

## **Homework #2**

**CSE 565: Software Verification/ Validation/ Test**

**(2015 FALL)**

**Design of Experiments**

**Submitted By:**

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## Design of Experiments

Design of Experiments also called DOE is used to investigate the behavior of system when variables are involved. Using DOE we can assess impact of multiple independent variables. DOE can be used to generate tests cases. There are two ways in which it can be implemented. One is “Full Factorial Design” in which all factor/ level combinations are considered. Second one is “Fractional Factorial Design” in which pairs of factor combinations are considered (Example: 2-way, 3-way).

### 1. Software Specification

Develop a print function which is embedded in Microsoft Word to print the word document. For the print function to be more effective a number of factors are required. Print function makes use of these factors to model the given document and set it ready for print. Given the factors and values for each factor, using DOE we can generate test cases in a more effective way. Evaluate the software in less number of test cases with complete test coverage. The factors that I am considering for the print function are:

**Number of Pages:** This factor gives user flexibility to choose only the page/ pages that user wants to print. For example I want to print the current page or a list of pages.

**Orientation:** This factor helps user to choose the orientation of his document.

**Paper Type:** Users tend to use different kinds of paper to print document. If user uses A4 sheet paper to print the document and the document is aligned to A5 size then print will not be accurate. This option helps user to set the document to the size of paper that one uses.

**Margins:** User might define their own margins for the document. In those cases this factor gives the user flexibility to change the print settings to the margin settings that one defined in their document.

**Pages per sheet:** This factor is used to choose number of pages of the word document that user wants to print on his actual paper. For example for printing power point presentations, if user wants to print 4 slides in page then user can use this option.

**Sides:** This factor helps user to choose number of sides of paper (one / two) that one wants to print.

## Factors and Levels

Factors	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8	Level 9	Level 10
Number of Pages	All Pages	Current Page	Custom Pages	Odd Pages	Even Pages	Page Range				
Orientation	Potrait	Landscape								
Paper Type	Letter	Tabloid	Legal	Executive	A3	A4	A5	Statement	Leder	B4
Margins	Normal	Narrow	Moderate	Wide	Mirrored	Office 2013 Default				
Pages per Sheet	1 Page	2 Pages	4 Pages	8 Pages	16 Pages					
Sides	One Side	Both Sides, Flip Short	Both Sides, Flip Long							

*Figure 1 Factors and Levels*

## 2. Tool Reports

It becomes almost infeasible to write all the test cases manually if there are a number of factors and number of levels for each factor. In such cases tools are required. There are a number of tools that are available online to generate test cases for DOE or in particular pairwise testing [1]. Of all the tools I choose "Pairwiser". This tool is Web-based, free and commercial. I use web-based free version. All I did was created an order in the tool home page [2]. Then I got an email to the registered email with a link to my account on Pairwiser, from which I can access the tool.

**Create a test plan:** Click on the new. Then enter test plan name and click ok.

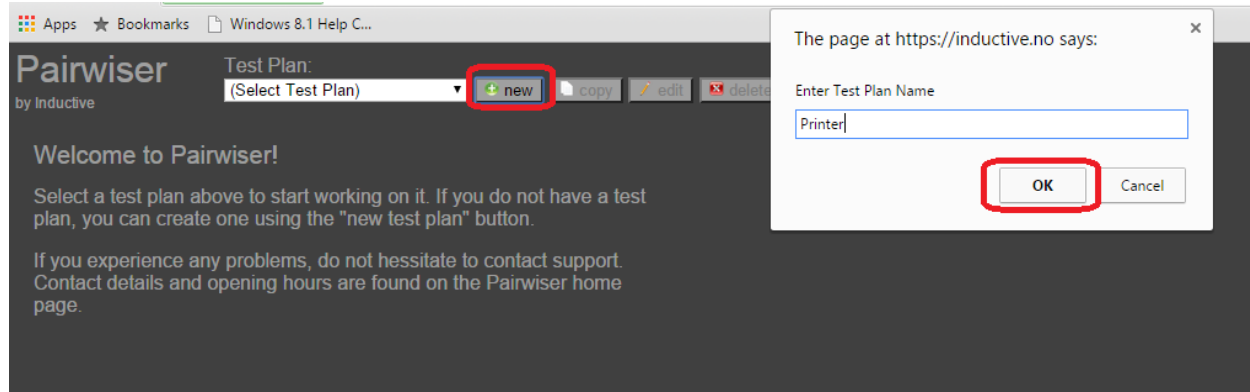


Figure 2 Create Test Plan

**Define Parameters:** Click on Define Parameters tab and enter the parameters.

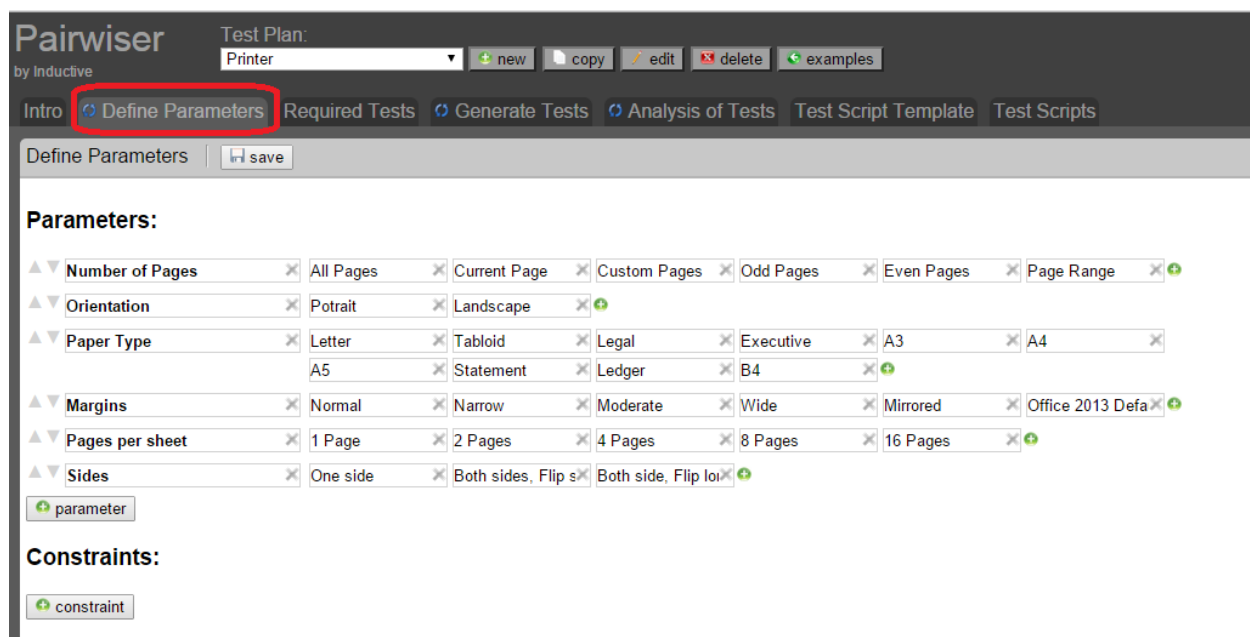


Figure 3 Insert Caption

**Generate Tests:** Click on Generate Tests tab. In Test Generator select 2-wise and then click on generate tests. It generates all the pairwise combination tests for the given factors and levels. We can also export the tests to excel using Export to Excel option.

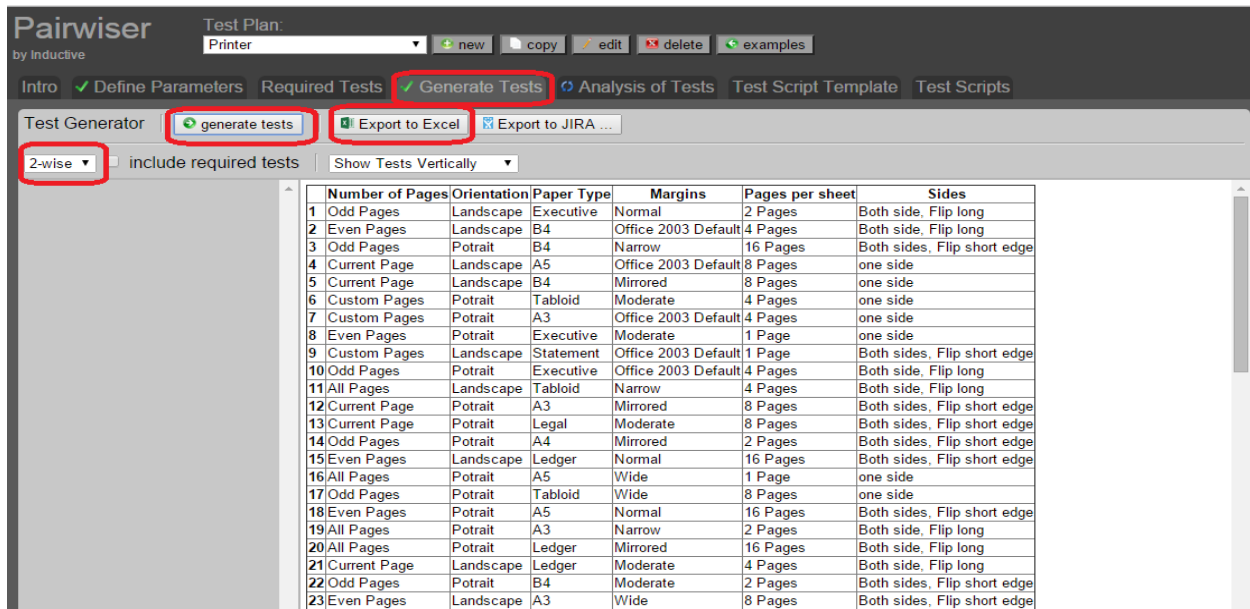


Figure 4 Generate Tests

**Analyze Tests:** Click on Analysis of Tests tab. Then click on analyze. It generates the 2-wise coverage. From this we can understand that only **79 test cases** out of 10800 are enough to show (100%) 2-wise test coverage. Also it shows how many valid combinations of 2 wise pairs are covered. In my example 407. Graph for test coverage is shown below.

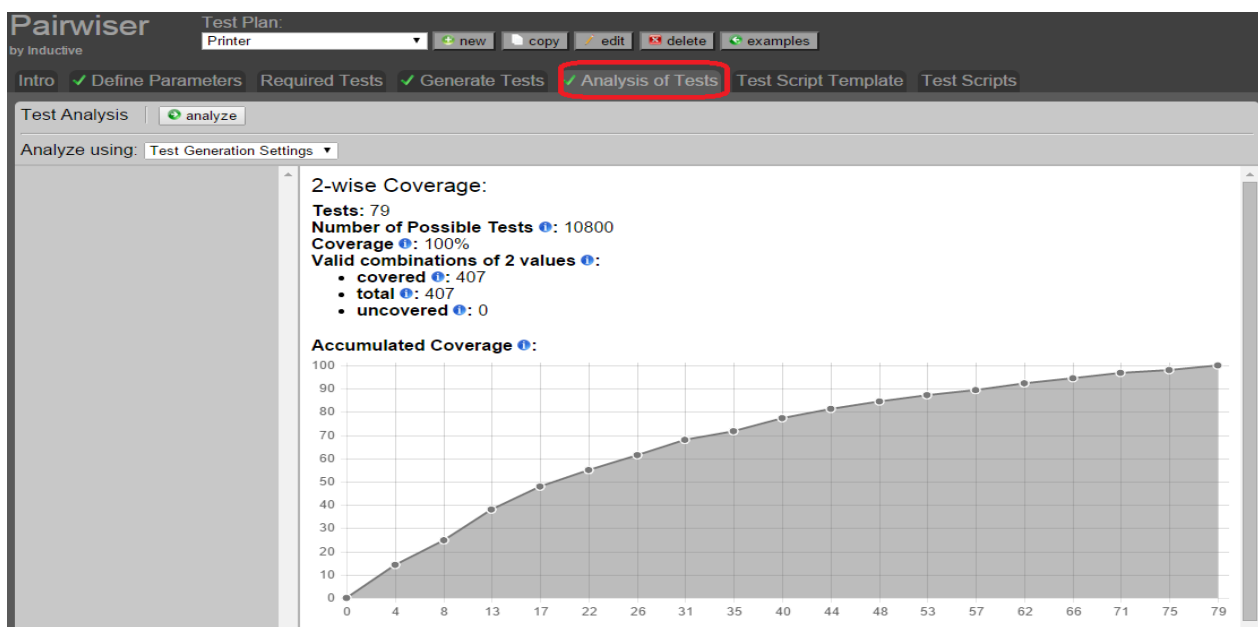


Figure 5 Analyze Tests

### 3. Test cases I would execute based on tool results

Tests \ Parameters	Number of Pages	Orientation	Paper Type	Margins	Pages per sheet	Sides
1	Odd Pages	Landscape	B4	Mirrored	8 Pages	one side
2	Odd Pages	Landscape	A5	Office 2003 Default	16 Pages	Both side, Flip long
3	Even Pages	Landscape	Tabloid	Narrow	16 Pages	Both sides, Flip short edge
4	Page Range	Potrait	Letter	Moderate	4 Pages	Both sides, Flip short edge
5	Odd Pages	Landscape	Letter	Wide	2 Pages	Both sides, Flip short edge
6	Current Page	Landscape	A5	Narrow	4 Pages	Both sides, Flip short edge
7	Current Page	Landscape	B4	Office 2003 Default	2 Pages	Both sides, Flip short edge
8	Custom Pages	Landscape	Statement	Wide	1 Page	one side
9	Even Pages	Potrait	Legal	Narrow	1 Page	Both side, Flip long
10	Custom Pages	Potrait	A4	Office 2003 Default	4 Pages	Both sides, Flip short edge
11	Page Range	Potrait	Statement	Wide	8 Pages	Both sides, Flip short edge
12	Even Pages	Landscape	A3	Moderate	1 Page	Both sides, Flip short edge
13	Custom Pages	Landscape	Executive	Normal	8 Pages	Both sides, Flip short edge
14	All Pages	Landscape	A5	Wide	1 Page	Both side, Flip long
15	All Pages	Potrait	Legal	Mirrored	2 Pages	Both side, Flip long
16	All Pages	Potrait	A3	Wide	16 Pages	one side
17	Page Range	Landscape	Ledger	Office 2003 Default	8 Pages	one side
18	Page Range	Potrait	Legal	Moderate	2 Pages	one side
19	Even Pages	Potrait	B4	Office 2003 Default	4 Pages	one side
20	Even Pages	Potrait	Executive	Moderate	1 Page	one side
21	Even Pages	Potrait	B4	Mirrored	16 Pages	Both side, Flip long
22	Current Page	Landscape	Statement	Wide	16 Pages	Both side, Flip long
23	Current Page	Potrait	Legal	Mirrored	1 Page	Both side, Flip long
24	Odd Pages	Potrait	Tabloid	Normal	4 Pages	Both side, Flip long
25	Custom Pages	Landscape	B4	Wide	16 Pages	one side
26	Page Range	Landscape	Letter	Narrow	1 Page	one side
27	Even Pages	Potrait	Ledger	Narrow	8 Pages	Both side, Flip long
28	All Pages	Landscape	A3	Narrow	4 Pages	Both side, Flip long
29	All Pages	Landscape	Executive	Narrow	1 Page	Both side, Flip short edge
30	Odd Pages	Landscape	A4	Mirrored	2 Pages	Both sides, Flip short edge
31	Current Page	Potrait	A3	Normal	8 Pages	one side
32	Even Pages	Potrait	Letter	Office 2003 Default	2 Pages	one side
33	Page Range	Landscape	A5	Office 2003 Default	1 Page	one side
34	All Pages	Landscape	A4	Office 2003 Default	8 Pages	one side
35	Current Page	Potrait	Tabloid	Mirrored	4 Pages	one side
36	Current Page	Landscape	Ledger	Moderate	16 Pages	Both side, Flip long
37	Page Range	Potrait	A3	Normal	1 Page	Both side, Flip long
38	Even Pages	Potrait	Statement	Moderate	8 Pages	Both side, Flip long
39	Odd Pages	Landscape	Statement	Narrow	2 Pages	Both side, Flip long
40	Odd Pages	Landscape	Legal	Office 2003 Default	4 Pages	Both sides, Flip short edge
41	Page Range	Landscape	A4	Office 2003 Default	16 Pages	Both side, Flip long
42	Custom Pages	Landscape	Letter	Normal	2 Pages	Both side, Flip long
43	Odd Pages	Potrait	A5	Normal	16 Pages	Both side, Flip long
44	Even Pages	Landscape	Statement	Normal	4 Pages	Both side, Flip long
45	Custom Pages	Landscape	Legal	Normal	2 Pages	Both side, Flip long
46	Odd Pages	Potrait	B4	Narrow	1 Page	Both side, Flip long
47	Page Range	Potrait	Executive	Mirrored	8 Pages	Both side, Flip long
48	Even Pages	Landscape	A4	Wide	1 Page	Both sides, Flip short edge
49	All Pages	Potrait	Statement	Normal	2 Pages	Both sides, Flip short edge
50	All Pages	Landscape	Tabloid	Normal	2 Pages	Both sides, Flip short edge
51	All Pages	Potrait	A4	Normal	1 Page	Both sides, Flip short edge
52	Custom Pages	Landscape	Ledger	Narrow	4 Pages	Both sides, Flip short edge
53	Page Range	Landscape	B4	Normal	8 Pages	Both sides, Flip short edge
54	All Pages	Landscape	Letter	Normal	16 Pages	one side
55	Custom Pages	Landscape	Ledger	Moderate	1 Page	one side
56	Odd Pages	Landscape	A5	Mirrored	2 Pages	Both side, Flip long
57	Custom Pages	Potrait	A5	Mirrored	8 Pages	Both sides, Flip short edge
58	Even Pages	Potrait	A5	Wide	4 Pages	Both side, Flip long
59	Odd Pages	Potrait	A5	Moderate	4 Pages	Both side, Flip long
60	Odd Pages	Potrait	Legal	Wide	8 Pages	Both side, Flip long

61	Odd Pages	Potrait	A3	Office 2003 Default	2 Pages	Both sides, Flip short edge
62	Page Range	Landscape	Tabloid	Office 2003 Default	1 Page	one side
63	All Pages	Potrait	Ledger	Mirrored	2 Pages	one side
64	Current Page	Potrait	Statement	Mirrored	8 Pages	one side
65	Custom Pages	Potrait	Tabloid	Wide	8 Pages	one side
66	Odd Pages	Potrait	Ledger	Wide	16 Pages	Both sides, Flip short edge
67	Current Page	Potrait	A4	Moderate	16 Pages	Both side, Flip long
68	Custom Pages	Potrait	A3	Mirrored	16 Pages	Both side, Flip long
69	Current Page	Potrait	Letter	Wide	8 Pages	Both side, Flip long
70	All Pages	Potrait	Tabloid	Moderate	16 Pages	one side
71	Current Page	Potrait	Statement	Office 2003 Default	4 Pages	Both side, Flip long
72	Custom Pages	Landscape	Letter	Mirrored	4 Pages	one side
73	Even Pages	Landscape	A4	Narrow	4 Pages	Both sides, Flip short edge
74	All Pages	Potrait	B4	Moderate	16 Pages	Both side, Flip long
75	Odd Pages	Potrait	Ledger	Normal	1 Page	Both side, Flip long
76	Current Page	Potrait	Executive	Office 2003 Default	16 Pages	Both side, Flip long
77	Odd Pages	Landscape	Executive	Wide	2 Pages	one side
78	Odd Pages	Potrait	Legal	Wide	16 Pages	Both sides, Flip short edge
79	Page Range	Landscape	Executive	Office 2003 Default	4 Pages	Both sides, Flip short edge

Figure 6 Test Cases

## References

1. <http://www.pairwise.org/tools.asp>
2. <https://inductive.no/pairwiser/>