ARCSTONE

Statistical Process Control (SPC) Solution Features & Templates

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1 Features

1.1 Multiple Input Options

1.1.1 Automatic Data Input with Machine Integration

Arcstone's arc.quire module offers the ability to connect to multiple different types of hardware components. Connection is made using any industry standard communication protocols for OT/IT data exchange (e.g., OPC UA, Modbus, MQTT, Profibus, TCP/IP, etc.). The full list of options for connection methods and protocols are listed in the table below.

Integration Option	Description	Apply to
Open communication protocols	Machine is open for connection through industry standard protocols such as OPC, MODBUS, MQTT, Profibus, FINS, etc.	Any equipment with open I/O port (Ethernet, RS232, RS485) and has available documentation for supported protocols
Log file/output file	Process machine output file or log file that contains production data	Any machine that supports file-based loggings, CNC machines that support DPRINT command
Use external remote I/O module or IoT box (will incur additional hardware cost for the I/O module or IoT box)	Tap on available I/O channels (analogue or digital) of the machine and map it with machine data point (status, count, etc.)	Machines with available I/O channels and I/O map drawing/documentations
Integration with available HMI connected with the machine	In case where machine has limited I/O port that is already used for the HMI, integration can be done with the HMI instead to pull machine data collected and displayed on the HMI	Any HMI that is open to integration through the above methods

Table 1.1.1 Available machine integration options

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la la	5 Profiles				Find a profi	e		+
*	Status	Profile Name	Туре	Number of tags	Actio	ns		
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	Pending	OPC TEST	OPCUA	0	►		Î	
	Error	ETHERNET CLIENT TEST	EthernetClient	0	►		Î	
	Stopped	ETHERNET SERVER TEST	EthernetServer	0	►		Î	
	Running	WEB API TEST	WebAPI	0	►	•	Î	
			annuire hu Arestane					
			arcquire by Arcstone.					

Figure 1.1.1 arc.quire configuration

In the case where the machines do not support such data exchange methods, an external IoT box or remote I/O modules can be used to map individual I/O signals, be it digital or analogue,



available from the machine circuit board to act as a middleman transferring machine data to arc.quire.



Figure 1.1.2 Common external I/O devices

Data collected from machines and hardware components will be streamed into a data processing engine for contextualization before being used as input for the SPC analytic module.

1.1.2 Automatic Data Input with 3rd Party Software System Integration

Arcstone's arc.flow module can connect and integrate with 3rd Party Software Systems. The list of standard integration methods supported by Arcstone is listed below. Integration done outside of this may require additional development and implementation effort.

Method	Description	Requirement
RESTApi	Done through HTTP/HTTPS protocol (recommended).	API documentation
SOAP Web	Done through HTTP/HTTPS protocol	WSDL files
Service		
Shared	Data exchanged is done through	Read-access account
Database	shared database. Support standard	Database schema and
Operation	SQL-based databases (MS SQL, MySQL,	documentation
	PostgreSQL, Oracle, etc.).	
File exchange	Done through FTP/SFTP/network	File format and data structure
	sharing.	FTP server/network drive
		access

Table 1.1.2 Supported integration methods

Integration events will trigger arc.flow profiles that can be flexibly configured to receive data and perform follow up actions. Similar to data coming from machines and hardware components, this data can be further processed/contextualized before being used as input for the SPC analytic module.





Figure 1.1.3 Sample arc.flow integration profile

1.1.3 Manual Data Input with Advanced Digital Checklists

Arcstone's Workstation module provides a unified interface to capture production related information, complimenting automatically captured data from machine integration with manual inputs and checks where needed.

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	Step Checklists	8
(View Order	Search	
dd - bh - mm - ss	Revision Checklist Name ↑↓ Form No. ↑↓ No. ↑↓	
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Figure 1.1.4 Workstation Interface

The workstation allows for:

- 1. **Timing information to be tracked**. Actual timing may be compared with target timing which may be automatically calculated based on cycle time, production quantity or other factors
- 2. Flow control. This ensures that production steps are executed in the right order (which can be specified in a workflow). Checks may also be enforced to make sure valid data is captured or certain parameters are met before the next step is allowed to be proceed. Alerts may automatically be triggered if such prerequisite conditions fail.



- 3. **Operator Instructions**. Documentation, videos and images may be displayed to provide step-by-step guidance to an operator completing a production step
- 4. **Personnel access control**. Ensure that only the qualified personnel can work on each production step. More granular control can be invoked for Quality control sign-offs.
- 5. Equipment control. Ensure only valid equipment with appropriate calibration is used
- 6. **Resource tracking**. Scan barcodes/QR-codes or RFIDs to track raw material used finished good produced.

In conjunction with the above, Arcstone incorporates and advanced checklist module into the workstation. Arcstone's FDA 21 CFR 11 compliant digital checklists provide a fully configurable way to manage and capture production data. Checklists provide:

- **Complete audit trail** of any data added or changed within a checklist, along with personnel name, date & time stamp
- The ability to auto-populate checklist fields from connected equipment or system.
- The ability to automatically perform calculations on previously entered values, or data captured elsewhere in the system
- **Configurable conditional logic** to enforce values on certain checklist fields. Automatically trigger warnings or halt production where pre-requisite conditions are not met.

Checklists							
ecklist Input							×
Checklist Name	Quality Inspection Checklis						
Form No.	XY12	•					
Revision No.	A						
Sno CheckList Item		Status			Detail		
ob Detail			WO Name	Step Name	Start Time	End Time	
Job Detail			GRBOX1	Polishing	5/4/2020 4:52:24 PM		
General Inspection			Check F	Performed	Remark	Performed By	
Check for foreign object		Pass	• Yes		• 123 Admin Admin 36/00/2008 15:55:13		1
Check for cleanliness			•	/es		Click here to Sign	1
Consistency			First Reading	Second Reading	Specification	Result	
Consistency Measurement			•	•	Measurement allowable limits: 50-100	-Select-	~
Color				Result		Remark	
Compare with sample				OPass O Fail			
Audit Log			Superviso	or Signature	Time stamp	Inspection Result File	
SignOff			Click he	re to Sign 🍡		Choose File No file chosen	
<u> </u>			1	-			

Figure 1.1.5 Checklist Overview

Checklists are configurable with a variety of controls such as text fields, drop down controls, images, attachments etc. The checklist builder provides an intuitive interface to populate these controls and customize the layout. Options exist to include images, attachments, and a variety of custom controls such as text fields, multi-select menus, signature fields and more.

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Figure 1.1.6 Option to add in checklist controls

The advanced digital checklist can be applied to capture data related to:

- 1) Incoming inspection
- 2) In-process quality control
- 3) Out-process quality control

Captured data can subsequently be used as input for the SPC analytic module.

1.1.4 Manual Data Input with File Upload

arc.flow comes with in-built file processing task that can be used within an automation flow to retrieve, read and process content from various file formats, including excel and csv. Files can be accessed through FTP, FTPS or network drive connection. As such, typical file outputs from various CMM, inspection machines/systems can be easily read and feed into the SPC analytic module.

A	arc.flow Sandbox							🚨 admin 🛛 😝	Log off
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•{	Workflows		HTTP Rec to a custor	File Operation			_		
۵	Configuration	>	POST	нттр	File Operation Task - Delete	File Operation Task - Read			
۶	Quick View	>		Messaging	Deletes file(s) from specified directory	Reads content into specified			
				NoSQL Queries		property.			
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		«		Unhandled Http Sta	tus		activities before joining execution into a single path.		

Figure 1.1.7 arc.flow in-built file operations

1.2 Flexible Data Processing, Transformation & Storage

1.2.1 Configurable Logic Flow

arc.flow comes with multiple in-built logic functions and scripting capabilities to support flexible data handling and processing. Some of these include:

- 1) Logic gate functions (if/else, looping, parallel task execution)
- 2) Javascript scripting function

ARCSTONE

3) Mathematical and Statistical functions

A arc.flo	w Sandbox							🚨 admin 🛛 🕸 Log off
+ New		>	Add Event Add	Available Tasks			×	Properties Workflows \$854
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Figure 1.2.1 arc.flow in-built logic operations

This allow for comprehensive data standardization, normalization and cross-process analysis, empowering the SPC engine further.

1.2.2 Extendable Capabilities with External Analytic Engines

arc.flow comes with in-built HTTP capability that allows for communication with open RESTApi of external services and analytics engines. This makes sure the solution is open to integration and can be scaled up and extended as needed. In certain use cases, arc.flow task lists can be extended to include more out-of-the-box modules and features to integrate with external services as well. For instance, if there are analytic libraries that come packaged as .NET dlls, arc.flow tasks can be built to expose the dlls' functions for usage within a configuration profile.

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+ New	>	Add Event Add	Available Tasks			×	Properties Workflows 2003
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Workflows		≓ Archive R	File Operations	Add			
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1.2.3 Compatible with Multiple Storage Formats

Input raw data, processed data and SPC result can be saved into multiple different storage formats. Storage with common databases are available out of the box, such as MongoDB, MS SQL, MySQL, PostgreSQL, and any other database that supports Open Database Connection (ODBC). Additionally, arc.flow also supports file storage.

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	Security	>		Control Flow	Add	Liquid input.	Add	
•f	Workflows			File Operation	_	Add	_	
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Figure 1.2.3 arc.flow in-built database operations

1.3 Modular & Comprehensive SPC Engine

1.3.1 Discrete Data Control Charts

The following control charts are supported:

- 1) U Chart: Attribute control chart for number of defects per unit
- 2) c Chart: Attribute control chart for total number of defects
- 3) p Chart: Attribute control chart for percentage of defectives
- 4) np Chart: Attribute control chart for number of defectives

1.3.2 Continuous Data Control Charts

The following control charts are supported:

- 1) X-MR/I-MR Chart: variable control chart for continuous data with sample size = 1
- 2) Xbar-R Chart: variable control chart for continuous data with sample size from 2 to 9
- 3) Xbar-S Chart: variable control chart for continuous data with sample size larger than 9

1.3.3 Open API

The above analysis can be run through open RESTAPI endpoints that allow any external parties to consume and perform SPC analysis. The result is returned in real-time for any follow up actions.



1.3.4 Sample control charts



Figure 1.3.1 Sample Xbar-R Chart



Figure 1.3.2 Sample Xbar-S Chart



Figure 1.3.3 Sample u Chart



Figure 1.3.4 Sample p Chart





Figure 1.3.5 Sample np Chart



Figure 1.3.6 Sample c Chart

1.4 Flexible Visualization & Reporting

1.4.1 Dashboard Designer

The Dashboard Designers provides a very intuitive drag-and-drop method for building dashboards suited for different users and different viewing needs, from operators on the shopfloor to upper management overseeing the entire factory or enterprise. It consists of a wide range of widgets with full configurability over the layout and data representations, including Pareto chart, box-and-whisker chart, histogram and more.

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REASON_TYPE		Small Liquid Pa 1.85K 0 100 0.1 13.0
TUN_NAME		Radial Survey 1.89K 0 100 92.6 3.0 Printing Machine 16.24 20990 43 6.6 15.8 OK Cavval
B SALES_NAME		Printing Machine 16.2M 20990 43 6.6 16.8 OK Cancel Machine 2.259 0.00%
TEP_NAME		Laser Engravi 6.5.47 798698 89 46.8 7.5 16 105770 54009 75.7% 10
TRANS_TYPE		Heat Press Ma 9.56M 8006202 54 124.6 28.9 23 65779 10999 85.7% 10
WORKFLOW_CA		Ferm SSM1005 383 0 100 4.6 9.5 100 83 1 98.8% 98
WORKFLOW_NAME		Driling and Mi 2.97M 20 100 169.1 13.7 8.0 10867 6677 61.9% 5.0

Figure 1.4.1 Dashboard Designer Charting Options



Figure 1.4.2 Dashboard Widget Additional Settings

The finished dashboard can be viewed through web browsers and are hence easily accessible by any devices. Filtering, sorting, as well as drilling down of charts for details are also available as built-in elements for quick and efficient data searching.

In terms of data manipulation, the designer comes with an expression editor allowing for complex calculations or formatting to be done over the data pulled from the data sources.



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ab DOWN reason	Availability							Belt Joint Machine: 3.57%
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BAD qty	Plan Cycle Time .							3.57%
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ab REASON_DETAIL		String		AddDays AddHours				Welding Machine: 2.70%
at REASON_TYPE	New Column			AddMilliSeconds		~		0.45% Machine: 0.45%
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Figure 1.4.3 Dashboard Designer Expression Editor

As for data source configuration, the dashboard designer supports a wide range of commonly used databases. In case where the data source is not readily accessible, there are also options for simple API calls as well as CSV ingestions.

Data Source Wizard					
Select the data p	rovider and specify the connection properties.				
Provider:	Microsoft SQL Server		-		
Server name:	Microsoft SQL Server Microsoft Access 207 Microsoft Access 2007		^		
Authentication type:	Microsoft SQL Server CE				
User name:	Orade				
Password:	Amazon Redshift Google BigQuery				
Database:	Teradata Firebird IBM DB2				
	MySQL Pervasive PSQL PostgreSQL				
	SAP Sybase Advantage SAP Sybase ASE		~		
		Next	Finish	1	

Figure 1.4.4 Dashboard Designer Data Source selection (Database)

For the SPC solution, the Dashboard Designer will be used to visualize SPC related data, including raw SPC data, SPC analysis result and plotting of the different control charts. Built dashboards will also be able to display and highlight issues detected within the analysis, including rule violations, out of control values and anomalies.

1.4.2 Report Designer

The Report Designer allows for consolidation of data captured from multiple sources and combining it into a drag-and-drop designer platform that is end-user-configurable and easy



to use. At the same time, it allows for additional analysis of the raw data using built-in formula editor, with an array of available algorithms for data processing and transformation. Any built report can be automatically generated and archived/emailed to relevant parties in multiple formats (picture, PDF, HTML, DOCS, XLSX, etc.).



Figure 1.4.5 Report Designer Options for data source



Figure 1.4.6 Highly configurable report designing interface

For the SPC solution, the Report Designer will be used to generate SPC related reports from the SPC analysis result. Report can be automatically generated, emailed out or archived.



1.5 Flexile Output Handling

1.5.1 Real-time Alarms & Alerts

Real-time alarms and alerts can be configured to trigger based on SPC analysis result. arc.flow comes with in-built alarm/alert features including in-app notification, email sending, SMS sending, Whatsapp/Slack/Telegram notification that can be configured as part of the automation flow.

Incoming Inspection Process Out-Of-Control Alert							
	Auto Alert Arcstone Tue 22-Feb-22 3:38 PM To: Khai Vo	$* \mathrel{{}^{\!$					
	Please take note that the following monitored machine data is out of r	ange.					
	WO Name/Inspected Material/Inspection ID	PO DEMO 1/SKU 102X30/39					
	Inspection Type	Varied Sample Size Defect					
	You can follow the link below to view the dashboard.						
	Open Machine Dashboard						
	DISCLAIMER: This is an automatically generated email, please do not reply.						
	Arcstone Support Team						
	© Arcstone . All Rights Reserved.						
	This email message (and attachments) may contain information that is confidential and/or privileged to Arcstone Pte Ltd. If you are not the intended recipient you cannot use, distribute or copy the message or attachments. In such a case, please notify the sender by return email immediately and erase all copies of the message and attachments. Internet communications are not secure. While effort has been made to ensure that this communication has not been amended or tampered with, Arcstone Pte Ltd cannot be responsible for changes made to the contents of this communication without its approval. Opinions, conclusions and other information in this message that do not relate to the official business of Arcstone Pte Ltd shall be understood						



1.5.2 Integration with External Services

Leveraging arc.flow's extensive capability to integrate with external services through open APIs/open integration channels, SPC analysis result can be posted to or used to trigger events/commands in external systems, such as triggering a Rework process in the MES, triggering a Maintenance Order in the Equipment Maintenance System, or trigger a rerun in the inspection machine.

