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Diana D. Glawe

Trinity University, dglawe@trinity.edu

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Mobile Design Station and Teaching Wall

Diana D. Glawe, Ph.D., P.E., LEED AP

A versatile, robust, and mobile design station can be economically constructed by integrating off-the-shelf components with a clever custom framework. Ten such design stations are performing wonderfully in the new Center for the Sciences and Innovation at Trinity University. Each unit supports the engineering design process from brainstorming and prototype design through construction and testing. The unit includes a permanent whiteboard; a removable whiteboard; a flat-screen display; power outlets; data ports; storage for tools, supplies, and student backpacks; and a compartment to house electronic equipment hardwired into the unit. All this and a custom worktable may be had for under \$15,000. A similarly constructed teaching wall was created for under \$18,000.

Background

Engineering design is a core focus of the Engineering Science Department curriculum at Trinity University. The Center for the Sciences and Innovation supports this focus through a comprehensive building design by EYP Architecture and Engineering, which supports the entire engineering design process in one integrated space, as shown in Figure 1.

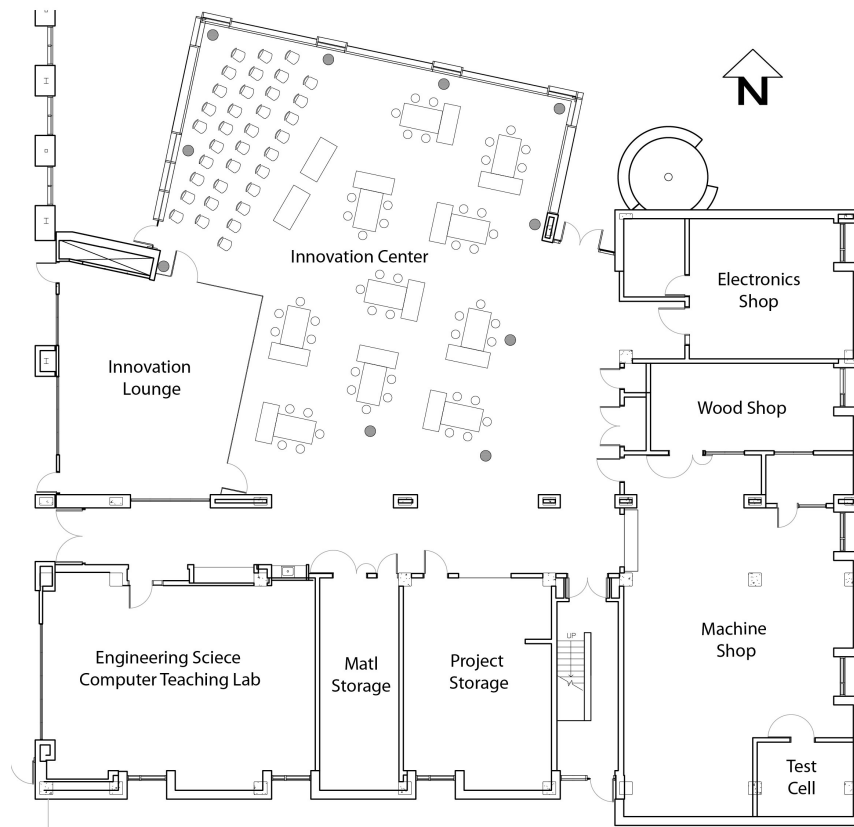


Figure 1. Engineering design space showing the Innovation Center with design stations, worktables, and teaching wall locations.

The ten design stations in the 3,963 square foot Innovation Center serve as the hub of the design process. These stations are the collaborative creation of Trinity University faculty and staff working with Design and Assembly Concepts, the distributor for Item America. Each station is best suited for a team of five students, but a few extra seats can be added when needed. Students can brainstorm as a group, conduct online research, complete computer-aided design schematics and analysis, fabricate components, assemble projects, test their prototypes, and modify designs at each design station. The arrangement of the design stations in the Innovation Center provides a level of privacy for each group.

Students can perform light fabrication and assembly on the worktable at each design station or at the worktables at the periphery of the Innovation Center and in the adjacent Machine Shop. Common hand tools and ancillary supplies are stored in the drawers of each design station. Locks on the design station drawers allow engineering students to secure tools so other groups can use the Innovation Center during open periods without safety concerns. Large and specialized equipment is housed in the adjacent machine, wood, and electrical shops for use under the supervision of full-time technicians.

Because 175 to 200 engineering students share this space each semester, a secure storage room was built for students to store their projects when they are not working on them, thereby clearing the design stations for others to use. A thoughtful schedule allows ample dedicated class-time and open studio time for students in four different engineering design courses per semester to work on their projects. Locking casters on the design stations, associated worktables, and teaching walls facilitate clearing the Innovation Center for University events. The stations and teaching walls can be rolled to other areas in the building, such as the atrium, for University functions, to provide a flat screen for presentations, or to serve as a temporary information kiosk. Despite each design station and teaching wall weighing a little over 1,000 lbs., rolling the stations across level ground only requires one person; however, two are recommended for better maneuverability.

The design station, worktable, and teaching wall are registered under a Creative Commons Attribution 4.0 International License (CC-BY), <http://creativecommons.org/licenses/by/4.0/>. This license gives others the right to share, use, and even build upon work created. Design and cost details can be found on the Trinity University digital commons, http://digitalcommons.trinity.edu/engine_faculty/8/.

Design Station Features

Although the design stations were created to support the engineering design process, the versatile, robust, and mobile design is well suited for group work in any discipline. Moreover, the design stations are economically constructed by integrating off-the-shelf components with a custom framework. See Figure 2.



Figure 2. Design station and worktable

The base of the design station is a commercially available heavy-duty steel cabinet, typically used to store tools. These are available in many colors, sizes, and drawer configurations. The height, length, and width of the cabinet was selected to accommodate a 4' high by 6' wide whiteboard above the cabinet and still fit through a standard 83" high and 36" wide door opening. The overall dimensions of the design station are 74" wide by 29" deep by 82" high. The cabinet is comprised of three sub-cabinets. Two sub-cabinets open from the back of the design station to avoid interference with the worktable at the front of the design station. Each of the three sub-cabinets has a lock to secure supplies in the drawers. The bottom drawer of the sub-cabinet on the right side was removed to create an Information Technology (IT) compartment to house data and power components. The IT compartment contains a surge protector, a digital media transmitter, a digital media receiver, and a controller for the display. A false front door panel is held in place with magnets for easy access to the IT compartment. Data and power cables run through a custom vertical chase on the inside of the cabinet that extends from the IT compartment to a custom chase on top of the cabinet. The power and data cables are connected to power outlets and data ports integrated into the custom framework atop the cabinet. The other end of the data and power cables exit the bottom of the cabinet through an umbilical casing connected to a floor box. The data cables entering the floor box are connected to the University network. Twenty-eight

floor boxes are distributed throughout the Innovation Center to provide flexibility for location of design stations and teaching walls. The associate worktable height of 36" falls just below the height of the power outlets and data ports, permitting easy access. The overall worktable dimensions are 72" long by 42" wide by 36" high. The top of the worktable is a 1½" thick butcher-block work surface suited for fabrication, assembly, and testing of design project prototypes. The top can be sanded and refinished to remove damage caused over time by activities such as clamping and cutting.

A custom aluminum framework mounted atop the base cabinet supports the rest of the functions of the design station. A durable porcelain-coated whiteboard forms the upper backside of the design station. This whiteboard can be used by the students at the adjacent design station or the students at their respective design stations. A vertical wall in the center of the design station serves multiple purposes. The space between the vertical wall and the whiteboard on the backside of the design module functions as storage space for students' backpacks on one side and a storage space for removable whiteboard panels on the other side. The vertical wall includes two vertical supports for a flat screen display mount, which can be easily adjusted up and down. A 1K-resolution flat screen display was selected for the design stations. The controller for the flat screen display includes a security feature that automatically sends a message to campus police and IT personnel if the display is disconnected from the design station. A custom rail on the top front member of the custom framework was designed to accommodate the hanging brackets on commercially available whiteboard panels. If student activities require a whiteboard facing towards the worktable instead of a flat screen display, the students simply hang whiteboard panels from this front rail. The whiteboard panels can also be placed flat on the tables and used as a large writing tablet or carried to a space outside the Innovation Center, such as the adjacent Innovation Lounge, for a more casual design discussion. Whiteboard marker trays are secured to the design stations by a magnetic mount.

The bottom front member of the custom framework houses ten 20-amp electrical outlets, five data ports, and one HDMI input connection for the flat screen display. The 20-amp electrical outlets can be used to power tools, laptop computers, or other equipment. An additional electrical outlet located below the flat screen display mount provides power to the display. The custom chase atop the base cabinet protects and hides all the data and power cables. Because students have access to University licensed software on their laptops, it was deemed most effective to allow students to attach their own laptop to the flat screen display rather than including a dedicated computer in the IT compartment of each design station. Students can either attach their laptop to the data port on the design station or transmit data wirelessly via the University network. By either method, students can submit CAD files from their laptop computer to a 3D printer (located in the adjacent Engineering Science Computer Teaching Lab) for rapid prototyping. Future capabilities to push audio and visual signals from an instructor's podium, or any of the design stations, to other design stations can be enabled through the addition of cards to the data control device located in the IT compartment.

Teaching Wall Features

Two teaching walls separate the lecture and presentation area (located in the northwest corner of the Innovation Center) from the group work area in the center. The teaching walls are constructed in much the same way as the design stations with a few exceptions. The overall dimensions of the teaching wall are 74" wide by 33" deep by 100" high. See Figure 3.



Figure 3. Two teaching walls showing one with whiteboard in the up position and the other in the down position. (Flat screen display mount is not yet installed on vertical center rails.)

Each teaching wall includes: a larger display; a sliding whiteboard added to the front of the module to facilitate a quick change between flat screen display and whiteboard use; a slightly taller design to enable line of site to the whiteboards and display from the back of the lecture and presentation area; an interstitial space between the vertical wall in the center of the custom frame and the whiteboard mounted on the backside of the custom frame that houses 19" wide standard rack mounts for audio visual equipment so each teaching wall can become a stand alone audio visual unit; and a base cabinet with all the drawers directed towards the backside. The teaching walls are currently connected to a teaching podium equipped with a computer and document camera for lectures and presentations. A high-resolution (4K) display was chosen to facilitate viewing details of the images. The most common student presentations in this space are design reviews.

Please see Trinity University digital commons (http://digitalcommons.trinity.edu/engine_faculty/8/) for schematics and further details on the design stations, worktables, and teaching walls.