

Logging of Time Elements with Digital Video Technology in Baby Piglet Production

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ABSTRACT

Manpower is an important expense factor in baby piglet production. A thorough knowledge of operational and element related time requirements is crucial for the calculation of economic costs and for labour organization.

Time measurements are influenced by the chosen measuring method. Digital video technology was used comparatively in this study to quantify any possible effects of a timekeeper.

Digital video screening can be applied more professionally for the collection of element specific standard times and for indoor monitoring than analogue screening, especially when home and stable separated by a great distance. For digital recording, special software with video capture cards, which can be installed on most desktop PCs or laptops, is required. Data transfer, editing and archiving is easier and more flexible, and picture quality, resolution and colour values are higher. By using the motion detection function, controlled via motion sensitivity, the masking of activation zones, and a deactivation delay, recording can be restricted to immediate activities of the employee in and around the farrowing crates, reducing recording time from 24 hours per day to a half an hour per day. Work time analysis on the element basis can be easily and efficiently controlled through the integrated analysis module of the video software. For nine of the 15 elements, statistically proven differences between video technology based and timekeeper based standard times could be compiled.

According to these results, employees do motor-stressed work processes more quickly, and precision-stressed work more slowly, when directly monitored by a timekeeper. Standard times showed differences between 61.6 % and minus 198 %. Moral and intrinsic motives of workers are considered to be responsible for these alterations in motivation and accuracy. These results in lower work time calculations based upon standard times taken by a timekeeper, therefore requiring a performance higher than the actual norm. More extensive research is necessary to comprehensively quantify and ascertain the extent.

Keywords: Working time requirements, digital video technology, time element, timekeeper

1. INTRODUCTION

Knowledge of work processes and their time factors is absolutely essential for a sustainable and economic production of piglets. It provides the basis for objective comparative evaluation, work time management, evaluation of process flows, financial prognosis and evaluation of operating efficiency. Objectively obtained work time data can be used not only by individual enterprises to optimize their production processes, but also to determine labor expenditure discrepancies for various housing systems and to make sectoral economic prognoses.

The quality of measurement results is influenced not only by a measuring method, but also by the technology used to measure. For an efficient, causal collection of time data following the time element method, a precise and cost-effective measuring technique should be used. It must be able to continually measure various elements in centiminutes (one hundredth of a minute) and to exclude influences by the timekeeper to a high degree, while still enabling a practicable analysis of data. These requirements are only partially met by conventional measuring technologies such as analog stopwatches or analog video.

In order to best fulfill the above conditions, to effectively design the collection and analysis of data and to detect any influences by the timekeeper, digital video technology with motion detection has been tested comparatively during an indoor production phase requiring minimal regional or temporal flexibility.

2. MATERIAL AND METHODS

Research was carried out in the farrowing stable of the Giesshübl Pig Center which have eleven rows of ten different types of farrowing pens with a total of 109 farrowing spots for up to 600 breeding sows. During the farrowing and suckling phases, sows are continually confined in seven different farrowing crate systems and are kept with no long-term confinement in the three open pen systems. Eight of these systems, all of them are produced by Austrian companies, are the focus of our study, five farrowing crates and three open stalls. (Baumgartner & Winckler, 2006)

Activities within the pen area were indirectly logged as elements for comparative purposes. Digital video technology with analog cameras was used to indirectly compile data to work processes. The video server and cameras had previously been installed for ethological research and had continually been in use before recording working processes. The digital video recording unit included a video server made up of a standard home computer (Pentium IV processor) with four video capture cards with four ports each, as well as a digital MSH Surveillance System, a software for computer-based digital recording, viewing and analysis and the graphic card required by the software.

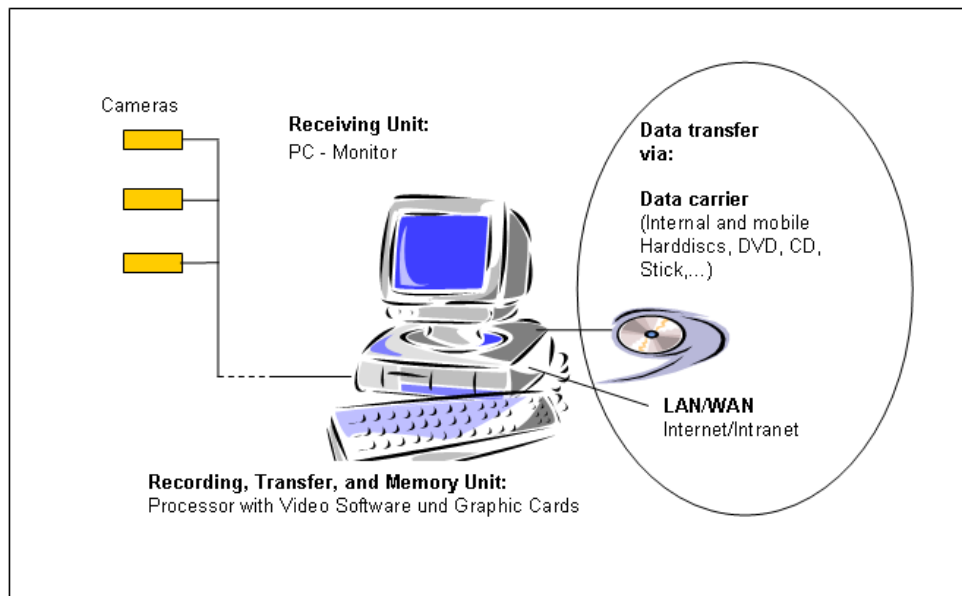


Figure 1. Digital video time analysis

The recordings were viewed and analyzed on standard computers using MSH video client software packages with serially integrated graphic cards. One to two cameras were placed around each pen, positioned to encompass the complete work area around the pen. Recording time is controlled and reduced to a minimum by motion detection functions – motion detection, image masking, and deactivation delay. An external hard drive was used to transfer recordings from the video server hard drive to the individual PCs for analysis. DVDs were used for archiving. It is also possible to work with computerless recording instruments using removable hard discs.

All activities that took place during one cycle, a farrowing and a suckling period, were recorded and measured on the work element basis with the MSH video client (software package for the MSH Surveillance System), and analyzed and comparatively portrayed in a spreadsheet environment.

Work elements that were frequently repeated within the two-month time period and which provided statistically verifiable standard times were used for comparison with the standard times of the timekeeper's measurements which necessitated time-intensive human observation of working processes.

3. RESULTS AND DISCUSSION

3.1 Recording of Work Processes

All pen-specific work in and around each type of pen were comprehensively gathered over a two-month time period, during the months October 2005, February 2006 and March 2006. The cameras were positioned to effectively record for analysis all work processes taking place within the eight focus areas. This was achieved with a single camera in the farrowing crates and by two cameras for the open pens, which are larger and have higher side walls.

Application showed that a computer-based digital recording system was able to fulfill with no considerable drawbacks all the functions of analog technology, including the time laps, video

recorder and multiplexer that were formerly used to analyze animal and human behavior. Various qualitative advantages were identified, including the marked reduction of flaws and noise interference, a higher resolution, greater processing flexibility, the easy transfer of videos to other and to multiple media, low investment costs and alternative uses of equipment.

Flaws and interference during signal transference are present to the same degree as in analog technologies, but can be more easily emphasized and clearly differentiated from content (Schmidt, 1996).

Camera sequences can be easily adjusted for contrast, brightness and saturation. Memory capacity use is determined above all by frame rate and recording length.

The MSH Video system with four video capture cards records a maximum of 100 frames per second. A frame rate of one to eight can be chosen for each of the 12 cameras monitoring the eight research pens. According to Haidn (1992), analog recordings of work processes with a rate of one frame per second are adequate for the exact identification of individual work tasks. In the first recording cycle of this research, the digital frame rate was raised from one to three frames per second, greatly reducing video jerkiness and thereby reducing eye fatigue during the evaluation process. The optimal image quality was achieved at four frames per second. Further raising of the frequency, for example to eight frames per second as was tested in the second cycle, had no optical advantages for the evaluating person, yet required a markedly higher storage capacity for an equivalent recording period. Blind areas on the video, which are sometimes necessary for the demarcation of work processes and are mentioned by Haidn (1992) as one of the weak points of this technique, were eliminated by the installation of a second camera from the opposite side.

The recordings are controlled by motion sequences through motion detection which recognizes color changes in the video pixels. The sensitivity for changes was reduced by 50% and raised for at least three motion zones (blocks). This preselection eliminated false activation of the recording process, for example by minimal positional changes in very small frame sections, above all by non-human elements around the pen, for example triggered by the ventilation or by small body parts of the piglets (ears).

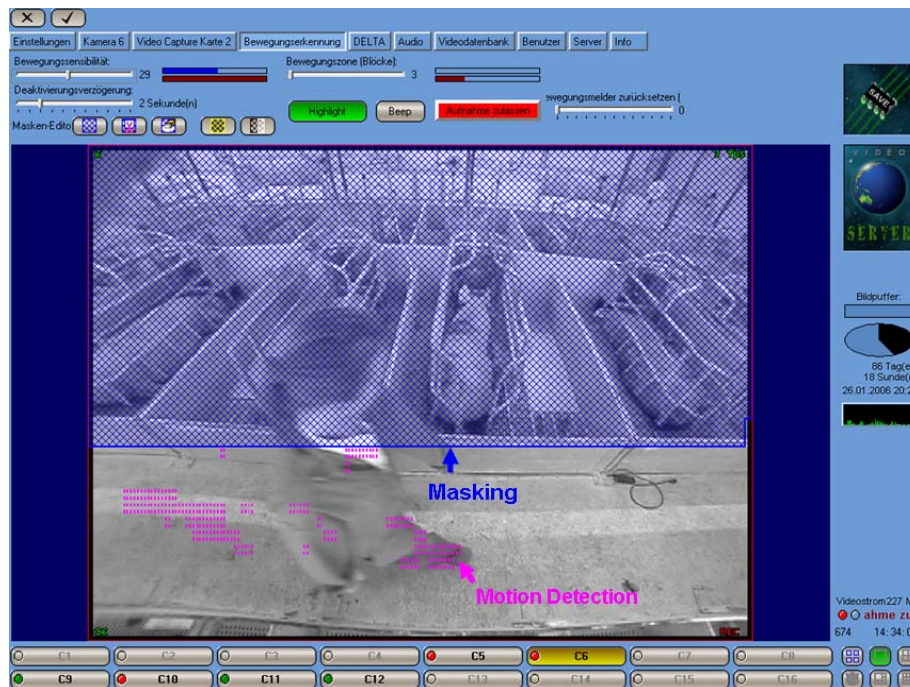


Figure 2. Functional principle of motion detection

Masking specific picture sections narrows the recording area. Within the masked interior of the pen, pixel changes caused by animal or human activity do not activate the camera's recording mode. Recording is limited to activities directly surrounding the pen. The deactivation lag or the specification of a shutdown delay ensures that any short-term human activities taking place outside of the aisle area, and therefore within the masked interior of the pen, are nonetheless recorded.

The cyclical recording function, which records over the oldest sequences when the existing memory capacity is reached, thereby jeopardizing recordings, was overridden in the first research cycle by backing up recordings to mobile hard discs, and in the second cycle by installing an additional stationary hard drive and a controller (Shafro, 2005).

The magnetic tapes used for saving data when using analog technology were substituted by more cost-efficient MPEG technology. Digital storage media such as CDs, DVDs, mobile hard discs and USB sticks are all highly computer-compatible and simple to archive and process. Also, no cassette change is necessary and limitless copies are possible. The saved digital sequences can easily be converted into AVI format for the simple viewing of video clips during presentations.

An alteration and deterioration of signals, such as with analog technologies during signal transfer from camera to recording device, to each further recording device and during each viewing, is not present in digital technology (Doucette, 2000).

When using the above recording modularities with a resolution of 768 x 288 in PAL format and a frame rate of four frames during the first cycle and eight frames per second in the second cycle, for saving the recordings of all work processes around the 8 pens for one farrowing and suckling period (28 days) by 12 cameras was necessary a memory of 40 GB for the first cycle and 100 GB for the second one.

Data was archived on ten DVDs in the first cycle and on 24 DVDs in the second. At a frequency of four frames per second, all work processes around one observation pen during one farrowing and suckling cycle could be archived on a single DVD. The storage capacity and analysis effort could be reduced in this manner from 24 hours per day to a half an hour per day for each pen.

Digital video surveillance is also possible via network or telephone. This offers a significant advantage for farms where the stalls and the domestic area are separated by a distance. In such a case, this technique can be implemented for surveillance, for documentation of labor and functional processes, as a source of information to minimize transit time for supervisory work and for the early recognition of malfunctioning systems.

If a standard home computer is available, investment costs are limited to software for recording and analysis, a video capture card and the necessary cameras and cables. The video capture card and software cost approximately 360 EURO. New, standard-quality cameras with a protective housing can be bought for 250 to 700 EURO and 0.70 EURO must be budgeted for one meter of video cable (BNC-RG 59). This means that acquisition costs are relatively moderate. Based upon this cost calculation, it is conceivable that the alternative uses of this technology, in terms of security and remote surveillance, could gain in relevance for practical farmers.

3.2 Video Data Analysis

To position the start and finish of the recording sequences of the pen types across two farrowing and suckling cycles as functions were used advance, rewind, fast forward, playback speed, motion search and mouse activation of camera frames. The level of the analysis is equivalent to that of the timekeeper's measurement of element based classification.

The computer keyboard is used to activate the start and finish of each work element within the camera frame area. The beginning and end of each measurable work element is marked with a letter. By pressing the correlating key, these key are shown with other parameters in a log file. They are noted down with the code-related start and finish times of a coded element, the time and date of analysis, camera number and recording date. Six to ten hours are needed to evaluate all pen-specific work tasks for each of the eight research pens. The evaluation data of the program-specific log files can be efficiently processed in an spreadsheet file, using macros. The time for each task was calculated through comparison and conversion to centiminutes as well as by using statistical parameters.

Distances and areas cannot be measured by video and must be surveyed separately on site. In this case, they were taken from direct on-site observations. For 15 work elements, there were a sufficient number of repetitions providing statistically confirmed standard times to be compared with ones of the timekeeper's on-site measurements.

3.3 Influence of Measuring Method on Measurement Results

According to Waibel & Niederhauser (2003), surveillance-like activities that are seen as negative incentives, such as the monitoring of labor, have a positive influence on labour productivity triggered by moral and intrinsic motives. Therefore it is to be expected that differences arising from the measurement method will be reflected in the standard times of work elements. The reason for the time difference is assumed to be the differences in measuring method, the impact potential of which is statistically tested with the variance analysis. It is assumed that when a timekeeper takes times locally by accompanying the

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worker throughout their tasks that this has a motivational effect and leads to an increase in efficiency and precision. For the monitoring by the video technique it is supposed that employees did not perceive the monitoring by the cameras as a controlling agent, since the cameras had already been in the same or similar positions for several months for ethological research. But even if it were to be registered as a monitoring instrument by the employees, certain advantages in terms of higher work process efficiency could be expected, since the reproducibility of work completion behavior is anchored in the conscious. This awareness tends to lead rather to longer work times as is known to be the case with high-precision tasks.

The time results gathered and the statistically validated averages for each work element in the pen area are listed in Table 1.

Table 1: Comparison of calculated standard times according to measuring method

	Measurement by:		Variance Analysis		VT-TK
	Video Technology (VT cmin)	Timekeeper (TK cmin)	T-, F-Test	Result	Difference
Work elements	Standard time/action $Av^2, \varepsilon^3, {}^4VC, {}^5n$	Standard time/action $Av^2, \varepsilon^3, {}^4VC, {}^5n$	$Pr>t/Pr>F$		in %
Complete Protocol	5.56,14.43,49.64,48	4.51,6.79,33.01,95	0.0162	*	18.84
Trough cleaning (FC ¹)	18.05,14.67,46.40,41	20.60,7.54,63.03,271	0.0143	*	-28.15
Trough cleaning (open pen)	15.70,15.68,32.49,19	25.52,12.37,111.0,312	< 0.0001	***	-68.45
Carry bucket to next pen	1.70,12.69,46.86,55	1.75,10.82,39.59,54	0.6933	n.s.	-3.33
Leave pen	5.63,15.30,21.53,10	5.54,9.06,23.3,28	0.8358	n.s.	1.70
Open door	6,15,14.66,27.51,16	4.80,6,74,43.42,162	0.075	n.s.	21.96
Catch piglet (FC ¹)	6.35,7.93,29.03,54	5.52,11.46,38.96,47	0.0343	*	13.01
Catch piglet (open pen)	6.50,15.76,60.38,59	6.92,8.28,37.63,82	0.47	**	-6.56
Enter pen	4.09,14.23,21.28,11	4.53,10.09,28.88,34	0.2154	n.s.	-10.72
Feeding check	2.88,10.92,71.01,165	8.59,13.32,74.55,123	< 0.0001	***	-198.23
Protocol entry	16.54,13.49,91.49,181	6.36,10.94,35.06,42	< 0.0001	***	61.56
Note injection	26.85,13.85,18.21,9	19.35,14.83,34.23	0.0022	n.s.	27.95
Fill piglet feed bowl	4.75,14.19,40.60,34	2.18,12.05,46.56,60	< 0.0001	***	54.08
Remove placenta	17.41,14.62,19.22,9	19.74,14.73,30.53,19	0.2015	n.s.	-13.38
Return piglet to pen	2.56,14.57,37.52,28	3.18,4.02,36.97,327	0.0029	**	-24.14

*¹FC: Farrowing Crate, **²Av: Average, ³ ε : Average, ⁴VC: Variation Coefficient, ⁵n: number of measurements
cmin: Centiminutes

Significant differences could be established for nine of the 15 tasks listed. Four of these nine tasks show lower time expenditures during timekeeper tracking and the other five during the unobserved situation. The element “farrowing crate trough cleaning” had a standard time difference of 28.15%, less time being needed without the presence of a timekeeper. The tasks “complete protocol” and “catch piglet (FC)” had statistically proven 18.8% and 13.01% more time expenditures by the digital video technique. The elements “catch piglet (open pen)” and “return piglet to pen” varied significantly, 6.5% and 13.3% less time was needed without the

observance of a timekeeper for the completion of the same element. Highly significant differences were detected for the tasks “open pen trough cleaning”, “feeding check”, “protocol entry”, and “fill piglet feed bowl”. The video-based standard times are around 68.45% and 198.23% lower than those under the timekeeper method for the first two above tasks. For “protocol entry” and “fill piglet feed bowl”, the standard times of the video technique method are 61.56% and 54.08% higher than those of the time keeper method. No statistically verifiable differences could be proven for six tasks – “open door”, “leave pen”, “carry bucket”, “enter pen”, “note injection”, and “remove placenta”. Overall, the results show sometimes considerable differences. During those activities with high physical stress upon the employee, the average task time under the timekeeper method was generally considerably lower. Thus, employees generally work faster in an observed situation. Tasks that are less labor intensive but require more precision generally take more time in an observed situation.

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