
AllPairs and PICT

Free tools for test design optimization

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Outline

- Combination Testing – Problem Statement
- Allpairs by James Bach
- PICT by Microsoft
- Examples from the Industry
- Tips
- Resources & References

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Let's go for a Test Drive

Electronic Stability Program (ESP)

Enhances driver control and helps maintain directional stability under all conditions. Provides the greatest benefit during critical driving situations such as when driving on mixed surface conditions such as snow, ice or gravel.

http://www.metacafe.com/watch/731344/exotic_cars_info20_com_esp_electronic_stability_program

Testing an ESP System

■ Car Weight

- ❑ Net, Maxload, Overload,
- ❑ Location: Front seat, back seat, trunk, roof

■ Tires:

- ❑ Type: Radial, Standard, min width, max width
- ❑ Condition: New, worn,
- ❑ Air Pressure: Nominal, over, under

■ Driving conditions:

- ❑ Surface: Asphalt, concrete, loose gravel, ice, snow, wet, flooded, wet+leaves, wet+gravel, oil, sand
- ❑ Incline: Up, Down, straight
- ❑ Contour: Left turn, right turn, straight
- ❑ Speed: Slow, Fast
- ❑ Wind: Left, Right, Front, Back

■ Actions:

- ❑ Quiescent, break, accelerate, down-shift, up-shift

Cross Product: 1,140,480 different test cases (for each car model!)

(ואת האלמנט לא הכנסתי)

Combination Testing

- **The problem: Combinatorial Explosion**

which leads to

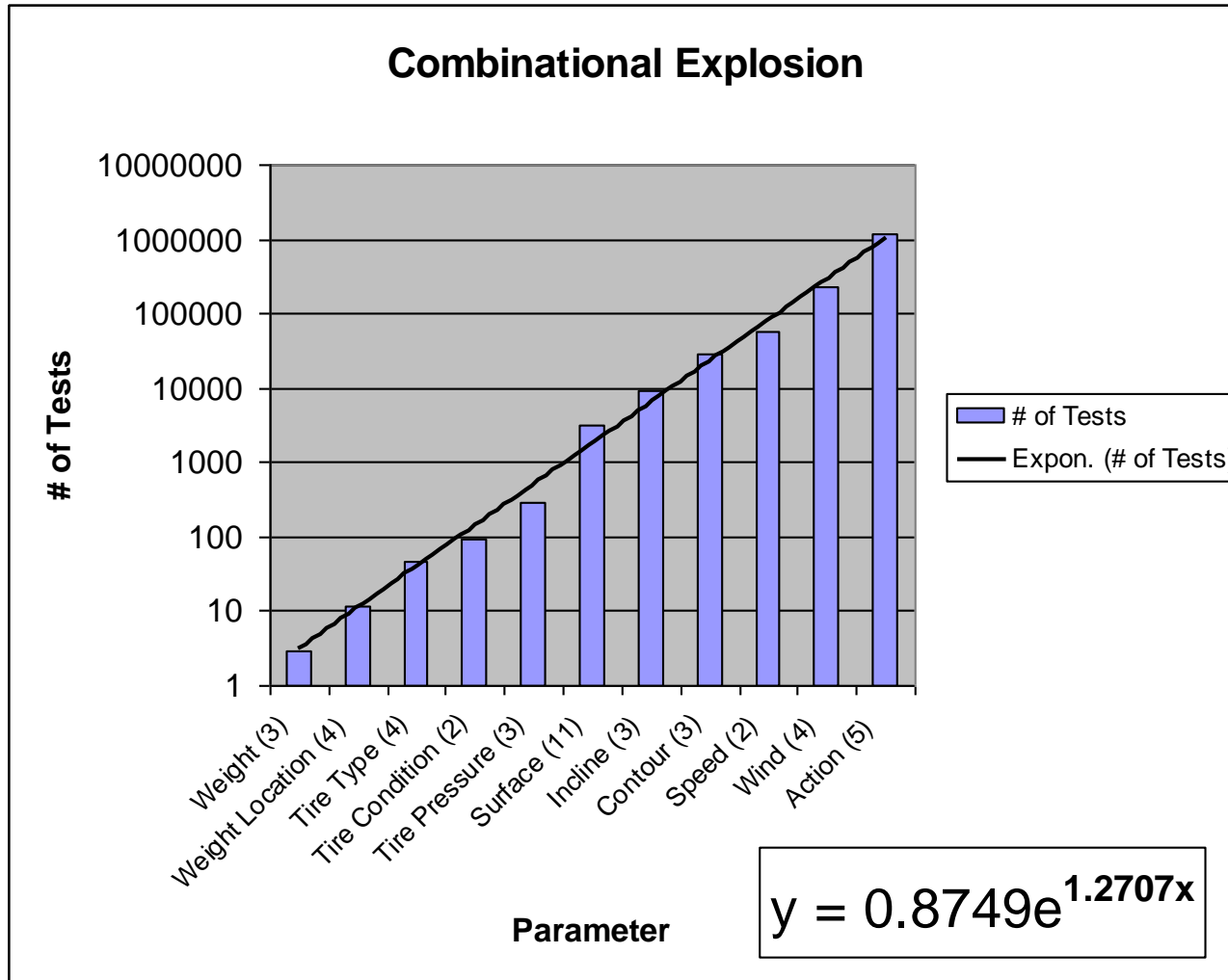
- **“Test Explosion”:**

- More tests than you can ever (want to) run

- **Common in Software:**

- Configuration parameters, internal events, external events, user inputs, environment parameters

Testing an ESP System



Strategy #1: Do you really have a problem?

- **Case#1:** The parameters are orthogonal, test each variable by itself
- **Case#2:** Combinations can be covered while testing other things (con: complicates test planning)
- **Case#3:** Enough planned iterations to cover the combinations (con: calls for tight control)
- **Example:**
 - Screen Input fields
- **Caveat:** Nothing is as simple as it looks
 - Evaluate the Risk!

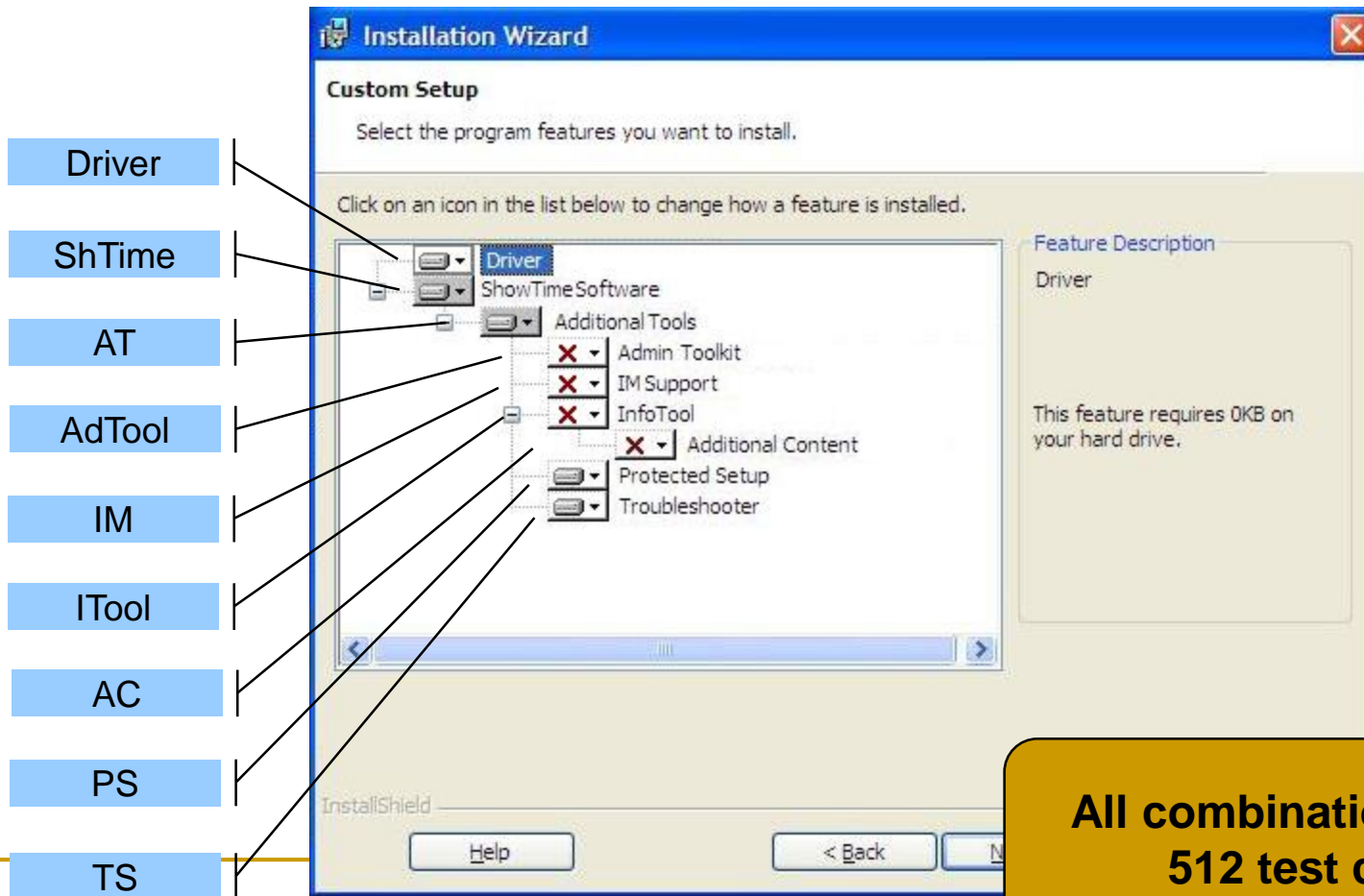
Strategy #2: All Pairs

- **Theory:** ([Tatsumi], [Cohen et al.])
 - (Bad) interaction between variables is usually between two variables
 - Bugs involving interactions between three or more parameters are progressively less common
- **Therefore:**
 - Test all-pair interactions
 - Augment with a few selected tests

Tools in Action

- Allpairs.exe (James Bach)
- PICT (Microsoft)

The Application Under Test: Generic Installer



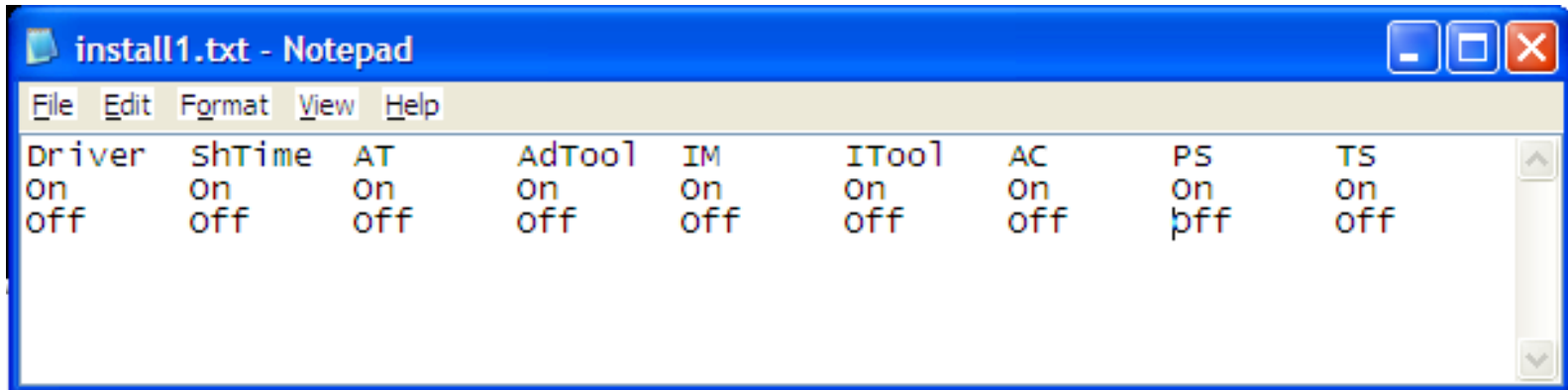
All-Pairs by James Bach

- Text-based, written in Perl by James Bach
- Command-line tool
- Simple
 - 10 minutes to download and learn
- Not optimal (by the author's testimony)
 - Good enough
- Free!

Get it at:

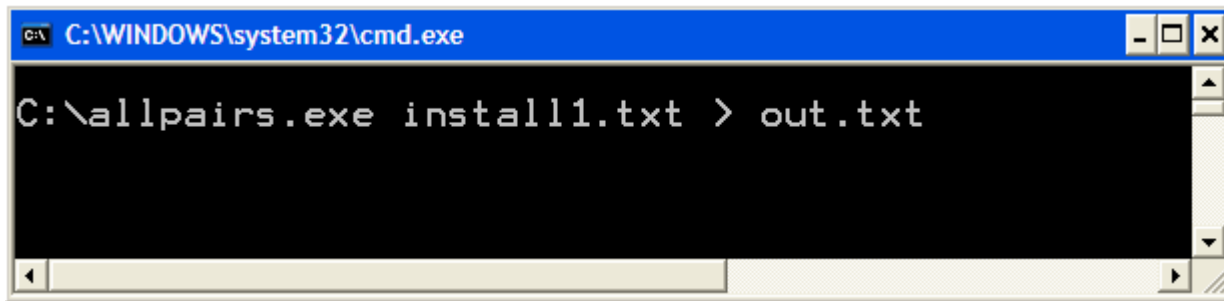
<http://www.satisfice.com/tools.shtml>

All-Pairs by James Bach: Input file



The screenshot shows a Notepad window with the title "install1.txt - Notepad". The menu bar includes File, Edit, Format, View, and Help. The text content is as follows:

Driver	ShTime	AT	AdTool	IM	ITool	AC	PS	TS
On	On	On	On	On	On	On	On	On
off	off	off	off	off	off	off	pff	off



The screenshot shows a Windows command prompt window with the title "C:\WINDOWS\system32\cmd.exe". The command entered is:

```
C:\>allpairs.exe install1.txt > out.txt
```

All-Pairs by James Bach: Output file



out.txt

All-Pairs: Additional Notes

- Input file is TAB limited – remove additional ones from the end
- Parameters names – max 8 chars
- "Don't Care" values ("~"): Choose a value which
 - Maximizes the probability of a failure; or:
 - Maximizes the impact of the failure
- Variable order in input file impacts number of times a given combination is tested
- Limitations:
 - No logic
 - Pairs only

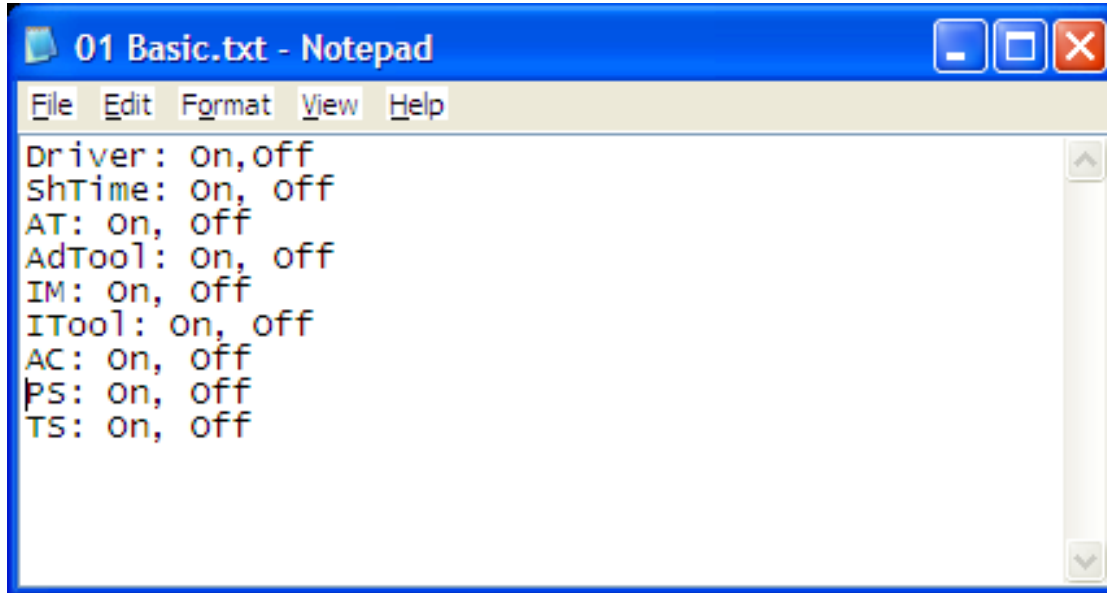
Pairwise Independent Combinatorial Testing tool (PICT)

- Command-line tool
- Created by Microsoft
- A bit more complicated than Allpairs
 - ... but much more powerful
- Free!

Get it at:

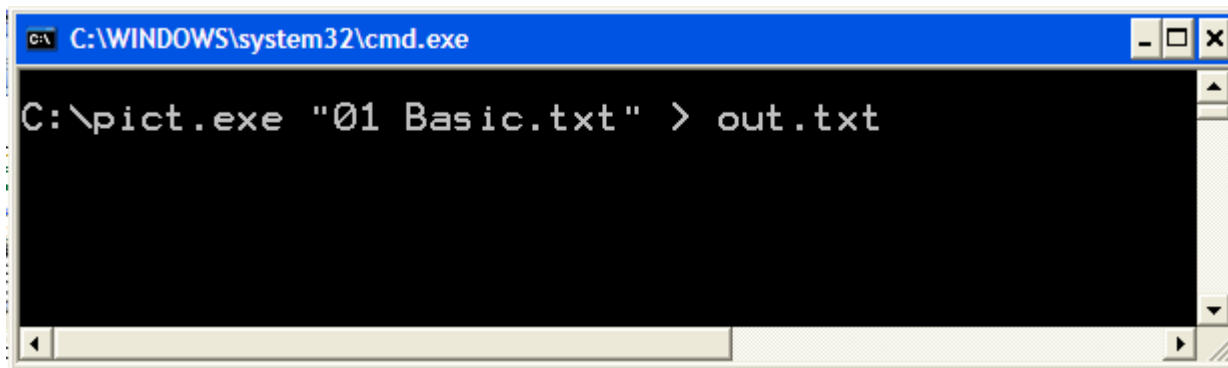
<http://msdn.microsoft.com/en-us/testing/bb980925.aspx>

PICT – Basic usage



A screenshot of a Notepad window titled "01 Basic.txt - Notepad". The window has a menu bar with "File", "Edit", "Format", "View", and "Help". The text content is as follows:

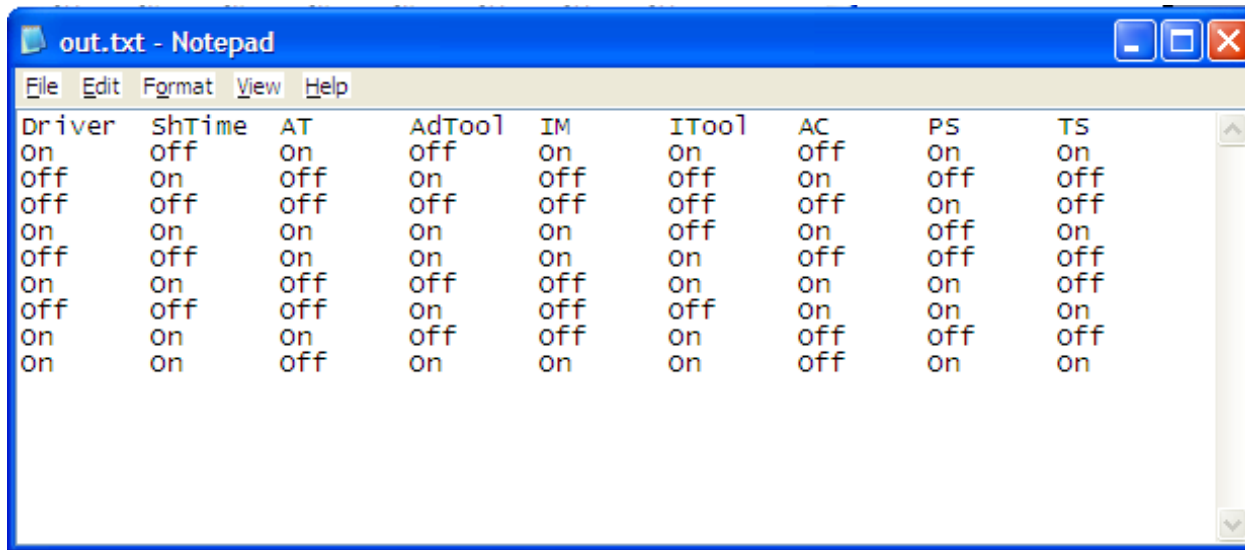
```
Driver: on, off  
ShTime: on, off  
AT: on, off  
AdTool: on, off  
IM: on, off  
ITool: on, off  
AC: on, off  
PS: on, off  
TS: on, off
```



A screenshot of a Windows command prompt window titled "C:\WINDOWS\system32\cmd.exe". The prompt shows the execution of the PICT command:

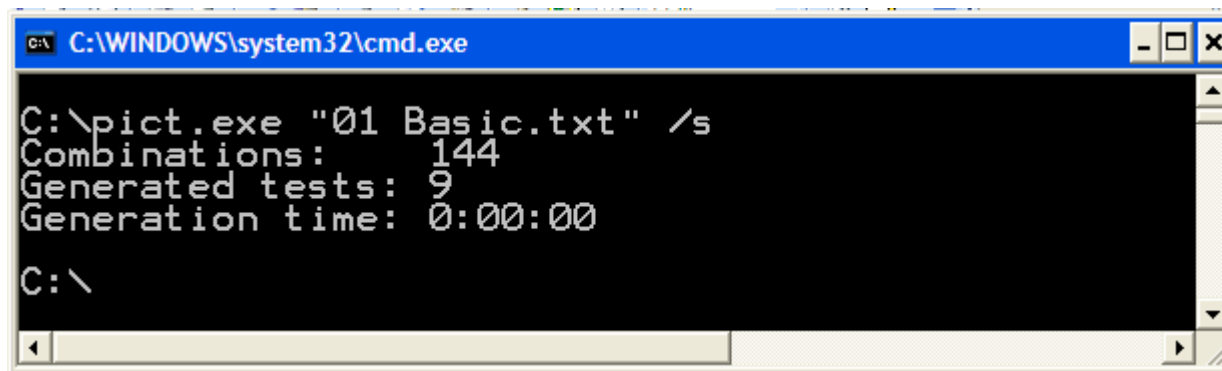
```
C:\>pict.exe "01 Basic.txt" > out.txt
```

PICT – Output



```
out.txt - Notepad
File Edit Format View Help
Driver  ShTime  AT      AdTool  IM      ITool   AC      PS      TS
On      off     on      off     on      on      off     on      on
off     on      off     on      off     off     on      off     off
off     off     off     off     off     off     off     on      off
on      on      on      on      on      off     on      off     on
off     off     on      on      on      on      off     off     off
on      on      off     off     off     on      on      on      off
off     off     off     on      off     off     on      on      on
on      on      on      off     off     on      off     off     off
on      on      off     on      on      on      off     on      on
```

- Statistics:



```
C:\WINDOWS\system32\cmd.exe
C:\>pict.exe "01 Basic.txt" /s
Combinations: 144
Generated tests: 9
Generation time: 0:00:00
C:\>
```

PICT Options

Usage: pict model [options]

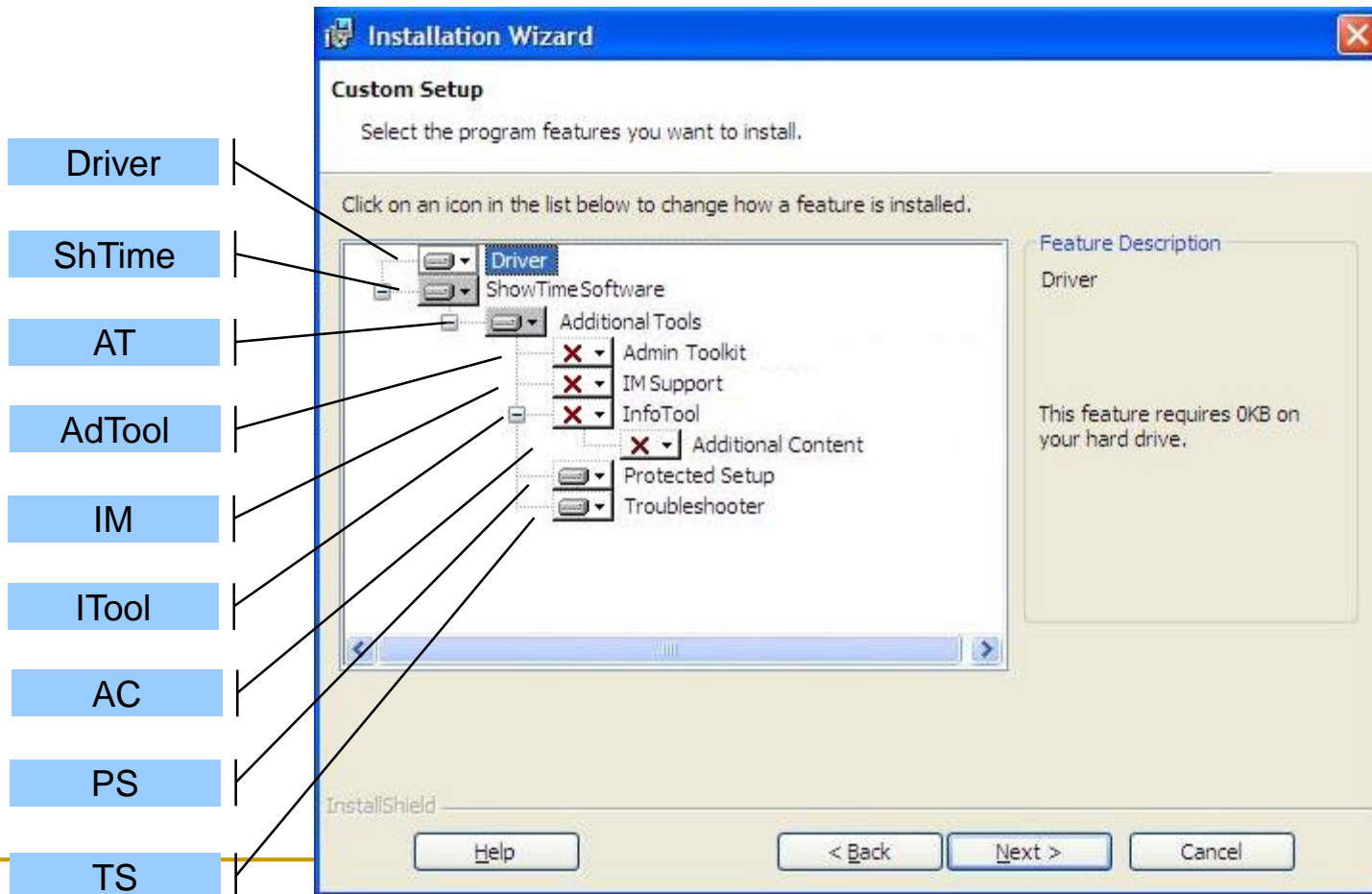
Options:

- /o:N - Order of combinations (default: 2)**
- /d:C - Separator for values (default: ,)**
- /a:C - Separator for aliases (default: |)**
- /n:C - Negative value prefix (default: ~)**
- /e:file - File with seeding rows**
- /r[:N] - Randomize generation, N - seed**
- /c - Case-sensitive model evaluation**
- /s - Show model statistics**

PICT Demo

- **Combination Order control**
- **Randomization**
- **Constraints**
- **Sub-Models**
- **Aliasing**
- **Weighting**
- **Negative Tests**
- **Seeding**

The Application Under Test: Generic Installer



Real World Cases – Case#1

Parameter	A	B	C	D	E	F
# of Values	2	5	6	7	8	22
			Cross Value (2x5x6x7x8x22)			73920

- ❑ **PICT file:**
 - 1 constraint
 - 56 IF-THEN-ELSE equations
 - All Pairs
- ❑ **Final result: 90 test cases**

Real World Cases – Case#2



Real World Cases – Case#2

Security	Power Source	H State	Link Policy	S State	Move to state	ME Wake-up	DUT Power Up
WPA-TKIP-PSK	AC/DC	H0	On S0	S0	ACDC->DC->ACDC cycle	Wake on ARP	Power Button during M1
WPA-TKIP-TLS	DC	Hx	On Sx/AC	S3	Link policy change to Sx/AC	Wake on ASFv4	Power Button during M0ff
WPA-TKIP-PEAP			Disabled	S5	S5	Wake on WebUIv4	RC Power On
WPA2-CCMP-PSK				S4	S4	Wake on Pingv4	
WPA2-CCMP-TLS					S3	Wake on SOL/IDE-Rv4	
WPA2-CCMP-PEAP					Power Source AC/DC	Wake on ASFv6(Local)	
open						Wake on WebUIv6(Local)	
wep						Wake on Pingv6(Local)	
						Wake on SOL/IDE-Rv6(Local)	
						Wake on NDP(Local)	
						Wake on ASFv6(DHCP)	
						Wake on WebUIv6(DHCP)	
						Wake on Pingv6(DHCP)	
						Wake on SOL/IDE-Rv6(DHCP)	
						Wake on NDP(DHCP)	
						Wake on ASFv6(AutoC)	
						Wake on WebUIv6(AutoC)	
						Wake on Pingv6(AutoC)	
						Wake on SOL/IDE-Rv6(AutoC)	
						Wake on NDP(AutoC)	

- ❑ **Cross value: 138240**
- ❑ **PICT file**
 - Security & ME Wake-up: Aliases
 - 6 IF-THEN
 - All combinations (/o:9)
- ❑ **Final Result: 90 tests**
- ❑ **Augmented by 18 special case tests**



Additional Benefits

- **Helps overcome the “Magic Seven” number problem:**
 - Not more than about seven items can be held simultaneously in working memory [Miller]
 - Impossible to manipulate large number of items and systematically explore all their potentially relevant combinations without help
 - **A test problem may involve 5,10 or more parameters**
 - Parameters can be combined in thousands of different ways
 - **PICT helps in organizing the information and analyzing it in manageable chunks**
- **Final result is a much better understanding of the problem and the feature**

Risks

- **N-pairs is another tool in your toolbox**
 - Not guaranteed to find all bugs
- **The test quality is dependant on the input values you chose**
 - Was your Equivalence Class partitioning correct?
 - Did you select the “right” representative value?
- **If the output is influenced by more then 2 variables, you need a higher level then all-pairs to catch bugs**
- **Blind selection of pairs will miss the “interesting” or often-used combinations**
- **Read [Bach, Shroeder]:**
 - “We believe that this technique is over promoted and poorly understood”

Don't fall in love with the tool – it's not a Silver Bullet

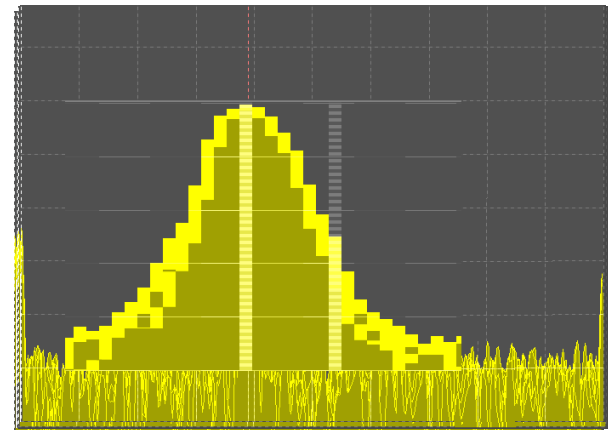
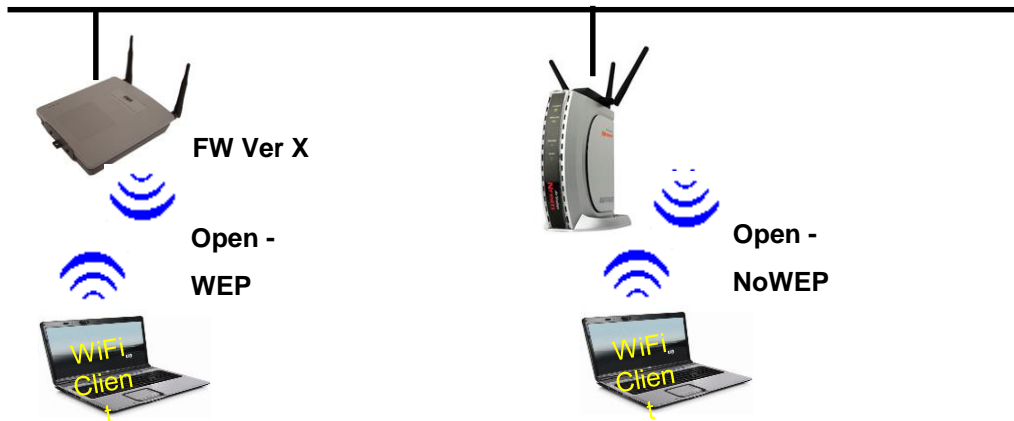
- Apply your Tester's instincts
- Analyze the situation

Tips

- **Use the tool for situation analysis – not just as a mechanical test-case generator**
 - ❑ Add constraint equations to document your conclusions
 - ❑ Use aliases – but ensure you cover all alias values
 - ❑ Document your considerations inside the file
 - You’ll be the first to ask “what was I thinking when I decided on this constraint”?
- **Save the PICT file as part of the Testware**
 - ❑ Document the orthogonally level used and other switches
- **Add the “augmentation tests” as a seed file or as comments in the PICT file**
- **Trivial but sometime forgotten:**
 - ❑ Are you sure all inputs and all values are relevant?
 - ❑ Avoid falling in love with a complicated scenario

It's not always just 2 parameters...

(Department of Horror Stories)



At least 6 parameters involved:

- AP1
- Config: Open/WEP
- FW X
- AP2
- Config: Open/NoWEP
- RF Toggle

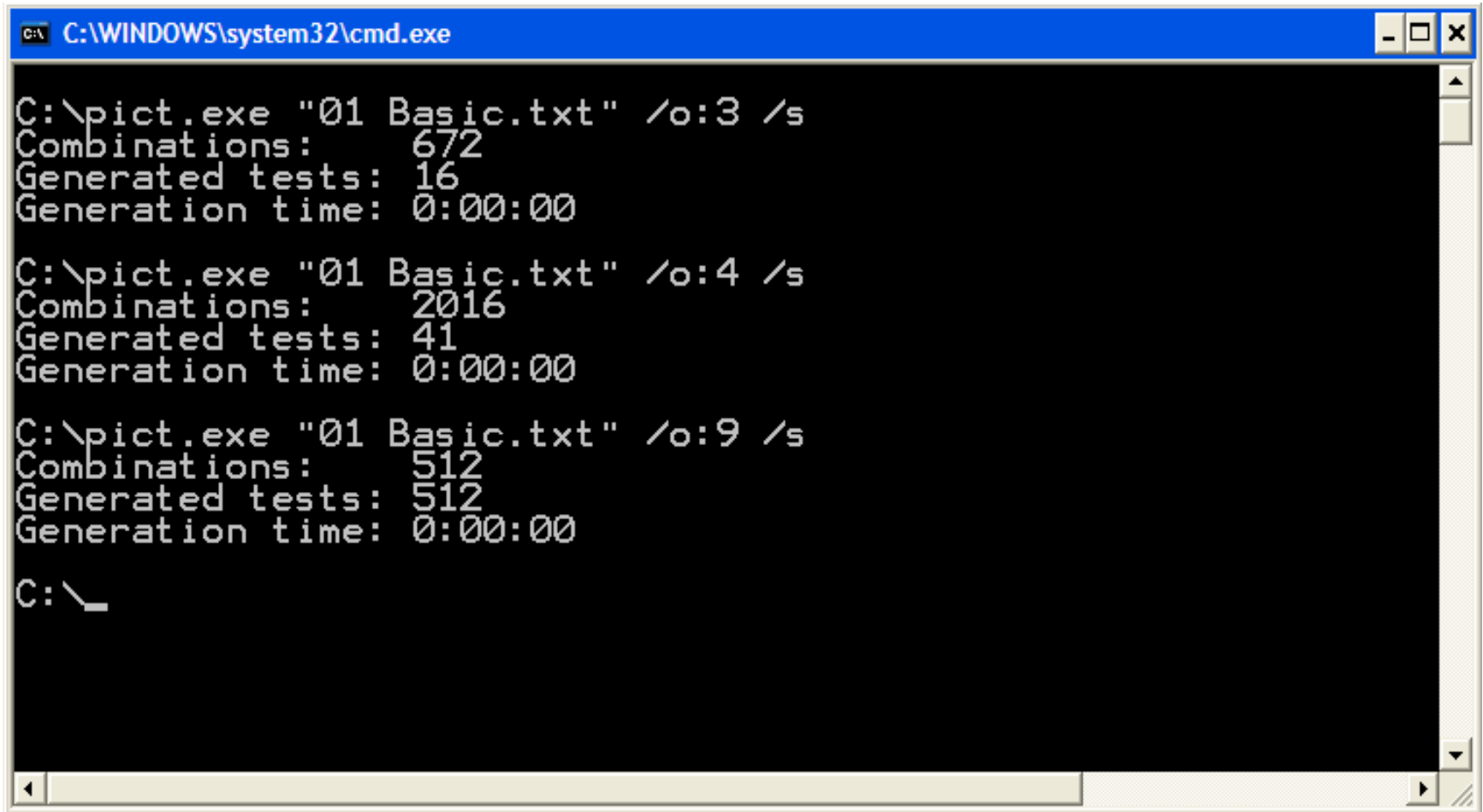
Go Figure!...

Resources & References

- www.allpairs.org
 - Articles, Resources, Tools list (29 tools; 5 Free)
- [Tatsumi]: <http://www.pairwise.org/docs/icqc87.pdf>
- [Cohen at al.]
<http://www.argreenhouse.com/papers/gcp/AETGissre96.shtml>
- [Miller]: Miller, G.A. (1956): The magical number seven, plus or minus two, *Psychological Review* 63:2, p. 81-97.
- <http://msdn.microsoft.com/en-us/library/cc150619.aspx>
- [Bach, Shroeder]: Bach, J., and P. Shroeder. “Pairwise Testing: A Best Practice that Isn’t.” In Proceedings of the 22nd Pacific Northwest Software Quality Conference, pages 180–196, 2004
(<http://www.testingeducation.org/wtst5/PairwisePNSQC2004.pdf>)

PICT Demo – Screen shots

PICT Options: /o:N



```
C:\WINDOWS\system32\cmd.exe

C:\>pict.exe "01 Basic.txt" /o:3 /s
Combinations:      672
Generated tests:   16
Generation time:   0:00:00

C:\>pict.exe "01 Basic.txt" /o:4 /s
Combinations:      2016
Generated tests:   41
Generation time:   0:00:00

C:\>pict.exe "01 Basic.txt" /o:9 /s
Combinations:      512
Generated tests:   512
Generation time:   0:00:00

C:\>
```

PICT Options: /r

```
C:\pict.exe "01 Basic.txt"
Driver ShTime AT AdTool IM ITool AC PS TS
On Off On Off On On Off On On
Off On Off On Off Off On Off Off
Off Off Off Off Off Off Off On Off
On On On On On Off On Off On
Off Off On On On On Off Off Off
On On Off Off Off On On On Off
Off Off Off On Off Off On On On
On On On Off Off On Off Off Off
On On Off On On On Off Off Off

C:\pict.exe "01 Basic.txt" /r
Used seed: 49506
Driver ShTime AT AdTool IM ITool AC PS TS
On Off On Off On On On Off Off
Off On Off On Off Off Off Off On
Off On On On On On Off On Off
Off Off Off Off Off Off On On On
On On On Off On Off Off On On
On Off Off On On On Off On Off
On Off On On On Off On Off Off
On On Off Off Off On Off Off Off

C:\pict.exe "01 Basic.txt" /r
Used seed: 49507
Driver ShTime AT AdTool IM ITool AC PS TS
On On Off Off Off Off On Off Off
Off Off On On On On Off On On
Off On Off Off On Off Off Off On
On Off On On On Off Off On Off
On Off Off Off Off Off On Off Off
Off On On On On On On Off Off
On Off Off On On Off On Off Off
On On On Off Off On Off Off Off
Off On On Off Off On On On On
```


PICT Options: /r:N

```
C:\pict.exe "01 Basic.txt" /r:7
Used seed: 7
Driver  ShTime  AT      AdTool  IM      ITool   AC      PS      TS
On      On       On      On      Off     On      Off     Off     Off
Off     Off     On      Off     On      Off     On      On      On
On      Off     Off     On      On      On      On      On      Off
Off     On      Off     Off     Off     Off     Off     On      On
On      On      Off     Off     On      Off     On      Off     Off
Off     Off     On      On      On      On      Off     Off     On
Off     Off     On      Off     Off     On      On      On      Off
On      On      Off     On      Off     Off     Off     On      On

C:\pict.exe "01 Basic.txt" /r:7
Used seed: 7
Driver  ShTime  AT      AdTool  IM      ITool   AC      PS      TS
On      On       On      On      Off     On      Off     Off     Off
Off     Off     On      Off     On      Off     On      On      On
On      Off     Off     On      On      On      On      On      Off
Off     On      Off     Off     Off     Off     Off     On      On
On      On      Off     Off     On      Off     On      Off     Off
Off     Off     On      On      On      On      Off     Off     On
Off     Off     On      Off     Off     On      On      On      Off
On      On      Off     On      Off     Off     Off     On      On

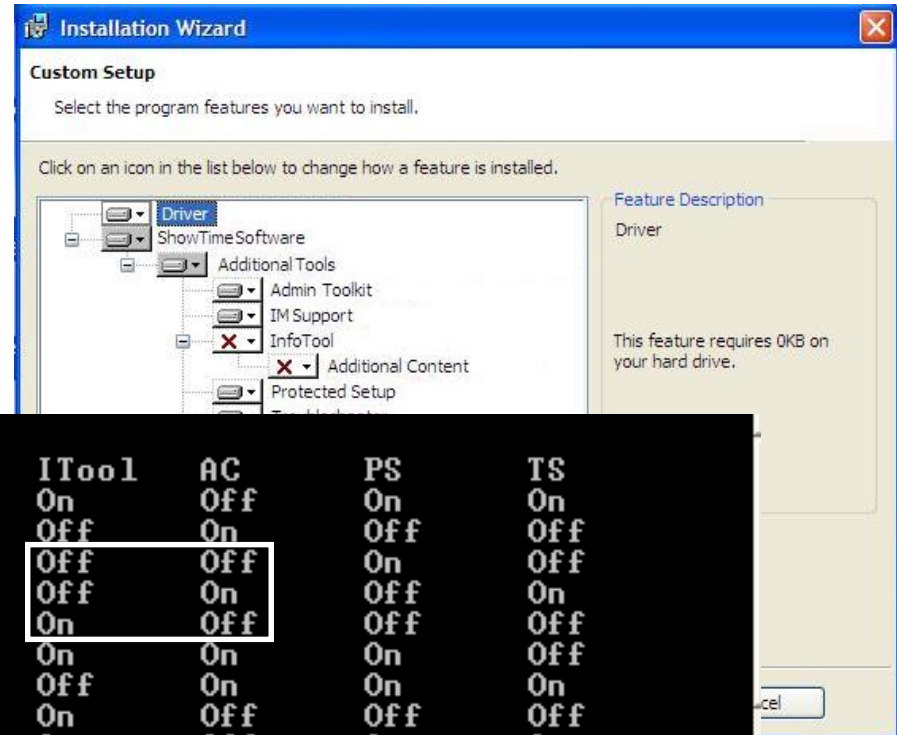
C:\pict.exe "01 Basic.txt" /r:7
Used seed: 7
Driver  ShTime  AT      AdTool  IM      ITool   AC      PS      TS
On      On       On      On      Off     On      Off     Off     Off
Off     Off     On      Off     On      Off     On      On      On
On      Off     Off     On      On      On      On      On      Off
Off     On      Off     Off     Off     Off     Off     On      On
On      On      Off     Off     On      Off     On      Off     Off
Off     Off     On      On      On      On      Off     Off     On
Off     Off     On      Off     Off     On      On      On      Off
On      On      Off     On      Off     Off     Off     On      On
```

PICT – Constraints

■ Example:

IF [ITool] = "Off"

THEN [AC] = "Off"



```
C:\>pict.exe "01 Basic.txt"
Driver  ShTime  AT      AdTool  IM      ITool   AC      PS      TS
On      Off      On      Off     On      On      Off     On      On
Off     On      Off     On      Off     Off     On      Off     Off
Off     Off     Off     Off     Off     Off     Off     On      Off
On      On      On      On      On      On      On      Off     On
Off     Off     On      On      On      On      Off     Off     Off
On      On      Off     Off     Off     On      On      On      Off
Off     Off     Off     On      Off     Off     On      On      On
On      On      On      Off     Off     On      Off     Off     Off
On      On      Off     On      On      On      Off     On      On
```

```
C:\>pict.exe "02 Constraints.txt"
Driver  ShTime  AT      AdTool  IM      ITool   AC      PS      TS
On      On      Off     Off     Off     On      Off     On      On
Off     On      On      On      On      On      On      Off     Off
Off     Off     Off     On      On      Off     Off     On      Off
On      Off     On      Off     Off     Off     Off     Off     On
On      On      On      On      On      Off     Off     On      On
On      Off     Off     Off     On      On      On      On      Off
Off     On      Off     On      Off     On      On      Off     On
Off     On      Off     Off     Off     On      On      Off     Off
```

PICT – Conditional Constraints

```
03 Full Constraints.txt - Notepad
File Edit Format View Help
Driver: on,off
ShTime: on, off
AT: on, off
AdTool: on, off
IM: on, off
ITool: on, off
AC: on, off
PS: on, off
TS: on, off

# AC is available only if ITool is installed
#
IF [ITool] = "off" THEN [AC] = "off";

# Nothing is available if the ShTime or the AT are not installed
#
IF ([ShTime] = "off" OR [AT] = "off")
THEN ([AT] = "off" AND [AdTool] = "off" AND [IM] = "off" AND [ITool] = "off" AND [AC] =
"off" AND [PS] = "off" AND [TS] = "off");
```

```
C:\pict.exe "03 Full Constraints.txt"
Driver  ShTime  AT      AdTool  IM      ITool   AC      PS      TS
Off     On       Off     Off     Off     Off     Off     Off     Off
Off     On       On      On      On      On      On      On      On
On      Off     Off     Off     Off     Off     Off     Off     Off
On      On      On      Off     On      On      Off     Off     On
On      On      On      On      Off     On      On      Off     Off
On      On      On      On      On      Off     Off     On      Off
Off     On      On      Off     Off     Off     Off     Off     On
Off     Off     Off     Off     Off     Off     Off     Off     Off
```

PICT – More Constraints

```
04 More Constraints.txt - Notepad
File Edit Format View Help
driver: on,off
shTime: on, off
AT: on, off
AdTool: on, off
IM: on, off
ITool: on, off
AC: on, off
PS: on, off
TS: on, off

# Don't test without the AC installation
[AC] = "On";

# If Driver is installed, don't install shTime. If it is uninstalled, always test
with AT
IF [Driver] = "On" THEN [ShTime] = "off" ELSE [AT] = "On";
```

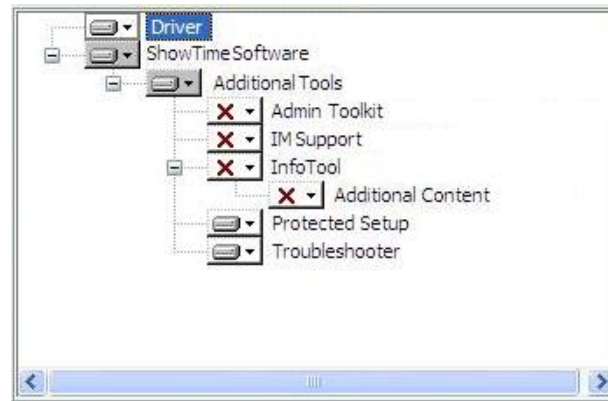
```
C:\pict.exe "04 More Constraints.txt"
Constraints Warning: Restrictive constraints. Output will not contain following
values:
AC: Off
Driver ShTime AT AdTool IM ITool AC PS TS
On Off On Off Off On On On On
On Off Off Off On Off On Off Off
Off On On On Off Off On On On
On Off Off Off On On On On Off
Off On On Off Off Off On Off Off
Off On On On On On On Off On
On Off Off Off Off Off On On On
Off Off On On On Off On On Off
```

PICT – Sub Models

- Bundle certain parameters into groups that get their own combinatory order
- Increase or decrease the coverage level within this group

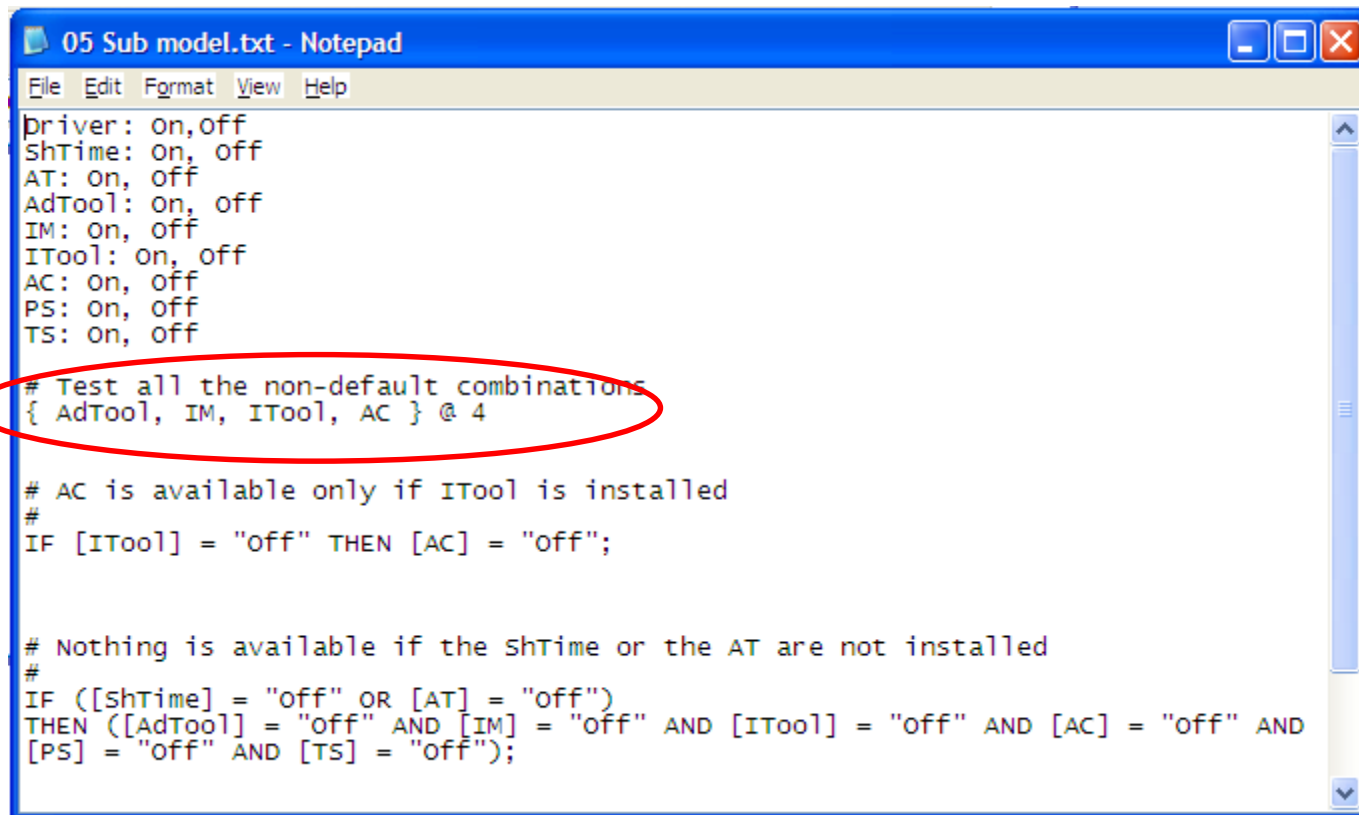
PICT – Sub Models - Example

- Default Install settings:



- PS, TS - On
- AdTool, IM, ITool, AC – Off
- Higher combinational risks for the “Off” group
 - Lower use internally (by testers, developers, beta testers)
 - Users more likely to “pick & choose”
- **Mitigation:** Check all combinations between the non-default options

PICT – Sub Models - Example



```
05 Sub model.txt - Notepad
File Edit Format View Help
Driver: On,Off
ShTime: On, off
AT: On, off
AdTool: On, off
IM: On, off
ITool: On, off
AC: On, off
PS: On, off
TS: On, off
# Test all the non-default combinations
{ AdTool, IM, ITool, AC } @ 4
# AC is available only if ITool is installed
#
IF [ITool] = "off" THEN [AC] = "off";
# Nothing is available if the ShTime or the AT are not installed
#
IF ([ShTime] = "off" OR [AT] = "off")
THEN ([AdTool] = "off" AND [IM] = "off" AND [ITool] = "off" AND [AC] = "off" AND
[PS] = "off" AND [TS] = "off");
```

PICT – Aliasing

- A certain parameter can take a few values
- Does not matter which value is used
 - But will be nice to test all values
- **Example:**
 - Add Operating System to the install parameters
 - No real difference between Service Packs – just make sure we test on all of them

PICT – Aliasing - Example

Without “Aliasing”: OS: XP-sp2,XP-sp3,V,V-SP1

```
C:\pict.exe "06 OS Before Aliasing.txt"
Driver  ShTime  AT      AdTool  IM      ITool   AC      PS      TS      OS
On      On       On      On      Off     Off     On      On      Off     XP-sp3
On      Off      Off     Off     On      On      Off     Off     On      XP-sp2
Off     On       Off     Off     Off     On      Off     On      Off     U
Off     Off      Off     On      On      Off     On      On      On      XP-sp3
Off     Off      On      Off     Off     Off     On      Off     On      U-SP1
On      On       On      On      On      On      Off     Off     Off     U-SP1
Off     Off      On      On      Off     Off     On      On      Off     XP-sp2
On      On       On      On      On      Off     On      Off     On      U
Off     Off      On      Off     Off     On      On      Off     On      XP-sp3
On      Off      Off     On      Off     Off     Off     On      Off     U
Off     On       Off     On      On      On      Off     Off     On      XP-sp2
Off     On       Off     Off     On      Off     Off     Off     On      XP-sp3
On      Off      Off     Off     Off     On      Off     On      On      U-SP1
```

With “Aliasing”: OS: XP-sp2|XP-sp3,V|V-SP1

```
C:\pict.exe "07 OS After Aliasing.txt"
Driver  ShTime  AT      AdTool  IM      ITool   AC      PS      TS      OS
On      Off     On      Off     Off     Off     On      On      Off     U
Off     On      Off     On      On      On      On      Off     On      XP-sp2
Off     Off     Off     Off     On      On      Off     Off     Off     U-SP1
On      On      On      On      On      Off     Off     On      On      XP-sp3
Off     Off     Off     Off     Off     Off     Off     Off     On      XP-sp2
Off     On      On      On      Off     On      Off     On      On      U
On      On      On      On      On      On      Off     Off     Off     XP-sp3
On      On      Off     Off     On      On      On      On      Off     XP-sp2
Off     Off     Off     On      On      Off     Off     On      On      U-SP1
```

No **guarantee** you will get all aliased values! PICT sees them as single value!

PICT – Weighting

- Bias the value distribution to test certain values more than others
- **Example:**
 - Vista is more important than XP

PICT – Weighting - Example

OS: XP, Vista

```
C:\>pict.exe "09 No Weighting.txt"
Memory CPU OS
2G T5800 XP
256M T5800 Vista
1G T5200 XP
4G T5800 XP
4G T5400 Vista
512M T5400 XP
4G T5200 Vista
2G T5200 Vista
256M T5200 XP
4G T2200 XP
256M T5400 Vista
2G T5400 XP
1G T2200 Vista
256M T2200 Vista
1G T5800 Vista
512M T2200 Vista
512M T5800 XP
512M T5200 Vista
1G T5400 Vista
2G T2200 XP
```

XP: 9 / Vista: 11

OS: XP, Vista (5)

```
C:\>pict.exe "10 Weighting.txt"
Memory CPU OS
2G T5800 XP
256M T5800 Vista
1G T5200 XP
4G T5800 XP
4G T5400 Vista
512M T5400 XP
4G T5200 Vista
2G T5200 Vista
256M T5200 XP
4G T2200 XP
256M T5400 Vista
2G T5400 Vista
1G T2200 Vista
256M T2200 Vista
1G T5800 Vista
512M T2200 Vista
512M T5800 Vista
512M T5200 Vista
1G T5400 Vista
2G T2200 Vista
```

XP: 6 / Vista: 14

Does not **guarantee** the requested ratio. PICT priorities:

- Cover all combinations in the smallest number of test cases
- Choose values according to their weights.

PICT – Negative Testing

- Wrong value in one parameter may mask the application's ability to catch wrong value in another
- Mark values as “negative” to avoid multi-negative values combinations
 - Prevents “masking” effects
- **Example:**
 - Application's prerequisites are: ActiveX and .Net
 - Need to verify each pre-requisite is tested

PICT – Negative Testing- Example

- ActX: On, ~Off
- dotNet: On, ~Off

```
C:\pict.exe "08 Negative Testing.txt"
Driver  ShTime  AT      AdTool  IM      ITool   ActX    dotNet
Off     On       Off     Off     Off     On       On      On
On      Off     On      On      On      Off     On      On
Off     Off     On      Off     On      On       On      On
On      Off     Off     Off     Off     Off     On      On
On      On      Off     On      On      On       On      On
Off     On      On      On      Off     Off     On      On
Off     On      Off     Off     Off     On       ~Off    On
Off     Off     On      On      On      Off     On      ~Off
On      Off     Off     On      Off     On       On      ~Off
On      Off     On      On      On      On       ~Off    On
On      Off     On      Off     Off     Off     On      ~Off
Off     On      Off     On      On      Off     ~Off    On
On      On      Off     Off     On      Off     On      ~Off
```

- No case of both “Off”
- (I’d add both “Off”)

PICT – Seeding

- **/e:file**

- Enforce specific combinations
- Reduce test-case changes when one parameter changes

PICT – Seeding - Example

```
11 Seed Default.txt - Notepad
File Edit Format View Help
Driver ShTime AT AdTool IM ITool AC PS TS
On On On off off off off On On
```

```
C:\pict "01 Basic.txt"
Driver ShTime AT AdTool IM ITool AC PS TS
On Off On Off On On Off On On
Off On Off On Off Off On Off Off
Off Off Off Off Off Off Off On Off
On On On On On Off On Off On
Off Off On Off On On On Off Off
On On Off Off Off Off On On On
Off Off Off On Off Off On On On
On On Off On On On Off On On

C:\pict "01 Basic.txt" /e:"11 Seed Default.txt"
Driver ShTime AT AdTool IM ITool AC PS TS
On On On Off Off Off Off On On
On Off Off On On On On Off Off
Off On Off Off On Off On Off On
Off Off On On Off On Off Off Off
On Off On Off Off On On On On
Off On Off On Off On Off On On
On On On Off Off On Off Off Off

C:\pict "01 Basic.txt" /e:"11 Seed Default.txt" /s
Combinations: 144
Generated tests: 8
Generation time: 0:00:00
```