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# CAD for College: Switching to Onshape for Engineering Design Tools

Kate N. Leipold
*Rochester Institute of Technology*

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**Ms. Kate N. Leipold, Rochester Institute of Technology (COE)**

Ms. Kate Leipold has a M.S. in Mechanical Engineering from Rochester Institute of Technology. She holds a Bachelor of Science degree in Mechanical Engineering from Rochester Institute of Technology. She is currently a senior lecturer of Mechanical Engineering at the Rochester Institute of Technology. She teaches graphics and design classes in Mechanical Engineering, as well as consulting with students and faculty on 3D solid modeling questions. Ms. Leipold's area of expertise is the new product development process. Ms. Leipold's professional experience includes three years spent as a New Product Development engineer at Pactiv Corporation in Canandaigua, NY. She holds 5 patents for products developed while working at Pactiv. Ms. Leipold's focus at RIT is on CAD and design process instruction.

# CAD for College:
# Switching to Onshape for Engineering Design Tools

Abstract:

*Engineering Design Tools aims to teach students to use industry standard CAD tools in the context of a design and build course. Previous versions of the course have been taught utilizing Creo Parametric. To alleviate install concerns, distributed team work, and the challenges of learning Creo in a short time frame, the class transitioned to utilizing Onshape. To quote the Onshape website - "Onshape is the first CAD system built for teams. Students can work in groups and edit models together simultaneously. Teachers can distribute assignments, review work and give feedback with ease. Additionally, Onshape keeps a complete history of changes so students will never accidentally lose work or overwrite each other's data."* [1]

*As Onshape was only released in 2014, there isn't significant adoption in industry. This is a concern that students and the department faculty share. The goal was to increase focus on CAD for College. By utilizing a package that can easily be used in other aspects of a student's college career, they might be more likely to "use it or lose it". This paper will address how the course incorporates concepts of lifelong learning to facilitate students expanding the topics learned in class to other CAD platforms that may be more desirable on a resume.*

Engineering Design Tools is a 3 credit lab course at the Rochester Institute of Technology. This course is typically taken by students in the 1st year of mechanical engineering and students pursuing a minor in mechanical engineering. The structure of the course is shown in Figure 1. The content is provided by two Mechanical Engineering faculty, one mechanical engineering staff member, and a group of undergraduate teaching assistants. The design project for the course is a robotic chime machine. CAD modeling techniques are demonstrated to enable team members to collaboratively design their chimes early enough to be able to build. Additionally, a full

| Monday | Tuesday | Wednesday | Thursday | Friday |
|---|---|---|---|---|
| CAD Lecture 50 min | CAD Lab 75 min | Design Studio 50 min | Machine Shop 75 min | Design Lecture 50 min |

*Figure 1- Engineering Design Tools Course Structure*

documentation and drawing package reflects the parts created in the context of the machining portion of the course. While incorporating these two projects, it's also the goal to learn good CAD design practice and techniques. Examples are shown of a robotic chime CAD design (Figure 2) and build (Figure 3). The machine shop build with the matching CAD model and shown later.

When the author started teaching CAD, it was a 2 credit lab course that met 4 hrs a week for a 10 week quarter. In this context, the CAD courses were taught with versions of PTC's 3D modeling software, ProEngineer, Wildfire, and Creo. In 2013 the school transitioned from quarters to

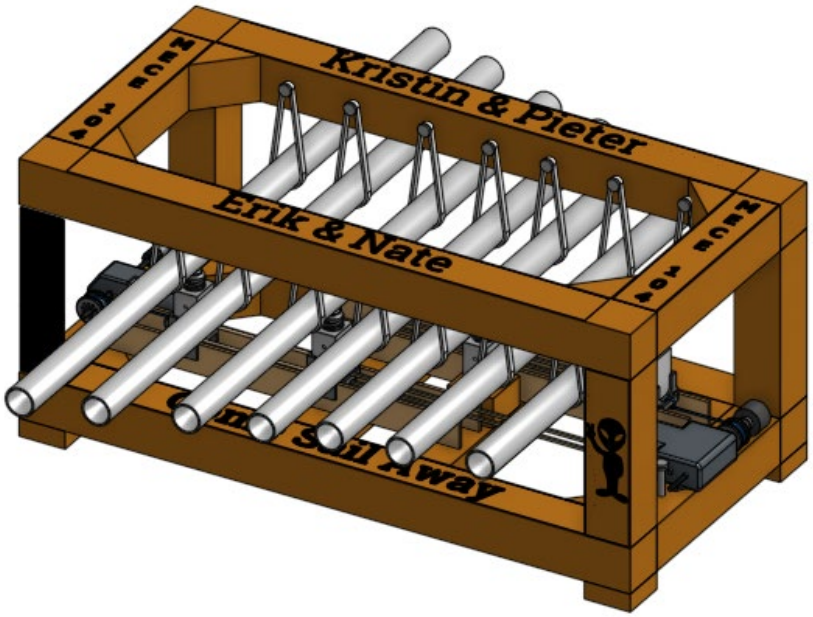


*Figure 2 - The CAD model of a completed chime model*


*Figure 3 -A completed chime machine*

semesters and several courses were consolidated. Several topics were omitted in the course consolidation. For 5 years, we continued to utilize Creo in the course. There was always issues in the beginning of the semester. Students without any knowledge of CAD systems struggled and fell behind quickly. The early weeks were frustrating dealing with licensing in the PC labs and students installing the software on home systems. Over these years, the author learned about Onshape as a browser based CAD option. The ease of use, the lack of install, and the free license for anyone made it an intriguing option.

A search of ASEE papers shows very little has been written with regards to using Onshape for a college CAD course. Dickrell and Virguez share why they selected Onshape for their Engineering Design and Society course - "Onshape was selected for the pilot course based on the combination of the software being free for students, exporting files well for 3D printer use, ease of online team collaboration, ease of linking solid modeling files into documents for faculty grading, and being a web based software, so there is no software installation required and it runs the same across various computer types." [2] The main topics of papers where Onshape is mentioned included work on direct modeling techniques [3], a tool to create models to 3-D print for visually impaired students [4], the availability of SolidProfessor videos [5], a model created for an Escape Room design [6], creating models for Statics instructions [7], and as a tool for helping High School students [8], [9]. Current literature mentions examples of Onshape being used, but does not explicitly discuss how Onshape was implemented, or examine the advantages and disadvantages of this new software.

To learn more about the feasibility of implementing Onshape in the first year Engineering Design Tools course, an independent study was conducted with a student to complete the existing Creo based projects in Onshape. The student found so much value in the offering, he introduced it to his Senior Design project team. The ease of use and focus on collaboration make it a valuable option. The transition to Onshape happened over the summer of 2018, with the first student offering in Fall, 2018.

One of the first hurdles to clear was how to have students submit their work. Onshape is cloud based. While you can export .stp files and other similar CAD files for use in other packages, there isn't a native Onshape file type. You share files by URL. Rochester Institute of Technology utilizes myCourses, which is a Brightspace product for course administration. Assignment dropboxes allow students to upload files for submission or text based submissions. While in the past students upload part files or assembly zip files, with Onshape, they submit URLs. To share the URLs, they need to set the appropriate permissions. We use a View setting, with Copy and Comment turned on, as shown in Figure 4. They create a "grading team" to set the permissions on a consistent basis.

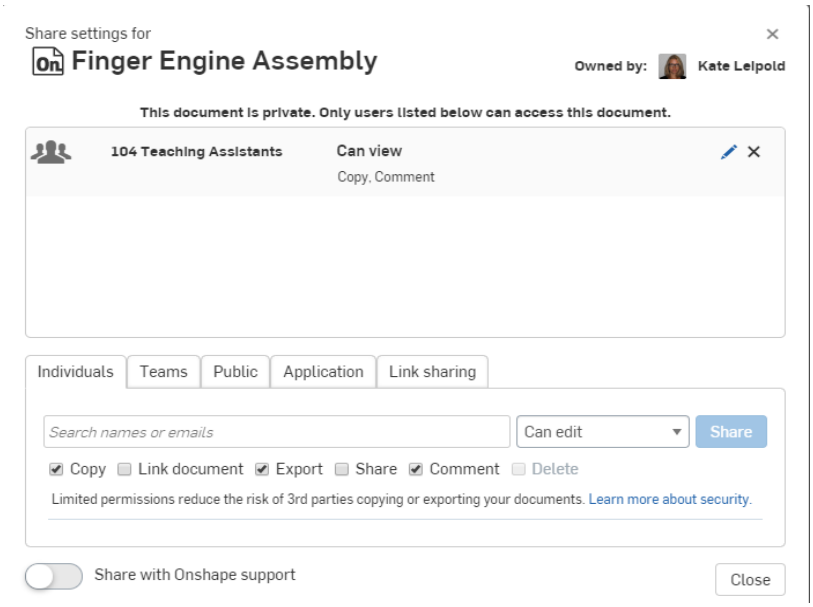


*Figure 4- View of Sharing Settings*

Onshape will save every move, meaning students don't need to remember to save. When they submit the url to the dropbox, changes they make after submitting to url would still be visible to the grader. The versioning system is a great tool to have students save a version when they are done with a homework, but continue to develop the project, while also introducing students to concepts of version control.

One of the main differences between Onshape and Creo is what is defined in a new file. Creo files contain a part or an assembly or a drawing. An Onshape document is more of a folder. There are tabs containing part studios, assemblies, drawings and other supporting documentation. Course instruction covers the same part, extrude, sketch, assemble, and drawing techniques that are common throughout all CAD packages. Onshape allows some interesting additions. Part Studios allow multiple parts to be created with the same sketches in the part studios. With the chime project, this enables very simple tools to design the chime frame.

Before chime teams start building, they need to have a CAD model of their design. Teams create a shared workspace which all team members can work in. Changes are tracked via the version history. Branching is seldom taken advantage of, but could be an option to explore multiple design ideas. With all students in a team having access to the current assembly revision, it's much easier for students, even ones without the lead or experience working in CAD, to access the group chime assembly. Anyone can access the latest designs for dimensions while working in the design lab. Another benefit for the team building the chime assembly is that the latest assembly designs are accessible from any browser, or on a phone or tablet through the Onshape app. The version control allows ease of comparison between where the original design started and where it ended up. We also request that students submit hand sketches of design ideas and

photos of final assemblies to the workspace. This final package makes an excellent show piece for potential employers.

The other workspace created and utilized throughout the semester is the Shop Finger Engine. Students work throughout the semester physically construction a finger engine device to learn machine shop safety and techniques, as shown in Figure 5. These same parts are created in Onshape throughout the semester – see Figure 6. They practice parts with materials assigned, standard holes, extrudes and revolves, purchased parts, assemblies, sheet metal techniques, and drawing packages. This comprehensive project, along with the physical model to match, is the culminating project in the CAD portion of the course. It's worth 3 homework grades. This ends up being another show piece we recommend students utilize when talking with employers.

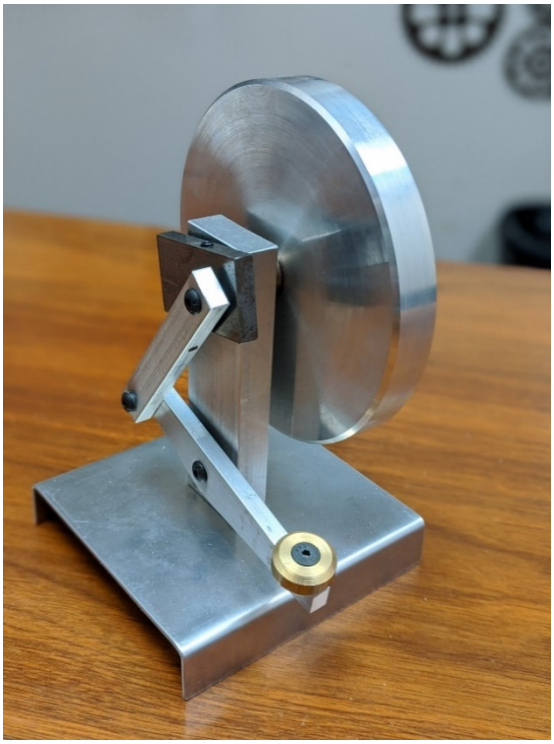

*Figure 5 - Machine Shop Build*

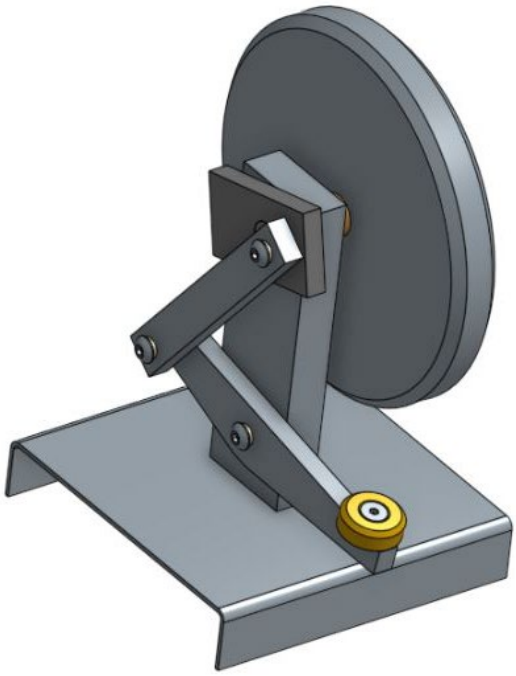

*Figure 6 - Machine Shop CAD model*

Other examples of design and build are 3D printed pumpkins and laser cut components for the chime assembly. All of these techniques are encouraged in this course and beyond. Students are encouraged to utilize the on campus "Construct" which is a student maker space. The university is building additional student maker spaces on campus in the coming years. This connection further exemplifies the "CAD for College" concept.

With the benefits of Onshape shown - installation, ease of use and collaboration, and better development of in class cohesion - there is one major drawback. Name recognition. Very little

industry is familiar with Onshape, and it's not typically a skill requested on job postings. This concern is heard frequently. The course has taken several steps to address this concern.

In the last week of the course, students are shown a simple part in SolidWorks and Creo Parametric. Students are shown how alternate CAD packages are similar in the tools they have been taught. Additionally, they are shown where to download SolidWorks, Creo Parametric, or Fusion 360 and how to access tutorials. The university has access to LinkedIn Learning with courses on Onshape, SolidWorks, Fusion 360 and more. These are recommended due to their certificates of completion and ease of access. All LinkedIn Learning courses are closed captioned, which is necessary for our student population. The university also has licenses to PTC University with online courses to develop skills in Creo Parametric.

At the end of the course students have skills to continue using a non-intimidating, easily accessible CAD package in subsequent courses, and for personal projects or university clubs. They are shown how to utilize a phone app to demonstrate in an interview setting that the CAD skills they learned are transferable to any CAD package. They are encouraged to take the initiative over the summer or winter breaks to fill in any perceived resume gaps on their own.

To help evaluate choices in the department regarding CAD package offerings, all mechanical engineering students were invited to participate in a CAD survey administered through Qualtrics. 224 students responded. The questions that were posed were:

- What year level are you? (Time spent, not credits)
- What aspects of CAD packages are important to you?
- Please select which is the MOST important to you.
- For each of the following CAD packages, please select the statement that best applies.
- For each of the following CAD packages, please select all the instances where you've used that package.
- For each of the following CAD packages, please select all the instances where you anticipate possibly using a CAD package in the future. If you do not anticipate using a CAD package, do not check any items.

Results are shown below. Unless otherwise stated, results are given as a percentage of responses.

### *Mechanical Engineering Student Survey on CAD Usage*

## Q1


*Figure 7 - Survey Question 1 Results*

## Q2

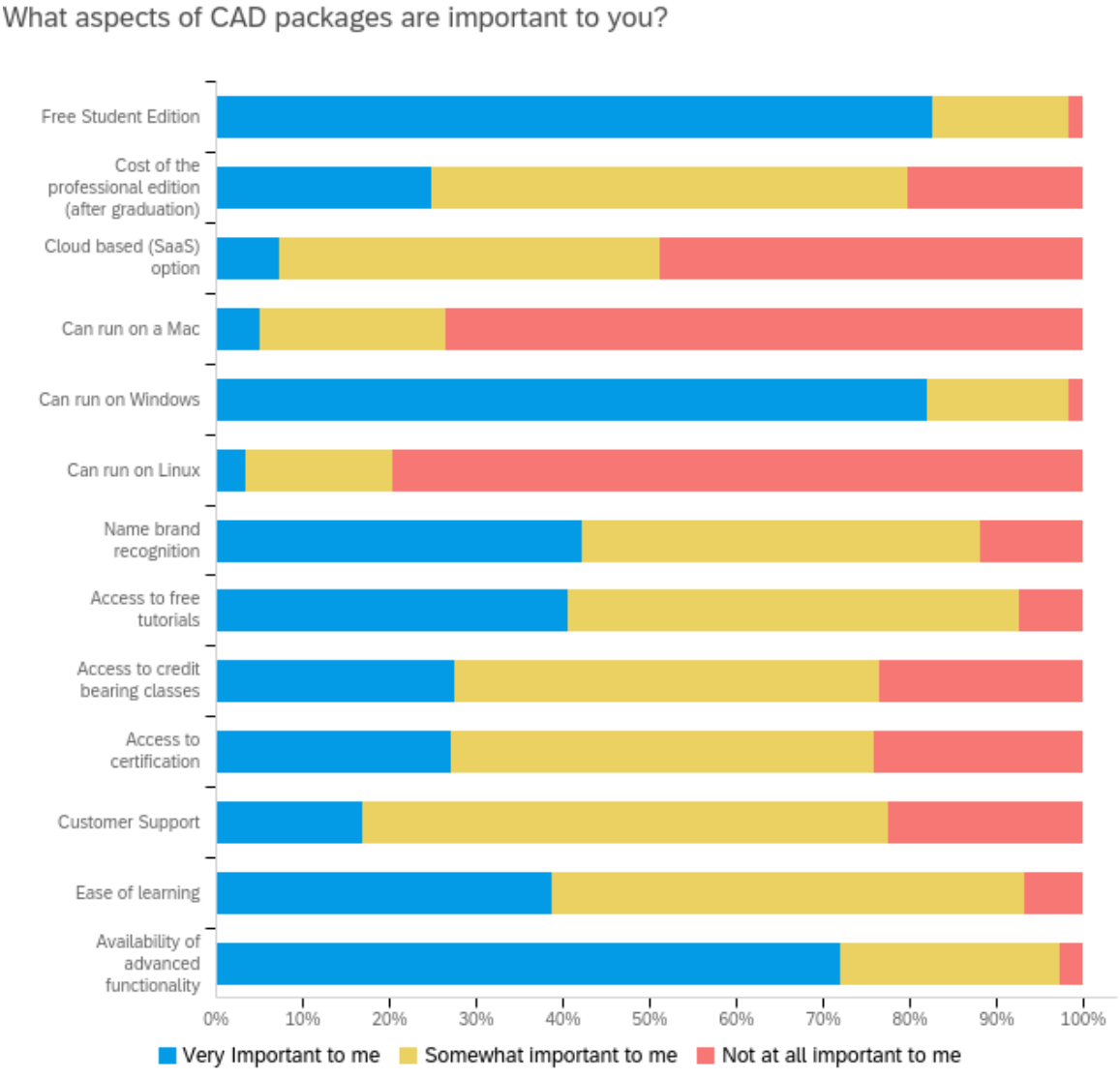


*Figure 8 - Survey Question 2 Results*

After students ranked each aspect as either Very Important, Somewhat important, or Not at all important, they were given their own list of Very Important aspects to select which was most important.

The most important aspects to students were 1) Free student edition (71 responses), 2) Availability of advanced functionality (41 responses), and 3) Name brand recognition (23 responses).

While Onshape does have easily accessible free student versions, it is less known for its advanced functionality and the name brand recognition. The procurement of Onshape by PTC could impact both of these concerns.

Creo Parametric, which is taught in Advanced CAD, does fit well with these aspects. SolidWorks, while commonly requested by students, does not have a universally available free student edition [10].

**Q4**

Select the statement that best applies for each CAD package.

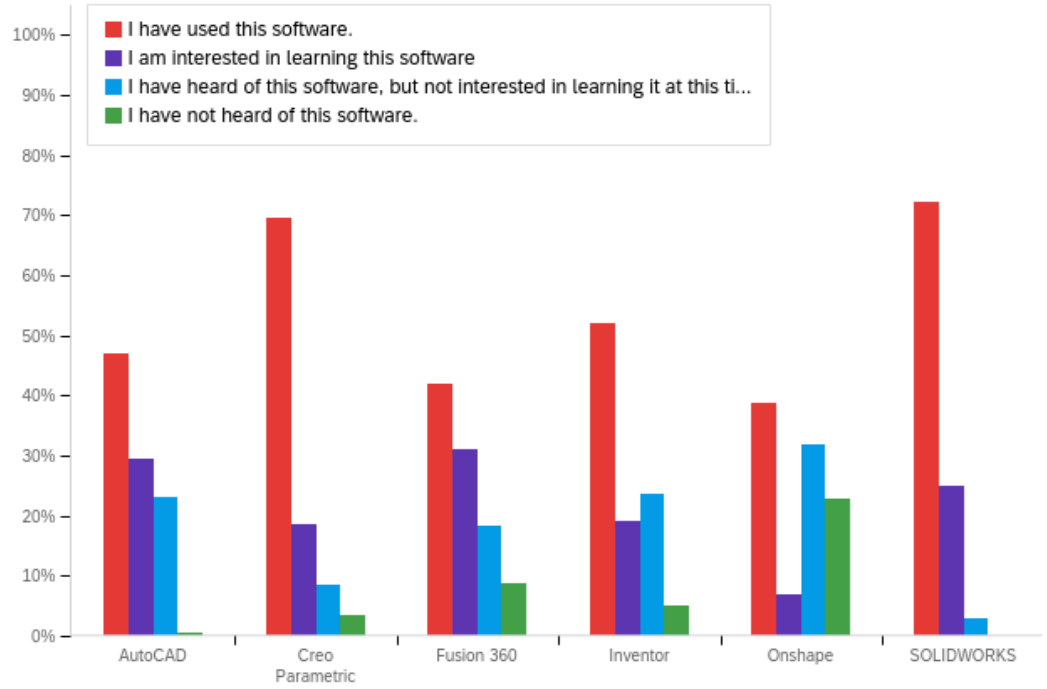


*Figure 9 - Survey Question 4 Results*

It is interesting to see that even though we do not teach SolidWorks, 72% of the students have used it.

## Q5

For each CAD package, select all the instances where you've used that package.

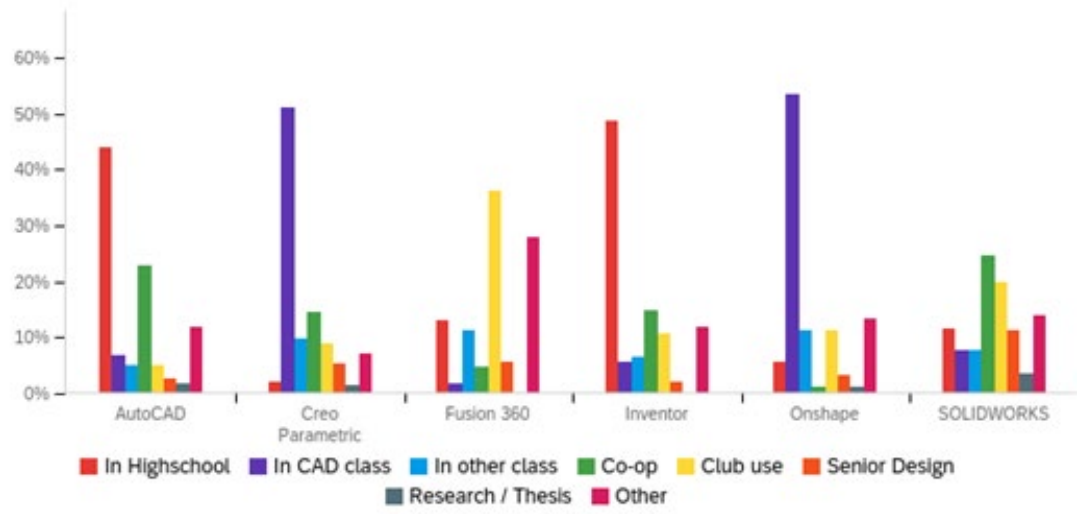


*Figure 10 - Survey Question 5 Results*

## Q6

For each CAD package, please select all the instances where you anticipate possibly using a CAD package in the future.

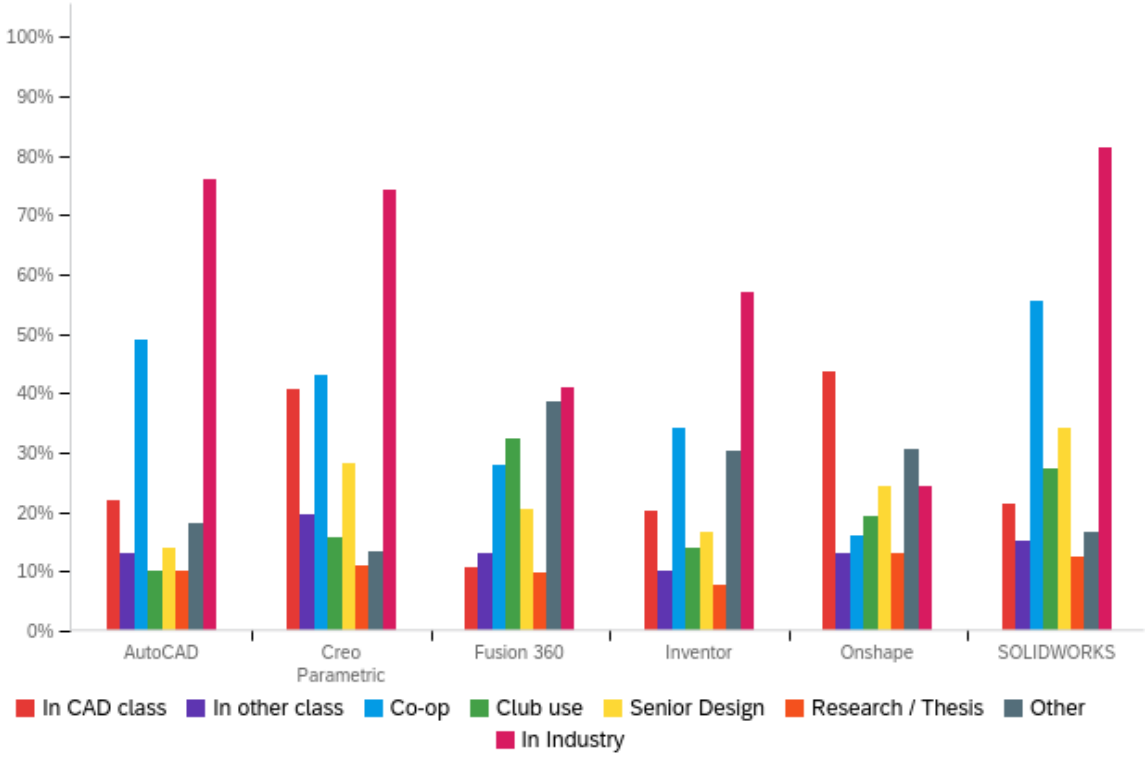


*Figure 11 - Survey Question 6 Results*

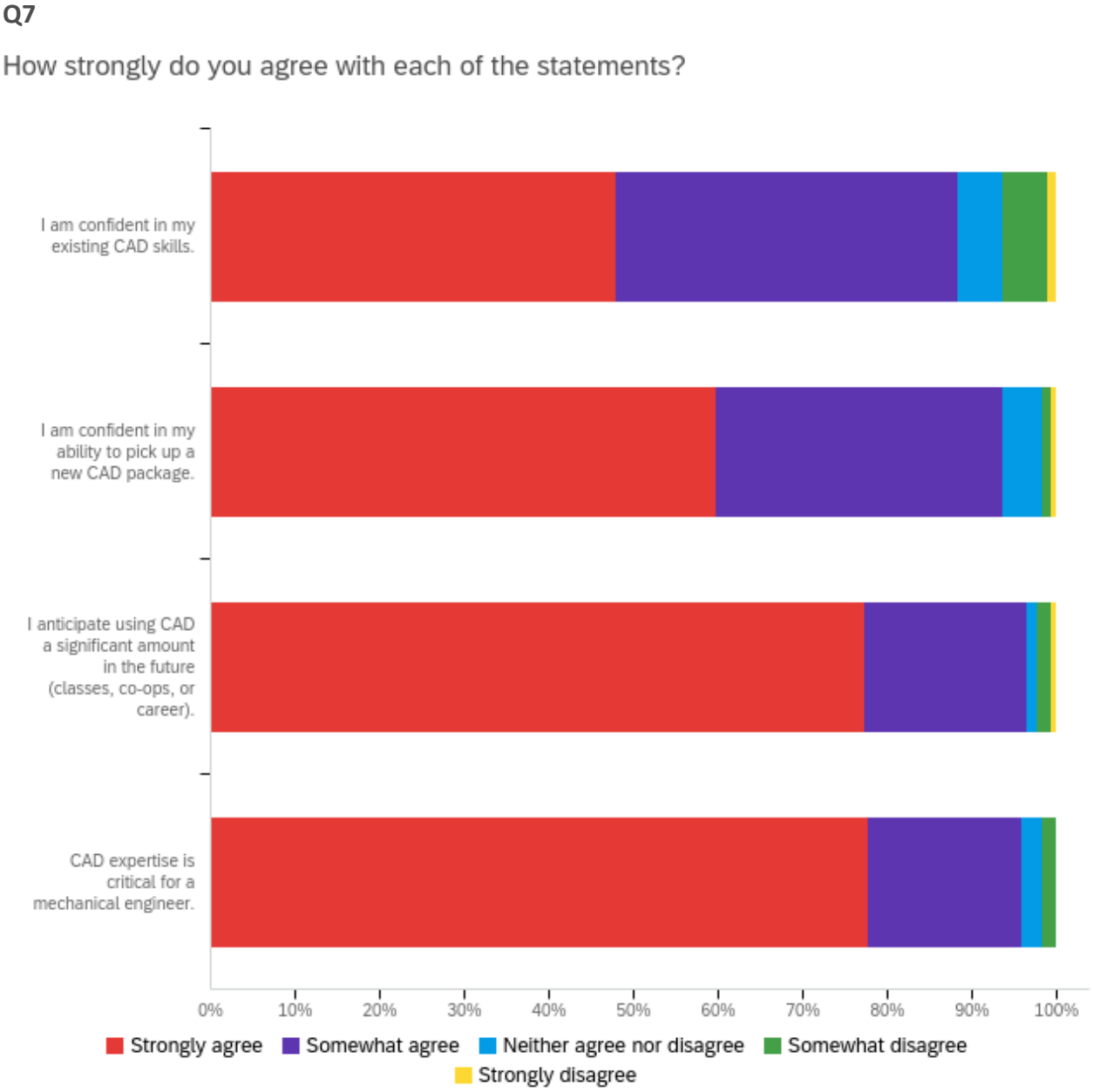


*Figure 12 - Survey Question 7 Results*

Students that participated in this survey strongly believe that CAD is important. As shown in Figure 12, almost 96% of students agreed or strongly agreed that CAD expertise is critical for a mechanical engineer and they anticipate using CAD a significant amount in the future.

88% of somewhat or strongly agreed that they were confident in their existing CAD skills, while 93% were confident in their ability to pick up a new CAD package.

Following this conversion, we will continue discussions with our co-op and careers department and with the industrial advisory board. With the ease of use and file sharing via URL, it is

advised that the department encourage additional CAD usage in courses throughout the curriculum. The ease of use, team participation, and file sharing available with Onshape should allow students to easily continue using CAD tools outside of their Engineering Design Tools course. If students continue to use their CAD skills, and take initiative to further develop those CAD skills with other packages demonstrated to them, they can continue to be confident in their skills.

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