COMPAQ
Technology Brief

April 1999
0051-0499-A

Prepared by Workstation Division

Compaq Computer Corporation

Contents

Professional3D: a New Graphics Classification

Abstract: 3D computer graphics has moved into the mainstream and is a core component of all Compaq Professional Workstations. Graphics cards with apparently identical specifications can differ in cost by ten times or more.

This paper explores the differences, using the ELSA GLoria Synergy+ and the PowerStorm 300 as representative examples. For many applications, the low-cost GLoria Synergy+ is an ideal solution. For technical applications that stress the 3D capabilities of a system, the PowerStorm 300 remains the clear choice and more than justifies the difference in cost.

The term *Professional3D* is introduced to help distinguish full capability 3D graphics from entry level 3D graphics.

Help us improve our technical communication. Let us know what you think about the technical information in this document. Your feedback is valuable and will help us structure future communications. Please send your comments to: Russ.Doty@compaq.com

Notice

Professional3D: a New Graphics Classification
Technology Brief prepared by Workstation Division

First Edition (April 1999)
Document Number 0051-0499-A

3D Everywhere

3D graphics has been a mainstay of high performance workstations, and has even been a defining characteristic of many workstations. Until recently there has been a clear distinction between 2D graphics and 3D graphics -- distinctions in capabilities, in specifications and in price.

However, recent developments in graphics technology have made 3D graphics broadly available. Virtually all graphics chips available today are 2D/3D capable, with 3D functionality now available at even the lowest price points.

While the new chips have added *some* 3D capabilities and are excellent choices for many applications, they do not have the full set of 3D functions needed to support many technical applications. Because the specifications between an entry level graphics controller and a high-end 3D graphics controller appear almost identical, considerable confusion has developed.

To give a better idea of the distinction between various 3D options, this paper explores the differences between graphics cards. This exploration introduces the concept of *Professional3D* to distinguish between basic 3D capabilities and the ability to support high-end technical applications such as CAD, GIS and Scientific Visualization.

3D Specification Confusion

The confusion becomes clear if we consider the specifications of two graphics cards offered by Compaq: the ELSA GLoria Synergy+ and the Compaq PowerStorm 300. The GLoria Synergy+ represents the new class of low-cost 2D/3D graphics controllers that are well suited to many applications. The PowerStorm 300 is a traditional 3D graphics controller designed for technical applications.

	Elsa GLoria Synergy+	**PowerStorm 300**
Maximum Resolution	1920x1200	1280x1024
True Color (24-bit)	Yes	Yes
Double Buffer	Yes	Yes
Z-Buffer	Yes	Yes
Gouraud Shading	Yes	Yes
Texture Mapping	Yes	Yes
OpenGL	Yes	Yes

The capabilities called out in the table are important 3D graphics features -- in fact, this is the basic feature set that defines 3D graphics.

Based on these specifications, you might conclude that the GLoria Synergy+, with higher maximum resolution, is actually a better choice! It appears that there is no justification for the PowerStorm 300, considering its substantially higher price.

3D Specification Clarification

What isn't immediately obvious is that Workstation 3D graphics has *minimum requirements* for each feature and often demands *all* of these features at the same time. The ability to meet the first criteria is what separates advanced 3D cards from entry level cards. In the rest of this section, we will explore these features in depth and illustrate the differences that begin to define the high-end.

Color and Depth

Workstation 3D graphics needs True Color -- 24 bit color. Lower color depths, such as HiColor (16 bit color) can be used, but this degrades the image by producing highly visible banding across shaded images. To achieve smooth movement on the screen, the display must be *double buffered* -- that is, it must have separate spaces to *display* graphics and to *manipulate* graphics.

To correctly sort out which objects are closest -- and thus visible -- 3D graphics uses a depth buffer or Z-buffer. The Z-buffer allows the graphics hardware to keep track of which objects are closest to the eye on a pixel by pixel basis.

Again comparing the GLoria Synergy+ and the Compaq PowerStorm 300:

	ELSA GLoria Synergy+			**PowerStorm 300**		
Resolution	Color Depth	Double Buffer	Z Buffer	Color Depth	Double Buffer	Z Buffer
1920x1200	16	No	No	N/A	N/A	N/A
1280x1024	16	Yes	Yes	24	Yes	Yes
1280x1024	24	No	No	24	Yes	Yes
1024x768	24	Yes	Yes	24	Yes	Yes
800x600	24	Yes	Yes	24	Yes	Yes
640x480	24	Yes	Yes	24	Yes	Yes

This chart really shows how features are compromised on entry 3D controllers. As shown here, the GLoria Synergy+ does not support True Color until resolution drops to 1280x1024, and doesn't support True Color with double buffering and Z buffer until resolution drops to 1024x768. So while the Synergy+ *can* support higher resolutions, it requires some significant tradeoffs in performance and visual image quality.

Another significant difference comes in with the depth of the Z buffer -- the number of bits of resolution in the Z buffer. A "deep" Z buffer (more bits) has greater resolution and accuracy than a shallower Z buffer. Since the Z buffer is used to determine which object is in front of another, resolution is important. When objects are close together, it becomes more difficult to tell which is actually in front. In fact, a situation arises where first one object and then the other is placed in front. This can produce a visual bleed-through that is visually disturbing.

Computer games and structured visual simulation databases are designed for display, and ensure that objects are far enough apart to cleanly separate. For these applications a 16 bit Z buffer is adequate. Technical applications, such as mechanical CAD, scientific visualization and Digital Content Creation (DCC) have unstructured datasets with objects that may be very close together. These applications require a 24 bit Z buffer to avoid visual corruption.

The GLoria Synergy+ has a 16 bit Z buffer. The PowerStorm 300 has a 24 bit Z buffer. Updating the previous chart to include support for a 24 bit Z buffer:

	Elsa GLoria Synergy+			**PowerStorm 300**		
Resolution	Color Depth	Double Buffer	24 bit Z Buffer	Color Depth	Double Buffer	24 bit Z Buffer
1920x1200	16	No	No	N/A	N/A	N/A
1280x1024	16	Yes	No	24	Yes	Yes
1280x1024	24	No	No	24	Yes	Yes
1024x768	24	Yes	No	24	Yes	Yes
800x600	24	Yes	No	24	Yes	Yes
640x480	24	Yes	No	24	Yes	Yes

Overlay

A feature used to improve performance is *Overlay Planes*. These are a set of special planes that lie "in front of" the other graphics planes. When something is drawn into the overlay planes it is visible -- no matter what else is on the screen. When this information is removed, the overlay plane is erased and whatever was behind it is again visible.

The alternative to using overlays is to draw into the normal graphics planes, which destructively writes over whatever was already there. When the new information is removed, the entire display must be re-drawn. For complex data, these re-draws can be time consuming.

The overlay planes are commonly used by high-end technical applications for user interfaces. This allows user interface elements, such as cascading menus, selection highlights, menu buttons and other elements to be quickly drawn and then quickly removed. Since modern applications have rich user interfaces that quickly pop-up and then disappear, use of overlay planes can significantly improve application performance.

Applications must deliberately choose to use overlay planes. Examples of applications that use overlays include Pro/ENGINEER, SoftImage 3D and Maya.

The PowerStorm 300 provides 8 bit double buffered overlays. The GLoria Synergy+ does not support overlay planes.

Texture Memory

Even when using an AGP interface, the best performance is obtained with local texture memory on the graphics card.

The GLoria Synergy+ shares memory between frame buffer and texture. The GLoria Synergy+ has a total of 8 MB of memory, with most of the memory being used for the frame buffer. Using the 3D feature set (True color, double buffered, Z buffer), at 1024x768 resolution almost 7.9 MB of memory is used by the frame buffer. This leaves practically nothing for texture.

Even dropping the resolution to 800x600 provides less than 4 MB of memory for texture.

The PowerStorm 300 includes 16 MB of dedicated high performance texture memory. The full 16 MB is available for textures at all resolutions. In addition, the texture memory is on a separate memory controller, so that the frame buffer and the texture memory don't have to share memory bandwidth.

The result is that the PowerStorm 300 provides much better performance when texturing.

In addition, there are several different ways of displaying textures -- point sampled, bilinear interpolated and trilinear interpolated. Without going into technical details, these improve the appearance and accuracy of texture display. The GLoria Synergy+ supports point sampled and bilinear texturing, while the PowerStorm 300 supports all three.

The result is better visual appearance for the PowerStorm 300, including elimination of the visible "crawling" or "sparkling" that occurs when textured objects move.

Performance

The last major difference between entry level and high-end graphics occurs in performance, and is clearly shown in graphics benchmarks.

	ProCDRS	CDRS	DRV	DX	Awadvs	Light
PowerStorm 300	9.94	101.40	7.33	16.09	18.85	1.36
GLoria Synergy+	3.53	27.72	5.00	8.28	13.66	1.24

All results on Compaq Professional Workstation AP400 500MHz Pentium III system. Results shown in weighted frames/sec., higher results are better.

Conclusion

Modern 2D/3D graphics cards such as the GLoria Synergy+ are powerful, flexible and versatile. They support 3D graphics and are the ideal choice for many applications.

Professional3D graphics cards such as the PowerStorm 300 support simultaneous use of the full 3D feature set and provide the best 3D performance. For 3D work involving shaded and textured display, they provide better visual quality and better performance than the 2D/3D graphics cards.

High-end technical applications that take advantage of the advanced features of Professional3D graphics deliver the best possible performance when used with cards such as the PowerStorm 300. In fact, some software vendors require the features of Professional3D graphics.

The differences between 2D/3D graphics cards and Professional3D graphics are much greater than a casual examination of the specifications would indicate. For technical applications, Professional3D graphics is the clear choice.