The Design and Applications of Flexsim/JMP based Quality Simulation for Mass Customization

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Abstract—As the latest quality control application, JMP has more advantages than Minitab, which is commonly used recent years, for it has better capability of dealing with data, mining data and its good automation ability, therefore, it can be used to analysis on batch data. At the other hand, simulation software Flexsim can obtain valid quality information of the products by modeling the produce process, in order to complete prior prevent and mass customization manufacture quality control effectively. So, this paper focuses on the design of open interaction system based on the good automation ability of JMP through both static and dynamic method to improve the efficiency of quality control system.

Keywords—Mass Customization, JMP; Quality Management and Control, Flexsim, Open Research

I. INTRODUCTION

Mass Customization (MC) refers to the customization of any number of products for a single customer or a market with special needs at the cost and speed of mass production. MC is the derivation and improvement of traditional mass production mode under market demand. The original intention of mass customization production is to reduce the cost waste caused by product diversification, reduce enterprise inventory, and obtain more profit space, so as to improve the competitiveness of enterprises. The quality control system of mass customization production is based on continuous improvement of production. It emphasizes pre-prevention and total quality management, pays attention to self-detection in modules, and makes proper use of multi-varieties and small batches of statistical process control while on-line testing. At present, multivariate quality control is the main means of mass customization production quality control. Quality simulation and quality process statistics are the main quality control methods in manufacturing stage and inspection service stage, respectively. In the aspect of system simulation, Flexsim, an object-oriented visualized 3D modeling and simulation software, can obtain quality data by simulating the production process of products. At the same time, Flexsim has good secondary development ability and can interact with other tools. In the aspect of quality statistics, JMP, as the latest cross-platform tool, has more powerful data processing ability, openness and script automation ability than the most commonly used quality analysis software, and can better complete the quality data statistics in production. However, depending on the separate operation of the two software, it cannot meet the requirements of mass customization production quality control in real time and effectively. Therefore, it is necessary to have an open interaction between them: Flexsim is used to simulate the mass customization production process, and the quality data are shared with JMP in real time for statistical analysis, so as to quickly and accurately study the quality level of the whole production process. This paper focuses on the design and application of Flexsim/JMP-based interactive system.

II. DESIGN OF FLEXSIM/JMP OPEN INTERACTIVE SCHEME

The overall design scheme of the open interactive system based on Flexsim/JMP is shown in Figure 1. Flexsim simulates the production process and records the data. It connects with the underlying statistical software JMP through middleware (static without middleware). This interaction scheme is divided into static and dynamic. Static mode does not pass through Middleware and the simulation data in Flexsim is exported directly through Excel menu command, while JMP accesses the data table offline. The design of dynamic connection mode needs to choose the appropriate interaction mode by comparing the support interfaces of Flexsim and JMP.
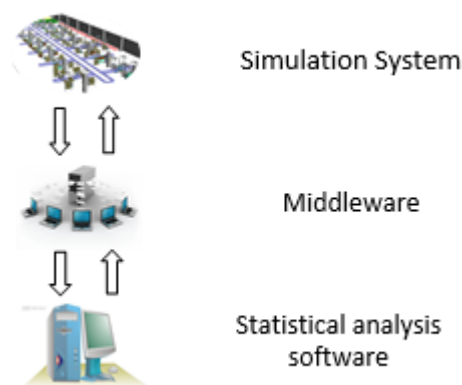

Fig. 1. System structure diagram

Flexsim's interaction ports are divided into three types: 1) Open database connection is used to complete the connection with Access, Oracle and other databases; 2) Dynamic data exchange connects with Excel which has been opened, and reads or writes a data table at the same time; 3) In other ways, commands such as Flies or Socket are used for real-time data communication.

The connection between JMP and external program can be divided into static and dynamic. Dynamic interface not only supports data exchange with external program through scripting in JSL language, but also can share data through external programming language such as VB and VC++, epecifically as shown in Table I.

TABLE I. HOW JMP ACCESSES EXTERNAL DATA

Connection Type		Object type	Description
Static connection	No ODBC driver support required	Internet	Network connection, open in text form, web page and data table
		Text file	Open txt type file directly
		SPSS file	Used for statistical connection with SPSS statistical software
		Excel	Displayed in JMP as a data sheet
		Minitab file	Can directly access the files generated by minitab
	Need ODBC driver support	Database file (.dbf,ndx, mdx)	Need a corresponding V3+ driver
		Access file (.mdb)	Need a corresponding V3+ driver
Dynamic interaction	By JSL	Real-time data processing (datafeed)	Connect to external ports of other machines to complete data exchange
		Dynamic link library (DLL)	Extend JMP functionality by loading dynamic link libraries through JSL
		Socket	Divided into streaming sockets and datagram sockets, usually data exchange with web pages
		EXCEL data sheet	Real-time interaction with data in JSL/VB and EXCEL
	Through external VB,VC++, etc.	OLE automation	Use VB to automate JMP

Considering the interface characteristics of JMP and Flexsim, this paper uses Excel as the middleware. Through its powerful open ability, it accepts the data of the real-time simulation system and shares it with JMP at the same time.

III. DEVELOPMENT OF OPEN INTERACTIVE SYSTEM BASED ON FLEXSIM/JMP

A. Development of Offline Interactive System

Flexsim can export emulation results as Excel tables with the option of its own menu bar, while JMP can access local databases offline through the ODBC feature.

1) The simulation data table is derived from Flexsim:
In the Flexsim menu bar,operator can select Data > Data and Report, select the relevant data in the list, click Generate Report, and the required data will appear in Excel form. Alternatively, you can click on the Excel icon in the toolbar to find the table you want to export in the dialog box.

2) JMP accesses local data through ODBC:
In JMP (version 10.0), click File > Database > open the table, you can select the connection in the dialog window, select the "Excel files" user data source in the machine data source, and select the tables you want to access in the workbook dialog box, for example (quality. xlsx).
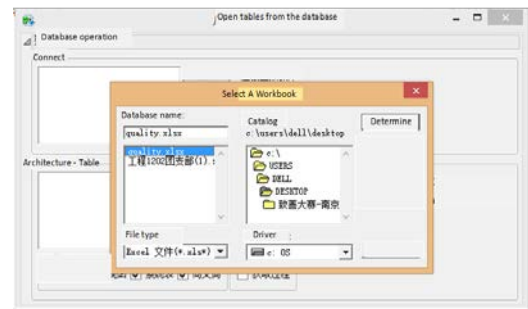

Fig. 2.   Accesses quality parameters through ODBC

In this dialog box, you can select the specified worksheet and set the imported data rows through the SQL query statement.
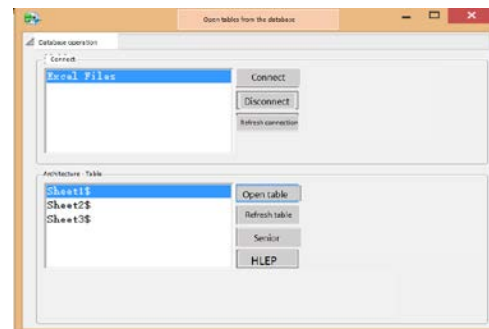

Fig. 3.   Opens the table interface from the database

B. Development of Online Interactive System

The dynamic interaction between Flexsim and JMP is realized directly in Excel by automating JMP, in VB language.

Flexsim, the top-level simulation system, can exchange real-time data with Excel through DDE. The specific command set is as follows:

Excellaunch ([strlaunchdir]) /open the Excel program, such asExcellaunch ("C:\Program Files (x86)\Microsoft Office\Office12")

Excelopen (str workbook)   / open Excel files, such as Excelopen ("quality.xlsx")

Excelsetsheet (strsheetname) / specify worksheets, such asExcelsetsheet ("sheet1")

Excelclose(num save[1/0]) /close Excel files, such as Excelclose (true)

Excelquit()   / shut down Excel

At this point, the connection between Flexsim and Excel's DEE is completed, and the simulation data in Flexsim will be transferred to Excel table in real time.

The dynamic interaction between Excel and JMP is accomplished by VBA in Excel.You can select the development tool > Visual Basic > tool > reference in

Excel's menu bar, as shown in the dialog box to find JMP, check and confirm.
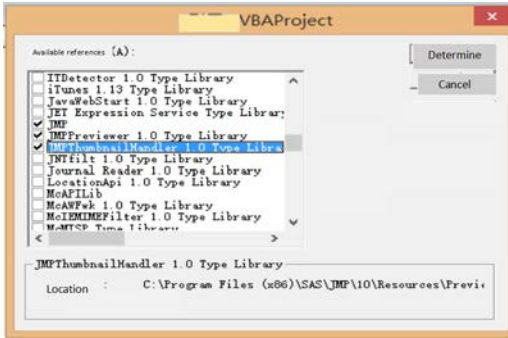

Fig. 4. Adding JMP Dynamic Link Library to VBA

First, you need to define global variables, click VBA Project > Insert > Module, and enter the following code:
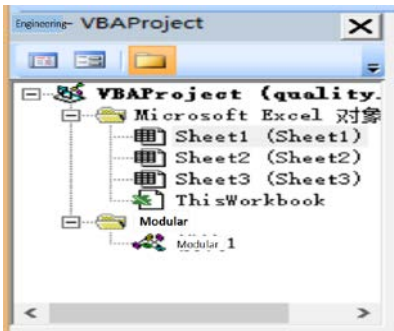

Fig. 5. VBA interface

Public MyJMP as JMP.Application / Define JMP applications

Public DT as JMP.DataTable / Define JMP data tables

Public DocOpen as Boolean / Mark whether the JMP data table has been opened

In interaction, several points need to be noted: when changes in Excel occur on the first line, JMP does not reflect them;When the number of rows that occur exceeds the number of rows that JMP is now tracking, JMP automatically calls the AddRows function to create new rows.

According to the JMP statement invocation rules shown in the following table, the main module commands invoked are as follows:

Public Counter As Integer /Count to ensure data updates after every five changes

Public JMPDoc As JMP.Document/Declare JMP file

Public CChart As JMP.ControlChart/Declare JMP control chart

Public ChartOpen as Boolean /Track Chart Opened

Public DB As AUTODB

Set MyJMP = CreateObject("JMP.Application") MyJMP.Visible=True /Enable JMP applications to be visibleCounter = 0 /Initialize variablecounter

Private Sub Workbook_SheetChange(ByValSh As Object, ByVal Source As Range)

Counter = Counter + 1

If (Counter Mod 5 = 0 Or Counter = 1) Then /When five changes occur, the update is transmitted to the control chart in JMP

If Not (ChartOpen) Then

Set CChart = JMPDoc.CreateControlChart /New control chart

CChart.LaunchAddProcess "Column 1" /Add column

CChart.LaunchAddSampleUnitSize 5 /Set sample cell size

CChart.LaunchSetChartTypejmpControlChartVar /Set chart type

CChart.Launch / Startup chart

ChartOpen = True /Mark a chart that has been opened

End If

TABLE II. JMP SUBROUTINE DESCRIPTION

Subroutine (object name_event name)	Explanation
Workbook_Open	Called when the table is initially loaded to initialize variables, JMP, and to remind JMP to open the same worksheet as a database
Workbook_Change	When a cell of any workbook in the worksheet is changed, a control chart is generated in JMP when it is first invoked.
Workbook_BeforeClose	Called before the worksheet window closes

IV. APPLICATION OF FLEXSIM/JMP OPEN INTERACTIVE SYSTEM

We simulate a mass customization production line by Flexsim (Fig. 6), monitor the weight of the product in real time, and control the quality of the weight index.

Firstly, add labels for product weight parameters in Flexsim, such as:

Addlabel(obj object, strlabelname) /Add labels to entities

Setlabelstr(obj object, str/num label, str value) /Set tag name

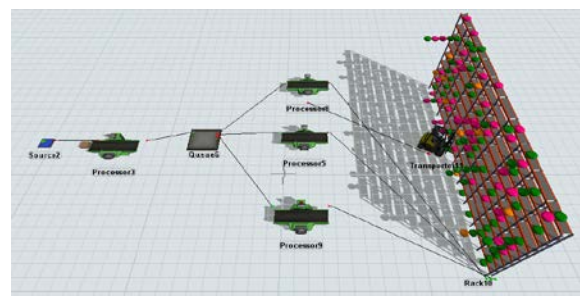Setlabelnum(obj object, str/num label, numvalue) /Set label value

Fig. 6. MC simulation overall operation diagram

Flexsim and JMP are connected by the dynamic interaction method in Section 3.2 above. The weight of 40 continuous products produced by pipeline simulation is

analyzed by JMP control chart. The size of subgroup is set to 5, and the Xbar-R control chart is obtained as shown in figure 7/8.According to the position of the points in the chart on the middle line, the weight index of the product can be judged, and the eight criteria for judging the difference of the standard reference control chart can be judged.(GB/T 4091-2001)
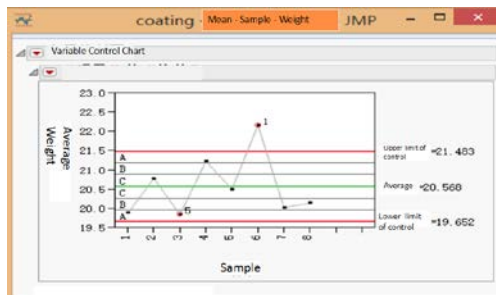

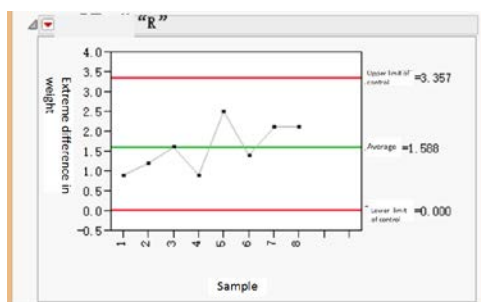Fig. 7. Xbar-R Control Chart of Weight Index (Mean Chart)

Fig. 8. Xbar-R control chart of weight index (range chart)

In the mean control chart shown in Fig. 7a, the marked abnormal points can be seen. According to the first criterion "one point falls out of area A" and the fifth criterion, "two points fall out of area B on the same side of the central line in three consecutive points", the abnormal process can be judged, and the abnormal phenomena can be classified according to the Six Sigma management method. Analysis and improvement, and re-monitoring of production simulation quality data, so as to ensure product quality.

V. CONCLUDING REMARKS

As a newcomer in quality control software, JMP can effectively share data with database and system simulation software in real time. It is the first time to carry out comprehensive quality control for the products of simulation production line, so as to solve quality Control of Mass Customization Production with low cost and high efficiency. As a newcomer in quality control software, JMP can effectively share data with database and system simulation

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Based on the simulation software Flexsim as an example, according to its characteristics of external interface, and JMP itself script automation ability, designs the simulation based on Flexsim/JMP quality control system, make both can real-time data sharing, and application in mass customization production, give full play to the advantages and JMP Flexsim simulation statistical advantage, effective for the production enterprise provides a train of thought to solve the quality control problem.

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