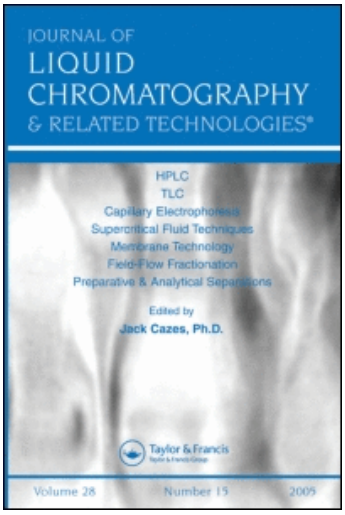

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The Perkin-Elmer MasterLab System

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THE PERKIN-ELMER MASTERLAB SYSTEM

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The Perkin-Elmer MasterLab System for automated sample preparation and analysis consists of three basic parts, the robot arm, the System Controller with the Perkin-Elmer Robot Language (PERL) Software, and the various modules required for the specific application.

The robot utilizes an articulated arm with 5 degrees of freedom. The motions include base rotation, shoulder rotation, elbow joint, wrist pitch and wrist rotation. This allows flexible movement between the sample preparation modules and analytical instruments. Positioning repeatability of the robot $\pm$ 0.5 mm. The payload of the robot is 2.7 pounds, making it consistant with the routine requirements of the analytical laboratory.

The robot has a travelling speed that is variable over nine levels, with the fastest speed set at 15.7 inches/second. The variable speed settings allow slow, cautious movement while performing delicate operations, or faster movements to increase the efficiency of the automated system.

The end effectors (fingers) of the robot are interchangeable to allow use with a variety of

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laboratory vessels, i.e., test tube, beakers, flasks, titrator cups etc. The position of the grippers can be set to assure safe operation even in the tightest spaces. The robot fingers are also equipped with tactile sensing, which increases the efficiency of the automated application by verifying the existence of a vessel in the fingers before the operation proceeds. In addition to different end effectors, the robot can also be equipped with items such as remote cannuals to allow, for example, interfacing with an injector for a liquid chromatograph, or remote pipette tips to aliquot samples avoiding cross contamination (see Figure 1).

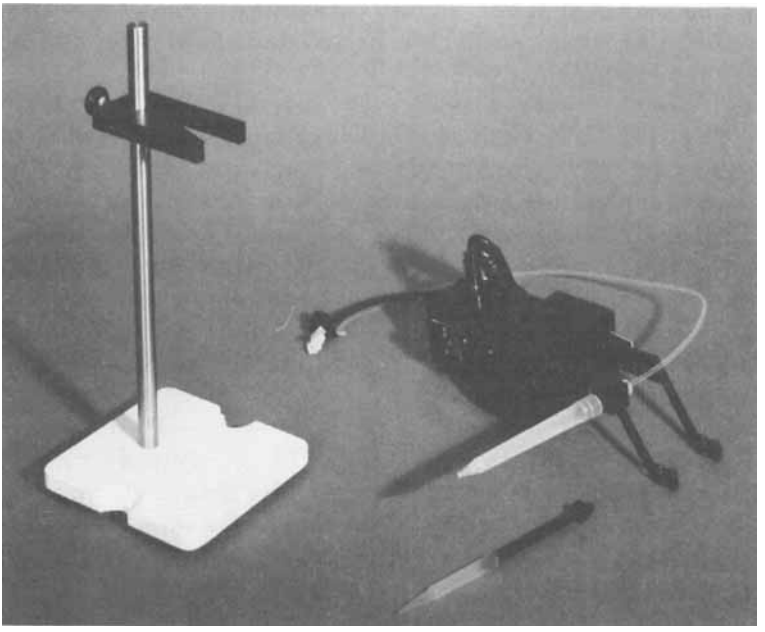

Figure 1. MasterLab remote pipette apparatus.

The controller for the system is the industry standard IBM PC. The IBM PC-AT and PC-XT can also be used as well as several of the IBM compatible computers. Using industry standard computers gives the user full access to the host of third party software available for these machines. The dual disk drive system is set up so that one drive is used to support user programs and the second to collect and store analytical data. Up to ten RS-232 communication ports are supported by the addition of special communication boards.

The user programs the sample preparation and analysis procedures in the Perkin-Elmer Robot Language or PERL. PERL is a high level programming language that is extremely flexible yet very easy to use. The language supports structured programming which allows the user to write and test small subroutines (or procedures) independently, then combine them into a larger program or application. Procedures can be added or deleted at any time, making it easy to tailor an application to changing tasks.

PERL can be divided into three major segments, Configure, a Teach Utility and the PERL Editor.

> The System Configuration Utility is an interactive program which allows the user to describe the configuration of the system and the initialization parameters for ports and devices. This information is stored in a configuration file which is run automatically each time PERL is loaded into memory.

The Teach Utility allows the user to define commands, name positions for the robot, name balance commands, or define actions such as turning devices on and off. Positions do not have to be calculated by the user, the system does the calculations automatically.

Once positions are taught and commands defined, they are ready to be put together in logical parts of the complete method. The PERL Editor allows the user to create procedures, or small steps that will be used in the entire method. The editor takes advantage of the function keys and other special keyboard keys available on the System Controller (IBM-PC).

When procedures are saved on disk, they are automatically compiled. The compiler is, in fact, a pre-interpreter so that programs are executed faster than a typically interpreted language. An example of a PERL procedure is shown in Figure 2.

PERL is a complete programming language. In PERL, you can do anything that you can do with any other programming language. It supports;

Data types (integer, real, character string and array)

Arithmetic operators (addition, subtraction, multiplication, division)

Relational operators (less than, less than or equal, equal, greater than, greater than or equal, not equal)

Arithmetic functions, logarithmic functions, trigonometric functions.

Character string operations and functions (concatenation, isolating subsets of strings, finding length of string, etc.)

Conditional constructs (if...then, if...then...else, case statements)

Looping constructs (for...next, while)

```
Enter file name: weighmt
procedure weighmt
  safe1
  over_balance
  ball
  bal2
  in_balance
  open
  over_balance
  doorcls
  tube$=mass_is
  tube_wt=val(tube$)-val(tare$)
  dooropn
  in_balance
  close
  bal2
  ball
  over_balance
  safe1
  display "tube weight", tube_wt
end procedure
```

Figure 2. Example of a PERL procedure.

Information and data collected during an

application can be gathered from different sources (balances, chromatography integrators,etc.) and transferred to a Laboratory Information Management System. In addition, it provides a means to format screen pages on the System Controller for setting up results and printing reports, and allows data to be stored for use by third party software. PERL also provides extensive facilities for standard RS-2322C communications to other laboratory instruments and computers.

Finally, the MasterLab System will include accessory modules as required for the specific application. Modules include bar code reader, balance kits, liquids and solids handling devices,vortex mixer, sonicator, centrifuge, capping station, vial crimping station, titrator interface kits, and analytical instrument interface kits to name just a few. Simple devices (those without RS-232 communication capability) are controlled with a Device Interface, which contains 12 external switch closures, 12 input level signal monitors, and AC power control. For large applications, or multiple applications using one robot, the Linear Transport Mechanism is available to move the robot between work stations.

The MasterLab System offers an integrated solution to automated laboratory analyses, which includes sample preparation, instrument analysis,and complete data handling. The complete system from a single manufacturer, followed by full customer support and training, assures the user maximum system utility for his investment.