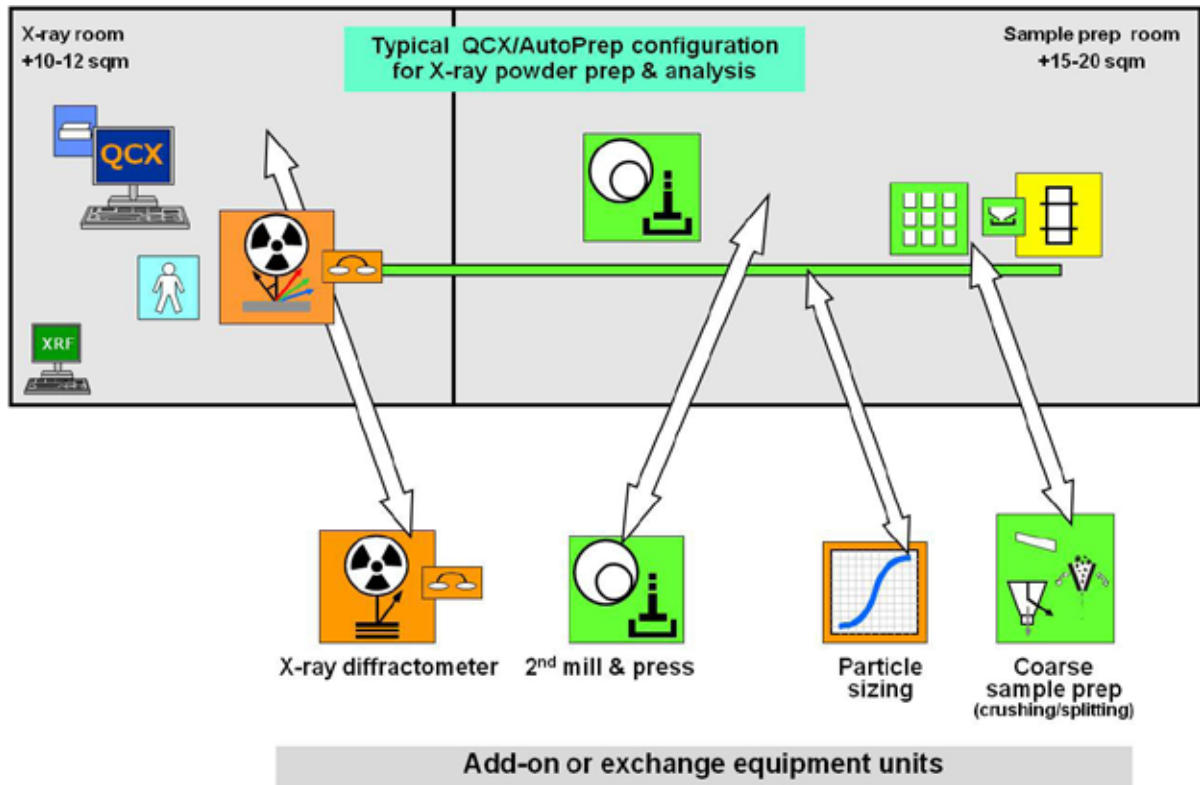


QCX/AutoPrep™

– a well proven fully automatic sample preparation concept targeted for handling of powder samples.





Application

QCX/AutoPrep provides automatic sample preparation based on dedicated fully automated equipment units. The basic concept is built around a linear arrangement of sample preparation equipment units linked together with belt conveyors. In most cases the configurations supplied by FLSmidth are dedicated for dry powder sample preparation for XRF and XRD analysis. However, there exist on the market suitable equipment solutions for fused bead analysis, particle sizing by laser granulometry etc.

A QCX/AutoPrep configuration can as a step in a lab automation scheme be expanded to a QCX/RoboLab system since the main preparation equipment used in the alternatives are almost identical.

In a typical project the sample preparation and analysis equipment are sub-supplied from the leading equipment suppliers, while FLSmidth as the system integrator produces the QCX/AutoPrep software, integrated and engineered to the project specific equipment configuration.

Pending the automation specifications existing equipment may be integrated into the set-up. FLSmidth normally undertakes integration tests of equipment prior to shipment, so that installation and commissioning time are minimized. In most cases the linear preparation arrangement is linked to an automatic sample transport system, so that complete automation from sampling to analysis is provided for. In these cases the system is software wise delivered as a completely integrated system, again with efficient commissioning in mind.

The typical configuration consists of one or two fine-grinding mills, a tablet press and a sample exchanger for the X-ray spectrometer. Often included additional components are composite sample magazines and/or a crushing/splitting unit for handling of coarse materials placed before the fine grinding mill. Auxiliary equipment such as dedusting and compressed air supply units are normally installed in a nearby room or one level down from the sample prep room. Alternatively QCX/AutoPrep can be delivered as a container solution ready for installation at an 'in-process' location.

Functionality

Samples can be entered manually at any equipment unit but normally arrive automatically via the automatic sample transport system. Samples entered may be divided into more individual sample portions with individual preparation specifications;

Control recipe status

ML_1 Grind Press Press

Dynamic information | Static information | Message log

Who: [] Sample group: [] Information Filter
 Warning Error

Time	Who	Description	Description	Sample group	Sampl.	Sub-sample key
11:14:56.85	PM	Cannot move to equipment	Xrl_1	RobTest5	1209	RobTestS1
11:14:56.85	PM	Function not ready at position	Xrl_1.NoPosAnalysis	RobTest5	1209	RobTestS1
11:15:01.85	PM	Cannot move to equipment	Press	RobTest1	1210	
11:15:01.85	PM	Equipment is not active	Press	RobTest1	1210	
11:15:01.85	PM	Waiting for transport	Xrl_1>XRF_OUTPUT	RobTest4	1208	
11:15:01.85	PM	Equipment is not active	Press	RobTest4	1208	
11:15:01.85	PM	Exit position not available	PressPRS_INRINS	RobTest4	1208	
11:15:56.93	PM	Cannot move to equipment	Xrl_1	RobTest5	1209	RobTestS1
11:15:56.93	PM	Function not ready at position	Xrl_1.NoPosAnalysis	RobTest5	1209	RobTestS1
11:16:01.94	PM	Cannot move to equipment	Press	RobTest1	1210	
11:16:01.94	PM	Equipment is not active	Press	RobTest1	1210	
11:16:07.95	PM	Waiting for transport	Xrl_1>XRF_OUTPUT	RobTest4	1208	
11:16:07.95	PM	Equipment is not active	Press	RobTest4	1208	
11:16:07.95	PM	Exit position not available	PressPRS_INRINS	RobTest4	1208	
11:16:57.02	PM	Cannot move to equipment	Xrl_1	RobTest5	1209	RobTestS1
11:16:57.02	PM	Function not ready at position	Xrl_1.NoPosAnalysis	RobTest5	1209	RobTestS1
11:17:02.03	PM	Cannot move to equipment	Press	RobTest1	1210	
11:17:02.03	PM	Equipment is not active	Press	RobTest1	1210	
11:17:14.04	PM	Waiting for transport	Xrl_1>XRF_OUTPUT	RobTest4	1208	
11:17:14.04	PM	Equipment is not active	Press	RobTest4	1208	
11:17:14.04	PM	Exit position not available	PressPRS_INRINS	RobTest4	1208	
11:17:57.10	PM	Cannot move to equipment	Xrl_1	RobTest5	1209	RobTestS1

QCX/AutoPrep software screen

e.g. as an example one portion for X-ray analysis and another portion for a shift composite sample container for the specific material.

Control of the individual components are normally undertaken via serial communication links, which supports download of individual preparation parameters for various types of material. Via the same interfaces detailed operational status of the individual equipment units are picked up for display on the QCX system monitors. The QCX/AutoPrep software provides a uniform and intuitive graphics based operator interface for all equipment units. Pending the interfacing specifications the configuration may include a small PLC for parallel signal interfacing. To the extent supported by the individual pieces of equipment, local operation can easily be established via built-in operator panels. Overall sequencing, priority handling and supervisory control is taken care of by the QCX/AutoPrep software accessible from one or more QCX terminals (PC or workstation). Mimic diagrams are provided for detailed monitoring of the system operation.

The QCX/AutoPrep software is delivered integrated in the project specific overall QCX system structure. At one end the easy integration with the QCX/AutoSampling module facilitates for instance automatic transfer of sample ID and thereby automatic set-up of relevant sample preparation parameters for the incoming sample. At the analysis instrument end, two main integration principles exist: if QCX/AutoPrep is integrated with a QCX/Laboratory module including the full range of LIMS and reporting functionality, then the software will control the analysis instrument and store the acquired

Analysis results in the QCX data base, eventually followed by automatic initiation of associated control calculations such as blending control. As a lower cost alternative QCX/Laboratory can be delivered without the full LIMS functionality ('SampleAdmin' layer only): in this integration set-up the generated analysis data are not stored in the QCX database, but passed on to external systems. The data passed on are either routed directly from the analysis instrument or via the QCX system.

QCX/AutoPrep features:

- **Sample receipt**
 - integrated with automatic sample transport system (automatic Sample ID) **or**
 - manual sample introduction (Sample ID from nearby QCX terminal) or pushbuttons or via bar code scanning
- **Sample splitting & dosing**
 - any incoming sample may be split into one or more sub-samples (individual quantity)
 - volumetric dosing is standard; gravimetric dosing available as option
 - sub-samples may be routed to integrated sample prep/analysis equipment units or dosed into a larger sample container in a composite sample magazine **or** routed to a position for operator pick-up
- **Individual preparation recipes**
- **Priority management**
- **Integrated control and dynamic supervision of**
 - sample prep equipment
 - analysis equipment
 - (- sample transport system PLC)

Three examples of QCX/AutoPrep linear configurations ▼



Kuwait 2009 (FAT test)



Spain, late 90'ties



Thailand, early 90'ties

Laboratory automation concepts

QCX/AutoPrep is one of two alternative laboratory automation concepts available from FLSmidth; the other is QCX/RoboLab. These two automation solutions are exponents from each of the following two main categories of automation concepts for sample preparation and analysis:

- Automated equipment systems: Laboratories in which the sample preparation units and the analysis equipment are automated and then linked together by conventional transport belts or alike. The automation is provided by dedicated highly specialised equipment units.
- Robotics systems: Laboratories in which automation is achieved by robotics. The equipment units serviced by the robot(s) may be fully automated, semi-automatic or manual versions. In the dedicated robot automation concept the robot is a specialized automation component and integrated in the detailed handling of the other equipment components to an extent making it very difficult to re-program the robot for modified procedures. In the flexible robot automation the operator is automated rather than the equipment. The main automation element provided by the robot is the transport of samples between the different stations in the robot cell. The concept implies that the robot can easily be re-programmed or set up to service new equipment units.

- Capacity and complexity of methods
- Sample types and material properties
- Analytical requirements
- Equipment location, building lay-out
- Current and future labour costs
- Daily operation and maintenance implications
- Data processing requirements
- Flexibility towards future needs

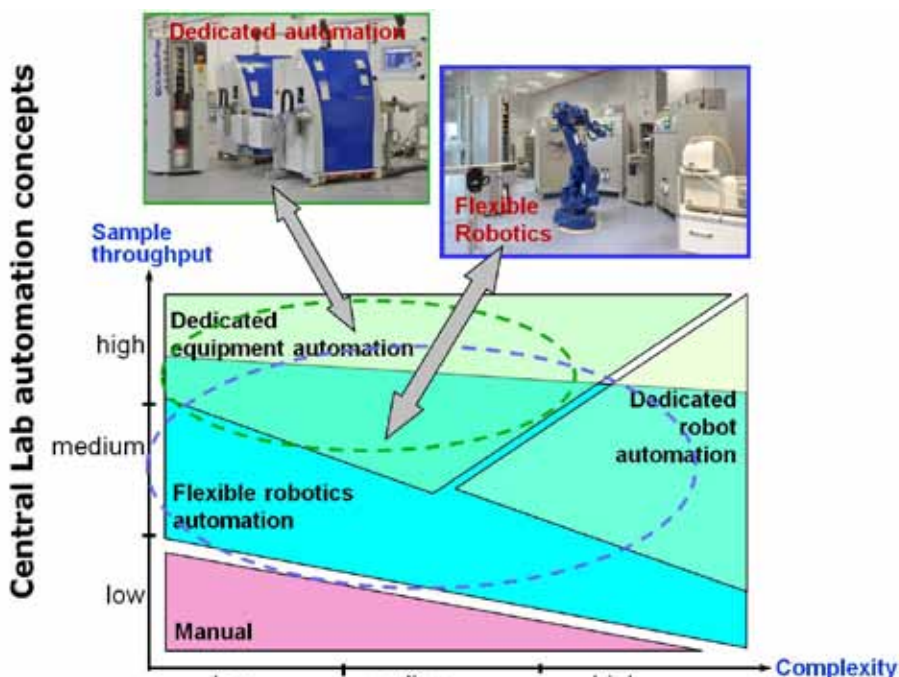
In general the dedicated automated equipment solution (as QCX/AutoPrep) is - as graphically outlined in the diagrams below: - favorable with high sample throughput and/or low complexity.

For a 'powder preparation only' configuration, which is regarded as a low complexity operation, this means in most cases that a linear type arrangement is the most cost effective of the two alternatives. Another factor in favour of a linear configuration could be space, since a linear configuration at least in one dimension only requires say 3-4 meter room width.

Robotics solutions are normally preferable with increased complexity of the procedures, because the robotics approach means less adaptation of equipment units and 'simpler' less expensive automation of a wider range of laboratory components.

The choice of automation concept depends on the complexity of a particular analysis method, the volume of the sample throughput and the overall automation concept desired.

Typical key decision criteria to consider are:



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