Laboratory Automation For Improved Food Safety

A New Methodology for Controlling Pipette Processors

In a state like Lower Saxony, Germany, with a high cattle count, particular importance is attached to applied epidemiology and research into the causes, spread and control of animal diseases.

The Hannover Veterinary Institute of the Lower Saxony State Office for Consumer Protection and Food Safety (LAVES) carries out an average 220,000 serological assays each year. In addition the Oldenburg Veterinary Institute of LAVES evaluates a large number of these serological samples. This form of testing is essential for preventing and containing serious outbreaks of animal disease.

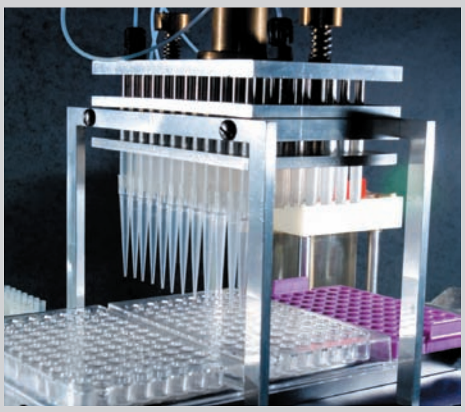

Figure 1. Pipetting is a routine process in everyday laboratory work

Pipetting is without doubt one of the most intensive repetitive processes in routine daily laboratory work. To protect the health of humans and animals, work in this sector is undertaken with the greatest precision and value is placed on optimum process safety and stability. For this purpose, German software company infoteam developed specialised system software and an entire methodology for controlling the subprocess/sample distributor. Work was done specifically on a processor for primary sample distribution in deep well plates (DWP), and also two selective pipettors for filling ELISA test plates. The task comprised overall optimisation of the work processes for serological testing.

A pipettor implements the primary distribution of bovine and porcine sera from two sample tubes of different sizes into deep well plates (DWP). These samples are provided with an adequate number of 24 and 32 piece samples, so-called tube racks, by the Hannover Veterinary Institute. At the end of the project the available pipettor plus one newly acquired have to perform the task of secondary distribution from the deep well plates (DWP) into microtitre or ELISA test plates.

For reasons of process safety, assembly of the carriers for pipetting and test plates is identical for both systems. This ensures that if one machine should be out of action the routine laboratory testing can continue undisturbed, albeit at reduced capacity. For the same reasons of process safety the pipettors are configured so that they can perform the tasks of the primary distributor. The samples should be processed for as short a time as possible as the test liquid mixed with e.g. bovine and porcine sera may have a short shelf-life. At the end of the filling process the pipette needles are processed in a washer for the next process.

The pipettor has a barcode scanner with autoload function. This device ensures that the individual samples can be traced using the integrated database system. If a sample is infected the plate from which the sample originates has to be identified in as short a time as possible. If an infection is present there must be no delay in response time so that, if appropriate, measures can be introduced to contain the infection.

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The software developers at infoteam developed the entire methodology for the manufacturer of the pipette processor: the system incorporates largely automated fault handling, to facilitate unsupervised processing during normal working hours. Features, such as continuous loading and parallel sample pipetting increase the throughput rate and enable efficient use of the equipment and optimal planning of the work processes. The modular arm of the processor is configured for up to 8x 1,000µl pipette channels. The 8 channels with 1000µl pipette heads are asymmetrically expandable in a y- and z-direction and can take 10, 50, 300 and 1,000 µl needles. The relevant system software was implemented on a standard PC with Core 2 Duo E6300 (1.86 GHz), 2048MB RAM, 5x RS232 interface, 1 x parallel port, running MSWindows® XP Professional, MSOffice 2007 Professional.

Based on the remit the method was to start with as few user entries as possible, also as few individual methods as possible. The parameters for the variants of the secondary distribution methods are stored in an Excel data file. Using the test codes, supplied by the Laboratory Information Management System (LIMS), parameters such as monophasic/biphasic and use of needles/tips can be read off.

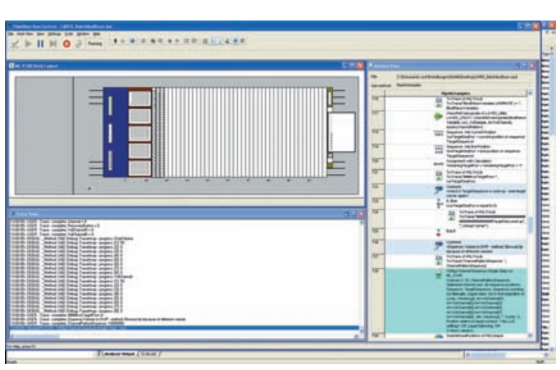

Figure 2. Sample output

The development team also had to think about the appearance of the output file. The primary focus was on high user friendliness and intuitive handling of the processor and test results. The required reloading steps are indicated to the user immediately if an error occurs in the testing process. Operation of the pipettor is easy to understand thanks to the new software-based methodology and the manual operator input is restricted to a minimum. The processor monitors all user interventions and thus combines maximum speed giving high sample throughput with optimum safety for process and user.

The whole project including intensive tests took 2 1/2 months. The pipette processor has been used successfully since November 2008 in the Hannover Veterinary Institute of LAVES. The procedure described was put into practice following the introduction of the new LIMS at the end of 2009.

OPTIMIZED DATA FLOW BETWEEN SAMPLES, ROBOT AND LIMS

All tests are administered in a centralised LIM system. The database and pipetting robot always operate independently of one another. To ensure a safe and efficient exchange of data only dedicated interfaces are used. In this project the data files have an appropriate format: the exact data sequence, the delimiter and the file format are fixed. In addition, code information is output which facilitates write-back to the database.

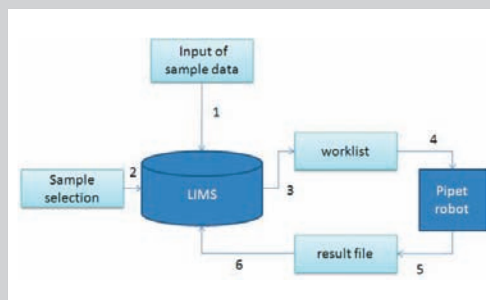

Figure 3. Step by step illustration of data flow.

To be able to start a process on the pipetting robot, input data must first be generated: all the samples to be processed must be registered in the database (1). For a certain test a subset of samples is then selected in the database (2) and output to a worklist with the above format (3).

This data is analysed by the robot (4). All the requirements for starting the pipetting process have thus been met and processing can commence. From this point on the robot operates independently of the database.

During the process all the results relating to the original samples are written to output files again (5). In addition to the unique codes in the LIMS database a status is stored there for each sample, indicating whether the process has been performed successfully or whether the result cannot be used.

At the end of the process this data is sent to the database again (6) and updated by the LIMS.

This method of data flow from the database to the pipetting robot and back ensures that a number of robots can access database subsets and that if a communication problem arises between the database and the robot the data remains available in an appropriate format and can be sent to the database again later.

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