14.x”W Aspect Ratio Alternatives

by

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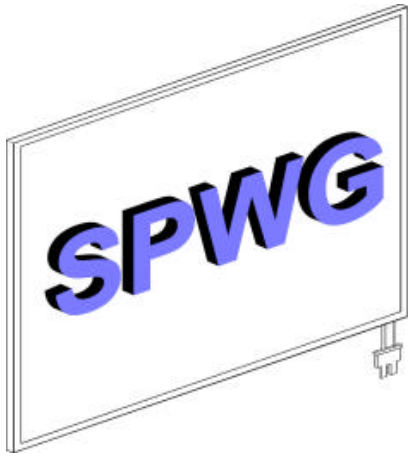
November 20, 2004



This presentation is offered in response to a recent document prepared by Hewlett-Packard. The HP presentation claims certain advantages related to 14.0”W panels (15:9 aspect ratio) in comparison to the SPWG’s recommendation of 14.1”W panels (16:10 aspect ratio).

- **Current production**
- **Match of panel format to others in common use**
- **Fab utilization/match to motherglass sizes**
- **Impacts on yield/cost**

14.0”W (15:9) vs. 14.1”W (16:10)

HP input: The title of HP’s presentation is:

14.0” vs. 14.1” for widescreen NB LCD panels

SPWG commentary: We believe the HP commentary is offered as a justification for their decision to implement a 14.0”W solution and does very little to actually compare the two formats.

As SPWG coordinators, we have no personal or professional reasons to favor one format vs. another (14.0”W 15:9 vs. 14.1”W 16:10). Our analysis is based only on a comparative examination of the facts, as we know them.

Most casual readers of the HP presentation would conclude that 14.0”W (15:9) panels are a better choice than 14.1”W (16:10) panels. Through careful wording and omission, however, we believe that HP’s presentation is little more than “spin” to justify their own decisions and is not aimed at the best interests of the notebook PC market as a whole.

We believe a careful comparison of the two alternatives leads to an inevitable conclusion that the 14.1” solution is the better choice, and so we offer it as our recommendation for industry standardization.

14.0”W (15:9) vs. 14.1”W (16:10)

SPWG commentary: We offer a few comparative facts:

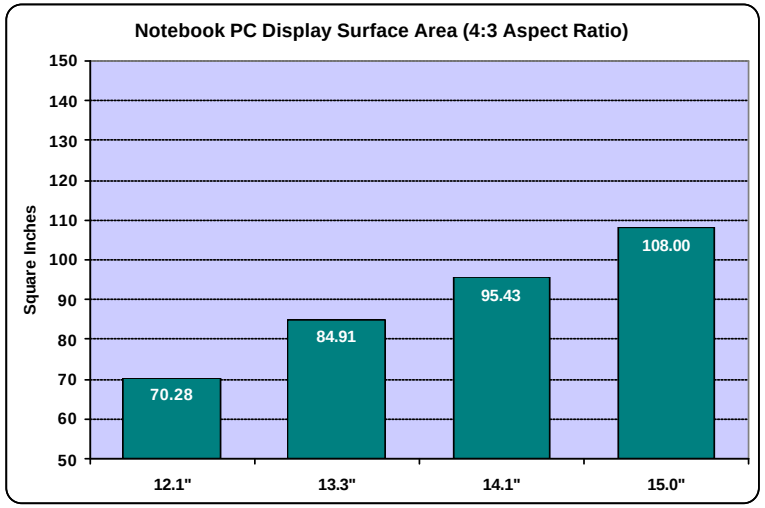
			14.1”W Advantages
Diagonal Size	**14.0”**	**14.1”**	**14.1” is slightly larger**
Pixel Format	**1280x768**	**1280x800**	**1280x800 is upgradeable**
Aspect Ratio	**15:9**	**16:10**	**16:10 is the PC industry standard**
Pixel Count	**983,040**	**1,024,000**	**Achieving 1 megapixel is a good marketing tool**
Pixel Density	**106.6 ppi**	**107.1 ppi**	**Slightly higher image quality**
Surface Area	**86.47 sq. in.**	**89.35 sq. in.**	**3.3% larger surface area**

The history of the notebook PC industry clearly tells us that when it comes to displays, it is much easier to “sell large”. In every case, the 14.1”W solution provides a “sell large” marketing advantage over the 14.0”W offering.

14.0”W (15:9) vs. 14.1”W (16:10)

SPWG commentary: While there are many inter-related factors associated with panel size “success,” one of the simplest is to consider the total surface area of the panel. Notebook PC makers seek differentiation, but history tells us that when it comes to panels, it’s difficult to establish a differentiable position. Consider the example of notebook PCs with 4:3 aspect ratios, where it’s important to note that 13.3” panels are essentially distinct, unable to differentiate between 12.1” and 14.1” offerings.

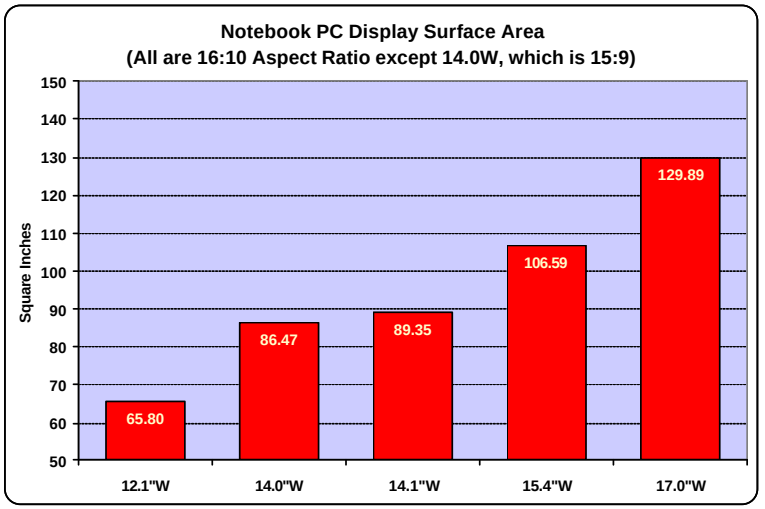
12.1”	4:3	70.28 sq in
13.3”	4:3	84.91 sq in
14.1”	4:3	95.43 sq in
15.0”	4:3	108.00 sq in



14.0”W (15:9) vs. 14.1”W (16:10)

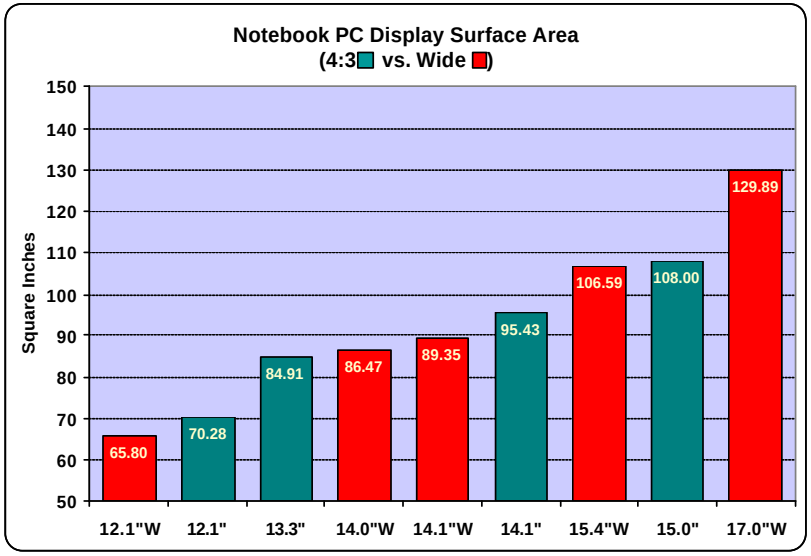
SPWG commentary: Considering the 4:3 market for notebook PCs could sustain only 3 differentiated panel sizes, in combination with the substantial growth of both 15.4”W and 17.0”W panels, there seems to be a reasonable “fit” in the market for the 14.x” panels.

12.1” W	16:10	65.80 sq in
14.0” W	15:9	86.47 sq in
14.1” W	16:10	89.35 sq in
15.4” W	16:10	106.59 sq in
17.0” W	16:10	129.89 sq in



14.0”W (15:9) vs. 14.1”W (16:10)

SPWG commentary: If indeed there is space for a 14.x”W panel, we believe that the sustained historical trend towards larger and larger sizes suggests that the 14.1”W solution is the better choice. The 14.0”W solution is actually more closely related in size to the “extinct” 13.3” solution than to a 14.1” solution. We believe that the 14.1”W (16:10) solution “fits” better into the total array of panels:



Positioning 14.x”W in the Market

SPWG commentary (continued): Clearly indicative of the difficulty in defining a differentiated position for 14.1”W products is HP’s own product offering. On November 17, 2004, among it’s many models and configurations, HP’s website offered “equivalent configurations”, except for the display, as follows:

		
Model	**HP dv1000**	**HP zv5000z**
Display	**14.0” 1280x768**	**15.4” 1280x800**
CPU	**1.8Ghz**	**1.8GHz**
Memory	**512MB**	**512MB**
HDD	**60GB**	**60GB**
Communications	**54g 802.11b/g WLAN**	**54g 802.11b/g WLAN**
Removable Storage	**8X DVD**	**8X DVD**
All Other Options	**Same or Standard**	**Same or Standard**
Price	**$1249**	**$1149**

“Reducing” Size Doesn’t Work

SPWG commentary: One clear lesson from history is that attempts to introduce new display formats require larger diagonal measurements than the existing solution.

- **STN LCD manufactures attempted to introduce 13.0” (1024x768) displays to be used as an alternative to 13.3” TFT LCD (1024x768). The effort failed.**
- **IBM introduced 13.7” (1280x1024) panels as a high resolution alternative to 14.1” (1024x768). The effort was not successful.**
- **10.0”W panels were introduced in a minor attempt to displace 10.4” (1280x600) panels (800x600). The effort failed.**

No doubt other factors contributed to the causes for these unsuccessful efforts, but still, we cannot think of an example when a panel with a smaller diagonal measurement successfully displaced a larger incumbent. We suspect that 14.0”W panels will face the same dilemma, particularly when a 14.1”W panel is also available.

Current and Planned Production

HP input: "A survey of manufacturers at FPD International (Yokohama, Oct. 2004) showed nearly all in production on, or at least demoing, the 14.0" wide NB panel type... No 14.1W seen!… Others known to have 14.0 on roadmap."

SPWG commentary: HP's input is correct, so far as it goes, but it fails to mention that several LCD makers have plans to introduce 14.1"W panels (16:10 aspect ratio) in the coming months. After carefully evaluating the two alternatives, the SPWG coordinators are recommending the adoption of a 14.1"W solution as a standard solution for notebook PCs.

We note from history that the first launch of a display format has not necessarily defined the "standard" solution. For example, Apple launched the first notebook PCs with a wide aspect ratio, (15.2" at a 15:10 aspect ratio). NEC later introduced 15.3" panels at a 15:9 aspect ratio. The "industry standard" form factor, however, is the late-comer to the market -- 15.4" panels at a 16:10 form factor.

Match of Panel Format to Others in Common Use

HP input: "15:9 format is a better match to HDTV imagery than 16:10

- **Smaller "black bars" for a letterboxed 1280 x 720 16:9 image (24 pixels above and below, vs. 40)"**

SPWG commentary: We recognize the argument that 15:9 is a better match for HDTV than 16:10. In fact, if the SPWG were helping to establish standards for the portable HDTV market, we might suggest a 15:9 aspect ratio (although we suppose that a 16:9 aspect ratio better supports HDTV signals).

The SPWG, however, is not focused on portable HDTV devices, but rather on the displays used in notebook PCs, where there are many other factors in addition to HDTV that must be considered.

Match of Panel Format to Others in Common Use

HP input: "15:9 format is a better match to HDTV imagery than 16:10

- **Slightly larger image"**

SPWG commentary: It's true that a 16:9 HDTV image is slightly larger on a 14.0"W (15:9) display than on a 14.1"W (16:10) display. For all other typical uses of a notebook PC, however, the 14.1"W solution provides a better utilization of a full-screen image. (Note that a high percentage of PC users frequently keep multiple windows open at less than full-screen, so such analysis is not particularly meaningful one way or another).

It's important to remember that no aspect ratio fully satisfies all the existing media. The 16:10 solution is a compromise solution between numerous media possibilities, and has emerged as the standard for computer applications, in large part due to the strength of that compromise.

Match of Panel Format to Others in Common Use

SPWG commentary (continued): Here we calculate and compare the diagonal measurement of several different media (when viewed full-screen):

Diagonal Measurements of Different Media on 14.x"W Displays

	Media	14.0"W 1280x768	14.1"W 1280x800	14.1"W Advantage
16:9 image	HDTV	13.77"	13.72"	-0.3%
4:3 image	NTSC/PAL, PowerPoint, etc.	12.00"	12.46"	+3.8%
3:2 image	e-Book, DVD	12.98"	13.47"	+3.8%
2 side-by-side pages	Word, Acrobat, (with typical toolbars)	11.30"	11.80"	+4.4%

Match of Panel Format to Others in Common Use

SPWG commentary (continued): Here we calculate and compare the viewable surface area of several different media (when viewed full-screen):

Viewable Surface Area of Different Media on 14.x"W Displays

	Media	14.0"W 1280x768	14.1"W 1280x800	14.1"W Advantage
16:9 image	HDTV	81.00	80.41	-0.7%
4:3 image	NTSC/PAL, PowerPoint, etc.	69.12	74.48	+7.8%
3:2 image	e-Book, DVD	77.76	83.74	+7.7%
2 side-by-side pages	Word, Acrobat, (with typical toolbars)	58.19	62.95	+8.2%

(square inches)

Match of Panel Format to Others in Common Use

HP input: "1280 x 768 is a better match to the existing XGA 4:3 format (also 768 lines) than 1280 x 800, which does not match any other standard format in line count".

SPWG commentary: It's not clear what advantages, if any, accrue by being "a better match to the existing XGA 4:3 format"…

We believe that a 16:10 format is consistent with the majority of widescreen displays in the computer industry, (both notebooks PCs and LCD monitors).

For notebook PCs, we note the following 16:10 widescreen panels are currently shipping in mass volumes, (many of them by HP), with already defined industry-wide standards:

12.1"W	**1280x800**
15.4"W	**1280x800, 1680x1050, 1920x1200**
17.0"W	**1440x900, 1680x1050, 1920x1200**

For 15:9 solutions in the notebook PC market, we are aware of only 10.6"W panels (1280x768) currently shipping in limited volumes, with no industry-wide standardization.

Match of Panel Format to Others in Common Use

SPWG commentary: With the 16:10 format already common in the computer industry (both for notebook PCs and LCD monitors), we note that 1280x800 format is also easier on the entire industry since all applications and drivers (and updates) have been established for the 1280x800 displays used in 12.1”W and 15.4”W systems.

The importance of this observation can be quickly understood when considering driver support for such peripheral devices as projectors.

Match of Panel Format to Others in Common Use

HP input: "All video frequencies somewhat lower for 1280 x 768 vs. 1280 x 800 at a given refresh rate. Example: At 60 Hz, CVT timing standard:

-- 1280 x 768: 79.5 MHz pixel clock

-- 1280 x 800: 83.5 MHz pixel clock

SPWG commentary: We believe that the typical video controller and LVDS interface used in notebook PCs can handle such minor differences without any measurable impact on performance, production yield, or system cost.

While there is arguably some correlation to lower power consumption and lower clock rates, this is not as significant as the ratio of clock speeds in use. It's very difficult to draw any conclusions in this area – such that 14.0" (1280x768) and 14.0" (1280x800) are essentially indistinguishable in terms of display performance.

Motherglass Utilization

HP input: "In all 20 known mother glass sizes from Gen 1 to Gen 6, the 14.0" panel is equal to or better than the 14.1".

MG size	Panels/MG		MG size	Panels/MG	
	14.0W	14.1W		14.0W	14.1W
300 x 350	1	1	620 x 750	6	4/6*
320 x 400	1	1	650 x 830	8	8
360 x 465	2	2	680 x 880	8	8
370 x 470	2	2	730 x 920	8	8
400 x 500	2	2	1000 x 1200	18	15
550 x 650	4	4	1100 x 1250	18	18
550 x 670	4	4	1100 x 1300	20	20
590 x 670	4	4	1200 x 1300	24	20
600 x 720	4/6*	4	1500 x 1800	36	35
610 x 720	6	4	1500 x 1850	36	36

Assumes handling borders of 5 mm, display borders of 6 mm, and a 2 mm scribe alley.
Results identified by asterisk are with borders reduced by 1 mm (others do not change with this reduction)

Motherglass Utilization

SPWG commentary: Fab optimization calculators are heavily dependent on the production and design capabilities associated with each fab, (glass and color filter supplier, glass thickness, LC fill method, scribe processes, etc). Using a single calculator and/or a single set of margin assumptions to determine optimization results will always be an approximation of actual outputs.

We used two different optimization calculators, and after considerable experimentation associated with the handling margins cited by HP, we were able to duplicate the HP results. We note, however, that other assumptions result in somewhat different results that are somewhat less favorable results for 14.0”W panels than suggested by HP.

For purposes of this report, however, we will use the HP results, as they serve adequately to support our recommendation to standardize on 14.1”W (16:10) panels.

Motherglass Utilization

SPWG commentary (continued): Of the 20 fab sizes listed in HP's report, we count a total of 60 active fabs. HP's report claims optimization advantages for 14.0"W (15:9) panels for 5 of the fab sizes -- at 610x720, 620x750, 1000x1200, 1200x1300, and 1500x1800. By our count, of the 60 active fabs, only 9 of them are supposedly optimized to manufacture 14.0"W (15:9) panels.

HP's report goes on to suggest that the other 15 fab sizes they list are "equal to" the optimization for 14.1"W panels (16:10). HP's analysis, however, does not fully consider the notion of "optimization".

Optimization should also consider glass utilization. In the following chart, we show calculated figures for how efficiently each fab utilizes the motherglass – as based on the HP calculations for the number of cuts. In other words, for 51 of the 60 fabs, 14.1"W (16:10) represent better utilization of the motherglass.

Motherglass Utilization

SPWG commentary (continued): The vast majority of fab sizes are better utilized when building 14.1”W panels.

MG size	Panels/MG		MG size	Panels/MG	
	14.0W	14.1W		14.0W	14.1W
300 x 350	1 (63.4%)	**1 (65.3%)**	620 x 750	6 (87.7%)	4 (59.9%)
320 x 400	1 (52.0%)	**1 (53.6%)**	650 x 830	8 (102.1%)	**8 (105.1%)**
360 x 465	2 (80.3%)	**2 (82.7%)**	680 x 880	8 (92.1%)	**8 (94.7%)**
370 x 470	2 (77.3%)	**2 (79.6%)**	730 x 920	8 (82.1%)	**8 (84.4%)**
400 x 500	2 (67.2%)	**2 (69.2%)**	1000 x 1200	18 (105.9%)	15 (89.9%)
550 x 650	4 (75.6%)	**4 (77.9%)**	1100 x 1250	18 (92.4%)	**18 (95.1%)**
550 x 670	4 (73.4%)	**4 (75.5%)**	1100 x 1300	20 (98.1%)	**20 100.9%)**
590 x 670	4 (68.4%)	**4 (70.4%)**	1200 x 1300	24 (108.5%)	20 (92.5%)
600 x 720	4 (62.6%)	**4 (64.4%)**	1500 x 1800	36 (97.4%)	35 (95.5%)
610 x 720	6 (92.9%)	4 (63.4%)	1500 x 1850	36 (94.7%)	**36 (95.9%)**

Listed percentages represent the portion of the motherglass utilized, given HP’s handling margin assumptions. As a practical matter, percentages > 100% and < 80% are very unlikely to be produced on these fabs.

Motherglass Utilization

SPWG commentary (continued): Many of the fabs listed by HP are extremely unlikely to ever produce panels in the 14.x”W category.

1). We are doubtful that Gen 1 or Gen 2 fabs will produce such panels (17 of the 60 fabs). Small size fabs are much better suited to make smaller sized panels.

2). We are also doubtful that Gen 5 or Gen 6 fabs will produce such panels, (12 of the 60 fabs). Larger size fabs are much better suited to make larger sized panels. We note that Gen 5 fabs may build 14.x”W in the future…

3). We also believe that fabs with motherglass utilization calculations of >100% or <80% are very unlikely to produce panels, as these fabs are better utilized building other panel sizes.

These general observations currently hold true for virtually all TFT LCDs currently manufactured for the notebook PC market.

Motherglass Utilization

SPWG commentary (continued): Considering the "unlikely" fabs, we believe it is appropriate to eliminate many of the fabs that HP considered in their analysis. If we also consider HP's suggestion to reduce the handling margins by 1mm, we are left considering the following fab optimizations:

MG size	# of Fabs	Panels/MG	
		14.0W	14.1W
600 x 720	4	6 (92.2%)	4 (62.9%)
610 x 720	1	6 (90.7%)	4 (61.9%)
620 x 750	5	6 (85.7%)	6 (88.2%)
680 x 880	6	8 (90.0%)	8 (92.6%)
730 x 920	5	8 (80.1%)	8 (82.5%)

3 active fabs for notebook PC panels

16 active fabs for notebook PC panels

Note 1: Of the 4 600x720 fabs, we believe that 2 of the companies do not currently have any plans to build panels for the notebook PC market.

Note 2: 730x920 fabs can build 15.4"W panels 8-up, and therefore are also unlikely to build 14.x"W panels.

Motherglass Utilization

SPWG commentary (continued): In sum, of the fabs likely to make 14.x”W panels, 5 are best suited to make 14.0”W panels (15:9) and 11 are best suited to make 14.1”W panels (16:10).

	14.0”W (15:9)
600x720	**Samsung, AUO**
610x720	**AUO**
	14.1”W (16:10)
620x750	**Sharp, BOE/Hydis, CMO, QDI, Toppoly**
680x880	**Sharp, Torisan, LGP, AUO, CMO, CPT**

And if we consider the less attractive 730x920 solution, we think that all likely manufacturers also have an optimized solution by which to make 14.1”W (16:10) panels.

730x920	**Hitachi, Sharp, Samsung, CPT, TMD**

Impacts on Yield/Cost

HP input: "A 1280 x 800 panel will require either additional or more costly row driver ICs vs. 1280 x 768".

SPWG commentary: Driver costs are certainly a concern, but it should be noted that row drivers comprise only a small portion of the total driver costs (as compared to column drivers).

- **Existing driver technology will support 800 or 768 channels without a need for additional drivers.**
- **32 additional channels represents a negligible expense.**
- **Drivers to support 1280x800 solutions already are mass produced to support 12.1"W and 15.4"W panels. 17.0"W panels are also available at 1280x800 pixels. Due to the economies of scale associated with these volumes, driver prices are expected to be very competitive.**

Impacts on Yield/Cost

HP input: "With 4.2% more pixels, and a slightly smaller pixel pitch, the 800-line panel will always see somewhat lower yields than a 768-line panel, all else being equal, and will require slightly more power".

SPWG commentary: We generally agree with HP's statement, although it's extremely rare to find "all else being equal". In fact, simply because 14.0"W panels have already been developed, it's likely that more advanced technologies associated with the newer development of 14.1"W panels will result in higher yields at reduced power.

- **The pixel density of the two panels is virtually identical (106.6ppi for the 14.0"W panel and 107.1ppi for the 14.1"W panel). Convincing a consumer that a display with <1 megapixel is "better" than a display with >1 megapixel is quite difficult.**
- **The differences in production yields and power consumption are so minor they simply will not impact cost.**
- **That said, 14.0"W manufacturers will probably be forced to offer lower prices in order to try to sustain business in competition with the larger, higher resolution 14.1"W solutions.**

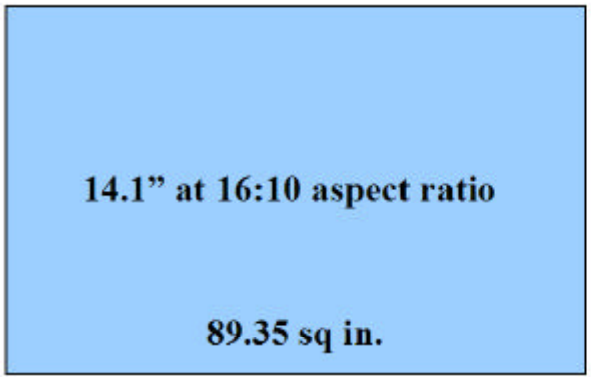
Impacts on Yield/Cost

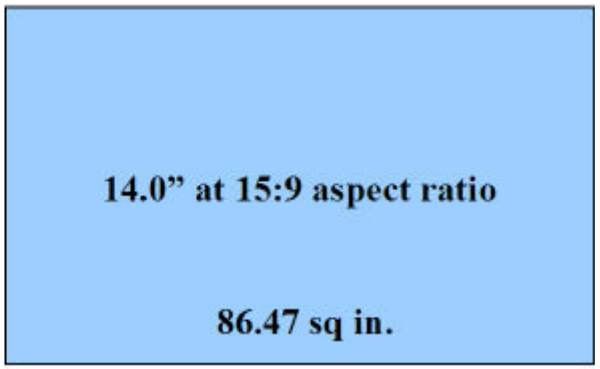
HP input: "No evidence that the additional pixels (32 lines) are of significant benefit as perceived by the customer".

Additional pixels are valuable for implementation of a useful toolbar. Since similar toolbars are already being developed by software applications companies for use with other notebook PCs with a 16:10 aspect ratio, we think that consistency associated with the existing solutions provides a considerable advantage for the 14.1"W 16:10 solution vs. a 14.0"W solution at a 15:9 aspect ratio.

Future…

The actual perceived differences between 14.0”W and 14.1”W panels are rather minor.





We believe that 14.1”W panels will prevail. We suspect that clever mechanical engineers at HP’s Taiwan manufacturer can implement a 14.1”W solution into HP’s existing notebook PC platform… Doing so will help assure mass volume production across the industry, a point to which industry standards best support the interests of the entire industry.

Summary

In most respects, 14.0”W and 14.1”W panels are very similar. The key differentiators are:

- **14.1"W is somewhat larger than 14.0"W in virtually all measurement methods, enabling certain marketing advantages.**
- **The 16:10 aspect ratio already exists for all other mainstream “wide” sizes, 12.1"W, 15.4"W, and 17.0"W.**
- **A resolution upgrade path is enabled by continuing a 16:10 aspect ratio in the 14.x” space.**

Accordingly, we recommend that the notebook PC industry standard on a 14.1”W (16:10) form factor.