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# Orthogonal Test Data Analysis on Visual Platform Based on C++ Builder

Jianhua Ren<sup>\*1</sup>, Chuan Li<sup>2</sup>, Zhengang Liang<sup>1</sup>, Ziyong Zhai<sup>1</sup>

<sup>1</sup>Hebei University of Engineering, Handan Hebei, 056038, China

<sup>2</sup>Handan city heating company, Handan Hebei, 056001, China

\*Corresponding author, e-mail: renjianhua1974@163.com

## Abstract

The design method of orthogonal test is commonly used in engineering test. It is very effective when many factors influences on one test. Orthogonal table experimental design is necessary to simplify the test procedure, to reduce the number of tests, and to improve test efficiency. By the orthogonal test, a level of each factor can be chosen to form the optimal production conditions. But in the current orthogonal experiment data analysis, we always adopt the manual calculation, and we will make big errors when we have a complex calculation. Therefore we consider the development by using computer programming of C++ computer builder to solve this problem. As long as the programming completed, the test data can be input to calculation, analysis, and the visual interface, more intuitively and simply.

**Keyword:** orthogonal test, C++ builder, visual programming

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## 1. Introduction

Orthogonal experimental method is used of neatly arranged tables-orthogonal table to test the overall design, comprehensive comparison, statistical analysis, which finds a better production conditions by a few number of experiments to achieve maximum production processes. Orthogonal table can be balanced sampling within the scope of changes in factors which makes each test strong representation. As a result of balanced dispersion characteristics, orthogonal table ensures some of the requirements of the comprehensive experiments which are often able to be good or better test objective [1-4]. Orthogonal experimental design consists of two parts: one is how to arrange the test; the other is how to analyze experimental results. But the data analysis of the orthogonal experiment often uses manual calculations, which computes complexity and has larger errors [5-7]. So a new method should be presented to make data processing more accurate and fast.

## 2. About C++ Builder Programming Platform

### 2.1. Brief Introduction

The C++ Builder is an object-oriented visual programming platform, used in the rapid development of the 32-bit Windows applications [8-9]. In C++ Builder programming, we can achieve efficient Windows application written with minimal code.

### 2.2. Overview of the Integrated Development Environment

Once entered the C++ Builder, one would immediately be involved in its integrated development environment. The integrated development environment is also known as IDE, it provides all needs for the tool to design, develop, test, debug, and publish an application.

Integrated development environment of C++ Builder includes visual form designer, the object viewer, component panel, project manager, the source code editor, debugging and installation tools and so on. In the forms designer, one can freely move the visual representation of the object. At the same time we could edit the operation state of object initialization in the object viewer, and could edit this object execution logic in a source code editor. When we change the object attributes associated with the code, such as changing the name of the event handler, object viewer will automatically change the corresponding source code. In addition,

changing the source code of the object in the source code editor, such as changing the name of the event handler in the form class statement, the object viewer will immediately reflect the changes.

### 2.3. Design Application

C++ Builder provides all the tools which are necessary to design application. A blank window, called "Forms" as a user interface for designing applications. An inclusive class library of reusable object extension. An object viewer, is used to check and change the characteristics of the object. A source code editor used for directly access to the basic program logic. A project manager can manage multiple projects. Many other tools used to support application development, such as the image editor in toolbar and integrated debugger in menu, etc.

A command line tool including the compiler, linker and many other tools. C++ Builder can be used to design any type of 32-bit Windows applications: Form the general utility application to complex data access programs or distributed applications. C++ Builder's database tools and data-aware components allow you to develop a powerful desktop database and client/server applications quickly. At the meantime, the use of C++ Builder data-aware components, the current data can be observed timely in the design of the application while the result of changes can immediately be seen in the database query operations and the application interface. C++ Builder supports a variety of database provider [10].

## 2. The Database

### 2.1. Basic Conception

The data is suitable forms of information for computer processing, such as the digital representation of numbers, texts, images, graphics, and sounds [11].

The database is a collection of data about a particular subject and the tasks, including data tables, format, reports, queries, etc. The database can contain almost any type of information (data). There are generally two kinds of ways to keep database. The first method is saved the whole database as a separate file; The second method is stored each element of database in each file.

### 2.2. Paradox Database

Paradox database is a kind of similar dbase desktop database, it is easy to operate, without complex configuration of large databases, takes single table database as object, and file directory as library name [12-14].

## 3. Analysis of Practical Example

### 3.1. Common Calculation Results of Orthogonal Test

For the orthogonal experimental design, the first step is to determine the experimental procedure, experimental goal and every factors. Then the experiment scheme is designed and levels of factors are determined. The factors level table is listed. At the same time, interaction of the various factors should be considered. Based on the above consideration, the orthogonal experiment schemes are obtained. Through orthogonal test, the optimal solution is presented. But in this process, many indicators need to be calculated through manual calculation. This method leads to large amount of calculation and low precision. So it is not suitable for higher requirements.

In Orthogonal experiment table, 'T', 'CT', 'Q<sub>T</sub>' are the main evaluation Indicators through complex calculation.

Taking an orthogonal table as an example ( $L_{27}(3^{13})$ ), 27 trials, based on a combination of factors in specified level orthogonal table, calculated according to the basic principles and calculation steps of the analysis of variance.

Table 1. Orthogonal Test Program, Test Results, Calculation and Analysis

Factor Column	A	B	AxB <sub>1</sub>	AxB <sub>2</sub>	C	AxC <sub>1</sub>	AxC <sub>2</sub>	AxD <sub>1</sub>	D	AxD <sub>2</sub>	e	E	e	The test results
No.	1	2	3	4	5	6	7	8	9	10	11	12	13	Efficiency (%)
Test No.														
1	1	1	1	1	1	1	1	1	1	1	1	1	1	4.46
2	1	1	1	1	2	2	2	2	2	2	2	2	2	11.94
3	1	1	1	1	3	3	3	3	3	3	3	3	3	9.90
4	1	2	2	2	1	1	1	2	2	2	3	3	3	3.81
5	1	2	2	2	2	2	2	3	3	3	1	1	1	10.32
6	1	2	2	2	3	3	3	1	1	1	2	2	2	12.63
7	1	3	3	3	1	1	1	3	3	3	2	2	2	12.83
8	1	3	3	3	2	2	2	1	1	1	3	3	3	18.68
9	1	3	3	3	3	3	3	2	2	2	1	1	1	12.57
10	2	1	2	3	1	2	3	1	2	3	1	2	3	11.87
11	2	1	2	3	2	3	1	2	3	1	2	3	1	5.22
12	2	1	2	3	3	1	2	3	1	2	3	1	2	21.96
13	2	2	3	1	1	2	3	2	3	1	3	1	2	6.15
14	2	2	3	1	2	3	1	3	1	2	1	2	3	19.95
15	2	2	3	1	3	1	2	1	2	3	2	3	1	10.72
16	2	3	1	2	1	2	3	3	1	2	2	3	1	24.22
17	2	3	1	2	2	3	1	1	2	3	3	1	2	13.26
18	2	3	1	2	3	1	2	2	3	1	1	2	3	12.54
19	3	1	3	2	1	3	2	1	3	2	1	3	2	9.72
20	3	1	3	2	2	1	3	2	1	3	2	1	3	15.14
21	3	1	3	2	3	2	1	3	2	1	3	2	1	8.66
22	3	2	1	3	1	3	2	2	1	3	3	2	1	9.99
23	3	2	1	3	2	1	3	3	2	1	1	3	2	10.32
24	3	2	1	3	3	2	1	1	3	2	2	1	3	6.96
25	3	3	2	1	1	3	2	3	2	1	2	1	3	3.59
26	3	3	2	1	2	1	3	1	3	2	3	2	1	8.31
27	3	3	2	1	3	2	1	2	1	3	1	3	2	11.22
K <sub>1</sub>	97.14	98.86	103.59	86.24	86.64	100.08	86.37	96.61	138.24	82.25	102.97	94.40	94.47	T=306.93
K <sub>2</sub>	125.88	90.85	88.92	110.30	113.14	110.02	109.45	88.58	86.74	119.43	103.25	108.72	110.02	CT=3489.112
K <sub>3</sub>	83.91	117.22	114.42	110.39	107.15	96.83	111.11	121.74	81.95	105.25	100.71	103.81	102.44	Q <sub>T</sub> =4194.206
$\bar{K}_1$	10.793	10.984	11.510	9.582	9.627	11.120	9.597	10.734	15.360	9.139	11.441	10.489	10.497	S <sub>r</sub> =705.093
$\bar{K}_2$	13.987	10.094	9.880	12.256	12.571	12.224	12.161	9.842	9.638	13.270	11.472	12.080	12.224	
$\bar{K}_3$	9.323	13.024	12.713	12.266	11.906	10.759	12.346	13.527	9.106	11.694	11.190	11.534	11.382	
S	102.315	40.616	36.398	43.041	42.918	10.494	42.500	66.503	216.436	78.238	0.431	11.767	13.436	

Calculate the sum of deviation squares of each column, and fill the results in Table 1.

$$T = \sum_{i=1}^n x_i = 306.93$$

$$CT = \frac{T^2}{n} = \frac{306.93^2}{27} = 3489.112$$

$$Q_T = \sum_{i=1}^n x_i^2 = (4.46^2 + 11.94^2 + \dots + 11.22^2) = 4194.206$$

$$S_T = Q_T - CT = 705.093$$

$$f_T = n - 1 = 26$$

$$S_j = \frac{1}{r} \sum_{i=1}^m K_{ij}^2 - \frac{T^2}{n} = \frac{1}{r} (K_{1j}^2 + K_{2j}^2 + K_{3j}^2) - CT$$

**3.2. Data Table Structure**

For the accurate, fast data processing and easy to promote the application of the outcomes, this paper works out a computer program design. The writing of the program based on Win98 operating system and the C++ Builder programming platform, and at the same time, in order to facilitate programming, also used the Paradox database technology. As the program holds very low requirements on the database, so we take this database structure. This program involves only a table MYDB2.DB. Its structure is as Table 2.

Table 2. Data table structure

Field name	type
A1	Automatic growth (integer, mean the number of data)
A2	integer
A3	integer
A4	integer
A5	integer
A6	integer
A7	integer
A8	integer
A9	integer
A10	integer
A11	integer
A12	integer
A13	integer
A14	integer
A15	floating point types

The value of sampling Table 1 is stored in A2-A14, the value of X stored in A15. Program functions include the data input and data calculation. Data input adopts a friendly interactive interface, real-time input, real-time changes. And in A1-A14, it provides 1, 2, 3, three kinds of data selection to update the database tables. Data calculation section provides clear button prompt to calculate the test results timely. And through the order of the experimental results, we will achieve more accurate experimental results.

#### 4. The Realization of the Visual

Due to the development of the program is in C++ Builder programming platform, the data input is to use the platform to provide some functions. And the only involved program is in the part of the calculation.

##### 4.1. The Flow Chart of Calculation

In this platform of C++ Builder, orthogonal table has been set by the program, meanwhile, different Orthogonal table with different structure can be set according different needs. Then, Orthogonal test solution is also input the computer through programming in advance. When program is working, that we need to do is inputting our test results. Computer may retrieve all the data in the database and traverse database to calculate T, CT, and QT. Then, it cycles to calculate K1, K2, K3, and S of each column. In the end, the data are inserted in the appropriate form to complete the calculation.

According to the basic principle and calculation steps of the variance The flow chart of calculation is as Figure 1.

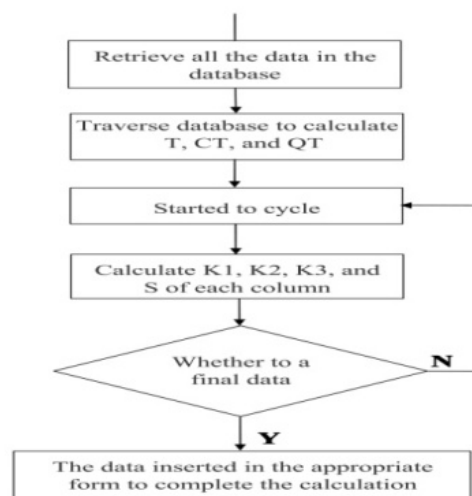


Figure 1. Flow Chart of Calculation

First, all of the data screen in the table should be Input is as Figure 2.

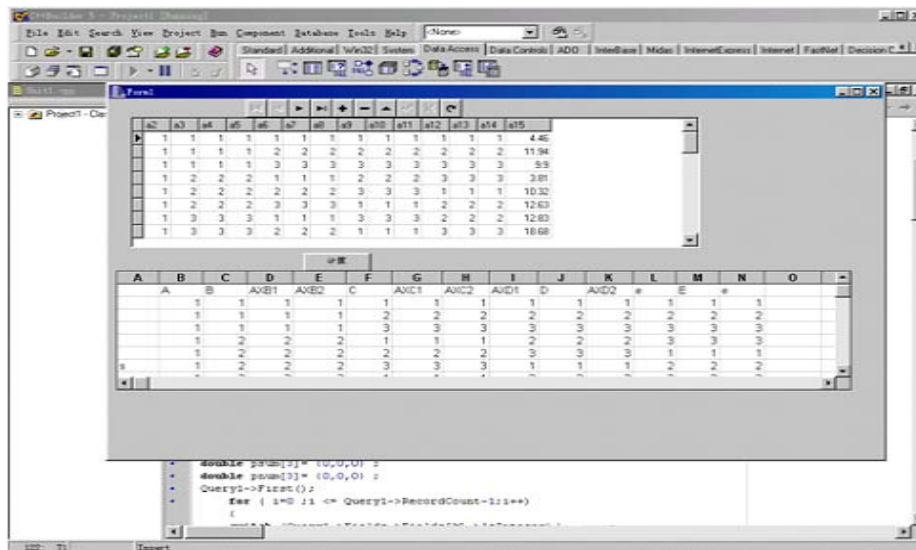


Figure 2. Input Screen

After the program runs, the data screen of results is as Figure 3.

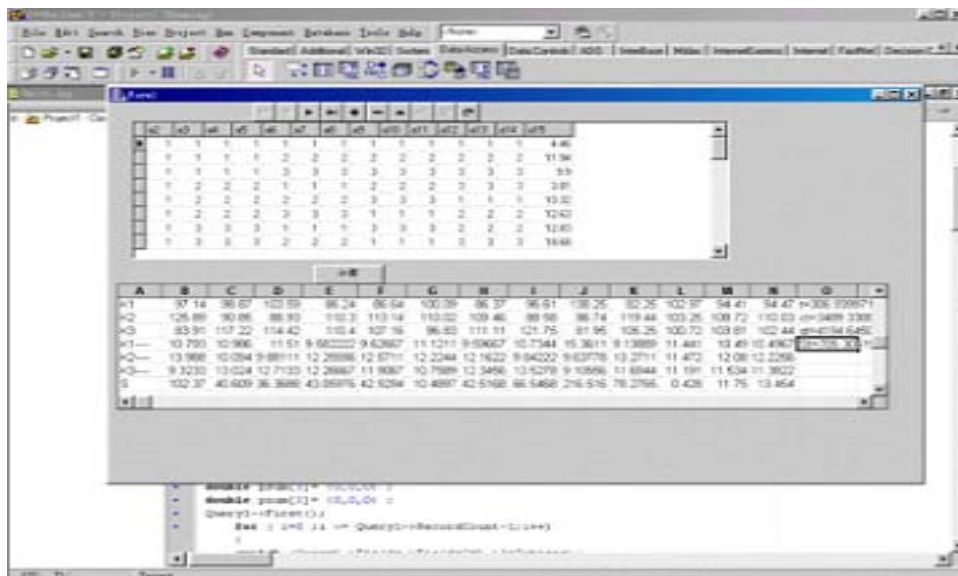


Figure 3. Results Calculation through C++ Builder

### 5. Conclusion

Orthogonal test applied widely, but the calculation was complex, so developing and utilizing the visual programming platform based on C++ Builder could process the data more intuitively and simply. For complex orthogonal experiment, the advantage is more obvious. Using C++ Builder programming platform, combined with the use of the database, the data processing is more accurate and fast. For any  $L_{27}(3^{13})$  orthogonal test table, no matter the test in which industry, as long you input the result of each test to the last column, you can achieve the visual calculation and analysis to the results of the whole test. Other orthogonal table can also

be used in this way, and the result can be achieved with making a little change. Its advantages will become more prominent especially in the process of the orthogonal experiment data and influence on more factors.

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