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Killer Graphics

Windows NT Symposium

Russell Doty
Graphics Product Manager

WORKSTATIONS

The LEADER in VISUAL COMPUTING

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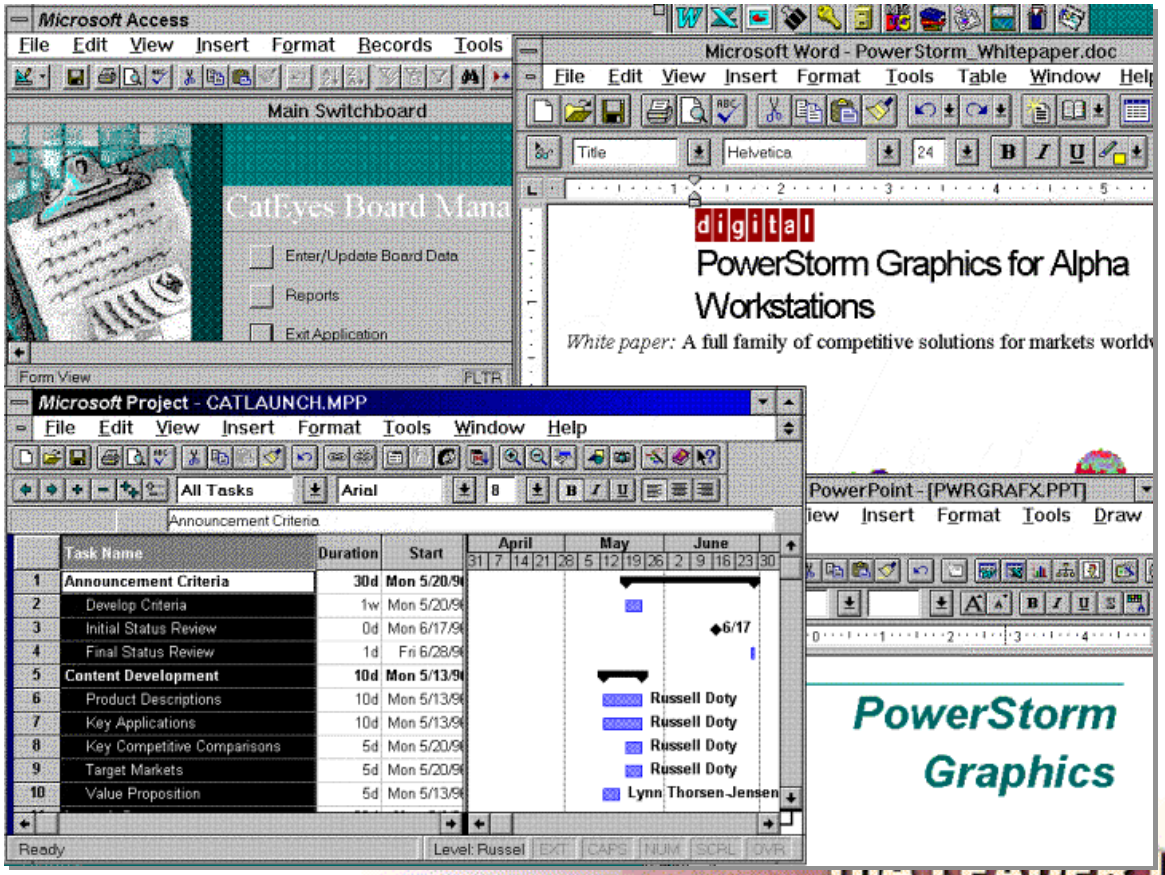
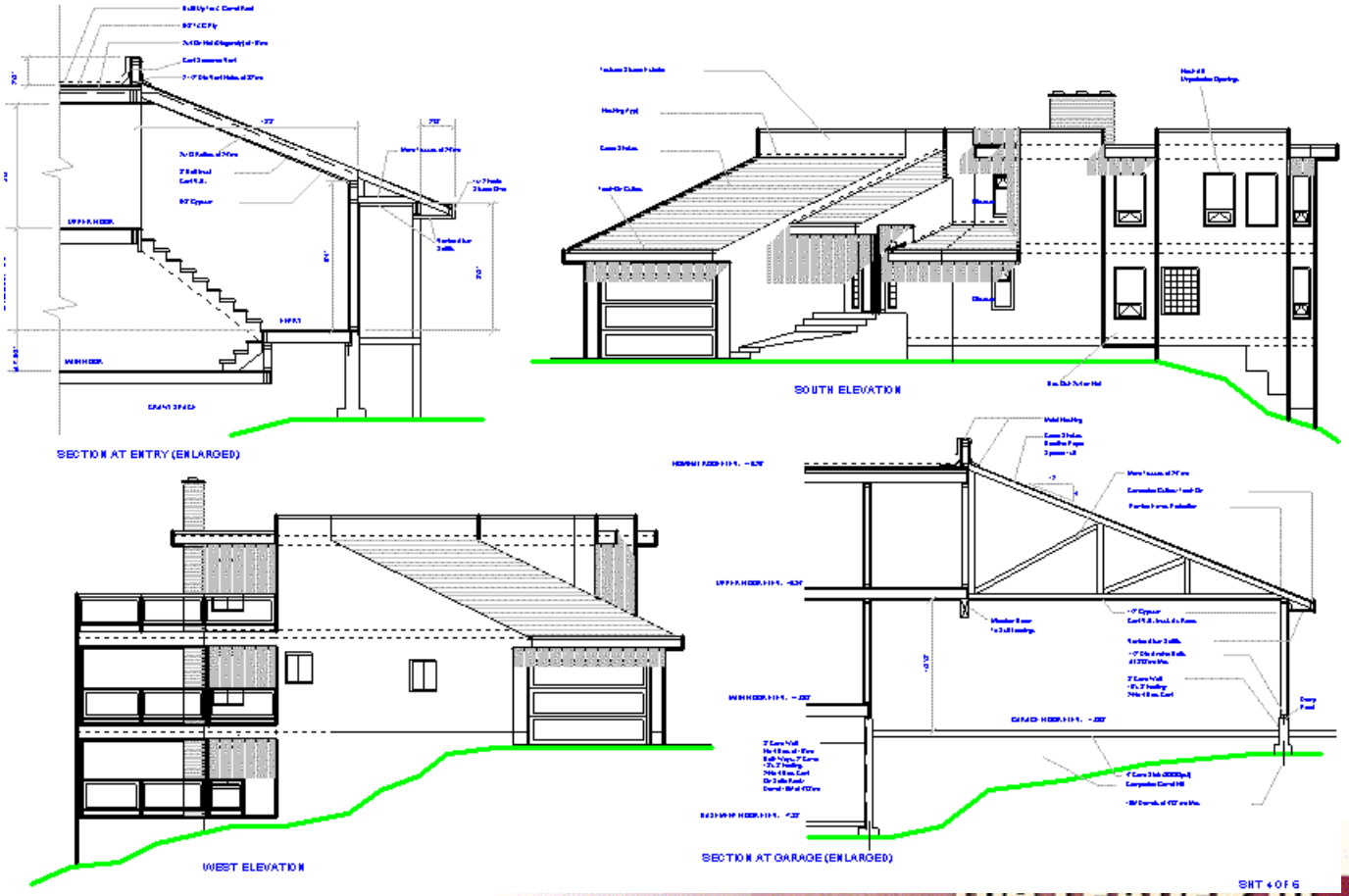
“Doing Graphics”

- What are the different types of graphics?
- What’s the problem?
- What is the graphics pipeline?
- How is the graphics pipeline implemented in PowerStorm systems?
- What are the advantages of the PowerStorm approach?

General Productivity Graphics



2D: Drafting



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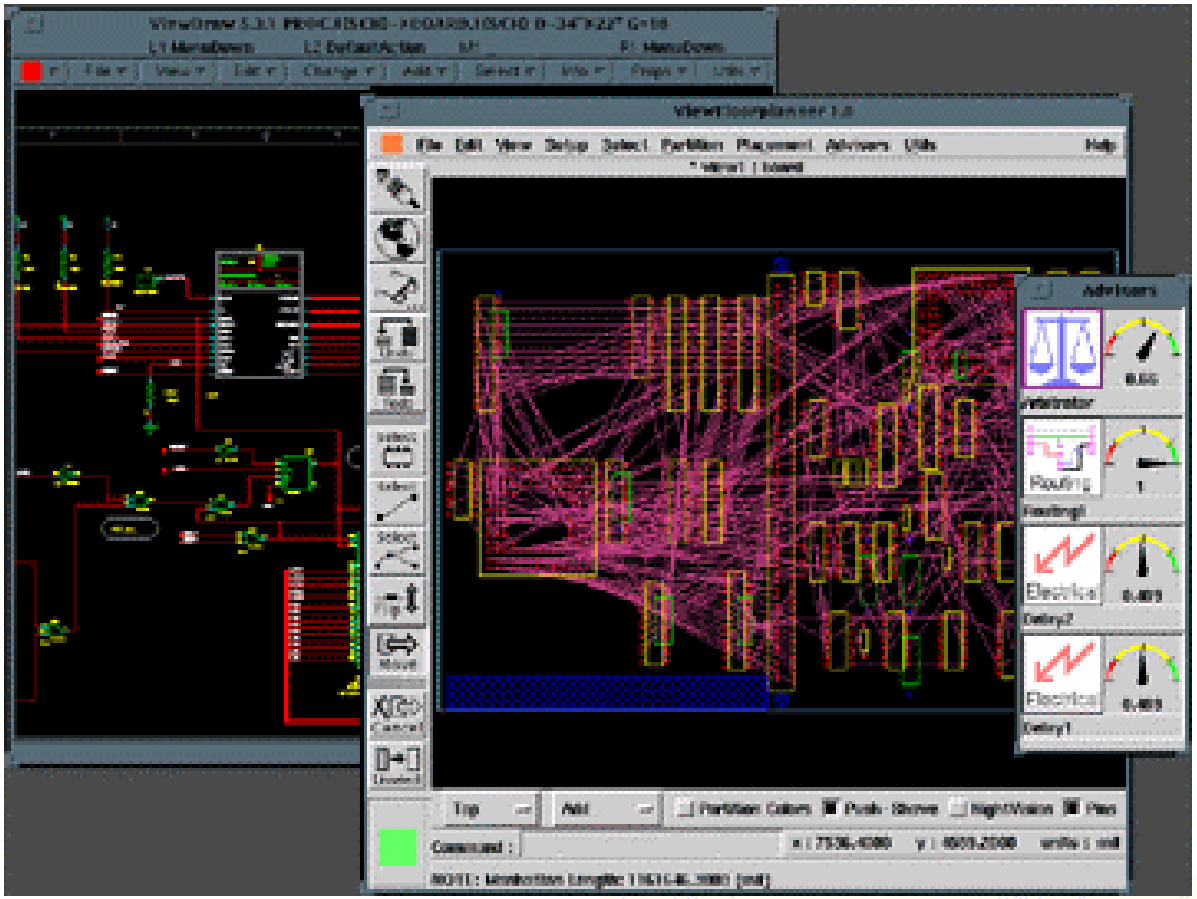
2D: Electrical CAD



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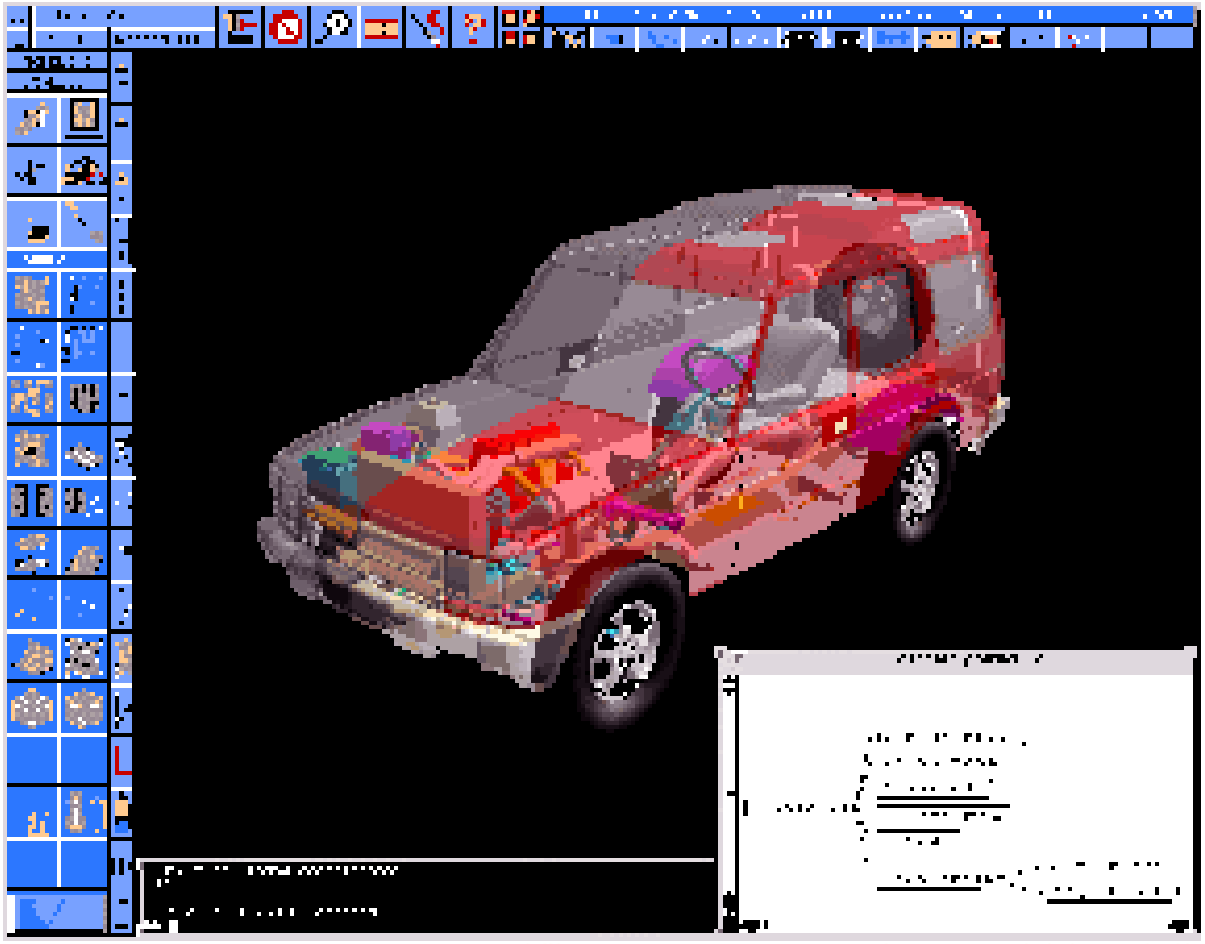
3D CAD



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Animation

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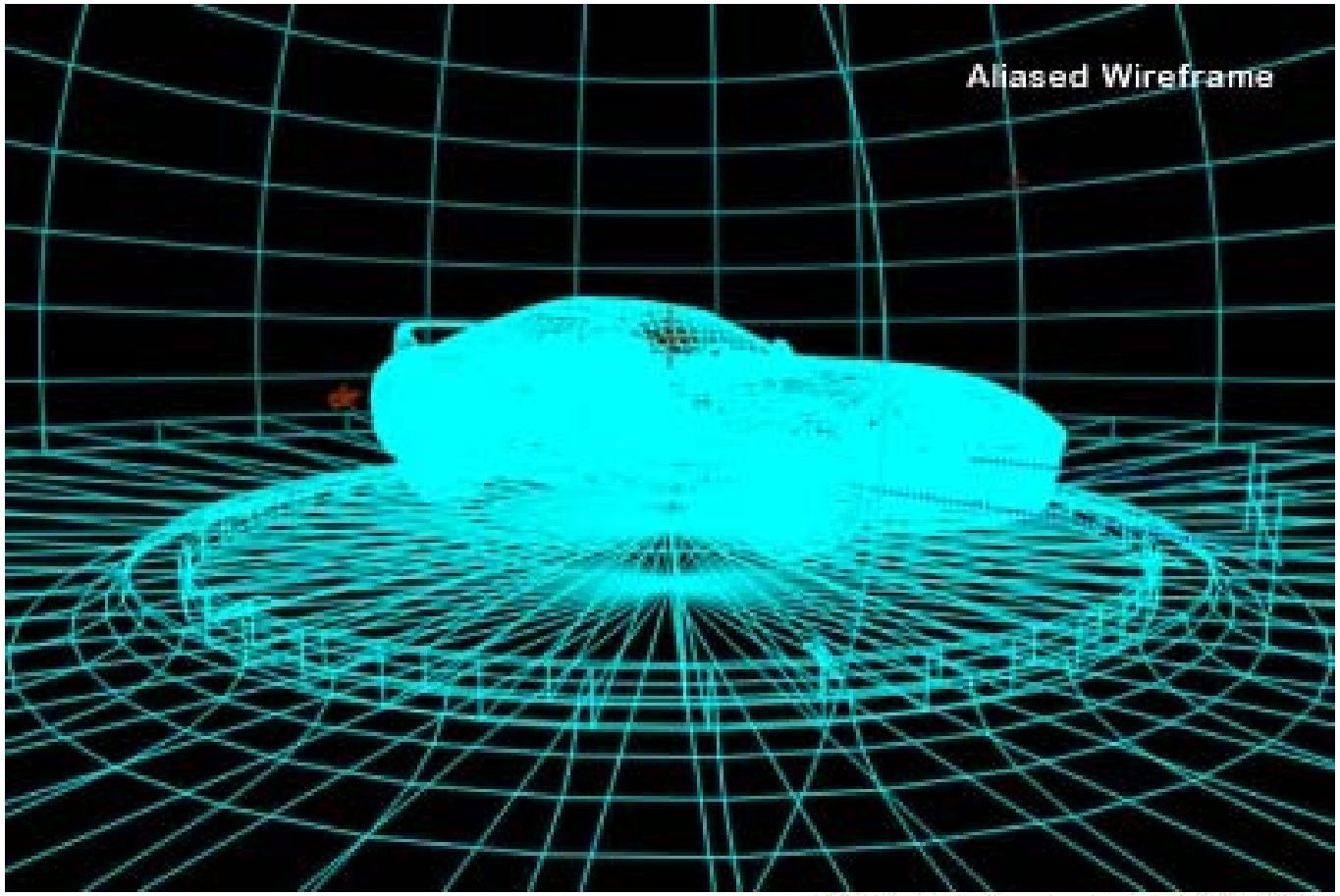
The Basics: Wire Frame



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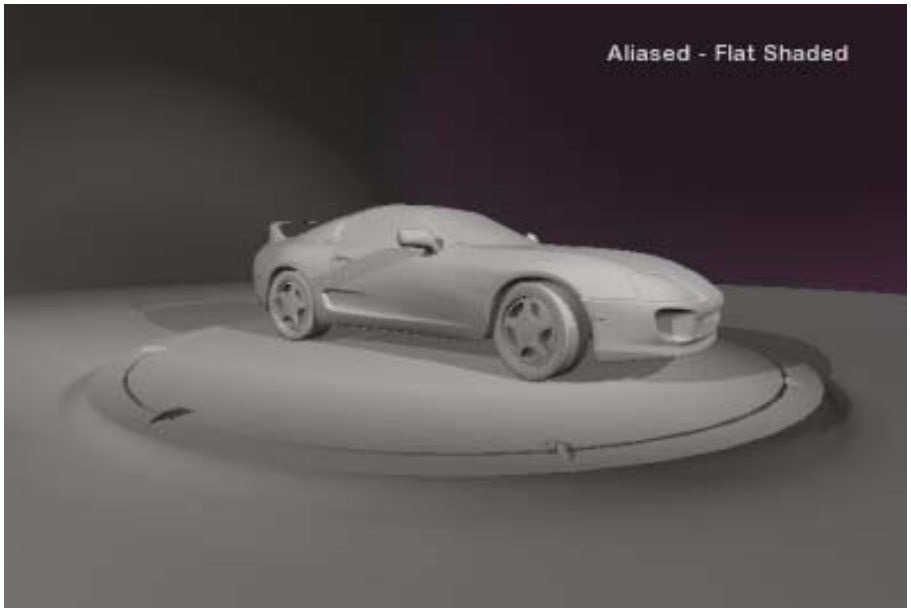
The Basics: Shading



Texture Mapping

- Applies a “photo-like” image to a surface
- Gives customers a higher level of detail and scene complexity
- Doesn’t add additional geometry
- Simulates material properties like wood, metal, brick
- Used to simulate surface properties like grooves, bumps, patterns

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Ray Tracing

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2D? 3D? 4D?

- All of the preceding slides are 2D
  - Some are generated from 2D data
  - Some are generated from 3D data
  - All are static images
- 3D *graphics* is different from 2D *graphics*
  - Different requirements
  - Different technology
  - Different algorithms

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Motion

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What's the Problem?

- **Displaying pixels on the monitor requires:**
  - **Traversing application data structures and generating display data structures**
  - **Model level transformations**
  - **Viewing transformations**
  - **Lighting**
  - **Texturing**
  - **Display**
- **Some steps are computationally intensive**
- **Some are simple, but repeated -- pixel level operations**
- **Must be done very fast to achieve interactive graphics performance**

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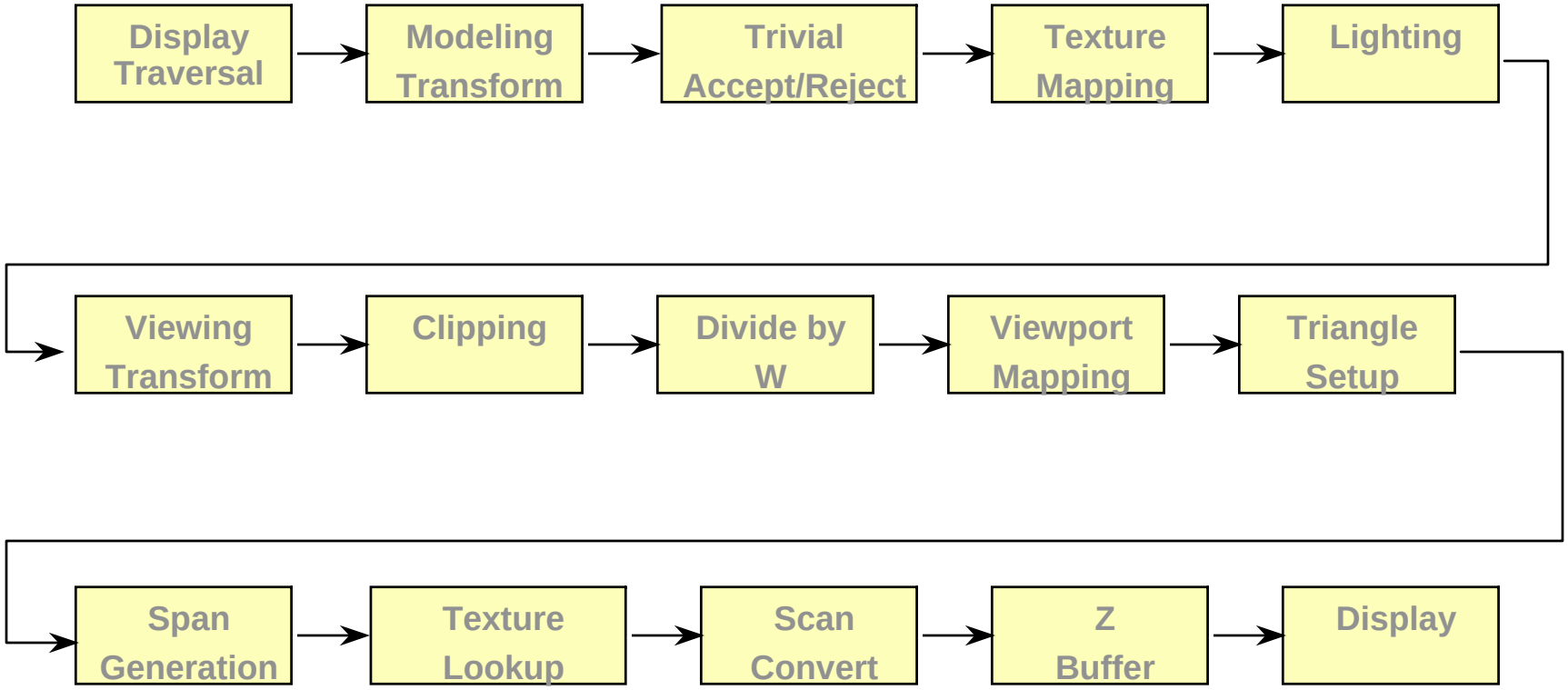
Graphics Pipeline



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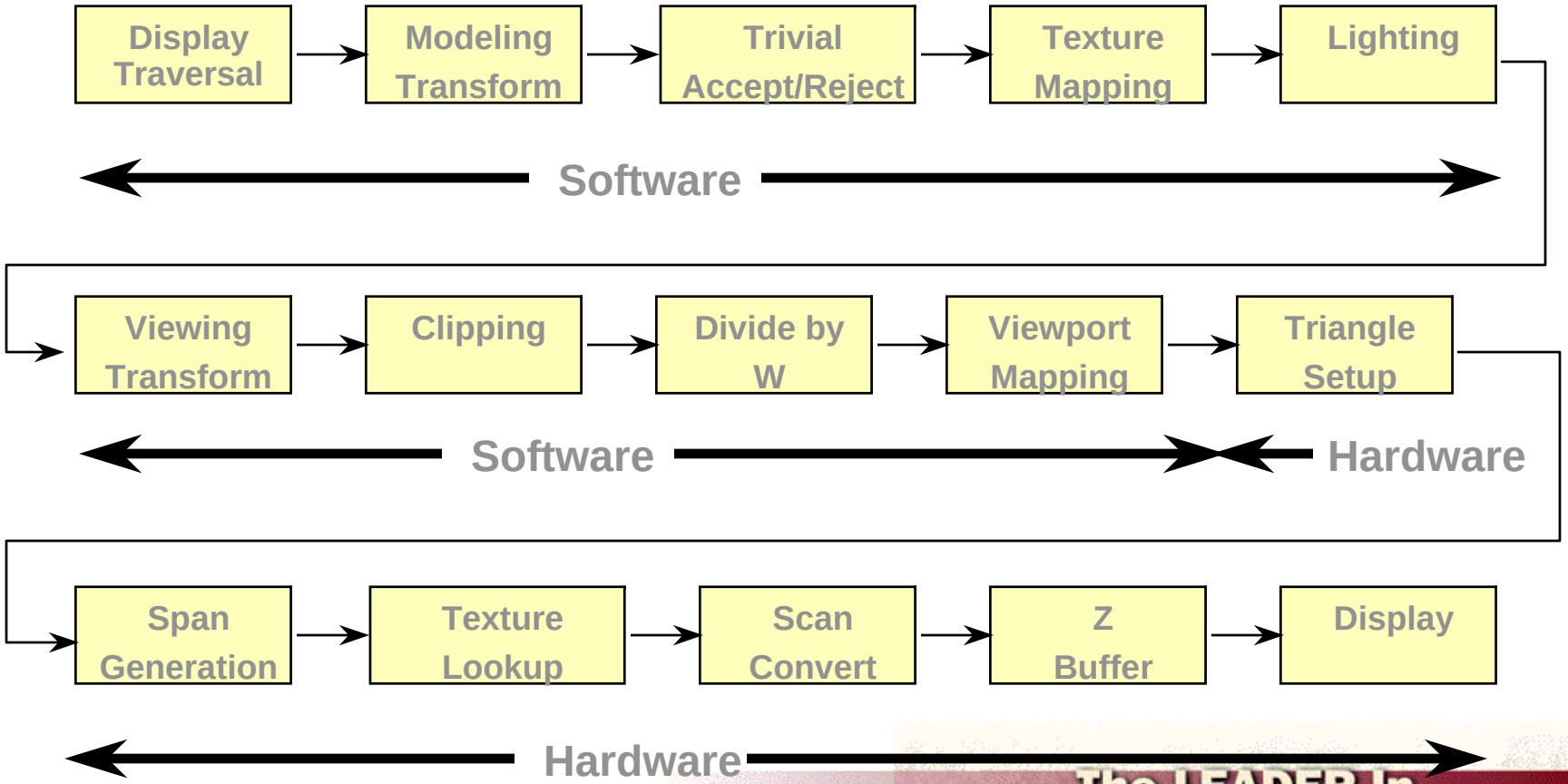
Graphics Pipeline on PowerStorm 4DT



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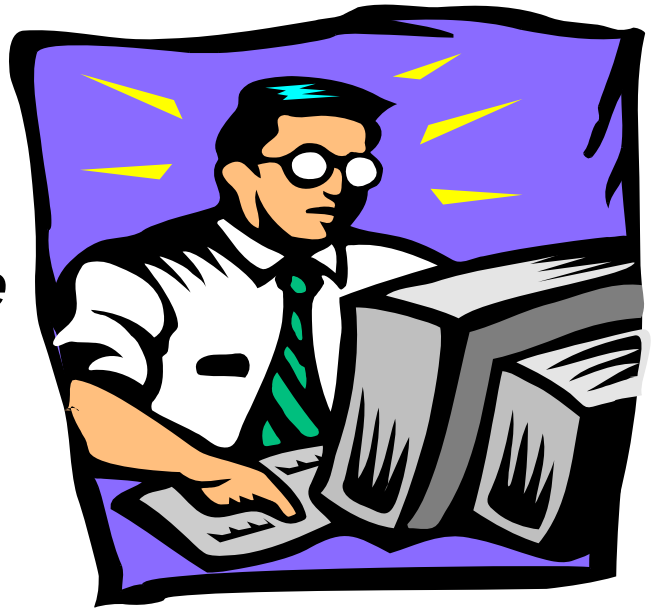
Workstations: Focused on the User



- **Better understanding**
  - Work with the *bigger picture*
  - Look at *all sides* of the task
- **Better interactivity**
  - "Speed is user friendly"
  - High performance 3D graphics
- **Do more iterations**

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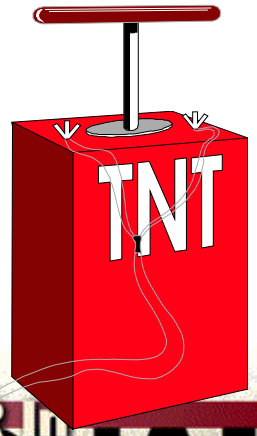
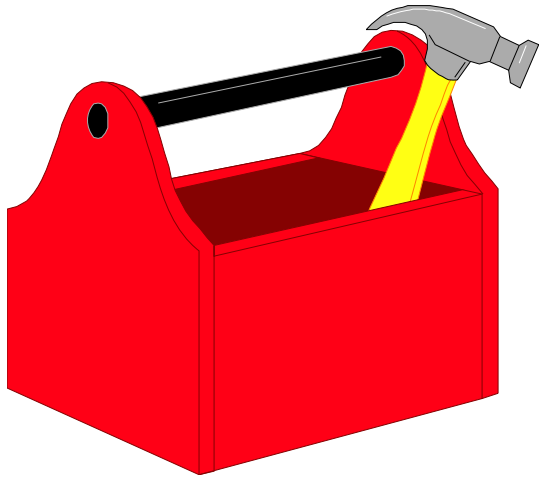
The tool for the job

- **Workstations are not “one size fits all”**
  - **Don’t try to use a PC for non-linear dynamic finite element analysis**
  - **Don’t use a 4-processor workstation to review manufacturing drawings**
- **Examine the total system, not just portions**



The Toolbox



- Digital Personal Workstations
- Alpha based multi-processor systems
- PowerStorm Graphics
  - PowerStorm 4DT
  - PowerStorm HiFIVE
- Windows NT *and* Digital UNIX

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Digital Personal Workstations

- **Intel Pentium II**
  - Single or dual processor
  - Industry standard
  - Upgradable to Alpha
- **Alpha**
  - 433-600 MHz
  - Windows NT and Digital UNIX
  - Highest performance

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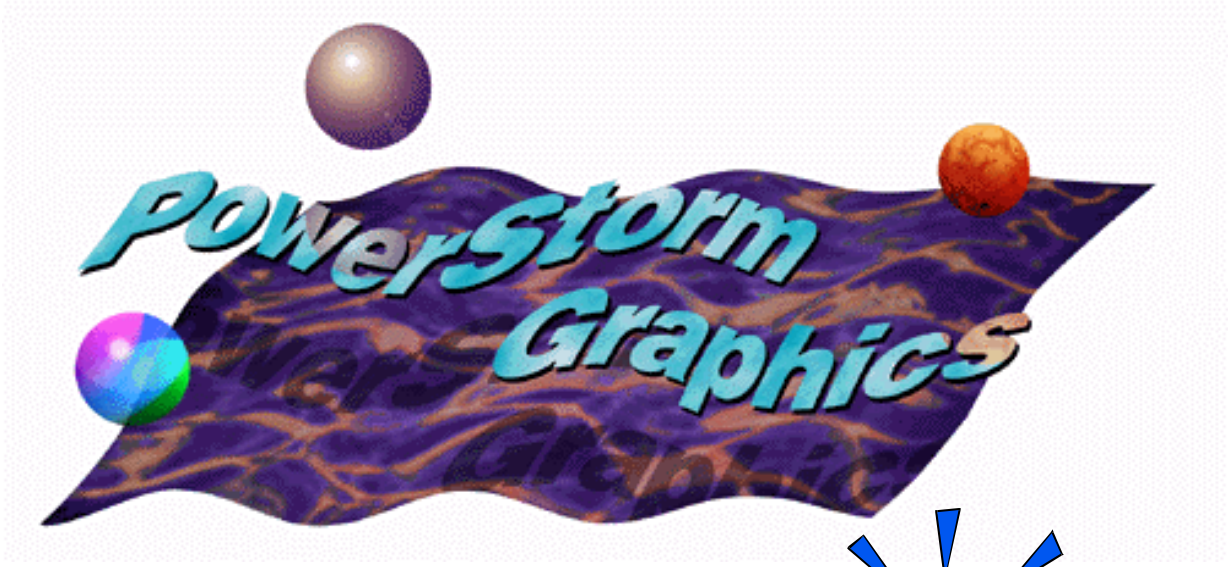
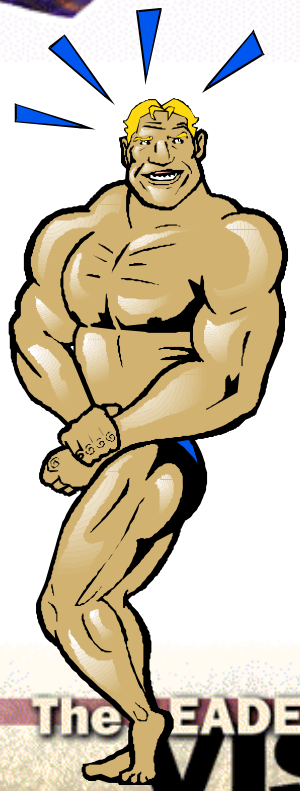
Multi-Processor Alpha

- **Ultimate Workstation**
  - Dual processor Alpha
- **Alpha 4100-class systems**
  - 1-4 Alpha processors
  - Up to 8GB of memory
  - High performance design



- **PowerStorm 4DT family**
  - **High performance workstation class 3D graphics**
  - **Great value**
- **PowerStorm HiFIVE**
  - **Ultimate realism**
  - **Highest performance**



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Alpha and Intel
Processors

Industry standard
PCI Bus
and
Open GL API

PowerStorm
Graphics
3D graphics
EVERYWHERE!

Windows NT
DIGITAL UNIX

The PowerStorm Advantage

WORKSTATIONS

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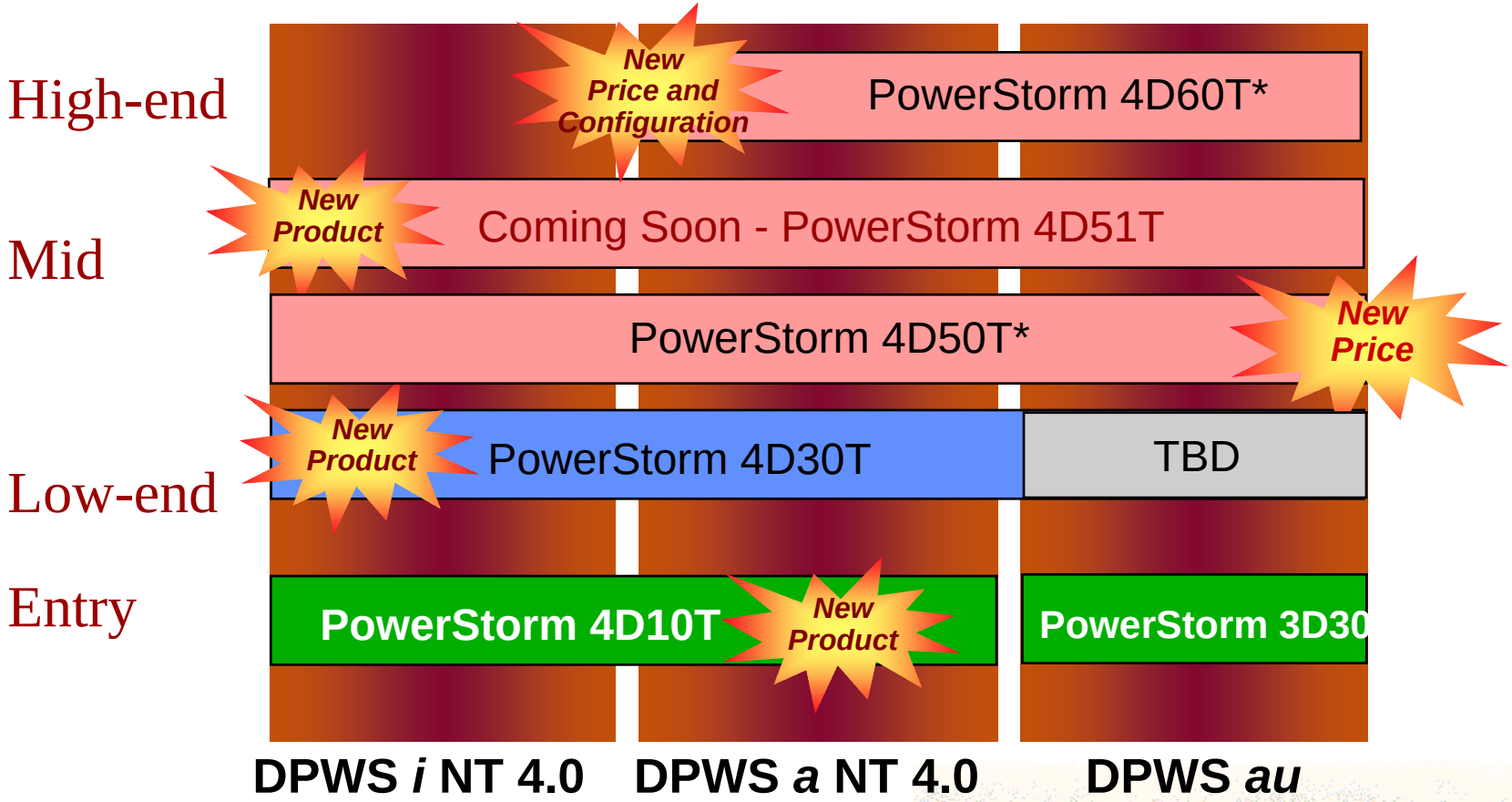
PowerStorm Graphics: Incredible Breadth



***Runs on Intel platform, but not recommended as Intel doesn't deliver full 3D performance**

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PowerStorm 4D10T

- **Low cost: $319 US MLP**
- **Full 2D functionality and performance**
  - **1280x1024 min. resolution, true color**
- **Good 3D functionality**
  - **Double buffered display (16 bit)**
  - **Z-buffer (16 bit)**
  - **Gouraud shading and bilinear texture mapping with shared frame buffer/texture memory**
  - **1M triangle/sec**

PowerStorm

4D10T

Description: Entry 3D graphics board at PC prices. Supports true color (24-bit) display, hardware shading and Bi-linear texture mapping.

Key Features: 1280x1024 true color resolution (16 bit color double buffered). 2D and 3D capabilities, including Gouraud shading, texture mapping, and Z-buffer. Entry level 3D; 16-bit double buffered color with 16-bit Z-buffer. Stereo support. Video in.

Target Markets: Entry level graphics offering for all markets.

Where to Use: Base graphics on NT systems. This should be the default choice unless customer or application requirements for greater features or performance dictate the need for a higher-end graphics card.

Alternatives: 4D60T: high resolution, large texture memory, stereo, UNIX. 4D50T/4D51T: UNIX, stereo, large textures. 4D30T: workstation class 3D graphics. HiFIVE: anti-aliasing, specular highlights, higher performance.

Part Number	SN-PBXGK_AB
US List Price	$319
O/S	WNT -UNIX Q4 97
Platforms	DPWS 433a,500a,600a,266/300 I, 266/300 I2
Workstation Class 3D	No
3D Support	OpenGL 1.1
Bus Interface	PCI 2.1
# Slots	1
Video Memory	8MB
HW Texture Mapping	Yes
Highest Texture Mode	Bilinear
Std. Texture Memory	shared with frame buffer
Max Texture Memory	8mb
Max Resolution	1600 x 1200
Max Refresh (1280x1024)	86Hz
Stereo	Y
Video Layout	
Color Planes	16 bit DB
Z-buffer	16 bit DB
Overlay Planes	NA
Stencil Planes	NA
Alpha Planes	NA
Window ID Planes	
Fast Clear Planes	
Total bits/pixel	
Hardware Performance	
3D Vectors/sec	1 M
3D AA Vectors/sec	na
25 Pixel Triangles/sec	1M
50 Pixel Triangles/sec	
Texture fill rate	80M wo Z; 40M w Z
Trilinear texture fill rate	n/a
ViewPerf Performance	
CDRS	tbd
DX	tbd
DRV	tbd
Awadvs	tbd
Light	tbd

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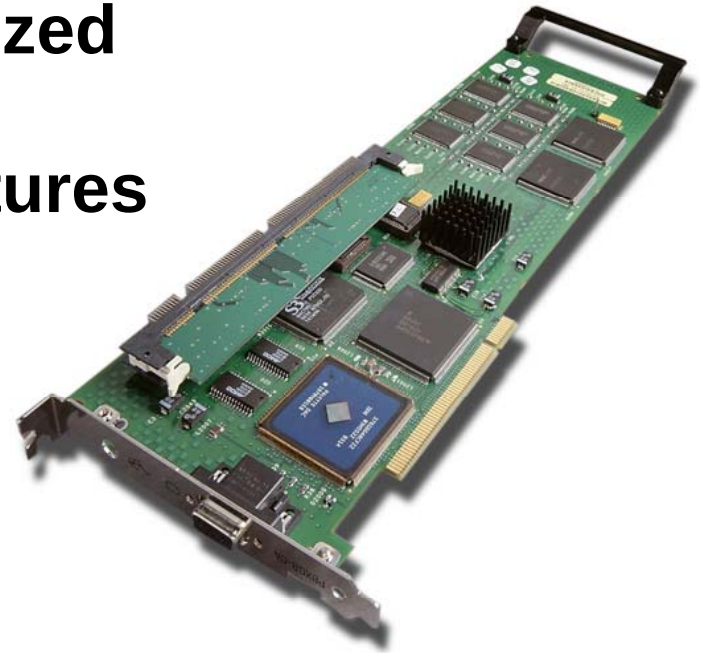
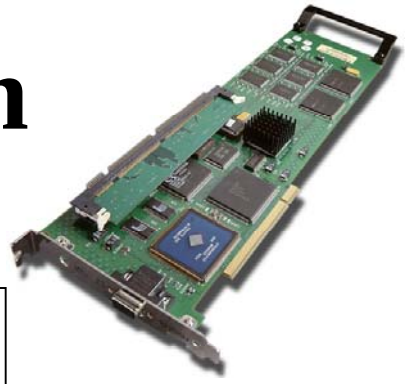
PowerStorm 4D30T

- **Digital performance optimized OpenGL**
- **High performance and features**
  - 2M triangles per second
  - 1280x1024 24-bit DB, 24-bit Z
  - 15MB frame buffer
  - Trilinear MIP-mapped textures
  - 4 or 16MB CDRAM texture memory
  - Single PCI slot
  - Windows NT
- **$2,995 w/ 4MB texture, $3,395 w/ 16MB**



PowerStorm

4D30T



Description: High productivity, under $3,000 (US MLP), advanced 3D graphics with OpenGL 1.1 acceleration for Windows NT on Intel and Alpha

Key Features: 1280x1024 resolution, true color double buffered. 3D shading and texture mapping, including TriLinear MIPmapping, with 4MB or 16MB texture standard. 24bit Z-buffer and 8bit double buffered overlay planes.

Target Markets: MCAD, especially solid and surface design. MCC, especially animation and modeling. GIS, especially 3D. Scientific Visualization. Visual Simulation.

Where to Use: Where high performance, low cost, and Windows NT support is required with 3D graphics. Use for shading and texture mapping. Use when display resolution does not exceed 1280x1024 and texture memory does not exceed 16MB.

Alternatives: 4D60T: high resolution, large texture memory, stereo, UNIX. 4D50T: UNIX, stereo, large textures. 4D10T: lower cost, less demanding 3D. Road Warrior: anti-aliasing, specular highlights, higher performance.

Part Number	SN-PBXGD-AA (4MB Texture) SN-PBXGD-AB (16 MB Texture)
US List Price	$2,995 (4MB texture) $3,395 (16MB texture)
O/S	NT-Intel, NT-Alpha
Platforms	DPWS 433a, 500a, 600a, 266i 266i2
Workstation Class 3D	Y
3D Support	OpenGL 1.1
Bus Interface	PCI 2.1
# Slots	1
Video Memory	15 MB
HW Texture Mapping	Yes
Highest Texture Mode	Trilinear
Std. Texture Memory	4 MB
Max Texture Memory	16 MB
Max Resolution	1280x1024
Max Refresh (1280x1024)	75 Hz
Stereo	No
Video Layout	
Color Planes	24 bit DB
Z-buffer	24 bit
Overlay Planes	8 bit DB
Stencil Planes	6
Alpha Planes	6
Window ID Planes	4
Fast Clear Planes	2
Total bits/pixel	96
Hardware Performance	
3D Vectors/sec	2 M
3D AA Vectors/sec	2 M
25 Pixel Triangles/sec	2 M
50 Pixel Triangles/sec	1 M
Texture fill rate	60 MP
Trilinear texture fill rate	30 MP
ViewPerf Performance	
CDRS	57.7
DX	13.57
DRV	6.73
Awadvs	13.94
Light	1.42

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PowerStorm 4D51T

- **High performance and features**
  - 1.25M triangles per second
  - 1280x1024 24-bit DB, 24-bit Z
  - 16MB frame buffer
  - Trilinear MIP-mapped textures
  - 4 MB texture memory
  - Single PCI slot
- **Digital UNIX and Windows NT**
- **Multi-head support (UNIX)**
- **AlphaServer support**
- **Stereo**

PowerStorm
4D51T

Description: Advanced 3D graphics with OpenGL 1.1 acceleration for UNIX and Windows NT on Alpha workstations and servers. Single slot

Key Features: 1280x1024 resolution, true color double buffered. 3D shading and texture mapping, including TriLinear MIPmapping, supporting up to 32MB texture memory (0MB standard). 24bit Z-buffer and 4bit double buffered overlay planes. Single PCI board.

Target Markets: MCAD, especially solid and surface design. MCC, especially animation and modeling. GIS, especially 3D. Scientific Visualization. Visual Simulation.

Where to Use: Where high performance, affordable 3D graphics is needed for UNIX and Windows NT. Use for shading and texture mapping. Use when display resolution does not exceed 1280x1024. Use where single slot solution is required.

Alternatives: 4D60T: high resolution, large texture memory, high resolution stereo. 4D30T: lower cost, Windows NT. 4D10T: lower cost, less demanding 3D. HiFIVE: anti-aliasing, specular highlights, higher performance.

Part Number	SN-PBXGI-AD, PBXGI-AD
US List Price	$3,495
O/S	NT-A, UNIX
Platforms	AS 500, AS 600, DPWSa
Workstation Class 3D	Y
3D Support	OpenGL 1.1
Bus Interface	PCI
# Slots	1
Video Memory	16 MB
HW Texture Mapping	Yes
Highest Texture Mode	Trilinear
Std. Texture Memory	4 MB
Max Texture Memory	32 MB
Max Resolution	1280x1024
Max Refresh (1280x1024)	85 Hz
Stereo	Yes, OpenGL
Video Layout	
Color Planes	24 bit DB
Z-buffer	24 bit
Overlay Planes	4 bit DB
Stencil Planes	8
Alpha Planes	8
Window ID Planes	4
Fast Clear Planes	2
Total bits/pixel	102
Hardware Performance	
3D Vectors/sec	2.7 M
3D AA Vectors/sec	1.4M
25 Pixel Triangles/sec	1.25 M
50 Pixel Triangles/sec	890 K
Texture fill rate	
Trilinear texture fill rate	38 MT
ViewPerf Performance	
CDRS	51.5
DX	11.6
DRV	6.7
Awadvs	15
Light	1.34

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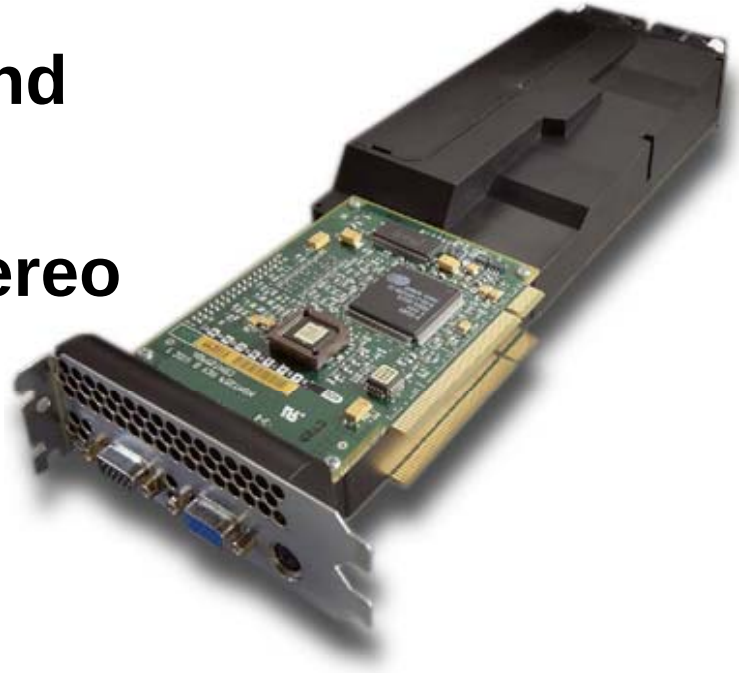
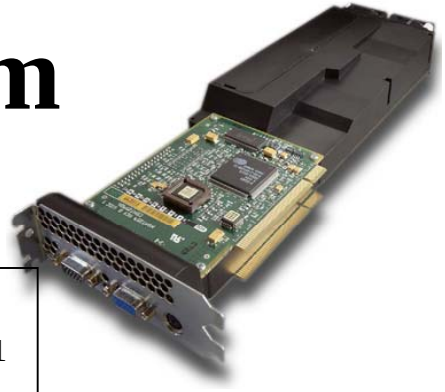
PowerStorm 4D60T

- Leadership performance and features
- High resolution, superb stereo
- New base price: $5,995
  - Includes 16MB texture memory
  - Upgradable to 32 or 64MB
  - Windows NT and UNIX
- Brings high-capability and performance graphics to midrange price-points



PowerStorm

4D60T



Description: Advanced high resolution 3D graphics with OpenGL 1.1 acceleration for Digital UNIX and Windows NT on Alpha workstations

Key Features: 1920x1200 resolution, true color double buffered. 3D shading and texture mapping, including TriLinear MIPmapping, with 16MB texture standard, 64 MB texture max. 24/32 bit Z-buffer and 8bit double buffered overlay planes.

Target Markets: MCAD, especially solid and surface design. MCC, especially animation and modeling. GIS, especially 3D. Scientific Visualization. Visual Simulation.

Where to Use: Use where high resolution and large texture memory are required. Industry leading stereo capabilities. Excellent support for UNIX and Windows NT on Alpha workstations.

Alternatives: 4D30T: lower cost, high performance on NT. 4D50T: lower cost, lower resolution. 4D10T: lower cost, less demanding 3D. Road Warrior: anti-aliasing, specular highlights, higher performance.

Part Number	SN-PBXGI-AC
US List Price	$5,995
O/S	NT-I, NT-A, UNIX
Platforms	AS 200, AS 250, AS 255, AS 500, AS 600, DPWSa, DPWSi
Workstation Class 3D	Y
3D Support	OpenGL 1.1
Bus Interface	PCI
# Slots	2
Video Memory	32 MB
HW Texture Mapping	Yes
Highest Texture Mode	Trilinear
Std. Texture Memory	16 MB
Max Texture Memory	64 MB
Max Resolution	1920x1200
Max Refresh (1280x1024)	85 Hz
Stereo	Yes, OpenGL
Video Layout	
Color Planes	24 bit DB
Z-buffer	32-bit
Overlay Planes	8 bit DB
Stencil Planes	8
Alpha Planes	8
Window ID Planes	4
Fast Clear Planes	2
Total bits/pixel	128
Hardware Performance	
3D Vectors/sec	2.7M
3D AA Vectors/sec	2.07 M
25 Pixel Triangles/sec	1.25M
50 Pixel Triangles/sec	1.22M
Texture fill rate	
Trilinear texture fill rate	38 MP
ViewPerf Performance	
CDRS	49.01
DX	11.47
DRV	7.22
Awadvs	15.38
Light	1.35

FY99 Workstation Graphics Roadmap

- Advanced 3D Features
  - Full scene antialiasing
  - Specular highlights
- Specialized Markets
- NT and UNIX

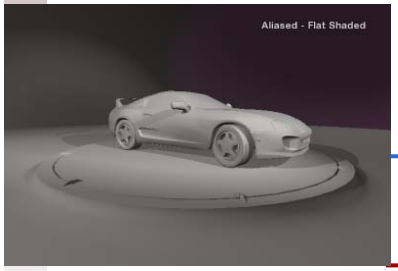
3D Visualization Graphics Subsystem

5D10T,5D20T, HR 4M tri/sec
2M,4M AA tri/sec

- 3D Feature Set with high resolution and large texture memory
- MCAD, MCC, GIS, Scientific Visualization
- NT and UNIX

Performance 3D with Large Frame Buffer and Texture Memory

4D35T 4M tri/sec 32MB texture max.
4D60T 1.2M tri/sec 64MB texture max. (2 board set)
4D51T 1.3M tri/sec 16MB texture max.
4D50T 1.2M tri/sec 32MB texture max. (2 board set)



- 3D Feature Set
- MCAD, MCC, GIS, Scientific Visualization
- NT and UNIX

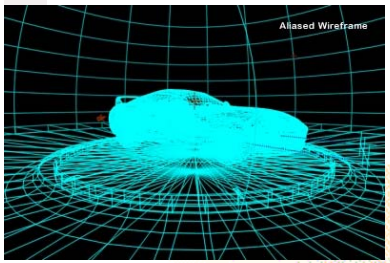
Value 3D with Texture Mapping

4D35T 4M tri/sec 4MB or 16MB texture
4D30T 2M tri/sec 4MB or 16MB texture
4D40T .5M tri/sec 4/16/32MB texture (2 board set)

- NT and UNIX

Entry 3D with Texture Mapping

4D15T 2M tri/sec16MB frame buffer max.
4D10T 1M tri/sec 8MB frame buffer max.



- Alpha-like Leadership Graphics Performance on Intel Platforms

Graphics Acceleration on Intel

4D31T GFX 3M tri/sec (Digital Alpha-GAB)
4D51T GFX 1.3M tri/sec (Integraph-DSP

- Cross Market
- OVMS/UNIX

Wireframe 2D

4D20 .8M tri/sec
3D30

The LEADER in VISUAL COMPUTING

Generation 2
Generation 3
Generation 4

Q4 FY98	Q1 FY99	Q2FY99	Q3FY99	Q4 FY99

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What Do User's Use?

Based on 1997 CGW CAD/CAM survey of 1,000 subscribers

- **3D modeling was very important to 75%**
- **For those who do 3D CAD**
  - **89% used solids**
  - **76% used surfaces**
  - **74% used wireframe**

- **And**
  - **47% consider styling and surface design features as very important when they select their CAD software**
  - **71% consider concept design as important**

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Graphics Realism: *the New Frontier*

- Faster is not better, just faster
- Computer design and visual analysis need a *faithful reproduction of real world objects*
  - Less price sensitive applications
  - For some applications, the feature requirement supersedes price sensitivity
- Realism requires a unique feature set
  - To be useful, it must be ***interactive***

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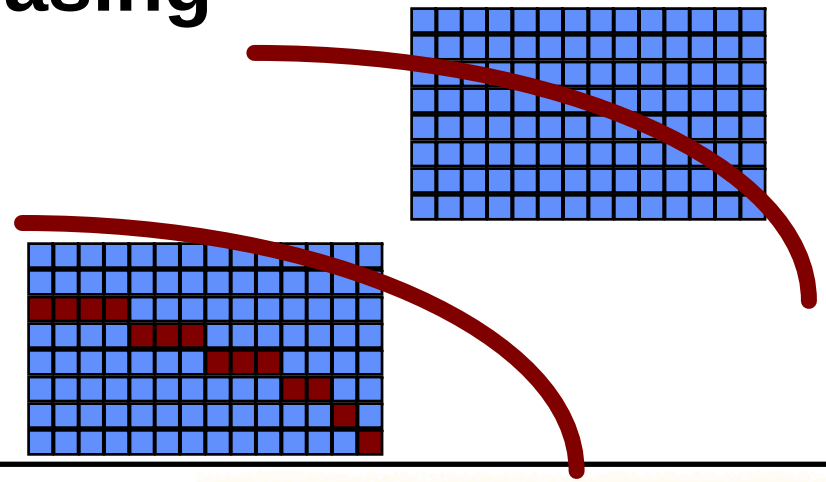
Realism - Faithful Reproduction

- **Reproduction of objects**
  - Removing the artifacts caused by raster display technology “aliasing”
- **Full scene antialiasing**
  - Critical to surface design!
  - Critical to eliminate “jitters”



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Realism - Lighting Effects

- **Specular highlights**
  - Reflections on objects of “hot lights”
- **Background reflection mapping**
  - Surface reflection of the surrounding environment
- **Critical to understand surface “fairness” and “integrity”**
  - Analysis of movement of light or background across surface
  - Must be interactive and smooth
  - Quickly shows surface defects

Realism - Transparency and Shadows

- **Ability to faithfully reproduce opaque and semi-opaque objects**
  - **Correct rendering of overlapping transparent surfaces**
  - **Maintain antialiasing through transparent surfaces**
- **Shadows provide additional visual depth cue**
  - **How objects are positioned to one another**

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DIGITAL Presents Hi-FIVE

High Fidelity Interactive Visual Environment

- **Offers the highest model realism available on any graphics system, including:**
  - **Full-scene polygon anti-aliasing eliminates jagged lines**
  - **Background reflection mapping needed to evaluate surfaces**
  - **Multiple layers of transparency for aesthetics and visual analysis**
  - **Shadows for model realism**
- **All real-time for full performance and value**

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HI-FIVE TECHNOLOGY
The Visible Difference

Today, state of the art real-time workstation graphics look like this

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Hi-FIVE Graphics

With PowerStorm Hi-FIVE, interactive graphics look like this -- at 30 frames per second

WORKSTATIONS

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Graphics Product Segmentation - GFX

- **GFX Is:**
  - **Geometry accelerator options for Digital's Intel based Personal Workstations**
  - **Designed to deliver full graphics performance on Digital's Intel-based Personal Workstations**
  - **Two generations of products**
    - **4D51T GFX based on DSP technology**
    - **4D31/35T GFX based on Digital's Alpha chip**
- **Works with 3D graphics card**
  - **GFX does high level functions for transformation and lighting**
  - **Graphics card does low level functions**
- **A cost-effective way to achieve highest possible levels of graphics performance**

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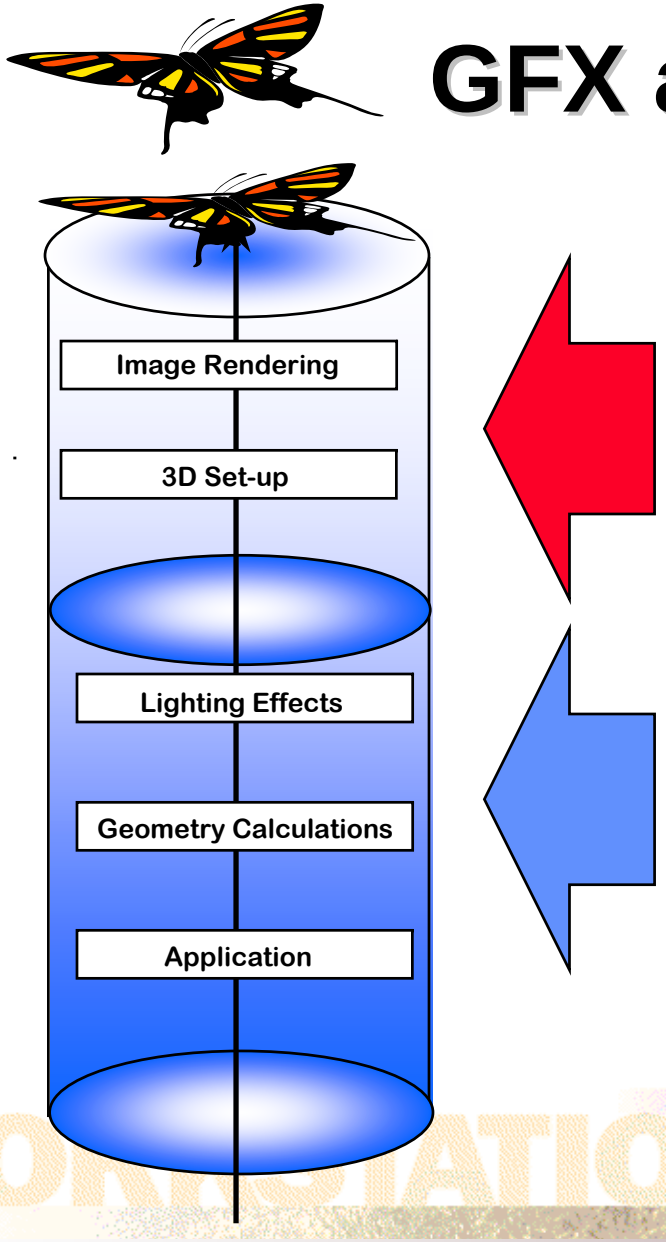
GFX and PowerStorm:



PowerStorm Graphics use custom chips to drive rendering "back-end" of OpenGL pipeline

GFX performs matrix and lighting calculations and drives applications

GFX offloads host processor

Host processor dedicated to application

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Alpha-based GFX Key Features

- 667 MHz Alpha PCA57 processor
- 32 MB SDRAM memory/2 MB cache
- 64 bit PCI interface (256 MB/sec)
- Full OpenGL 3D pipeline
  - Complete OpenGL implementation, with all features and capabilities
  - Highly optimized software originally developed for Alpha workstations
- 4D31T and 4D35T graphics hardware

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Technology's Nice

- **But who can afford it!**

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Workstation Cost

- Purchase price
- Upgrades
- Support
- Software
- Maintenance and warranty
- Ability to do all tasks
- TCO (with a grain of salt)
- The User

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TCO of a Coffee Pot

- Purchase Price: $25.00
- Coffee and Supplies: $48 per year
- Drinking coffee: 3 cups/day @ 8 minutes/cup: $4,183 per year
- Making coffee and cleanup: 15 minutes/day: $2,612 per year
- 5 year TCO: $34,240

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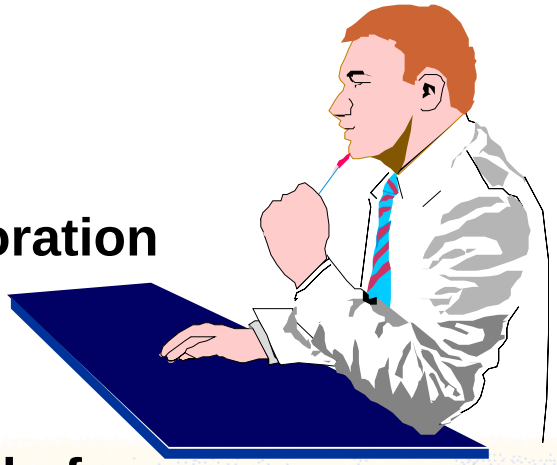
Workstation Economics

- Technical user costs $150K-$200K/year (burdened cost)
- Workstation 30%-100% faster than PC
- Direct productivity improvement:
  - $65K/year: $325K/5 years
- Payback time, $20K workstation vs $6K PC:
  - Under 3 months
- 5 year ROI: 2,170%

Hard Benefits/Soft Benefits

- **Hard Benefits**
  - **Measured using traditional metrics: Productivity, Efficiency, ROI**

- **Soft Benefits**
  - **Difficult to isolate and measure:**
    - **Better understanding**
    - **Better communications and collaboration**
    - **Improved design quality**
    - **Improved marketability**
    - **Doing things that couldn't be done before**



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In Summary:

- Not workstations *or* PCs
  - Best tool for specific user
- Workstations are fast
- Workstations graphics centric
- Decisions must be *User* focused
  - *User* is most critical component
  - *User* is most expensive component
  - System is there to make *user* more effective

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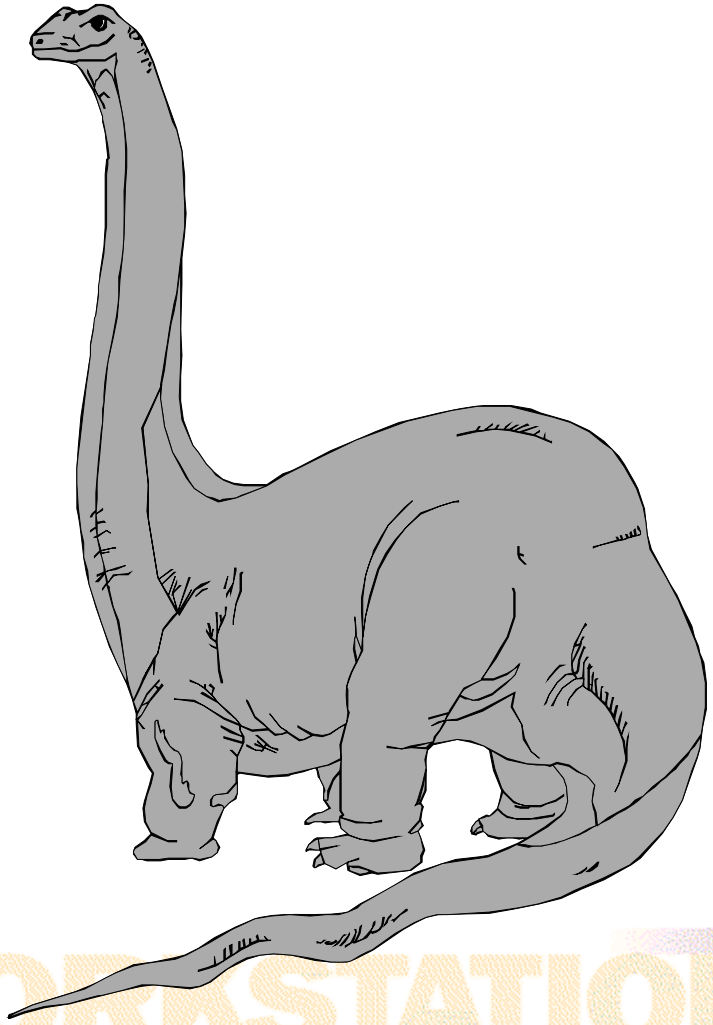
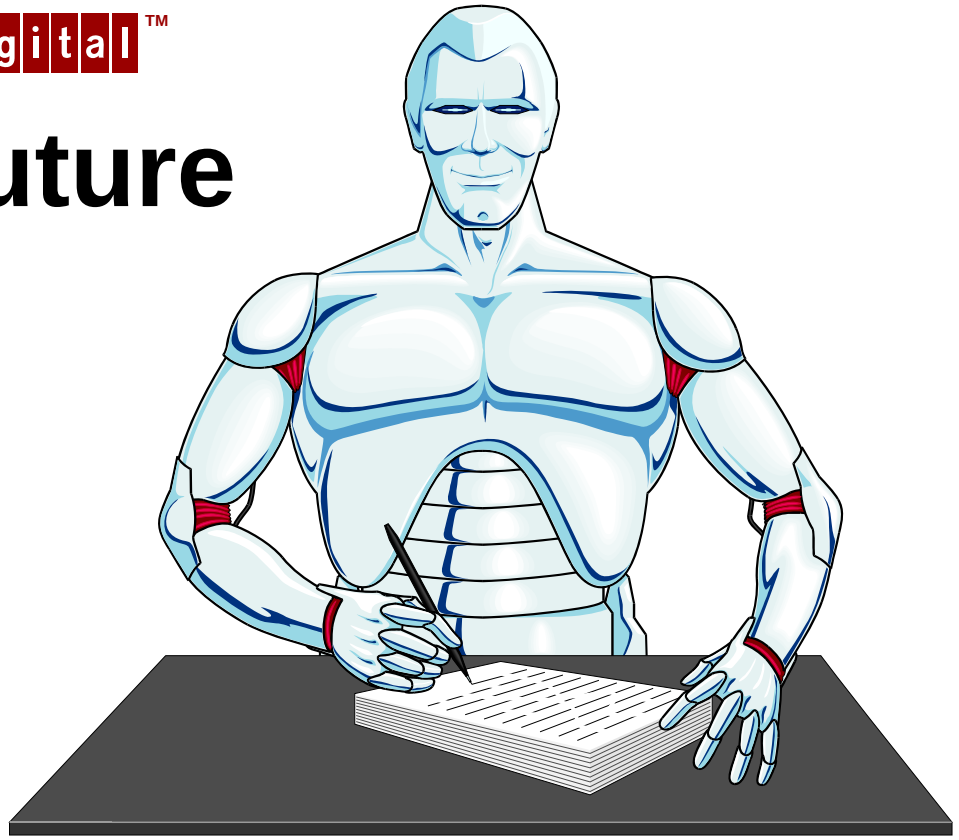
Choose your future





WORKSTATIONS

The LEADER In VISUAL COMPUTING

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Example: *Real Time Animation*

- **Demanding Application**
- **SGI too slow & too expensive**
- **Digital has systems & graphics**
- **Digital willing to work with ISV**

LEADING THE NEXT GENERATION OF VISUAL COMPUTING !

Digital Equipment Corporation

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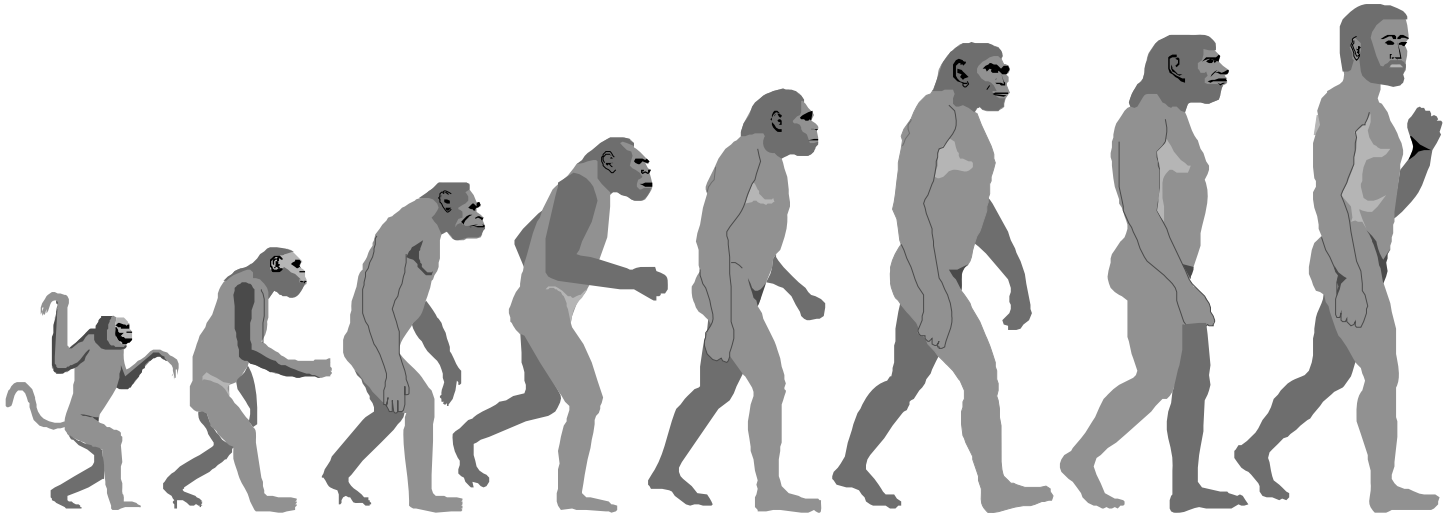
Consider an example...



The evolution of

Computer Aided Design

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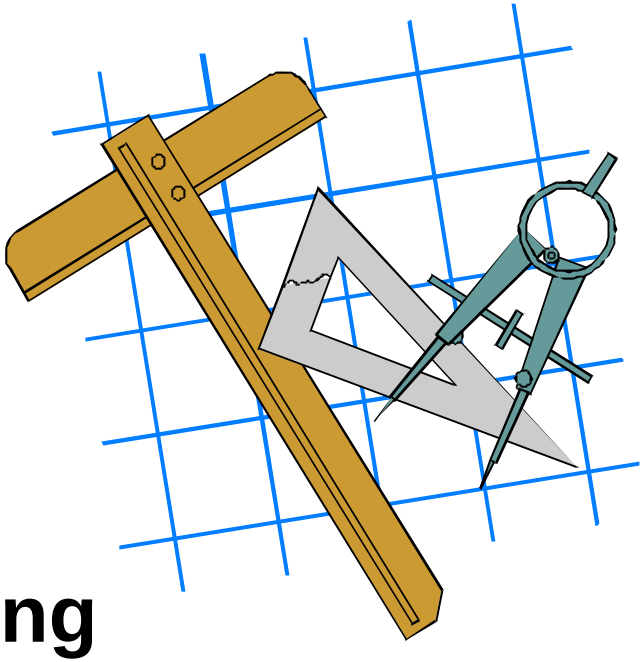
CAD Tasks



- Drafting
- 3D Design
- Surface and Solid Modeling
- Assembly Design
- Analysis (FEA, DFM)
- Large Assembly Design and Configuration Management
- Industrial Design

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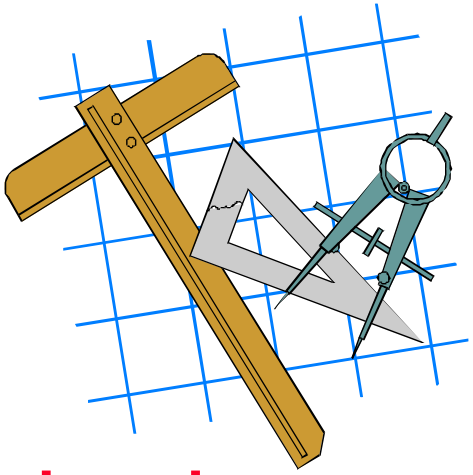
CAD Systems



- Drafting — PC
- 3D Design — PC or Entry Workstation
- Surface/Solid Modeling — Workstation
- Assembly Design — Workstation
- Analysis (FEA, DFM) — High End Workstation
- Large Assembly Design and Configuration Management — MP and High End Graphics
- Industrial Design — WS and Specialized Graphics

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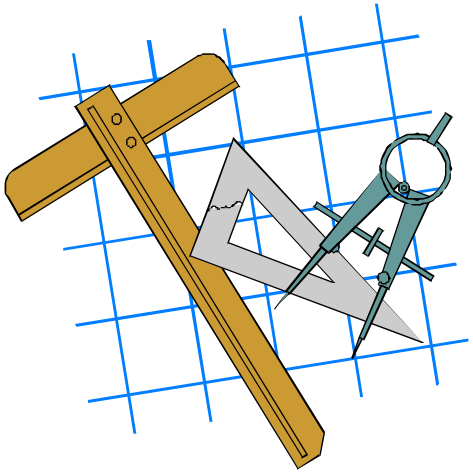
CAD Users



- **Drafting** Large user base
- **3D Design** Large user base
- **Surface/Solid Modeling** Medium user base
- **Assembly Design** Medium user base
- **Analysis (FEA, DFM)** Small user base
- **Large Assembly Design and Configuration Management** Very Small base
- **Industrial Design** Very Small user base

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Secret of Design Success: *"Making more mistakes"*

- Design is an *iterative* process of *refinement* and *change*
- Design builds on *existing foundations*
- Design builds on *itself*
- View of *overall design* vital
- *Cross functional* design valuable
- *Collaborative* design valuable