Fade Resistance. An overview.

To put it simply, confusion abounds. Anyone using ink jet printers to produce their work wants to know how long their precious print is going to last, but the user faces a minefield of information and conflicting opinion. There is currently no industry standard that all printer and ink manufacturers are required to uphold. Attempts to create one are still bogged down in administration and argument. The methodologies used to calculate fade resistance of ink jet prints varies dramatically from one manufacturer to another. The purpose of this document is to highlight the crucial ways in which these different methodologies can effect the figures and to also try and demystify the science involved. Throughout this document the methods and results published by Epson will be referred to. This is for no reason other than of all the printer manufacturers, Epson have placed the most emphasis on the fade resistance of their inks and have published the most data.

The basics.

All fade resistance tests have one thing in common. The printed targets are exposed to a light source many times more powerful than that found in an "average indoor display condition". The target then fades at an accelerated rate. The time taken for the target to fade at this accelerated rate is entered into an equation. This equation also contains the multiple of how much more powerful the target's light source is when compared to the average indoor display condition. From these two figures a predicted life span of a print is produced. The predicted life span describes how long that same target would have lasted if exposed to the average indoor display condition. The media (paper) that the target was printed on has an impact on the performance of the target as well as the ink used to print it. The ink and paper in combination provides the fade resistance, not the ink alone.
These accelerated fade tests are the only viable way for manufacturers to measure the performance of the product. After all, customers should not have to wait for ten years of real time testing to be told that their prints will last ten years.

How light intensity is measured.

Most figures are based on units called lux. One lux equals the total intensity of light that falls upon a one square metre surface that is positioned 1 metre away from a point of light equal to one candle power. The average indoor display condition is a light intensity of between 450 and 500 lux depending on whose specification is being used.

Points to make.

1. **Reciprocity**.

Take two targets printed with two different inks. One is exposed to a light

source of 15000 lux and lasts for x hours. Another target is exposed to a light source of 30000 lux and lasts the same amount of time. The target exposed to the more powerful light source is predicted to last longer than that exposed to the lower intensity source. But is it as simple as that? Many manufacturers and researchers do not believe so. They have found that in some cases a target will fade at the same rate for any light intensity above a certain level.

For example, what if a target exposed to a 70000 lux light source fades at the same rate as one exposed to a 40000 lux source. This phenomenon is called **reciprocity** as is particularly prevalent with pigmented inks. In fact, rather than light it has been shown to be atmospheric conditions such as humidity, pollutants, ozone, that will cause pigments to fade at a particular rate. These factors can be grouped together under the term “Gas Fading”. The logical way to measure the impact that gas fading will have on a target is to expose an identical target to a much lower intensity source and compare the results. The results are controversial. In tests conducted by one of the world’s largest printer and computer manufacturers, the predicted life of certain pigmented ink/ paper combinations was slashed. This brought the predicted life of certain pigment-based inks down to that of the dye-based ink equivalents. For example, Epson 2000P/ Epson Premium Photo Paper, Epson predict a life of 140 years. This figure is reduced to 30 years when reciprocity is taken into account, according to these independent tests.

Reciprocity is progressively more likely to effect life span predictions the more intense the light source is that is used in the test. It should be pointed out that Lyson test at a lux of 15000. The Wilhelm Institute, an independent testing facility currently uses 35000 lux. Epson test at 70000, nearly five times as powerful a source as that used by Lyson.

2. The impact of dilute inks.

It is a fact that the lower the concentration of dye present in an ink, the faster it will fade. It was because of this that Lyson led the way in doubling the strength of the dilute cyan and magenta inks in our six colour ink systems, to minimize this loss in fade resistance. In order for fade tests to be valid they must take into account the impact these dilute inks will have on the predicted life. Lyson measure the colours printed on a target at two different optical densities. For example, on a six-colour photo printer a colour such as magenta is measured at an optical density of 1.0, a high density where the full strength ink channel will be dominating, and 0.6, a lower density of colour which will be mostly printed with the dilute channel. As it is common for the dilute inks to fade more quickly than the full strength inks the optical density values measured from a starting point of 0.6 may fall more quickly. This obviously reduces the predicted display life of the print.

It should be pointed out that *Epson only measure optical density at 1.0.* This means that they do not take into account the impact of using dilute inks.

3. Discoloration.

When has a print faded? What happens to the colours of a print as it fades? These questions can either be addressed or ignored in fade tests. For example, a print on display for ten years may show discoloration, especially in the neutral tones so that in effect the print takes on a green or blue cast. The appearance of the print is obviously unacceptable. However, that same combination of ink and paper when tested did not show the 30% drop (Epson criteria) of the optical densities of the pure magenta, cyan or yellow that would have classed the target as faded until the target had been exposed for the equivalent of fifty years. This situation is entirely possible because inks interact with each other when printed in combination. This interaction can cause discoloration at a faster rate than a pure colour would fade. Everyone has their own level of awareness of colour change; everyone's eyes are different. Also, the discoloration could happen over such a slow rate that it might not be noticed until the same image is reprinted years later. With these factors in mind Lyson decided to account for discoloration in their testing methods. We used criteria similar to that set forward by Henry Wilhelm and the ANSI board whereby the cyan, magenta and yellow content in a compound grey tone was measured and the changes over time calculated as a percentage. These grey tones were again measured at both 0.6 and 1.0 optical densities. As can be seen with the results posted on this site the printed target was judged to have faded because of discoloration in just over half of the tests performed. This means that if Epson test criteria were followed and discoloration was discounted, more than half of the life span predictions on our web site would be higher than those figures already quoted.
Epson carry this on their website:
"The estimated longevity does not indicate the colour changing and the durability of the paper itself". This is certainly the case.

4. Guarantees.

There are no guarantees of fade resistance issued by any of the manufacturers of photo quality printers. For example, Epson carry these quotes on their website.
"The data is calculated by EPSON's accelerated test and does not mean EPSON guarantees periods"
For this reason the fade resistance figures issued by anyone, Epson, Canon, Lyson, HP, should only be taken as guidelines. It is the criteria used to calculate these guidelines that this document has attempted to explain. Knowledge of how these figures are calculated helps the user make their own decision as to how reliable they think those figures are. Lyson have attempted to be as stringent and scientific as possible when issuing the figures posted on this web site, and we have followed the latest developments in this new science closely. We will shortly be issuing life span figures based on comparisons between our own ink/paper combinations and those of Epson and Canon, using Epson and Canon

life span predictions as a base line rather than the methodologies described above. Keep watching our web site for further details.