

CTE: Hardware Options

A modern CTE Innovation space requires robust hardware to truly train today's students to thrive in tomorrow's workforce. The following is a list of some of the components necessary in creating a diverse and dynamic CTE workspace.

Windows 10 PC

Of all the available device form factors, PCs are the most appropriate for building 21st century skills as they can more easily accommodate extremely resource intensive features such as 3D graphics, video editing and various image-based applications.

- CPU: 64-bit multi-core processor with SSE4.2 instruction set and running 2Ghz or faster
- Memory: 8 GB RAM minimum with 16+ GB strongly preferred
- Storage: SSD drives are highly recommended. Free disk space for software installation varies greatly, but 100 GB is not uncommon. If an SSD is not an option, 7200 RPM Hard Disc Drive (HDD) hard-drive would be considered a minimum for many graphics and video-editing tasks
- Monitors: 1920x1080 or higher resolution with 32-bit color. Many apps such as those used for video editing and 3D animation perform better with two monitors. Refresh rates for gaming (144 Hz - 240 Hz) are generally faster than those needed for image-editing and graphics creation. Generally speaking, a 60MHz refresh rate is fine for most workflows including video-editing. Monitors for graphic design also usually employ an in-plane switching (IPS) or plane to line switching (PLS) for better color accuracy and contrast ratio (as opposed to the older TN standard)
- It's worth noting that 4K monitors come in two sizes with slightly different aspect ratios. DCI 4K is more of a film standard and its 4096x2160 pixel

resolution results in a 256:135 aspect ratio. Most video cameras record on the UHD 4K standard at 3840x2160 px which is the standard 16:9 aspect ratio most common on TV and YouTube, etc.

- GPU/Graphics cards: Must support Open GL 3.3 or higher. Having as much onboard memory (vRAM) as possible also assists performance. 8 GB would be considered a minimum for many graphics intensive applications and especially for anything 3D. It should support multiple monitors through HDMI, VGA, DCI or Display Port

Input Devices

- Mouse: Most 3D software apps require a three-button mouse to access even basic functionality. Within this restriction, there are plenty of options including trackballs, scroll-wheels, etc. Most 2D design apps do not require a three-button mouse however
- Stylus Tablets: In order to fully take advantage of much functionality within image-editing apps, a pressure sensitive stylus is required. This is more common in 2D graphics software such as Photoshop or Corel Painter. Several companies including Wacom and Huion offer products which allow users to interact directly with the display screen using from 2048 to a whopping 8192 levels of pressure sensitivity. It's possible to configure a Wacom pen to behave like a three-button mouse as well as set unique behaviors for individual apps

Tablet Options

Summary: Generally speaking, tablets do not have the same capabilities or affordances as desktop and laptops for working with more resource intensive graphics applications, but they are nonetheless, increasingly powerful and utilitarian tools for a great many design tasks.

- Android/iOS (for app building)
- iOS
- Microsoft Surface Pro 6 - 12.3" Tablet Computer (Intel Core i7-8650U, 8 - 16GB RAM, 256GB - 1TB SSD storage, 2736x1824 resolution, Intel Graphics, Windows 10)
- Apple iPad Pro - 12.9" (2732x2048 resolution, 64GB - 1TB storage, 64-bit A12X Bionic Chip CPU with embedded M12 coprocessor, 4-6GB RAM)
- Wacom MobileStudioPro - 13" and 16" models (2560x1440 and 3840x2160 resolution respectively. Intel i5 or i7 processor, 4GB - 16GB RAM, 64-512GB SSD storage, Intel Iris or NVIDIA Quadro M600M or M1000M graphics card. 8192 levels of pressure sensitivity and integrated 3D Scanning Camera)
- Samsung Galaxy A with S Pen Tablet (16-256GB storage, 3GB RAM, Android OS)

*NOTE: The following pen tablets are both input devices and displays that connect to your computer. They are not standalone devices like an iPad or other tablet PCs. These are all pressure sensitive tablets which work with a pen or stylus. Mac and PC compatible.

- Wacom Intuos Pro Digital Graphic Drawing Tablet
- Wacom DTH1320AK0 Cintiq Pro 13" Creative Pen Display
- Huion INSPIROY Q11K Wireless Digital Graphics Drawing Pen Painting Tablet

- Huion GT-191 KAMVAS Drawing Tablet with HD Screen (19.5" display, 8192 levels of pressure sensitivity, 1000:1 contrast ratio, and 1980x1080 resolution)

3D Printers

Summary: Most 3D printers intended for home, education and prosumer markets (under \$4,000) build 3D objects out of successive layers of molten plastic. This technique is known as Fused Filament Fabrication (FFF) and sometimes by the trademarked term Fused Deposition Modeling (FDM). Some 3D printers employ an alternative, Stereolithography instead. 3D printing resolution is measured in microns where 0.001 equals 1mm. Most 3D printers are currently able to print at 200 microns with many capable of 100 microns or better.

- MakerBot Replicator + (FDM @ 100 microns resolution)
- XYZ Printing Da Vinci Mini (FFF @ 100 microns resolution)
- Ultimaker 2+ (FDM @ 20 microns resolution is higher professional grade)
- FlashForge Creator Pro (FDM @ 100 microns resolution)
- Cube Pro Trio (FDM @ 70 microns resolution Unlike the printers listed above, this printer is able to create objects in as many as three colors)
- Dremel DigiLab 3D45 (FFF @ 50 microns resolution)
- FormLabs Form 2 (Stereolithography @ 25 microns resolution)

Apparel Printers (screenprinting)

- Kornit Breeze
- Epson F2100
- Brother GTX
- Col-Desi (DTG Digital) M2
- M&R M-Link X

Large Format Printers

- Epson SureColor P20000
- HP DesignJet Z9+ 44" Large Format Color Printer
- Canon imagePROGRAPH PRO-2000
- HP DesignJet T120

3D Scanners

Summary: 3D scanners analyze real world objects and convert the collected data into files which can then be used to construct virtual computer models. Uses include medical, hobby, motion-capture for film, industrial design and prototyping. Common output formats are OBJ, STL, and ASC. 3D software apps can then be employed to further refine and/or edit these models.

- Matter and Form MFS1V1 (Desktop Max resolution is 0.43mm and output is STL)
- EinScan Pro (Handheld Max resolution is 0.16mm and outputs OBJ, STL and ASC)
- RangeVision Smart (Desktop Max resolution is 0.12mm and outputs OBJ, STL and PLY)
- 3D Systems Cubify Sense (Handheld Max resolution is 0.9mm and outputs OBJ, WRL, STL and PLY)

VR Headsets

Summary: Virtual Reality (VR) headsets come in both tethered (cord) and untethered varieties with the former generally providing a better experience. There are many factors to consider including resolution, refresh rate and display technology (LCD, OLED or AMOLED).

- Oculus Quest (2880x1600 @ 72 Hz), Oculus Rift (2560x1440 @ 80 Hz) and Oculus Go (2560x1440 @ 72 Hz)
- HTC Vive (2160x1200px) and HTC Vive Pro (2880x1600 @ 90 Hz)
- Acer Windows Mixed Reality Headset (2880x1440 @ 90 Hz)
- Samsung HMD Odyssey (2880x1600 @ 90 Hz)