development and system test

Type 2 (Farm data recording for farm management):
Additionally, the farm data with appropriate cost data is fed into the IMI®. To this basis data is continuously added the two parameters

- "working time" (implement in working position)
- "working travel" (distance between GPS positions)

- whenever their condition changes. Both parameters remain available for a utilisation evaluation at any time and enable the determination of implement-specific information

- area worked = working travel (working width
- average working speed = working distance/working time

Type 3 (Machinery utilisation for ÜMV):
Within the IMI®, further data (working depth, load) are recorded via sensors and additionally integrated are observations on total establishment time, working time, and total distance. From this can be conducted a large amount of differentiated utilisation data such as:

- proportion of work utilisation = working time/total utilisation time
- average driving speed = total distance/ total time....
- average working speed = working distance/working time

First results

The IMI implement electronic identification card is part of the research project „Automated process data recording". With this up until now more than 800 000 data units could be collected. These cover the given times and areas under practical conditions as in *table 2*.

IMIs from types 1 and 2 are applied. The data recorded with a 1 Hz frequency were analysed and aggregated via post processing.

Reliability

IMI® software can, analogue the authentification by UNIX with help from passwords, regulate the specific reading/writing access to different data. Manipulation through direct access to the hardware can to a great extent be avoided when all data is coded with a number directly integrated in the program text. Without knowledge of the code it is then very difficult to alter data to such an extent that a deliberate alteration could not be discovered by a plausibility control. Therefore the IMI® must be so built that every access into the electronics (and, with that, every attempt to decode the software) can be recognised.

Summary

Through LBS and GPS a differentiated implement utilisation documentation for fieldwork can be established. Through the integration in implement specific identification units are produced „Electronic implement identification cards". These allow completely new evaluations of implement application for:

- cost evaluation for own machinery
- replacement decisions
- resale
- buying of used machinery
- additional information for the implement constructor
- science.

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Table 2: Process data collected by the „automated data aquisition"

	Total time (h)	Field-time (h)	Travelling transport (km)	Travelling field (km)	Worked area (ha)	Time/ field (h/ha)	Distance/ field (km/ha)
Ploughing	46,97	43,41	27,86	224,94	29,0	1,21	7,75
Cultivating	46,40	39,52	64,23	256,51	65,2	0,56	3,94
KE-drilling	7,96	6,58	2,63	32,99	9,1	0,60	3,61
Precision seeding	21,93	9,21	111,67	36,36	10,8	0,61	3,37
Fertilising	27,62	21,25	33,17	103,43	88,6	0,16	1,17
Mulching	6,83	6,24	12,37	59,05	17,6	0,32	3,35
Transport (SM-harv.)	29,07	17,06	241,70	76,42			
Total	**186,78**	**143,27**	**493,63**	**789,70**	**220,3**		