ClevrLIMS
Oil Analysis Laboratory Information Management System

Software System Information

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Introduction

Clevr is an independent developer of analytical laboratory software, specialising in oil analysis.

Our experience in the oil analysis (tribology) industry enables us to understand the specialised requirements of these laboratories and create valuable, innovative software solutions.

Our primary developer, David Brand is a qualified analytical chemist (BSc) with a background in oil analysis laboratories.

David understands the niche needs of the industry, having previously worked with Oilcheck, ALS Tribology, Lubetech both as an analytical chemist and a laboratory software developer.

Clevr aims to build innovative laboratory software which is user-friendly, but powerful. We want our clients to enjoy using our software, to be able to easily maintain it and to see the benefits of increased efficiency and quality.

We have worked with companies across Australia and in Europe to provide smart and efficient software solutions.

Software Overview

Laboratory

LIMS Application

slack
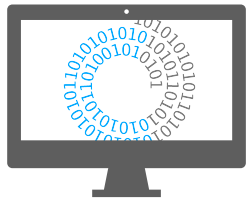
Lab Status Display

Auto Diagnosis API

LIMS Worker

CrossLinkr API

Reporting API

LIMS Database

Customer API

Email

Customer Portal

Mobile App

Customer (Client)

LIMS

Internal Laboratory Application

This is the centrepiece of the ClevrLIMS. The internal-facing laboratory software provides comprehensive interaction, tracking, diagnosis and control of the sample analysis process.
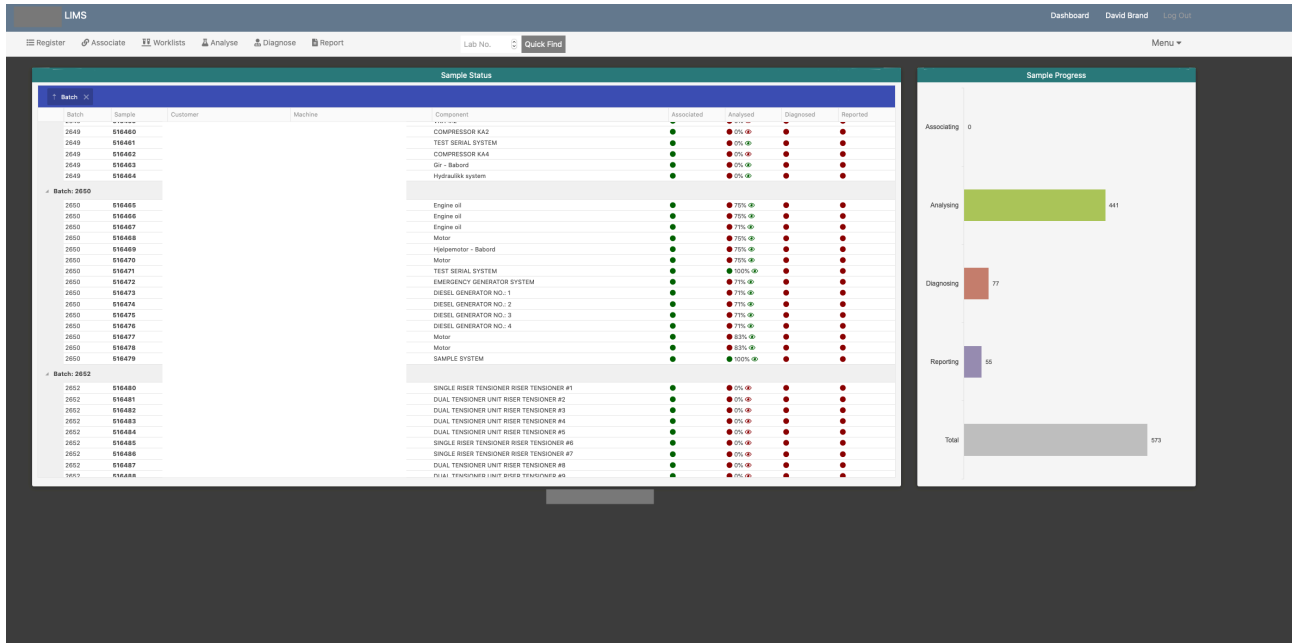
The **Dashboard** is the first screen that a user will see after logging in. It provides a comprehensive overview of active samples in the system and their progress, as well as statistics.
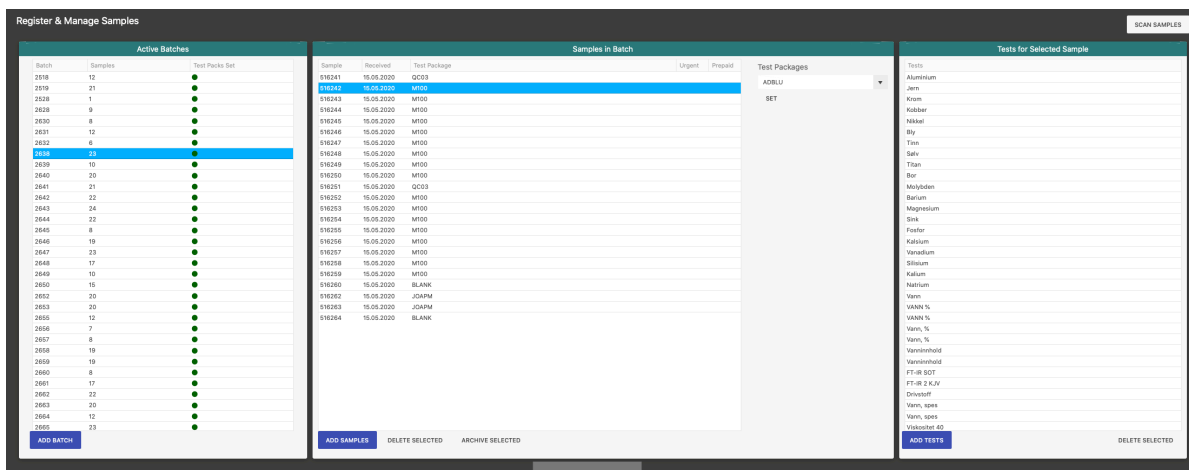
Rapid registration of samples is possible in the **Register** screen, with only the lab's sample number and the testing package required. It is also possible to scan the samples in via a barcode or QR code, which will pre-fill all required information, as long as this has been entered by the customer on the web portal.

Any extra analysis can be added at this point, and the sample marked *urgent* if necessary (which will highlight and prioritise the sample in the LIMS).

The sample can then enter the laboratory, where digital worksheets and the laboratory status display will give lab technicians and analysts information on the required testing schedule.
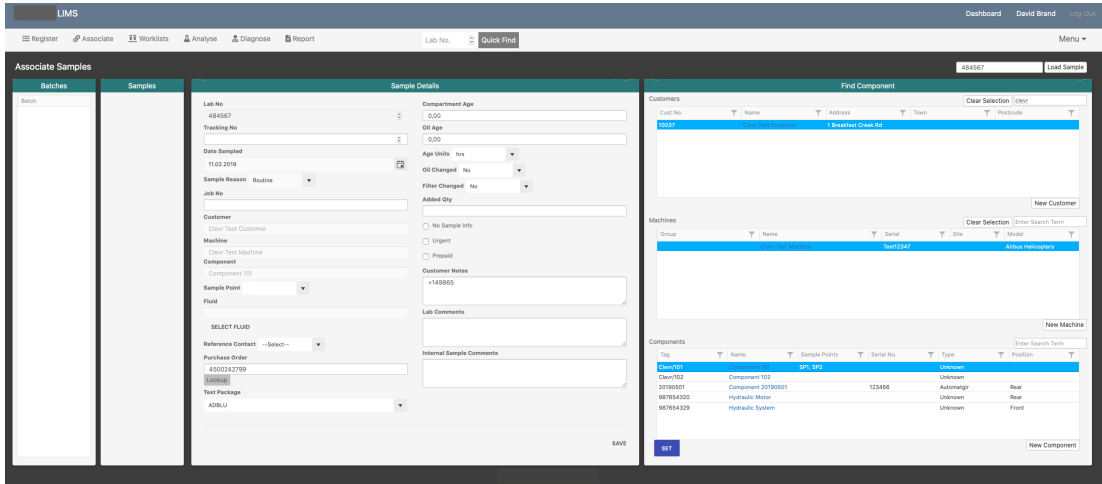
Simultaneously, a separate **Associate** screen is provided for a staff member to quickly find the customer, machine and compartment (or sample point) relating to the sample and add information such as machine hours, oil changes and other relevant information. This screen includes highly responsive search functions and quick access to add or edit missing or changed information.
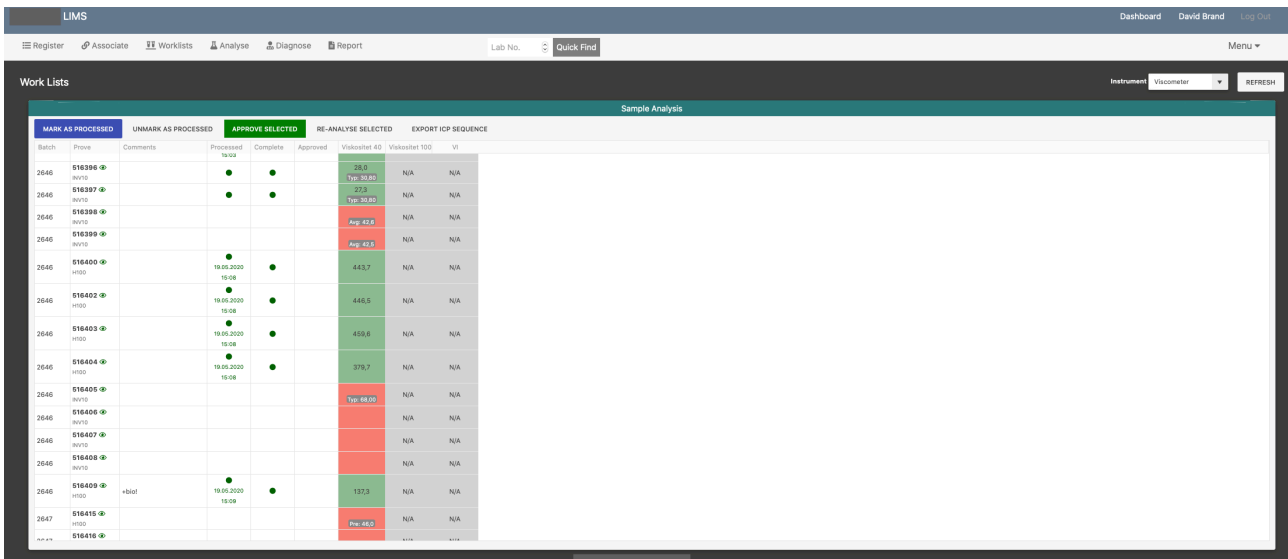
Lab technicians are provided with multiple screens to manage their work. Digital **Work Lists** allow analysis to be managed by instrument or lab station and to quickly see (via colour coding) which samples require processing, which need review and approval of uploaded results and any re-testing that is required. It is also possible to see an expected or typical result to enable validation.

Any results that require hand entry are able to be entered in the **Analyse** screen where comments for each analysis can also be entered, for review by diagnosticians. The results are automatically adjusted for the correct precision and limit of reporting (LOR).

The **Diagnose** screen is the workhorse of the LIMS, providing a comprehensive overview of sample results, previous trends, laboratory comments and any images taken for the sample. The diagnostician can quickly highlight abnormal results (with multiple levels of severity) and access comments from previous samples for the same sample point.

An overall status for the report can also be chosen (and will automatically change if an abnormal result is marked). This provides the customer with a quick indication of the sample status before reading comments or viewing the results.

Finally, a **Reports** screen provides an overview of reports that are awaiting submission to customers, or which may be pending other samples (for batch reporting). This screen provides a search function and allows viewing PDF reports and a log of email notifications for each.

Additionally, a multitude of screens are provided for managing customers, contacts, machines, compartments, analysis settings, test methods, instrument management and interfacing and user roles, and much more.

A **Sample Search** screen provides the ability to very quickly find a sample in the system, whether currently active or historical. Access to all results and reports for the sample is provided. From here, a previously reported sample can also be re-activated for revision purposes.

Reporting API

The ClevrLIMS Reporting API is a web service which handles automated generation of PDF reports, combining batch reports and emailing.

Emailing can be connected to an external email API (such as Postmark) which further enhances email presentation, delivery and feedback for issues such as incorrect email addresses, staff changes and full mailboxes.

REPORT EXAMPLE (PLEASE NOTE BLACK REDACTIONS ARE FOR PRIVACY REASONS)

Report templates are fully customisable and configurable. PDF Reports can display sample information, trend charts, sample images, comprehensive trend results, diagnosis comments and highlighting for abnormal results carries through from the Diagnosis screen.

PDF documents (such as instrument reports) can also be appended to the reports easily through the LIMS.

Batch reporting is possible, allowing a customer to receive a single report for all samples for a machine. A cover page is produced with a summary showing each sample and the overall outcome and comments. This process is entirely automated (with an override feature in the LIMS).

Background Worker

The ClevrLIMS background worker handles all the heavy lifting behind the scenes. Running constantly on the server, the worker checks queues for tasks such as report generation and actions these. By removing these processes from the LIMS application and running them separately, users never have to wait for these processes while they complete other work (even though generation of a report takes a matter of seconds).

Queues

As ClevrLIMS has many automated processes, queues are used to ensure reliable completion of each task. This may include generating PDF reports, automatically diagnosing samples, emailing reports to customers or generating an invoice. Queues ensure that each and every task completes even if there is an issue (e.g. network problem, external API connection issues).

Auto Diagnosis API (Optional)

Optionally, ClevrLIMS can auto-diagnose samples based on limits provided per client, fluid type, compartment type or machine make/model. This is an automated process that means samples are pre-diagnosed after analysis is complete. This minimises work for diagnosticians and reduces the possibility for missed issues in the sample results.

Instrument Interfacing (CrossLinkr)
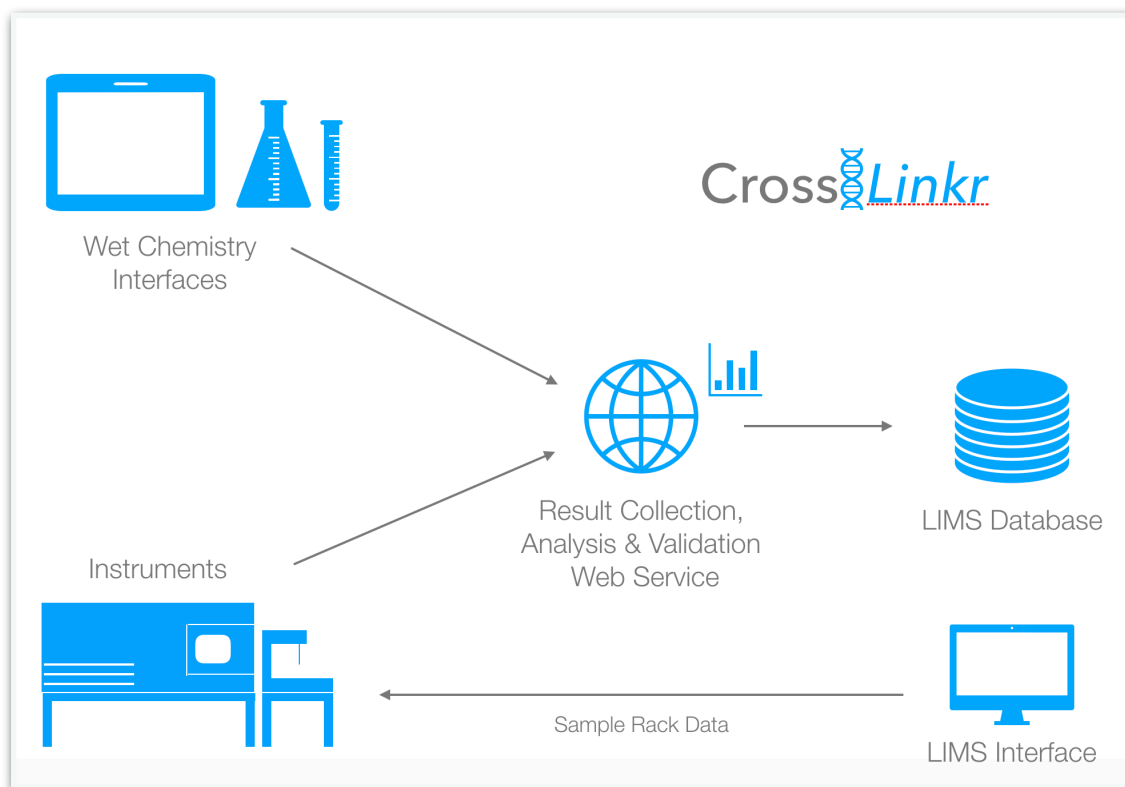
It is commonplace now for laboratories to have integration of instruments to their LIMS. This provides instant transfer of results and automatic export of sample racks (optional).

CrossLinkr provides a fully automated, rapid and configurable platform for retrieving, processing and uploading results from instruments.

Files are collected from instruments and sent to the *CrossLinkr* Web API which handles all processing, validation, rounding and precision functions in a matter of seconds.

New instruments can be configured in ClevrLIMS and many kinds of instrument export files are supported including csv, tsv, plain text files and Excel (xls/xlsx).

Optionally, ClevrLIMS can also generate instrument rack files for sample batches to eliminate the need for lab technicians to hand enter or scan sample numbers into the instrument software.

Laboratory Dashboard

A separate laboratory dashboard application is provided which provides a detailed, yet simple overview of analysis in the laboratory.

For each sample batch counts are provided for samples awaiting processing, awaiting results and awaiting approval.

A table indicating re-analysis required is shown, providing a quick way for lab technicians to be alerted that a diagnostician or supervisor has requested re-testing.

The dashboard is updated in real-time, so the current status of the laboratory can be seen at all times.

Laboratory Dashboard

Batch Status

Batch	Inndato	ICP	FTIR	KF	Auto Titrator Omnis	Flashpoint	Particle Counter LNF	GC	Viscometer	Microscopy (gammel)	Auto Titrator Metrohm	Other	Bio	MPC & Ruler	pH, Nitritt, frysepunkt og egenvekt	Gjennomslag og farge	Crack	Auto-Microscopy	Klassifiseringer (test)	Subcontracted
2628 👁	14.05.2020									✎1 ▣8									✎9	
2630 👁	14.05.2020								✎4	✎8									✎8	
2632 👁	14.05.2020								✓1											
2638 👁	15.05.2020	✎1							▣16											
2639 👁	15.05.2020			▣5	▣9				✎9											
2640 👁	15.05.2020			▣18	▣18															
2641 👁	15.05.2020								✎21	✎21									✎21	
2642 👁	15.05.2020			▣7		✎9			✎15		✎9				✎15				✎15	
2643 👁	18.05.2020			▣22	▣22				✎1 ✓10											
2644 👁	18.05.2020	✎1		▣20	▣20		✎13		✓20										✎13	
2645 👁	18.05.2020			▣7	✎2				✓2											
2646 👁	18.05.2020			▣13	✎13		✎8		✎6 ✓7				▣1						✎8	
2647 👁	18.05.2020			▣21	✎21		✎10		✎12 ✓9										✎10	
2648 👁	18.05.2020				✎12	✎12			✎3 ✓9		✎3				✎3					
2649	18.05.2020	✎10			✎9	✎9			✎9											
2650 👁	18.05.2020		✎13	✎11			✎8		✎11				▣11				✎2			
2652	18.05.2020								✎19	✎20		▣20			✎20				✎20	
2653 👁	18.05.2020	✎20					✎20												✎20	
2655 👁	19.05.2020	✎12					✎12												✎12	
2656 👁	19.05.2020	✎7					✎7												✎7	
2657	19.05.2020	✎8																		
2658 👁	19.05.2020	✎19	✎17	✎17			✎8		✎17										✎8	
2659 👁	19.05.2020	✎19	✎17	✎17			✎6		✎17										✎6	

Reanalysis Required 🔴

Batch	Sample	Analysis
2638	**516262**	ICP [20]
2650	**516467**	Flashpoint (Drivstoff, FLAMMEPUNKT, Flammepunkt)

Sample Progress

Stage	Count
Associating	0
Analysing	441
Diagnosing	77
Reporting	55
Total	573

Completed Batches

Batch	Time	Analysed	Diagnosed	Reported
2522	18.05.2020 14.15	●	●	●
2528	19.05.2020 09.15	●	●	●
2551	19.05.2020 12.06	●	●	●
2552	19.05.2020 09.16	●	●	●
2594	19.05.2020 09.17	●	●	●
2599	19.05.2020 11.51	●	●	●
2604	19.05.2020 09.30	●	●	●
2608	18.05.2020 11.34	●	●	●
2609	18.05.2020 11.18	●	●	●
2615	19.05.2020 11.50	●	●	●
2616	19.05.2020 13.41	●	●	●
2620	18.05.2020 12.15	●	●	●
2622	19.05.2020 14.01	●	●	●
2624	18.05.2020 16.07	●	●	●
2625	19.05.2020 08.22	●	●	●
2626	18.05.2020 07.50	●	●	●

Customer Portal

A comprehensive customer portal is provided, providing the ability for customers of the laboratory to login and view the current status of samples, recent reports, sample scheduling and register samples.
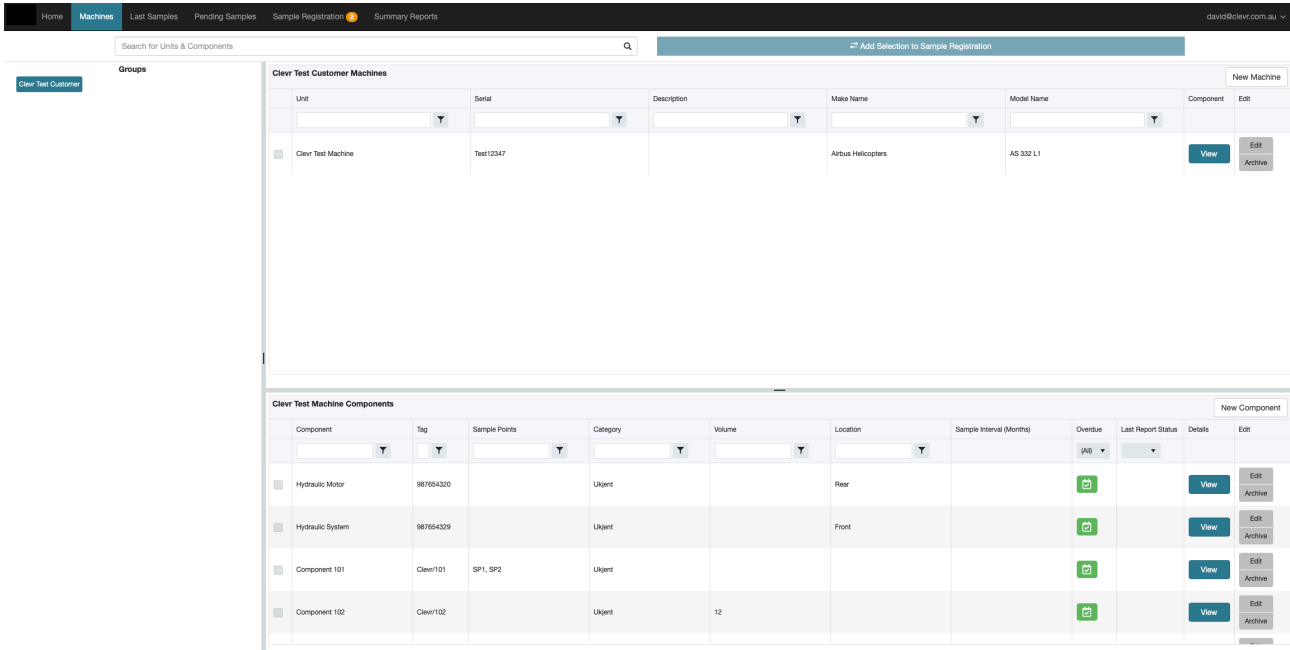
Sample registration allows the customer to quickly select machines and compartments for sampling and enter only the required information (e.g. oil hours, fluid changes) and submit to the lab.
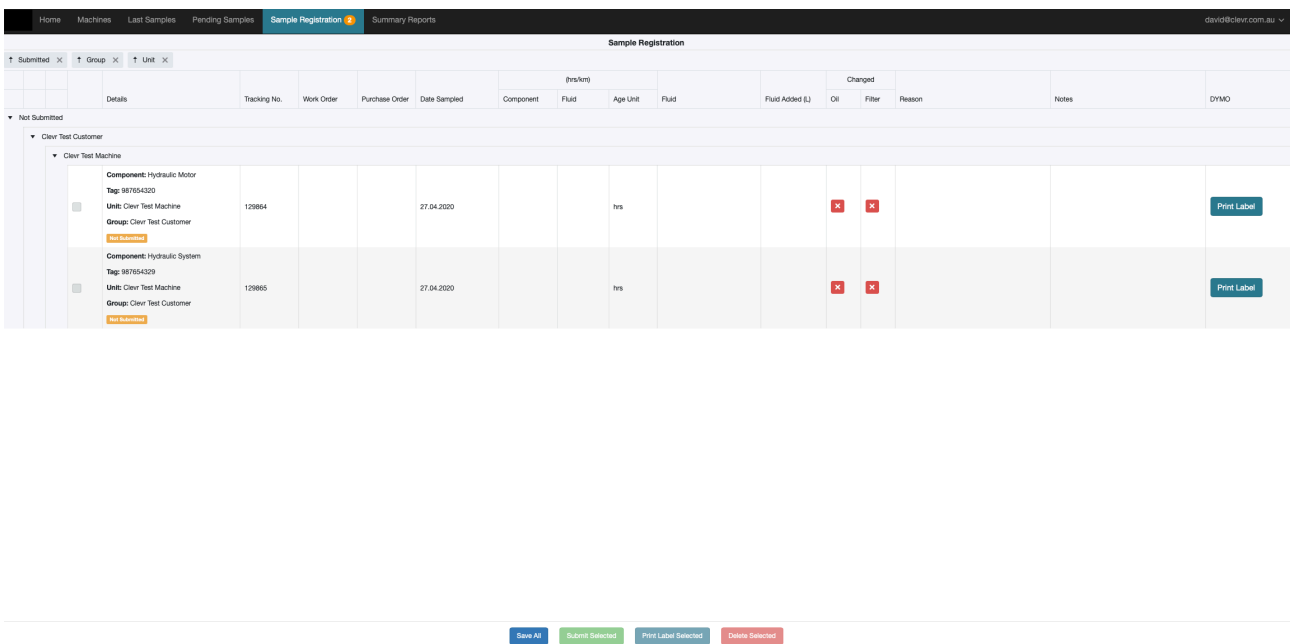
The user can also print a Dymo label with a QR code to attach to the sample, which can be scanned on arrival to the lab to pre-fill all required information (including sample point, fluid type and normal testing schedule).

Also, the customer can add and update assets including machines and compartments and view reports and trend charts.
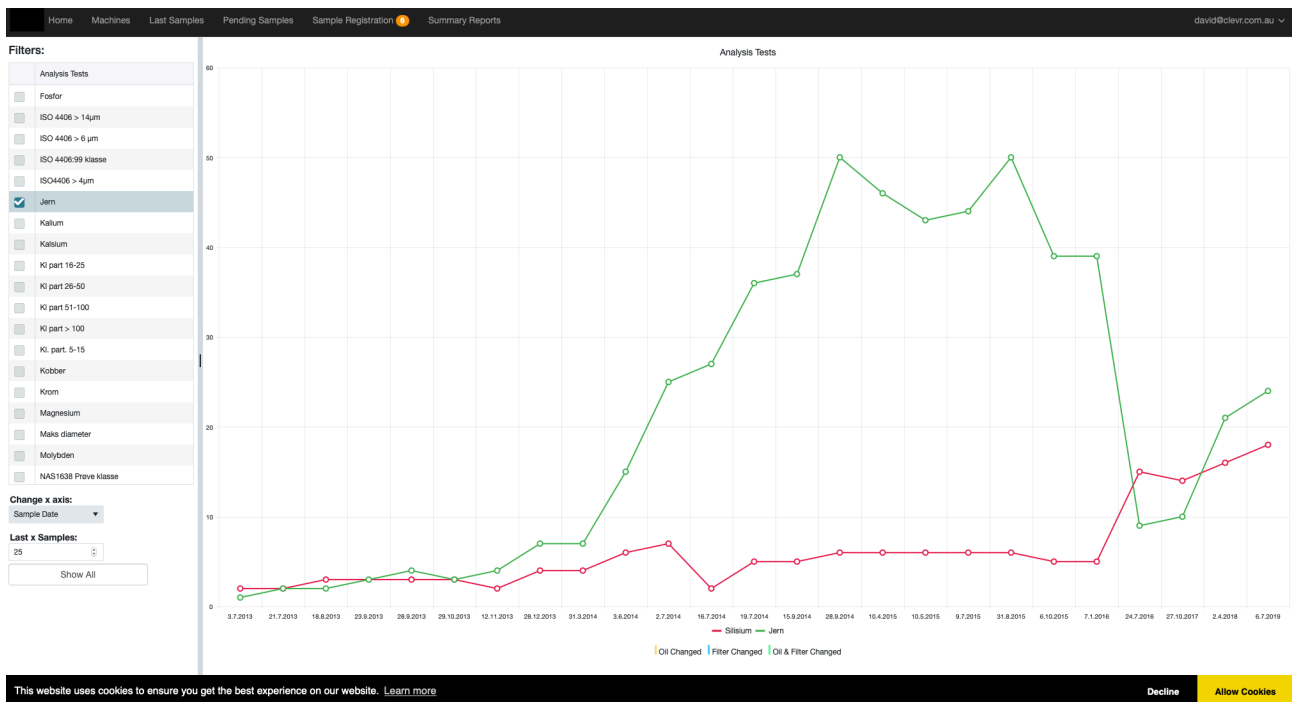
Finally, there is also the ability to export CSV data files for sample results and to generate management reports with counts of abnormal conditions and testing schedules used.

Customer API (Optional)

The Customer API is a REST API interface for customers to access data from the ClevrLIMS oil analysis software system.

An API user can develop their own software or integrate a reliability system or ERP (for example) to access analysis results, diagnosis comments and metadata for machine components.

The system is secured and requires a username, password and API key to access. These are generated by ClevrLIMS.

This provides a very modern and interactive way for customers to integrate with an oil analysis laboratory.

The main functions are shown below, however new functionality is being added continuously.

MACHINES (UNITS)	COMPARTMENTS	SAMPLES	RESULTS	REPORTS
GET Units	GET Compartments	GET Samples	GET Sample Results	GET Download Report
GET Search Units	GET Search Compartments	GET Sample Details	GET Trend Data	
	POST Update Sampling Interval	POST Register Sample		
	GET Overdue Compartments	GET Summary Report		
		GET Sample Status		
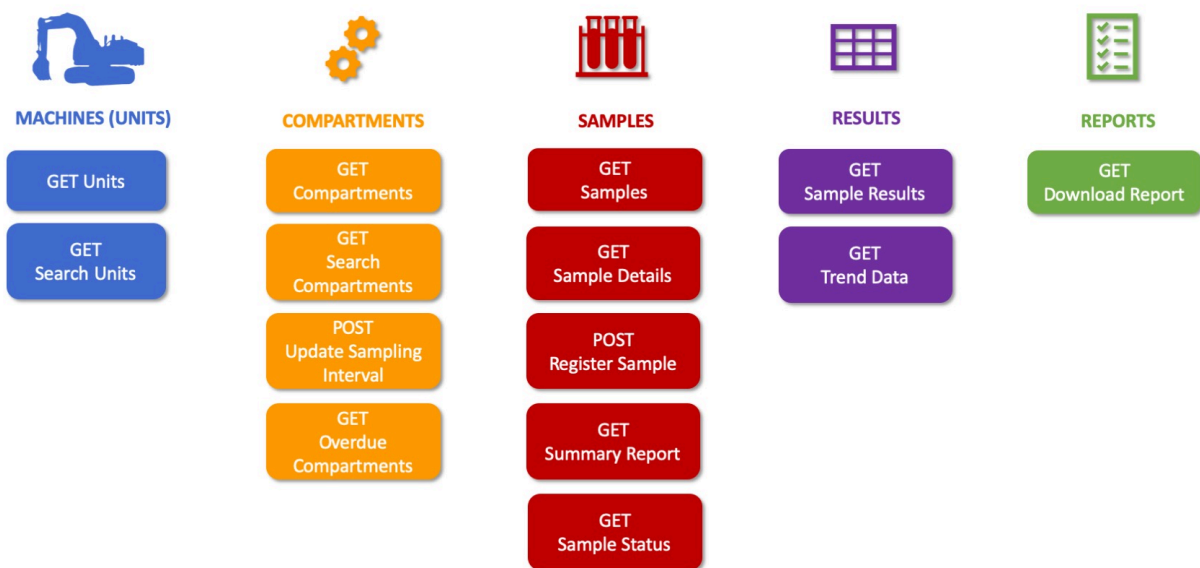
Customer Mobile App (Optional)

A customer-facing mobile app for ClevrLIMS is currently in development (expected late 2020). The app will support both Apple iOS and Android devices.

Features will be similar to the Customer Portal, with the ability to view reports, register samples and find machine information quickly.

Invoicing Integration (Optional)

ClevrLIMS can also be configured to handle fully automated integration with an invoicing system (if the invoicing system has an available API).

This means invoices for samples can be automatically generated upon reporting, and can also handle a variety of invoicing methods, such as per sample, per batch, per month or can be disabled where the customer does not require invoicing or the samples are prepaid.

The invoicing service will also update information in the LIMS showing that invoices have been generated and checking when they have been sent to the customer.

Sample pricing is read from the invoicing system, but can also be overridden with customer-specific pricing in the LIMS.

Urgent samples can be handled with additional fees and additional testing requirements (extra testing on top of the test package) is also handled automatically.

Customers added to the LIMS will also be added to the invoicing system.

Slack Integration (Optional)

ClevrLIMS can be integrated with *Slack®*, which is a highly useful cloud messaging platform used by many companies across the world.

ClevrLIMS can provide live updates of events directly into Slack channels, such as registration of urgent samples, confirmation of emailed reports, feedback from customers and a real-time overview of the laboratory's operations.

Additionally, Slack can be used to upload images from mobile devices to ClevrLIMS which forms a very convenient way of attaching images of samples or other items of interest to reports and providing more information for diagnosis.
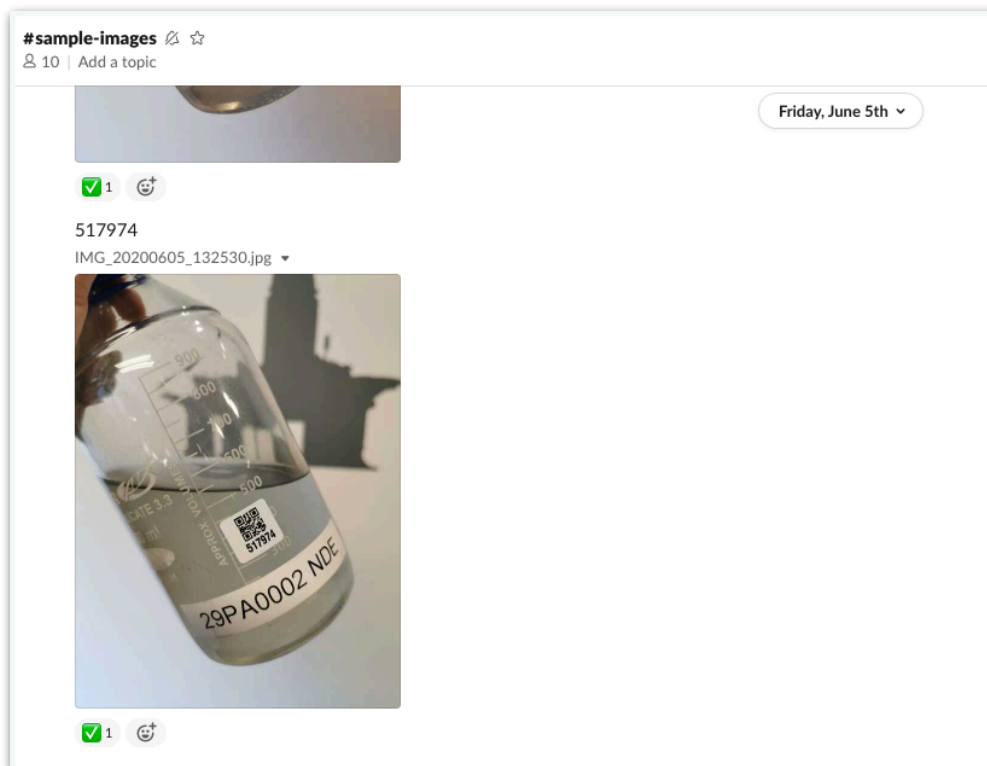
Data Migration

One of the major barriers to moving to a new LIMS system is the retention and integrity of existing data. Often a new system comes with a new database structure or even a different database technology.

Clevr can quickly and reliably transfer existing client, asset and sample data to ClevrLIMS, while improving data integrity in the process.

Clevr can also assist with tools for importing data from other laboratories or reliability software when on-boarding a new client.
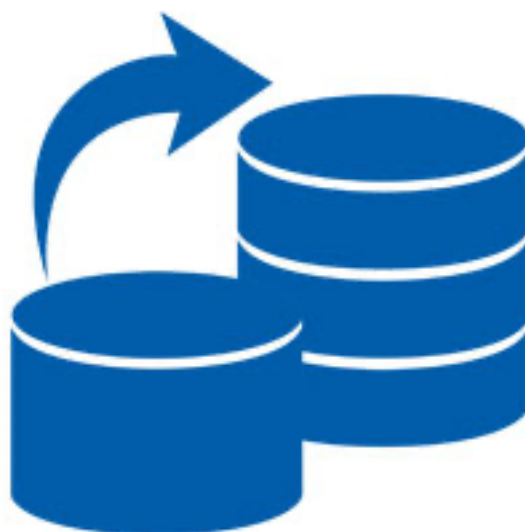
Technical Information

Development Frameworks and Technology

ClevrLIMS is built on *Microsoft .NET Core* ®. This is a very modern and fast framework which allows ClevrLIMS applications to operate with fast response times and rapid processing speeds.

Front-end technologies include HTML5, CSS, Bootstrap, jQuery and Angular.

Microsoft SQL databases are used for rapid queries, high availability and strong integration with .NET Core applications.

Clevr use *Telerik Kendo UI* ® controls for web applications, which provide user-friendly functionality and effective presentation of data.

Hosting and Deployment

ClevrLIMS is designed to be hosted on AWS (Amazon Web Services) cloud. This provides a highly available, powerful, reliable, scalable and cost-effective solution.

ClevrLIMS is also able to be deployed on a local network using an internal web server, if needed.

Security

ClevrLIMS is secured using:

- HTTPS (SSL/TLS)

- Microsoft Identity Framework

- JSON Web Tokens (JWT) *(For API)*

- Cloudflare Proxy (Optional)

Summary List of Features and Functionality

LIMS

Sample Registration

- Manual entry of batches and samples

- QR code entry of samples registered on customer portal

- Search and select a testing schedule

- Add additional testing not included in a testing schedule

Data Entry (Associate)

- Find and attach customer, machine and compartment in one step

- Rapid search functionality

- Enter sample information (date sampled, reason, customer job number, fluid type, oil & filter changes, added fluid, customer notes, internal sample comments).

- Automatic setting of fluid type based on previous sample

- Automatic notification if test schedule doesn't match previous sample

Digital Work Lists

- View required analysis by instrument type/lab station

- Mark samples as processed (with auto time stamp)

- Review sample results (and "typical" or "expected" result)

- Approve sample results

- Mark for re-testing

- Colour-coded status of sample analysis (processed, awaiting results, awaiting approved, re-testing required).

Analyse Screen

- Batch indication of all samples complete

- Indication and setting for visual inspection

- Enter sample comments

- Quickly mark if sample has particles, free water, emulsion or an odour

- View and enter results

- Results automatically adjust for precision and limit of reporting

- Enter analysis notes

- Approve analysis result (with log of user and timestamp)

- Re-testing required indicator

- Request re-analysis

Diagnose Screen

- Show samples ready for diagnosis (all testing and data entry complete)

- Show a scrollable table of all relevant sample information for current sample and for several previous samples for the compartment/sample point

- Diagnostician can mark a result as abnormal with varying levels of severity. Coloured highlight carries through to report

- Diagnostician can mark a result as needing re-testing

- Diagnostician can view all lab comments and indicators for particles, free water, emulsion or an odour

- Diagnostician can enter comments to appear on the report

- Quick access for diagnostic comments on previous samples for the compartment/ sample point by hovering over their status in the results table. User can copy comments if required.

- Access to a list of "Preset Comments" used for diagnosis, organised by category

- Set an "overall condition" for the sample report

- "Approve" the diagnosis, which triggers generation of a PDF report and starts the reporting process for the sample

- Quick access to full customer, machine and compartment information

- View sample attachments (e.g. images & documents) with indicator

Report Screen

- View pending and recently submitted reports

- View email notification logs and view PDF for each report

- View a list of pending batch reports

- Override batch report and submit completed reports for a machine

- Search function

Quick Find

Enter a sample number in the navigation bar to instantly view a summary of information for a sample with links to more detailed information.

LIMS Dashboard/Status

- Shows a detailed list of all active and recently active samples in the system with progress indicators

- Shows a chart of statistics for the current counts of samples in the lab and their progress

Database Management

- Comprehensive screens for searching, adding, editing and deleting customers, contacts, machines, compartments, tests, test packages, lab instruments, fluid types, makes and models, machine and compartment types and positions and compartment attributes.

Sample Search & Management

- Search any sample by date range, customer, machine, compartment, sample or tracking number

- Generate statistics for any of the filters above (with an exportable report)

- View all available information for a sample in a single screen

- Submit sample for revision (and what stage of the process)

- Email a previous report

- Generate a new report for a sample

Diagnosis Limits

- Store caution limits

- Limits can be set in a group by any combination of customer, machine make/model, fluid type, compartment type/category.

- Base limits can be set, and more detailed limits for specific analysis can be "stacked" on top

- Multiple limits can be set for various levels of severity

Processing and Validation of Results

- LIMS stores units, precision and limit of reporting (LOR) for each analysis

- Raw result is stored in the database, while the reported result is calculated based on the precision and LOR settings

- This processing occurs whether the result is hand entered or uploaded from an instrument

Audit Logging

- All changes to data are logged in the database, by user and time.

- Each item (e.g. customer, machine, test, sample) has a window where the log can be viewed to see which user changed what and when.

- Complies with ISO17025 (NATA) requirements.

Reporting

- Generate a PDF report for a sample

- Automatically can add images and configurable trend charts to each report

- Can generate batch reports (per customer machine)

- Automatically emails reports to customers

- Report notifications are logged

- Best implemented in conjunction with an external email API service (e.g. *Postmark*).

Instrument Interfacing (CrossLinkr)

Automatic Upload of Result Files

- A small service runs on the PC attached to the instrument to automatically retrieve result files and upload to the *CrossLinkr* API

- Files supported include csv, tsv, plain text and Excel (xls/xlsx).

Processing and Validation of Results

- Uploaded files are processed to retrieve sample numbers, results, times, users and other relevant information

- Results are validated and adjusted depending on precision and limit of reporting settings in the LIMS

- Raw result is recorded

- Result file is archived for audit purposes

File Configuration

- Create configurations for different instrument export files

- No need to develop a new upload procedure if a new instrument is ordered or the export file needs to be changed

- Can upload same result to multiple analyses in the LIMS (e.g. water %, ppm)

- Can adjust result with multipliers and set valid ranges (minimum and maximum).

Customer Portal

Web based, with email & password login.

Home Screen

• User can view status of submitted samples (e.g. in transit to lab, being tested, reported)

• Table of compartments overdue for sampling

• Quick access to recent reports submitted by lab

Machines and Compartments

• User can locate machines and compartments by customer and group

• Global search function

• User can select multiple machines or compartments for sample registration

• User can add and edit machines and compartments

• User can set sample schedule for each compartment

Recent Reports

• User can view a list of recent reports (with some details and overall outcome) and download PDF copy or link through to further details

• Possible to filter by date and number of reports

Sample Registration

• User can enter data for each sample including oil and compartment hours, whether the oil and filter were changed, reason for sampling and other notes

• User can change fluid type if different from previous sample

• Samples are grouped by machine and likely duplicate information is automatically copied to other samples

• User can print a Dymo label with QR code for each sample (requires Dymo label printer)

• User can submit sample information to the lab when information is complete (which will be profiled when scanning the QR code upon receipt).

Pending Samples

- User can see a full list of samples submitted to the lab (whether registered in the customer portal or not)

- Shows status of the sample (e.g. in transit, being analysed).

Report

- View of sample data and diagnosis results

- Table of results from analysis, shown against previous samples

- Button to download PDF copy of the report

- User can add comments for the sample (which are communicated to the lab if necessary)

Compartment Screen

- Shows detailed information about the compartment & sample point

- Shows all previous sample reports for the compartment

- Link to view trend charts, which are visually appealing and any combination of analyses can be selected for viewing

User Profile

- User can view and edit their own details (name, email address, phone number)

- User can change their language (if using multi-language support)

- User can change their password

- User can request removal of their data (compliant with GDPR)

Optional Features

Multi-Language Support

While the LIMS interface is only available in a single language, the customer portal, emails and reports are possible to be provided to clients in any number of languages. Translations are configurable in the LIMS and via a settings file for the customer portal. Language can be set by customer or by contact.

Auto-Diagnosis

• Samples can be automatically diagnosed by a background service, based on caution limits

• When diagnostician reaches the sample in the LIMS, the results will already be highlighted

• Automatic commenting based on abnormal results, or combinations of results is possible

Slack Integration

• Events can be logged to slack channels (e.g. data entry for an urgent sample, samples ready to diagnose, results changed, problems).

• Images and documents can be uploaded to the LIMS for a sample using a mobile device

• Slack can be used for internal messaging, reminders and other lab communications.

• Slack can be integrated with many other cloud applications and services.

Customer API

• Provides an interface for clients to develop their own software applications, or integrate existing applications with the laboratory's database

• Secured by username, password and API key

• Access is completely configurable in the LIMS

Invoicing

- Automatically generate invoices for samples registered and reported through the LIMS
- Queries test package pricing from the invoicing system
- Can update customer information in the invoicing system
- Lab can set custom pricing per customer in the LIMS for each test package
- Handles urgent samples (with extra fee)
- Can handle invoicing by sample, batch, month or annually
- Handles prepaid samples

Sample Rack Export

- LIMS can generate sample rack files for instruments with auto samplers

Lab Dashboard

- Shows a table of sample batches with columns organised by instrument type
- Counts are shown for samples awaiting processing, awaiting results or requiring approval
- Re-analysis is highlighted and shown in detail in a table
- Shows statistics (customisable) for the overall lab status
- Can show details such as the current weather or interface with gas monitoring systems, for example

Additional Custom Features

Clevr's foundation is as a custom software company, specialising in oil analysis. If this software solution does not fully match your needs, we are more than happy to discuss further customising a LIMS system to your laboratory (whether removing, adding or changing features).

We can also develop custom software for any part of the business.