CAD for VEX Robotics

(updated 7/18/19)

The question of CAD comes up from time to time, so here is some information and sources you can use to help you and your students get started with CAD.

"COMPUTER AIDED DESIGN" OR "COMPUTER AIDED DOCUMENTATION"?

First off, the nature of VEX in general, is a highly versatile prototyping system, and this leads to "tinkerbots" (for good or bad, how many robots are truly planned out down to the specific parts prior to building?). The team that actually uses CAD for design (that is, CAD is done before building), will usually be an advanced high school team, juniors or seniors (and VEX-U teams, of course), and they will still likely use CAD only for preliminary design, then future mods and improvements will be tinkered onto the original design. The exception is 3d printed parts (U-teams only, for now) which obviously have to be designed in CAD. I will say that I'm seeing an encouraging trend that more students are looking to CAD design than in the past. One thing that has helped is that computers don't need to be so powerful and expensive to run some of the newer CAD software…especially OnShape.

Here's some reality: most VEX people look at CAD to document their design and create neat looking renderings of their robots. If you don't have the time to learn CAD, I suggest taking pictures. Seriously though, CAD stands for Computer Aided Design, not Computer Aided Documentation. It takes time to learn, which is why community colleges have 2-year degrees in CAD, or you can take weeks of training (paid for by your employer, of course). You will need to do more than watch a couple Youtube videos to become provicent. Basics, however, like assembling/constraining parts can be learned in a few hours, especially if you have a mentor to help out. To get started, modeling your existing robot(s) is a good way to learn, then you can do some real design work next year.

WHICH CAD SOFTWARE IS BEST?

ALL of the industrial CAD packages have free educational licenses, and **ALL** have VEX part libraries available. When somebody says "I use Inventor because it's free" they are really saying "Autodesk has a great marketing department!" There has to be more than "it's free" or "there are parts libraries" to make a good decision: I suggest you try some different software packages and see what works best. Other considerations include what computer you have (Soldiworks is a high-powered program that required a high end system while Onshape runs in the cloud and you can use a Chromebook), what kind of learning support you have (does your team have a mentor who knows a particular software), and what are your future goals (do you want to use CAD on the job?). It certainly doesn't hurt to learn a couple different CAD packages, like Inventor and Onshape, for example.

The major industrial CAD packages are SolidWorks, Onshape, Inventor, Fusion 360, and SolidEdge. SnapCAD is available for VEXIQ, to give an introduction to young students. (SnapCAD details are here: https://www.vexrobotics.com/vexiq/resources/cad-snapcad) It is my opinion that, with some guidance, Middle School students can learn SolidWorks or Onshape assembly well enough to build IQ Bots.

In southeast Michigan (center of the Automotive industry), most people use SolidWorks or Catia (Catia is optimized for working on curves and surfaces like car fenders). But elsewhere in the country, things are probably different. Check to see what your local community college is teaching, since they will do what local industry needs. We encourage our students to learn both SolidWorks and Inventor (and SnapCAD for the elementary IQ), but they all seem to prefer SolidWorks in the end. Onshape and Solid Edge are equivalent competitors to SolidWorks. Using Onshape is very much like SolidWorks, except it is cloud based, so it can run even on a Chromebook. Being equivalent parametric CAD packages, SolidWorks, Onshape, and Solid Edge can load each other's part and assembly files (but not drawing files), without loss of assembly data; however, a conversion will take place and you can't just switch back and forth. There is no compatibility with the Autodesk programs or "hobby" software (other than the universal file formats like .step). All the software packages can make files for 3d printing in the .stl format.

For SolidWorks, the most advanced CAD software in industry, you need a team sponsorship to get the software free. You'll generally get enough licenses for the entire team, and it is an annual renewal. The other CAD packages have free download links for students and educators that don't required the sponsorship.

SolidWorks link: www.SolidWorks.com/sw/education/all-student-competitions.htm .

Onshape link: https://www.onshape.com/products/education

Solid Edge link: https://www.plm.automation.siemens.com/plmapp/education/solid-edge/en_us/free-software/student

Inventor link: https://www.autodesk.com/education/free-software/inventor-professional

Fusion 360 link: https://www.autodesk.com/products/fusion-360/students-teachers-educators

FOR PARTS LIBRARIES, HERE'S WHERE YOU CAN FIND STUFF:

The official CAD for every part can be found on the products pages in www.vexrobotics.com. Go to the part listing in the catalog, and you can download a .step (.stp) format file of every VEX and VEXIQ part. "Step" is a universal ISO part format that can be imported to most any software package.

VEX Robotics does not have a "parts library" they only maintain the .step files for downloads. All other libraries are made by users: students, teams, mentors, and Autodesk engineers who have built (and sometimes maintain) unofficial libraries.

Autodesk's libraries include both EDR and VEXIQ parts and builds of the trainers. Here is where some "unofficial" parts libraries can be found (Inventor and Fusion can share libraries):
https://www.autodesk.com/education/competitions-and-events/vex/recommended-software#Kit-of-parts

The Purdue Sigbots created an **Inventor** library, with axis features added to the square holes to facilitate mating: https://www.mediafire.com/?222qx89cjxe3qe5

Here's an **Inventor** library by team 5062E that includes V5 parts:

https://drive.google.com/open?id=1MrJhDGJBQGRkEB-MyYnweJlluZD-xqxS

And another **Inventor** library by team 6142W:

https://drive.google.com/file/d/1Hb6ZZx6DezmiXDbrLP1zW8cwH4IPcGX6/view?usp=sharing

Team 2114A has created an **Onshape** library, details here:

https://cad.onshape.com/documents/5782e53fe4b0b7679dbf9f2c/w/b62de756a6f06dfc82b8fcef/e/bdbaf7b4a0cbf3da59b1e980

In **SolidWorks**, you'll find parts in the "3d Content Central", and also Team 7479 has worked on a library of parts here:

http://www.mediafire.com/download/3v7rf1xkqs7kh75/Team_7479_SolidWorks_Library.zip

The parts in the 7479 library have an extra circular feature which I added to the VEX square holes to allow rotating concentric mates to be made. Really soon, these structure parts with the circular hole will be in the Onshape library as well.

For a V5 update in **SolidWorks**, you'll find a complete V5 Clawbot Trainer model here:

https://grabcad.com/library/vex-robotics-v5-clawbot-1

You'll have to make a GrabCAD account to get it. This model has all the new V5 components except the camera, all as proper SolidWorks models. The assembly is mated for full motion. In this model, the structural parts do not have the circular features added: they are straight conversions from the VEX step files.

For V5 from **Inventor**, Lucas Lyra has uploaded a V5 clawbot trainer here:

https://gallery.autodesk.com/projects/134041/clawbot-v5---vex-robotics---robo-de-manipulacao-terrestre