**Lesson Title:** CAD and CNC Use in Design and Manufacturing **Part One**

**Total Time:** Two 60-minute periods

**Brief Description:**
In the first part of this ***The House That STEM Built*** lesson plan, students will be introduced to CAD and CNC technologies by following along with ***The House That STEM Built: CAD and CNC Use in Design and Manufacturing*** video. Students will become more familiar with how these technologies can be integrated into the design and manufacturing process of constructing a kitchen.

**Curriculum Outcomes:** Taken from the New Brunswick 2023 MSTE Technology Curriculum. Content in this video and lesson plan also applies to the 2023 BBTE Technology Curriculum.

**Strand:**
Digital Skills

**Big Idea:**
Computational Practice: Apply basic coding skills to solve problems.

**New Brunswick Global Competencies Achieved:**
https://www2.gnb.ca/content/dam/gnb/Departments/ed/pdf/K12/curric/competencies/NBCompetencies.pdf?fbclid=IwAR1ldrZs1gFgiNm8rC4oz7Fmx6mSn-6t_QJkenev0eD33rZ-foYYn6bmdmc

Critical Thinking and Problem-Solving
- Learners construct, relate and apply knowledge to all domains of life, such as school, home, work, friends, and community.
- Learners solve complex problems by taking concrete steps to design and manage solutions.

Innovation, Creativity and Entrepreneurship
- Learners enhance concepts, ideas, or products through a creative process.

Collaboration
- Learners participate in teams by establishing positive and respectful relationships, developing trust, and acting interdependently and with integrity.
- Learners learn from and contribute to the learning of others by co-constructing knowledge, meaning, and content.

**Learning Objectives:**
Learners will
- Have a basic understanding of CAD software.
- Have a basic understanding of CNC machines.
- Have a basic understanding of how CAD software and CNC machines work together to complete final products.

- Have an understanding of the design and manufacturing process of a kitchen.

**Materials:**

- ***The House That STEM Built Video: CAD and CNC Use in Design and Manufacturing*** video
- SMART Board or a projector
- **Video Questions for CAD and CNC Use in Design and Manufacturing** worksheet (1 per student)
- Loose-leaf or white paper (1 per student)
- Writing utensils

**Before Class:**

- Print one copy of the **Video Questions for *CAD and CNC Use in Design and Manufacturing*** handout for each student.

**Warm-up:** 15 minutes

- Start the lesson by engaging students in the design and manufacturing processes they are familiar with based on their prior knowledge.
- Place students in groups of two or three, depending on the class size. They will work together on the following activity.
- Present students with the scenario that they are designers who have been tasked with building a free-standing bookcase for the classroom. Explain that they must create a detailed plan that highlights the materials required and the steps necessary to complete the task. They should consider both the design and manufacturing processes required.
- Students must write down their work on a sheet of loose-leaf or white paper.
- Give students 10 minutes to complete the activity.
- After students have finished their plans, ask the class if there are any groups who would like to share what they created.
- Students will need to keep their sheets of paper because they will be needed again at the end of class.

**Activity:** 35 minutes

- Pass out the worksheet titled "**Video Questions for *CAD and CNC Use in Design and Manufacturing*.*"*** Go over the directions of the worksheet with students. They will be required to answer all 13 questions. Most of the answers come directly from the information presented in the video.
- Start watching ***The House That STEM Built: CAD and CNC Use in Design and Manufacturing*** video. Since the video is short (approximately 8 minutes), it will be played more than once, so no pauses are necessary. Students will also be given the opportunity to discuss the questions and answers with peers between the playings of the video.
- As students watch the video, the teacher should circulate the classroom to ensure all students are paying attention to the video and answering the required questions.
- Once the video has finished playing through the first time, allow students approximately 10 minutes to fill in any answers they may know. Students may discuss these with their peers.

- Start playing the video again for the second time. The teacher should continue circulating the classroom as the students watch the video and answer the questions.
- Once the video has finished playing through the second time, allow students the opportunity to have a class discussion for approximately 10 minutes to debrief the video and questions. They may share any new ideas or questions the video prompted or discuss any answers they struggled with finding.
- The teacher may collect these worksheets to be used as a formative assessment tool, or they can be notes for the students' personal use.

**Conclusion:** 10 minutes

- Now that students have been introduced to new technologies that aid in construction, ask students to return to their groups from the warm-up.
- Ask the groups to reflect on how CAD software and CNC machines can be integrated into their original plans for building a free-standing bookcase. They can either write their new ideas directly on their original copy or start from scratch on a new sheet.
- Prompt students with the following questions to get them thinking:
    - Where can CAD software and/or CNC machines be integrated into your original plans for building the bookcase? Can any steps be removed?
    - What would be the benefits of integrating CAD software and/or CNC machines into your plans?
    - What would be the drawbacks of integrating CAD software and/or CNC machines into your plans?
    - Does CAD software and/or CNC machines make the job of building your bookcase easier? Harder? More complex?
    - Does the introduction of CAD software and/or CNC machines affect the tools and materials required to complete the bookcase?
    - Would you like to have the opportunity to work with these machines, or would you prefer the manual methods of construction?
- The teacher should circulate the classroom and check in with each group to get a sense of their understanding of CAD software and CNC machines.
- Before students leave class, have them pass in both their original and reworked plans on building a free-standing bookcase to be used for formative assessment.

**Differentiation:**

**Content:**

- While watching ***The House That STEM Built*** video, students may struggle to write down what is being said aloud. The teacher can turn on the subtitles for the video. If necessary, the teacher can also pause the video after an important piece of information is stated to ensure all students have the opportunity to write down the answer.

**Practice:**

- Some students may not be able to complete all 13 questions in the allotted time. Teachers may assign certain questions from the set to be answered, or additional time may be set aside for those needing it.

**Product:**

- For the warm-up activity, allow each group to select their own piece of furniture to build

instead of everyone completing the same task. This allows each group to choose something of interest to plan and present.

**Extension:**

- ***The House That STEM Built: CAD and CNC Use in Design and Manufacturing*** video focuses on how CAD software and CNC machines are used in the construction of a home. However, there are many other fields where these technologies are used. As an extension, students can research a particular field of interest and find where and how these technologies are used within it.

**Video Questions for *CAD and CNC Use in Design and Manufacturing***

Name: _____ Class:_____ Date:_____

**Directions**
While watching *The House That STEM Built: CAD and CNC Used in Design and Manufacturing* video, answer the following questions.

1. What does the acronym CAD mean?

2. What can CAD software create?

3. What are some key questions that designers must consider when designing a kitchen?

4. What is a blueprint?

5. What does the acronym CNC mean?

6. How do CNC machines use CAD software?

7. What are the steps required to transform an idea into a final product using CAD software and CNC machines?

8. What CNC machines were used in the construction of the house that stem built? What are their purposes?

9. What are some factors that you think the designer of your home thought about when choosing the layout for your kitchen?

10. What are the three points of the triangle that designers consider when creating the layout of a kitchen?

11. What is the importance of the triangle in the kitchen design?

12. Have you ever worked with machines like these before? If so, where?

13. How could you apply this information to technology like a 3D printer?

**Video Questions for *CAD and CNC Use in Design and Manufacturing***

Name: _____ANSWER KEY_____ Class:_____ Date:_____

**Answers**

1. What does the acronym CAD mean?
   Computer Aided Design.

2. What can CAD software create?
   2D and 3D models on computers.

3. What are some key questions that designers must consider when designing a kitchen?
   Is the space easy to walk through and move around in?
   Is there enough storage space?
   Are the fridge, stove, and sink too close together?

4. What is a blueprint?
   A draft that shows what the final product will look like in the end.
   OR
   A set of instructions for the production of the physical product.

5. What does the acronym CNC mean?
   Computer Numerical Control.

6. How do CNC machines use CAD software?
   They use CAD software to program predetermined movements to physically produce the designs that the user created.

7. What are the steps required to transform an idea into a final product using CAD software and CNC machines?
   First, the user creates a 2D or 3D design using the CAD software. Next, the design must be converted into information the machine can understand, which is often referred to as code. This conversion is done using computer aided manufacturing software. Finally, the CNC machine reads the code to perform the operations required to create the physical product.

8. What CNC machines were used in the construction of The House That STEM Built? What are their purposes?
   CNC router: Responsible for cutting the wood that will form the sides and doors of the kitchen cabinets.
   CNC drill: Drill perfectly round holes in the wood with great accuracy to ensure everything lines up when being put together.
   CNC dowel inserting machine: Place dowels in the holes drilled in the cabinets by the CNC drill.
   CNC edging machine: Produces clean sides on all of the cabinet doors.

9. What are some factors that you think the designer of your home thought about when choosing the layout for your kitchen?
   Answers to this question may vary based on each students' home.
   Some may include:
   - Where the windows are located in the kitchen.
   - How big the room is for the kitchen.
   - The easiest path for moving around the cabinets and furniture.

10. What are the three points of the triangle that designers consider when creating the layout of a kitchen?
    Cooking space (oven and stove), sink, and refrigerator.

11. What is the importance of the triangle in the kitchen design?
    When cooking, you are commonly transporting food and dishes between all points of the triangle, so you will want to keep an easy path along this triangle.

12. Have you ever worked with machines like these before? If so, where?
    Answers to this question may vary.
    Some may include:
    - Cricut machines
    - 3D printers
    - Laser cutters

13. How could you apply this information to technology like a 3D printer?
    3D printers are a type of CNC machine. Designs that are produced using CAD softwares on computers are used as guides for the 3D printer to produce the final product.

**Lesson Title:** CAD and CNC Use in Design and Manufacturing **Part Two**

**Total Time:** Two 60-minute periods

**Brief Description:**
In the second part of this ***The House That STEM Built*** lesson plan, students will have the opportunity to design their own kitchens using the information presented in the video. They will create their own blueprints, similar to what would be designed using CAD software.

**Curriculum Outcomes:** Taken from the New Brunswick 2023 MSTE Technology Curriculum. Content in this video and lesson plan also applies to the 2023 BBTE Technology Curriculum.

**Strand:**
Digital Skills

**Big Idea:**
Computational Practice: Apply basic coding skills to solve problems.

**New Brunswick Global Competencies Achieved:**
https://www2.gnb.ca/content/dam/gnb/Departments/ed/pdf/K12/curric/competencies/NBCompetencies.pdf?fbclid=IwAR1ldrZs1gFgiNm8rC4oz7Fmx6mSn-6t_QJkenev0eD33rZ-foYYn6bmdmc

Critical Thinking and Problem-Solving
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- Learners enhance concepts, ideas, or products through a creative process.

Collaboration
- Learners participate in teams by establishing positive and respectful relationships, developing trust, and acting interdependently and with integrity.
- Learners learn from and contribute to the learning of others by co-constructing knowledge, meaning, and content.

**Learning Objectives:**
Learners will
- Have a basic understanding of CAD.
- Have a basic understanding of CNC.
- Have a basic understanding of how CAD and CNC work together to complete final products.
- Have an understanding of the design and manufacturing process of a kitchen.

**Materials:**
- ***The House That STEM Built: CAD and CNC Use in Design and Manufacturing***

video
- SMART Board or a projector
- **Kitchen Design Project** handout (1 per student)
- Graph paper or white paper (1 per student)
- Tape

**Before Class:**
- Print one copy of the **Kitchen Design Project** handout for each student.

**Warm-up:** 10 minutes
- In the previous lesson, students had the opportunity to engage with ***The House That STEM Built: CAD and CNC Use in Design and Manufacturing*** video. They were introduced to how CAD software and CNC machines are used in the construction of a kitchen.
- Start the lesson with a brief 4-5 minute recap of the information from the video by asking students to discuss as a class the following questions:
    - What is CAD software?
        - CAD stands for Computer Aided Design. It is used to create 2D and 3D models.
    - What are CNC machines?
        - CNC stands for Computer Numerical Control. These are machines that use code from CAD software to create a physical product.
    - What are the three points of the triangle that are considered when designing a kitchen?
        - Cooking space (oven and stove), sink, and refrigerator.
- Show students the end of ***The House That STEM Built: CAD and CNC Use in Design and Manufacturing*** video that outlines the project. This begins at **6:18**.
- Explain to students that this is an introduction to the project that they will be completing in this lesson.

**Activity:** 40 minutes
- Pass out the **Kitchen Design Project** instruction handout and graph paper. Go over the directions with the students and allow the opportunity for questions to be asked.
- Remind students of the minimal requirements, but encourage them to be creative with their kitchen design.
- The teacher should circulate the classroom while students work on their projects to ensure they remain on task and understand what they are required to do.
- As mentioned in the video, teamwork is required when constructing a house. After approximately 30 minutes of students independently working, ask them to collaborate with a peer. They can discuss new ideas that can be incorporated into their kitchen designs and suggest edits based on functionality and aesthetics.

**Conclusion:** 10 minutes
- The final 10 minutes of class will be used as an opportunity for students to showcase their kitchen designs.
- Have students tape their designs to a space along the walls. They can then walk around the room browsing their peers' designs. This is also a time where students have the opportunity to ask questions to their peers about their designs to gain more insight about their thought process.
- The teacher will collect each students' kitchen design. They can decide if it will be

used as a formative or summative assessment tool.

**Differentiation:**

**Content:**

- Some students may benefit from watching the entire ***The House That STEM Built: CAD and CNC Use in Design and Manufacturing*** video again. They can take a few minutes before starting their kitchen blueprint and watch it on an individual device.

**Practice:**

- The kitchen design project is presented in a one period time frame; however, this can be stretched across additional days. This will allow students to be more creative, add more detail, and collaborate with their peers.
- With additional time, students can also have the opportunity to create rough drafts before completing a final copy.

**Product:**

- If students have access to CAD software such as TinkerCAD, SketchUP, or Easel and are familiar with their functions, they can use these softwares to create their designs instead of paper.
- With additional time, the walk around gallery at the end of class can be extended to short presentations where all students have the opportunity to explain their design to the class.

**Extension:**

- As an extension, students can design more than a kitchen. They may choose to extend their blueprints to include living rooms, bathrooms, and bedrooms.

# Kitchen Design Project

**Directions**

You are an designer who has been tasked with a project to design a kitchen for a new house being built. The homeowner has provided some requirements for the kitchen that you must make sure are included in the design. There must be:

- An oven and stove
- A refrigerator
- A microwave
- A sink
- A pantry
- A table and chairs
- Cabinets and drawers

These are the minimum requirements. The homeowner also indicated that you may be creative and add anything else you feel will make the kitchen perfect. You will create the blueprint for your kitchen using a blank piece of graph paper.