To Professional/Technical Writing Students at USF-SM: This article demonstrates the real-world value of precise and accurate language in technical communications. Note in particular the term “spec exaggeration” as applied to the iPhone and many other high-tech products. -- T. Roberts, Instructor

Does the iPhone 4 Really Have a "Retina Display"? (Updated)

A display expert chimes in on Apple's claims and finds that, though the display is undoubtedly excellent, its claims might be a little exaggerated.

Jason Cross, PC World / Friday, June 11, 2010 09:40 AM PDT

Dr. Raymond Soneira runs DisplayMate Technologies, which makes software to test display quality. He has a PhD in Theoretical Physics from Princeton University, and was a Long-Term Member of the Einstein Institute for Advanced Study in Princeton. (Read Dr. Soneira's Bio.) He also knows more about digital displays than just about anyone I know - and I know some pretty tech-savvy folks. This morning, Dr. Soneira shot me an interesting email regarding the so-called "Retina Display" of the iPhone 4. To clarify: a retina display is one whose resolution meets or exceeds the maximum resolution the human retina is capable of resolving, assuming perfect vision.

This is a bit tricky, since the eye doesn't have "pixels" and the resolution required to match the human eye's capability depends on the distance from your eye to the display. If you sit four feet away from a 50" 1080p television, you'll see pixels. If you sit 100 feet away, you won't. The distance between any two visual elements is a matter of how many pixels per "arc degree" of vision it covers. Dr. Soniera's email, in full and unedited, is as follows.

The iPhone 4 has an outstanding display... and I'm glad that Apple resisted the emotional rush to OLEDs because they still need lots of improvement before they will be ready to compete with the highly refined IPS LCDs. The iPhone 4 display should be comparable to the outstanding IPS LCD in the Motorola Droid, which I tested and compared to the Nexus One OLED, which was trounced by the Droid.

Steve Jobs claimed that the iPhone 4 has a resolution higher than the retina - that's not right:

1. The resolution of the retina is in angular measure - it's 50 Cycles Per Degree. A cycle is a line pair, which is two pixels, so the angular resolution of the eye is 0.6 arc minutes per pixel.

2. So if you hold an iPhone at the typical 12 inches from your eyes, that works out to 477 pixels per inch. At 8 inches it's 716 ppi. You have to hold it out 18 inches before it falls to 318 ppi.

So the iPhone has significantly lower resolution than the retina. It actually needs a resolution significantly higher than the retina in order to deliver an image that appears perfect to the retina.

It's a great display, most likely the best mobile display in production (and I can't wait to test it) but this is another example of spec exaggeration.

So there you have it - some math from a display expert showing that, while the iPhone 4's display is certainly exciting and probably represents a step forward for smartphones, it may fall short of Apple's claims of meeting or exceeding the resolution of the human retina.

Update 06/11/10: Dr. Soneira sent us some additional information, clarifying some of the misconceptions flowing around in comments and on other sites. He wishes to stress that his comments do *not* mean that he thinks the iPhone 4 display (or the phone itself) is bad. On the contrary, he thinks the display seems like a significant step forward. Dr. Soneira's comments are only regarding the claim Steve Jobs made of 300 pixels per inch being all that the retina can distinguish at a distance of "10 to 12 inches." Dr. Soneira's update is as follows

The iPhone 4 is actually very far from a retina display. It's a substantial discrepancy and not even close: At 12 inches the 1 dimensional linear difference is 326/477 = 68 percent. But the pixel (area) density for two dimensions, which is the actual relevant observable, is that value squared = 0.47, so the iPhone 4 is more than a factor of two from being a retina display at the typical 12 inch viewing distance. Stated another way: The iPhone display would need to have 1.3 megapixels instead of 0.6 megapixels to be a retina display.

There have been some comments that my analysis is for perfect vision. Jobs' statement is for the *retina* not the *eye* with a poor lens. If you allow poor vision to enter into the specs then any display becomes a retina display. That turns it into a meaningless concept that will be exploited by everyone. The iPhone 3GS is a retina display too for good percentage of the population.

Specs need to be objective, precise and accurate. Allowing puffery and exaggerations in the sales and marketing starts a snowballing effect that eventually leads to the 1000% rampant spec abuse that I document for many other displays. (Highlighting added by T. Roberts)