It was only two or three years ago that the editorial board of IEEE Computer Graphics and Applications debated whether to include information about personal computers. The initial impression was that the personal computer was low performance and had poor visual quality. The consensus held that professional readers of CG& A would have little interest in that technology. However, it soon became clear that whatever limitations the PC had, the expectation was that the performance would rapidly improve, and the personal computer would become a major factor in computer graphics.

The issue is how one defines a personal computer. Some marketing research organizations arbitrarily describe a personal computer as a four-, eight-, or sixteen-bit microprocessor, while an engineering workstation...
has a thirty-two-bit microprocessor. Like most performance-dependent definitions, this one became obsolete almost as soon as it was written. It is extremely difficult to create an arbitrary quantitative definition of a personal computer. Instead, we need to work with qualitative definitions. For a short time personal computers could be defined by price, but even that distinction has blurred.

The personal computer certainly is part of the workstation environment (whatever that is). I think we are safe in describing workstations as having low, medium, and high performance. In fact, in an effort to provide some parameters of performance levels, I developed the performance range chart shown here. This chart does not try to establish an absolute number for each performance item in the low, medium, and high categories, but rather provides some guidance as to relative performance. In other words, if a medium performance workstation is normalized at one for a variety of such factors as processing power, graphics performance, picture quality, throughput, and price, in my judgment the low-end units could be normalized as shown in the chart, as can the high-end units. Using this kind of classification, I argue that personal computers fall into the low end of the graphics workstation environment. And increasingly, as we begin to get fast CPUs, improved coprocessors, other application accelerators, and higher resolution displays, personal computers begin to move into the medium range. The difficulty is that whatever absolute number represents performance of a medium range unit today, the number drifts down to become the absolute number representing a low performance unit tomorrow.

Having been involved in computer graphics for over three decades, I find the most exciting aspect of personal computers is their proliferation. The PC has brought graphics to a so much larger community than most of us had ever predicted possible. I believe the potential is at least another order of magnitude.

The PC with graphics capability has become the dominant workstation in CAD/CAM. By the end of 1987 I forecast that there would be about twice as many PC-based workstations used in CAD/CAM systems as conventional workstations. I find the most exciting thing about this is that the growth has all occurred in the last five years, whereas the conventional CAD systems have been sold since about 1970.

Increasingly the PC is becoming the workstation of choice for engineers and scientists of almost all the disciplines. Realistically, the graphic aspects of those applications are important but perhaps not dominant.

The PC has found its way into the graphic arts environment and the art and animation world. It is currently the dominant workstation in at least the desktop publishing area.

The PC with graphics is becoming the workstation of choice in process-control applications, lab instrumenta-

tion, business graphics, and image processing.

Because of the increasingly ubiquitous presence of the personal computer in computer graphics, it seemed appropriate to devote a special issue of CG&A to personal computers. This special issue consists of invited papers, each encompassing what the special issue editor believes are important issues in PCs and graphics. In addition to discussion of hardware and software issues, one article includes what we believe is a "first" for CG&A, a program developed by the authors of the paper to accomplish a commonly needed graphics function.

One of the things that surprised the editor was that there was essentially no response to the call for papers. Whether people doing work on PCs tend not to write about it unless they are personally solicited, or whether there are so many other places these articles appear is not clear. For example, magazines like Byte, PC Technology, PC World, and Personal Computing regularly contain excellent articles about many aspects of the PC and graphics.

One of the other "omissions" in this special issue is a lack of articles describing any of the architectures for some of the new personal computers that have recently come to market. Examples are the enhanced IBM RT, the Personal System/2 series recently announced by IBM, and the new Macintosh series announced by Apple. The preparation of an issue like this takes more than a year. With many fast-moving developments like the introduction of new computers, companies are unwilling to prepare so far in advance the data that describes new products that will be announced just as the magazine is being put together. That kind of data is often available in the product-oriented publications listed earlier.

One of the concerns of PC users has always been the relatively poor response time of the PC compared to what was available in the larger workstations. Tom Hall
of Procreate, in "Productivity Issues in PC-CAD Graphics," discusses some of the response issues and at least one solution.

If the graphics window on the PC environment is the personal computer display, Satish Gupta and Daniel H. McCabe of the IBM Thomas J. Watson Research Center discuss it in "Personal Computer Displays." The article describes the technological and architectural evolution of personal computer displays and the impact of this evolution on systems-application software.

Some of us in the field feel the early significance of the personal computer was not that it necessarily provided a quality graphics workstation, but that it precipitated the development of low-cost plotters—whose performance was comparable to the more expensive units that were available up to that time...and whose prices could be significantly reduced because of the potentially larger volume involved.

Michael James, VP of Marketing and Sales at Vectrix, discusses "The Third Generation of PC Graphics Controllers." As he says, quite accurately, "The use of graphic applications has been revolutionized over the last five years by high-performance graphics subsystems used in the personal computer." He discusses the three generations of controllers that have appeared between 1983 and 1987.

"PC Hardware Developments and CAD Software" by Tom Lazear, president of Versacad, talks about the symbiotic effect of PC hardware and the software that can be developed to run on it. Lazear includes a discussion of what the ideal graphics board is from the CAD software developer's point of view.

Doyle K. Cavin, president of the Houston Instrument Division of Ametek, discusses "Peripheral Considerations for PC CAD Users" and reviews a variety of the input and output devices available for the PC.

Computer graphics practitioners are constantly faced with developing specialized programs to accomplish graphics manipulation tasks they had every reason to believe were standard features of their systems. Tom DeFanti, Rick Frankel, and Larry Leske, of the University of Illinois at Chicago, talk about direct high-level language access to low-level graphics functions for personal computer workstations in "A Call for the Publishing of Blt-Stones." They use a graphics analog to whetstones and dhrystones as a performance measure for computer processing speeds. The article includes a set of low-level C-language routines which directly address graphics boards, making assembly-language driver interfaces unnecessary. As pointed out earlier, we believe this is the first article published in CG&A that includes complete computer routines.

Increasingly, the user of the personal computer would like to have the ability to do conventional NTSC video recording of PC graphics images. Read "The Usable Intersection of PC Graphics and NTSC Video Recording" by Tom DeFanti and Don Sandin of the Electronic Visualization Laboratory at the University of Illinois at Chicago. They point out that "Unfortunately most raster graphic devices do not, in fact, generate as good NTSC video as a cheap cassette recorder or color video camera." This article exposes the problems created by non-standard video on PCs and proposes many solutions. It also offers a case study of one system in detail.

With such a fast-moving field as computer graphics, limitations described in today's articles could easily be eliminated by a new development announced tomorrow.

On the other hand, the articles in this special issue are very effective in describing today's environment, and each of the authors knowledgeably predicts some future directions.

One thing does seem clear: In the not-too-distant future, there may not be a visible distinction between what is now described as a PC and what we generally describe as an engineering workstation. As the articles in this special issue illustrate, the boundaries between these two classifications are becoming increasingly blurred.

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