Appendix G "Synchronous detection" - summing data relative to installation

As we saw earlier (App. B) installation **of cameras over many years seems at first glance to make analysis difficult** because the cameras' effects, also distributed over many years, **are not visible.**

But in reality staggered installation is very helpful because it allows the use of the "*synchronous detection*" principle, familiar to generations of electronic signal engineers - and in practice to everyone, whether they realise it or not:

- the wheels of speeding stagecoaches appear stationary **if the spokes are in the same position each time the camera shutter opens**
- if a film projector stops the **previously clear picture deteriorates markedly because we can now see the "grain" of the film material that our brains ignored when it is different in successive frames.**
- an electronic signal on an oscilloscope screen **is displayed clearly when its frequency matches the oscilloscope's repetition rate but is virtually invisible otherwise.** Hence changing that rate allows us to choose – "tune in to" - whichever signal we wish to see, while all others virtually disappear.

There is nothing new or particularly clever about this!

Statisticians may struggle to differentiate camera effects from a handful of confounding factors but that task **seems trivial to electronic signal engineers** who have, for many decades differentiated **wanted signals from tens or hundreds of unwanted ones, even when the latter are far larger!**

One of their methods uses the above principle as the above examples - that **we see clearly what is constant, but hardly notice what is always changing.**

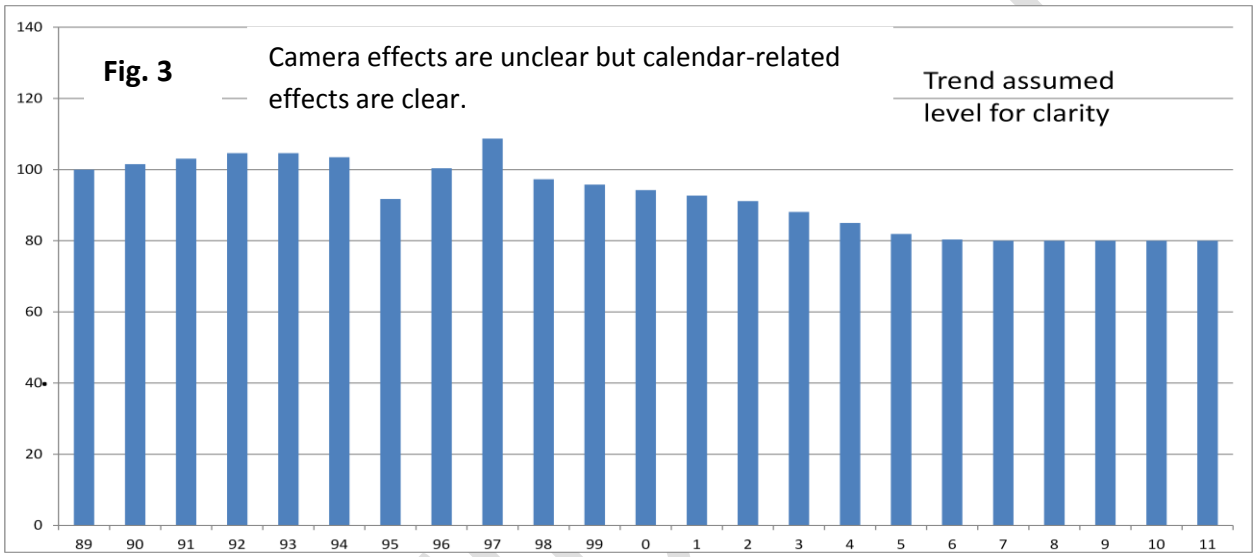
The next graphs show how, **when collision data is summed relative to camera installation dates instead of by the calendar, the post-installation effects we need to measure are all aligned properly to sum correctly but all other effects unrelated to cameras are misaligned and so reduced by more than 90%.**

Importantly also, as RTM must by definition end before installation and cameras have no effect until installed, **collisions in the installation month are bound to be very close to normal for those sites.**

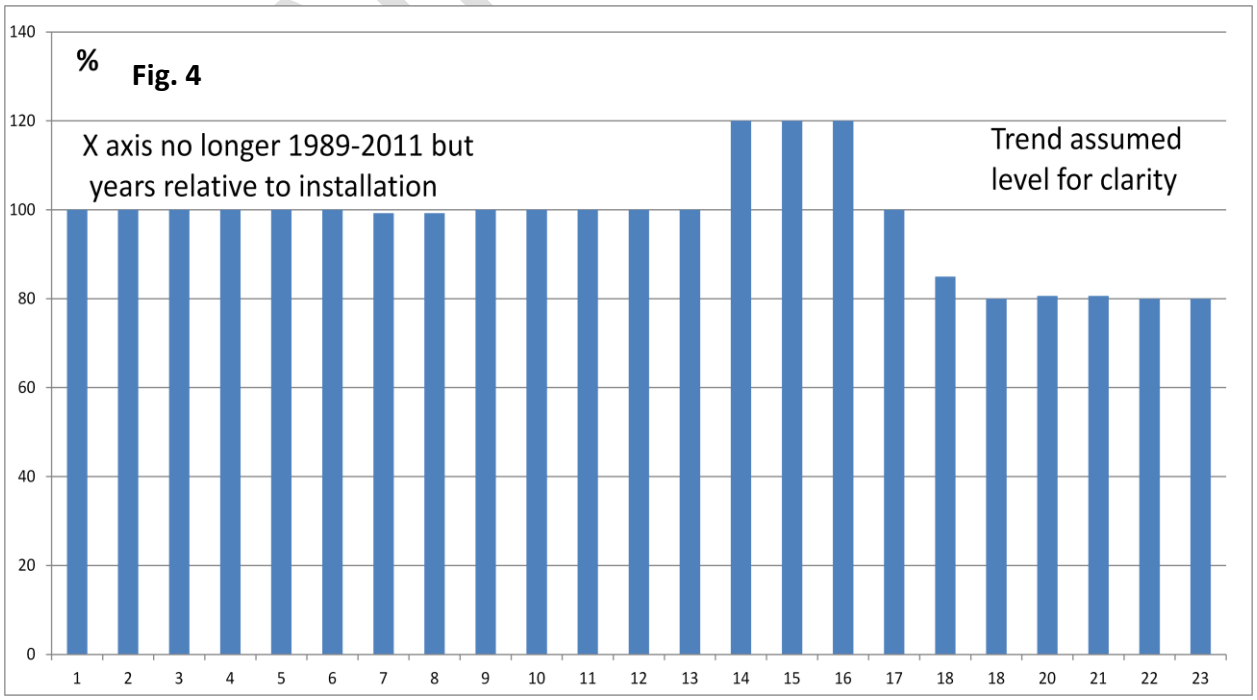
Yes, it really is that simple! So now let's see how and why it works:

Summing data by calendar year masks camera effects

We saw in App. B how summing by calendar year data for large numbers of cameras installed at different times and with different delays between the end of the site selection period and installation leads to graphs like Fig.18 below in which it is impossible to identify any camera effects, though effects like deviations in area collision rates year-on-year remain clear:



But when <u>precisely the same data</u> is summed relative to installation, it is the **camera effects that are clear while all other effects almost disappear, only very small differences being visible:**



The reason for this – the *synchronous detection principle* – is that **the camera effects all now occur at the same positions long the X axis of the graph while all other effects, not related to camera installation, <u>are distributed along the X axis</u> and thereby averaged out to trivial levels.**

If, for example, **12 cameras were installed at a rate of 1 per year and collisions at their sites were summed relative to their installation dates, all other effects would be distributed over 12 years and reduced by 12:1 or 92% i.e. to trivial levels.**

Note however that **because SSB and RTM falls occur at different times relative to installation due to differing installation delays, graphs of <u>real</u> data would show SSB spread over more than the 3 years of Fig. 3.** But this is not a problem because **the analysis does not need to quantify SSB or RTM as they cannot affect post-installation data.**

<u>Summing data relative to installation dates also averages-out trends</u>

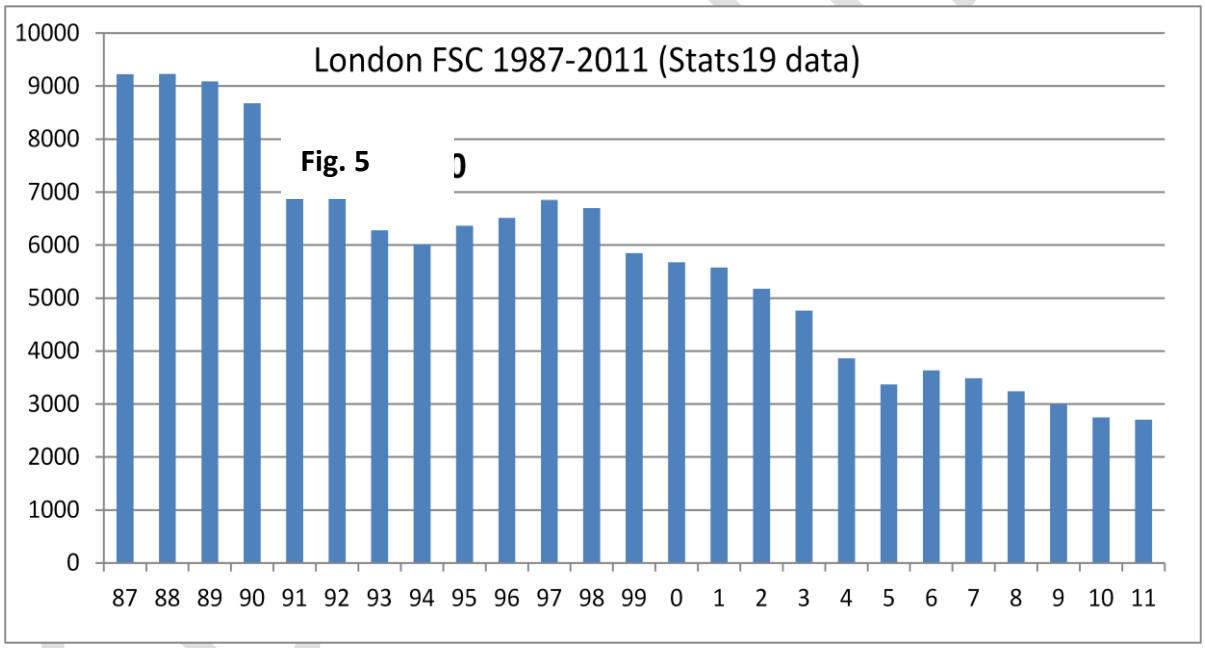


Fig. 5

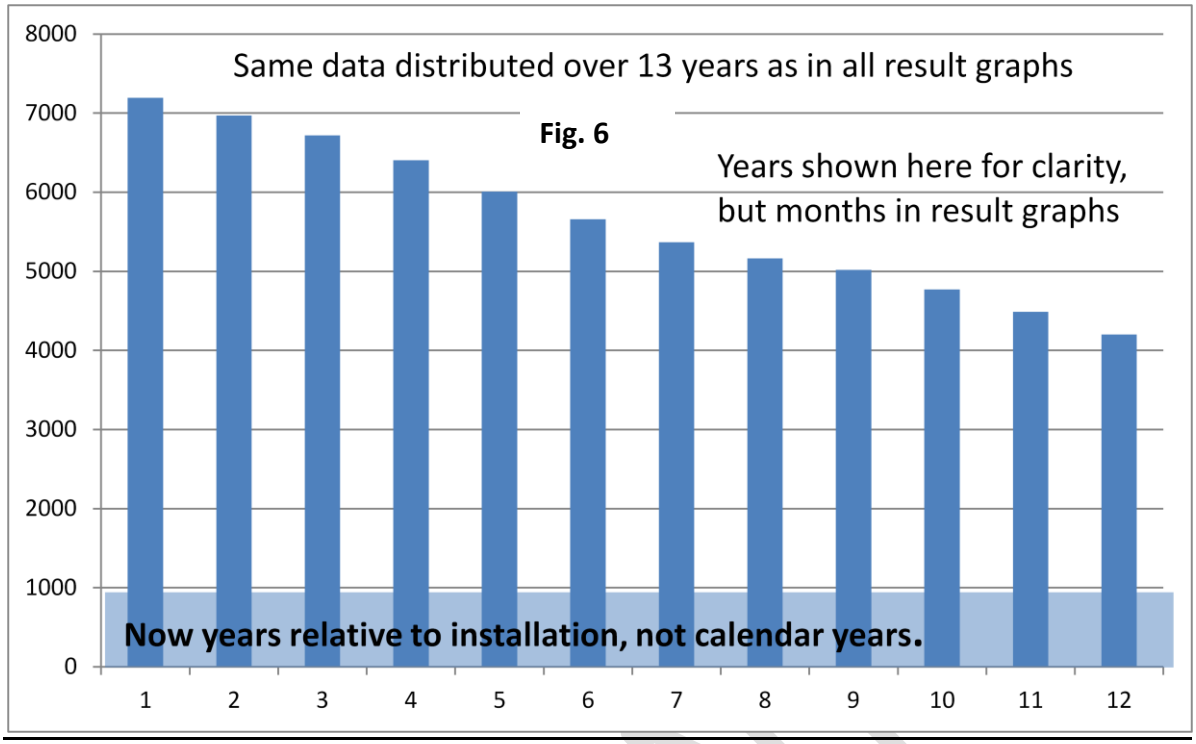


Fig. 6

Even the large deviations from trend in 1987-2011 are almost entirely eliminated. The same applies to short-term trends, random, localised or seasonal variations.

This is important because **the trivial deviations that remain cannot cause any significant and/or rapid deviations in the graphs of results**. **Any such deviations that are visible must therefore be due only due to the presence of the cameras.**

end