

Printing grids at the University of Southampton Print Centre

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The person to contact is:

Ian Wilcox - Design and Print Services manager
University of Southampton - The Print Centre
Unit 2 Itchen House | 186 Empress Road | Southampton | SO14 0JY
Telephone Unit : 023 8033 4645 | Telephone Mobile : 07958 136066

Ian has been very patient and helpful, and spent hours with me to achieve to obtain the best possible results. For a first contact, e-mail first.

The printer is a Canon Océ Arizona 1260 XT. It is a UV flatbed inkjet technology printer, and can print on surfaces as large as 2.51m (98.8") x 3.09m (121.6") on rigid substrates up to 50.8 mm (2.0") thick. The printer uses vacuum to secure media to the printer table.



The crucial point for fine grid printing is the resolution. The *nominal* ones are, depending on the printing quality selectable in the software:

'High' : H x V = 1058 x 902

'Fine Art' : H x V = 446 x 601

'Quality' : H x V = 446 x 451

'Express production' : H x V = 446 x 301

I used the 'Quality' one, as it was easier to have a grid of similar pitches along the H (x) and V (y) directions. Some tests have been made to print a high frequency grid having a period of 4 points (two points black, two points not printed), corresponding to $px = 0.227803$ mm and $py = 0.225277$ mm. A remaining periodic defect (one period being slightly different) appeared with a period of 80 mm along the x direction, leading to change the resolution from 446 DPI to 445.6825 according to the formula:

$$\Delta\text{DPI} = \pm \frac{d_0}{d}$$

where d is the defect period and $d_0 = 25.4$ mm. With $d = 80.$, one obtains 0.3175 DPI, and a test showed it had to be subtracted to the nominal value, hence the exotic value of 445.6825.

So the real printing resolution is:

445.6825 x 451

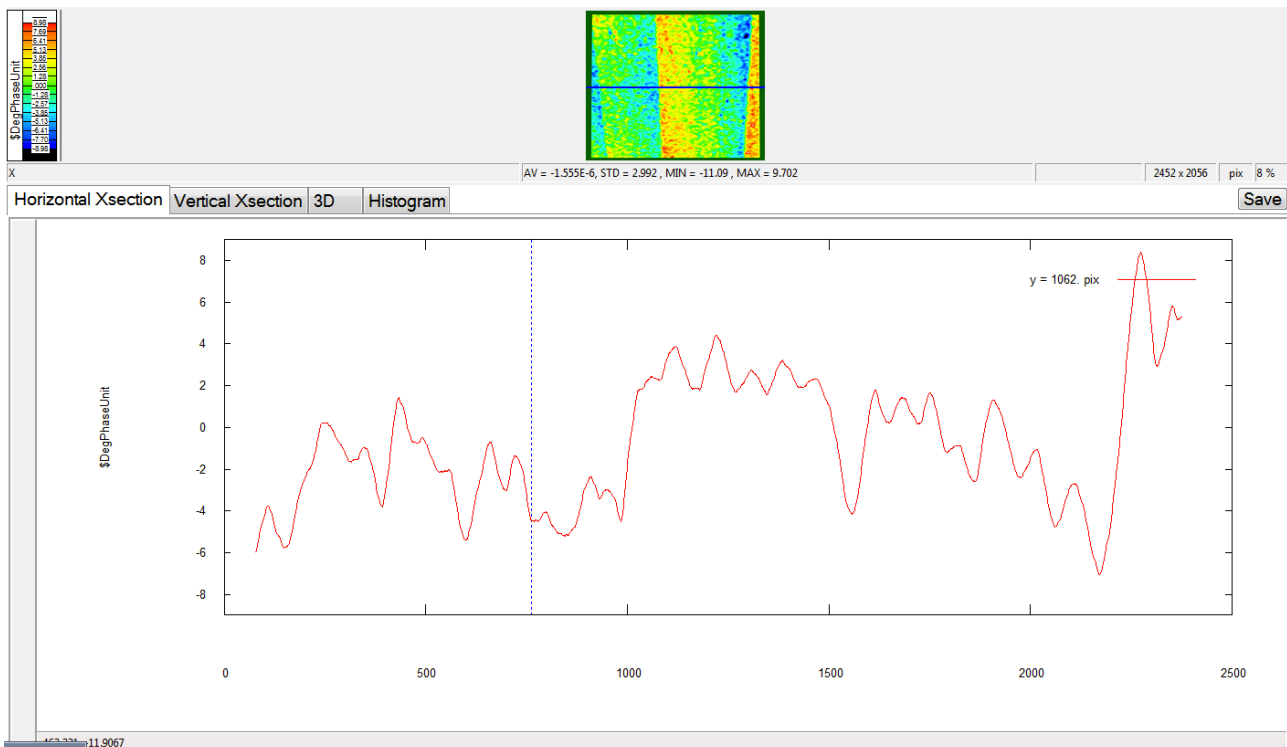
which allowed to print a 'perfect' grid of 0.22 mm, looking uniformly gray at some distance.

Please specify 'Quality' printing when ordering!

However, two technological features limit the printing quality:

-the inkjet technology which allows contactless printing has the drawback that the ink droplets trajectories in the air cannot be fully reproducible, leading to point position irregularities, apparently of the order of .1 mm. Observed with a magnifying glass, the pattern of dots of the .22 mm grid shows clearly these irregularities, and such a fine grid cannot be used practically without a very large phase noise. I would not recommend going below a 12-pt period grid, *i.e.* 0.68 mm.

-the asymmetry of the technologies for the movement of the printing head : alternating carriage movement of the printing head along a rail beam in the x direction, stepwise movement of the beam in the y direction. The printing head carries many nozzles and partially prints a band of approximately 25 mm at each pass. Three passes are necessary to print the band, so irregularities in the phase field appear with a period of about 25 mm. Here is what I obtained with a grid of 0.68 mm:



The phase jumps from zone to zone are about 8 degrees, which corresponds to 15 μm . For grid method applications, it makes it mandatory to process the phase fields in a way that takes into account the grid imperfections, as explained by M. Grédiac.

In this approach, the phase is no more considered as a ruler, but only as a marker, exactly as is the speckle pattern in DIC. So these irregularities are *not* an obstacle for using these printed grids for grid method experiments. (Actually, this goes against my previous comment about not using grids of periods below 0.6 mm... Maybe to be investigated and tested in real. A good student project...)

For direct printing on mechanical samples, I suggest to use a thick cardboard template (the kind that is used for wall calendars) and cut window(s) to place the sample(s) in. This template will both secure the sample position during printing, and ease the preparation of the printer bed suction. Indeed, the 2 m x 3 m vacuum bed is divided in zones that can be activated or not. However, even the smallest zones are much larger than A4, so the substrate to be printed has to be surrounded by extra material for the suction to operate properly. Having a large rectangular template will certainly ease the process. Best is probably to ask Ian Wilcox about the proper way to prepare this.

As the achievable x and y periods are different, I had to amend the PostScript file that generates the grid. Here is the one I used for the 12 pt grid, to be cut and pasted for your needs ; the relevant lines are outlined in blue :

```
%!PS-Adobe-2.0
%%Creator: Yves Surrel
%%Title: Grille A4 10 t/cm
%%Pages: 1
%%BoundingBox: 0 0 595 842
%%DocumentPaperSizes: A4
%%EndComments
%%BeginProlog
/GrilleDict 50 dict def
/str 20 string def

/fraction 72. def

GrilleDict begin
/cm % (S longueur_en_cm -- longueur_en_points )
{
    2.54 div fraction mul
} bind def

/printer_pt_to_PSptH { 1.0 resolutionH div fraction mul mul } bind def
/printer_pt_to_PSptV { 1.0 resolutionV div fraction mul mul } bind def

/pt_size_cmH { 2.54 resolutionH div } bind def
/pt_size_cmV { 2.54 resolutionV div } bind def

/half_pt_size_cmH { 1.27 resolutionH div } bind def
/half_pt_size_cmV { 1.27 resolutionV div } bind def

/adjustH % ( size_cm -- )
% Convertit size_cm en une longueur en cm
% correspondant à un nombre demi-entier de points de résolution
{
    pt_size_cmH div round pt_size_cmH mul % half_pt_size_cm add
} bind def

/adjustV % ( size_cm -- )
% Convertit size_cm en une longueur en cm
% correspondant à un nombre demi-entier de points de résolution
{
    pt_size_cmV div round pt_size_cmV mul % half_pt_size_cm add
} bind def
```

```

/PasH 0 def
/PasV 0 def
/Hauteur 0 def
/Largeur 0 def

/Negatif? false def
/Positif { /Negatif? false def } bind def
/Negatif { /Negatif? true def } bind def

/PrepareCouleur
{
  Negatif?
  {
    0 setcolor
    currentpoint Largeur Hauteur rectfill
    1 setcolor
  }
  {
    1 setcolor
    currentpoint Largeur Hauteur rectfill
    0 setcolor
  } ifelse
} bind def

/$GrilleVerticale % (S -- )
{
  PasH 2 div setlinewidth
  Largeur PasH div ceiling cvi 1 add
  {
    currentpoint
    0 Hauteur PasH div ceiling PasH mul rlineto
    exch PasH add exch moveto
  } repeat
  stroke
} bind def

/$GrilleHorizontale % ( -- )
{
  PasV 2 div setlinewidth
  currentlinewidth -2 div 0 rmoveto
  Hauteur PasV div ceiling cvi 1 add
  {
    currentpoint
    Largeur PasV div ceiling PasV mul currentlinewidth add 0 rlineto
    PasV add moveto
  } repeat
  stroke
} bind def

/Titre
{
  /Courier findfont 9 scalefont setfont
  0 -20 rmoveto
  (p_x = ) show
  PasH 72 div 25.4 mul str cvs show
  ( mm ; p_y = ) show
  PasV 72 div 25.4 mul str cvs show
  ( mm ; DPI = ) show
  resolutionH str cvs show
  ( (x) ) show
  resolutionV str cvs show
  ( (y) ; ) show
  pts_per_period str cvs show
  ( pts per period) show
}

```

```

} bind def

/GrilleVerticale % (S x y -- )
{
  /Hauteur exch def
  /Largeur exch def
  pts_per_period printer_pt_to_PSptV /PasV exch def
  gsave
  PrepareCouleur
  $GrilleVerticale
  grestore 0 setcolor Titre
} bind def

/GrilleHorizontale % (S x y -- )
{
  /Hauteur exch def
  /Largeur exch def
  pts_per_period printer_pt_to_PSptH /PasH exch def
  gsave
  PrepareCouleur
  $GrilleHorizontale
  grestore 0 setcolor Titre
} bind def

/GrilleCroisee % (S x y -- )
{
  /Hauteur exch def
  /Largeur exch def
  pts_per_period printer_pt_to_PSptH /PasH exch def
  pts_per_period printer_pt_to_PSptV /PasV exch def
  gsave
  PrepareCouleur
  gsave
  $GrilleVerticale
  grestore
  $GrilleHorizontale
  grestore 0 setcolor Titre
} bind def
end
%%EndProlog

%%BeginSetup
GrilleDict begin
%%BeginPaperSize: A4
%%EndPaperSize

%%Page: 1 1
a4

/resolutionH 446 .3175 sub def
/resolutionV 451 def
/pts_per_period 12 def

1 adjustH cm 1.7 adjustV cm moveto
gsave
Negatif

19 cm 27.5 cm GrilleCroisee
grestore

showpage
end
%%EOF

```

The most notable change is that the grid is now specified directly in points per period. Change the line `/pts_per_period 12 def` to fit your needs. The line with `negatif` can be commented out (with a percent sign) or not to obtain black dots on a white background or white dots on a black background.

The caption at the bottom of the printed grid has also been changed to be more informative. With the listed file, the printed caption is:

`p_x = 0.683895 mm ; p_y = 0.675831 mm ; DPI = 445.682 (x) 451 (y) ; 12 pts per period`