

## DRAWING WITH BRANCHED FUNCTION<sup>1</sup>

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**Abstract.** The branched function is defined as  $f(x) = \begin{cases} f_1(x), x \in I_1 \\ \dots \\ f_n(x), x \in I_n \end{cases}$  from  $I$  to  $\mathbf{R}$

where  $I = I_1 \cup \dots \cup I_n$  and  $I_i \cap I_j = \emptyset, j = 1, \dots, n$ . This function can be used to draw symmetric shapes. By using Excel programm, united graphs of branched function produce some interesting pictures. This paper

presents various graphs of  $f(x) = \begin{cases} f_1(x), x \in I_1 \\ \dots \\ f_n(x), x \in I_n \end{cases}$  in the interval  $-3 \leq x \leq 3$

**Keywords:** branched function, united graphs

### 1. Introduction

There are many specifics building in the world, such as the roof of traditional building, prayer building, or landmark of a province. These shapes could be drawn by using branched function or united branch function aided Excel Program.

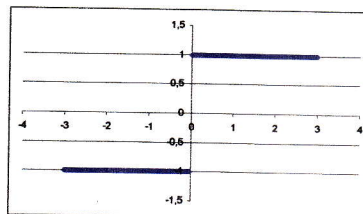
### 2. Branched Function

In this paper branched function is an expression of the form

$$f(x) = \begin{cases} f_1(x), x \in I_1 \\ \dots \\ f_n(x), x \in I_n \end{cases}$$

where  $I = I_1 \cup \dots \cup I_n$  and  $I_i \cap I_j = \emptyset, j = 1, \dots, n$ .

For example:  $f(x) = \begin{cases} -1, x < 0 \\ 1, x \geq 0 \end{cases}$

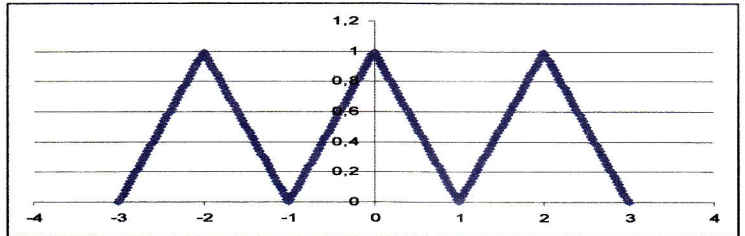


Graph 1: =IF(A1<0;-1;1)

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Picture of roof:

1. Function  $f(x) = \begin{cases} x \bmod 1, & \text{if } \lfloor x \rfloor \bmod 2 = 1 \\ 1 - x \bmod 1, & \text{for the others} \end{cases}$

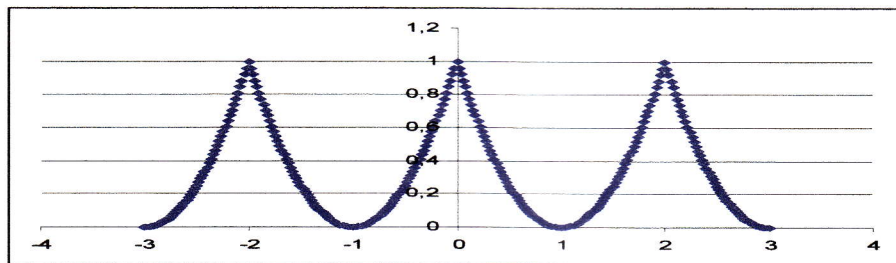


Graph 2: =IF(MOD(INT(A1);2)=1;MOD(A1;1);1-MOD(A1;1))  
for A1=-3 ... A601=3

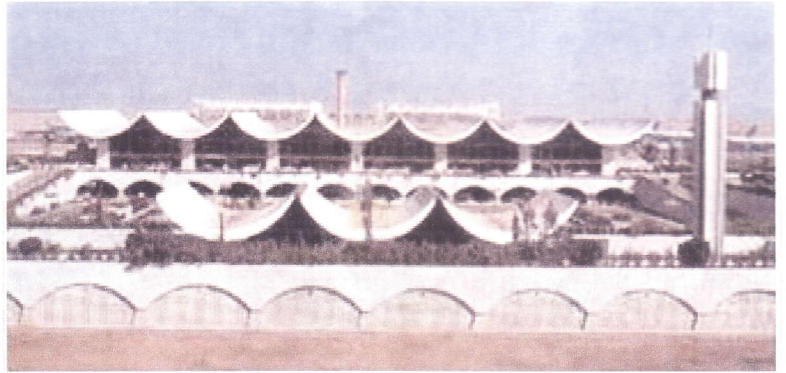


Picture 1: Mosque At-Tiin  
2048 x 1536 - 790k - jpg  
[www.panoramio.com](http://www.panoramio.com)

2. Function  $f(x) = \begin{cases} (x \bmod 1)^2, & \text{if } \lfloor x \rfloor \bmod 2 = 1 \\ (1 - x \bmod 1)^2, & \text{for the others} \end{cases}$

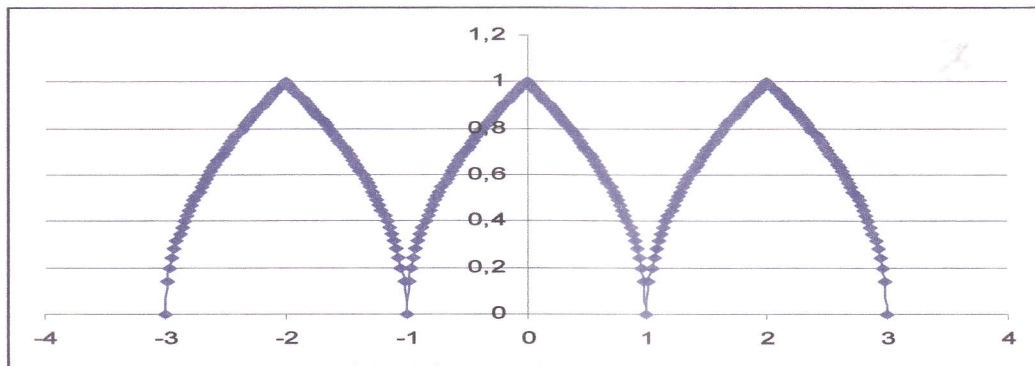


Graph 3: =IF(MOD(INT(A1);2)=1;MOD(A1;1)^2;(1-MOD(A1;1))^2)  
for A1=-3 ... A601=3



Picture 2: King Abdulaziz International Airport ...  
340 x 149 - 10k - jpg  
[www.gaca.gov.sa](http://www.gaca.gov.sa)

3. Function  $f(x) = \begin{cases} (x \bmod 1)^{0,5}, & \text{mod}(\lfloor x \rfloor, 2) = 1 \\ (1 - x \bmod 1)^{0,5}, & \text{for the others} \end{cases}$

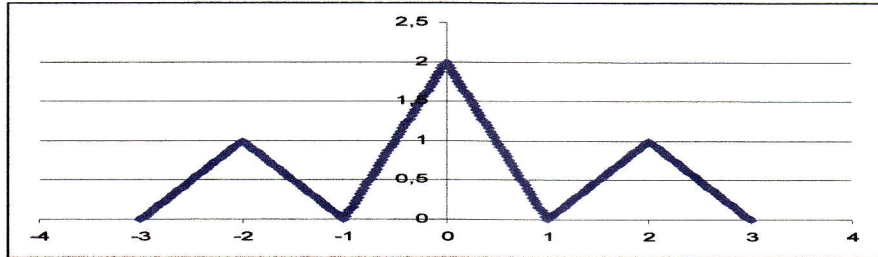


Graph 4: =IF(MOD(INT(A1);2)=1;MOD(A1;1)^0,5;(1-MOD(A1;1))^0,5)  
for A1=-3 ... A601=3

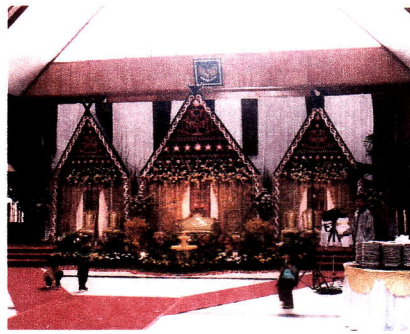


Picture 3: Sydney Opera House with skyline  
640 x 457 - 61k - jpg  
[www.travelsinparadise.com](http://www.travelsinparadise.com)

4. Function  $f(x) = \begin{cases} 2(1 - |x| \bmod 1), & \text{if } |x| < 1 \\ |x| \bmod 1, & \text{if } |x| < 2 \\ (1 - |x| \bmod 1), & \text{if } |x| < 3 \\ 0, & \text{for the others} \end{cases}$

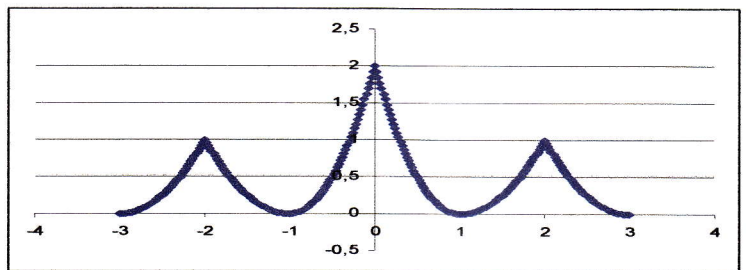


Graph 5: =IF(ABS(A1)<1;2\*(1-MOD(ABS(A1);1));  
IF(ABS(A1)<2;MOD(ABS(A1);1);  
IF(ABS(A1)<3;(1-MOD(ABS(A1);1));0)))  
for A1=-3 ... A601=3



Picture 4: Batak's wedding decoration  
737 x 586 - 94k - jpg  
[www.hj-dadangcatering.com](http://www.hj-dadangcatering.com)

5. Function  $f(x) = \begin{cases} 2(1 - |x| \bmod 1)^2, & \text{if } |x| < 1 \\ (|x| \bmod 1)^2, & \text{if } |x| < 2 \\ (1 - |x| \bmod 1)^2, & \text{if } |x| < 3 \\ 0, & \text{for the others} \end{cases}$



Graph 6: =IF(ABS(A1)<1;2\*(1-MOD(ABS(A1);1))^2;IF(ABS(A1)<2;MOD(ABS(A1);1)^2;  
IF(ABS(A1)<3;(1-MOD(ABS(A1);1))^2;0)))  
for A1=-3 ... A601=3

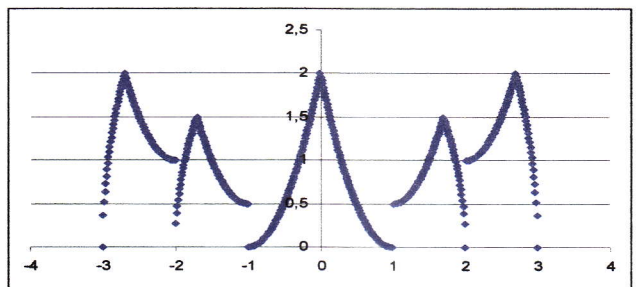




Picture 5: Aula Barat ITB  
800 x 600 - 388k - jpg  
kebebasan.wordpress.com

6. Function

$$f(x) = \begin{cases} 2 \cdot (1 - |x| \bmod 1)^2, & \text{if } |x| < 1 \\ 0,5 + (|x| \bmod 1 / 0,7)^2, & \text{if } 1 \leq |x| < 1,7 \\ 1,5 \sqrt{(1 - |x| \bmod 1) \times 10/3}, & \text{if } 1,7 \leq |x| < 2 \\ 1 + (|x| \bmod 1 / 0,7)^2, & \text{if } 2 \leq |x| < 2,7 \\ 2 \sqrt{(1 - |x| \bmod 1) \times 10/3}, & \text{if } 2,7 \leq |x| < 3 \\ 0, & \text{for the others} \end{cases}$$

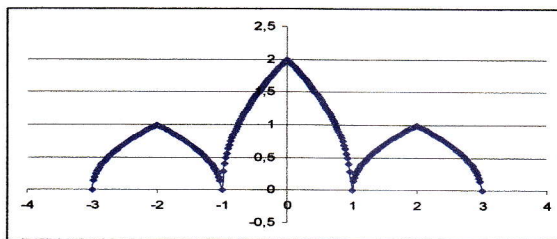


Graph 7: =IF(ABS(E1)<1;2\*(MOD(ABS(E1);1))^2;  
IF(ABS(E1)<1;7;0,5+(MOD(ABS(E1);1)/0,7)^2;  
IF(ABS(E1)<2;1,5\*(((1-MOD(ABS(E1);1))\*10/3)^0,5);  
IF(ABS(E1)<2,7;1+(MOD(ABS(E1);1)/0,7)^2;  
IF(ABS(E1)<3;2\*(((1-MOD(ABS(E1);1))\*10/3)^0,5);0))))  
for A1=-3 ... A601=3

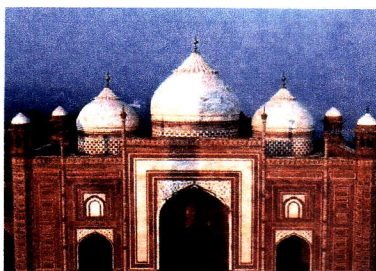


Picture 6: Rumah Gadang (Traditional Houses)  
648 x 486 - 101k - jpg  
www.elisasjourneys.com

7. Function  $f(x) = \begin{cases} 2(1 - \text{mod}(|x|,1))^{0,5}, & \text{if } |x| < 1 \\ \text{mod}(|x|,1)^{0,5}, & \text{if } |x| < 2 \\ (1 - \text{mod}(|x|,1))^{0,5}, & \text{if } |x| < 3 \\ 0, & \text{for the others} \end{cases}$



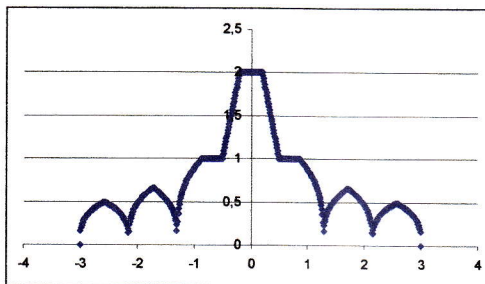
Graph 8: =IF(ABS(A1)<1;2\*(1-MOD(ABS(A1);1))^0,5;  
IF(ABS(A1)<2;MOD(ABS(A1);1)^0,5;  
IF(ABS(A1)<3;(1-MOD(ABS(A1);1))^0,5;0)))  
for A1=-3 ... A601=3



Picture 7: The Mosque or Masjid, which stands to, the west of the Taj Mahal  
492 x 344 - 23k - jpg  
[www.taj-mahal.net/common/MMIImages/mosque2.jpg](http://www.taj-mahal.net/common/MMIImages/mosque2.jpg)

Picture of Buliding

1. Function  $f(x) = \begin{cases} \left(2,0,5 - \frac{7}{6}x \text{ mod } 1\right)^{0,3}, & \text{if } |x| > \frac{6}{7} \\ 1 - \left[\frac{7}{6}\left(|x| + \frac{3}{7}\right)\right], & \text{if } |x| > 0,5 \\ 2 - \frac{10}{3}(0,2 - |x|), & \text{if } |x| > 0,2 \\ 2, & \text{for the others} \end{cases}$



Graph 9: =IF(ABS(A1)>6/7;2\*((2\*ABS(0,5-MOD(7/6\*(A1);1)))^0,3)/(1+INT(7/6\*(ABS(A1)+3/7)));  
IF(ABS(A1)>0,5;1; IF(ABS(A1)>0,2;2+10/3\*(0,2-ABS(A1));2)))

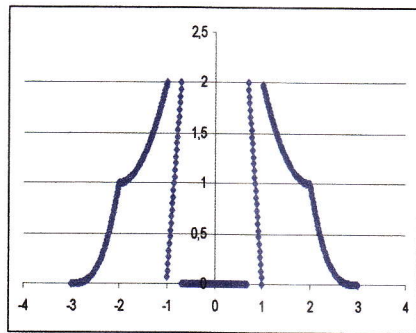
for A1=-3 ... A601=3



Picture 8: Borobudur Temple  
614 x 440 - 83k - jpg  
partisanturbine.w

**2.Function**

$$f(x) = \begin{cases} 0; & \text{if } |x| < 0,7 \text{ or } |x| = 3 \\ (1 - |x| \bmod 1)^3; & \text{if } |x| > 2 \\ 1 + (1 - |x| \bmod 1)^2; & \text{if } |x| > 1 \\ \frac{20}{3}(1 - |x|); & \text{for the others} \end{cases}$$

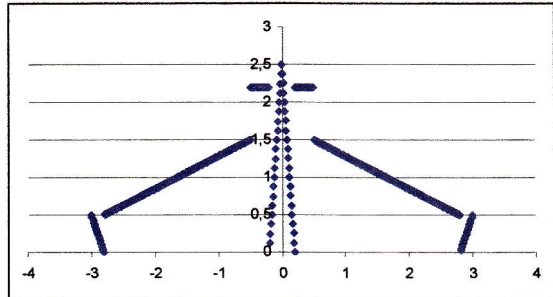


Graph 10: =IF(OR(ABS(A1)=3;ABS(A1)<0,699);0;IF(ABS(A1)>2;(1-MOD(ABS(A1);1))^3;IF(ABS(A1)>1;(1-MOD(ABS(A1);1))^2+1;20/3\*(1-ABS(A1))))))  
for A1=-3 ... A601=3



Picture 9: Gate of Wringin Lawang  
450 x 319 - 40k - jpg  
www.mojokerto.info

3. Function  $f(x) = \begin{cases} 2,5(1-5|x|), & \text{if } |x| < 0,2 \\ 2, & \text{if } 0,2 \leq |x| < 0,5 \\ 0,5 + (2,8 - |x|)/2,3; & \text{if } 0,2 \leq |x| < 0,5 \\ 2,5(|x - 2,8|) & \text{for the others} \end{cases}$

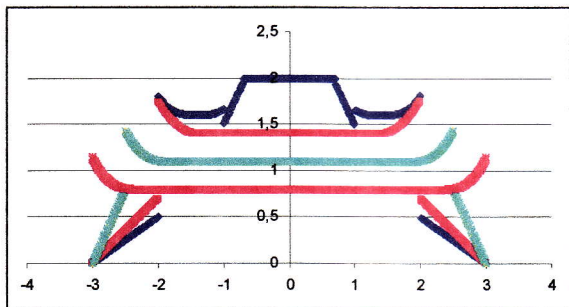


Graph 11:=IF(ABS(A1)<0,2;2,5\*(1-5\*(ABS(A1)));IF(ABS(A1)<0,5;2,2;  
IF(ABS(A1)<2,8;0,5+(2,8-ABS(A1))/2,3;2,5\*((ABS(A1)-2,8))))  
for A1=-3 ... A601=3



Picture 10: Katolik's Church it Rantau Parapat, Kabupaten Labuhan Batu  
1200 x 1600 - 294k  
jomelian.wordpress.com

4. United Four Functions:



Garphs 12:

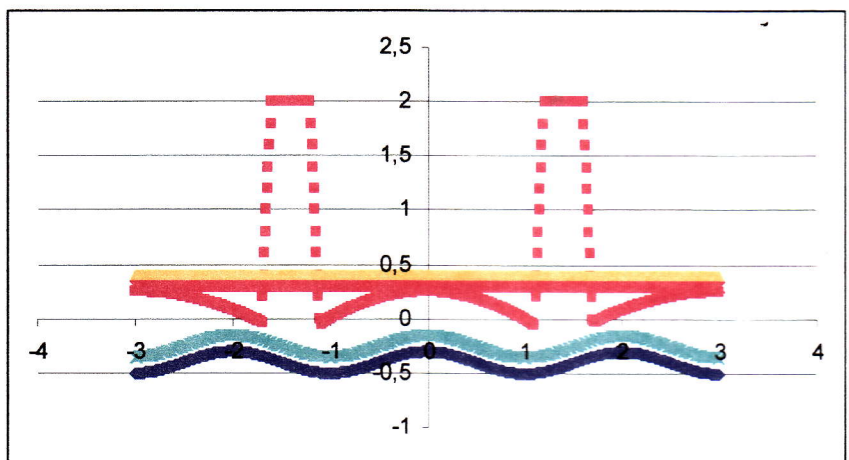
(1): =IF(ABS(A1)<0,7;2;IF(ABS(A1)<1;1,5+5\*(1-ABS(A1))\*0,3;  
IF(ABS(A1)<2;1,6+MOD(ABS(ABS(A1)-1,4);1)^3;0,5\*(3-ABS(A1))))))  
(2):=IF(ABS(A1)<1,4;1,4;IF(ABS(A1)<2;1,4+(ABS(A1)-1,4)^2;0,7\*(3-ABS(A1))))  
(3):=IF(ABS(A1)<1,4;1,4;IF(ABS(A1)<2;1,4+(ABS(A1)-1,4)^2;0,7\*(3-ABS(A1))))  
(4):=IF(ABS(A1)<2,3;0,8;0,8+(ABS(A1)-2,3)^3)  
for A1=-3 ... A601=3





Picture 11: Sam Poo Kong Temple  
448 x 336 - 31k - jpg  
winboy07.blogjurnalistikonlain.com

### 5. United Five Functions



Graphs 13:

$$(1): =-0,4+\text{COS}(A1*\text{PI}())/10$$

$$(2): =\text{IF}(\text{ABS}(A1)>1,7;(1,5-(\text{ABS}(A1)-3)^2)/6;\text{IF}(\text{ABS}(A1)>1,6;20*(1,7-\text{ABS}(A1))\text{IF}(\text{ABS}(A1)>1,2;2;\text{IF}(\text{ABS}(A1)>1,1;20*(\text{ABS}(A1)-1)-2;(1-A1^2)/4))))$$

$$(3): =0,4$$

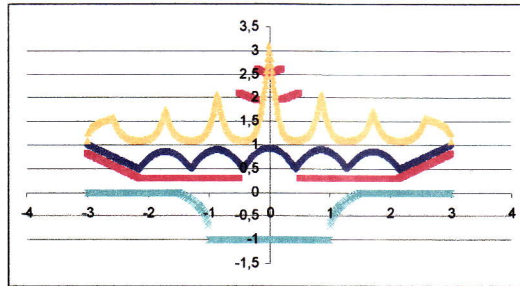
$$(4): =-0,25+\text{COS}(A1*\text{PI}())/10$$

$$(5): =0,3$$



Picture 12: Ampera Bridge in Palembang  
210 x 158 - 4k - jpg  
www.detiknews.com

## 6. United Four Functions



Graphs 14:

$$(1): =\text{IF}(\text{ABS}(A1)<3/7;2,4*(9/49-A1^2)+0,5;$$

$$\text{IF}(\text{ABS}(A1)<9/7;2,2*(9/49-(\text{ABS}(A1)-6/7)^2)+0,5;$$

$$\text{IF}(\text{ABS}(A1)<15/7;2*(9/49-(\text{ABS}(A1)-12/7)^2)+0,5;0,5+0,6*(\text{ABS}(A1)-15/7)))$$

$$(2): =\text{IF}(\text{ABS}(A1)<0,2;2,5+0,5*\text{ABS}(A1);$$

$$\text{IF}(\text{ABS}(A1)<0,5;2+0,5*(\text{ABS}(A1)-0,3);$$

$$\text{IF}(\text{ABS}(A1)<15/7;0,3;\text{B1}-0,2)))$$

$$(3): =\text{IF}(\text{ABS}(A1)<18/7;2*((2*\text{ABS}(0,5-$$

$$\text{MOD}(7/6*(A1);1))^3)/(1+\text{INT}(7/6*(\text{ABS}(A1)+3/7)))+1,1;2*((2*\text{ABS}(0,5-$$

$$\text{MOD}(7/6*(A1);1))^3)/(1+\text{INT}(7/6*(\text{ABS}(A1)+3/7))))^0,1/2+1,1)$$

$$(4): =\text{IF}(\text{ABS}(A1)<1;-1;\text{IF}(\text{ABS}(A1)<1,5;-1+((\text{ABS}(A1)-1)/0,5)^0,3;0))$$



Picture 13: SIGER TOWER, the Pride of Lampung Province

1280 x 960 - 100k - jpg

ima.dada.net/image/9099875.jpg

### Conclusion

Symetry plan geometric shape can be drawn with single or union of branched function. Excel Program makes drawing the graph easier than that manually.

### References:

- [1] Apostol, Tom M. 1967. *Calculus*. Volume 1, Second Edition. New York: John Wiley & Sons, Inc.
- [2] Bartle, Robert G. and Sherbert, Donald R. 1982. *Introduction to Real Analysis* New York: John Wiley & Sons, Inc.
- [3] <http://newtonexcelbach.wordpress.com/2008/11/11/drawing-in-excel-7-creating-drawings-from-coordinates/> ; Accessed: June 5<sup>th</sup> 2009