COURSE PROFILE TITLE PAGE

Technological Education

Course Profile:

Technological Design

Course Code: TDJ3M

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Note: partial developed,

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COURSE OVERVIEW

IDENTIFYING INFORMATION

COURSE TITLE: Technological Design

GRADE: 11

COURSE TYPE: College, University

MINISTRY COURSE CODE: TDJ3M

CREDIT VALUE: One

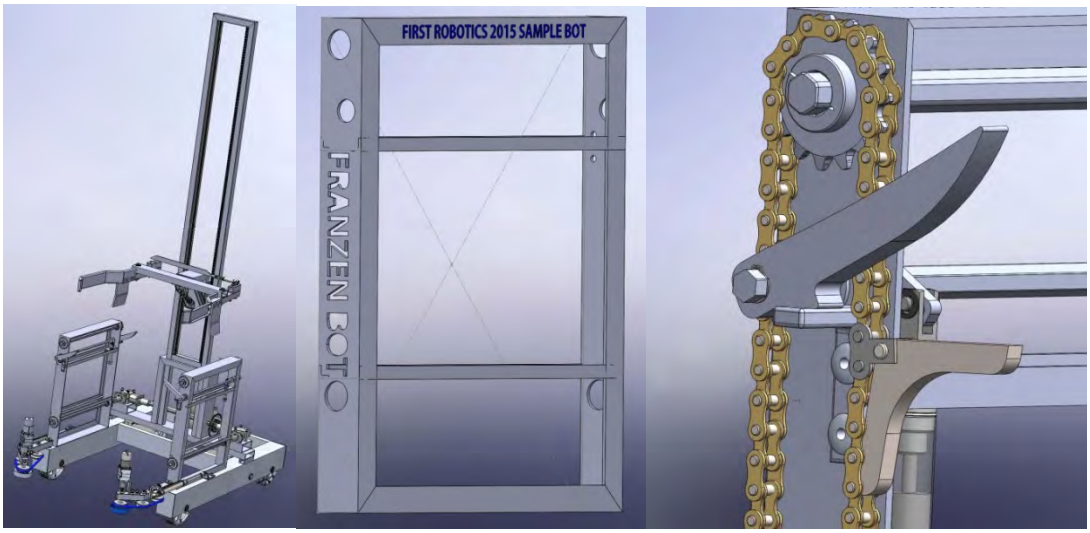
SECONDARY POLICY DOCUMENT: *The Ontario Curriculum, Grades 11 and 12: Technological Education, 2009 (revised)*

PREREQUISITE: None

HOURS: 110 or approximately 18 weeks with 75 minute periods

COURSE DESCRIPTION

This course examines how technological design is influenced by human, environmental, financial, and material requirements and resources. Students will research, design, build, and assess solutions that meet specific human needs, using working drawings and other communication methods to present their design ideas. They will develop an awareness of environmental, societal, and cultural issues related to technological design, and will explore career opportunities in the field, as well as the college and/or university program requirements for them. Focus will be on robotics, related to the FIRST FRC (FIRST Robotics Competition) program.



COURSE NOTES

This course profile provides a framework for students to be a better consumer, by analysing the information that makes a great design. By being made aware of sustainability issues, learning what the user needs are, and practicing a common procedures to find an effective solution, allows students to gain an understanding of a systematic design model which engineers use regularly. This course uses the SPICE design model to explore this process in-depth, and apply each step of the process with each task or project challenge. Students are encouraged to always know where they are in this process with each project activity and take the necessary steps to get to their goal of their solution to the problem. Knowing where they are in this process and what they need to do will help them get to a better solution.

Throughout the course, because students develop an understanding of the design process, developing products and/or services for specific user needs, analyse, research, and fabricate, with the knowledge, skills, and experience gained from this course (all transferable) can be applied to any career path a student may pursues. With that being said, projects for the students are intended to give students a realistic look at what designers need to know and do throughout their responsibilities on the job. Effective communication, able to sketch ideas quickly on paper, using technical related terms, working collaboratively, having a systematic approach, and being able to find solutions to user needs are important skills and characteristics to being a great Engineer/Designer. Different career positions in the technology design field require similar responsibilities and roles which students explore when researching, related career positions at the beginning of the course. Throughout the course whenever possible, it is very helpful to involve the community such as a guest speaker, having a field trip, including local internet research, encouraging job shadowing, relating possible apprenticeships, and highlight any co-op opportunities that may present themselves. Also by making reports reflections, journals, reviewing project process and communication can also make this a very realistic and responsible direction towards many related careers.

Students are encouraged to scan or take a picture of completed sketches and drawings done on paper for later presentation and also to include in their portfolio. Any other project work is also to be saved for including in their portfolio at the end. Students are asked to make entries into their journal throughout course on their project work as to what they have done and learned in the form of new knowledge, skills, and values. Through this recording method, students will be able to see their learning progress and be able to report this path of growth easily in their portfolio.

Teachers should ensure that all resources have been prepared and course materials are ready to go prior to starting the project, so they may focus on the students and not preparation throughout the project. Students should always be reminded of safety, reinforce it, and add support as you work with new tools or equipment in new projects. Your number one priority is to keep students safe and students must be made aware of all aspects of that machine/tool and its proper operation/use. If as the teacher you are unfamiliar and/or uncertified to use that particular tool or equipment, then do not use this with your students.

When using computers, make sure you review your school's policy and that students know which type of sites they are not allowed to be on. Ensure that all software that is needed is installed and working prior to project start to allow students consistent flow through the project and limit possible confusion and stop points, which can lead to students loosing focus on the project and design process steps.

This course has a focus towards robotics and specifically FIRST FRC program. Using their robot design challenges to design and model a full size robot has a lot of engineering real life process involved with it. Students really enjoy taking on challenges like this because of the hands-on activities and collaboration that an open-ended project like this has. Using a sample robot as model to practice with, students will come up with their own design and learn a lot about the process of technological design. The intension is to go through the design process of a robot already completed as a model, and then apply those new techniques and learning to a new design that they will come up on their own through a 21st century class environment. Student centred, open-ended, project based, students really enjoy coming up with their own designs and then building them. Students will review technical sketching, mechanisms, function integration, assemblies all the while using project management to assess, track, and support themselves and their peers. Students that take this course will get more opportunity to participate with FIRST more effectively and support their team and accelerate there learning even further.

FOSTERING INCLUSIVENESS

Laying down a foundation of support to allow the opportunity for each student to maximize their learning in an equitable classroom environment is something a teacher will have put in place and continue to accommodate and modify as needed throughout the course. Several considerations such as building a community of learning, watching your hidden language, always question your actions and interaction, classroom layout, classroom materials, routines, and group interactions. Here are some ideas on fostering inclusiveness more in your class:

One way is to provide choice and flexibility for students to explore and learn in a manner that will allow them more opportunity to success. Making opportunities in curriculum to allow flexibility and choice can make learning with these differences easier for students. This can be incorporated into your lessons as part of their learning process. Gender, race, age, social class, challenge or ability should not be a determining factor for what a person is able to do or accomplish. These can become barriers to a students learning and need to be identified and minimize if they are present in your classroom/course. Teach communication, negotiation and problem solving skills to build co-operation in the classroom. Encourage students to feel free to speak their mind in relation to the learning process and feel comfortable doing this in front of others in the class. Allow students to speak, and be heard not just by you but also by others in the class. Arrange projects, class discussions, and project work in groups or pairing to allow for collaboration and co-operation. Mix these groups with genders, race, abilities, and levels. Routinely change the class seating and/or groups to foster more and new collaboration and interpersonal social interactions. Arrange into pairs first, then move two pairs together to build further collaboration, and then arrange larger groups as interpersonal, listening, and problem solving skills improve. Check to make sure you do not have any resources such as magazines or posters sending the wrong messages of inclusiveness. Make sure all students have equal access to the materials you supply for each of your projects. Allow classroom routines to provide and promote listening and respect for other student comments and values, teaching fairness, support and equality towards each other to also establish a safe, positive learning environment. Encourage appropriate and acceptable behaviour and confront concerns of inappropriate and unacceptable behavior right away to help students understand those concerns.

Taking into account the points above with this course will set the proper stage to fostering an inclusive class setting. By listening and accommodating where necessary throughout the course you can provide a safe, equitable, and fertile learning environment which will foster inclusiveness for all students and keep this a great learning experience for all.

LEARNING SKILLS AND WORK HABITS

Students are measured on the following learning 6 essential learning skills and work habits throughout the course.

Responsibility

- Completes and submits class work, homework, and assignments, according to time agreed on
- Takes ownership for personal share of work
- Fulfills commitments in learning environments
- Manages his/her behaviour
- Ask questions when not clear to get to understanding
- Designs created consider safety, ergonomics, and sustainability
- Follow through with assigned project design tasks
- Completes project work on time and with care
- Fulfills responsibilities and commitments within the learning environment

Organization

- Establishes priorities and manages time to achieve goals
- Comes to class prepared and with appropriate materials
- Creates and follows a plan to complete work and tasks
- Manages time effectively
- Demonstrates the ability to organize and manage work
- Use SPICE to effectively solve project challenges
- Clarify the challenge prior to solving the solution
- Devises and follows a plan and process for completing work and tasks
- Identifies, gathers, evaluates and uses information technology, and resources to complete tasks

Independent work

- Begins to work promptly and use time effectively
- monitors, assesses, and revises plans to complete tasks and meet goals
- Uses class time appropriately to complete tasks
- Seeks new opportunity for learning
- Seeks Assistance when required
- Accomplishes tasks independently
- Follows instructions with minimal supervision
- Takes the initiative to find solutions to challenges
- Focus on design solution rather than the problem

Collaboration

- Works with others to resolves conflicts and builds consensus to achieve group goals
- Shares information, resources, and expertise to solve problems and make decisions
- Accepts various roles and an equitable share of the work within a group
- Responds positively to the ideas, opinions, values, and traditions of others
- Share design ideas to improve and refine solutions
- Use team work to design and build complex ideas
- Builds healthy peer to peer relationships through personal and media-assisted interactions

Initiative

- Approaches new learning ideas and concepts with confidence
- Acts upon new ideas and opportunities for learning
- Demonstrates a willingness to take risks

- Demonstrates curiosity and interest in learning
- Accepts various roles and tasks
- Always participates actively
- Approaches new tasks with a positive attitude
- Recognizes and advocates appropriately for the rights of self and others
- Makes decisions to move forward with project designs
- Research ideas to be knowledgeable about your design challenge

Self-regulation

- Takes the initiative to work on homework
- Regularly review and study notes
- Displays exceptional work skills
- Participates in required activities
- Sets his/her individual goals and monitors progress towards achieving them
- Seeks assistance when needed;
- Assesses and reflects critically on her/his strengths, needs and interests
- Identify learning opportunities, choices, and strategies to meet personal needs and achieve goals
- Perseveres when facing challenges
- Break down project tasks to complete successfully
- Be consistent with your design focus

In addition to the specific skills that are developed throughout the course, students learn:

- improved collaboration skills with others in a co-operative and effective manner
- To problem solve through a set of specific steps and apply it to a project to come up with an working solution
- To apply the same problem-solving process to different projects to come up with a working solution
- The importance of keeping their focus and attention on the work at hand to improve their chances for success
- Quickly communicate their idea though visual simple sketches
- Be responsible with what materials should be used in home designs

See Appendix P4 for posters of the above learning skills.

ROOM FACILITY AND RESOURCES

SAFETY

GENERAL

The safety of your students is your number one concern and has to be addressed immediately at the beginning of the course, and then continually supported throughout the course. Students cannot effectively learn if they feel unsafe, so it is important to ensure that they are aware of dangers and concerns, and be made aware of the proper procedure, and be able to follow it, and understand it, to have the right kind of confidence to proceed with project tasks, materials, tools, equipment, and machines. Because of the variety of materials, tools, equipment and machines in a classroom/shop environment each has to reviewed, in terms of safety. It is usually the actions of the person that result in an unsafe situation, and therefore being aware of what to look out for and following proper procedures will prevent most accidents. Through diagnostic and observation, the teacher can insure accidents will not happen, but because students are sometimes unpredictable, the teacher must be very cautious here, and do everything possible to prevent any accident from happening in the first place.

Students must know that they are not allowed into a room without the presence of the teacher, not allowed to use any class materials, tools, and equipment unless they have had specific permission first, have had a lesson on it's safe operation and handling, and understand and feel comfortable knowing the safety procedure before handling or operating that component.

GENERAL SAFETY CONTRACT

This course right away starts with a general safety sheet which students review, sign and date, and then bring to their parents to also get signed. This sheet is brought back to the teacher to be checked off and recorded. This is also supported by a safety presentation that goes into detail of general safety concerns that may be evident throughout the course, such as computer usage, fire alarms, power control and emergency stops, room resources and danger concerns, emergency procedures, safety right responsibilities, reporting unsafe conditions or tools, safety procedures, wellbeing, horseplay, dressing appropriately and so on, With this understanding students should understand that this is an important and serious topic meant to protect them both individually and as a group.

SAFETY PASSPORT CERTIFICATE COURSE

Students are also given an assignment to log on to SafetyPassport.com and complete a "Passport to Safety for Teens" course that allows students to learn about their rights and the law, common dangers in the workplace and the home, hidden dangers, WHMIS, bullying, safety gear, and avoidance awareness. Once students finish this course successfully through online quizzes based on their tutorials students will be awarded an electronic PDF certificate, which they submit to me, for marks and to print on quality certificate bond paper. This usually being a $15 service is available to registered teachers here in Ontario, and a great safety orientation for students to use and include in their work portfolio.

SAFETY PASSPORT LOG

Depending on the resources of the room or facilities, the teacher should have some method of keeping track of who has not been given a safety lesson on any dangerous tools or equipment. For this, a safety passport log is used to support the teacher and student in this area. Students use this to be aware of which machines, tools, and processes need to be reviewed prior to using, in order to not be hurt for lack of not know how to use properly. Marks could be part of this process as a way to confirm if the student has had a safety lesson first. This can be done throughout the semester as a safety check to ensure that each student has completed the lesson/contract and is familiar with the operation and proper procedure. Each safety lesson could be as simple as a verbal instruction, or as detailed as a handout with a formal lesson, teacher demonstration, student demonstration and written quiz. Once this process is complete you can sign-off on that student's safety passport log and check off in your own log and/or assign a mark. You as the certified professional teacher will have to make that call as to the depth of safety process you will need to go, to ensure that student is safe.

There are many ways to practice safety, and as a teacher one of the first methods to employ safety is by example. Students learn not just from what you preach, but also what you do, so ensure you are always setting an excellent example that students can mentor from you. Make sure you take the above steps to ensure students are safe and continue to remind and reinforce safety throughout the course.

COURSE RESOURCE REQUIREMENTS

The units in this course profile rely upon the availability of room facilities, equipment, tools, materials, and software provided for students and the teacher. Although some of what is mentioned below is not absolutely necessary, it will enhance or improve the teaching process for each of the students.

FACILITY

The classroom facility should be set-up with access to computer table chair sets around the outside, with tables against the wall and chairs facing for easy line of sight from teacher station/area. Student group tables, drafting tables and/or work area should be located in the centre for classroom theory instruction, work area, and group discussions. The teacher area should be located at the front of the class with related equipment to support teacher instruction and include a demonstration, and small group or individual instruction/discussions area. There should be sufficient room to move about the room safely and have safety measures in place, such as a house phone for administration and teacher communication, local time, and fire extinguisher. The classroom should also have a white or traditional chalk board, digital whiteboard (nice to have) a bulletin board for current events/news, and surrounding walls showing samples of student work, course related information, support steps, and exemplars. The room should be organized and efficient in its layout and teaching process and include recycle and garbage bins. There should be a place to keep class text books, magazines, and technical books to support the class projects and topics. If possible an in classroom water fountain to reduce the number of students leaving the room. There should be an area for students to hand in work such as a bin at the front of the class in the teacher area. In summary classroom must be designed to support and encourage student-learning effectively and inclusively.

EQUIPMENT

An important piece of equipment that is a staple in most technical classrooms should include a reasonable mid to high-end range set of computers. These computers should also be set-up on a sharing network to save work to and have easy and secure access from any location. Other key classroom equipment to include is a colour laser printer, scanner, electric pencil sharpener, stapler, and projector to support and assist with the teacher instruction, student learning, and their project process. Specific equipment that can support and enhance projects include a structural tester for bridge and tower testing, light-weight digital scale, wind tunnel, 3D abs plastic printer, large format printer/plotter, light table, paper cutter, clam press iron (t-shirts design heat transfer), digital white board, mini (computer numeric control) CNC lathe, and mini CNC mill. Access to other equipment in the school such as CNC milling, lathe, grinders, band saw, chop saw, miter saw, welders, drill press are also available. With school- corporate partnerships, additional high-end equipment such as wire EDM, CNC, and water jet cutters could be accessible.

TOOLS

Tools to support student learning in this course should include model tools such as metric/imperial rulers, straight edges, scales, scissors, light wood cutters, rasp & files, x-acto blade knives, assortment of clamps, screwdrivers, glue guns, self-healing cutting mat, 3 hole punch, planning calendar, and extra calculators. Always good to have a couple of extra USB memory sticks around for students and for general class projects. Although drafting is no longer used having

older tools for drafting can come in handy such as T-squares and set-squares, and eraser shields. Additional basic prototyping tools should be considered depending on the type of prototyping students are planning on working on and again may be possible to borrow from with-in the school. Students must have access and ability to build physical prototypes in order to prove their design before spending a lot of time developing further.

MATERIALS

Although you keep materials for specific projects it is a good idea to keep common materials that you made need to get yourself out of a tight situation, for example using some crazy glue to fix a student's music player, or elastics to roll-up a drawing or poster to take home. Here are some common materials that would be great to keep on hand would include card stock, bristle board, assortment of blank paper, line paper, graph paper, isometric paper, foam core, corrugated cardboard, pencils hard and soft leads, extra erasers staples, assorted elastics, white glue, wood glue, crazy glue, wax paper, foil, push pins, 5*5 mm bass wood strips, hot glue sticks, string, extra pens, duct tape, masking tape, assorted colour white board markers, permanent markers, assorted colour marking pens popsicle sticks, thick paper clamps, note pads/post-it notes, construction paper, specialty thick bond quality paper. Light-weight wood, cardboard, and other similar materials can support prototype building very well, so students may easily prove if their design is going to work or not.

SOFTWARE

Being that computers have become another necessary tool in technology, it goes without saying that it is only as good as the programs or applications that run on it. Software is a whole other resource that cannot be ignored and it is very important as we venture into a virtual-digital world. For education we use the computer and its application as a tool to help us throughout our process and also as an educational tool. The operating system is the first concern, then which applications you want to use. In Technical Design some programs we use include office related apps such as Word, Excel, and PowerPoint. For digital graphic manipulation, Photoshop, and for vector art and illustration, Illustrator is quite common. Going into 2D and 3D programs, two great free ones are DraftSight and Sketchup. Newly added SolidWorks (purchased) along with Creo 2 free educational version, and Inventor free educational version for mechanical engineering design and for building structures, Revit free educational version can be used. For web page authorware, Dreamweaver is a popular choice which can be used to create some great web portfolios. With the added free online web site generators such as Weebly.com, Wix.com, Portfliobox.net and foliohd.com, there are lots of options here. There are also web apps, such as Wordle, Prezi, Slide share, Mindmup, FreeMind, Coggle, Draw.io, CoSketch.com, Giffy Diagrams, Schemelt, and even an easy to use 3D home maker called FloorPlanner.

ROOM RESOURCE/UNIT CHART

The chart below provides an overview of the classroom equipment, resources and facilities required in specific units, some of which is used in each unit as they are commonly used throughout the course by both the teacher and students. Some items listed but are not used could be used for unseen circumstances, but not critical to this course.

Classroom Resource Descriptions	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7
Facilities							
Teacher Desk	✓	✓	✓	✓	✓	✓	✓
Teacher Demo Bench	✓	✓	✓	✓	✓	✓	✓
Teacher/student(s) small group/individual area	✓	✓	✓	✓	✓	✓	✓
White board	✓	✓	✓	✓	✓	✓	✓
Bookcase/library	✓	✓	✓	✓	✓	✓	✓
Bulletin boards	✓	✓	✓	✓	✓	✓	✓
Recycle and garbage bins	✓	✓	✓	✓	✓	✓	✓
In house water fountain	✓	✓	✓	✓	✓	✓	✓
Computer table and chairs	✓	✓	✓	✓	✓	✓	✓
Surrounding wall bulletin boards	✓	✓	✓	✓	✓	✓	✓
Drafting tables and stools	✓	✓	✓	✓	✓	✓	✓
Group table and chairs	✓	✓	✓	✓	✓	✓	✓
Storage cupboards	✓	✓	✓	✓	✓	✓	✓
Light table							
Fire extinguisher	✓	✓	✓	✓	✓	✓	✓
Computer internet & intranetworking	✓	✓	✓	✓	✓	✓	✓
Equipment							
Computer system	✓	✓	✓	✓	✓	✓	✓
Projector	✓	✓	✓	✓	✓	✓	✓
Laser printer	✓			✓	✓	✓	✓
Scanner		✓					✓
Structural tester							
Light weight digital scale							
3D Printer				✓			
Tape dispenser							
Electric pencil sharpener	✓	✓	✓	✓	✓	✓	✓
Large format paper cutter							
T-Shirt C-clamp Ironer							✓
Tools							
Pencils hard and soft lead	✓	✓	✓	✓	✓	✓	✓
eraser	✓	✓	✓	✓	✓	✓	✓
Straight edge							

Classroom Resource Descriptions	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7
Ruler- metric and imperial			✓	✓	✓	✓	✓
Scale – metric and imperial			✓	✓			
Pen	✓	✓	✓	✓	✓	✓	✓
scissors				✓			
Light wood chop style cutter				✓			
Light wood plier style cutter				✓			
Mini hack saw				✓			
Mini miter form				✓			
Table clamp and vice				✓			
X-Acto blade knife				✓			
USB memory stick	✓	✓	✓	✓	✓	✓	✓
Stapler	✓	✓	✓	✓	✓	✓	✓
3 hole punch	✓	✓	✓	✓	✓	✓	✓
Glue gun				✓			
Cut board				✓			
Paper clamps				✓			
Push pins				✓			
Elastic rubber bands				✓			
Plastic syringes 20-60CC sizes				✓	✓		
Vinyl tubing				✓	✓		
Vinyl tubing assorted connectors				✓	✓		
Vinyl tubing 2 & 3way stopcocks				✓	✓		
Pulley and gear assortment				✓			
Consumable Materials							
Quality bond Certificate paper 8.5 * 11	✓						
Card stock				✓			
String				✓			
¾” masking tape							
Foil paper							
5* 5 mm * 24” bass wood strips				✓			
Wax paper							
Wood glue				✓			
Hot glue strips				✓			
Coloured plastic ABS filament rolls			✓				
Blank Paper 8.5 *11				✓			
Graph Paper 8.5 * 11		✓		✓			
Isometric Paper 8.5 * 11		✓					
Blank paper 8.5 * 14							
Tabloid blank paper 11*17							

Classroom Resource Descriptions	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7
T-Shirts (school crested) assorted sizes							✓
Heat transfer paper for laser 8.5 * 11							✓
Software * Free software alternatives, ** Free software							
MS Word / *Open Office Writer	✓	✓	✓	✓	✓	✓	✓
MS PowerPoint / * Open Office Impress	✓	✓	✓	✓	✓	✓	✓
MS Excel / * Open Office Calc	✓	✓	✓	✓	✓	✓	✓
**Prezi – free online app	✓			✓			
**Wordle –free online app	✓						
Adobe Photoshop / * Paint.net		✓	✓	✓	✓	✓	✓
Adobe Illustrator / *Linkscape							✓
Adobe Dreamweaver/ *Kompzer							✓
AutoCAD / *Draftsight							
**Sketchup							
SolidWorks / Inventor /*Creo 2			✓	✓	✓	✓	✓
**eDrawings							✓
**Freemind	✓						
**FloorPlanner – free online app							
Revit / *Educational Registered Version							
** Axon – BFB 3D Printer conversion			✓				

PROFILE UNITS TITLES ACTIVITIES & TIME OUTLILNES CHART

Unit #	Unit Titles	Unit Activity Short-Title	# of Weeks
Unit 1	Careers & Safety	Intro /Computers organization / Research career	1
Unit 2	Technical Sketching	Sketching / Ortho-ISO/ Custom ortho/Robot Design	2
Unit 3	Structure and Materials	Materials & Measurement / Joints / Frame /3D Model	3
Unit 4	Driven Mechanisms	Gears/Gearbox to Wheel /Drive Train/1st Function	3
Unit 5	Functions and Integration	Body base /Pneumatics / 2nd Function /3rd Function	3
Unit 6	Robot Assembly	Robot Build/ Function Supports/ Drawings/Presenting	4
Unit 7	Marketing and Portfolio	Web authoring / Portfolio / Presentation	2

PROFILE UNIT OVERVIEWS

Each unit has a description of the unit activities, a chart overview, and a list of skills/knowledge learned from that unit. The unit chart overview outlines the activity number related to the unit number and section, along with activity title, learning expectations, assessment categories and major tasks. Learning expectations have been cross checked to ensure they are all there. Some expectations will show up more than once because of overlap and/or repeat reinforcement throughout assigned projects. Quick online quizzes should be previously prepared with a bank of questions to use throughout the units as needed to receive some direct feedback on students' knowledge and skills. Unit 1 is an introduction and Unit 7 is a portfolio presentation and wrap-up. As most culminating dates end early the last two weeks will contribute to the term mark thereby relieving students of being cut-off with their culminating due date, as some extensions can then be assigned due to special circumstances. As this is an open course, students are highly encouraged to take the grade 10 Technological Design to be better prepared for this course which moves faster over similar tasks/expectations already taken in grade 10 allowing for more time, base knowledge, and skill building in this course.

There are many hands-on activities as this is a project based, student centred focused course. Custom designs, usually referenced at the end of each unit and/or section are a secondary priority and may be used for advanced and/or gifted students in addition to the standard sample project the whole class will be working . Ideally it would be optimal if students are allowed to create their own robot design from scratch to give the course more open-ended solutions to their ideas and interests. As this is a very large and complex project, students may be overwhelmed by being required to complete their own design. Another strategy may be to group students accordingly which would improve the chances of success, but spread the ownership of the design. Time, class level, and class resources will support your determination whether to include the custom design or not, or just look at how to include strategies. If included, it will optimally be best to work with each aspect as it is being developed throughout the course while it is still fresh in students' minds and will support learning reinforcement.

UNIT 1: CAREERS AND SAFETY

Time: 1 Week

DESCRIPTION OF UNIT 1: CAREERS AND SAFETY

This unit introduces the course; room, resources, equipment, materials, software, routine, class policies, emergency procedures, and general information about the course. Students are required to; create files, folders, shortcuts for necessary common used network and folder locations, learn backup procedures, and basic computing. Students will be introduced to Excel and a custom template that can be used for general project management and will update time blocks based on course outline. Students will be introduced to project management and given an Excel template with multiple sheets inside to help them with their organization, learning, peer interaction, collaboration, and design process. A report on Society, technological development, and comparisons will finish the last section.

Students learn about general safety in the classroom, associations, and organizations, and then are assigned a registration pass key to complete a certified safety course made for teens at senior level, after which they will have earned their safety passport for teen's official certificate electronic PDF and printed quality certificate. Safety passport log is also reviewed and handed out for students to keep track of all safety lessons and contracts. Safety assessment for learning rubric with tracking for self and peer package is handed out for students to use now and for future times as instructor sees fit. Students will review all of their safety information and make a related Wordle safety poster. Both the safety passport log and general safety sheets are sent home to be signed by parents after thoroughly reviewed.

For the last activity, students will create a Prezi or mind map (suggested Freemind), to show their selected related Engineering design career position, that person's characteristics, strengths, required education, future outlook, salary, common responsibilities, and daily activities of this person's life, and then do a quick presentation allowing the class to learn about different careers in this field.

CHART FOR UNIT 1: CAREERS AND SAFETY OVERVIEW

Activity #	Activity Title/Name	Learning Expectations Overall/Specific	Assessment Categories	Tasks
1.1	Course introduction	• A1.1, A1.3, A1.4, A2, A2.2, A4.2, C2, C2.1, C2.2, C2.3	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Course outline, class policy, room layout, routines, machines, tools, materials, responsibilities, software, and logs - **Review (REV)** • Create folder locations, short-cuts to them, short cut to web site, then submit short-cut assignment- **Hands-on activity(HOA)** • Intro to project management using excel, see Appendix P5 for sample - **Assignment (ASS)**

				• General assessment on • Research on Society, Technological Developments, and Comparisons - **Report (RPT)**
1.2	Safety	• D1, D1.1	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• General safety ,local safety associations, and organizations - **presentation (PPT)** • Complete online safety tutorials for Safety Passport for Teens certificate - Quiz • Safety self/peer assessment tracking – **rubric (RUB)** • Create a Wordle Safety poster • Safety Passport - Log
1.3	Career steps	• D2, D2.1, D2.2, D2.3, D2.4	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Prezi or Freemind related career, professional associations, unions, support groups/programs – (PPT)

SKILLS AND KNOWLEDGE LEARNED FROM UNIT 1: CAREERS AND SAFETY

The following is a list of skills and knowledge that students should have learned by completing this unit:

- Course information and direction
- Class policy and routines
- Class room layout, equipment, tools, and materials
- Software desktop and online
- Student responsibilities
- Journal log entries
- Portfolio collection materials – pictures and text information
- Digital file/folder organization
- Computer file back-up, USB saving
- Network short-cuts
- Researching process
- Technological eras comparisons
- Technological Design improvements
- Technological Design inspirations in history, trends, culture, and geography
- General safety, associations, and organizations
- Safety passport for teens certification
- Ontario Workplace Safety and Insurance Act
- Workplace Hazardous Materials Information System (WHMIS)
- Ontario Health Protection and Promotion Act
- Ontario Building Code

- Occupational Health and Safety Act
- Right to safety in the workplace
- Safety at home
- Safety at school
- Wordle poster creation
- Safety log
- Live Safe! Work Smart! – website and related resources
- Workplace Safety and Insurance Board (WSIB)
- Industrial Accident Prevention Association (IAPA)
- Ontario Ministry of Labour (MOL)
- Canadian Centre for Occupational Health and Safety (CCOHS)
- Self and peer Rubric tracking sheet process
- Career in related Engineering field, qualifications, education, responsibilities, salary, characteristics, strengths, and work habits
- Professional associations, organizations, unions, groups, and related programs
- Process of handing in work digitally through network drives
- Presentation formats

UNIT 2: ENGINEERING COMMUNICATION

Time: 2 Weeks

DESCRIPTION OF UNIT 2: ENGINEERING COMMUNICATION

In this unit the focus is to have students practice their freehand technical sketching skills with geometric shapes, learn about orthographic (ortho) and Isometric (ISO) drawing types and start to apply it to robotic designs and familiarizing themselves with FIRST FRC robotic competition game and robot rules and requirements.

Students sketch simple geometric shapes in 2D, 3D Isometric (ISO), 3D wire-frame, a custom block shape, using addition/subtraction sketching techniques. Students will also familiarize themselves with FIRST FRC robotic game and robot rules, standards, process, and requirements. Based on feedback from sketching assignment and using their FRC information they will practice their freehand technical sketching principles and techniques and on a possible robot design using ISO with details and notes supporting FRC.

Students then practice their sketching techniques by copying an orthographic note with front view rule selection and accompanying isometric view. Included also are overall and detail dimensions, non-cylindrical and cylindrical features, with all related components labeled with descriptions. Students will get assignment back marked with rubric tracking sheet package initially filled out by teacher, so they can continue to assess themselves and their peers in the near future to support their efforts in being successful in this key task/process.

Students will complete either a quiz or rev questions on ortho/ISO and sketching for feedback to ensure students are on track. For further practice, students will be given a set of complex and simple geometric blocks and/or classroom objects to sketch ortho/ISO format, scale to fit on page, and dimension based on ortho/ISO note. Last for this section students in groups will research, show, and describe different ways robot design ideas have been shown graphically and comment on principles and elements of graphic design related to those shown and hand in as an electronic report.

In the last section, we look at SPICE – a simple design model showing steps on how to solve a problem or challenge in a systematic way. Students will also be given a self and peer rubric tracking sheet to allow them to assess their own success in this area in the near future. Students will use this process and apply it to coming up with three new robot designs in the form of ISO sketches on a single page. Students will also complete an assignment on the role of how the five senses play in technological design. Finishing off the last sketching task of three ideas, students will pick one final idea which will be used for their custom robot design in future projects and create a more detailed ortho/ISO sketch showing details, notes, and dimensions. Students will also hand in a short post report on their design detailing its operation, features, and game play strategies.

CHART FOR UNIT 2: ENGINEERING COMMUNICATION OVERVIEW

Activity #	Activity Title/Name	Learning Expectations Overall/Specific	Assessment Categories	Tasks
2.1	Freehand technical sketching	• B2.1, A1.5, A3.3	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Sketch basic shapes square, rectangle, triangle, and circle in 2D, 3D ISO, 3D ISO wire frame, and then apply to a step block shape - HOA • List FIRST FRC Robot criteria based on game, technical **drawings (DWGS),** and robot - ASS • Sketch a possible FRC robot design on back, using above info and sketching principles - HOA
2.2	Ortho and ISO graphical note	• A3, A5.1	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Sketch ortho step block example note with the addition non-cylindrical and cylindrical features, dimensions, ISO, labels, and front rules selection – HOA • Ortho/ISO self/peer assessment tracking - RUB
2.3	Custom orthographic	• A3, A5.1	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Ortho/ISO review questions – REV • Select a custom block or simple class object, measure, scale to fit on page, and draw without labels, dimensions, and ISO using ortho note above - HOA
2.4	Robot designs	• A1, A1.6, A2, A4.3, A5, A5.1, B2, B2.1, B2.3, B2.4, B2.5	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• SPICE design process – note • SPICE design self/peer assessment tracking - RUB • Applying SPICE to a Robot Design - ASS • Robot ortho design - note • Three new robot designs ISO sketches – HOA • Technology Design - pleasing to our 5 senses-and model/prototype assessment criteria - ASS • final design sketch an ortho/ISO - HOA • Post report on final robot sketch design - RPT

SKILLS AND KNOWLEDGE LEARNED FROM UNIT 2: ENGINEERING COMMUNICATION

The following is a list of skills and knowledge that students should have learned by completing this unit.

- Sharpen a pencil and keep it sharp while sketching (conical)
- Properly erase pencil lines.
- Sketch common plane geometrical figures (triangles, rectangles, square, regular polygons, etc.)
- Sketch objects in outline form (with lead pencil)
- Common engineering drawing types
- Block in orthographic views using sketching techniques
- Lay out the border line (continuous and in segments)
- Upper case printing (gothic font style)
- Sketch orthographic views of objects with horizontal and vertical surfaces
- Sketch orthographic views of objects with non-cylindrical features and cylindrical features
- Sketch orthographic views of objects with hidden features
- Sketch isometric views in both wireframe and standard views
- Sketch relative scale to page size
- Sketch different line types - construction, object, hidden, centre, leader, projection lines
- Sketch views relative to each other
- Sketch views in third angle projection
- Measure objects by use of the metric system.
- Print measurements on the drawing.
- Sketch dimension and projection lines.
- Dimension circles or holes and locate them.
- Dimension non-cylindrical features
- Dimension overall dimensions
- Dimension detail dimensions
- Dimensioning inside the envelope
- Selecting the front view, applying the three rules
- Defining the front view in drafting standard definition
- FIRST FRC game criteria for robot and field
- Online quiz format
- Different graphic formats of robots designs and their principles and element characteristics
- Design process model SPICE – steps, application, and process
- Application of SPICE to a challenge – FRC robot design
- Design report

UNIT 3: STRUCTURE AND MATERIALS

Time: 3. Weeks

DESCRIPTION OF UNIT 3: FUNCTIONS AND INTEGRATION

This unit first introduces the student to common materials, the environment, and sustainability then look at imperial and metric measurements and conversion, project management. SolidWorks is introduced and work with some simple design models and drawings. The 3D printer is also introduced and students print their design. Mechanical joinery and connections are looked at to understand how they can be used in a robot to support design ideas. Students finish the unit with their frame design using the weldment part creation tool.

Students are introduced to common materials and their characteristics. They are to watch an environmental sustainability video and then look at their robot design and come up with a library bank of practical materials for their robot, taking in account material characteristics, sustainability, and the environment. Looking at imperial and metric standards, measurements, and conversions is reviewed for future CAD work. Project management using Excel is re-vested in more detail looking closer at timelines, team organization, material costs and sources. Students will use this to start organizing there robot support group and establish materials, costs, sources, etc. to help support their robot design and model build process. Students are encouraged to continually update it as they add new materials, parts, and complete processes. Students will be introduced to 3D CAD SolidWorks program (Any similar program could be substituted here such as Creo 2 or Inventor.) and complete a simple part, the step block, for their first assignment. They will make a part, and then create an ortho/ISO drawing file with dimensions on standard A4 sheet output following demonstration.

Students will be introduced to common joints, fasteners, methods, hinges, slides, tracks, brackets, bushings, and bearings through a presentation and look at sample robot examples, then students will create a report based on their own custom design on what they will be using on their robot using criteria from the game, information from presentation and research. Students will also work on how to create 2D sketch profiles to be later used with their frame build through the weldment model build process. Students will be given parameters of size and shape – cylindrical and non-cylindrical features for a simple robotic key-fob design model. First they will sketch three ides and select the best one, check with instructor, and then create in SolidWorks. After the model is done, create an ortho/ISO drawing with dimensions, check with teacher again to continue to export out to STL file format to 3D print out of ABS plastic. This printing process will be a bottle neck and assure students they can print this whenever the printer is free, or come after school.

FRC robot frame designs will be reviewed through a presentation. Students are asked to assess the sample frame and their custom frame through product and process development to come up with criteria to allow comparisons and then use those comparison criteria to compare to 3 peer custom frames in a chart type report. At this stage students will have given each other feedback on their frame designs and students will have an opportunity to modify or upgrade their frame design before creating their 2D profiles. Students will learn how to properly create 2D sketch profiles for use with weldments process later. Students will look at the different frame pieces used on sample robot and create their own profiles, and then also look at their own custom frame and make profiles for their custom robot also.

Weldments are introduced in SolidWorks, using their 2D profiles, students are shown how to create, join, trim, and place weldment paths. Students use their 2D profiles to create the sample frame. Another demo will show how to create holes for the bearings using the hole-wizard and then mirror those featured holes to the other side. Students will follow the steps and prepare frame with bearing holes for wheels and gearbox locations and then create their own custom frame with appropriate bearing size holes.

CHART FOR UNIT 3: FUNCTIONS AND INTEGRATION OVERVIEW

Activity #	Activity Title/Name	Learning Expectations Overall/Specific	Assessment Categories	Tasks
3.1	Selecting the right materials	• C1, C1.1, C1.2, C1.3, B1, B1.2, B3.2	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Intro to materials –PPT • Video on sustainability and the environment • Ultimate materials, environment, sustainability research - RPT • Imperial & metric measurements and conversions - ASS • Project management - REV • 3D CAD intro step block – HOA
3.2	Joinery types and methods	• B2, B2.2	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Common Joints, fasteners, methods, hinges, slides, tracks, brackets, bushings, and bearings – PPT & note • Application - your robot design mechanical connections - RPT • 3D CAD Custom robotic key fob– HOA • 3D Print (tutorial) their key fob– HOA
3.3	Frame design	• B2, B2.2, B3.3	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Frame types and design – PPT • Compare product/process assessment on both frame designs – RPT • 2D Sketch profiles samples - HOA
3.4	Frame model	• B2, B2.2,	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• 3D CAD weldments, hole wizard, and feature mirror tool demo • 3D frame design build sample- HOA • Custom frame design & build - HOA

SKILLS AND KNOWLEDGE LEARNED FROM UNIT 3: STRUCTURE AND MATERIALS

The following is a list of skills and knowledge that students should have learned by completing this unit.

- Common robot related material
- Material characteristics
- Environment and sustainability issues and concerns
- Material selection criteria
- Identification and selection of proper materials
- Imperial and metric measurements, standards, and conversions
- Project management details – time, resources, materials, source, and personal organization
- Excel use – cell entries, editing, formulas, format, alignment, customization, and sheets
- 3D CAD – SolidWorks
- Interface and control
- 2D sketching
- Saving files and folder locations
- Choosing the best profile
- Choosing the sketch plane
- Sketch entities
- Basic sketching
- Rules that govern sketches
- Design intent
- Sketch relations
- Dimensions
- Extrude
- Basic modeling
- Details of the part
- Sketching on a planar face/surface
- Using the hole wizard
- View options
- Editing tools
- Creating drawings
- Sheet sizes, formats, and templates
- Customizing a sheet format
- Title block entries
- Updating sheet formats
- Drawing views and projections
- Center marks and centerlines
- Dimensioning
- Changing view parameters
- Drawing sheets and views
- Smart Dimensions
- Moving and deleting dimensions
- Dimension properties
- Adding annotations
- Annotation types

- Mechanical joint types
- Fastener types
- Hinges
- Slides
- Bearings
- Bushings
- Identification and selection of joints and fasteners
- Exporting to STL file format
- 3D STL conversion to BFB printer file process
- 3D printing process
- ABS melting temperature
- 3D printer configuration and set-up
- 3D printer calibration
- Common frame types and design
- Frame comparison criteria
- Assessing other frames product and process
- Creating 2D sketch profiles
- SolidWorks option configuration menu
- Saving 2D sketch profiles properly
- Weldment creation, pathways, joining, trim, profile placement
- Hole wizard tool
- Mirror feature tool

UNIT 4: DRIVEN MECHANISMS

Time: 3 Weeks

DESCRIPTION OF UNIT 4: DRIVEN MECHANISMS

This unit focuses on mechanisms and leads into the first major function the elevator. Gears, gearboxes, ratios, speed, torque, calculations, drive train design and build are the focus. Chain drawing from sprocket to sprocket is looked at along with creating a physical and virtual working prototype robotic 3 axis arm. Unit finishes with the elevator design and build.

Students are introduced to gear principles, types, ratios, speed, and torque presentation and then look at robot sample. Students are asked to decide on their motor gearbox set-up on their custom robot and calculate gearbox output speed to hand-in as an assignment showing all work. Shaft, bearings, and bushings types, uses, and methods are presented so students can think about possible drive train basics. Students are asked to research 5 general CAD supporting sites, 5 part files sites, and 5 support tutorial sites that they feel will be useful in helping them build their model design in SolidWorks and share with class through the class wiki (or other similar sharing venues available, such as a blog or a networked Excel sheet). For the last task in this section, teacher will demo how to import STEP files (common standard) into SolidWorks to be used in their own projects. Demonstration of creating an assembly by placing parts, moving into position and then mating or constraining those parts to a specific location will be shown. Using sample robot files and previously made frame, students are to create a new robot drive train assembly file and mate bearings and gearbox/motor sub-assembly to their sample frame, then mirror those components to the other side. If time permits continue on to adding bearings and gearbox/motor to their custom frame.

Wheel, sprockets, pulleys, belt, and roller chain sizes, types, and methods is presented to class and students will use this information to understand how the sample robot was designed and then come up with their own chain and sprocket sizing to complete a custom Gearbox to wheel power transfer design assignment. Students will then open up their sample drive train assembly file and add bearings, shafts, wheels, and sprockets using placement and constraints techniques learned in the last lesson. After a presentation on basic robotic arm designs, students in groups are to research, design, and create a physical working prototype 3 axis arm – rotate, base and elbow control and hook using a variety of school local materials and create a presentation to show the class their design, calculations, process, tools, materials, and build methods.

A presentation on some different drive train types will show students several different drive type systems that could also be employed on robots. (At this point if custom robots are being continued students may consider modifying their drive system on their custom robot.) Students will follow a tutorial on how to create a chain/belt pathway, model a chain link, then pattern the chain link around the pathway to create the chain connecting from the gearbox to the 2 wheels. Once the two chains are complete, those chains can be mirrored on to the other side. Students will take the prior robot arm challenge and build a virtual prototype with the addition of a 2 point end effect gripper using appropriate materials and a drawing to show in a post report/presentation to class.

Now that the robot has a drive train on the frame, students can now create the elevator function. Students will be introduced to the elevator design and how it works. An outline of the model building process will help students

complete this assembly themselves. Students will start by creating the frame weldment part with bearing holes, create parts as required and bring into the assembly and then put the assembly together. Students will need a demo on how to create reference planes to create custom circlip locations to keep shaft components in place and process on how to get the pneumatic actuator and place it to control the secondary tote latch Once the assembly is complete a master assembly file can be created and bring in the drive train and frame, and the elevator. The elevator can be placed then mirror the entire elevator assembly to the other side of the robot frame deck.

CHART FOR UNIT 4: DRIVEN MECHANISMS OVERVIEW

Activity #	Activity Title/Name	Learning Expectations Overall/Specific	Assessment Categories	Tasks
4.1	Gears types, ratios, and characteristics	• B1.1, B2, B2.2, B2.4	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Gear principles, types, ratios, speed, and torque introduction -PPT • Robot speed and torque design requirements - ASS • Shaft bearing & bushings intro • CAD research resources support note • 3D Motor/gearbox mount - HOA
4.2	Gearbox to wheel design	• A1.2, A4, A4.2, B1, B2, B3, B4, B2.1, B2.2, B3.1 D1.2, D1.3, D2.2, D2.3, D2.6	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Wheel, sprockets, pulleys, belt, and roller chain intro - PPT • Gearbox to wheel power transfer design- ASS • 3D wheel, shaft, sprocket modeling – HOA • Robotic arm designs - PPT • Research and create a physical-scaled prototype of a robotic arm - HOA • Prototype physical robotic arm, design process post - RPT & PPT
4.3	Drive train build	• A1.2, A3, A5, A2.1, A3.2, A4.1, A5.1, A5.3, B2, B2.4, B3, B3.1, B3.2, B4.1, B4.2	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Drive train types Intro - note • 3D Drive train modeling - HOA • 3D chain modeling tutorial - HOA • Create a virtual prototype of same robotic arm 3D model, drawing - HOA • Prototype virtual robotic arm, design process post - RPT & PPT
4.4	1st Function - elevator build	• B2, B2.2, B2.4	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Elevator design on frame model • Shaft and sprocket build - HOA • Tote latch Lift and pneumatic actuator - HOA • Chain, chain link accessory, and tote lift - HOA • Custom Function design - REV

SKILLS AND KNOWLEDGE LEARNED FROM UNIT 4: DRIVEN MECHANISMS

The following is a list of skills and knowledge that students should have learned by completing this unit:

- Gear principles and operation
- Gear types
- Gear ratios
- Speed and torque
- Calculating speed and torque
- Factors affecting speed and torque
- Getting the right speed and torque to your output
- Shaft, bearings, and bushing types, uses, and purpose
- Creating assemblies
- Hole wizard hole reference transfers
- Robot arm types
- Prototyping a working 3 axis robot arm
- Calculating load vs strength and distance
- Working with basic hand tools
- Using a variety of prototyping materials
- Simulating pneumatic actuators
- Creating scaled prototypes
- Drive train types
- Creating chain in SolidWorks
- Referencing centre planes
- Belt chain pathway tool
- Using geometry to create chains
- Fillet and chamfer feature tool
- Selecting part material and appearance
- Pattering chain link along a pathway
- Mirroring components
- Creating simple virtual prototypes
- Elevator function and tote latch lift
- Creating multiple reference planes
- Working with pneumatic actuators
- Advanced sliding mate for functional movement

UNIT 5: FUNCTIONS AND INTEGRATION

Time: 3 Weeks

DESCRIPTION OF UNIT 5: FUNCTIONS AND INTEGRATION

This unit will reinforce a lot of what was previously learned up until now through practicing using SolidWorks using previously learned techniques to create more functional assemblies to later add to the main robot assembly.

Instructor will review the design of the mid base body frame design, purpose, and build method. A new sketch type will be demonstrated using the 3D sketch tool with weldments, and then students will create the sample robot mid frame using similar process. Once students are done the mid body frame, students will get a demo on how to create an exploded view of it. Animation of assembly of the exploded view can played in the same window and saved as a video file. A quick explanation of codec compression, video standard window sizing, frames per second vs size of file. Students may continue to work on their own custom robot if time permits here.

Next, students will be presented pneumatic systems and actuators. Students will learn what is required in a pneumatic system, different types of solenoid valves, and actuators, pressure switches, reserve tanks, relief valves and then will be asked to create a sketch of a pneumatic system for the sample robot showing all the components.

Tote grabber function design will be reviewed discussing the key design features such as the gearbox, special wheel, pulleys, urethane round belt, pivot support base, and actuator. Quick review on the model build process will follow and then allow students to build it. Some parts will have to be made while others will already be available to use. Once done, the tote grabber assembly can be brought into the main robot assembly and then mirrored to the other side.

Gripper function design will be reviewed discussing the key design features such the H frame gripping mechanism, the hinged 90 degree alternate angle gripping function and the slide carriage design. Demo will show how to create the gripper arms and/or angle gussets using the sheet metal tool. Students can then continue to make parts and build the assembly. Once done students will have to make the tower slide assembly and then both can be brought in to main assembly to place and constrain.

Again if time resources permit, students can continue to work also on their custom robot once they have completed the sample robot.

CHART FOR UNIT 5: FUNCTIONS AND INTEGRATION OVERVIEW

Activity #	Activity Title/Name	Learning Expectations Overall/Specific	Assessment Categories	Tasks
5.1	Mid-base body-frame build	• B2, B2.2, B2.4	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Mid base body design - REV • 3D sketch with weldment demo • 3D Mid base body build - HOA • Exploded assembly process • Animated assembly, rotating and exploding demo • Custom support base - HOA
5.2	Pneumatic actuators and system	• B2.4,	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Basic pneumatic system intro - PPT • Actuator size and selections -ASS • Custom pneumatic system sketch - HOA
5.3	2nd Function -tote grabber build	• B2, B2.2, B2.4	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Tote Grabber design - REV • Frame, motor support, shaft extension, round belt pulleys, bane wheel, actuator mounts, bushing supports, and round belt parts - HOA • Custom function - HOA
5.4	3rd Function - gripper build	• B2, B2.2, B2.4	• Knowledge / Understanding • Thinking / Inquiry • Application	• Gripper function design – REV • 3D Sheet metal demo • 3D Sheet metal process build - HOA • Gripper arms, H-frame, actuator and extension, slide support, gussets, 90 degree hinged actuator – HOA • Tower support slide – HOA • Custom function - HOA

SKILLS AND KNOWLEDGE LEARNED FROM UNIT 5: FUNCTIONS AND INTEGRATION

The following is a list of skills and knowledge that students should have learned by completing this unit:

- 3D sketching and weldments
- Exploded assemblies
- Animating exploded assemblies
- Recording AVI animation
- Basic video recording
- Codecs, FPS, and size standards
- Pneumatic systems and components
- Pneumatic actuators
- Designing a pneumatic system for robot

- Editing a part inside an assembly
- Round belt and pathway creation
- Sheet metal parts
- Adding bends to sheet metal
- Flattening out design
- Ridge and flexible assemblies
- Converting from STL to a part file
- Scaling imported parts

UNIT 6: 3D MODEL ASSEMBLIES

Time: 4 Weeks

DESCRIPTION OF UNIT 6: 3D MODEL ASSEMBLIES

This unit focuses on finishing the robot assembly, creating ortho/ISO drawings, and a presentation 360 rotation animation.

Major assembly functions should be completed, and if not already done, will need to be added to robot. The instructor will review the steps to bring in sub-assemblies into the main robot assembly. Some sub-assemblies may need to be mirrored in some cases to represent the other side or mirrored function. Sub-assemblies that do need to be mirrored on the sample robot are the elevator and the tote grabber, as there is one on each side, similar to the drive train motor/gearbox assembly which was done some near the beginning of the robot model build. There will need to be fastening components brought in to show how each of the major function assemblies is attached to the robot. For example the elevator has six quarter-twenty bolts, washers, and nylon-insert locknuts through the deck of the robot to secure it to the base of the robot.

The function supports section is all about making sure all of the functions that were put into the model are working together to support your robots functioning tasks effectively. Review with students, additional function supports that need to be completed for this robot to reasonably solid strength and function wise. For some examples:

- The tower and elevators need additional strengthening on top, so an upper frame needs to be built and added to main assembly to support both.

- Additional frame strengthening brackets at the middle of the robot are needed to ensure the C shape frame support around the tote/elevator chamber is strong enough to support the rest of the robot and prevent a disastrous bend or break from an unintentional impact.

Ensure students make an effort to have mechanical moving joints working as best as possible to show or prototype their movements in relation to the rest of the robot design. The belly pan which houses all of the electronics, battery, and motor controls should be one of the last things added as its priority can be flexible and be fitted with what space is left on the robot design. Students need to understand that some components are more flexible in location and space needs as the robot goes through several iterations, this space and shape may change to support other high-priority designs. By waiting till now you can safely using current space without the danger of having to relocate, resize, or redesign the belly pan. As with similar reasoning as above, students can now go back to their frame components and lighten up parts carefully using patterned cut extrudes to safety remove material, being careful to keep intended strength maximized.

Once the robot is fully complete, drawings can be started. Students will have a demonstration of the steps to take to select a standard sized sheet. Sample robot drawings were done on an ANSI A3 size, to allow for a larger scale and more room for details and dimensions to be shown. Students are shown the difference between sheet format and templates and bringing in assemblies using the standard ortho/ISO third-angle projection placement process. Students

are shown how to add and edit dimensions, setting standards in the options - configuration window, and made aware to ensure all overall and some of the key features or details of that assembly are dimensioned.

Instructor will demonstrate how to make a basic 360 model rotation through the lower animation tab by rotating the model around the z axis and how to save it to an AVI video file. Codecs, frames per second, speed of rotation, size of window are all factors on the quality, smoothness, and file size relations that can be discussed. Have students animate their robot by doing a simple 360 rotation about the y axis to show off their completed robot. Students can save their video and upload it to their YouTube account for public viewing and link to their digital portfolio for later. Students are asked to save both the final model and the drawing files to eDrawing format, for free dynamic viewing without the application software. Students should already have been updating their project management sheets as they go through the project and should be reminded to do any final updates before submitting and including in their post report.

The priority here is to finish the sample robot, drawing files, and animations and complete a post report on their process throughout the project. Part of the report will be to research a variety of FRC robot graphic-image-formatted designs with principles of design characteristics and apply it to their report noting the connections with elements and principles of design. Students will also use this post report for their web portfolio in the next unit. If time permits students can now finish their custom robot model, drawings, and animations following the same process. Only one post report is necessary. If they have finished both the sample and their custom robot, then the post report should focus on the custom robot with the sample robot as a secondary supporting task.

CHART FOR UNIT 6: 3D MODEL ASSEMBLIES OVERVIEW

Activity #	Activity Title/Name	Learning Expectations Overall/Specific	Assessment Categories	Tasks
6.1	Robot assembly build	• B2	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Robot assemble design - REV • Assemble sub-assemblies - HOA • Mirror components tool – HOA • Custom Assembly - HOA
6.2	Function integration	• A1, A4, B1, B3, D2.5	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Robot function support designs - note • Ensure working prototype of joints in model– HOA • Upper tower/elevator frame support - HOA • Belly pan and components assembly - HOA • C-frame support brackets – HOA • Custom assembly supports - HOA
6.3	Drawings	• A3, B2	• Communication • Knowledge / Understanding	• Drawing files for all major assembled functions and components in the form of ortho/ISO with dimensions -

			• Thinking / Inquiry • Application	HOA • Custom robot drawings – HOA
6.4	Presentation	• A2, A3.1, A5, B4, B4.1, B4.2	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Basic model animation - HOA • Update project management sheets - ASS • Summary post wrap-up - RPT

SKILLS AND KNOWLEDGE LEARNED FROM UNIT 6: 3D MODEL ASSEMBLIES

The following is a list of skills and knowledge that students should have learned by completing this unit:

- Assemblies and sub-assemblies
- Assembly mirroring
- Function assembly interaction and support design
- Sheet size, scale, and format
- Information block
- Adding views
- Configuring views
- Centre lines & marks
- Dimensioning
- Annotations
- eDrawing files
- Model animations
- Saving model animations into videos

UNIT 7: MARKETING AND PORTFOLIO

Time: 2 Weeks

DESCRIPTION OF UNIT 7: MARKETING AND PORTFOLIO

In this unit, students will showcase all of their work in a web page portfolio.

Students will be given a completed web-template in a folder with the necessary basic web elements to customize. Given this is an extremely portable and flexible medium; students will learn that this can be used in a wide variety of presentations and formats to showcase and present their work, knowledge, and skills. Web authoring will allow students to learn how to bring images and text in, create links, use thumbnails to link to larger images – saving bandwidth and speeding up page loads, and basic editing.

Students are encouraged to use their log to support their text feedback on new learning. Once their page has been organized into an introduction, projects, and conclusion, students are to ensure all file related components are in a single folder to submit for class presentation.

After this short intro to using Dreamweaver, students are to gather all of their project images, sort organize, and gather their thoughts on each of the projects, the design process, new skills, knowledge, and values they have gained to add to their web page in an organized fashion. Portfolio should show your accomplishments, research and sources, design process, materials, techniques, testing, prototyping, design improvements and developments, project management sheets, created designs, and conclude with what they have learned in the course.

Optional online web site generators could be used but are not as flexible. Students having difficulty using Dreamweaver could use an online option, but will have to start from scratch for their layout, as the layout is provided in class is designed for Dreamweaver or similar authorware editing software.

Class presentations students will present their portfolio and review all aspects in their web portfolio for the course. For the T-shirt print project, students will add their isometric robot model image with white background to an Illustrator template file advertising the Technological Design and print a colour copy to special heat transfer paper, and then transfer this to a school crested white t-shirt for them to take home.

CHART FOR UNIT 7: MARKETING AND PORTFOLIO OVERVIEW

Activity #	Activity Title/Name	Learning Expectations Overall/Specific	Assessment Categories	Tasks
7.1	Web authoring	• A3.1	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Open up web page template and create STE set-up file - HOA • Add, modify, move, remove text and images - HOA • Prepare image types and sizes - HOA • Creating text, links and picture links - HOA

7.2	Portfolio	• A5.2, A5.3	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Discussion on content and how its presented • Collect all related images, create thumbnails - HOA • Create and add content from course, post reports, and projects - HOA
7.3	Presentation	• A3.2, A5.4, B4, D2.7	• Communication • Knowledge / Understanding • Thinking / Inquiry	• Present to class, highlighting major course topics, your project designs, new learning and growth - PPT • T-Shirt print of robot - HOA

SKILLS AND KNOWLEDGE LEARNED FROM UNIT 7: MARKETING AND PORTFOLIO

The following is a list of skills and knowledge that students should have learned by completing this unit.

- Dreamweaver application set-up, program features, layout and basic operation
- Working with templates, project file set-up
- Basic add modify and move text and images
- HTML text and image links
- Image size preparation
- Testing web page and operation
- Creating portfolio, using Photoshop and MS Word to support Dreamweaver
- Summary of all the work students accomplished throughout the semester
- Design process and their steps to finishing their robot(s)
- Project management table completed and shown
- Robot project work, images, drawings, and animations
- T-shirt print process
- Realization of the total learning, knowledge, and skills acquired throughout the course

PROFILE TEACHING/LEARNING STRATEGIES

There are a wide variety of teaching/learning strategies that can be used throughout the course that students may grow through more knowledge, skills, and values. The following is a list strategies used in this profile in alpha order.

- Brainstorming – group idea generation expressed without any criticism or analysis
- Buddy System – links students for peer support
- Case Study – investigation of real life and simulated issues and situations
- Class Discussion – students actively participate by taking turns discussing current tasks and/or issues
- Collaborative and Co-operative Learning – small group learning providing high levels of student engagement, interdependence, and group support
- Computer-Assisted Learning – use software and Internet applications to research, write, develop, draw, build, and communicate ideas
- Conferencing/Discussion – student-to-student discussion and teacher-to-student discussion to encourage confidence and motivation to be successful
- Cooperative learning – students work collaboratively supporting each other's learning and understanding
- Demonstration – direct instruction to model a process, how something works , or an example of concept
- Design Process –problem-solving approaches using a prescribed processes involving a number of specific steps
- Differentiated instruction – instruction that meets the needs of students leaning needs and abilities
- Guided Discussion – a directed exchange of information dialog between two parties
- Group work – students work in small groups to accomplish a task, project, or exercise together as a whole
- Hands-on-projects – students learn by actively doing or participating in the process while learning
- Homework – an extension of class work, support, time extension and material review
- Independent Study – exploration and research of a project topic interesting to students
- Inquiry process – problem-solving approach using a prescribed process involving a number of steps
- Jigsaw – cooperative learning by mixed groups with different goals on same topic, later to share as a whole
- Job Shadowing – develop awareness of various related career opportunities
- Journal Writing – the practice of expressing ideas, experiences, questions, reflections, personal understanding, and/or new learning in written form on regular basis
- Lecture - direct instruction by presenter to orally pass on structured information to a group while listeners take notes
- Mentoring – students will support and assist with others learning
- Mind Map – involves representing physical, demographic, numerical data through visual line connections showing the relationships between ideas
- Note Taking – a method for recording information for a variety of purposes
- Open note testing – students answer questions from their own documented notes
- Overview – reviewing what will be covered in the near future
- Peer teaching – student mentors class, small group, or individuals on learning content
- Portfolios –display of students best work which can be showcased in many different mediums such as folders, documents, and web page/sites
- Problem Solving –a model for helping students to identify and work through a problem/challenge
- Prototype Fabrication – construction of a working model to test or demonstrate a specific function, features, design concept, or pattern
- Reading assignments – read about a specific topic and/or process
- Reading out loud – students read out loud to share with others

- Report/Presentation – oral, visual, and/or written presentation of a researched topic to class and/or community
- Reflection – students based on information give their attitude and thoughts on that topic or information
- Research – a process of investigation about a topic or focus
- Review – going over or summarizing information and/or process previously taught
- Socratic Lesson – oral presentation of information and process by the teacher
- Survey/Interview – consulting peers and/or community members for purposes of information gathering
- Think pair share – students presented with open ended question, think about it, then discuss in pairs, share with other group, and then share with class
- Think pair square – students presented with open ended question, think about it, group in four, then discuss in pairs, then back to four to share
- Tutorials – students follow a step-by-step guided process usually individually
- Web site – support curriculum and teaching information with online support
- White board – write and share ideas and information with class
- Wiki reporting – students report, or keep a journal of their learning process to share with others
- Word association terminology – students create a poster based on related words to that topic or subject

PROFILE ASSESSMENT & EVALUATION OF STUDENT ACHIEVEMENT

The assessment techniques described below focus on both the process and product of student learning.

ASSESSMENT/EVALUATION TECHNIQUES

PAPER-AND-PENCIL

- Quizzes and tests
- Worksheets
- Project proposals
- Final written evaluation

PERFORMANCE ASSESSMENT

- Skills demonstrations
- Presentation
- Finished product
- Portfolio

PERSONAL COMMUNICATION

- Conferencing
- Student-teacher
- Teacher-group
- Daily activity log or journal
- Critique peer conferencing

ASSESSMENT TOOLS

- Checklists
- Marking schemes
- Rubrics
- Anecdotal comments with suggestions for improvement
- Rating scales

PURPOSES OF ASSESSMENT

- Assessment for Learning – This is data assessment in both formative and summative. The idea is to provide feedback for your students on their next steps for Learning – to improve their learning.
- Assessment as Learning – Assessment as learning is a reflective, metacognition process where the student engages in self-assessment, thinking about their achievement. Once students begin to think about the overall learning of skills, they begin to become independent thinkers.
- Assessment of Learning – In assessment of learning, the teacher gathers evidence of the students' achievement through summative activities. This is always based on the course expectations and forms the basis for the students overall evaluation.

EVALUATION OF STUDENT ACHIEVEMENT

Students are formally evaluated on their demonstration of curriculum expectations using the categories of skills and knowledge set out in the Achievement Chart. Checklists are used to provide information about the operational steps of the production process (such as the completion of planning documents) and an ongoing means of monitoring the level of achievement attained. Rating scales and rubrics describe the look and feel of completed products. All evaluation tools should be available to students at the beginning of an activity to provide information about task requirements and the features of exemplars. Teacher/student discussions during pre-production, production and post-production can clarify standards and expectations as well as provide a way of monitoring progress. The inclusion of informal opportunities for peer and self-assessment can promote in students a sense of responsibility, accountability, and growth. Written tests and question sheets are effective in the evaluation of required knowledge. The vocabulary used in test questions should reflect that used in the learning situation. The option for oral testing and student demonstrations of acquired skills should also be used. Although students are encouraged to write answers in proper sentence form, diagrammatic answers are effective assessment instruments in technological education. In their planning and implementation of projects, work assignments, and problem-solving activities, students demonstrate their ability to combine skills and knowledge successfully in practical tasks. Seventy per cent of the grade will be based on assessments and evaluations conducted throughout the course. Thirty per cent of the grade will be based on a final evaluation in the form of an examination, performance, essay, and/or other methods of evaluation.

PROFILE ACCOMMODATIONS

The teacher consults individual student IEPs for specific direction on accommodations for individuals. The teacher uses a range of teaching/learning strategies to accommodate the needs of all students. Exceptional students benefit from accommodations in the overall activity criteria, as well as teacher and peer assistance when appropriate. Written tests are designed to suit students' reading and writing levels. The teacher adapts teaching strategies to accommodate learning styles. These may include:

- Verbal instead of written tests;
- Demonstrations of acquired skills instead of written evaluations;
- Providing rewrite opportunities when appropriate;
- Conferencing discussions
- Small-group learning;
- Flexible timelines;
- Adapting handouts;
- Peer tutoring;
- Mentoring
- Additional activities
- Enrichment and/or extension activities.

PROFILE RESOURCES

Units in this Course Profile make reference to the use of specific texts, magazines, films and websites. The teacher must consult board policies regarding the use of any copyrighted materials. Before reproducing materials for student use from printed publications, the teacher must ensure that the school board has a Cancopy licence and that this licence covers the resources to be used. Before screening videos/films with the students, the teacher must ensure that

the board/school has obtained the appropriate public performance videocassette licence from an authorized distributor, e.g., Audio Cine Films Inc. **Note:** much of the material on the Internet is protected by copyright. The person or organization that created the work usually owns the copyright. Reproduction of any work or substantial part of any work on the Internet is not allowed without the permission of the owner.

Each activity in this profile lists specific resources that may include textbooks, training manuals, magazines, websites, multimedia and presentation packages, videos, online tutorials and career/industry sources. Below is a comprehensive list of resources referenced in the activity descriptions for each course unit.

BOOKS

- Robotics: Modelling, Planning and Control https://books.google.ca/books?id=jPCAFmE-logC&printsec=frontcover#v=onepage&q&f=false
- FIRST Robots: Aim High: Behind the Design https://books.google.ca/books?id=NcLPFv1jAGUC&printsec=frontcover#v=onepage&q&f=false
- Solid Works Design Bible 2 https://books.google.ca/books?id=9CZOAgAAQBAJ&printsec=frontcover#v=onepage&q&f=false
- Parametric Modeling with SolidWorks 2014 https://books.google.ca/books?id=5hi-AgAAQBAJ&printsec=frontcover#v=onepage&q&f=false
- Engineering Design with SolidWorks 2014 and Video Instruction https://books.google.ca/books?id=px1kAgAAQBAJ&printsec=frontcover#v=onepage&q&f=false
- The Effect of the FIRST Robotics Competition on High School Students https://books.google.ca/books?id=BTMsBFS6swwC&printsec=frontcover#v=onepage&q&f=false
- Design Engineering: A Manual for Enhanced Creativity https://books.google.ca/books?id=RzIRTbZ-U6MC&printsec=frontcover#v=onepage&q&f=false
- Engineering Systems: Meeting Human Needs in a Complex Technological World https://books.google.ca/books?id=lGaGjE2i0S0C&printsec=frontcover#v=onepage&q&f=false
- Engineering Design: A Systematic Approach https://books.google.ca/books?id=qsKNwB2gL5wC&printsec=frontcover#v=onepage&q&f=false
- Manufacturing Technologies for Machines of the Future: 21st Century Technologies https://books.google.ca/books?isbn=3540434925
- Manufacturing and Design: Understanding the Principles of How Things Are Made https://books.google.ca/books?isbn=0080999263
- Manufacturing Processes and Materials https://www.google.ca/search?tbo=p&tbm=bks&q=isbn:0872635171

JOURNALS/MAGAZINES

- Design World http://www.designworldonline.com/
- Design News http://www.designnews.com/
- Desktop Engineering http://www.designnews.com/
- Design Engineering http://www.design-engineering.com/

- Index of free Engineering publications http://magz.tradepub.com/category/engineering/1201/

WEBSITES

DESIGN PROCESS

- Design Process http://www.technologystudent.com/designpro/despro1.htm
- Slide Share on Design Theory http://www.slideshare.net/Leursism/design-theory-lecture-02
- Slide Share on Design Process http://www.slideshare.net/ChristopherBearden/the-design-process-final
- Design Process 2 http://www.slideshare.net/oregonfirst/first-fare-2010-the-design-process-and-first-robotics
- DesTech Wiki http://www.ruthtrumpold.id.au/designtech/pmwiki.php?n=Main.DesignProcess
- Design Process http://district.fms.k12.nm.us/departments/currinst/textbooks/science/Physical_Science_Textbook/iText/products/0-13-190327-6/ch1/ch1_s4_1.html
- Design Process http://www.mesc.gov.ws/pdf/DT_Teacher_Student_Notes_wk.pdf
- Design Process http://www.curriculumsupport.education.nsw.gov.au/designproduce/tech_process.htm

CREATIVE/CRITICAL THINKING

- The 21st century classroom – where the 3 R's meet the 4 C's http://web.tech4learning.com/blog-0/bid/45149/The-21st-century-classroom-where-the-3-R-s-meet-the-4-C-s
- Effects of Robotics on 21st Century Skills http://eujournal.org/index.php/esj/article/download/1805/1795
- Teacher tap http://eduscapes.com/tap/topic69.htm
- Critical and creative thinking pdf http://www.australiancurriculum.edu.au/GeneralCapabilities/Pdf/Critical-and-creative-thinking
- Creative Thinking Skills for Life and Education http://www.asa3.org/ASA/education/think/creative.htm
- Using Technology to Support Creativity and Critical Thinking http://farroutlinks.net/blog/creativity-and-critical-thinkin/
- Slide Share on Developing creative thinking and creativity http://www.slideshare.net/mpetit2/developing-creative-thinking-and-creativity
- Slide Share on Creative Workshop http://www.slideshare.net/changeorder/creative-workshop-authors-talk-at-sxswi
- Slide Share on Critical Thinking http://www.slideshare.net/gtteacher/critical-thinking-258041
- Slide Share on Critical Thinking and How to Teach it http://www.slideshare.net/pjeschofnig/critical-thinking-el-ccpj3

ROBOTICS

- Slide Share on Modularity http://www.slideshare.net/Leursism/grid-systems

- Slide Share Motors and Control for Robots http://www.slideshare.net/m_algmmal/motors-control-v2
- Slide Share Manipulator Design 1 http://www.slideshare.net/oregonfirst/first-fare-2013-manipulators-firstfare-2013
- Slide Share Manipulator Design 2 http://www.slideshare.net/guestf64799/first-robotics-manipulator-design
- Drive Trains http://www.slideshare.net/oregonfirst/first-fare-2012-drive-trains
- Pneumatics http://www.slideshare.net/oregonfirst/first-fare-2010-pneumatics-presentation
- Toronto Gears http://www.torontogear.com/Products.html
- Rockwell Automation Literature Library http://literature.rockwellautomation.com/idc/groups/public/documents/webassets/browse_category.hcst
- Pneumatics 1 http://www.usfirst.org/uploadedImages/Robotics_Programs/FRC/Game_and_Season__Info/2014/2014FRCPneumaticsManual.pdf
- Pneumatics 2 http://www.teamdavinci.com/understanding_pneumatics.htm
- Pneumatics 3 http://team358.org/files/pneumatic/

MANUFACTURING AND DESIGN PRODUCTION PROCESS

- NPTEL E-Learning course resources http://nptel.ac.in/downloads/112101005/ also has a lot of other related course materials
- Instructables: http://www.instructables.com/id/How-to-Build-your-Everything-Really-Really-Fast/?ALLSTEPS
- Index of how products are made http://www.madehow.com/
- Animated Gifs on how things are made http://www.buzzfeed.com/kellyoakes/mesmerising-gifs-that-show-how-things-are-made#.tpnZAvLJQ
- Design for manufacturability http://en.wikipedia.org/wiki/Design_for_manufacturability
- Design for Assembly and Manufacturing http://me.gatech.edu/files/capstone/L071ME4182DFA
- Basic Facts to Consider When Selecting a Material for a Particular Design http://www.brighthubengineering.com/machine-design/55560-basic-facts-to-consider-when-selecting-a-material-for-a-particular-design/

SOLIDWORKS RELATED

- "2015 Swerve Drive Module." - 1716 Redbird Robotics Wiki. N.p., n.d.
- "3D Design Overview I Getting Started I SOLIDWORKS." 3D Design Overview I Getting Started I SOLIDWORKS. N.p., n.d.
- "9.5: Gear Train Design." 9.5: Gear Train Design. N.p., n.d.
- "Adjustable Shock Absorbers." Shock Absorber Supplier -. N.p., n.d.
- "Belt Length Calculator." Belt Length Calculator. N.p., n.d.
- "The Blue Alliance." The Blue Alliance. N.p., n.d.
- "Build Blog." Build Blog. N.p., n.d.
- "Calculating Roller Chain Length." Calculating Roller Chain Length. N.p., n.d.

- "Calculator for Conical Springs." Calculator for Conical Springs. N.p., n.d.
- "Calculators." Calculators. N.p., n.d.
- "Central Valley Regional FRC Tournament." Team 254 Home Comments. N.p., n.d.
- "Chief Delphi - Powered by VBulletin." Chief Delphi RSS. N.p., n.d.
- "Community." RoboRIO Details and Specifications Version History. N.p., n.d.
- "Competition Manual." FRC RSS. N.p., n.d.
- "ENGINEERING.com | Shaft Speed Calculator." ENGINEERING.com | Shaft Speed Calculator. N.p., n.d.
- "ETBX Helical Spring Design Module." ETBX Helical Spring Design Module. N.p., n.d.
- "FIRST Robot Student Design Contest SOLIDWORKS." FIRST Robot Student Design Contest SOLIDWORKS. N.p., n.d.
- "FIRST Robotics - Parts Models and CAD Drawings." FIRST Robotics: Parts & Assemblies. N.p., n.d.
- "FIRST Robotics." Andrew R George. N.p., n.d.
- "FRC Designs." FRC Designs. N.p., n.d.
- "Gear Ratio." Wikipedia. Wikimedia Foundation, n.d.
- "GrabCAD Helps Mechanical Engineers Build Great Products Faster." CAD Collaboration Solution That Accelerates Product Development. N.p., n.d.
- "Home." Frcsupplierscanada -. N.p., n.d.
- "How Do I Convert STL Graphics to a Solid Model?" - GrabCAD. N.p., n.d.
- "How to Determine Gear Ratio." WikiHow. N.p., n.d.
- "Huntington County 4-H Robotics." Huntington County 4-H Robotics. N.p., n.d.
- "Introduction." 2013 SOLIDWORKS Help -. N.p., n.d.
- "Library." - Bimba Manufacturing. N.p., n.d.
- "Mckinnon Metals Inc. Where Professionals Buy Their Metal." Mckinnon Metals Inc. Where Professionals Buy Their Metal. N.p., n.d.
- "McMaster-Carr." McMaster-Carr. N.p., n.d.
- "METAL SUPERMARKETS - Buy Metal Online - Small Quantity Orders for Aluminum, Stainless Steel, Hot Rolled Steel, Cold Rolled Steel for Delivery or Local Pickup." METAL SUPERMARKETS - Buy Metal Online - Small Quantity Orders for Aluminum, Stainless Steel, Hot Rolled Steel, Cold Rolled Steel for Delivery or Local Pickup. N.p., n.d.
- "Motors & Electronics - VEXpro - VEX Robotics." Motors & Electronics - VEXpro - VEX Robotics. N.p., n.d.
- "New Catalogs." Free 2D & 3D CAD Files, Models and Drawings of Mechanical, Electrical & Mechatronics Part Catalogs. N.p., n.d.
-
- "On the Rocks... a Blog: Understanding Suspension Spring Dynamics & Why We Chose Dual Rate." On the Rocks... a Blog: Understanding Suspension Spring Dynamics & Why We Chose Dual Rate. N.p., n.d.
- "Online Materials Information Resource - MatWeb." Online Materials Information Resource - MatWeb. N.p., n.d.
- "Photos." Chief Delphi RSS. N.p., n.d.
- "Products & CAD." Inch. N.p., n.d.
- "Quentin Weir." Quentin Weir. N.p., n.d.

- "RAMP Videos." Team 973. N.p., n.d.
- "Resources." Robotic Resources. Simbotics, n.d.
- "RoboKnights." RoboKnights. N.p., n.d.
- "Robot MarketPlace - 682 NPC Wheels with Delrin Hubs." Robot MarketPlace - 682 NPC Wheels with Delrin Hubs. N.p., n.d.
- "Robotics Competitionsprove to Be a Great Toolto Teach 21st Century Skills!" Robotics Academy. N.p., n.d.
- "Roller Chain." Roller Chain. N.p., n.d.
- "Roller Chain Specs." Red Boar Chain & Fastener Call 208-597-3500. N.p., n.d.
- "Round Belts (Round Belting)." DuraBelt ROUND BELTS, round Belting. N.p., n.d.
- "SolidWorks Education." Facebook. N.p., n.d.
- "Solving Triangles." Solving Triangles. N.p., n.d.
- "Springs." Springs. N.p., n.d.
- "A Step by Step Guide." SolidWorks Tutorials RSS. N.p., n.d.
- "Tap and Clearance Drill Sizes." Tap and Clearance Drill Sizes. N.p., n.d.
- "Team358.org - Robotic Eagles - FIRST® Robotics Competition." Team358.org - Robotic Eagles - FIRST® Robotics Competition. N.p., n.d.
- "TheRobotSpace.com." The Robot Space. N.p., n.d.
- "Timing Belt Pulleys & Timing Belts." - Power Transmission Components. N.p., n.d.
- "VEXpro - VEX Robotics." VEXpro RSS. N.p., n.d.
- "VEXpro Build Blitz 2015 - Page 4 - Chief Delphi." Chief Delphi RSS. N.p., n.d.
- "VEXpro Build Blitz." VEXpro Build Blitz. N.p., n.d.
- "WestCoast Products." WCP. N.p., n.d.
- "What Do We Do?" About. N.p., n.d.
- "Wheel Assembly 1." 955 Robotics. N.p., 22 Dec. 2013.
- "Www.AndyMark.com." 2014 Curiculum. N.p., n.d.

VIDEOS

- "2015 FRC Prototype Two Speed Swerve Drive Rough Design." YouTube. YouTube, n.d.
- "Beginning Solidworks for FRC Session 1 Part 1." YouTube. YouTube, n.d.
- "Belts and Chains in SolidWorks." YouTube. YouTube, n.d.
- "Designing A Sheet Metal Robot Chassis In Solidworks." YouTube. YouTube, n.d.
- "Drive Systems for FRC." YouTube. YouTube, n.d.
- "Module 3 Solid Works-cut and Extrude Text." YouTube. YouTube, n.d.
- "SOLIDWORKS â" Creating High-Resolution Images." YouTube. YouTube, n.d.
- "SolidWorks for Sheet Metal Design - A Basic Introduction.mp4." YouTube. YouTube,
- "SolidWorks Sheet Metal How to Start a Part." YouTube. YouTube, n.d.
- "Tech Tip Tuesdays: Extruded Frames in SOLIDWORKS." YouTube. YouTube, n.d.
- "Unit 1: Introduction - Lesson 1: What Is SOLIDWORKS." YouTube. YouTube, n.d.

- "Unit 3: Assemblies - Lesson 5: Main Assembly (Part 2 of 3)." YouTube. YouTube, n.d.
- Introduction to the 4 Cs https://www.youtube.com/watch?v=lNVQNz2Hto8
- Inquire: Creative and Critical Thinking video https://www.youtube.com/watch?v=-3s0WkEU1uo
- Project Based Learning https://www.youtube.com/watch?v=LMCZvGesRz8
- Creative thinking - how to get out of the box and generate ideas video https://www.youtube.com/watch?v=bEusrD8g-dM
- Where Good Ideas come From video https://www.youtube.com/watch?v=NugRZGDbPFU
- Index of FIRST Robotic related videos 1 https://www.youtube.com/playlist?list=PLaJ2K33GUrbZeD5t0UynCuJv3aKb8Os0G
- Index of FIRST Robotic related videos 2 https://www.youtube.com/watch?v=fivMiePNjCc&list=PL7JWUTbWy-haKfaY1t-stzF_7wkoHQshk
- Gears -You tube index https://www.youtube.com/results?search_query=how+gears+work
- Green https://www.youtube.com/watch?v=54pQd1Jq4eY
- Material science https://www.youtube.com/watch?v=0s5kBrk0d80
- Channel of how things are made https://www.youtube.com/results?search_query=how+things+are+made+discovery+channel+full+episodes
- Channel of how things are made http://science.howstuffworks.com/how-its-made-videos-playlist.htm

WEBSITES FOR TEACHERS

- Tons of CAD related reviews, articles, and tutorials. If you need something, this is a great place to start for specific know-how resources for your related CAD needs. For example, need a quick tutorial on a specific process to support your lesson, you will probably find it here. http://www.caddigest.com/subjects/INDEX.htm
- Lots of related technology design related support resources that teachers can use to support their course projects. You can use the A-Z index for example to get a huge index of all the different topics you can look up. As it is so large, you might find some dead links, but it has a lot of indexed links related to technology design topics. http://www.design-technology.info/home.htm
- This has a lot of practical information for all kinds of projects to further creative ideas by explaining the how it works technical support pages on a wide variety of related tech subjects that can be used by teachers as support documentation for students. http://www.technologystudent.com/
- As a big fan of FIRST robotics over the years, if you haven't heard of this organization, then it is something to check out. All about robotics and multiple levels of supported programs for students all over. For High School click on the FRC link at the top. http://www3.usfirst.org/
- SketchUP is great tool that all students should try out and the site has a lot of support resources that teachers and students can use to communicate their 3D ideas. http://www.sketchup.com/

PROFILE STRANDS & LEARNING EXPECTATIONS

Strand(s): A ➔Technology Design Fundamentals / B ➔ Technology Design Skills / C ➔Technology, the Environment, and Society / D ➔Professional Practice and Career Opportunities

A. TECHNOLOGY DESIGN FUNDAMENTALS

OVERALL EXPECTATIONS

- A1. demonstrate an understanding of factors and relationships that affect technological design and the design process;
- A2. describe appropriate strategies, techniques, and tools for researching, organizing, planning, and managing design projects and related activities, with an emphasis on financial, human, and material resources;
- A3. demonstrate an understanding of drafting standards, conventions, and guidelines for various types of drawings used to represent designs;
- A4. demonstrate an understanding of a variety of tools, materials, equipment, and processes used to build, test, and evaluate models and prototypes;
- A5. use appropriate terminology and communication methods to document, report, and present progress and results.

SPECIFIC EXPECTATIONS

A1. DESIGN PROCESS

By the end of this course, students will:

- A1.1 describe ways in which society, the environment, and the economy inspire and/or affect technological design (e.g., need for barrier-free access or alternative-energy vehicles), with reference to key technological concepts (e.g., aesthetics, control, environmental sustainability/stewardship, ergonomics, fabrication, function, innovation, material, mechanism, power and energy, structure, safety, systems) (see pp. 7–8);
- A1.2 identify the steps in the design process(e.g., define the problem or challenge, taking into account relevant contextual or background information; gather information about criteria, constraints, and available materials; generate possible solutions, using techniques such as brainstorming; choose the best solution; develop and produce a model or prototype; test the model or prototype; incorporate improvements or redesign and retest; report results) (see pp. 22–23), and demonstrate an understanding of the relationships among the steps (e.g., prototype testing can show that more idea development is needed);
- A1.3 evaluate various technical products (e.g., portable music player, backpack, cell phone) in terms of key technological concepts;
- A1.4 demonstrate an understanding of the relationship between technological design and art, science, technology, the environment, and commerce;
- A1.5 establish design criteria based on client interviews, consultations, and research (e.g., determine client's needs, budget, and lifestyle; research technical requirements, material limitations, function of space, and existing infrastructure);
- A1.6 describe the role that the five senses (touch, taste, smell, sight, and hearing) play in technological design (e.g., shapes, colours, and layouts that make controls easy to read and operate; lighting and colour schemes that set a mood and/or make a room, garden, or building attractive).

A2. RESEARCH AND PROJECT MANAGEMENT

By the end of this course, students will:

- A2.1 identify and locate sources of technical and design information (e.g., Machinery's Handbook, Sweet's building product catalogues, magazines, the Internet, interviews), using a variety of techniques and tools;
- A2.2 research and describe strategies for the planning, organization, and management of human, material, and financial resources for a design project (e.g., strategies for delegating tasks, selecting materials, estimating costs).

A3. REPRESENTING DESIGN IDEAS GRAPHICALLY

By the end of this course, students will:

- A3.1 identify and describe different methods for representing design ideas graphically (e.g., mind maps, sketches, design layouts, computer-aided drafting), with reference to principles and elements of graphic design (e.g., principles: gradation, emphasis, pattern, balance; elements: space, shape, size, value);
- A3.2 demonstrate an understanding of drawing types (e.g., pictorial drawings, floor plans, elevations, sections, detail drawings, rendered drawings) and of drafting standards and conventions (e.g., standards: Canadian Standards Association [CSA]; conventions: symbols, abbreviations, shading, dimension labels, geometries), with an emphasis on working drawings;
- A3.3 accurately interpret technical drawings and specifications.

A4. MAKING AND TESTING MODELS AND PROTOTYPES

By the end of this course, students will:

- A4.1 identify and describe different types of models (e.g., conceptual, physical, virtual, theoretical) and prototypes (e.g., proof-of-principle, functional, form study);
- A4.2 compare a variety of modelling tools (e.g., shaping tools; fabric shears; computer-aided design [CAD] software; computer numerically controlled [CNC] mill, lathe, or router) and materials (e.g., matt board, starch, linen) in terms of suitability, time, budget, and availability;
- A4.3 identify various criteria for assessing models and prototypes (e.g., adherence to specifications, material cost, assembly time, material availability, waste produced, cultural appropriateness) and the methods and equipment used to perform the assessment (e.g., methods: measuring dimensions, wind tunnel testing; equipment: colour wheel, decibel meter, weigh scale).

A5. REPORTING AND PRESENTING

By the end of this course, students will:

- A5.1 use technical terminology correctly when documenting, reporting on, and presenting design projects (e.g., vernier caliper, orthographic, fillet, bisect, construction lines, shears);
- A5.2 compare reporting styles and formats (e.g., styles: American Psychological Association [APA], Modern Language Association [MLA]; formats: portfolio, journal, logbook, technical report, reflection paper);
- A5.3 describe and use the appropriate tools (e.g., word processor, multimedia hardware, display board, image board [lifestyle, mood, styling, usage]) and formats (e.g., oral or multimedia presentation, technical report) for documenting, reporting, and presenting design ideas and results;
- A5.4 demonstrate an understanding of the components of a technical report (e.g., design brief, criteria and constraints, idea development, planning, design analysis, evaluation, technical drawings, design summary).

B. TECHNOLOGY DESIGN SKILLS

OVERALL EXPECTAIONS

By the end of this course, students will:

- B1. use appropriate strategies and tools to research and manage design projects and related activities;
- B2. apply appropriate methods for generating and graphically representing design ideas and solutions;
- B3. create and test models and/or prototypes, using a variety of techniques, tools, and materials;
- B4. use a variety of formats and tools to create and present reports summarizing the design process and to reflect on decisions made during the process.

SPECIFIC EXPECATATIONS

B1. RESEARCHING AND MANAGING PROJECTS

By the end of this course, students will:

- B1.1 use various research methods and strategies to gather, organize, and interpret design information from appropriate resources (e.g., building codes, Machinery's Handbook, interviews, union contracts);
- B1.2 use project management strategies and tools (e.g., project evaluation and review technique [PERT], time sheets, critical path analysis) to plan and organize finances, human resources, and materials for projects and related activities.

B2. DEVELOPING AND REPRESENTING DESIGN IDEAS

By the end of this course, students will:

- B2.1 use freehand sketches to help brainstorm initial design concepts for a project;
- B2.2 apply mathematical and scientific concepts and skills as required in the course of designing projects;
- B2.3 differentiate between artistic and technical criteria for a design;
- B2.4 produce hand-drafted and/or computer-based working drawings and other technical drawings of design solutions, using industry-recognized drafting standards and conventions;
- B2.5 apply principles and elements of graphic design to enhance design ideas in concept drawings and/or presentation-quality drawings.

B3. MAKING AND TESTING MODELS AND PROTOTYPES

By the end of this course, students will:

- B3.1 create design models (e.g., conceptual, physical, virtual, theoretical) and/or functional prototypes (e.g., proof-of-principle, functional) using appropriate tools (e.g., fabric shears, computer-aided design [CAD] software, computer numerical control [CNC] machine tools), equipment (e.g., computer, cut-out pattern), procedures (e.g., tracing, forming, assembly), and materials (e.g., matt board, starch, linen, neoprene);
- B3.2 use appropriate metric and imperial measuring tools, scales (e.g., metric: 1:10, 1 cm:1 m or 1:100, 1:500; imperial: 1/2":1' or 1:24), and proportion techniques when creating and assessing models and/or prototypes;
- B3.3 assess products and/or processes on the basis of student-developed criteria (e.g., adherence to specifications, effectiveness, cost, durability, appearance, estimated labour and material costs, cultural sensitivities, effect on the environment).

B4. REPORTING AND PRESENTING

By the end of this course, students will:

- B4.1 create and present reports summarizing design choices and the steps taken in the design process, using a variety of formats and tools (e.g., word processor, presentation software, interactive white board, web pages);

- B4.2 report and reflect on decisions made throughout the design process, using a variety of oral and/or written formats.

C. TECHNOLOGY, THE ENVIROMENT, AND SOCIETY

OVERAL EXPECTATIONS

By the end of this course, students will:

- C1. demonstrate an understanding of environmentally responsible design practices, and apply them in the technological design process and related activities;
- C2. describe the relationship between society and technological development.

SPECIFIC EXPECTAIONS

C1. TECHNOLOGY AND THE ENVIRONMENT

By the end of this course, students will:

- C1.1 demonstrate an understanding of environmental issues that affect the design of products and/or processes (e.g., gasoline consumption, pollution, greenhouse gases, habitat loss, extinction of species, depletion of natural resources);
- C1.2 describe, advocate, and apply best practices for conserving energy and other resources when designing a product or process (e.g., reuse or recycle lumber and other materials; use materials with recycled content; use wood glue instead of hot glue; use renewable energy sources, high-efficiency motors and appliances, and passive heating and cooling of buildings);
- C1.3 describe ways to reduce the waste produced by the manufacture and use of products (e.g., cutting patterns that minimize leftover materials, use of materials that are easily recycled, energy-management controls in electronic equipment), and apply such practices when developing and building prototypes.

C2. TECHNOLOGY AND SOCIETY

By the end of this course, students will:

- C2.1 research and compare technological eras(e.g., agricultural, industrial, information), and describe ways in which societal needs influenced these eras;
- C2.2 research and describe cases where technological design has improved the quality of living (e.g., fireproofing, prosthetic limbs, air purifiers, catalytic converters);
- C2.3 demonstrate an understanding of ways in which history, trends, culture, and geography have inspired technological design.

D. PROFESSIONAL PRACTICE AND CAREER OPPORUTNITIES

OVERAL EXPECTATIONS

By the end of this course, students will:

- D1. describe and apply health, safety, and environmental practices related to technological design;
- D2. identify career opportunities in fields related to technological design, and describe the training and education required for these careers.

SPECIFIC EXPECTATIONS

D1. HEALTH AND SAFETY

By the end of this course, students will:

- D1.1 describe the importance of health and safety laws, regulations, and standards that apply to technological design (e.g., regulations and standards from the Occupational Health and Safety Act, Canadian Standards Association [CSA], Ontario Building Code, and Workplace Hazardous Materials Information System [WHMIS]);
- D1.2 adhere to appropriate personal and environmental health and safety standards and procedures with respect to processes, materials, tools, equipment, and facilities throughout the design process and when performing related activities (e.g., use protective equipment; set tool and equipment guards properly; ensure adequate ventilation and ergonomic seating and other workplace arrangements; follow safe operating procedures; keep work areas clean and organized; store materials and dispose of wastes properly);
- D1.3 use protective clothing, gear, and equipment appropriately (e.g., dust mask, safety glasses).

D2. CAREER OPPORTUNITIES

By the end of this course, students will:

- D2.1 identify a variety of career opportunities related to technological design (e.g., architect, architectural technologist, draftsperson, interior designer);
- D2.2 describe the educational and training pathways (i.e., selection of secondary and postsecondary courses, programs, and learning experiences) and entry requirements (e.g., portfolio, internship) for careers related to technological design;
- D2.3 research and report on professional associations and unions for technical designers (e.g., Professional Engineers of Ontario [PEO], Ontario Association of Chartered Industrial Designers of Ontario [OACID], Ontario Association of Certified Engineering Technicians and Technologists [OACETT], Ontario Association of Architects [OAA], Association of Registered Interior Designers of Ontario [ARIDO]), and describe how these organizations affect jobs in technological design (e.g., working conditions, job security);
- D2.4 identify groups and programs that are available to support students who are interested in pursuing non-traditional career choices in the technological design industry (e.g., mentoring programs, virtual networking/support groups, specialized postsecondary programs, relevant trade/industry associations);
- D2.5 demonstrate an understanding of and apply the Essential Skills that are important for success in the technological design industry, as identified in the Ontario Skills Passport (e.g., reading text, writing, document use, measurement and calculation);
- D2.6 demonstrate an understanding of and apply the work habits that are important for success in the technological design industry, as identified in the Ontario Skills Passport (e.g., working safely, teamwork, reliability, initiative, customer service, entrepreneurship);
- D2.7 maintain an up-to-date portfolio that includes pieces of work and other materials that provide evidence of their skills and achievements in technological design (e.g., work logs, skills checklist, sketches, drawings, photographs of models and prototypes), and explain why having a current portfolio is important for career development and advancement.

PROFILE, APENDIX P

These are support **print resource graphic samples** used in this profile to give a visual cue and support to reader.

APENDIX P1

GENERAL SAFETY

Safety contract

Keeping Students Safe

Name:
Date: Section:

General Safety in the Shop and Classroom

Safety in the classroom is very important for every one to understand and use. Without this understanding and knowledge, accidents will happen. This sheet is for your protection. Keep this sheet handy (in your note book) for your record of safety, and review regularly until safe work habits are practiced automatically.

Student Behaviour - Personal and Group

1. **Respect** for people, equipment and materials.
2. Working on equipment only **after instruction** and full understanding.
3. Using and wearing **proper** safety devices and equipment.
4. Being **appropriately attired** such as no loose hair or clothing, etc.
5. Distractions will not be tolerated.
6. No horseplay!

Organization - Personal and Group

1. Putting **tools back** where they belong.
2. **Cleaning up** one's own mess, workstation/area and equipment.
3. Broken or missing tools and/or equipment should be **reported** right away.
4. **Awareness** of tools, equipment, supplies, shop and routines.
5. **Emergency** power shut down buttons, know where they are.
6. Minor or major accidents to be **report**ed right away.
7. If you are not sure... **Ask!**

I was present for the review of the rules above with the teacher and clearly understood and agreed to follow them at all times.

By signing below, it confirms that you do understand the safety concerns and rules above, and will abide by them at all times.

Student signature _____, Please print your name and date above.

Parent or guardian confirmation signature _____

Parent or guardian name printed _____

Teacher: *Mr. Franzen*, File: General Safety contract Gen 2.doc *Page 1 of 1*

SAFETY PASSPORT CHECKLIST

Technological Design
A Challenged Process of Ideas to a Working Solution

Name:
Date: Section:

Student Safety Passport Checklist

Parent's- Signature: **Print Name:**

This is to make you aware of the tools, equipment and processes that are part of the Integrated Technologies course and that I the teacher, is taking every possible precaution to maximize safety for your son or daughter here at Western. Please sign your name above **so that I know you have seen this checklist and are aware of our safety concerns**.

Students- Signature: **Print Name:**

With all of the tools, equipment and processes around the shop and classrooms, it is important that every student have full understanding and operation of each, prior to using for paramount safety concerns. Students must be checked off after a discussion, demonstration, and safety contract have been completed. **Only after students have taken the appropriate steps, will they then allowed to use shop tools and equipment.**

#	Tool, Equipment, or Process	Date of Contract	Teachers' Initial	#	Tool, Equipment, or Process	Date of Contract	Teachers' Initial
1	Acrylic Bender			26	Compressed Air		
2	Acrylic Oven			27	Data projector		
3	Band Saw			28	Dig Camera		
4	Buffer			29	Dig Weight Scale		
5	CNC Router			30	Gen. Hand tools		
6	Computer			31	Hot Glue Gun		
7	Disk Sander			32	Jig Saw		
8	Drill Press			33	Painting		
9	Grinder			34	Paper Cutter		
10	Injection Moulder			35	Portable Drill		
11	Lathe			36	Railroad Set		
12	Mag-Lev Track Sys.			37	Set/T-Square		
13	Media Protection			38	Sharp Blades		
14	Printer Dot Matrix			39	Solder iron		
15	Printer Ink Jet			40	Step ladder		
16	Digital Scanner			41	Tracing Table		
17	Structural Tester			42	Vibration Sander		
18	Styrofoam Cutter			43	Vacuum Cleaner		
19	Table Router			44	3D Printer		
20	Vacuum Moulder			45	Co2 Launcher		
21	Wind Tunnel			46	Rocket Launcher		
22	Clam Iron - T-shirts			47	x-Acto knife		
23	Light Table			48			
24				49			
25				50			

Teacher: *Mr. Franzen*, File: Student Safety Passport Checklist td *Page 1 of 1*

SAFETY PASSPORT SAMPLE CERTIFICATE

SAFETY WORDLE SAMPLE

SAFETY RUBRIC

Rubric Assessment Tool

Name:

Date: Section:

Safety

A Rubric is an assessment tool used to see where you are in terms of levels 1 to 4 in a particular area and what areas require more work and effort to improve level.

Criteria	Level 1 (50-59%) Limited Success	Level 2 (60-69%) Some Success	Level 3 (70-79%) Considerable Success	Level 4 80-100% High degree of Success
• Safety Rules	• Requires constant reminders to follow general safety rules	• Requires some reminders to follow general safety rules	• Respects and follows all general safety rules	• Sets a consistent proactive example of general safety rules
• Procedures	• Requires constant reminders to follow safety procedures	• Requires some reminders to follow safety procedures	• Follows safety procedures with only occasional lapses	• Routinely follows all safety procedures
• Prevention Self prevention	• Rarely reports or prevents unsafe objects or situations	• Some evidence of reporting or prevention of unsafe objects or situations	• Attentive observation and reaction to unsafe objects or situations	• Extensive sharp observation and reaction to unsafe objects or situations
• Assistance with peers	• Offers little assistance or help with peers, to insure safety	• Offers some assistance or help with peers, to insure safety	• Offers appropriate assistance or help with peers, to insure safety, when needed	• Extremely helpful giving assistance or help with peers, to insure safety
• Protective Accessories Using all	• Little evidence of using required safety protective accessories	• Some evidence using required safety protective accessories	• Adequate use of required safety protective accessories	• Habitually uses all safety protective accessories
Using Correctly	• Has difficulty properly using safety protective accessories	• Some evidence of properly using safety protective accessories	• Demonstrated proper use of safety protective accessories	• Skillfully uses safety protective accessories properly
• Hand Tools	• Has difficulty using and handling hand tools safely	• Attempts to use and handle hand tools safely	• Appropriately uses and handles tools safely	• Skillfully uses and handles tools safely
• Equipment	• With significant assistance, uses equipment with materials safely	• With some assistance, uses equipment with materials safely	• Uses equipment and materials safely with only occasional assistance	• Independently uses equipment and materials safely
• Computers Ergonomics, eye strain, and posture	• Requires constant reminders on safety related issues	• Requires some assistance on safety related issues:	• Requires little assistance on safety related issues	• No assistance on safety related issues
• Media protection and back-up	• Loss of media from lack of care and/or saving and back-up	• Some loss of media from lack of care and/or saving and back-up	• Little loss of media from lack of care and/or saving and back-up	• No loss of media and consistent steps evident, ensuring no media loss
• Work Area, materials, Tools, and equipment	• Little evidence of keeping work area safe and clean	• Some evidence of keeping work area safe and clean	• Work area kept relatively safe and clean	• Work area is consistently kept safe and clean

Teacher: *Mr. Franzen*, File: Rubric- Safety.doc *Page 1 of 1*

APENDIX P2

SPICE, A DESIGN PROCESS MODEL

Design in Technology

Name:

Date: Section:

S.P.I.C.E.- A Design Process Model

When attempting to build, construct and/or plan towards a final goal, you must go through a process. This process is an important part of being able to create the best product/solution possible. By breaking down the common steps in a proven process, these steps can be used as a model. Using this model would always get the best solution or product quickly, efficiently and accurately for any product/solution required.

SITUATION
This is the BIG picture or the setting -that which surrounds the problem.

PROBLEM
This is the identified CHALLENGE to overcome with-in the situation.

IDEAS & INVESTIGATION
Research the circumstances and identify the resources required. Generate lots of ideas.

CHOOSE & CONSTRUCT
Select the best idea under the circumstances, plan what you are to do, and test as you

EVALUATION
Review problem, insure product/solution meets requirements and consider improvements.

Detours

May have to get more info, to help clarify further.

May need new skills, more time and/or knowledge.

Consider equip., tools and material to complete.

May have a new perspective, to redefine problem.

Back-tracking

Back-tracking will always be required for a number of reasons throughout the process model. Circumstances may have to be looked at more closely or over a different period of time. New problems may arise causing you to return back to the situation or re-evaluate the solution and choose another idea in your investigation.

Teacher: Mr. Franzen, File:spice-design-flow-chart.doc Page 1 of 1

SPICE, DESIGN PROCESS RUBRIC

Rubric Assessment Tool

Name: Date: Section:

The Design Process

A Rubric is an assessment tool used to see where you are in terms of levels 1 to 4 in a particular area and what areas require more work and effort to improve level.

Criteria	Level 1 (50-59%) Limited Success	Level 2 (60-69%) Some Success	Level 3 (70-79%) Considerable Success	Level 4 (80-100%) High degree of Success
Situation	Demonstrates limited understanding of the situation	Demonstrates a partial understanding of the situation	Demonstrates an understanding of the situation	Demonstrates a thorough understanding of the situation
Challenge (problem)	Demonstrates limited understanding of the challenge	Demonstrates a partial understanding of the challenge	Demonstrates an understanding of the challenge	Demonstrates a thorough understanding of the challenge
Investigation & Ideas Research process	Demonstrates few, if any, research strategies from only one source	Demonstrates some effective research strategies from more than one source	Follows a workable research process (e.g., question and method) with a variety of sources	Uses a systematic research process (e.g., from general to specific) from a wide variety of sources
Ideas / opinions	Shows little evidence of having formulated own ideas/opinions	Attempts to combine research with own ideas/opinions	Combines research with own ideas/opinions	Combines research with own ideas/opinions in a fluent and skillful manner
Design Criteria met	Meets design criteria in a limited way	Partially meets design criteria	Meets design criteria	Meets design criteria to exact specifications
Create & Construct	Makes limited use of appropriate materials	Makes adequate use of appropriate materials	Makes effective use of appropriate materials	Makes innovative use of appropriate materials
Previously learned skills and knowledge	Requires significant prompting to apply previously learned skills/ procedures	Requires some prompting to apply previously learned skills/ procedures in new contexts	Applies most previously learned skills/procedures in new contexts	Consistently applies previously learned skills/ procedures in new contexts
Evaluation product solves challenge	Product solves the challenge in a limited manner	Product solves some of the challenge	Product solves the challenge within acceptable limits of performance	Product solves the challenge and exceeds the expected performance
Testing of product	Conducts insufficient testing on the product	Conducts some simple tests on the product	Conducts appropriate and sufficient tests on the product	Conducts exhaustive testing on the product
Explanation & Notes	Explanations/ solutions are incomplete and contain major misconceptions	Explanations/ solutions are partially complete but may contain some minor misconceptions	Explanations/ solutions are complete and accurate but may lack detail	Explanations/ solutions are thorough and accurate

Teacher: *Mr. Franzen*, File: Rubric - The Design Process.doc → *Page 1 of 1*

APENDIX P3

DAILY LOG REPORT-GENERAL

Daily Log Report

Name:

Class Section:

Date 1	Hmwk & Tasks 3	New Experience / Learning Achieved: (K.S&V) 6
Monday: / / Day, Month, Year /10	*Due:* *Tasks:*	*Hmwk Assigned:*
Tuesday: / / Day, Month, Year /10	*Due:* *Tasks:*	*Hmwk Assigned:*
Wednesday: / / Day, Month, Year /10	*Due:* *Tasks:*	*Hmwk Assigned:*
Thursday: / / Day, Month, Year /10	*Due:* *Tasks:*	*Hmwk Assigned:*
Friday: / / Day, Month, Year /10	*Due:* *Tasks:*	*Hmwk Assigned:*
Teacher Comments:		
Parent Feedback: /50		*Parent Initial:*

Teacher: *Mr. Franzen,* File: Log-daily student-Non Semestered-4 *Page 1 of 1*

DAILY LOG REPORT-SPICE/WIKI

Individual Task-Process-Report

Name:

Course: Date:

Task Report Details Group Project:

Hands-on activities related to your course and your interest, give you ownership of your work, make learning fun and meaningful, and give you the opportunity to broaden your skills, knowledge and values. In order to formalize this process, this SPICE, task-report sheet is used with the online Wiki to track your progress and learning. Students must complete this page weekly **in pen**!.

Create and construct a general summary of what your major steps taken this week[1]:

Evaluation - specific feedback of NEW skills, knowledge and values, i.e. learning and project status update:

Detailed Daily Task Mark Breakdown Table:

* Tasks neatly filled in line 1, in point form, to the point, and specific details to your individual work done (not your partners).

Date: *Example:* **Monday** Sept 04	Daily Point rating	**Specific Student Daily Tasks Details*:** Must be filled in and initialed by the teacher every 2 days at the end of the period. **NOTE:** Failure to get signed will result in 1 mark loss for each missed day!	Task verified	Over-time (in min.)	Over-time verified	Mark assigned
Monday				min.		
				/5 =		
Tuesday				min.		
				/5 =		
Wednesday				min.		
				/5 =		
Thursday				min.		
				/5 =		
Friday				min.		
				/5 =		

* Overtime description filled in on line 2, time in min./5, & calculated by student, then initialed/verified by teacher same day!

General Overall Completed Task Mark Table: Peer marked by:

Breakdown with quick explanations of each:	Self Eval.	Peer Eval.	Teacher Eval.
Group Work: *How well did you work/co-operate with your group partner(s), were your workloads shared equally?*	/2	/2	/2
Design Process: *Has the Wiki been updated – adding resources, planning, progress, etc. C&E filled in above?*	/4	/4	/4
Process/Product: *How well did you work this week, did you accomplish a lot, and are you on track?*	/4	/4	/4
Total Mark: *Used to apply to each individual day mark in the above table, dependant on the current daily point rating.*	**/10**	**/10**	**/10**

*Remember to keep your online Wiki updated throughout the week with additional resources, updates to planning and progress.

[1] Create, and Evaluation are filled in at the end of the week, after you have updated your Wiki resources, planning, and progress.

Teacher: *Mr. Franzen,* File: task-process-report-with-wiki *Page 1 of 1*

APENDIX P4

PREZI ON ENGINEERING, CAREERS, PATHWAYS, AND RESOURCES

To see this live presentation go to my public share Link (note a lot of resources included):
http://prezi.com/xedzzg3i5672/?utm_campaign=share&utm_medium=copy

LEARNING SKILLS & WORK HABITS 1

LEARNING SKILLS & WORK HABITS 2

Technological Design

A Challenged Process of Ideas to a Working Solution

Essential Learning Skills and Work Habits

Well-developed learning skills and work habits can help improve your academic achievement and help prepare you further for success beyond school.

Responsibility

- Completes and submits class work, homework, and assignments according to agreed upon timelines
- Takes ownership for personal share of work
- Fulfills commitments in learning environments
- Manages his/her behaviour
- Ask questions when not clear to get to understanding
- Designs created consider safety, ergonomics, and sustainability
- Follow through with assigned project design tasks
- Completes project work on time and with care
- Fulfills responsibilities and commitments within the learning environment

Organization

- Establishes priorities and manages time to achieve goals
- Comes to class prepared and with appropriate materials
- Creates and follows a plan to complete work and tasks
- Manages time effectively
- Demonstrates the ability to organize and manage work
- Use SPICE to effectively solve project challenges
- Clarify the challenge prior to solving the solution
- Devises and follows a plan and process for completing work and tasks
- Identifies, gathers, evaluates and uses information technology, and resources to complete tasks

Independent work

- Begins to work promptly and use time effectively
- Monitors, assesses, and revises plans to complete tasks and meet goals
- Uses class time appropriately to complete tasks
- Seeks new opportunity for learning
- Seeks Assistance when required
- Accomplishes tasks independently
- Follows instructions with minimal supervision
- Takes the initiative to find solutions to challenges
- Focus on design solution rather than the problem

Collaboration

- Works with others to resolves conflicts and builds consensus to achieve group goals
- Shares information, resources, and expertise to solve problems and make decisions
- Accepts various roles and an equitable share of the work within a group
- Responds positively to the ideas, opinions, values, and traditions of others
- Share design ideas to improve and refine solutions
- Use team work to design and build complex ideas
- Builds healthy peer to peer relationships through personal and media-assisted interactions

Initiative

- Approaches new learning ideas and concepts with confidence
- Acts upon new ideas and opportunities for learning
- Demonstrates a willingness to take risks
- Demonstrates curiosity and interest in learning
- Accepts various roles and tasks
- Always participates actively
- Approaches new tasks with a positive attitude
- Recognizes and advocates appropriately for the rights of self and others
- Makes decisions to move forward with project designs
- Research ideas to be knowledgeable about your design challenge

Self-regulation

- Takes the initiative to work on homework
- Regularly review and study notes
- Displays exceptional work skills
- Participates in required activities
- Sets his/her individual goals and monitors progress towards achieving them
- Seeks assistance when needed
- Assesses and reflects critically on her/his strengths, needs and interests
- Identify learning opportunities, choices, and strategies to meet personal needs and achieve goals
- Perseveres when facing challenges
- Break down project tasks to complete successfully
- Be consistent with your design focus

Name: *Mr. Franzen,* File: 2015-04-03_mfranzen-TD-Learn-Skill-Work Habits2-I *Page 1 of 1*

APENDIX P5

PROJECT MANAGEMENT (PM) ASSESSMENT

This will be used throughout the course by the student to assess how they are doing. With initial use, the teacher will demonstrate and model the process, then use this sheet for students to review use for their own self-assessment.

Technological Design
A Challenged Process of Ideas to a Working Solution

Name:
Date: _____

EXCEL PROJECT MANAGEMENT CHECK LIST

This is a check list for ensuring you follow the right steps and check that you have completed all of the tasks. Check it off, if it is done ☑

Peer Marker Name:

#	Task	Description	Self	Peer	Teacher	Weight
1	Using Excel	Understand how to make entries, edit sheets, copy sheets, and print to pdf				
2	Excel as a project management tool	Using Excel as a project management system for documentation, design log and notes, materials/costs and suppliers, peer expert organization, and robotic design resources.				
3	Personal Mgmt. done	Fill in all 'experts' in each of the robotic engineering background fields for future support.				
4	Gantt chart review on course breakdown	Reviewed and understand how to read, bar graph with timeline, to keep on track with related tasks and course projects.				
5	Gantt chart review on robot design process	Reviewed and understand how to read the bar graph with the timeline for a clear view on the robot design process and being able to keep yourself on track with projects and timelines.				
6	Design log up-to-date	Design log, fully-filled in daily with material covered each day, your hours spent "working on class work" at school and at home, filled in at least, one knowledge, skill, and /or value and last, an optional reflection to support post design reports and records of your design process.				
7	Material sheet updates	Material cost sheet to be filled out with parts and/or raw materials used on your sample and custom-robot model (separate sheets) as you build your model.				
9	Robotic digital resources recorded	Throughout the course, any related digital robotic design resources you have found useful are to be organized and recorded here to show research, learning, and process.				
10						

Name: *Michael Franzen*, File: 2015-04-07_mfranzen-A-for-L-checklist_excel-pm

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PM EXCEL GANTT CHART FOR THIS COURSE (PROJECT MANAGEMENT)

Students will use this to get a good idea graphically what is happening in the course, timelines, project tasks, and course process. Directly below is a full length Gantt chart for the course. This chart shows the entire course with daily entries, weekly marks, and related activities. It was developed to be easily updated each. Following that, will be print outs of each of page, in legal sizes. Normally this would not be printed, but would recommend printing on a large format printer to post on the wall for students to see through a large PDF file format. Ideally it should be used digitally in excel where students can interact, edit, add their own input to support their learning.

GANTT Design Timeline Chart — Page 1

GANTT Chart Showing Robotic Course Breakdown	Wed 9-Sep	Thu 10-Sep	Fri 11-Sep	12-Sep	13-Sep	Mon 14-Sep	Tue 15-Sep	Wed 16-Sep	Thu 17-Sep	Fri 18-Sep	19-Sep	20-Sep	Mon 21-Sep	Tue 22-Sep	Wed 23-Sep	Thu 24-Sep
	Wk 1						Wk1	Wk2						Wk2	Wk 3	
Careers & Safety																
Course Introduction																
Safety																
Career Steps																
Engineering Communication																
Freehand Technical Sketching																
Ortho and ISO Note																
Custom Orthographic																
Robot Designs																
Structure and Materials																
Selecting the Right Materials-																
Joinery Types and Methods																
Frame Design																
Frame Model																
Driven Mechanisms																
Gears types, ratios, and Characteristics																
Gearbox to Wheel Design																
Drive Train Build																
1st Function -Elevator Build																
Functions & Integration																
Mid Base Body Frame build																
Pneumatic actuators and system																
2nd Function -Tote Grabber Build																
3rd Function - Gripper build																
Robot Assembly																
Robot Assembly Build																
Function Supports																
Drawings																
Presentation																
Marketing and Portfolio																
Web Authoring																
Portfolio																
Presentation																

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GANTT Design Timeline Chart — Page 2

GANTT Chart Showing Robotic Course Breakdown	Fri 25-Sep	26-Sep	27-Sep	Mon 28-Sep	Tue 29-Sep	Wed 30-Sep	Thu 1-Oct	Fri 2-Oct	3-Oct	4-Oct	Mon 5-Oct	Tue 6-Oct	Wed 7-Oct	Thu 8-Oct	Fri 9-Oct	10-Oct
					Wk3	Wk4						Wk4	Wk 5			
Careers & Safety																
Course Introduction																
Safety																
Career Steps																
Engineering Communication																
Freehand Technical Sketching																
Ortho and ISO Note																
Custom Orthographic																
Robot Designs																
Structure and Materials																
Selecting the Right Materials-																
Joinery Types and Methods																
Frame Design																
Frame Model																
Driven Mechanisms																
Gears types, ratios, and Characteristics																
Gearbox to Wheel Design																
Drive Train Build																
1st Function -Elevator Build																
Functions & Integration																
Mid Base Body Frame build																
Pneumatic actuators and system																
2nd Function -Tote Grabber Build																
3rd Function - Gripper build																
Robot Assembly																
Robot Assembly Build																
Function Supports																
Drawings																
Presentation																
Marketing and Portfolio																
Web Authoring																
Portfolio																
Presentation																

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GANTT Design Timeline Chart — Page 3

GANTT Chart Showing Robotic Course Breakdown	11-Oct	Mon 12-Oct	Tue 13-Oct	Wed 14-Oct	Thu 15-Oct	Fri 16-Oct	17-Oct	18-Oct	Mon 19-Oct	Tue 20-Oct	Wed 21-Oct	Thu 22-Oct	Fri 23-Oct	24-Oct	25-Oct	Mon 26-Oct
		H	Wk5	Wk6						Wk6	Wk 7					
Careers & Safety																
Course Introduction																
Safety																
Career Steps																
Engineering Communication																
Freehand Technical Sketching																
Ortho and ISO Note																
Custom Orthographic																
Robot Designs																
Structure and Materials																
Selecting the Right Materials-																
Joinery Types and Methods																
Frame Design																
Frame Model																
Driven Mechanisms																
Gears types, ratios, and Characteristics																
Gearbox to Wheel Design																
Drive Train Build																
1st Function -Elevator Build																
Functions & Integration																
Mid Base Body Frame build																
Pneumatic actuators and system																
2nd Function -Tote Grabber Build																
3rd Function - Gripper build																
Robot Assembly																
Robot Assembly Build																
Function Supports																
Drawings																
Presentation																
Marketing and Portfolio																
Web Authoring																
Portfolio																
Presentation																

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GANTT Design Timeline Chart — Page 4

GANTT Chart Showing Robotic Course Breakdown	Tue 27-Oct	Wed 28-Oct	Thu 29-Oct	Fri 30-Oct	31-Oct	1-Nov	Mon 2-Nov	Tue 3-Nov	Wed 4-Nov	Thu 5-Nov	Fri 6-Nov	7-Nov	8-Nov	Mon 9-Nov	Tue 10-Nov	Wed 11-Nov
	Wk7	Wk8						Wk8	Wk 9						Wk9	Wk10
Careers & Safety																
Course Introduction																
Safety																
Career Steps																
Engineering Communication																
Freehand Technical Sketching																
Ortho and ISO Note																
Custom Orthographic																
Robot Designs																
Structure and Materials																
Selecting the Right Materials-																
Joinery Types and Methods																
Frame Design																
Frame Model																
Driven Mechanisms																
Gears types, ratios, and Characteristics																
Gearbox to Wheel Design																
Drive Train Build																
1st Function -Elevator Build																
Functions & Integration																
Mid Base Body Frame build																
Pneumatic actuators and system																
2nd Function -Tote Grabber Build																
3rd Function - Gripper build																
Robot Assembly																
Robot Assembly Build																
Function Supports																
Drawings																
Presentation																
Marketing and Portfolio																
Web Authoring																
Portfolio																
Presentation																

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GANTT Design Timeline Chart — Page 5

GANTT Chart Showing Robotic Course Breakdown	Thu 12-Nov	Fri 13-Nov	14-Nov	15-Nov	Mon 16-Nov	Tue 17-Nov	Wed 18-Nov	Thu 19-Nov	Fri 20-Nov	21-Nov	22-Nov	Mon 23-Nov	Tue 24-Nov	Wed 25-Nov	Thu 26-Nov	Fri 27-Nov
		PA				Wk10	Wk 11						Wk11	Wk12		
Careers & Safety																
Course Introduction																
Safety																
Career Steps																
Engineering Communication																
Freehand Technical Sketching																
Ortho and ISO Note																
Custom Orthographic																
Robot Designs																
Structure and Materials																
Selecting the Right Materials-																
Joinery Types and Methods																
Frame Design																
Frame Model																
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Gears types, ratios, and Characteristics																
Gearbox to Wheel Design																
Drive Train Build																
1st Function -Elevator Build																
Functions & Integration																
Mid Base Body Frame build																
Pneumatic actuators and system																
2nd Function -Tote Grabber Build																
3rd Function - Gripper build																
Robot Assembly																
Robot Assembly Build																
Function Supports																
Drawings																
Presentation																
Marketing and Portfolio																
Web Authoring																
Portfolio																
Presentation																

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GANTT Design Timeline Chart — Page 6

GANTT Chart Showing Robotic Course Breakdown	28-Nov	29-Nov	Mon 30-Nov	Tue 1-Dec	Wed 2-Dec	Thu 3-Dec	Fri 4-Dec	5-Dec	6-Dec	Mon 7-Dec	Tue 8-Dec	Wed 9-Dec	Thu 10-Dec	Fri 11-Dec	12-Dec	13-Dec
				Wk12	Wk 13						Wk13	Wk14				
Careers & Safety																
Course Introduction																
Safety																
Career Steps																
Engineering Communication																
Freehand Technical Sketching																
Ortho and ISO Note																
Custom Orthographic																
Robot Designs																
Structure and Materials																
Selecting the Right Materials-																
Joinery Types and Methods																
Frame Design																
Frame Model																
Driven Mechanisms																
Gears types, ratios, and Characteristics																
Gearbox to Wheel Design																
Drive Train Build																
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Mid Base Body Frame build																
Pneumatic actuators and system																
2nd Function -Tote Grabber Build																
3rd Function - Gripper build																
Robot Assembly																
Robot Assembly Build																
Function Supports																
Drawings																
Presentation																
Marketing and Portfolio																
Web Authoring																
Portfolio																
Presentation																

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GANTT Design Timeline Chart — Page 7

GANTT Chart Showing Robotic Course Breakdown	Mon 14-Dec	Tue 15-Dec	Wed 16-Dec	Thu 17-Dec	Fri 18-Dec	19-Dec	20-Dec	Mon 21-Dec	Tue 22-Dec	Wed 23-Dec	Thu 24-Dec	Fri 25-Dec	26-Dec	27-Dec	Mon 28-Dec	Tue 29-Dec
		Wk14	Wk 15						Wk15	Wk16						Wk16
								B	B	B	B	B	B	B	B	B
Careers & Safety																
Course Introduction																
Safety																
Career Steps																
Engineering Communication																
Freehand Technical Sketching																
Ortho and ISO Note																
Custom Orthographic																
Robot Designs																
Structure and Materials																
Selecting the Right Materials-																
Joinery Types and Methods																
Frame Design																
Frame Model																
Driven Mechanisms																
Gears types, ratios, and Characteristics																
Gearbox to Wheel Design																
Drive Train Build																
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Functions & Integration																
Mid Base Body Frame build																
Pneumatic actuators and system																
2nd Function -Tote Grabber Build																
3rd Function - Gripper build																
Robot Assembly																
Robot Assembly Build																
Function Supports																
Drawings																
Presentation																
Marketing and Portfolio																
Web Authoring																
Portfolio																
Presentation																

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GANTT Design Timeline Chart — Page 8

GANTT Chart Showing Robotic Course Breakdown	Wed 30-Dec	Thu 31-Dec	Fri 1-Jan	2-Jan	3-Jan	Mon 4-Jan	Tue 5-Jan	Wed 6-Jan	Thu 7-Jan	Fri 8-Jan	9-Jan	10-Jan	Mon 11-Jan	Tue 12-Jan	Wed 13-Jan	Thu 14-Jan
	Wk 17						Wk17	Wk18						Wk18	Wk19	
	B	B	H													
Careers & Safety																
Course Introduction																
Safety																
Career Steps																
Engineering Communication																
Freehand Technical Sketching																
Ortho and ISO Note																
Custom Orthographic																
Robot Designs																
Structure and Materials																
Selecting the Right Materials-																
Joinery Types and Methods																
Frame Design																
Frame Model																
Driven Mechanisms																
Gears types, ratios, and Characteristics																
Gearbox to Wheel Design																
Drive Train Build																
1st Function -Elevator Build																
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Pneumatic actuators and system																
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Robot Assembly																
Robot Assembly Build																
Function Supports																
Drawings																
Presentation																
Marketing and Portfolio																
Web Authoring																
Portfolio																
Presentation																

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GANTT Design Timeline Chart — Page 9

GANTT Chart Showing Robotic Course Breakdown	Fri 15-Jan	16-Jan	17-Jan	Mon 18-Jan	Tue 19-Jan	Wed 20-Jan	Thu 21-Jan	Fri 22-Jan	23-Jan	24-Jan	Mon 25-Jan	Tue 26-Jan	Wed 27-Jan	Thu 28-Jan	Fri 29-Jan	30-Jan
					Wk19	Wk20						Wk20	Wk21			
Careers & Safety																
Course Introduction																
Safety																
Career Steps																
Engineering Communication																
Freehand Technical Sketching																
Ortho and ISO Note																
Custom Orthographic																
Robot Designs																
Structure and Materials																
Selecting the Right Materials-																
Joinery Types and Methods																
Frame Design																
Frame Model																
Driven Mechanisms																
Gears types, ratios, and Characteristics																
Gearbox to Wheel Design																
Drive Train Build																
1st Function -Elevator Build																
Functions & Integration																
Mid Base Body Frame build																
Pneumatic actuators and system																
2nd Function -Tote Grabber Build																
3rd Function - Gripper build																
Robot Assembly																
Robot Assembly Build																
Function Supports																
Drawings																
Presentation																
Marketing and Portfolio																
Web Authoring																
Portfolio																
Presentation																

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GANTT Design Timeline Chart

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GANTT Chart Showing Robotic Course Breakdown	31-Jan	Mon 1-Feb	Tue 2-Feb	Wed 3-Feb	Thu 4-Feb	Fri 5-Feb	6-Feb	7-Feb	Mon 8-Feb	Tue 9-Feb
			Wk21	Wk22 PA						Wk22
Careers & Safety										
Course Introduction										
Safety										
Career Steps										
Engineering Communication										
Freehand Technical Sketching										
Ortho and ISO Note										
Custom Orthographic										
Robot Designs										
Structure and Materials										
Selecting the Right Materials-										
Joinery Types and Methods										
Frame Design										
Frame Model										
Driven Mechanisms										
Gears types, ratios, and Characteristics										
Gearbox to Wheel Design										
Drive Train Build										
1st Function -Elevator Build										
Functions & Integration										
Mid Base Body Frame build										
Pneumatic actuators and system										
2nd Function -Tote Grabber Build										
3rd Function - Gripper build										
Robot Assembly										
Robot Assembly Build										
Function Supports										
Drawings										
Presentation										
Marketing and Portfolio										
Web Authoring										
Portfolio										
Presentation										

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PM EXCEL GANTT CHART FOR ROBOTIC DESIGN PROCESS (PROJECT MANAGEMENT)

Students will use this to get a good idea graphically what the design process looks like all at once and see the relationships between each of the steps, timelines, and project tasks. Directly below is full length Gantt chart for the robotic design process. This chart shows the entire sheet with daily entries, weekly marks, and all related activities. It was developed to be easily updated each. Following that, will be print outs of each of page, in legal sizes. Normally this would not be printed, but would recommend printing on a large format printer to post on the wall for students to see through a large PDF file format. Ideally it should be used digitally in excel where students can interact, edit, add their own input to support their learning. The process on this Grant chart was developed with and uses the document to explain steps in detail using the Engineering Design Process for Design of a Competition Robot http://www.chiefdelphi.com/media/papers/2303

GANTT Design Timeline Chart — Page 11

GANTT Chart Showing Robotic Design Process		Wed 9-Sep Wk 1	Thu 10-Sep	Fri 11-Sep	12-Sep	13-Sep	Mon 14-Sep	Tue 15-Sep Wk1	Wed 16-Sep Wk2	Thu 17-Sep	Fri 18-Sep	19-Sep	20-Sep	Mon 21-Sep	Tue 22-Sep Wk2	Wed 23-Sep Wk 3	Thu 24-Sep
Rules and Strategies	**S**																
Define the Problem	**P**																
Generate Specs																	
-Design constraints																	
-Functional requirements																	
Spec rankings																	
Generate concepts	**I**																
- brainstorming																	
Prototyping																	
Choose/dev a concept (WOT)	**C**																
Detailed design Sketches																	
Crayola CAD																	
Design calculations																	
CAD design																	
Chassis																	
Drive train																	
Frame																	
Function(s) *- mini SPICE's*																	
-Mechanism 1																	
-Mechanism 2																	
-Mechanism 3																	
Assembly																	
Functional Integration																	
Model iterations																	
Model refinements																	
Model finish																	
Drawings & media																	
Design presentation/review	**E**																
Cost-benefits analysis																	
Testing and analysis																	
Iteration																	

Robot design stages based on "Using the Engineering Design Process for Design of a Competition Robot" found here: http://www.chiefdelphi.com/media/papers/download/2555

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GANTT Design Timeline Chart — Page 12

GANTT Chart Showing Robotic Design Process		Fri 25-Sep	26-Sep	27-Sep	Mon 28-Sep	Tue 29-Sep	Wed 30-Sep	Thu 1-Oct	Fri 2-Oct	3-Oct	4-Oct	Mon 5-Oct	Tue 6-Oct	Wed 7-Oct	Thu 8-Oct	Fri 9-Oct	10-Oct
						Wk3	Wk4						Wk4	Wk 5			
Rules and Strategies	**S**																
Define the Problem	**P**																
Generate Specs																	
-Design constraints																	
-Functional requirements																	
Spec rankings																	
Generate concepts	**I**																
- brainstorming																	
Prototyping																	
Choose/dev a concept (WOT)	**C**																
Detailed design Sketches																	
Crayola CAD																	
Design calculations																	
CAD design																	
Chassis																	
Drive train																	
Frame																	
Function(s) *- mini SPICE's*																	
-Mechanism 1																	
-Mechanism 2																	
-Mechanism 3																	
Assembly																	
Functional Integration																	
Model iterations																	
Model refinements																	
Model finish																	
Drawings & media																	
Design presentation/review	**E**																
Cost-benefits analysis																	
Testing and analysis																	
Iteration																	

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GANTT Design Timeline Chart — Page 13

GANTT Chart Showing Robotic Design Process		11-Oct	Mon 12-Oct	Tue 13-Oct	Wed 14-Oct	Thu 15-Oct	Fri 16-Oct	17-Oct	18-Oct	Mon 19-Oct	Tue 20-Oct	Wed 21-Oct	Thu 22-Oct	Fri 23-Oct	24-Oct	25-Oct	Mon 26-Oct
			H	Wk5	Wk6						Wk6	Wk 7					
Rules and Strategies	**S**																
Define the Problem	**P**																
Generate Specs																	
-Design constraints																	
-Functional requirements																	
Spec rankings																	
Generate concepts	**I**																
- brainstorming																	
Prototyping																	
Choose/dev a concept (WOT)	**C**																
Detailed design Sketches																	
Crayola CAD																	
Design calculations																	
CAD design																	
Chassis																	
Drive train																	
Frame																	
Function(s) *- mini SPICE's*																	
-Mechanism 1																	
-Mechanism 2																	
-Mechanism 3																	
Assembly																	
Functional Integration																	
Model iterations																	
Model refinements																	
Model finish																	
Drawings & media																	
Design presentation/review	**E**																
Cost-benefits analysis																	
Testing and analysis																	
Iteration																	

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GANTT Design Timeline Chart — Page 14

GANTT Chart Showing Robotic Design Process		Tue 27-Oct	Wed 28-Oct	Thu 29-Oct	Fri 30-Oct	31-Oct	1-Nov	Mon 2-Nov	Tue 3-Nov	Wed 4-Nov	Thu 5-Nov	Fri 6-Nov	7-Nov	8-Nov	Mon 9-Nov	Tue 10-Nov	Wed 11-Nov
		Wk7	Wk8						Wk8	Wk 9						Wk9	Wk10
Rules and Strategies	**S**																
Define the Problem	**P**																
Generate Specs																	
-Design constraints																	
-Functional requirements																	
Spec rankings																	
Generate concepts	**I**																
- brainstorming																	
Prototyping																	
Choose/dev a concept (WOT)	**C**																
Detailed design Sketches																	
Crayola CAD																	
Design calculations																	
CAD design																	
Chassis																	
Drive train																	
Frame																	
Function(s) *- mini SPICE's*																	
-Mechanism 1																	
-Mechanism 2																	
-Mechanism 3																	
Assembly																	
Functional Integration																	
Model iterations																	
Model refinements																	
Model finish																	
Drawings & media																	
Design presentation/review	**E**																
Cost-benefits analysis																	
Testing and analysis																	
Iteration																	

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GANTT Design Timeline Chart — Page 15

GANTT Chart Showing Robotic Design Process		Thu 12-Nov	Fri 13-Nov	14-Nov	15-Nov	Mon 16-Nov	Tue 17-Nov	Wed 18-Nov	Thu 19-Nov	Fri 20-Nov	21-Nov	22-Nov	Mon 23-Nov	Tue 24-Nov	Wed 25-Nov	Thu 26-Nov	Fri 27-Nov
			PA				Wk10	Wk 11						Wk11	Wk12		
Rules and Strategies	**S**																
Define the Problem	**P**																
Generate Specs																	
-Design constraints																	
-Functional requirements																	
Spec rankings																	
Generate concepts	**I**																
- brainstorming																	
Prototyping																	
Choose/dev a concept (WOT)	**C**																
Detailed design Sketches																	
Crayola CAD																	
Design calculations																	
CAD design																	
Chassis																	
Drive train																	
Frame																	
Function(s) *- mini SPICE's*																	
-Mechanism 1																	
-Mechanism 2																	
-Mechanism 3																	
Assembly																	
Functional Integration																	
Model iterations																	
Model refinements																	
Model finish																	
Drawings & media																	
Design presentation/review	**E**																
Cost-benefits analysis																	
Testing and analysis																	
Iteration																	

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GANTT Design Timeline Chart — Page 16

GANTT Chart Showing Robotic Design Process		28-Nov	29-Nov	Mon 30-Nov	Tue 1-Dec	Wed 2-Dec	Thu 3-Dec	Fri 4-Dec	5-Dec	6-Dec	Mon 7-Dec	Tue 8-Dec	Wed 9-Dec	Thu 10-Dec	Fri 11-Dec	12-Dec	13-Dec
					Wk12	Wk 13						Wk13	Wk14				
Rules and Strategies	**S**																
Define the Problem	**P**																
Generate Specs																	
-Design constraints																	
-Functional requirements																	
Spec rankings																	
Generate concepts	**I**																
- brainstorming																	
Prototyping																	
Choose/dev a concept (WOT)	**C**																
Detailed design Sketches																	
Crayola CAD																	
Design calculations																	
CAD design																	
Chassis																	
Drive train																	
Frame																	
Function(s) *- mini SPICE's*																	
-Mechanism 1																	
-Mechanism 2																	
-Mechanism 3																	
Assembly																	
Functional Integration																	
Model iterations																	
Model refinements																	
Model finish																	
Drawings & media																	
Design presentation/review	**E**																
Cost-benefits analysis																	
Testing and analysis																	
Iteration																	

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GANTT Design Timeline Chart — Page 17

GANTT Chart Showing Robotic Design Process		Mon 14-Dec	Tue 15-Dec	Wed 16-Dec	Thu 17-Dec	Fri 18-Dec	19-Dec	20-Dec	Mon 21-Dec	Tue 22-Dec	Wed 23-Dec	Thu 24-Dec	Fri 25-Dec	26-Dec	27-Dec	Mon 28-Dec	Tue 29-Dec
			Wk14	Wk 15						Wk15	Wk16						Wk16
									B	B	B	B	B	B	B	B	B
Rules and Strategies	**S**																
Define the Problem	**P**																
Generate Specs																	
-Design constraints																	
-Functional requirements																	
Spec rankings																	
Generate concepts	**I**																
- brainstorming																	
Prototyping																	
Choose/dev a concept (WOT)	**C**																
Detailed design Sketches																	
Crayola CAD																	
Design calculations																	
CAD design																	
Chassis																	
Drive train																	
Frame																	
Function(s) *- mini SPICE's*																	
-Mechanism 1																	
-Mechanism 2																	
-Mechanism 3																	
Assembly																	
Functional Integration																	
Model iterations																	
Model refinements																	
Model finish																	
Drawings & media																	
Design presentation/review	**E**																
Cost-benefits analysis																	
Testing and analysis																	
Iteration																	

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GANTT Design Timeline Chart — Page 18

GANTT Chart Showing Robotic Design Process		Wed 30-Dec Wk 17 B	Thu 31-Dec B	Fri 1-Jan H	2-Jan	3-Jan	Mon 4-Jan	Tue 5-Jan Wk17	Wed 6-Jan Wk18	Thu 7-Jan	Fri 8-Jan	9-Jan	10-Jan	Mon 11-Jan	Tue 12-Jan Wk18	Wed 13-Jan Wk19	Thu 14-Jan
Rules and Strategies	**S**																
Define the Problem	**P**																
Generate Specs																	
-Design constraints																	
-Functional requirements																	
Spec rankings																	
Generate concepts	**I**																
- brainstorming																	
Prototyping																	
Choose/dev a concept (WOT)	**C**																
Detailed design Sketches																	
Crayola CAD																	
Design calculations																	
CAD design																	
Chassis																	
Drive train																	
Frame																	
Function(s) *- mini SPICE's*																	
-Mechanism 1																	
-Mechanism 2																	
-Mechanism 3																	
Assembly																	
Functional Integration																	
Model iterations																	
Model refinements																	
Model finish																	
Drawings & media																	
Design presentation/review	**E**																
Cost-benefits analysis																	
Testing and analysis																	
Iteration																	

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GANTT Design Timeline Chart — Page 19

GANTT Chart Showing Robotic Design Process		Fri 15-Jan	16-Jan	17-Jan	Mon 18-Jan	Tue 19-Jan Wk19	Wed 20-Jan Wk20	Thu 21-Jan	Fri 22-Jan	23-Jan	24-Jan	Mon 25-Jan	Tue 26-Jan Wk20	Wed 27-Jan Wk21	28-Jan	Fri 29-Jan	30-Jan
Rules and Strategies	**S**																
Define the Problem	**P**																
Generate Specs																	
-Design constraints																	
-Functional requirements																	
Spec rankings																	
Generate concepts	**I**																
- brainstorming																	
Prototyping																	
Choose/dev a concept (WOT)	**C**																
Detailed design Sketches																	
Crayola CAD																	
Design calculations																	
CAD design																	
Chassis																	
Drive train																	
Frame																	
Function(s) *- mini SPICE's*																	
-Mechanism 1																	
-Mechanism 2																	
-Mechanism 3																	
Assembly																	
Functional Integration																	
Model iterations																	
Model refinements																	
Model finish																	
Drawings & media																	
Design presentation/review	**E**																
Cost-benefits analysis																	
Testing and analysis																	
Iteration																	

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GANTT Design Timeline Chart

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GANTT Chart Showing Robotic Design Process		31-Jan	Mon 1-Feb	Tue 2-Feb	Wed 3-Feb	Thu 4-Feb	Fri 5-Feb	6-Feb	7-Feb	Mon 8-Feb	Tue 9-Feb
				Wk21	Wk22 PA						Wk22
Rules and Strategies	**S**										
Define the Problem	**P**										
Generate Specs											
-Design constraints											
-Functional requirements											
Spec rankings											
Generate concepts	**I**										
- brainstorming											
Prototyping											
Choose/dev a concept (WOT)	**C**										
Detailed design Sketches											
Crayola CAD											
Design calculations											
CAD design											
Chassis											
Drive train											
Frame											
Function(s) *- mini SPICE's*											
-Mechanism 1											
-Mechanism 2											
-Mechanism 3											
Assembly											
Functional Integration											
Model iterations											
Model refinements											
Model finish											
Drawings & media											
Design presentation/review	**E**										
Cost-benefits analysis											
Testing and analysis											
Iteration											

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PM EXCEL FOR STUDENT DESIGN LOG (PROJECT MANAGEMENT)

Students will use the Excel to enter in their hours, material covered each day, any new knowledge, skills, and/or values formed from class each day. It also has a small section for students to reflect on their design process, ideas, and thoughts on decisions made throughout the design process, for later use in their post reports. This is in a similar format to the Gantt chart, so students will be familiar with it and it is also very colourful making it that much more accommodating to work with.

Student Design Log — Page 21

#	Day	Date	Wk	S	Unit	Activity	Hrs	Material covered	New Knowledge, Skills, and/or Values	Refelection, New insight
1	Wed	9-Sep	Wk1		**Careers & Safety**	Course Introduction				
2	Thr	10-Sep				Safety				
3	Fri	11-Sep								
4	Sat	12-Sep								
5	Sun	13-Sep								
6	Mon	14-Sep				Career Steps				
7	Tue	15-Sep	Wk1							
8	Wed	16-Sep	WK2		**Communication**	Technical Sketching				
9	Thr	17-Sep								
10	Fri	18-Sep								
11	Sat	19-Sep								
12	Sun	20-Sep								
13	Mon	21-Sep				Custom Orthographic				
14	Tue	22-Sep	Wk2							
15	Wed	23-Sep	Wk3							
16	Thr	24-Sep				Robot Designs				
17	Fri	25-Sep								
18	Sat	26-Sep								
19	Sun	27-Sep								
20	Mon	28-Sep								
21	Tue	29-Sep	Wk3							
22	Wed	30-Sep	WK4		**Materials**	Selecting the Right Materials-				
23	Thr	1-Oct								
24	Fri	2-Oct								
25	Sat	3-Oct								
26	Sun	4-Oct								
27	Mon	5-Oct				Joinery Types and Methods				
28	Tue	6-Oct	Wk4							
29	Wed	7-Oct	Wk5							
30	Thr	8-Oct								
31	Fri	9-Oct				Frame Design				
32	Sat	10-Oct								
33	Sun	11-Oct								

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Student Design Log — Page 22

#	Day	Date	Wk	S	Unit	Activity	Hrs	Material covered	New Knowledge, Skills, and/or Values	Refelection, New insight
34	Mon	12-Oct		H						
35	Tue	13-Oct	Wk5							
36	Wed	14-Oct	WK6							
37	Thr	15-Oct				Frame Model				
38	Fri	16-Oct								
39	Sat	17-Oct								
40	Sun	18-Oct								
41	Mon	19-Oct								
42	Tue	20-Oct	Wk6							
43	Wed	21-Oct	Wk7		**Mechanisms**	Characteristics				
44	Thr	22-Oct								
45	Fri	23-Oct								
46	Sat	24-Oct								
47	Sun	25-Oct								
48	Mon	26-Oct								
49	Tue	27-Oct	Wk7			Gearbox to Wheel Design				
50	Wed	28-Oct	WK8							
51	Thr	29-Oct								
52	Fri	30-Oct				Drive Train Build				
53	Sat	31-Oct								
54	Sun	1-Nov								
55	Mon	2-Nov								
56	Tue	3-Nov	Wk8							
57	Wed	4-Nov	Wk9							
58	Thr	5-Nov				1st Function -Elevator Build				
59	Fri	6-Nov								
60	Sat	7-Nov								
61	Sun	8-Nov								
62	Mon	9-Nov								
63	Tue	10-Nov	Wk9							
64	Wed	11-Nov	WK10		**Integration**	Mid Base Body Frame build				
65	Thr	12-Nov								
66	Fri	13-Nov		PA						

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Student Design Log — Page 23

#	Day	Date	Wk	S	Unit	Activity	Hrs	Material covered	New Knowledge, Skills, and/or Values	Refelection, New insight
67	Sat	14-Nov								
68	Sun	15-Nov								
69	Mon	16-Nov								
70	Tue	17-Nov	Wk10			Pneumatic actuators and system				
71	Wed	18-Nov	Wk11							
72	Thr	19-Nov								
73	Fri	20-Nov				2nd Function -Tote Grabber Build				
74	Sat	21-Nov								
75	Sun	22-Nov								
76	Mon	23-Nov								
77	Tue	24-Nov	Wk11							
78	Wed	25-Nov	WK12							
79	Thr	26-Nov				3rd Function - Gripper build				
80	Fri	27-Nov								
81	Sat	28-Nov								
82	Sun	29-Nov								
83	Mon	30-Nov								
84	Tue	1-Dec	Wk12							
85	Wed	2-Dec	Wk13		**Robot Assembly**	Robot Assembly Build				
86	Thr	3-Dec				Function Supports				
87	Fri	4-Dec								
88	Sat	5-Dec								
89	Sun	6-Dec								
90	Mon	7-Dec				Function Supports				
91	Tue	8-Dec	Wk13							
92	Wed	9-Dec	WK14							
93	Thr	10-Dec								
94	Fri	11-Dec								
95	Sat	12-Dec								
96	Sun	13-Dec								
97	Mon	14-Dec								
98	Tue	15-Dec	Wk14							

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Student Design Log — Page 24

#	Day	Date	Wk	S	Unit	Activity	Hrs	Material covered	New Knowledge, Skills, and/or Values	Refelection, New insight
99	Wed	16-Dec	Wk15			Drawings				
100	Thr	17-Dec								
101	Fri	18-Dec								
102	Sat	19-Dec								
103	Sun	20-Dec								
104	Mon	21-Dec		B						
105	Tue	22-Dec	Wk15	B						
106	Wed	23-Dec	WK16	B						
107	Thr	24-Dec		B						
108	Fri	25-Dec		B						
109	Sat	26-Dec		B						
110	Sun	27-Dec		B						
111	Mon	28-Dec		B						
112	Tue	29-Dec	Wk16	B						
113	Wed	30-Dec	Wk17	B						
114	Thr	31-Dec		B						
115	Fri	1-Jan		H						
116	Sat	2-Jan								
117	Sun	3-Jan								
118	Mon	4-Jan								
119	Tue	5-Jan	Wk17							
120	Wed	6-Jan	WK18			Presentation				
121	Thr	7-Jan								
122	Fri	8-Jan								
123	Sat	9-Jan								
124	Sun	10-Jan								
125	Mon	11-Jan								
126	Tue	12-Jan	Wk18							
127	Wed	13-Jan	Wk19		Portfolio	Web Authoring				
128	Thr	14-Jan								
129	Fri	15-Jan				Portfolio				
130	Sat	16-Jan								
131	Sun	17-Jan								

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Student Design Log — Page 25

#	Day	Date	Wk	S	Unit	Activity	Hrs	Material covered	New Knowledge, Skills, and/or Values	Refelection, New insight
132	Mon	18-Jan								
133	Tue	19-Jan	Wk19							
134	Wed	20-Jan	WK20							
135	Thr	21-Jan								
136	Fri	22-Jan				Presentation				
137	Sat	23-Jan								
138	Sun	24-Jan								
139	Mon	25-Jan								
140	Tue	26-Jan	Wk20							
141	Wed	27-Jan	Wk21							
142	Thr	28-Jan								
143	Fri	29-Jan								
144	Sat	30-Jan								
145	Sun	31-Jan								
146	Mon	1-Feb								
147	Tue	2-Feb	Wk21							
148	Wed	3-Feb	Wk22	PA						
149	Thr	4-Feb								
150	Fri	5-Feb								
151	Sat	6-Feb								
152	Sun	7-Feb								
153	Mon	8-Feb								
154	Tue	9-Feb	Wk22							

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PM EXCEL SHEET FOR MATERIAL, SUPPLIER, AND COSTS DOCUMENTATION (PROJECT MANAGEMENT)

Materials can be easily copied and pasted into the cells. Formatting, formulas, and sample have been provided for them to record all of their own materials used on project work created. It is important to stress that students do this as they work on their projects rather than going back later and have to do the work twice, and probably not as motivated at that late of a time after the project. Sample materials and costs are from the sample robot's drive train, used in this profile.

Material Cost Breakdown — Page 26

#	Category	Supplier Name	Q	Product Name	Part #	Product Descripton	Web Link	Unit Cost	Total Cost
1	Drive Train	VexPro	2	Single Speed, Double Reduction Gearbox	217-2454	Weight: 1.26 lbs, Ratio 9.52:1	http://www.vexrobotics.com/	$59.99	$119.98
2	Drive Train	VexPro	2	6" Omni Wheel	217-2585	0.94 lbs, Load Rating: on 200 lb robots	http://www.vexrobotics.com/	$22.99	$45.98
3	Drive Train	VexPro	2	6" Traction Wheel	217-2589	0.58 lb, Load Rating: on 200 lb robots	http://www.vexrobotics.com/	$15.99	$31.98
4	Drive Train	VexPro	3	6" Traction Tire (0.5" Wide, 2-pack)	217-2860	0.375 lb, Coefficient of Friction 1.1	http://www.vexrobotics.com/	$6.99	$20.97
5	Drive Train	VexPro	8	VersaHub (1/2" Hex, Plastic)	217-4009	torque transfer between wheels, gears, sprockets, a	http://www.vexrobotics.com/	$2.99	$23.92
6	Drive Train	VexPro	10	Flanged Bearing	217-3875	0.500in (Hex) x 1.125in x 0.313in v2	http://www.vexrobotics.com/	$4.99	$49.90
7	Drive Train	VexPro	4	#25 Sprocket w/ Hub - 16t - 1/2" Hex ID	217-2642	7075-T6 aluminum, Face Width: 0.110" thick	http://www.vexrobotics.com/	$6.99	$27.96
8	Drive Train	VexPro	4	#25 Sprocket w/ Hub - 22t - 1/2" Hex ID	217-2640	7075-T6 aluminum, Face Width: 0.110" thick	http://www.vexrobotics.com/	$6.99	$27.96
9	Drive Train	VexPro	6	Clamping Shaft Collar - 1/2" Hex ID	217-2737	0.019 lbs, 6061-T6 Aluminum, Black Type II Anodizir	http://www.vexrobotics.com/	$2.99	$17.94
10	Drive Train	VexPro	2	#25 Roller Chain (10 feet)	217-2775	App. 0.104 lb / ft	http://www.vexrobotics.com/	$9.99	$19.98
11	Drive Train	VexPro	4	#25 Heavy Duty Master Link	217-2998	0.007 lb	http://www.vexrobotics.com/	$2.49	$9.96
12									$0.00
13									$0.00
14									$0.00
15									$0.00
16									$0.00
17									$0.00
18									$0.00
19									$0.00
20									$0.00
21									$0.00
22									$0.00
23									$0.00
24									$0.00
25									$0.00
26									$0.00
27									$0.00
28									$0.00
29									$0.00
30									$0.00
31									$0.00
32									$0.00
33									$0.00
34									$0.00
35									$0.00
36									$0.00
37									$0.00
38									$0.00
								Total Cost	**$396.53**

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PM EXCEL SHEET FOR ROBOTIC DIGITAL RESOURCES (PROJECT MANAGEMENT)

Digital links to resources that students have found useful can be recorded them here. The sheet is formatted and organized to easily resort with a number of options.

Robotic Digitial Resources Page 27

#	Res Type	Category	Title	Description	Web Site
1	Database	CAD - Supplier	SDP-SI	Part supplier and CAD	www.sdp-si.com
2	Forum	Robotics FIRST	Chief Delphi	Robotic related info	http://www.chiefdelphi.com/forums/index.php
3	Site	Robotics FIRST	FIRST FRC	Robotics high school competitition	http://www.usfirst.org/
4	Database	CAD - Library	3D ContentCentral	2D and 3D parts and assemblies	http://www.3dcontentcentral.com/Default.aspx
5	Database	CAD -Share	GrabCAD	Sharing site and resources	https://grabcad.com/
6	Database	CAD - Supplier	McMaster-Carr	Fasteners	http://www.mcmaster.com/
7	Wiki	Supplier	Canadian Suppliers	Robot components in Canada	http://frcsupplierscanada.wikispaces.com/
8	Database	Materials	MatWeb	Source for Materials Information	http://www.matweb.com/
9	Database	Supplier	Bimba	Pneumatic, hydraulic and electric solutions	http://www.bimba.com/
10	Database	CAD - Supplier	VexPro	FIRST robotic components & CAD	http://www.vexrobotics.com/vexpro

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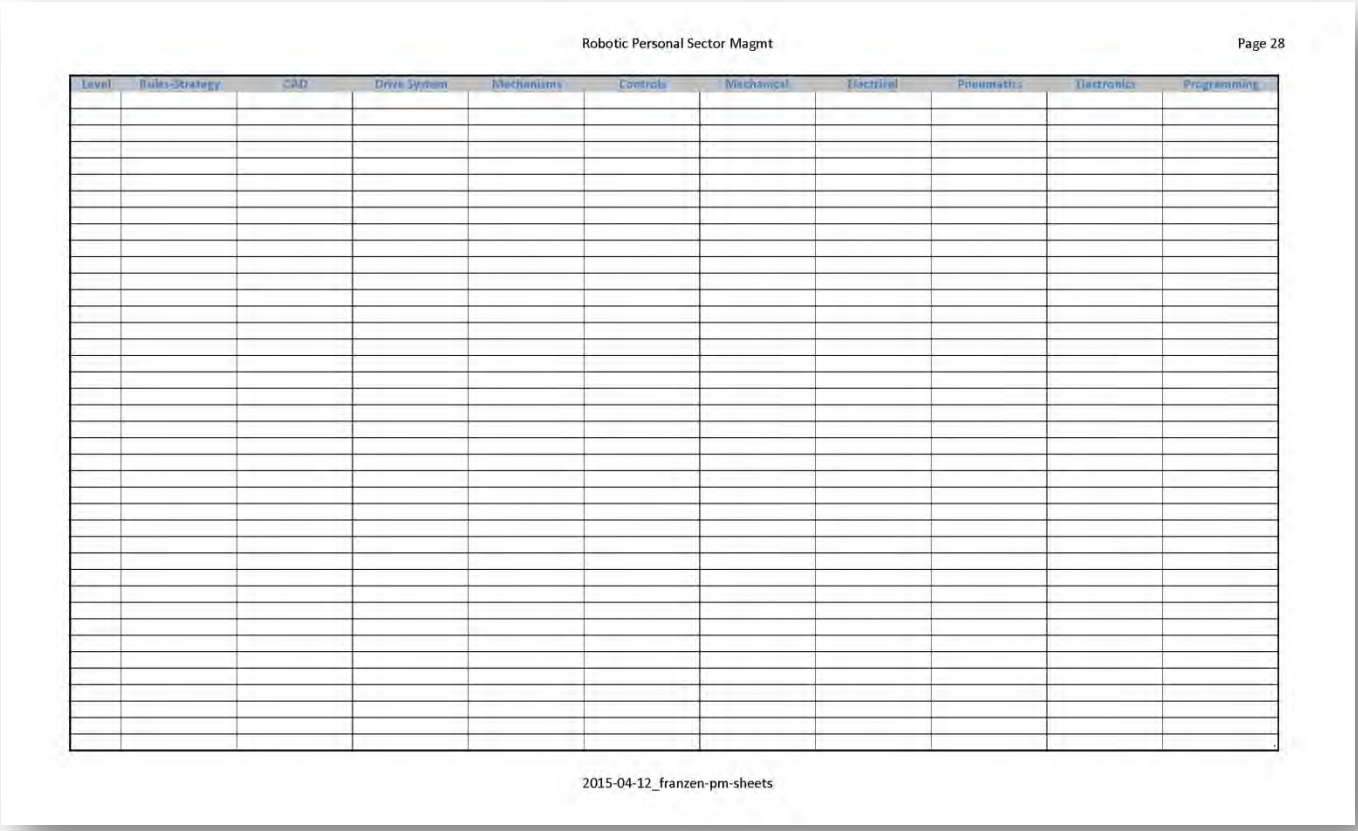
PM EXCEL SHEET FOR ROBOTIC PERSONAL SECTOR MANAGEMENT (PROJECT MANAGEMENT)

This is another tool for students to use and support peer interaction. There is not a lot on this sheet, as it is prepared to allow students fill it out and use for peer interaction, collaboration, and peer support. Each student will be asked at the beginning to select an area to be an 'expert' in, giving them the opportunity to explore that area and later share with other students during everyone's robot design and model build. This will create interdependence among each creating collaboration and peer to peer support.



Robotic Personal Sector Magmt

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Level	Rules-Strategy	CAD	Drive System	Mechanisms	Controls	Mechanical	Electrical	Pneumatics	Electronics	Programming

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UNIT 2: ENGINEERING COMMUNICATIONS

Time: 2 Weeks

UNIT 2, DESCRIPTION: ENGINEERING COMMUNICATION

In this unit the focus is to have students practice their freehand technical sketching skills with geometric shapes, learn about orthographic (ortho) and Isometric (ISO) drawing types and start to apply it to robotic designs and familiarizing themselves with FIRST FRC robotic competition game and robot rules and requirements.

Students sketch simple geometric shapes in 2D, 3D Isometric (ISO), 3D wire-frame, a custom block shape, using addition/subtraction sketching techniques. Students will also familiarize themselves with FIRST FRC robotic game and robot rules, standards, process, and requirements. Based on feedback from sketching assignment and using their FRC information they will practice their freehand technical sketching principles and techniques and on a possible robot design using ISO with details and notes supporting FRC.

Students then practice their sketching techniques by copying an orthographic note with front view rule selection and accompanying isometric view. Included also are overall and detail dimensions, non-cylindrical and cylindrical features, with all related components labeled with descriptions. Students will get assignment back marked with rubric tracking sheet package initially filled out by teacher, so they can continue to assess themselves and their peers in the near future to support their efforts in being successful in this key task/process.

Students will complete either a quiz or rev questions on ortho/ISO and sketching for feedback to ensure students are on track. For further practice, students will be given a set of complex and simple geometric blocks and/or classroom objects to sketch ortho/ISO format, scale to fit on page, and dimension based on ortho/ISO note. Last for this section students in groups will research, show, and describe different ways robot design ideas have been shown graphically and comment on principles and elements of graphic design related to those shown and hand in as an electronic report.

In the last section, we look at SPICE – a simple design model showing steps on how to solve a problem or challenge in a systematic way. Students will also be given a self and peer rubric tracking sheet to allow them to assess their own success in this area in the near future. Students will use this process and apply it to coming up with three new robot designs in the form of ISO sketches on a single page. Students will also complete an assignment on the role of how the five senses play in technological design. Finishing off the last sketching task of three ideas, students will pick one final idea which will be used for their custom robot design in future projects and create a more detailed ortho/ISO sketch showing details, notes, and dimensions. Students will also hand in a short post report on their design detailing its operation, features, and game play strategies.

UNIT 2, TABLE OVERVIEW: ENGINEERING COMMUNICATION

Activity #	Activity Title/Name	Learning Expectations Overall/Specific	Assessment Categories	Tasks
2.1	Freehand technical sketching	• B2.1, A1.5, A3.3	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Sketch basic shapes square, rectangle, triangle, and circle in 2D, 3D ISO, 3D ISO wire frame, and then apply to a step block shape - HOA • List FIRST FRC Robot criteria based on game, technical **drawings (DWGS),** and robot - ASS • Sketch a possible FRC robot design on back, using above info and sketching principles - HOA
2.2	Ortho and ISO graphical note	• A3, A5.1	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Sketch ortho step block example note with the addition non-cylindrical and cylindrical features, dimensions, ISO, labels, and front rules selection – HOA • Ortho/ISO self/peer assessment tracking - RUB
2.3	Custom orthographic	• A3, A3.1, A5.1	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Ortho/ISO review questions – REV • Select a custom block or simple class object, measure, scale to fit on page, and draw without labels, dimensions, and ISO using ortho note above - HOA • Research a variety of FRC robot graphic-image-formatted designs with principles of design characteristics - RPT
2.4	Robot designs	• A1, A1.6, A2, A4.3, A5, A5.1, B2, B2.1, B2.3, B2.4, B2.5	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• SPICE design process – note • SPICE design self/peer assessment tracking - RUB • Applying SPICE to a Robot Design - ASS • Robot ortho design - note • Three new robot designs ISO

				sketches – HOA • Technology Design - pleasing to our 5 senses-and model/prototype assessment criteria - ASS • final design sketch an ortho/ISO - HOA • Post report on final robot sketch design - RPT

UNIT 2, ACTIVITIES 1-4

ACTIVITY 2.3: CUSTOM ORTHOGRAPHIC

Time: 3 Days

DESCRIPTION

Students just finished a detailed graphic note showing a step block with a hole through the bottom step, that shows examples of different line types, blocking in the views, projection lines, dimensioning – overall and detail, isometric and all parts labeled.

Discuss and review the ortho note and what the three rules for selection the front view of an object is. Using some sample objects in the room, review how the three rules affect which view is actually the front. Review third angle projection and re-affirm which views are chosen after the front view is selected and finish the discussion with different line types and why construction lines are important to start with blocking in your different views.

Their task is to pick a challenging custom block to sketch in the form of an orthographic three-view full-page drawing and include appropriate dimensions properly spaced and an isometric in the top-right quadrant. Students will need to use the three rules for selecting a front view of an object to select the front view of the object they picked.

STRANDS & LEARNING EXPECTATIONS

Strand(s): A ➔Technology Design Fundamentals / B ➔ Technology Design Skills / C ➔Technology, the Environment, and Society / D ➔Professional Practice and Career Opportunities

OVERALL EXPECTATIONS

By the end of this course, students will:

- A3. demonstrate an understanding of drafting standards, conventions, and guidelines for various types of drawings used to represent designs;

SPECIFIC EXPECTATIONS

By the end of this course, students will:

- A5.1 use technical terminology correctly when documenting, reporting on, and presenting design projects (e.g., vernier caliper, orthographic, fillet, bisect, construction lines, shears);

PRIOR KNOWLEDGE & SKILLS

A basic understanding of Technology Design, Grade 10.sketching key concepts are:

Have had practice with

- Sharpen a pencil and keep it sharp while sketching (conical)
- Erase pencil lines.
- Sketch long, short, parallel, & straight lines (light and heavy)
- Sketch perpendicular lines (at various positions)
- Sketch arcs and circles (large and small)
- Sketch common plane geometrical figures (triangles, rectangles, square, regular polygons, etc.)
- Sketch objects in outline form (with lead pencil)

PLANNING NOTES

- Have students buddy up to ensure they can share ideas about what they are drawing to maximize the learning experience
- Review why this type of drawing is important, comparison of other different types of drawings, and why we are doing this specific exercise, i.e. bring the custom block into context of where it stands with the industry and what we will be doing in class
- Make sure students have all their sketching tools and are focused ready to work
- Ensure you have extra pencils HB and 2H lead hardness, white eraser, more blank paper, graph paper, on hand
- Be prepared to support students when they get their custom block shape that they are on the right track to selecting the front view
- Use directed questions and their notes to help guide them
- Review dimensioning, as students in general tend to make mistakes in this area, so more review and/or emphasis on this are will help a lot

Skills and learning to focus on:

- Common engineering drawing types
- Block in orthographic views using sketching techniques
- Lay out the border line (continuous and in segments)
- Upper case printing (gothic font style)
- Sketch orthographic views of objects with horizontal and vertical surfaces
- Sketch orthographic views of objects with non-cylindrical features and cylindrical features
- Sketch orthographic views of objects with hidden features
- Sketch relative scale to page size
- Sketch different line types - construction, object, hidden, centre, leader, projection lines
- Sketch views relative to each other
- Sketch views in third angle projection
- Measure objects by use of the metric system.
- Print metric measurements on the drawing.
- Sketch dimension and projection lines.
- Dimension circles or holes and locate them.

- Dimension non-cylindrical features
- Dimension overall dimensions
- Dimension detail dimensions
- Dimensioning inside the envelope
- Selecting the front view, applying the three rules
- Defining the front view in drafting standard definition

TEACHING/LEARNING STRATEGIES

- Socratic Lesson – oral presentation of information and process by the teacher
- Buddy System – links students for peer support
- Class Discussion – students actively participate by taking turns discussing current tasks and/or issues
- Collaborative and Co-operative Learning – small group learning providing high levels of student engagement, interdependence, and group support
- Conferencing/Discussion – student-to-student discussion and teacher-to-student discussion to encourage confidence and motivation to be successful
- Homework – an extension of class work, support, time extension and material review

ASSESSMENT & EVALUATION OF STUDENT ACHIEVEMENT

The major project here is a hands-on orthographic sketch which includes three major parts, the different views of an object sketched out correctly with the proper line work, scaling, and views, the correct placement of dimensions, and the isometric view. For this reason I have broken down it down in the chart below.

Task/Product	Tool	Purpose	Assessment Categories
Ortho Matching HO	• Peer evaluation	Formative	• Knowledge / Understanding • Thinking / Inquiry
Front view selection	• Class discussion	Diagnostic	Observation only
Observation	• Anecdotal comments/notes	Formative	• Knowledge / Understanding
Custom block orthographic sketched views	• Peer review • Check list • One-on-one marking	Formative	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application
Custom block orthographic dimensions	• Peer review • Check list • One-on-one marking	Formative	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application
Custom block isometric	• Peer review • Check list • One-on-one marking	Formative	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application
Orthographic	• Online Moodle quiz	Formative	• Communication

terminology quiz			• Knowledge / Understanding
Design Idea graphic variations	• Research report	Formative	• Communication • Knowledge / Understanding

ACCOMMODATIONS

The teacher consults individual student IEPs for specific direction on accommodation and adapts the activity and teaching strategies to meet the needs of individual students. Students' individual needs may be accommodated through an adaptation of the design and/or production stages of the activity.

- Students may need more time, as such the source files for activities 1-2 can be accessed on the web at any time, and therefore they may finish the work from home. Activity 3 is based on some simple custom block shapes which students can measure , then take home to further work on it if necessary
- Observation - after assigning work in class, walk around the class for direct and immediate feedback to see how everyone is doing, if they need some more support in anyway
- Have graph paper and isometric grid paper on hand for those students having difficulty with different sketching tasks and review with them how to use the paper to help them create better sketches
- Mark work in class, in front of individual students giving them direct feedback – examples, repeat live demo if needed and do a comparison, and/or give more specific details for understanding, as the teacher reviews the students' work
- Giving students the option of redoing work if they want for a better mark after I have finished evaluating what they have completed.
- Live demo lesson allowing students to focus, watch as the teacher creates their required sketch assignment, break it down step-by-step, and give tips on common challenges that students usually run into
- Have a supply of extra pencils and erasers available if students do not have with them
- Common pencil is HB, so keep some harder lead pencils like 2h for students who are having difficulty with applying a lighter pressure to produce construction lines
- Buddy up students who are having difficulty with some of the sketching tasks, so they can have some direct peer support to help assist them through certain challenges they may have

RESOURCES

There are not a lot of resources needed for this activity, but it is important to have some extra materials below to support some student's accommodations if needed.

GENERAL

The equipment and tools required to complete the activity include:

- Pencil
- White eraser
- Ruler (metric/imperial)
- Blank paper
- Sample physical step block for demonstration
- Custom assortment of wooden shapes for student selection for orthographic sketch
- For accommodations and extra support teacher should keep the following on hand:
- ¼" graph paper,

- isometric grid paper
- hard lead pencils (2h or similar)

BOOKS

- Text book: Drafting fundamentals 4th edition by Jensen Mason, McGraw hill Ryerson, p43
- http://web.dsbn.edu.on.ca/~paul.brunet/S0355DFCF.1/Orthographic%20Drawing%20-%20Non-Cylindrical%20Objects.pdf
- http://www.sdcpublications.com/pdfsample/978-1-58503-439-0-c.pdf

VIDEOS

- https://www.youtube.com/watch?v=Hos10VmP4Oc
- https://www.youtube.com/watch?v=Pz2FDjF5b6E
- https://www.youtube.com/watch?v=XEOLsqRsjDQ
- https://www.youtube.com/watch?v=B-phn5rb0Go
- http://www.sketch-a-day.com/page/44/

MAGAZINES

- http://www.woodcraftmagazine.com/FreeStuff/Elevations.pdf

WEBSITES

- http://www.shopteacher.org/mcs/tutorials/tech_ed/projects/3d/3dblocks.htm
- http://www.manufacturinget.org/tag/orthographic-projection/
- http://design.tutsplus.com/tutorials/working-with-orthographic-projections-and-basic-isometrics--vector-893
- http://www.g-w.com/pdf/sampchap/9781605254289_ch03.pdf
- https://www.google.ca/search?q=first+robot+frc&espv=2&biw=882&bih=776&source=lnms&tbm=isch&sa=X&ei=0t0kVc2AAoaesAWFmIJg&ved=0CAYQ_AUoAQ

UNIT 2, LESSONS

UNIT 2 LESSON 3 (ACT 3): ORTHOGRAPHIC PROJECTION

Differentiated Instruction Lesson Plan

Technological Design – TDJ3M
Orthographic Projection / Technological Education
Duration: 3 - 75 minute periods
This lesson can be used in any Technology Education course to introduce the student to different drawing types, orthographic projection and dimensioning for quick accurate communication of technical ideas. This lesson uses a simple step block initially, as the teaching aid and focus.

1	Think-Pair-Square – Engineer communication, drawing types, sketches, and orthographic questions, cues and advance organizers *
2	Guided discussion with graphic sketch note on orthographic projection, dimensioning, terms, and definitions
3	Pair Share -guided discussion /note on front view selection rules*
4	Choice selections-pair share custom block orthographic sketch process (co-operative)**
5	Peer assessment (setting objectives and providing feedback)*
6	Ortho online quiz – matching, true/false, and multiple choice

*Marzano's Categories of Instructional Strategies
**Differentiated Instruction Structure

KEY INFO

Knowledge of Students
Differentiation based on student:
☑ Readiness ☑ Interests ☑ Preferences:
☑ Styles ❒ Intelligences ❒ Other (e.g., environment, gender, culture)

Need to Know
Students' prior experience with sketching lines, basic shapes, isometric standard and wireframe view.

How to Find Out
Class discussion, Observation, verbal survey, marks on previous line and shape sketching activities.

Differentiated Instruction Response
☑ Learning materials (content) ❒ Ways of learning (process) ☑ Ways of demonstrating learning (product) ❒ Learning environment

CURRICULUM CONNECTIONS

OVERALL EXPECTATION(S):

By the end of this course, students will:

- A3. demonstrate an understanding of drafting standards, conventions, and guidelines for various types of drawings used to represent designs;

SPECIFIC EXPECTATION(S):

By the end of this course, students will:

- A5.1 use technical terminology correctly when documenting, reporting on, and presenting design projects (e.g., vernier caliper, orthographic, fillet, bisect, construction lines, shears)

LEARNING GOALS:

GENERAL

- Common drawing types commonly including ortho, isometric, oblique, floor plan, section, elevation, etc.
- How to sketch a basic orthographic drawing of a simple block object
- How to select/identify the front view of an object in technology design
- Dimension basic non-cylindrical and cylindrical feature with overall and detailed dimensions
- Know the basic related terminology of an orthographic drawing and it's drawing process

SPECIFIC

- Common engineering drawing types
- Lay out the border line (continuous and in segments)
- Block in orthographic views using sketching techniques
- Upper case printing (gothic font style)
- Sketch orthographic views of objects with horizontal and vertical surfaces
- Sketch orthographic views of objects with non-cylindrical features and cylindrical features
- Sketch different line types - construction, object, hidden, centre, leader, projection, dimension, extension lines
- Sketch orthographic views of objects with hidden features
- Sketch isometric views in both wireframe and standard views
- Sketch relative scale to page size
- Sketch views relative to each other
- Sketch views in third angle projection
- Measure objects by use of the metric system & print on the drawing.
- Dimension circles or holes and locate them.
- Dimension non-cylindrical features
- Dimension overall and detail dimensions inside the envelope

ASSESSMENT AND EVALUATION

ASSESSMENT/SUCCESS CRITERIA	Assessment Tools
Knowledge and Understanding • Common Engineering drawings, orthographic, isometric and general related terminology and definitions • Process and steps to create an orthographic drawing of a basic shape *Communication* • Show projection views of objects • Demonstrate appropriate and clear graphical communication of object sketched • Clear organized dimensions • Dimension appropriate number needed for object sketched *Thinking & Inquiry*	Note accuracy Check list Peer review Marking scheme Rubric Written test

• Correctly identify the front of an object for orthographic placement • Visualize the correct right side and top views • Place dimensions near detail/feature dimensioning *Application* • Layout and block in views in initial sketch with light construction/projection lines • Correctly sketch the views of a simple object • Graphical note correctly labelled *Note Project Rubric attached as Appendix UL2-5	

PRIOR LEARNING

Prior to this lesson, students will have Some experience with sketching in a technical format with some confidence and speed. More specifically, students' prior experience with sketching lines, basic shapes, including isometric recently include:

- Skills to sharpen a pencil and keep it sharp while sketching (conical)
- Sketched long, short, parallel, & straight lines (light and heavy)
- Sketched perpendicular lines (at various positions)
- Sketched arcs and circles (large and small)
- Sketched common plane geometrical figures (triangles, rectangles, square, regular polygons, etc.)

ACCOMIDATIONS

Class information will first establish what kind of accommodations and/modifications you may need to adjust for the class in general. Below are some specific ones that you can apply at any point when needed. For individuals with IEP's, use this as a tool/guide to help direct you to better support specific student needs.

- Balance out group members based on individual support or work load
- Supply internet site with links, resources, lesson information, notes, and ortho note, allow students to finish work at home
- With ortho custom blocks, allow students to pick the shape they feel challenged or comfortable with, and also group them together so they may discuss ideas, concerns, and thoughts on related project requirements
- One of the ortho custom shapes has the sides identified, anther closely resembles the sample in the orthographic note, for those who are having difficulty/struggling with this concept
- Allow students more time, if they are struggling with the sketching or having difficulty with theory component and maybe partner up with someone else.
- Observation - after assigning work in class, walk around the class for direct and immediate feedback to see how everyone is doing, if they need some more support in anyway
- Have graph paper and isometric grid paper on hand for those students having difficulty with different sketching tasks and review with them how to use the paper to help them create better sketches
- Mark work in class, in front of individual students giving them direct feedback – examples, repeat live demo if needed and do a comparison, and/or give more specific details for understanding, as the teacher reviews the students' work
- Giving students the option of redoing work if they want for a better mark after I have finished evaluating what they have completed.
- Live demo lesson allowing students to focus, watch as the teacher creates their required sketch assignment, break it down step-by-step, and give tips on common challenges that students usually run into
- Have a supply of extra pencils and erasers available if students do not have with them
- Common pencil is HB, so keep some harder lead pencils like 2h for students who are having difficulty with applying a lighter pressure to produce construction lines

MATERIALS AND RESOURCES

MATERIALS:

Student will require a pencil, soft-white eraser, ruler (metric), and blank paper. Teacher should also have a sample block for demonstration of the step block, and have an assortment of wooden shapes students can select from to choose a shape to sketch.
For accommodations and extra support teacher should keep ¼" graph paper, isometric grid paper, hard lead pencils (2h or similar), extra blank paper, HB pencils, and erasers.

TEACHER AIDS:

It is suggested to have the following to use with your lesson:

- A white board with complimentary set of marker, or chalk board with chalk, or a digital white board
- Digital projector
- Demo bench or drafting table
- Step block sample you can physically hold up to show students to pass around- a great visual and tactile aid
- Assortment of custom wooden block shapes for students to use with their sketch project
- Samples on the wall students can view, showing student past work for comparison

APPENDIX UL2.1 TO 4:

This appendix has

- A three part orthographic note,
- ISO to Ortho student exercise, sample student drawing types (extra),
- Picture showing custom wood block shapes for students to use for their custom ortho block selection,
- An orthographic drawing support page on how to get started with drawing an orthographic drawing, and
- A rubric package for students to assess themselves and their peers

BOOKS

- Text book: Drafting fundamentals 4th edition by Jensen Mason, McGraw hill Ryerson, p43
- http://web.dsbn.edu.on.ca/~paul.brunet/S0355DFCF.1/Orthographic%20Drawing%20-%20Non-Cylindrical%20Objects.pdf
- http://www.sdcpublications.com/pdfsample/978-1-58503-439-0-c.pdf

VIDEOS

Videos are there as a resource and not all necessary to use, as live demonstrations will suffice.

- https://www.youtube.com/watch?v=Hos10VmP4Oc
- https://www.youtube.com/watch?v=Pz2FDjF5b6E
- https://www.youtube.com/watch?v=XEOLsqRsjDQ
- https://www.youtube.com/watch?v=B-phn5rb0Go
- http://www.sketch-a-day.com/page/44/

MAGAZINES

- http://www.woodcraftmagazine.com/FreeStuff/Elevations.pdf

WEBSITES

- http://www.shopteacher.org/mcs/tutorials/tech_ed/projects/3d/3dblocks.htm
- http://www.manufacturinget.org/tag/orthographic-projection/
- http://design.tutsplus.com/tutorials/working-with-orthographic-projections-and-basic-isometrics--vector-893
- http://www.g-w.com/pdf/sampchap/9781605254289_ch03.pdf

LESSON DETAILS

MINDS ON

◆ Establishing a positive learning environment ◆ Connecting to prior learning and/or experiences ◆ Setting the context for learning	Connections L: Literacy ML: Mathematical Literacy AfL, AaL, AoL: Assessment for/as/of Learning
1-Whole Class/Groups of 3 ⇒ Engineer communications • Class discussion on what engineers and designers need to do as part of their profession • In groups of 3 discuss why it is important to be able to accurately communicate specific ideas that are graphic intense, and how they might do this • Share with class • Motivation: being able to sketch out an idea that everyone can understand is critical for this type of profession • Review of proper technical sketching techniques	DI Interests L: Subject-specific vocabulary/Guided Discussion AfL: Review/Think-pair-square-Anecdotal comments

ACTION

◆ Introducing new learning or extending/reinforcing prior learning ◆ Providing opportunities for practice and application of learning (guided > independent)	Connections L: Literacy ML: Mathematical Literacy AfL, AaL, AoL: Assessment for/as/of Learning
2-Whole Class ⇒ Step block orthographic drawing note & guided discussion • Start with a guided discussion of orthographic drawing basics, while sketching out a graphical note, see Appendix UL2-1, students learn about the basics of drawing an object orthographically • Use sample wooden-scaled model of our graphic note and discuss the placement of three main views, the front, right side and the top view. I have three different views shown in the graphic note. To keep it simple each stage is drawn in gradual succession • Basic orthographic non-cylindrical object sketched • Cylindrical feature and dimensioning standards • Terminology, steps, line types, ortho drawing parts • Have students also copy the three rules for selecting the front view, on the back of this note.	L: Subject terminology-note ML: dimensions-units-spacing AfL: Strategy/Assessment Tool
3-Groups of 3 - Share with Class ⇒ Rules for selecting and placing front view • Review the three rules for selecting the front view and what they mean o Most detail o Length across the page o Least amount of hidden lines • Break up into groups and have each group select a block sample and decide on which is the front view, and the leader will share with the class which is the front view and why • Students will pass their note to a non-partner, write their peer marker name on sheet and with the graphic note still up, and see if they can find any information missing or improperly sketched. Once completed, they will pass it back to the owner with the number of issues marked that need to be fixed. Once the owner has fixed the concerns of the peer marker, the note is to be handed in for review/marking by the teacher	AaL: Peer supported check AoL: Note/check list assessment AfL: Intro, review, pair-share- AfL- peer evaluation L AoL: Note/check list assessment

4-Groups of 3 ⇒ Custom Block Drawing • Students in their groups can work together, but their ISO and ortho sketches must be individual sketched. Students select a 2nd block of interest in groups and make out a quick isometric sketch of the object on the back of their drawing sheet. Students are to measure all of the overall and details dimensions and transfer on to the rough isometric sketch they have. As a group they decide which the front view, then confirm with a second group. They are all to sketch out their block on the front page using the graphic ortho note they copied earlier as a guide with their own steps. It is to include all three scaled relative views along with dimensions, views named , and an isometric view DI Readiness, Interests, Preferences - styles	ML- measurements, units, dimensioning

CONSOLIDATION AND CONNECTION

◆ Helping students demonstrate what they have learned ◆ Providing opportunities for consolidation and reflection	Connections L: Literacy ML: Mathematical Literacy AfL, AaL, AoL: Assessment for/as/of Learning
5-Pairs of 2 ⇒ Evaluating custom sketch • Students will pass their work to a non-partner for peer assessment, marker will put their name at the top of the page, and mark with a different coloured pen or pencil • Students will use their graphic ortho note, rubric, and experience to compare and mark custom block sketch, dimensioning, line work, view placement, and isometric • Once marked, students pass back to the owner and discuss feedback and issues, then owner will hand in for teacher assessment 6-Ortho online quiz ⇒ matching, true/false, and multiple choice • Quiz (set-up on-line if possible), have students write it can be marked instantly	AaL: Peer supported check ML AoL: Note/check list assessment

SIDE NOTE DEFINITION/SUPPORT:

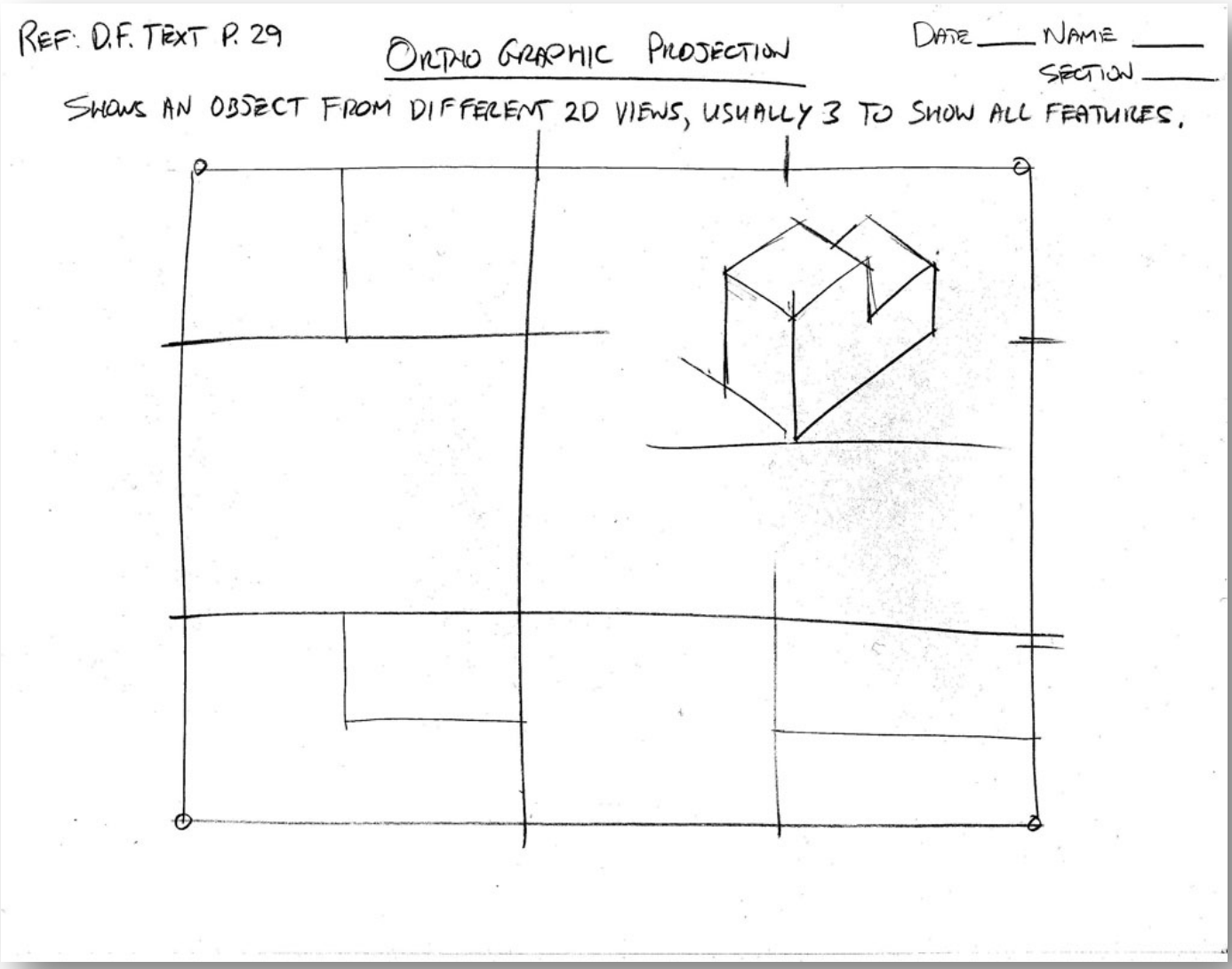
- **Assessment for Learning** - student info to adapt, DI, teaching and learning activities (before/during)
- **Assessment as Learning** - students monitors their own learning - feedback to adjust, adapt, and change what they understand.
- **Assessment of Learning** - helping students improve while they are still gaining knowledge/skills

UNIT 2, APPENDIX UL2

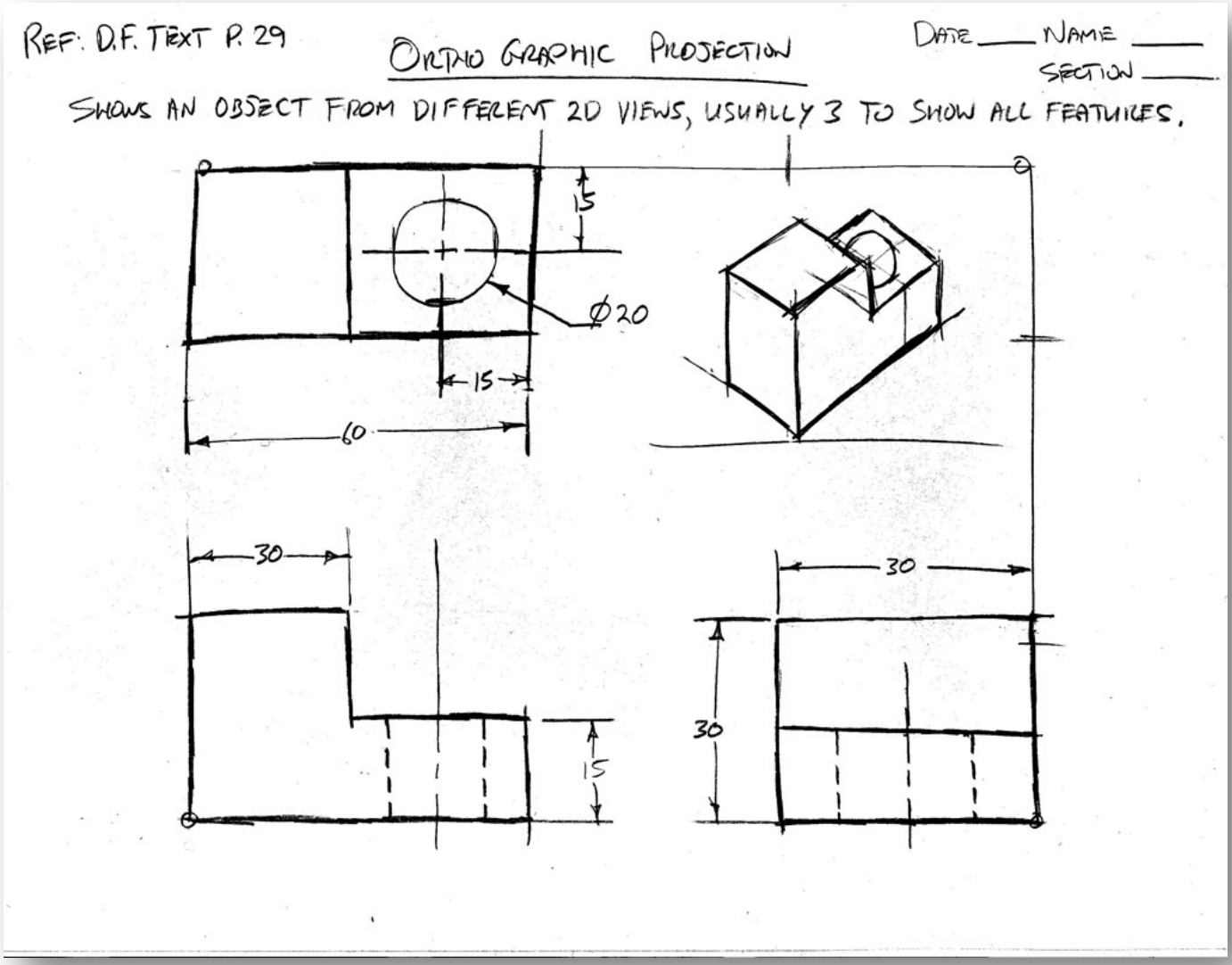
Attached are related samples of support resources for Unit 2

APPENDIX UL2-1

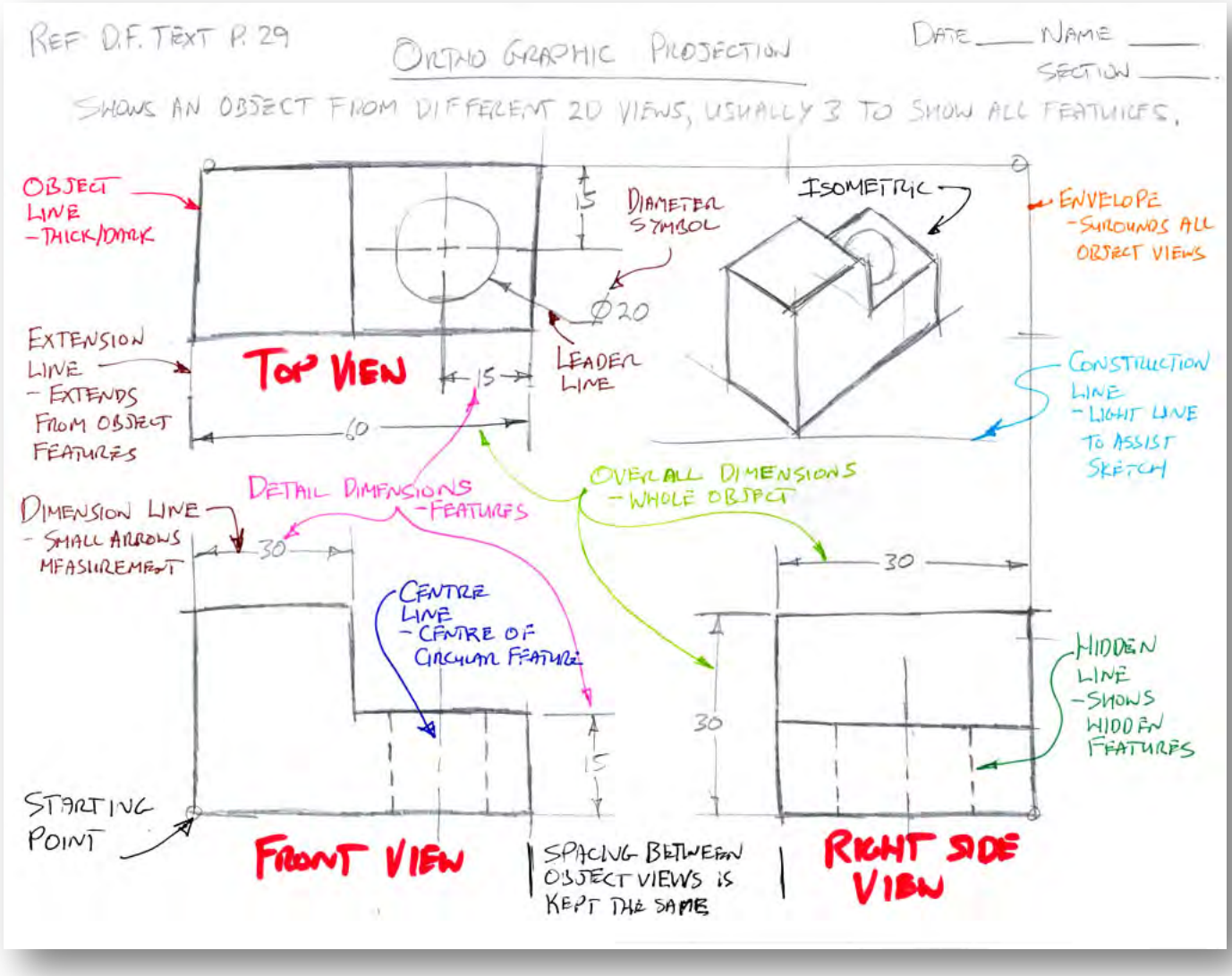
ORTHOGRAPHIC NOTE – PART 1 OF 3 (PART OF PREVIOUS LESSON)



ORTHOGRAPHIC NOTE – PART 2 OF 3



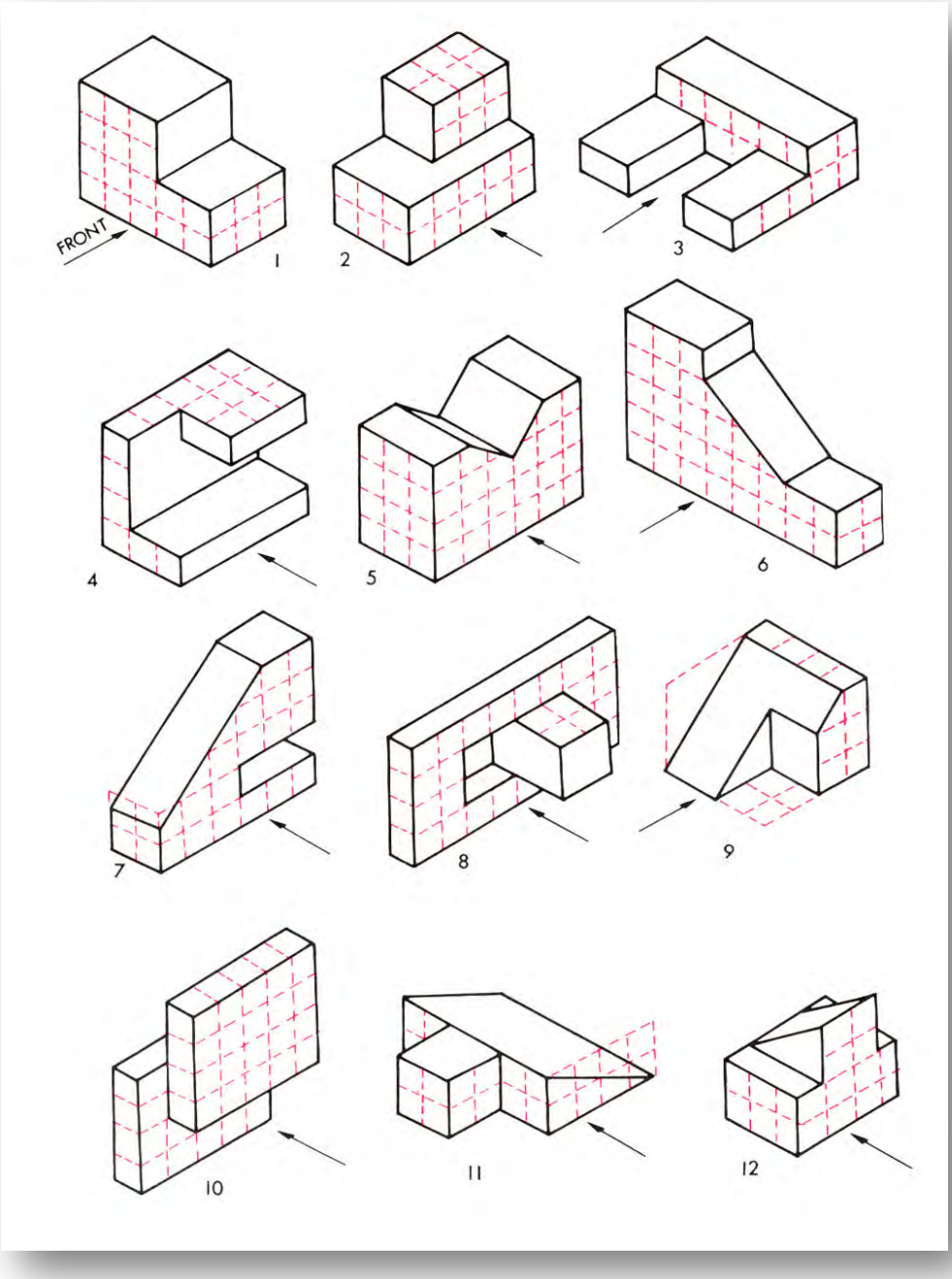
ORTHOGRAPHIC NOTE – PART 3 OF 3



APPENDIX UL2-2

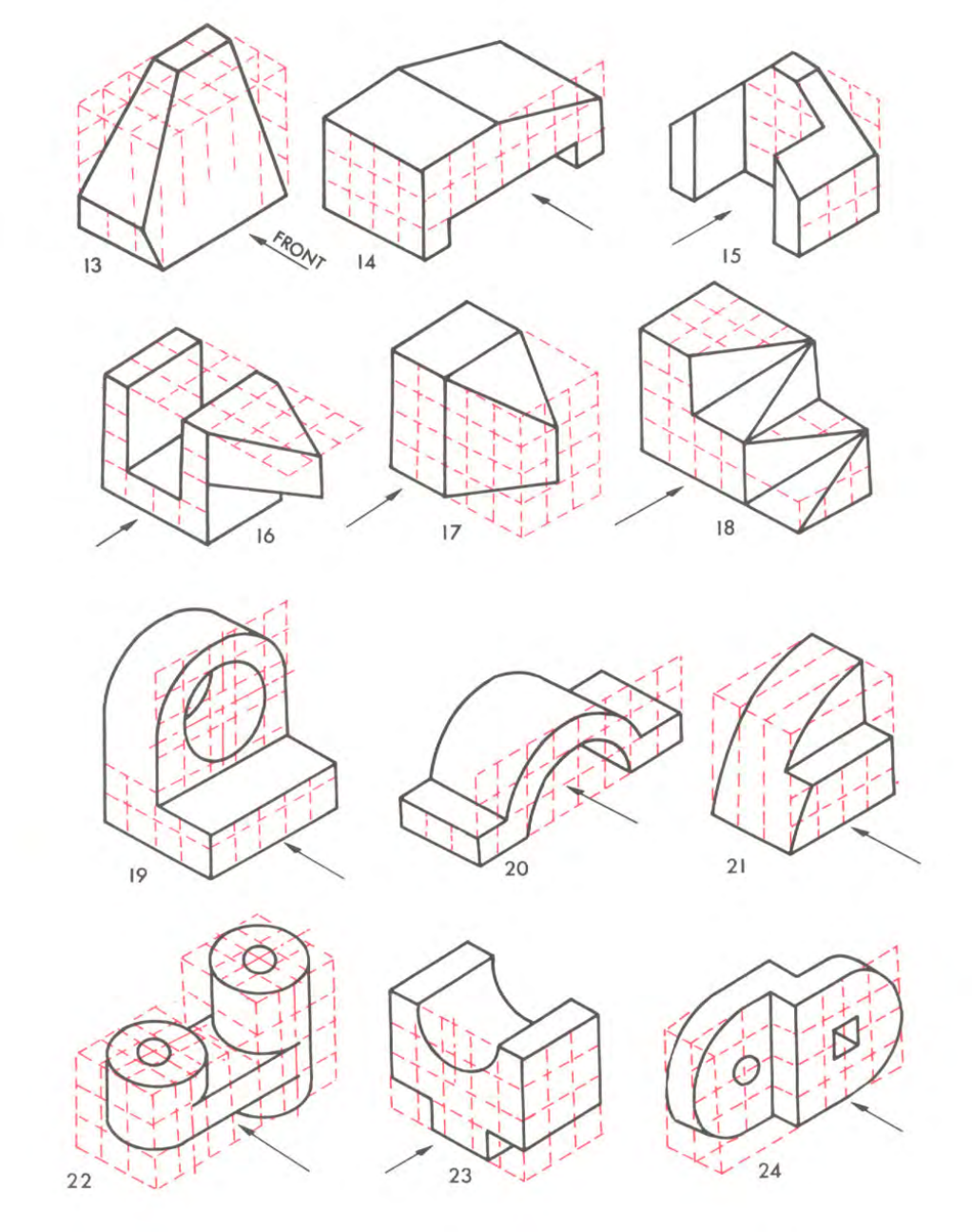
ISOMETRIC DRAWINGS TO ORTHOGRAPHIC VIEWS EXERCISE

This is a drawing activity that students use to draw the orthographic equivalent. Student sample follows.



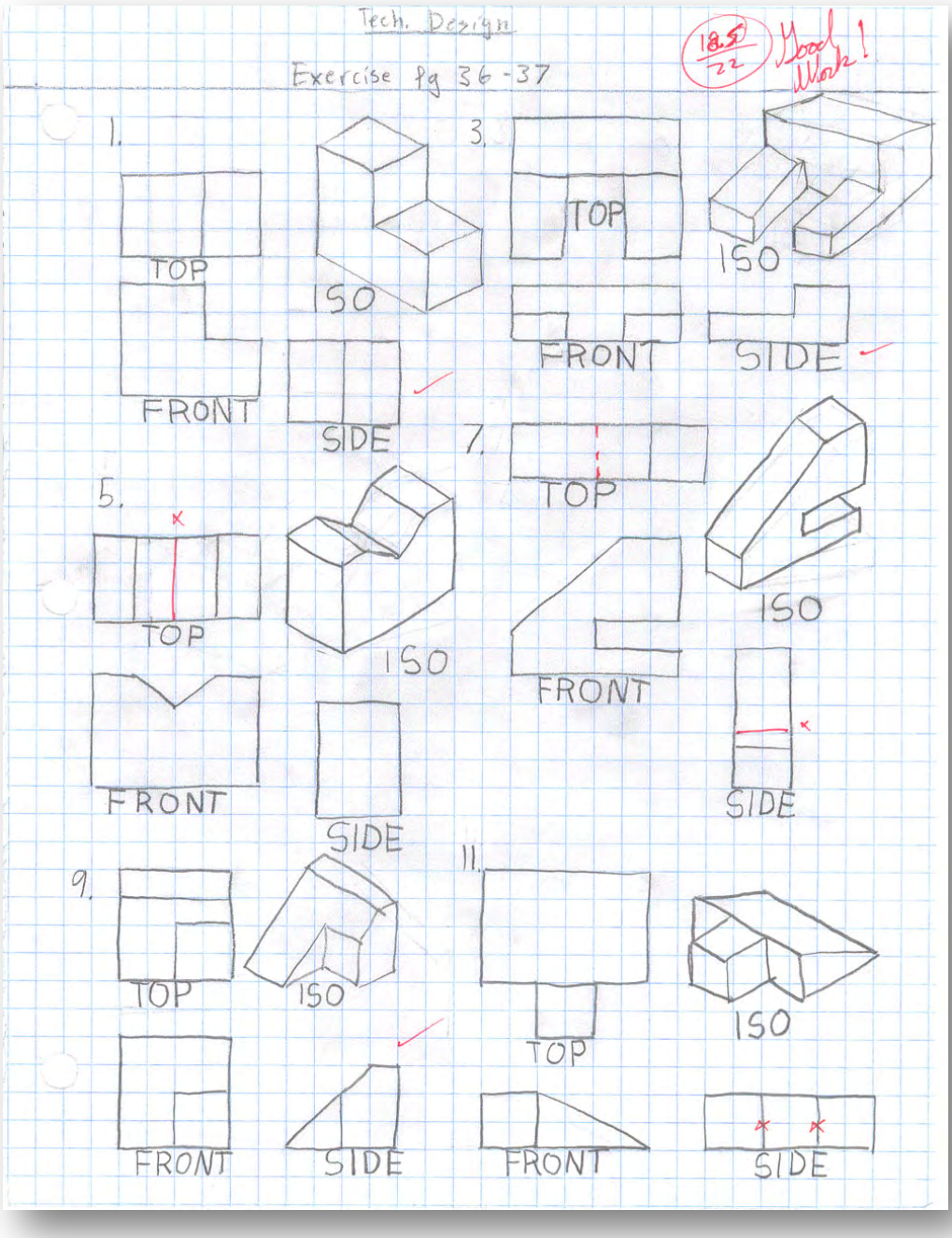
ISOMETRIC DRAWINGS TO ORTHOGRAPHIC VIEWS EXERCISE

This is a drawing activity that students use to draw the orthographic equivalent.

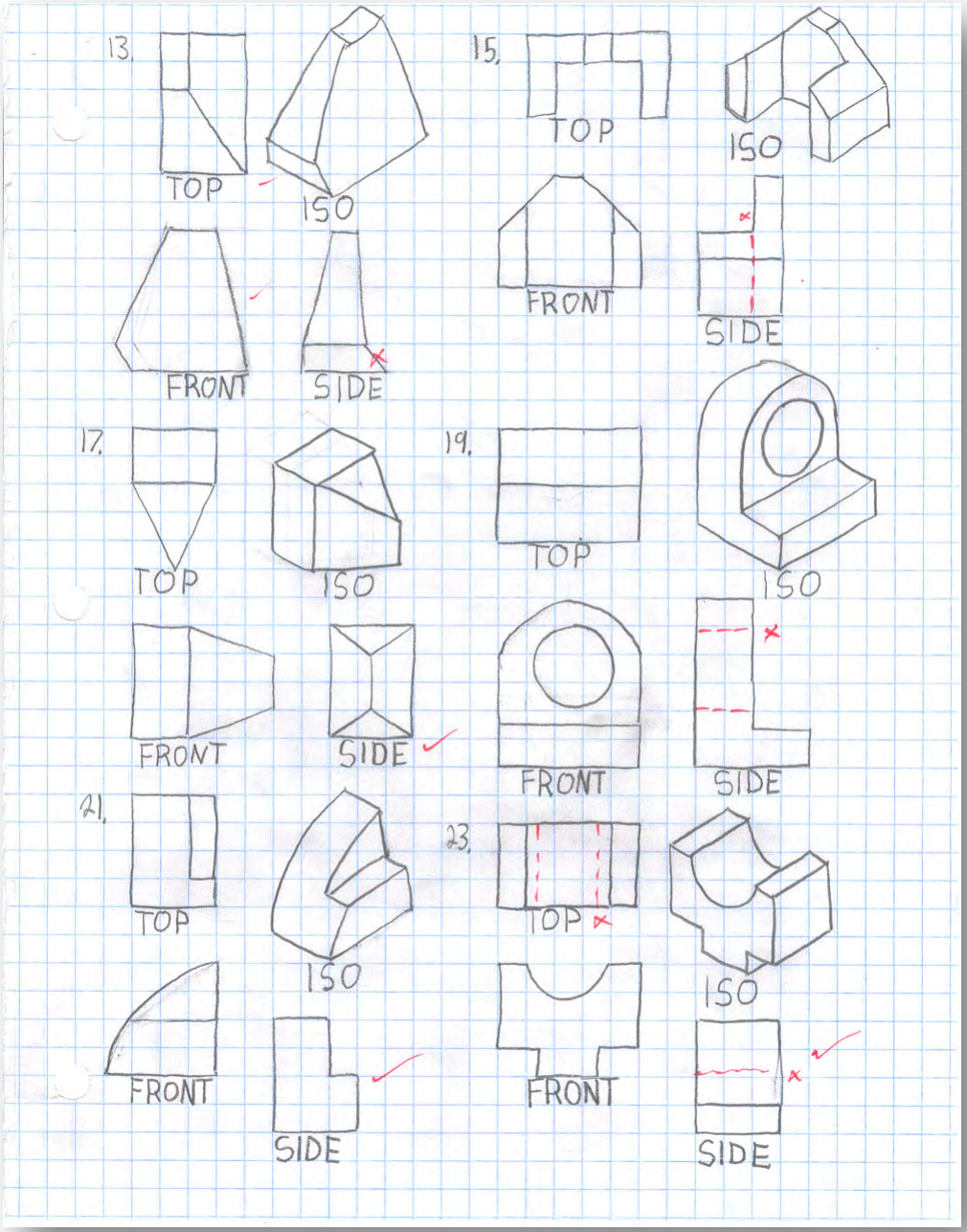


ISOMETRIC DRAWINGS TO ORTHOGRAPHIC VIEWS EXERCISE

This is a drawing activity that a student has completed.



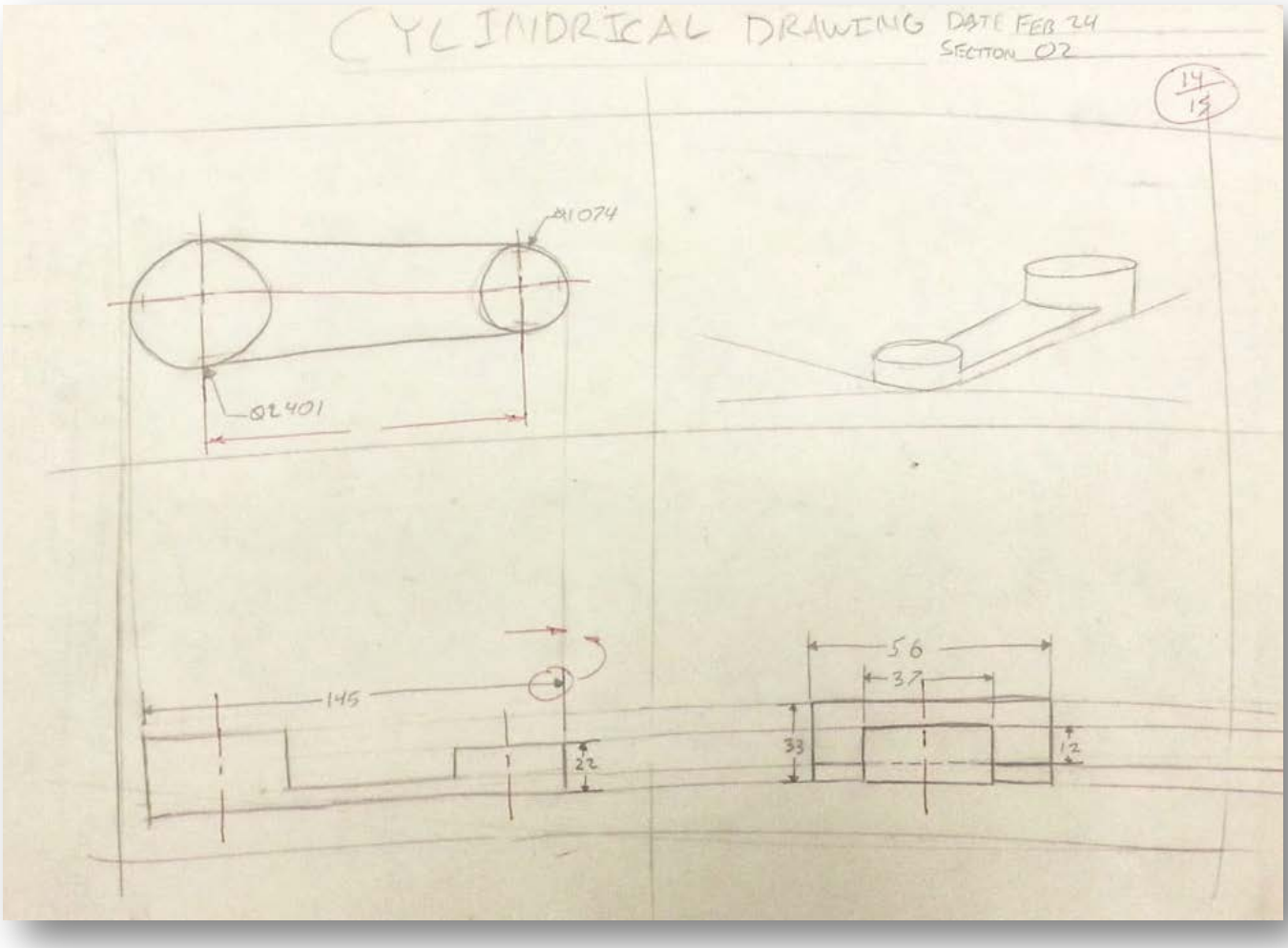
Student assignment continues…



APPENDIX UL2-3

ORTHOGRAPHIC CUSTOM SHAPE SAMPLES

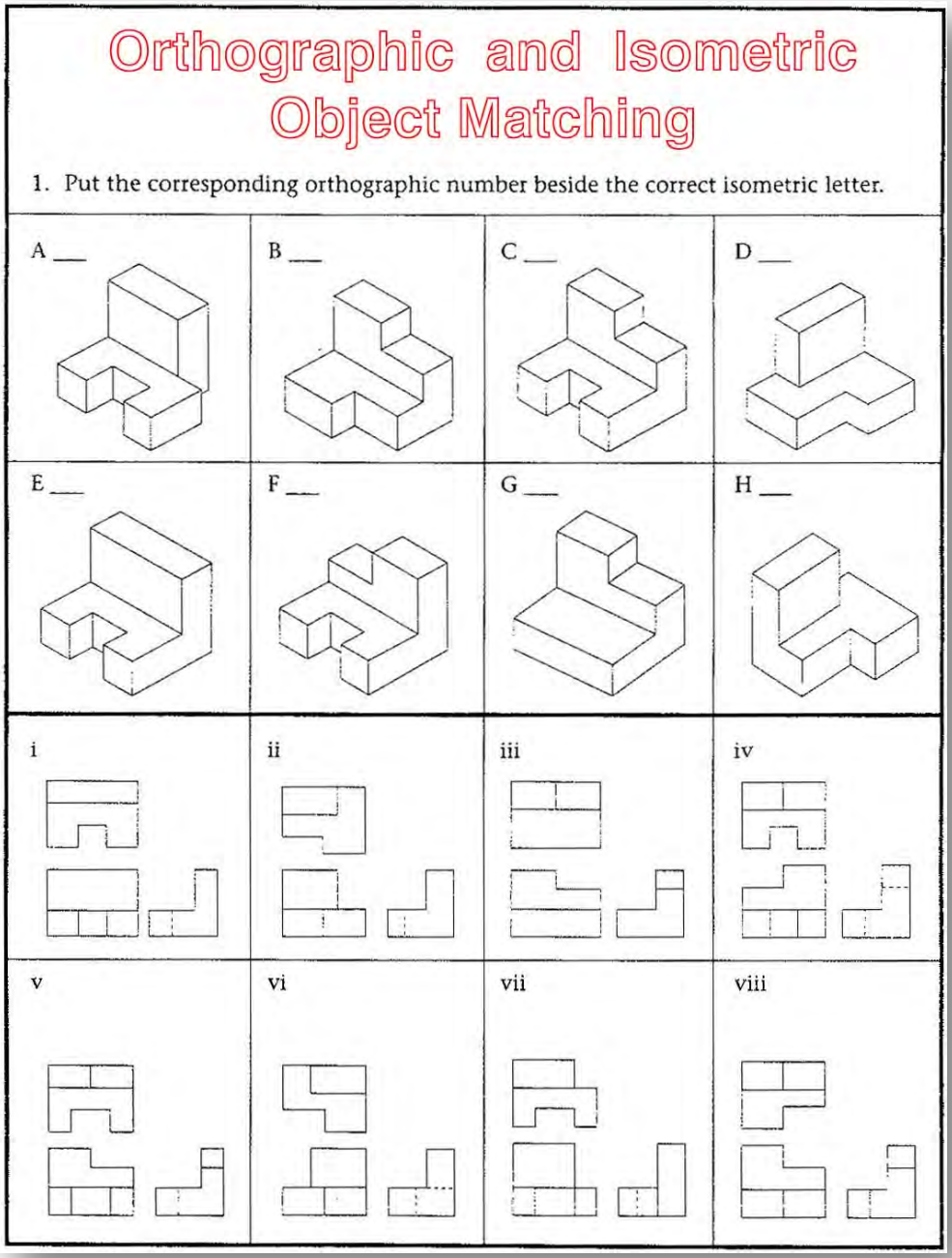
STUDENT SAMPLE - ORTHOGRAPHIC CUSTOM SKETCH



ORTHOGRAPHIC MATCHING QUIZ

Orthographic and Isometric Object Matching

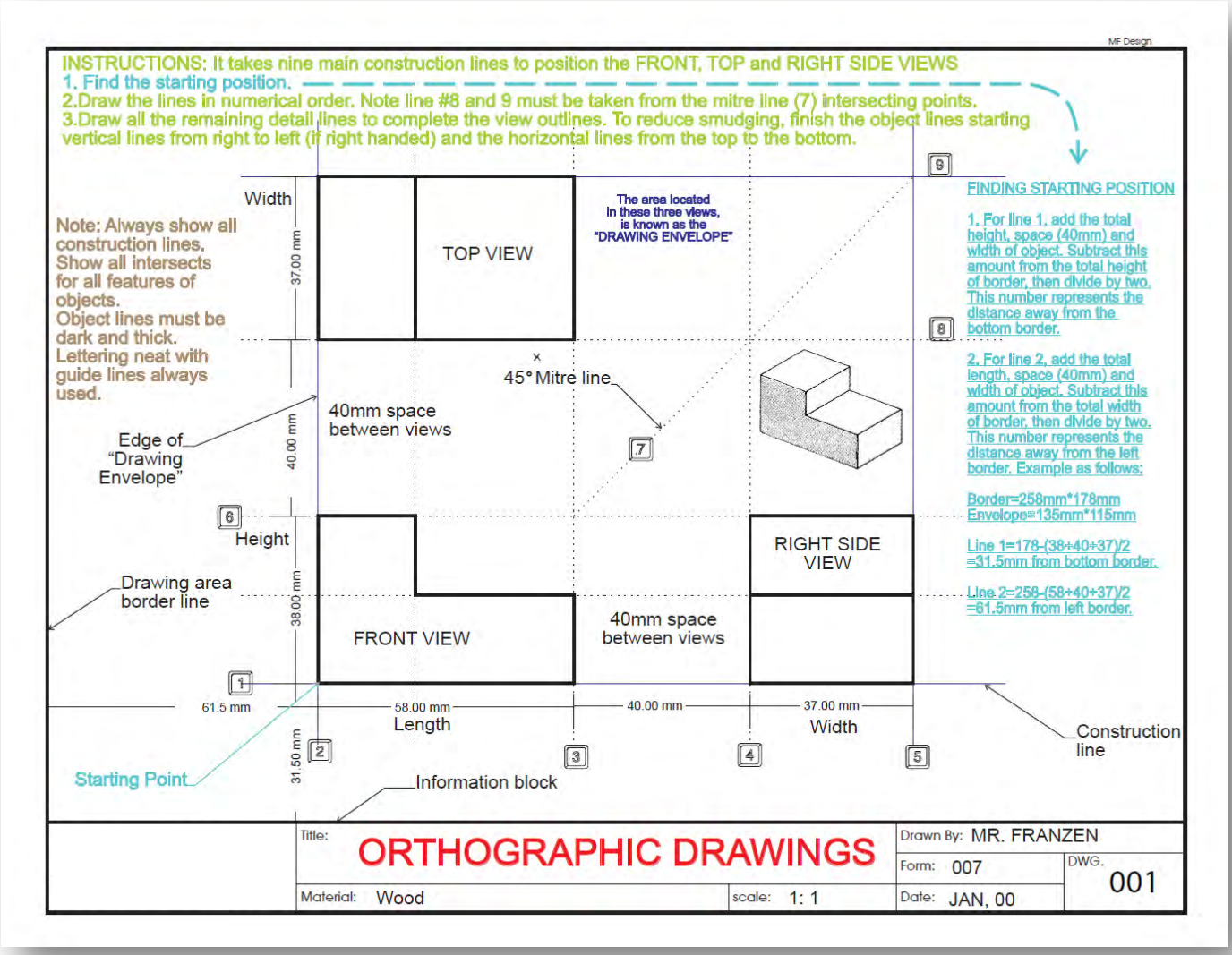
1. Put the corresponding orthographic number beside the correct isometric letter.



APPENDIX UL2-4

ORTHOGRAPHIC DRAWING SUPPORT (EXTRA)

This is an older support drawing for drafting, but is great to show students how objects were centred inside an information block when manual drafting was part of the Technical design program



APPENDIX UL2-5

RUBRIC FOR ORTHOGRAPHIC SKETCHING

A Rubric is an assessment tool to assess your level of success and how to improve to be successful.

Criteria	Level 1 (50-59%) Limited Success	Level 2 (60-69%) Some Success	Level 3 (70-79%) Considerable Success	Level 4 (80-100%) High degree of Success
Sketching Technique Sketching technique should be done freehand with no mechanical means. Lines and shapes should be made with crisp, clean, smooth	•Few or no straight lines are straight, clean crisp and sharp •Few or no curves and circular lines are smooth, clean, and crisp •Few or no Shapes are conformed, neat, and accurate	•Some straight lines are straight, clean crisp and sharp •Some curves and circular lines are smooth, clean, and crisp •Some Shapes are conformed, neat, and accurate	•Most straight lines are straight, clean crisp and sharp •Most curves and circular lines are smooth, clean, and crisp •Most Shapes are conformed, neat, and accurate	•All straight lines are straight, clean crisp and sharp •All curves and circular lines are smooth, clean, and crisp •All Shapes are conformed, neat, and accurate
Layout Construction and placement of views, spacing, blocking out view locations, using construction lines are all part of making a great layout.	•None of the object views are not spaced out correctly •Ortho object views and features do not line up and are different sizes •Using the wrong page orientation •Page space not used effectively	•Some object views are not spaced out properly •Some ortho object views and features line up and/or are relative to each other •Using the wrong page orientation •Some of the page space is used	•Most of the object views are spaced out evenly on page •Most of the ortho object views and features line up and are relative to each other •Using page orientation properly •Most of the page space is used	•Object views are spaced out evenly on page •Ortho object views and features line up and are relative to each other •Using page orientation properly •Page space is used effectively
Ortho Views Front view must be correctly selected based on the three rules and other views must fall suit to third angle projection. Views should be the right scale, and features must be	•Incorrect front view was identified •Views are not in their proper location and do not show the correct view orientation •Very few, or no view features are shown •All views are not appropriately	•Incorrect front view was identified •Some views are in their proper location and/or do not show the correct view orientation •Some features are shown correctly •Some views are appropriately	•Correct front view was identified •Most views are in their proper location and show the correct view orientation •Most view features are shown correctly •Most views are appropriately scaled and show	•Correct front view was identified •Views are in their proper location and show the correct view orientation •All view features are shown correctly •All views are appropriately scaled and show features clearly

Criteria	Level 1 (50-59%) Limited Success	Level 2 (60-69%) Some Success	Level 3 (70-79%) Considerable Success	Level 4 (80-100%) High degree of Success
relative to each other.	scaled and features difficult to see	scaled , features difficult to see	features clearly	
Line Work Each line type has its own characteristic and weight. Construction lines are to be light and left to show how object was built/drawn. Object lines must be dark and thick to show object views.	•Very few or no construction lines shown • Few or no line types have been drawn correctly – object, hidden, dimension, construction •Line types do not show the relative/proper line weights	•Some construction lines shown • Some line types have been drawn correctly –object, hidden, dimension, construction •Some line types show the relative/proper line weights	•Most construction lines show proper object build and layout process •Most line types needed, have been drawn correctly – object, hidden, dimension, construction •Most line types show the proper line weights	•Construction lines show proper object build and layout process •All proper line types needed, have been drawn correctly – object, hidden, dimension, construction •Line types show the relative/proper line weights
Dimensions Include overall and detail dimensions of object with dimensions shown inside the envelope and located closest to that features shown detail. Number of dimensions to be limited to as few as possible, but enough that it could be built.	•Few or no overall dimensions present •Few or no detail dimensions present •Few or no Dimensions were placed and spaced correctly •Not enough or too many dimensions are shown •Few or no extension and dimension lines are spaced out and drawn properly •Dimension arrows are thick & too big	•Some overall dimensions present •Some detail dimensions present •Some dimensions were placed and spaced correctly •Not quite enough or too many dimensions shown •Some extension and dimension lines are spaced out and drawn properly •Some dimension arrows are thin and neat	•Most overall dimensions present •Most detail dimensions present •Most dimensions were placed and spaced correctly •Almost the right amount of dimensions shown •Most extension and dimension lines are spaced out and drawn properly •Most dimension arrows are thin and neat	•All overall dimensions present •All detail dimensions present •All dimensions were placed and spaced correctly •Right amount of dimensions shown •All extension and dimension lines are spaced out and drawn properly •Dimension arrows are thin and neat
Isometric View Sketched view of object showing 3D view with 30° angles from base line and showing the most detail to the viewer.	•View chosen shows the least detail •Few or no lines are relatively 30 degrees or vertical •View and features are not scaled properly	•View chosen shows the some detail •Some lines are relatively 30 degrees or vertical •View and/or features are not scaled properly	•View chosen shows the most detail •Most lines are relatively 30 degrees or vertical •View and/or most of the features are scaled correctly	•View chosen shows the most detail •All lines are relatively 30 degrees or vertical •View and features are scaled correctly

RUBRIC FOR ORTHOGRAPHIC SKETCHING - SELF AND PEER TRACKING SHEET

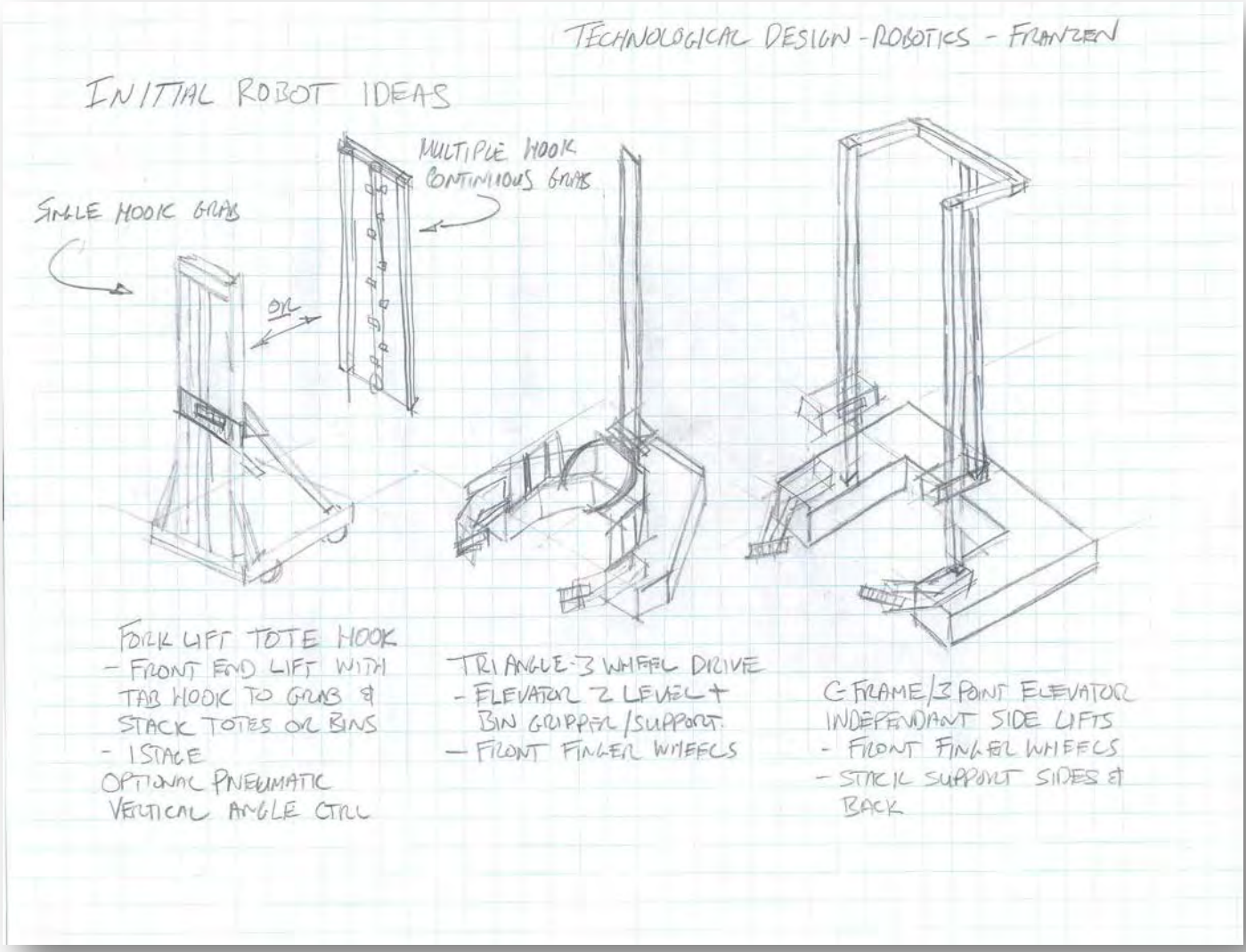
Neatly print assessor name, date, and then fill in the appropriate levels 1, 2, 3, 4 based on rubric chart.

Name (First name, last initial of assessor)									
Date (month, day, year)									
Sketching Technique									
Freehand line work, straight, crisp, clean, smooth curves, conformed shapes, and accurate									
Layout									
Construction, placement of views, spacing, blocking in views, and construction lines									
Orthographic Views									
Front view selected based on the three rules, third angle projection view placement, appropriate scaling and features relative to each other									
Line Work									
Proper line characteristics, weight, and type, construction lines still present showing process									
Dimensions									
Overall and detail, located inside drawing envelope, closest to feature, right amount of dimensions									
Isometric Views									
Correct 3D view at ~ 30°from base line showing most detail towards the viewer									
Over-all totals for each assessment									

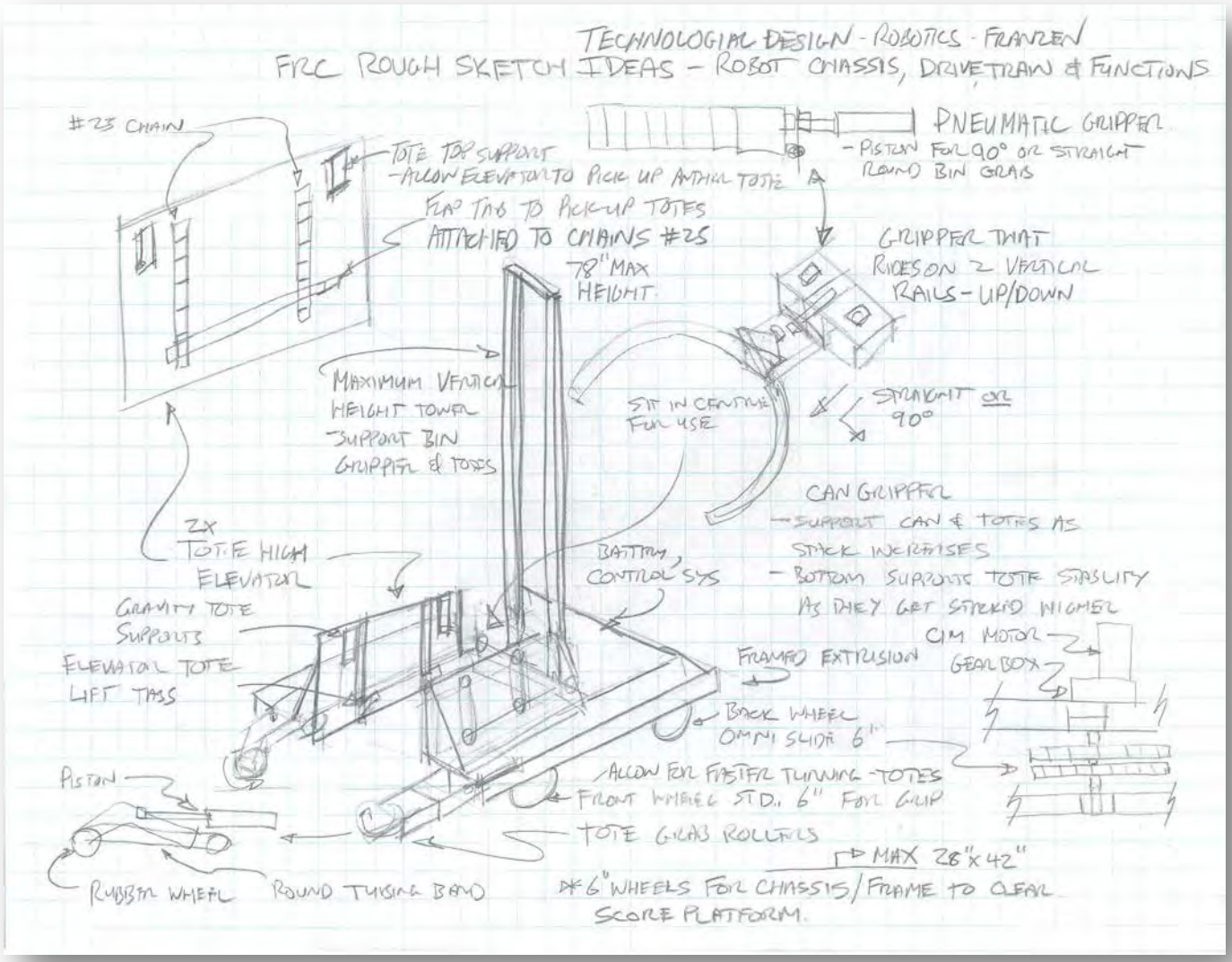
APPENDIX UL2-6

Some sketches showing preliminary ideas on robot design.

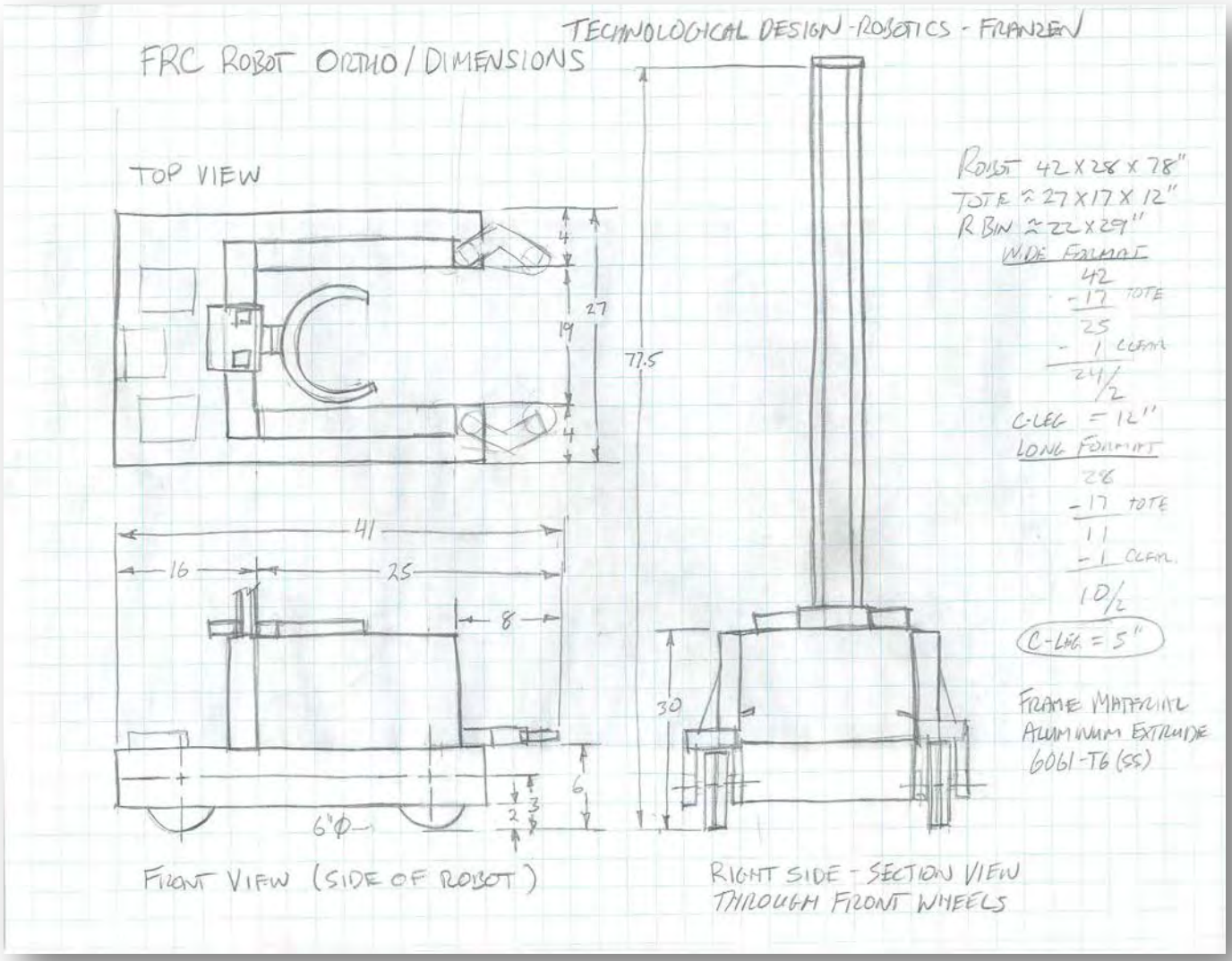
ROBOT SKETCHING INITIAL IDEAS



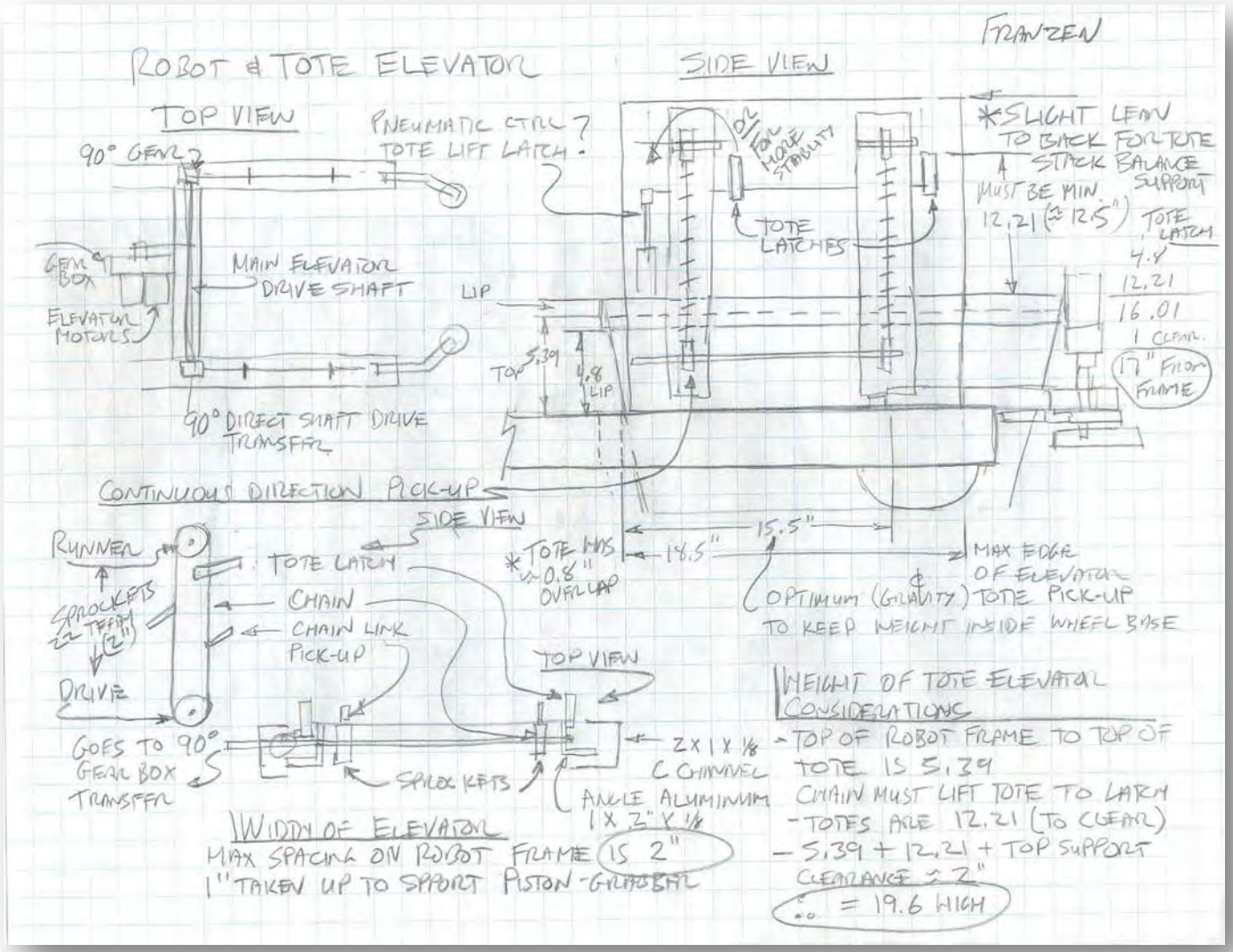
ROBOT SKETCHING DETAIL ROUGH IDEAS



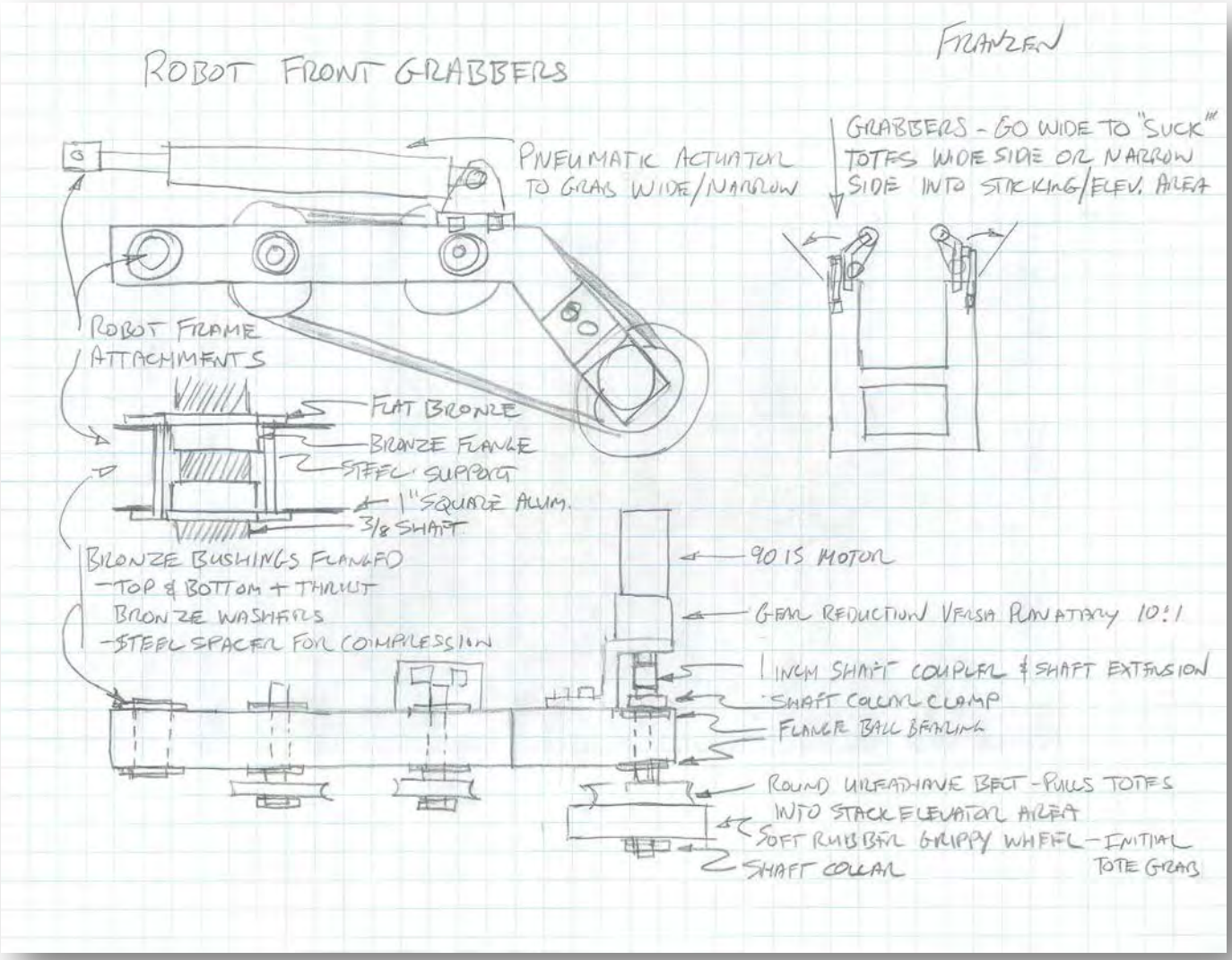
ROBOT SKETCHING ORTHOGRAPHIC



ROBOT SKETCHING ELEVATOR DESIGN



T ROBOT SKETCHING OTE GRABBER DESIGN



UNIT 6: ROBOT ASSEMBLY

Time: 4 Weeks

UNIT 6, DESCRIPTION: ROBOT ASSEMBLY

This unit focuses on finishing the robot assembly, creating ortho/ISO drawings, and a presentation 360 rotation animation.

Major assembly functions should be completed, and if not already done, will need to be added to robot. The instructor will review the steps to bring in sub-assemblies into the main robot assembly. Some sub-assemblies may need to be mirrored in some cases to represent the other side or mirrored function. Sub-assemblies that do need to be mirrored on the sample robot are the elevator and the tote grabber, as there is one on each side, similar to the drive train motor/gearbox assembly which was done some near the beginning of the robot model build. There will need to be fastening components brought in to show how each of the major function assemblies is attached to the robot. For example the elevator has six quarter-twenty bolts, washers, and nylon-insert locknuts through the deck of the robot to secure it to the base of the robot.

The function supports section is all about making sure all of the functions that were put into the model are working together to support your robots functioning tasks effectively. Review with students, additional function supports that need to be completed for this robot to reasonably solid strength and function wise. For some examples:

- The tower and elevators need additional strengthening on top, so an upper frame needs to be built and added to main assembly to support both

- Additional frame strengthening brackets at the middle of the robot are needed to ensure the C shape frame support around the tote/elevator chamber is strong enough to support the rest of the robot and prevent a disastrous bend or break from an unintentional impact.

Ensure students make an effort to have mechanical moving joints working as best as possible to show or prototype their movements in relation to the rest of the robot design. The belly pan which houses all of the electronics, battery, and motor controls should be one of the last things added as its priority can be flexible and be fitted with what space is left on the robot design. Students need to understand that some components are more flexible in location and space needs as the robot goes through several iterations, this space and shape may change to support other high-priority designs. By waiting till now you can safely using current space without the danger of having to relocate, resize, or redesign the belly pan. As with similar reasoning as above, students can now go back to their frame components and lighten up parts carefully using patterned cut extrudes to safety remove material, being careful to keep intended strength maximized.

Once the robot is fully complete, drawings can be started. Students will have a demonstration of the steps to take to select a standard sized sheet. Sample robot drawings were done on an ANSI A3 size, to allow for a larger scale and more room for details and dimensions to be shown. Students are shown the difference between sheet format and templates and bringing in assemblies using the standard ortho/ISO third-angle projection placement process. Students

are shown how to add and edit dimensions, setting standards in the options - configuration window, and made aware to ensure all overall and some of the key features or details of that assembly are dimensioned.

Instructor will demonstrate how to make a basic 360 model rotation through the lower animation tab by rotating the model around the z axis and how to save it to an AVI video file. Codecs, frames per second, speed of rotation, size of window are all factors on the quality, smoothness, and file size relations that can be discussed. Have students animate their robot by doing a simple 360 rotation about the y axis to show off their completed robot. Students can save their video and upload it to their YouTube account for public viewing and link to their digital portfolio for later. Students are asked to save both the final model and the drawing files to eDrawing format, for free dynamic viewing without the application software. Students should already have been updating their project management sheets as they go through the project and should be reminded to do any final updates before submitting and including in their post report.

The priority here is to finish the sample robot, drawing files, and animations and complete a post report on their process throughout the project. Part of the report will be to research a variety of FRC robot graphic-image-formatted designs with principles of design characteristics and apply it to their report noting the connections with elements and principles of design. Students will also use this post report for their web portfolio in the next unit. If time permits students can now finish their custom robot model, drawings, and animations following the same process. Only one post report is necessary. If they have finished both the sample and their custom robot, then the post report should focus on the custom robot with the sample robot as a secondary supporting task.

UNIT 6, TABLE OVERVIEW: ROBOT ASSEMBLY

Activity #	Activity Title/Name	Learning Expectations Overall/Specific	Assessment Categories	Tasks
6.1	Robot assembly build	• B2	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Robot assemble design - REV • Assemble sub-assemblies - HOA • Mirror components tool – HOA • Custom Assembly - HOA
6.2	Functions Integration	• A1, A4, B1, B3, D2.5	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Robot function support designs - note • Ensure working prototype of joints in model– HOA • Upper tower/elevator frame support - HOA • Belly pan and components assembly - HOA • C-frame support brackets – HOA • Custom assembly supports - HOA
6.3	Drawings	• A3, B2	• Communication • Knowledge /	• Drawing files for all major assembled functions and

			Understanding • Thinking / Inquiry • Application	components in the form of ortho/ISO with dimensions - HOA • Custom robot drawings – HOA
6.4	Presentation	• A2, A3.1, A5, B4, B4.1, B4.2	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application	• Basic model animation - HOA • Update project management sheets - ASS • Summary post wrap-up - RPT

UNIT 6, ACTIVITIES 1-4

ACTIVITY 6-1: ROBOT ASSEMBLY BUILD

Time: 3 Days

DESCRIPTION

Students finished most of their functional assemblies in unit 5 and adopted a lot of program process learning reinforcement. As such, major assembly functions should be completed, and if not already done, will need to be added to robot. The instructor will review the steps to bring in sub-assemblies into the main robot assembly. Some sub-assemblies may need to be mirrored in some cases to represent the other side or mirrored function. Sub-assemblies that do need to be mirrored on the sample robot are the elevator and the tote grabber, as there is one on each side, similar to the drive train motor/gearbox assembly which was done some near the beginning of the robot model build. There will need to be fastening components brought in to show how each of the major function assemblies is attached to the robot. For example the elevator has six quarter-twenty bolts, washers, and nylon-insert locknuts through the deck of the robot to secure it to the base of the robot.

* Custom robot is worked on after sample robot is finished (time permitting)

STRANDS & LEARNING EXPECTATIONS

Strand(s): A ➔Technology Design Fundamentals / B ➔ Technology Design Skills / C ➔Technology, the Environment, and Society / D ➔Professional Practice and Career Opportunities

OVERALL EXPECTATIONS

By the end of this course, students will:

- A B2. apply appropriate methods for generating and graphically representing design ideas and solutions;

SPECIFIC EXPECTATIONS

By the end of this course, students will:

- Not directly relevant here.

PRIOR KNOWLEDGE & SKILLS

A basic understanding of assemblies and characteristics:

Have had practice with

- Part placement and constraining
- Hole wizard tool and referenced holes
- Building assemblies
- Placing parts in assemblies
- Constraining parts in assemblies
- Saving assemblies

PLANNING NOTES

- Have students buddy up to ensure they can share ideas about their assembly build process and maximize the learning experience
- Discuss master assemblies and sub-assembly interaction
- Assembly file naming suggestions before bringing into master assembly
- Ensure students have completed their assemblies and there are no errors or warnings
- Remind students that they are updating their project management sheets continually
- Prepared to assist with assembly errors or warnings
- Review constraints and mating techniques

Skills and learning to focus on:

- Assembly placement constraint locations – design intent
- Assembly function mechanical connections
- Troubleshooting assembly errors and warnings
- Assembly rigid or flexible awareness concerns
- Mirroring assembly process

TEACHING/LEARNING STRATEGIES

- Discussion – an exchange of information dialog between two parties
- Demonstration – direct instruction to model a process, how something works , or an example of concept
- Buddy System – links students for peer support
- Class Discussion – students actively participate by taking turns discussing current tasks and/or issues
- Collaborative and Co-operative Learning – small group learning providing high levels of student engagement, interdependence, and group support
- Conferencing/Discussion – student-to-student discussion and teacher-to-student discussion to encourage confidence and motivation to be successful
- Homework – an extension of class work, support, time extension and material review

ASSESSMENT & EVALUATION OF STUDENT ACHIEVEMENT

Students will be assessed here to get feedback on how their robot assembly is coming together. The addition of sub-assemblies, their constraints, mirroring when needed and mechanical joints will be looked at. Below is a chart listing the breakdown of the assessments.

*Repeat process for last two row assessment in chart for custom robot after sample is done.

Task/Product	Tool	Purpose	Assessment Categories
Bringing all your major components together	• Class guided discussion	Diagnostic	Observation only
Assemblies and mirroring	• Class Post-demonstration discussion	Diagnostic	Observation only
Observation on robot assembly process	• Anecdotal comments/notes	Formative	• Knowledge / Understanding • Thinking / Inquiry • Application
*Sub-assemblies correctly placed, mated, and mechanically attached appropriately	• Peer review • Weighted check list by peer • One-on-one marking	Formative	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application
*Master assembly correctly completed and fully defined	• Weighted Check list	Formative	• Knowledge / Understanding • Thinking / Inquiry • Application

ACCOMMODATIONS

The teacher consults individual student IEPs for specific direction on accommodation and adapts the activity and teaching strategies to meet the needs of individual students. Students' individual needs may be accommodated through an adaptation of the design and/or production stages of the activity.

- Students may need more time especially if they have sub-assembly errors
- Observation - after demonstrating in class, discussion, walk around the class for direct and immediate feedback to see how everyone is doing, if they need some more support in anyway
- Mark work in class, in front of individual students giving them direct feedback – examples, repeat live demo if needed and do a comparison, and/or give more specific details for understanding, as the teacher reviews the students' work
- Giving students the option of redoing work if needed, to improve mark after peer evaluating
- Live demonstration lesson allowing students to focus, watch the instructor go through the major steps scaffolding the process such as fixing errors or warnings, sub-assembly placement, adding mechanical connections, mirroring sub-assembly, and tips on common challenges that students may run into
- Record demonstration for later viewing and/or refer them to specific web site resources, videos, etc.
- Buddy up students so they can cooperatively work together on their own projects assisting and supporting each other through certain challenges they may have

- Top level students can be used for additional mentor support

RESOURCES

Resources here focus on supporting two major processes – master assembly and sub-assemblies interacting with each other and mirroring whole assemblies.

GENERAL

Equipment and tools required to complete the activity include:

- Pen, pencil, eraser, calculator
- Computer
- Network access
- Design notes and sketches on robot design
- Excel
- SolidWorks

BOOKS

- Part and Assembly Modeling with SolidWorks 2014, page 86
  https://dl.dropboxusercontent.com/u/42872562/SWG2014/SWG2014.pdf
- Basic Sketching and Assembly P22 http://www.andrew.cmu.edu/user/shc17/DesignI/Notes---Intro_to_SolidWorks.pdf

VIDEOS

- Sample robot 360 animation https://www.youtube.com/watch?v=EK77quNgweo
- Section 3.1 Shaft Assembly https://www.youtube.com/watch?v=lxpprQE6lhE
- Section 3.2 Universal Joint https://www.youtube.com/watch?v=pMjdAD88JVU
- Section 3.3 Clamp https://www.youtube.com/watch?v=nII48lPCx_A
- Mirror Components at the Assembly Level https://www.youtube.com/watch?v=Mh_oCj4UbZE
- Flexible Sub-Assemblies https://www.youtube.com/watch?v=n9hbOqNiFBw
- Assembly Tips https://www.youtube.com/watch?v=evtNMDHWZAE

MAGAZINES

- Cadalyst magazine archives and subscriber resources http://www.cadalyst.com/cadalyst-magazine-0
- Compass magazine http://compassmag.3ds.com/

WEBSITES

- Part and Assembly Modeling with SolidWorks 2014
  http://myweb.ncku.edu.tw/~hhlee/Myweb_at_NCKU/SWG2014.html
- SolidWorks 3D solutions https://www.solidworks.com/sw/resources/solidworks-tutorials.htm
- SolidWorks Online Help
  http://help.solidworks.com/2014/English/SolidWorks/sldworks/c_introduction_toplevel_topic.htm

ACTIVITY 6-2: FUNCTION SUPPORTS

Time: 7 Days

DESCRIPTION

At this point students should have mastered all course materials and process and will now be working towards their summative marks for the next three weeks.

The function supports section is all about making sure all of the functions that were put into the model are working together to support your robots functioning tasks effectively. Review with students, additional function supports that need to be completed for this robot to reasonably solid strength and function wise. For some examples:

- The tower and elevators need additional strengthening on top, so an upper frame needs to be built and added to main assembly to support both

- Additional frame strengthening brackets at the middle of the robot are needed to ensure the C shape frame support around the tote/elevator chamber is strong enough to support the rest of the robot and prevent a disastrous bend or break from an unintentional impact.

Students should be reminded to update their project management sheets for this project. Ensure students make an effort to have mechanical moving joints working as best as possible to show or prototype their movements in relation to the rest of the robot design. The belly pan which houses all of the electronics, battery, and motor controls should be one of the last things added as its priority can be flexible and be fitted with what space is left on the robot design. Students need to understand that some components are more flexible in location and space needs as the robot goes through several iterations, this space and shape may change to support other high-priority designs. By waiting till now you can safely using current space without the danger of having to relocate, resize, or redesign the belly pan. As with similar reasoning as above, students can now go back to their frame components and lighten up parts carefully using patterned cut extrudes to safety remove material, being careful to keep intended strength maximized.

* Custom robot is worked on after sample robot is finished (time permitting).

STRANDS & LEARNING EXPECTATIONS

Strand(s): **A** ➔Technology Design Fundamentals / **B** ➔ Technology Design Skills / **C** ➔Technology, the Environment, and Society / **D** ➔Professional Practice and Career Opportunities

OVERALL EXPECTATIONS

By the end of this course, students will:

- A1. demonstrate an understanding of factors and relationships that affect technological design and the design process;
- A2. describe appropriate strategies, techniques, and tools for researching, organizing, planning, and managing design projects and related activities, with an emphasis on financial, human, and material resources;

- A4. demonstrate an understanding of a variety of tools, materials, equipment, and processes used to build, test, and evaluate models and prototypes;
- B1. use appropriate strategies and tools to research and manage design projects and related activities;
- B3. create and test models and/or prototypes, using a variety of techniques, tools, and materials;

SPECIFIC EXPECTATIONS

By the end of this course, students will:

- D2.5 demonstrate an understanding of and apply the Essential Skills that are important for success in the technological design industry, as identified in the Ontario Skills Passport (e.g., reading text, writing, document use, measurement and calculation);

PRIOR KNOWLEDGE & SKILLS

A basic understanding of the robots functions and their operation:

Have had practice with

- Making parts
- Making weldments
- Making sheet metal parts
- Placing fasteners
- Referenced geometry
- Referenced planes
- Part placement and mating
- Working with Excel
- Project management entries
- Assembling parts from manufactures
- Building assemblies
- Placing parts in assemblies
- Constraining parts in assemblies
- Saving assemblies

PLANNING NOTES

- Have students buddy up to ensure they can share ideas about their functional support mechanisms and assemblies to maximize the learning experience
- Discuss how sub-assembly functions interact with master assembly drive train
- Stabilizing and supporting function robot design and functions
- Ensure students are updating their project management sheets continually
- Upper tower/elevator design, build and sub-assembly placement
- Belly pan design, build, and placement – must be light weight and support all electronic hardware
- C-frame brackets to strengthen the frame around the tote chamber
- Removing unnecessary materials to lighten components without weakening structure of robot

Skills and learning to focus on:

- Understanding why we need extra support in key areas of the robot
- Prioritizing which functions, components, and processes need to be done first or last and why

- File size, computer power, and speed of application
- Setting flexible assemblies ridged or mating for alignment for drawings
- Using flexible mates to prototype movements
- Patterned holes – using fillets for strength
- eDrawing export

TEACHING/LEARNING STRATEGIES

- Socratic Lesson – oral presentation of information and process by the teacher
- Demonstration – direct instruction to model a process, how something works , or an example of concept
- Buddy System – links students for peer support
- Class Discussion – students actively participate by taking turns discussing current tasks and/or issues
- Collaborative and Co-operative Learning – small group learning providing high levels of student engagement, interdependence, and group support

ASSESSMENT & EVALUATION OF STUDENT ACHIEVEMENT

Students will be assessed here to get feedback on how their robot assembly is coming together. The addition of sub-assemblies, their constraints, mirroring when needed and mechanical joints will be looked at. Below is a chart listing the breakdown of the assessments. This part of the project will be counted towards their summative project mark.

*Repeat process for last two row assessment in chart for custom robot after sample is done.

Task/Product	Tool	Purpose	Assessment Categories
Functional design and completing the robot	• Class guided discussion	Diagnostic	Observation only
Adding sub-assemblies and parts, taking away material, to refine design	• Class post-demonstration discussion	Diagnostic	Observation only
Observation on function support design and model process	• Anecdotal comments/notes	Formative	• Knowledge / Understanding • Thinking / Inquiry • Application
*Support sub-assemblies and parts created and placed properly	• Peer review • Weighted check list by peer • One-on-one marking	Formative	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application
*Master assembly correctly completed and fully defined	• Weighted check list	Summative	• Knowledge / Understanding • Thinking / Inquiry • Application

ACCOMMODATIONS

The teacher consults individual student IEPs for specific direction on accommodation and adapts the activity and teaching strategies to meet the needs of individual students. Students' individual needs may be accommodated through an adaptation of the design and/or production stages of the activity.

- Students may need more time especially if they are still having problems with design or adding more parts and required assemblies
- Observation - after demonstrating in class, think pair share, discussion, walk around the class for direct and immediate feedback to see how everyone is doing, if they need some more support in anyway
- Mark work in class, in front of individual students giving them direct feedback – examples, repeat live demo if needed and do a comparison, and/or give more specific details for understanding, as the teacher reviews the students' work
- Live demo lesson allowing students to focus, watch the instructor go through the major steps scaffolding the steps to create support functions, extra needed parts and assemblies, and give tips on common challenges students may run into
- Buddy up students so they can cooperatively work together on their own projects assisting and supporting each other through certain challenges they may have
- Top level students can be used for additional mentor support

RESOURCES

Resources here focus on similar ones as in 6-1 because of the similar processes with the addition of functional design.

GENERAL

Equipment and tools required to complete the activity include:

- Pen, pencil, eraser, calculator
- Computer
- Network access
- Design notes and sketches on robot design
- Excel
- SolidWorks

BOOKS

- Mechanical Design of Machine Elements and Machines https://books.google.ca/books?id=909-5C4eyUkC&printsec=frontcover#v=onepage&q&f=false
- Mechanical engineering principles http://www.slideshare.net/goldenakos/mechanical-engineering-principles
- Engineering mechanics-by-timoshenko http://www.slideshare.net/Nuumero1/engineering-mechanicsbytimoshenko?related=2
- Strength of materials by s k mondal http://www.slideshare.net/shubhrasaxena37/strength-of-materials-by-s-k-mondal
- Part and Assembly Modeling with SolidWorks 2014, page 86 https://dl.dropboxusercontent.com/u/42872562/SWG2014/SWG2014.pdf
- Basic Sketching and Assembly P22 http://www.andrew.cmu.edu/user/shc17/DesignI/Notes---Intro_to_SolidWorks.pdf

VIDEOS

- Sample robot 360 animation https://www.youtube.com/watch?v=EK77quNgweo

- Section 3.1 Shaft Assembly https://www.youtube.com/watch?v=lxpprQE6lhE
- Section 3.2 Universal Joint https://www.youtube.com/watch?v=pMjdAD88JVU
- Section 3.3 Clamp https://www.youtube.com/watch?v=nII48lPCx_A
- Mirror Components at the Assembly Level https://www.youtube.com/watch?v=Mh_oCj4UbZE
- Flexible Sub-Assemblies https://www.youtube.com/watch?v=n9hbOqNiFBw
- Assembly Tips https://www.youtube.com/watch?v=evtNMDHWZAE

MAGAZINES

- Cadalyst magazine archives and subscriber resources http://www.cadalyst.com/cadalyst-magazine-0
- Compass magazine http://compassmag.3ds.com/

WEBSITES

- Part and Assembly Modeling with SolidWorks 2014 http://myweb.ncku.edu.tw/~hhlee/Myweb_at_NCKU/SWG2014.html
- SolidWorks 3D solutions https://www.solidworks.com/sw/resources/solidworks-tutorials.htm
- SolidWorks Online Help http://help.solidworks.com/2014/English/SolidWorks/sldworks/c_introduction_toplevel_topic.htm

ACTIVITY 6-3: DRAWINGS

Time: 5 Days

DESCRIPTION

Students will have a demonstration of the steps to take to select a standard sized sheet. Sample robot drawings were done on an ANSI A3 size, to allow for a larger scale and more room for details and dimensions to be shown. Students are shown the difference between sheet format and templates and bringing in assemblies using the standard ortho/ISO third-angle projection placement process. Students are shown how to add and edit dimensions, setting standards in the options - configuration window, and made aware to ensure all overall and some of the key features or details of that assembly are dimensioned.

* Custom robot is worked on after sample robot is finished (time permitting)

STRANDS & LEARNING EXPECTATIONS

Strand(s): **A** ➔Technology Design Fundamentals / **B** ➔ Technology Design Skills / **C** ➔Technology, the Environment, and Society / **D** ➔Professional Practice and Career Opportunities

OVERALL EXPECTATIONS

By the end of this course, students will:

- A3. demonstrate an understanding of drafting standards, conventions, and guidelines for various types of drawings used to represent designs;
- B2. apply appropriate methods for generating and graphically representing design ideas and solutions;

SPECIFIC EXPECTATIONS

By the end of this course, students will:

- Not directly relevant here.

PRIOR KNOWLEDGE & SKILLS

Students should know their orthographic/isometric drawing principles and dimension placement techniques and standards.

Have had practice with

- Orthographic views
- Dimensioning overall and detail dimensions
- Dimensioning features on view most relevant
- Familiar with assemblies and components completed
- SolidWorks basic interface and layout

PLANNING NOTES

- Have students buddy up to ensure they can share ideas about their drawings and reinforce the learning experience
- Review orthographic view placement and dimensioning
- Drafting standards, conventions and guidelines for drawings
- Dimensioning requirements in an assembly – all overall and key detail dimensioning
- Sheet format and template options and the difference between the two
- Filling out the information block
- Placing views in relation to dimensions
- Scaling views appropriately to space available
- Adjusting view states for different views
- Excel sheets, formula, and text entries

Skills and learning to focus on:

- Sheet size, scale, and format
- Object view placements
- Space and dimension considerations
- Configuring views
- Scaling views
- Dimension standards and configurations
- Grid use, smart dimension tool, and dimension placement
- Editing dimensions
- Centre lines and centre marks
- Which dimensions to include
- Individual sheets or sheet-sets
- Renaming individual sheets in sheet set
- Annotations
- eDrawing export

TEACHING/LEARNING STRATEGIES

- Demonstration – direct instruction to model a process, how something works , or an example of concept
- Buddy System – links students for peer support
- Class Discussion – students actively participate by taking turns discussing current tasks and/or issues
- Collaborative and Co-operative Learning – small group learning providing high levels of student engagement, interdependence, and group support

ASSESSMENT & EVALUATION OF STUDENT ACHIEVEMENT

Students will be assessed here to get feedback on how their robot drawings are doing. Several things will be looked at such as sheet format, standards, and configurations, sheet size and format, view placements, scaling, view types, all overall and key detail dimensions properly placed, and use of annotations where needed. Below is a chart listing the breakdown of the assessments. This part of the project will be counted towards their summative project mark.

*Repeat process for last two row assessment in chart for custom robot after sample is done.

Task/Product	Tool	Purpose	Assessment Categories
Ortho/ISO view placement and dimensions	• Class discussion	Diagnostic	Observation only
Drawing creation post discussion	• Class post-demonstration discussion	Diagnostic	Observation only
Observation on student drawing process	• Anecdotal comments/notes	Formative	• Knowledge / Understanding • Thinking / Inquiry • Application
*Sheet set-up, standards, info block, view placements, scale, and dimensions	• Peer review • Weighted check list by peer • One-on-one marking	Formative	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application
*Finished sheets, set-up, info block, view placements, scale and dimensions	• Weighted	Summative	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application

ACCOMMODATIONS

The teacher consults individual student IEPs for specific direction on accommodation and adapts the activity and teaching strategies to meet the needs of individual students. Students' individual needs may be accommodated through an adaptation of the design and/or production stages of the activity.

- Students may need more time
- Observation - after demonstrating in class, think pair share, discussion, walk around the class for direct and immediate feedback to see how everyone is doing, if they need some more support in anyway
- Live demo lesson allowing students to focus, watch the instructor go through the major steps scaffolding the steps to creating drawing sheets, information block fill-in, view placement, view configurations, scaling dimensioning, and give tips on common challenges that students may run into
- Buddy up students so they can cooperatively work together on their own projects assisting and supporting each other through certain challenges they may have
- Top level students can be used for additional mentor support

RESOURCES

Resources here focus on the creation of drawing parts, assemblies, dimensions, templates, sheet management, and tips.

GENERAL

Equipment and tools required to complete the activity include:

- Pen, pencil, eraser, calculator
- Computer
- Network access
- Design notes and sketches on robot design
- Excel
- SolidWorks

BOOKS

- Introduction to SolidWorks, Page 118 http://www.scribd.com/doc/176131537/Introduction-to-SolidWorks?post_id=501239105_10151922694179106#_=_
- Introducing SolidWorks, Page 4-1 http://www.eng.uwo.ca/designcentre/CAD%20resources/Introduction_to_SolidWorks.pdf
- Drawing and Detailing with SolidWorks 2014 http://books.google.ca/books?id=ik25AgAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

VIDEOS

- Part Drawings https://www.youtube.com/watch?v=RrRnDE3Oazo
- Assembly Drawings https://www.youtube.com/watch?v=xZPoWpl_KRE
- Inserting Model Dimensions into a Drawing: https://www.youtube.com/watch?v=i7cSkw2khhU
- Creating a Simple Drawing https://www.youtube.com/watch?v=cpwvqZ8TJao
- Dimension a Drawing https://www.youtube.com/watch?v=WEkF8oINyKY
- Drawing Template https://www.youtube.com/watch?v=zheRAkyVYts
- Drawings and drawing templates https://www.youtube.com/watch?v=_oi29H05ILc
- Title Blocks in 10 Minutes https://www.youtube.com/watch?v=1wpGtFdBKAs
- drawings basic https://www.youtube.com/watch?v=WmbzMPwZ8ZE
- Drawings in SolidWorks https://www.youtube.com/watch?v=1ivAEisPrXI
- Managing Drawing Sheets https://www.youtube.com/watch?v=XBAq1rZDEJo
- Drawing Tips 1 https://www.youtube.com/watch?v=eJ0IbI_Yr3o
- Drawing Tips 2 https://www.youtube.com/watch?v=T7Dl9BaGNyY

MAGAZINES

- Cadalyst magazine archives and subscriber resources http://www.cadalyst.com/cadalyst-magazine-0
- Compass magazine http://compassmag.3ds.com/

WEBSITES

- Part and Assembly Modeling with SolidWorks 2014 http://myweb.ncku.edu.tw/~hhlee/Myweb_at_NCKU/SWG2014.html
- SolidWorks 3D solutions https://www.solidworks.com/sw/resources/solidworks-tutorials.htm
- SolidWorks Online Help http://help.solidworks.com/2014/English/SolidWorks/sldworks/c_introduction_toplevel_topic.htm

ACTIVITY 6-4: PRESENTATION

Time: 5 Days

DESCRIPTION

Instructor will demonstrate how to make a basic 360 model rotation through the lower animation tab by rotating the model around the z axis and how to save it to an AVI video file. Codecs, frames per second, speed of rotation, size of window are all factors on the quality, smoothness, and file size relations that can be discussed. Have students animate their robot by doing a simple 360 rotation about the y axis to show off their completed robot. Students can save their video and upload it to their YouTube account for public viewing and link to their digital portfolio for later. Students are asked to save both the final model and the drawing files to eDrawing format, for free dynamic viewing without the application software. Students should already have been updating their project management sheets as they go through the project and should be reminded to do any final updates before submitting and including in their post report.

The priority here is to finish the sample robot, drawing files, and animations and complete a post report on their process throughout the project. Part of the report will be to research a variety of FRC robot graphic-image-formatted designs with principles of design characteristics and apply it to their report noting the connections with elements and principles of design. Students will also use this post report for their web portfolio in the next unit. If time permits students can now finish their custom robot model, drawings, and animations following the same process. Only one post report is necessary. If they have finished both the sample and their custom robot, then the post report should focus on the custom robot with the sample robot as a secondary supporting task.

* Custom robot is worked on after sample robot is finished (time permitting).

STRANDS & LEARNING EXPECTATIONS

Strand(s): A ➔Technology Design Fundamentals / B ➔ Technology Design Skills / C ➔Technology, the Environment, and Society / D ➔Professional Practice and Career Opportunities

OVERALL EXPECTATIONS

By the end of this course, students will:

- A2. describe appropriate strategies, techniques, and tools for researching, organizing, planning, and managing design projects and related activities, with an emphasis on financial, human, and material resources;
- A5. use appropriate terminology and communication methods to document, report, and present progress and results.
- B4. use a variety of formats and tools to create and present reports summarizing the design process and to reflect on decisions made during the process.

SPECIFIC EXPECTATIONS

By the end of this course, students will:

- A3.1 identify and describe different methods for representing design ideas graphically (e.g., mind maps, sketches, design layouts, computer-aided drafting), with reference to principles and elements of graphic design (e.g., principles: gradation, emphasis, pattern, balance; elements: space, shape, size, value);
- B4.1 create and present reports summarizing design choices and the steps taken in the design process, using a variety of formats and tools (e.g., word processor, presentation software, interactive white board, web pages);
- B4.2 report and reflect on decisions made throughout the design process, using a variety of oral and/or written formats.

PRIOR KNOWLEDGE & SKILLS

Completed a FIRST FRC robot model and a set of assembly drawings:

Have had practice with

- Conversion, editing, and displaying images in different formats
- Exploding a part, saving video animation
- Excel table and content information transfer
- Post report writing and presenting requirements and process
- Uploading videos to YouTube

PLANNING NOTES

- Have students buddy up to so they can share ideas about their report process and support report creation process
- Camera set-up and animating your robot model along the y axis
- Speed, frames per second, codec, standard window sizes, and file size
- Posting to YouTube for sharing
- Project management sheets are due
- Discuss report requirements, methods, variety of formats, report tools, and process
- Use of terminology, images, and reflections in reporting process
- Listing different ways ideas can be represented graphically in relation to principles an elements of design

Skills and learning to focus on:

- Animation tab
- Camera set-up
- Setting parameters to create a 360 rotation view
- Saving animation to an video file

TEACHING/LEARNING STRATEGIES

- Demonstration – direct instruction to model a process, how something works , or an example of concept
- Class Discussion – students actively participate by taking turns discussing current tasks and/or issues
- Buddy System – links students for peer support

ASSESSMENT & EVALUATION OF STUDENT ACHIEVEMENT

Students will be assessed here to get feedback on how their report is coming together. Students need to complete a 360 degree animation and post on YouTube for sharing. They will also create a post report on their robot build process

from start to finish including their drawings. Below is a chart listing the breakdown of the assessments. Students with completed custom robot model done with drawings will include sample robot, but focus on their custom robot.

*Repeat process for last two row assessments in chart for custom robot after sample is done.

Task/Product	Tool	Purpose	Assessment Categories
Report requirements and 360 º animation	• Class post-demonstration discussion	Diagnostic	Observation only
Observation on animation and report process	• Anecdotal comments/notes	Formative	• Knowledge / Understanding • Thinking / Inquiry • Application
Robot post report	• Self-review • Check list	Formative	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application
Project management Excel sheets updated and complete	• Self-review • Check list	Formative	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application
*360 degree robot model animation	• Subjective and completion	Summative	• Knowledge / Understanding • Application
Project management Excel sheets filled out and up-to-date	• Check list	Summative	• Communication • Knowledge / Understanding • Thinking / Inquiry • Application
*Presented animation and required post robot model report	• Weighted Check list	Summative	• Communication • Knowledge / Understanding • Thinking / Inquiry

ACCOMMODATIONS

The teacher consults individual student IEPs for specific direction on accommodation and adapts the activity and teaching strategies to meet the needs of individual students. Students' individual needs may be accommodated through an adaptation of the design and/or production stages of the activity.

- Students may need more time which can run into the next unit (use part of their term work time)
- Live demo lesson allowing students to focus, watch the instructor go through the major steps scaffolding the process creating a 360 degree robot model rotation animation and give tips on common challenges students may run into
- Buddy up students so they can cooperatively work together on their own projects assisting and supporting each other through certain challenges they may have
- Top level students can be used for additional mentor support

RESOURCES

Resources here focus on some animation but more on how to write project reports, characteristics, and project management.

GENERAL

Equipment and tools required to complete the activity include:

- Pen, pencil, eraser, calculator
- Computer
- Network access
- Design notes and sketches on robot design
- Excel and Word
- SolidWorks

BOOKS

- How To Write Project Reports https://www.google.ca/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&ved=0CCgQFjAC&url=http%3A%2F%2Fwww-users.york.ac.uk%2F~dajp1%2FProject%2520Reports.doc&ei=c1YnVYbZAcWisAWTs4DYAw&usg=AFQjCNFfmrN02gz2oc5sQLUks9EpmNXa5A&sig2=3K9HLLcv5-J61yEszE-rEQ&bvm=bv.90491159,d.b2w&cad=rja
- Guide to Project Management www.projects.uts.edu.au/resources/pdfs/StepbyStepGuide2009.pdf
- More than Robots: http://www.usfirst.org/uploadedFiles/Who/Impact/Brandeis_Studies/FRC_eval_execsum.pdf
- Design Project Reports http://www.ohio.edu/mechanical/design/SnrDesign07_08/me470/SrD_designreportguidelines_07.pdf

VIDEOS

- Sample robot 360 animation https://www.youtube.com/watch?v=EK77quNgweo
- What is Project Management? https://www.youtube.com/watch?v=9LSnINglkQA
- The Essential Skills Series - Project Management https://www.youtube.com/watch?v=SxmTFTZ9T1c
- Project Management in under 8 minutes https://www.youtube.com/watch?v=qkuUBcmmBpk
- Top 5 Types of Project Management Reports https://www.youtube.com/watch?v=GmI-d2O_O9w

MAGAZINES

- Cadalyst magazine archives and subscriber resources http://www.cadalyst.com/cadalyst-magazine-0
- Compass magazine http://compassmag.3ds.com/
- Project Reports http://www.industryleadersmagazine.com/category/project-reports/

WEBSITES

- How to Write a Project Report? http://www.engineeringcivil.com/how-to-write-a-project-report.html
- Making Sure That What You Delivered Actually Works http://www.mindtools.com/pages/article/newPPM_74.htm
- Post Project Review http://www.pma.doit.wisc.edu/close/2/print.html

UNIT 6, LESSONS

UNIT 6, LESSON 1 (ACT 1): 3D MODEL ASSEMBLIES

Differentiated Instruction Lesson Plan

Technological Design – TDJ3M
3D Model Assemblies / Technological Education
Duration: 3 - 75 minute periods
This lesson can be used in a Technological Design course to learn about 3D model assemblies, working with sub-assemblies, how those assemblies interact and connect with each other, mirroring assemblies while designing and building a complex robot in a 3D CAD program.

1	Guided discussion – bringing all your major components together
2	Demonstration – assemblies and mirroring
3	Discussions – robot assemblies and mirroring, cues, advance organizers, and check list*
4	Buddy partners – build sub-assemblies and mirroring cooperatively **
5	Self & peer assessment – check list of tasks, and requirements
6	Teacher assessment – individual mark feedback and support

*Marzano's Categories of Instructional Strategies
**Differentiated Instruction Structure

KEY INFO

Knowledge of Students
Differentiation based on student:
☑ Readiness ☑ Interests ☑ Preferences:
☑ Styles ❒ Intelligences ❒ Other (e.g., environment, gender, culture)

Need to Know
Students' prior experience with assembly creation, part placement, and constraints.

How to Find Out
Class discussion, Observation, verbal survey, and/or on marks on previous assembled projects.

Differentiated Instruction Response
☑ Learning materials (content) ☑ Ways of learning (process) ☑ Ways of demonstrating learning (product) ❒ Learning environment

CURRICULUM CONNECTIONS

Overall Expectation(s):

By the end of this course, students will:

- A B2. apply appropriate methods for generating and graphically representing design ideas and solutions;

SPECIFIC EXPECTATION(S):

By the end of this course, students will:

- Not directly relevant here.

LEARNING GOALS:

GENERAL

- Have students buddy up to ensure they can share ideas about their assembly build process and maximize the learning experience
- Discuss master assemblies and sub-assembly interaction
- Assembly file naming suggestions before bringing into master assembly
- Ensure students have completed their assemblies and there are no errors or warnings
- Remind students that they are updating their project management sheets continually
- Prepared to assist with assembly errors or warnings
- Review constraints and mating techniques

SPECIFIC

- Assembly placement constraint locations – design intent
- Assembly mechanical connections
- Troubleshooting assembly errors and warnings
- Assembly rigid or flexible awareness
- Mirroring assembly process

ASSESSMENT AND EVALUATION

ASSESSMENT/SUCCESS CRITERIA

Knowledge and Understanding

- Master assembly
- Sub-assembly
- Constraints and mates
- Mirroring an assembly
- Mechanical fastening methods

Communication

- Show peer project process
- Explanation of process
- Completion of all sub-assemblies
- Completion of mirroring
- Show mechanical fastening of sub-assemblies
- Completed checklist

Thinking & Inquiry

- Correctly place and mate assembly accurately
- Visualize the proper mirror to confirm if it is correct
- Decide if placement is in proper location
- Compare check list with work completed

Application

Assessment Tools

Note accuracy
Teacher observation
Peer check list/ review

• Accurate placement of sub-assemblies • Constraining with appropriate mates • Mirroring proper features correctly • Appropriate fastening methods used • Use of Excel to manage project design resources	

PRIOR LEARNING

A basic understanding of assemblies and their characteristics.
Have had practice with

- Part placement and constraining
- Hole wizard tool and referenced holes
- Building assemblies
- Placing parts in assemblies
- Constraining parts in assemblies
- Saving assemblies

ACCOMIDATIONS

The teacher consults individual student IEPs for specific direction on accommodation and adapts the activity and teaching strategies to meet the needs of individual students. Students' individual needs may be accommodated through an adaptation of the design and/or production stages of the activity.

- Students may need more time especially if they have sub-assembly errors
- Observation - after demonstrating in class, discussion, walk around the class for direct and immediate feedback to see how everyone is doing, if they need some more support in anyway
- Mark work in class, in front of individual students giving them direct feedback – examples, repeat live demo if needed and do a comparison, and/or give more specific details for understanding, as the teacher reviews the students' work
- Giving students the option of redoing work if needed, to improve mark after peer evaluating
- Live demonstration lesson allowing students to focus, watch the instructor go through the major steps scaffolding the process such as fixing errors or warnings, sub-assembly placement, adding mechanical connections, mirroring sub-assembly, and tips on common challenges that students may run into
- Record demonstration for later viewing and/or refer them to specific web site resources, videos, etc.
- Buddy up students so they can cooperatively work together on their own projects assisting and supporting each other through certain challenges they may have
- Top level students can be used for additional mentor support

MATERIALS AND RESOURCES

Resources here focus on supporting two major processes – master assembly and sub-assemblies interacting with each other and mirroring whole assemblies.

MATERIALS:

Equipment and tools required to complete the activity include:

- Pen, pencil, eraser, calculator
- Computer

- Network access
- Design notes and sketches on robot design
- Excel
- SolidWorks

TEACHER AIDS:

It is suggested to have the following to use with your lesson:

- A white board with complimentary set of marker, or chalk board with chalk, or a digital white board
- Digital projector
- Access to the internet
- Sample project file to show
- Examples on the wall students can view, showing student past work for comparison

APPENDIX U6

This appendix has

- Appendix UL6-1 3D CAD sub-assemblies
- Appendix UL6-2 Robot rendered product
- Appendix UL6-4 Assessment check list for sample and custom robot assembly
- Appendix P5 – Assessment check list for Excel project management
- Appendix P5 – Gantt chart on robot design process
- Appendix P5 – Excel student robotic design log
- Appendix P5 – Excel material cost sheet
- Appendix P5 – Excel personal sector management

BOOKS

- Part and Assembly Modeling with SolidWorks 2014, page 86 https://dl.dropboxusercontent.com/u/42872562/SWG2014/SWG2014.pdf
- Basic Sketching and Assembly P22 http://www.andrew.cmu.edu/user/shc17/DesignI/Notes---Intro_to_SolidWorks.pdf

VIDEOS

Videos are here as a support resource and not all necessary to use, as live demonstrations will suffice.

- Sample robot 360 animation https://www.youtube.com/watch?v=EK77quNgweo
- Section 3.1 Shaft Assembly https://www.youtube.com/watch?v=lxpprQE6lhE
- Section 3.2 Universal Joint https://www.youtube.com/watch?v=pMjdAD88JVU
- Section 3.3 Clamp https://www.youtube.com/watch?v=nII48lPCx_A
- Mirror Components at the Assembly Level https://www.youtube.com/watch?v=Mh_oCj4UbZE
- Flexible Sub-Assemblies https://www.youtube.com/watch?v=n9hbOqNiFBw
- Assembly Tips https://www.youtube.com/watch?v=evtNMDHWZAE

MAGAZINES

- Cadalyst magazine archives and subscriber resources http://www.cadalyst.com/cadalyst-magazine-0
- Compass magazine http://compassmag.3ds.com/

WEBSITES

- Part and Assembly Modeling with SolidWorks 2014 http://myweb.ncku.edu.tw/~hhlee/Myweb_at_NCKU/SWG2014.html
- SolidWorks 3D solutions https://www.solidworks.com/sw/resources/solidworks-tutorials.htm
- SolidWorks Online Help http://help.solidworks.com/2014/English/SolidWorks/sldworks/c_introduction_toplevel_topic.htm

LESSON DETAILS

MINDS ON

	Connections
◆ Establishing a positive learning environment ◆ Connecting to prior learning and/or experiences ◆ Setting the context for learning	L: Literacy ML: Mathematical Literacy AfL, AaL, AoL: Assessment for/as/of Learning
1-Whole Class ⇒ Guided discussion on assembly builds • Class discussion on why we use assemblies • Best way you have found to create assemblies, i.e. what works best? DI Interests • Share with class • Motivation: sharing better or faster ways that you have found will make working with them easier and. less time to complete • Review of proper technical assembly terms.	L: Subject-specific vocabulary/Guided Discussion AfL: Review Anecdotal comments L: Subject terminology

ACTION

	Connections
◆ Introducing new learning or extending/reinforcing prior learning ◆ Providing opportunities for practice and application of learning (guided > independent)	L: Literacy ML: Mathematical Literacy AfL, AaL, AoL: Assessment for/as/of Learning
2-Whole Class ⇒ Demonstration on master and sub-assemblies and mirroring • New master assembly file, proper placement of first components • Open frame and place by selecting the green checkmark • Bring in other sub-assemblies, place in position, mate until fully defined • May have to calculate exact location based on your design • Mirror – select whole assembly, centre plane to your assembly, edit individual parts to get the right mirror then green checkmark • Design intent	ML: locating assembly placement location
3-Whole Class ⇒ Review, questions, and check list. • Questions –on major steps • Review on steps and check list handout	AfL: Process steps
4-Buddy Partners ⇒ Hands-on assembly build • Students may work with their partners, but they must complete their own assemblies. Student's first sub-assembly to work with is their elevator. They must bring in and position, then work on mating it to its exact location. Then using the 6 bolt fasteners and the hole-wizard secure it to the robot deck. Next they will need to properly mirror the assembly and supports DI Readiness, Interests, Preferences - styles • Students can use the check list to check if they have completed all of the steps completely • Students will continue to work on placing the other sub-assemblies, mating, fastening, and mirroring where needed until they are done • Once students are done the sample robot tasks, they may work on their own robot (if	AfL: self-evaluation check

time is permitted). Additional custom check list sheet is sampled in the appendix that students would fill out and used based on the first sheet	

CONSOLIDATION AND CONNECTION

◆ Helping students demonstrate what they have learned ◆ Providing opportunities for consolidation and reflection	Connections L: Literacy ML: Mathematical Literacy AfL, AaL, AoL: Assessment for/as/of Learning
5-Pairs of 2 ⇒ Self and peer assessment check list • Students will self-evaluate and then peer evaluate their partner using the checklist to check if they have completed all of the tasks, qualities, and requirements • Students will use their own experience and compare with theirs to give any further advice or support 6-Teacher check ⇒ Checklist and observation • Instructor will visit each student and check robot master assemblies and give feedback advice on project work to support them now and for their next unit activity which will also count towards their summative mark	AaL: Self supported check AaL: Peer supported check ML checking calculations and accuracy AoL: Note/check list assessment

SIDE NOTE DEFINITION/SUPPORT:

- **Assessment for Learning** - student info to adapt, DI, teaching and learning activities (before/during)
- **Assessment as Learning** - students monitors their own learning - feedback to adjust, adapt, and change what they understand.
- **Assessment of Learning** - helping students improve while they are still gaining knowledge/skills

UNIT 6, LESSON 2 (ACT 2): FUNCTION INTEGRATION

Differentiated Instruction Lesson Plan

Technological Design – TDJ3M
Function Integration / Technological Education
Duration: 7 - 75 minute periods
This lesson can be used in a Technological Design course to review 3D model functional supports with-in a master assembly, adding sub-assemblies and parts, removing material, and design adjustments in a process such as designing and building a complex robot in a 3D CAD program.

1	Guided discussion – functional design and completing the robot
2	Demonstration – how to refine your design effectively
3	Discussions – additional sub-assemblies and parts, taking away material, to refine design - cues, advance organizers, and check list*
4	Buddy partners – continue build process cooperatively **
5	Self & peer assessment – check list of tasks, and requirements
6	Teacher assessment – individual mark feedback and support

*Marzano's Categories of Instructional Strategies
**Differentiated Instruction Structure

KEY INFO

Knowledge of Students
Differentiation based on student:
☑ Readiness ☑ Interests ☑ Preferences:
☑ Styles ❒ Intelligences ❒ Other (e.g., environment, gender, culture)

Need to Know
Students' prior experience with part/assembly creation, part/assembly placement, constraints, and functional design.

How to Find Out
Class discussion, Observation, verbal survey, and/or on marks on previous assembled projects.

Differentiated Instruction Response
☑ Learning materials (content) ☑ Ways of learning (process) ☑ Ways of demonstrating learning (product) ❒ Learning environment

CURRICULUM CONNECTIONS

Overall Expectation(s):

By the end of this course, students will:

- A1. demonstrate an understanding of factors and relationships that affect technological design and the design process;
- A2. describe appropriate strategies, techniques, and tools for researching, organizing, planning, and managing design projects and related activities, with an emphasis on financial, human, and material resources;
- A4. demonstrate an understanding of a variety of tools, materials, equipment, and processes used to build, test, and evaluate models and prototypes;
- B1. use appropriate strategies and tools to research and manage design projects and related activities;
- B3. create and test models and/or prototypes, using a variety of techniques, tools, and materials;

SPECIFIC EXPECTATION(S):

By the end of this course, students will:

- D2.5 demonstrate an understanding of and apply the Essential Skills that are important for success in the technological design industry, as identified in the Ontario Skills Passport (e.g., reading text, writing, document use, measurement and calculation)

LEARNING GOALS:

These learning goals have already been covered but are still being mastered. As this is a summative project mark, these are still things the teacher should be looking for when evaluating students work in this unit activity. This is still considered a learning process/experience to further reinforce these learning goals.

GENERAL

- Have students buddy up to ensure they can share ideas about their functional support mechanisms and assemblies to maximize the learning experience
- Discuss how sub-assembly functions interact with master assembly drive train
- Stabilizing and supporting function robot design and functions
- Ensure students are updating their project management sheets continually
- Upper tower/elevator design, build and sub-assembly placement
- Belly pan design, build, and placement – must be light weight and support all electronic hardware
- C-frame brackets to strengthen the frame around the tote chamber
- Removing unnecessary materials to lighten components without weakening structure of robot

SPECIFIC

- Understanding why we need extra support in key areas of the robot
- Prioritizing which functions, components, and processes need to be done first or last and why
- File size, computer power, and speed of application
- Setting flexible assemblies ridged or mating for alignment for drawings
- Using flexible mates to prototype movements
- Patterned holes – using fillets for strength
- eDrawing export

ASSESSMENT AND EVALUATION

ASSESSMENT/SUCCESS CRITERIA	Assessment Tools
Note: Evaluation changes from formative to summative for the rest of this unit, although students will still be using tools to assess themselves throughout. *Knowledge and Understanding* • Master assembly • Sub-assembly	Note accuracy Teacher observation Peer check list/ review

- Constraints and mates
- Mirroring an assembly
- Mechanical fastening methods
- Part creation
- Features
- Design intent
- Referencing
- General tools
- 2D/3D profile sketching
- Part manipulation and viewing
- Fully defined operations

Communication

- Show peer project process
- Explanation of process
- Completion of all sub-assemblies
- Completion of mirroring
- Show mechanical fastening of sub-assemblies
- Verbal terminology
- Questioning intent
- Completed checklist

Thinking & Inquiry

- Correctly place and mate assembly accurately
- Visualize the proper mirror to confirm if it is correct
- Design concepts understood
- Understanding factors and relationships that affect technology design and the design process
- Use of design intent and iteration process to a solution
- Decide if placement is in proper location
- Compare check list with work completed
- Effective material removal design section

Application

- Accurate placement of sub-assemblies
- Constraining with appropriate mates
- Mirroring proper features correctly
- Appropriate fastening methods used
- 2D and 3D sketching
- Part creation and editing
- Features creating and editing
- Hole wizard and referencing
- Geometry references
- Adding, editing components
- Creating profile weldments
- Sheet metal parts
- Virtual prototyping, and testing
- Extrude and revolve
- Use of Excel to manage project design resources

PRIOR LEARNING

As this is a summative project, the following prior learning listed here, are the major components which students should have a good grasp on and this ***list overlaps the listed learning goals not yet mastered with, but are familiar with*** and continue to build on from previous units recently completed. The following prior learning is basic understanding of the robots function design and 3D CAD modeling:
Have had practice with

- Making parts
- Making weldments
- Making sheet metal parts
- Placing fasteners
- Referenced geometry
- Referenced planes
- Part placement and mating
- Working with Excel
- Project management entries
- Assembling parts from manufactures
- Building assemblies
- Placing parts in assemblies
- Constraining parts in assemblies
- Saving assemblies
- Hole creation and referencing
- Extrude cut and add
- 2D/3D sketching and dimensions
- Fully defining operations
- Mirroring entities, parts, and assemblies
- Chain/belt pathway tool
- Plane referencing
- Text engraving and extruding

ACCOMIDATIONS

The teacher consults individual student IEPs for specific direction on accommodation and adapts the activity and teaching strategies to meet the needs of individual students. Students' individual needs may be accommodated through an adaptation of the design and/or production stages of the activity.

- Students may need more time especially if they are still having problems with design or adding more parts and required assemblies
- Observation - after demonstrating in class, think pair share, discussion, walk around the class for direct and immediate feedback to see how everyone is doing, if they need some more support in anyway
- Mark work in class, in front of individual students giving them direct feedback – examples, repeat live demo if needed and do a comparison, and/or give more specific details for understanding, as the teacher reviews the students' work
- Live demo lesson allowing students to focus, watch the instructor go through the major steps scaffolding the steps to create support functions, extra needed parts and assemblies, and give tips on common challenges students may run into
- Buddy up students so they can cooperatively work together on their own projects assisting and supporting each other through certain challenges they may have
- Top level students can be used for additional mentor support

MATERIALS AND RESOURCES

Resources here focus on similarly as the ones in 6-1 as there are similar processes with the addition of functional design, hence the addition of several books on this area.

MATERIALS:

Equipment and tools required to complete the activity include:

- Pen, pencil, eraser, calculator
- Computer
- Network access
- Design notes and sketches on robot design
- Excel
- SolidWorks

TEACHER AIDS:

It is suggested to have the following to use with your lesson:

- A white board with complimentary set of marker, or chalk board with chalk, or a digital white board
- Digital projector
- Access to the internet
- Sample project file to show
- Examples on the wall students can view, showing student past work for comparison

APPENDIX U6

This appendix has

- Appendix UL6-1 3D CAD sub-assemblies
- Appendix UL6-2 Robot rendered product
- Appendix UL6-4 Assessment check list for sample and custom robot assembly
- Appendix P5 – Assessment check list for Excel project management
- Appendix P5 – Gantt chart on robot design process
- Appendix P5 – Excel student robotic design log
- Appendix P5 – Excel material cost sheet
- Appendix P5 – Excel personal sector management

BOOKS

- Mechanical Design of Machine Elements and Machines https://books.google.ca/books?id=909-5C4eyUkC&printsec=frontcover#v=onepage&q&f=false
- Mechanical engineering principles http://www.slideshare.net/goldenakos/mechanical-engineering-principles
- Engineering mechanics-by-timoshenko http://www.slideshare.net/Nuumero1/engineering-mechanicsbytimoshenko?related=2
- Strength of materials by s k mondal http://www.slideshare.net/shubhrasaxena37/strength-of-materials-by-s-k-mondal
- Part and Assembly Modeling with SolidWorks 2014, page 86 https://dl.dropboxusercontent.com/u/42872562/SWG2014/SWG2014.pdf
- Basic Sketching and Assembly P22 http://www.andrew.cmu.edu/user/shc17/DesignI/Notes---Intro_to_SolidWorks.pdf

VIDEOS

Videos are here as a support resource and not all necessary to use, as live demonstrations will suffice.

- Sample robot 360 animation https://www.youtube.com/watch?v=EK77quNgweo
- Section 3.1 Shaft Assembly https://www.youtube.com/watch?v=lxpprQE6lhE
- Section 3.2 Universal Joint https://www.youtube.com/watch?v=pMjdAD88JVU
- Section 3.3 Clamp https://www.youtube.com/watch?v=nII48lPCx_A

- Mirror Components at the Assembly Level https://www.youtube.com/watch?v=Mh_oCj4UbZE
- Flexible Sub-Assemblies https://www.youtube.com/watch?v=n9hbOqNiFBw
- Assembly Tips https://www.youtube.com/watch?v=evtNMDHWZAE

MAGAZINES

- Cadalyst magazine archives and subscriber resources http://www.cadalyst.com/cadalyst-magazine-0
- Compass magazine http://compassmag.3ds.com/

WEBSITES

- Part and Assembly Modeling with SolidWorks 2014 http://myweb.ncku.edu.tw/~hhlee/Myweb_at_NCKU/SWG2014.html
- SolidWorks 3D solutions https://www.solidworks.com/sw/resources/solidworks-tutorials.htm
- SolidWorks Online Help http://help.solidworks.com/2014/English/SolidWorks/sldworks/c_introduction_toplevel_topic.htm

LESSON DETAILS

MINDS ON

◆ Establishing a positive learning environment ◆ Connecting to prior learning and/or experiences ◆ Setting the context for learning	Connections L: Literacy ML: Mathematical Literacy AfL, AaL, AoL: Assessment for/as/of Learning
1-Whole Class ⇒ Guided discussion on functional design and completing the robot • Class discussion on making robot functional and effective • What is left to complete on your robot and which do you do first and what do you do last? • Share with class • Motivation: completing tasks in the wrong format may end up making more work, so a little planning, design intent, some iteration, you can finish quicker • Review of major processes that each should be familiar with by now and tie any loose ends here so that students are well prepared for completing their robot design	DI Interests L: Subject-specific vocabulary/Guided Discussion AfL: Socratic review Anecdotal comments L: Subject process

ACTION

◆ Introducing new learning or extending/reinforcing prior learning ◆ Providing opportunities for practice and application of learning (guided > independent)	Connections L: Literacy ML: Mathematical Literacy AfL, AaL, AoL: Assessment for/as/of Learning
2-Whole Class ⇒ Demonstrations how to refine your design effectively • Make a list of what you have to do and prioritize • Reviewing your goals, limitations and intent, design will start to flourish • Functions must work independently, but also together effectively, so there will be a lot of planning to make sure this happens • You will have many calculations, integrations, and connections that need to work together	ML: locating assembly placement location

• Sketching continuously will help you visualize and solve design bumps along the way • Using blend of logic, creativity, and other ideas will support new or refined ideas like a sculpture works slowly from a block to a piece of art • Design intent- know it and use it 3-Whole Class ⇒ Review, questions, and check list. • additional sub-assemblies and parts, taking away material, to refine design • Questions –on major steps • Review on steps and check list handout 4-Buddy Partners ⇒ Continue hands-on assembly build • Students may continue to work with their partners, but they must complete their own assemblies. Student's should be starting on creating the assembly for the tower side rail parts and assembly build • Students use the check list to see what they need to do and check it off as they • Students will continue to add more parts and sub-assemblies to their robot, and then after, removing unwanted material • Once students are done the sample robot, they may work on their own robot (if time is permitted). Additional custom check list sheet is sampled in the appendix that students would fill out and used based on the first sheet	AfL: Process steps Readiness, Interests, Preferences - styles AfL: self-evaluation check

CONSOLIDATION AND CONNECTION

◆ Helping students demonstrate what they have learned ◆ Providing opportunities for consolidation and reflection	Connections L: Literacy ML: Mathematical Literacy AfL, AaL, AoL: Assessment for/as/of Learning
5-Pairs of 2 ⇒ Self and peer assessment check list • Students will self-evaluate and then peer evaluate their partner using the checklist to check if they have completed all of the tasks, qualities, and requirements • Students will use their own experience and compare with theirs to give any further advice or support 6-Teacher check ⇒ Checklist and observation • Instructor will visit each student and check robot master assemblies and give feedback advice on project work to support them now and for their next unit activity which will also count towards their summative mark	AaL: Self supported check AaL: Peer supported check ML checking calculations and accuracy AoL: Note/check list assessment (Summative)

SIDE NOTE DEFINITION/SUPPORT:

- **Assessment for Learning** - student info to adapt, DI, teaching and learning activities (before/during)
- **Assessment as Learning** - students monitors their own learning - feedback to adjust, adapt, and change what they understand.
- **Assessment of Learning** - helping students improve while they are still gaining knowledge/skills

UNIT 6, LESSON 3 (ACT 3): DRAWINGS

Differentiated Instruction Lesson Plan

Technological Design – TDJ3M Drawings / Technological Education Duration: 5 - 75 minute periods This lesson can be used in a Technological Design course to review 3D mechanical assembly drawings forming orthographic and isometric views with dimensions on designing and building a complex robot in a 3D CAD program.	
1	Guided discussion – graphic communication and documentation
2	Demonstration – drawing sheets, views, and dimensions
3	Discussions – drawing creation and dimensioning challenges, cues, advance organizers, and check list*
4	Buddy partners – creating drawing with dimensions cooperatively **
5	Self & peer assessment – check list of tasks, and requirements
6	Teacher assessment – individual mark feedback and support

*Marzano's Categories of Instructional Strategies
**Differentiated Instruction Structure

KEY INFO

Knowledge of Students

Differentiation based on student:

☑ Readiness ☑ Interests ☑ Preferences:
☑ Styles ❒ Intelligences ❒ Other (e.g., environment, gender, culture)

Need to Know

Students' prior experience with part/assembly edit and creation, model components built, ready for drawing creation.

How to Find Out

Class discussion, Observation, verbal survey, and/or on marks on previous assembled projects.

Differentiated Instruction Response

☑ Learning materials (content) ☑ Ways of learning (process) ☑ Ways of demonstrating learning (product) ❒ Learning environment

CURRICULUM CONNECTIONS

Overall Expectation(s):

By the end of this course, students will:

- A3. demonstrate an understanding of drafting standards, conventions, and guidelines for various types of drawings used to represent designs;
- B2. apply appropriate methods for generating and graphically representing design ideas and solutions;

SPECIFIC EXPECTATION(S):

By the end of this course, students will:

- Not directly relevant here.

LEARNING GOALS:

These learning goals have already been covered but are still being mastered. As this is a summative project mark, these are still things the teacher should be looking for when evaluating students work in this unit activity. This is still considered a learning process/experience to further reinforce these learning goals.

GENERAL

- Have students buddy up to ensure they can share ideas about their drawings and reinforce the learning experience
- Review orthographic view placement and dimensioning
- Drafting standards, conventions and guidelines for drawings
- Dimensioning requirements in an assembly – all overall and key detail dimensioning
- Sheet format and template options and the difference between the two
- Filling out the information block
- Placing views in relation to dimensions
- Scaling views appropriately to space available
- Adjusting view states for different views
- Excel sheets, formula, and text entries

SPECIFIC

- Sheet size, scale, and format
- Object view placements
- Space and dimension considerations
- Configuring views
- Scaling views
- Dimension standards and configurations
- Grid use, smart dimension tool, and dimension placement
- Editing dimensions
- Centre lines and centre marks
- Which dimensions to include
- Individual sheets or sheet-sets
- Renaming individual sheets in sheet set
- Annotations
- eDrawing export

ASSESSMENT AND EVALUATION

ASSESSMENT/SUCCESS CRITERIA	Assessment Tools
Knowledge and Understanding • Sheet format and standards • Object view placement and projection standards • Dimensioning techniques • Placement of overall and detail dimensions • View types, scale, location, and spacing • Purpose of drawings *Communication* • Views clear and easy to see	Note accuracy Teacher observation Peer check list/ review

• Dimensions clean, organized, and appropriately spaced • All overall dimensions shown • Key features dimension in related view • Show centre lines and centre marks • Information block filled in *Thinking & Inquiry* • Correctly placed views • Dimensions placed correctly • Best scaling and spacing to fill the page • Appropriate dimensions placed on views *Application* • Drafting standards, conventions, and guidelines • Sheet set-up and fill in • Sheet format, standards, sizing, and standards • Brining in views of object • Changing view state of object • Scaling object in view • Dimension placement, editing, and removal • Creating annotations • Placing centre lines and centre marks • Sheet organization and management • Use of Excel to manage project design resources	

PRIOR LEARNING

As this is a summative project, the following prior learning listed here, are the major components which students should have a good grasp on and this ***list overlaps the listed learning goals not yet mastered with, but are familiar with*** and continue to build on from previous units recently completed. Students should know their orthographic/isometric drawing principles and proper dimension placement techniques and standards.

Have had practice with

- Orthographic views
- Dimensioning overall and detail dimensions
- Dimensioning features on view most relevant
- Familiar with assemblies and components completed
- SolidWorks basic interface and layout

ACCOMMODATIONS

The teacher consults individual student IEPs for specific direction on accommodation and adapts the activity and teaching strategies to meet the needs of individual students. Students' individual needs may be accommodated through an adaptation of the design and/or production stages of the activity.

- Students may need more time
- Observation - after demonstrating in class, think pair share, discussion, walk around the class for direct and immediate feedback to see how everyone is doing, if they need some more support in anyway
- Live demo lesson allowing students to focus, watch the instructor go through the major steps scaffolding the steps to creating drawing sheets, information block fill-in, view placement, view configurations, scaling dimensioning, and give tips on common challenges that students may run into
- Buddy up students so they can cooperatively work together on their own projects assisting and supporting each other through certain challenges they may have
- Top level students can be used for additional mentor support

MATERIALS AND RESOURCES

Resources here focus on the creation of drawing parts, assemblies, dimensions, templates, sheet management, and tips.

MATERIALS:

Equipment and tools required to complete the activity include:

- Pen, pencil, eraser, calculator
- Computer
- Network access
- Design notes and sketches on robot design
- Excel
- SolidWorks

TEACHER AIDS:

It is suggested to have the following to use with your lesson:

- A white board with complimentary set of marker, or chalk board with chalk, or a digital white board
- Digital projector
- Access to the internet
- Sample project file to show
- Examples on the wall students can view, showing student past work for comparison

APPENDIX U6

This appendix has

- Appendix UL6-2 Robot rendered product
- Appendix UL6-3 3D CAD assembly drawings
- Appendix UL6-4 Assessment check list for sample and custom robot assembly
- Appendix P5 – Assessment check list for Excel project management
- Appendix P5 – Gantt chart on robot design process
- Appendix P5 – Excel student robotic design log
- Appendix P5 – Excel material cost sheet
- Appendix P5 – Excel personal sector management

BOOKS

- Introduction to SolidWorks, Page 118 http://www.scribd.com/doc/176131537/Introduction-to-SolidWorks?post_id=501239105_10151922694179106#_=_
- Introducing SolidWorks, Page 4-1 http://www.eng.uwo.ca/designcentre/CAD%20resources/Introduction_to_SolidWorks.pdf
- Drawing and Detailing with SolidWorks 2014 http://books.google.ca/books?id=ik25AgAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

VIDEOS

Videos are there as a resource and not all necessary to use, as live demonstrations will suffice.

- Part Drawings https://www.youtube.com/watch?v=RrRnDE3Oazo
- Assembly Drawings https://www.youtube.com/watch?v=xZPoWpl_KRE
- Inserting Model Dimensions into a Drawing: https://www.youtube.com/watch?v=i7cSkw2khhU
- Creating a Simple Drawing https://www.youtube.com/watch?v=cpwvqZ8TJao
- Dimension a Drawing https://www.youtube.com/watch?v=WEkF8oINyKY
- Drawing Template https://www.youtube.com/watch?v=zheRAkyVYts
- Drawings and drawing templates https://www.youtube.com/watch?v=_oi29H05ILc
- Title Blocks in 10 Minutes https://www.youtube.com/watch?v=1wpGtFdBKAs
- drawings basic https://www.youtube.com/watch?v=WmbzMPwZ8ZE
- Drawings in SolidWorks https://www.youtube.com/watch?v=1ivAEisPrXI
- Managing Drawing Sheets https://www.youtube.com/watch?v=XBAq1rZDEJo
- Drawing Tips 1 https://www.youtube.com/watch?v=eJ0IbI_Yr3o
- Drawing Tips 2 https://www.youtube.com/watch?v=T7Dl9BaGNyY

MAGAZINES

- Cadalyst magazine archives and subscriber resources http://www.cadalyst.com/cadalyst-magazine-0
- Compass magazine http://compassmag.3ds.com/

WEBSITES

- Part and Assembly Modeling with SolidWorks 2014 http://myweb.ncku.edu.tw/~hhlee/Myweb_at_NCKU/SWG2014.html
- SolidWorks 3D solutions https://www.solidworks.com/sw/resources/solidworks-tutorials.htm
- SolidWorks Online Help http://help.solidworks.com/2014/English/SolidWorks/sldworks/c_introduction_toplevel_topic.htm

LESSON DETAILS

MINDS ON

◆ Establishing a positive learning environment ◆ Connecting to prior learning and/or experiences ◆ Setting the context for learning	Connections L: Literacy ML: Mathematical Literacy AfL, AaL, AoL: Assessment for/as/of Learning
1-Whole Class ⇒ Guided Discussion graphic communication and documentation • 3D models are commonly now sent to manufacture • Why do you think we need to create drawings? • Share with class • Motivation: knowing that drawings communicate a lot of information that a model	DI Interests L: Subject-specific vocabulary/Guided Discussion AfL: Review Anecdotal comments

does not and that designs need to be documented, shows them the need and importance of them in industry • Review of proper technical drawing terms.	L: Subject terminology

ACTION

◆ Introducing new learning or extending/reinforcing prior learning ◆ Providing opportunities for practice and application of learning (guided > independent)	Connections L: Literacy ML: Mathematical Literacy AfL, AaL, AoL: Assessment for/as/of Learning
2-Whole Class ⇒ Demonstration drawing sheets, views, and dimensions • Drawing sheet sizing, standards, templates, sheet format, and configurations • Multiple ways to bring a 3D model into a drawing sheet • View configurations, scaling, types, and shading • Dimensioning, editing, placing, deleting, moving, views • Overall and detail dimensioning technique review • Adjusting live dimensions changing object sizing in drawing • Filling in the information block • Sheet organization and management	ML: locating assembly placement location
3-Whole Class ⇒ Review, questions, and check list. • Drawing creation and dimensioning challenges • Questions –on major steps • Review on steps and check list handout	AfL: Process steps
4-Buddy Partners ⇒ Hands-on assembly build • Students may work with their partners, but they must complete their own drawings. Student should start with sheet size selection, format, and configuration standards, then work on bringing in there different assemblies to place and dimension • Students can use the check list to check if they have completed all of the steps completely • Students will continue to work on placing and dimensioning all of the assembly components until they are done • Once students are done the sample robot drawings, they may work on their own robot drawings (if time is permitted). Additional custom check list sheet is sampled in the appendix that students would fill out and used based on the first sheet	DI Readiness, Interests, Preferences - styles AfL: self-evaluation check

CONSOLIDATION AND CONNECTION

◆ Helping students demonstrate what they have learned ◆ Providing opportunities for consolidation and reflection	Connections L: Literacy ML: Mathematical Literacy AfL, AaL, AoL: Assessment for/as/of Learning
5-Pairs of 2 ⇒ Self and peer assessment check list • Students will self-evaluate and then peer evaluate their partner using the checklist to check if they have completed all of the tasks, qualities, and requirements • Students will use their own experience and compare with theirs to give any further advice or support	AaL: Self supported check AaL: Peer supported check ML checking calculations and accuracy

6-Teacher check ⇒ Checklist and observation • Instructor will visit each student and check robot drawing files and give feedback advice on project work to support them now and for their next unit activity which will also count towards their summative mark	AoL: Note/check list assessment

SIDE NOTE DEFINITION/SUPPORT:

- **Assessment for Learning** - student info to adapt, DI, teaching and learning activities (before/during)
- **Assessment as Learning** - students monitors their own learning - feedback to adjust, adapt, and change what they understand.
- **Assessment of Learning** - helping students improve while they are still gaining knowledge/skills

UNIT 6, LESSON 4 (ACT 4): PRESENTATION

Differentiated Instruction Lesson Plan

Technological Design – TDJ3M Presentation / Technological Education Duration: 5 - 75 minute periods This lesson can be used in a Technological Design course to make 3D robot model animations and create a post robot report on designing and building a complex robot in a 3D CAD program.	
1	Guided discussion – presenting and reporting
2	Demonstration – animation process and creating a post robot report
3	Discussions – animation steps and post report details cues, advance organizers, check list*
4	Buddy partners – create animation and post report cooperatively **
5	Self & peer assessment – check list of tasks, and requirements
6	Teacher assessment – individual mark feedback and support

*Marzano's Categories of Instructional Strategies
**Differentiated Instruction Structure

KEY INFO

Knowledge of Students

Differentiation based on student:

☑ Readiness ☑ Interests ☑ Preferences:
☑ Styles ❒ Intelligences ❒ Other (e.g., environment, gender, culture)

Need to Know

Students' prior experience with past exploded view animation, previous completed reports, and project management tracking sheet.

How to Find Out

Class discussion, Observation, verbal survey, and/or on marks on previous assembled projects.

Differentiated Instruction Response

☑ Learning materials (content) ☑ Ways of learning (process) ☑ Ways of demonstrating learning (product) ❒ Learning environment

CURRICULUM CONNECTIONS

Overall Expectation(s):

By the end of this course, students will:

- A2. describe appropriate strategies, techniques, and tools for researching, organizing, planning, and managing design projects and related activities, with an emphasis on financial, human, and material resources;
- A5. use appropriate terminology and communication methods to document, report, and present progress and results.
- B4. use a variety of formats and tools to create and present reports summarizing the design process and to reflect on decisions made during the process.

SPECIFIC EXPECTATION(S):

By the end of this course, students will:

- A3.1 identify and describe different methods for representing design ideas graphically (e.g., mind maps, sketches, design layouts, computer-aided drafting), with reference to principles and elements of graphic design (e.g., principles: gradation, emphasis, pattern, balance; elements: space, shape, size, value);
- B4.1 create and present reports summarizing design choices and the steps taken in the design process, using a variety of formats and tools (e.g., word processor, presentation software, interactive white board, web pages);
- B4.2 report and reflect on decisions made throughout the design process, using a variety of oral and/or written formats.

LEARNING GOALS:

These learning goals have already been covered but are still being mastered. As this is a summative project mark, these are still things the teacher should be looking for when evaluating students work in this unit activity. This is still considered a learning process/experience to further reinforce these learning goals. Although the student has not done the specific learning goals, they are very similar to creating an exploding view.

GENERAL

- Have students buddy up to so they can share ideas about their report process and support report creation process
- Camera set-up and animating your robot model along the y axis
- Speed, frames per second, codec, standard window sizes, and file size
- Posting to YouTube for sharing
- Project management sheets are due
- Discuss report requirements, methods, variety of formats, report tools, and process
- Use of terminology, images, and reflections in reporting process
- Listing different ways ideas can be represented graphically in relation to principles an elements of design

SPECIFIC

- Animation tab
- Camera set-up
- Setting parameters to create a 360 rotation view
- Saving animation to an video file

ASSESSMENT AND EVALUATION

ASSESSMENT/SUCCESS CRITERIA

Knowledge and Understanding

- How to use the animation tab tools
- Setting up a camera
- Video file saving, codecs, standards, and size,
- Post design report requirements
- Use and application of SPICE with your robot design process
- Elements and principles of design
- Project management

Communication

Assessment Tools

Note accuracy
Teacher observation
Peer check list/ review

• Show animated model clearly with smooth motion • Describe appropriate strategies, techniques, and tools for researching, organizing and managing design projects • Show and use of appropriate terminology • Show different methods of representing design ideas graphically with reference to the principles and elements of design • Summarize reflections on decisions made throughout the design process • Show material costs, tools and equipment used during design process • Use a variety of oral and/or written formats • Show completed checklist *Thinking & Inquiry* • Reflect on decisions made throughout the design process • Summarize design choices and steps taken the design process • Decide on what worked and what didn't and how you could improve in your design project *Application* • Use a variety of formats and tools to create and present reports • Apply a variety of different tools and methods to show design process • Use of communication tools to document, report and present project progress and results • Use of Excel to manage project design resources	

PRIOR LEARNING

As this is a summative project, the following prior learning listed here, are the major components which students should have a good grasp on and this ***list overlaps the listed learning goals not yet mastered with, but are familiar with*** and continue to build on from previous units recently completed. An understanding of past exploded view animations, previous completed reports, and project management tracking sheets related to this unit activity.

Have had practice with

- Conversion, editing, and displaying images in different formats
- Exploding a part, saving video animation
- Excel table and content information transfer
- Post report writing and presenting requirements and process
- Uploading videos to YouTube

ACCOMMODATIONS

The teacher consults individual student IEPs for specific direction on accommodation and adapts the activity and teaching strategies to meet the needs of individual students. Students' individual needs may be accommodated through an adaptation of the design and/or production stages of the activity.

- Observation - after demonstrating in class, discussion, walk around the class for direct and immediate feedback to see how everyone is doing, if they need some more support in anyway
- Students may need more time which can run into the next unit (use part of their term work time)
- Live demo lesson allowing students to focus, watch the instructor go through the major steps scaffolding the process creating a 360 degree robot model rotation animation and give tips on common challenges students may run into
- Buddy up students so they can cooperatively work together on their own projects assisting and supporting each other through certain challenges they may have
- Top level students can be used for additional mentor support

MATERIALS AND RESOURCES

Resources here focus on some animation but more on how to write project reports, characteristics, and project management.

MATERIALS:

Equipment and tools required to complete the activity include:

- Pen, pencil, eraser, calculator
- Computer
- Network access
- Design notes and sketches on robot design
- Excel
- SolidWorks

TEACHER AIDS:

It is suggested to have the following to use with your lesson:

- A white board with complimentary set of marker, or chalk board with chalk, or a digital white board
- Digital projector
- Access to the internet
- Sample test file to show
- Examples on the wall students can view, showing student past work for comparison

APPENDIX U6

This appendix has

- Appendix UL6-5 Sample robot design project
- Appendix UL6-5 Sample robot post design report
- Appendix UL6-4 Assessment check list for post design report
- Appendix P5 – Assessment check list for Excel project management
- Appendix P5 – Gantt chart on robot design process
- Appendix P5 – Excel student robotic design log
- Appendix P5 – Excel material cost sheet
- Appendix P5 – Excel personal sector management

BOOKS

- How To Write Project Reports doc http://tinyurl.com/mtfqwwz
- Guide to Project Management www.projects.uts.edu.au/resources/pdfs/StepbyStepGuide2009.pdf
- More than Robots: http://www.usfirst.org/uploadedFiles/Who/Impact/Brandeis_Studies/FRC_eval_execsum.pdf
- Design Project Reports http://www.ohio.edu/mechanical/design/SnrDesign07_08/me470/SrD_designreportguidelines_07.pdf

VIDEOS

Videos are there as a resource and not all necessary to use, as live demonstrations will suffice.

- Sample robot 360 animation https://www.youtube.com/watch?v=EK77quNgweo
- What is Project Management? https://www.youtube.com/watch?v=9LSnINglkQA
- The Essential Skills Series - Project Management https://www.youtube.com/watch?v=SxmTFTZ9T1c
- Project Management in under 8 minutes https://www.youtube.com/watch?v=qkuUBcmmBpk
- Top 5 Types of Project Management Reports https://www.youtube.com/watch?v=GmI-d2O_O9w

MAGAZINES

- Cadalyst magazine archives and subscriber resources http://www.cadalyst.com/cadalyst-magazine-0
- Compass magazine http://compassmag.3ds.com/
- Project Reports http://www.industryleadersmagazine.com/category/project-reports/

WEBSITES

- How to Write a Project Report? http://www.engineeringcivil.com/how-to-write-a-project-report.html
- Making Sure That What You Delivered Actually Works http://www.mindtools.com/pages/article/newPPM_74.htm
- Post Project Review http://www.pma.doit.wisc.edu/close/2/print.html

LESSON DETAILS

MINDS ON

◆ Establishing a positive learning environment ◆ Connecting to prior learning and/or experiences ◆ Setting the context for learning	Connections L: Literacy ML: Mathematical Literacy AfL, AaL, AoL: Assessment for/as/of Learning
1-Whole Class ⇒ Guided Discussion presenting and reporting • Class discussion what post design reports are and why they are used • What are some different ways you could show your research, project, and design process? • Share with class, and write on board • Motivation: whole class contributes to ways to present your ideas giving them a lot of options they may not have thought of • Review of proper technical terms that should be used in the report and presentation	DI Interests L: Subject-specific vocabulary/Guided Discussion AfL: Review Anecdotal comments L: Subject terminology

ACTION

◆ Introducing new learning or extending/reinforcing prior learning	Connections

◆ Providing opportunities for practice and application of learning (guided > independent)	L: Literacy ML: Mathematical Literacy AfL, AaL, AoL: Assessment for/as/of Learning
2-Whole Class ⇒ Demonstration on animation process • Animation samples • Animation tab tools, steps, and methods • How to include them in your report • Setting up a camera for animation capture • Speed of animation and direction • Review sample report creating a post robot report • Steps to creating a great report - data	ML: locating assembly placement location
3-Whole Class ⇒ Review, questions, and check list. • Animation steps and post report details • Questions –on major steps • Review on steps and check list handout	AfL: Process steps
4-Buddy Partners ⇒ Hands-on assembly build • Students may work with their partners, but they must complete their own animations and reports. • Using your Excel project management sheets, a lot of data can be gathered and used in different ways, such as pie graphs and charts • Students can use the check list to check if they have completed all of the steps completely • Students will continue to work on placing the other sub-assemblies, mating, fastening, and mirroring where needed until they are done • Note if students completed their custom robot also, they may focus on it for their report. t	Readiness, Interests, Preferences - styles AfL: self-evaluation check

CONSOLIDATION AND CONNECTION

◆ Helping students demonstrate what they have learned ◆ Providing opportunities for consolidation and reflection	Connections L: Literacy ML: Mathematical Literacy AfL, AaL, AoL: Assessment for/as/of Learning
5-Pairs of 2 ⇒ Self and peer assessment check list • Students will self-evaluate and then peer evaluate their partner using the checklist to check if they have completed all of the tasks, qualities, and requirements • Students will use their own experience and compare with theirs to give any further advice or support	AaL: Self supported check AaL: Peer supported check
6-Teacher check ⇒ Checklist and observation • Instructor with class will view each students report presentation. Students will have it handed in prior to the presentation so when it is their turn to present their presentation will already be ready to go	AoL: Note/check list assessment (Summative)

SIDE NOTE DEFINITION/SUPPORT:

- **Assessment for Learning** - student info to adapt, DI, teaching and learning activities (before/during)
- **Assessment as Learning** - students monitors their own learning - feedback to adjust, adapt, and change what they understand.

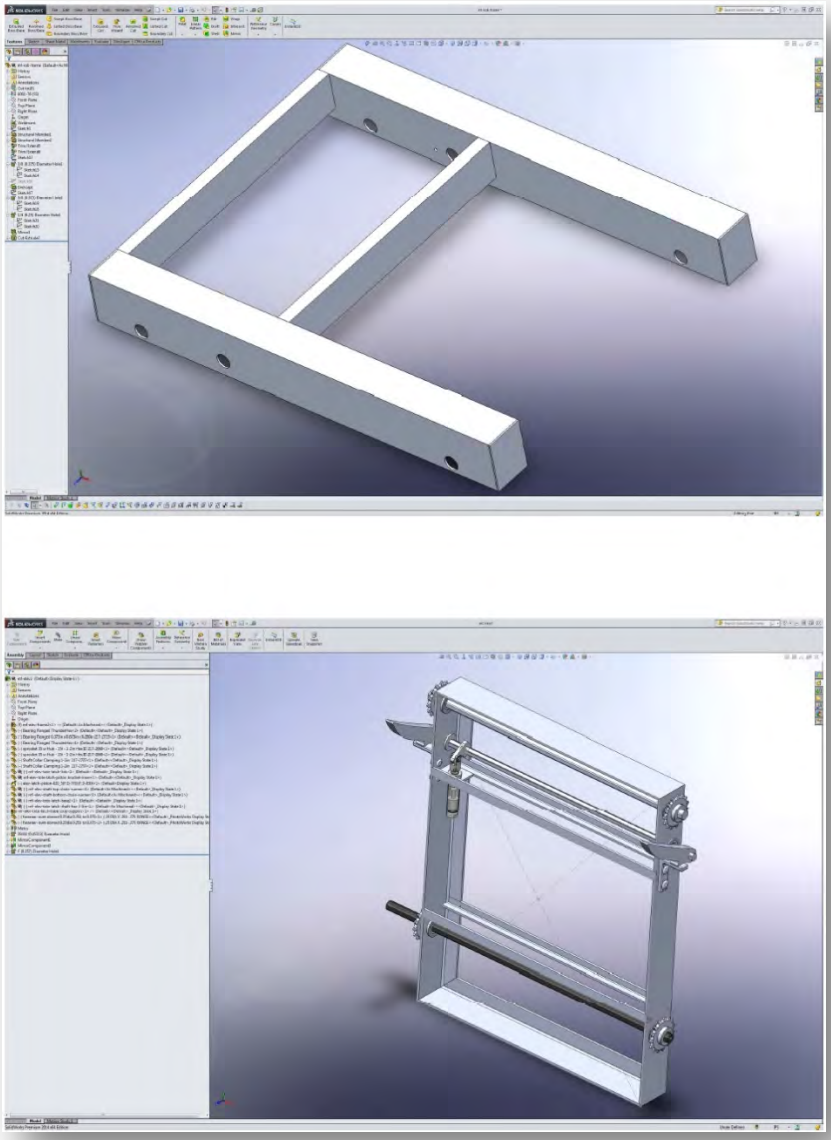
- **Assessment of Learning** - helping students improve while they are still gaining knowledge/skills

UNIT 6, APPENDIX U6

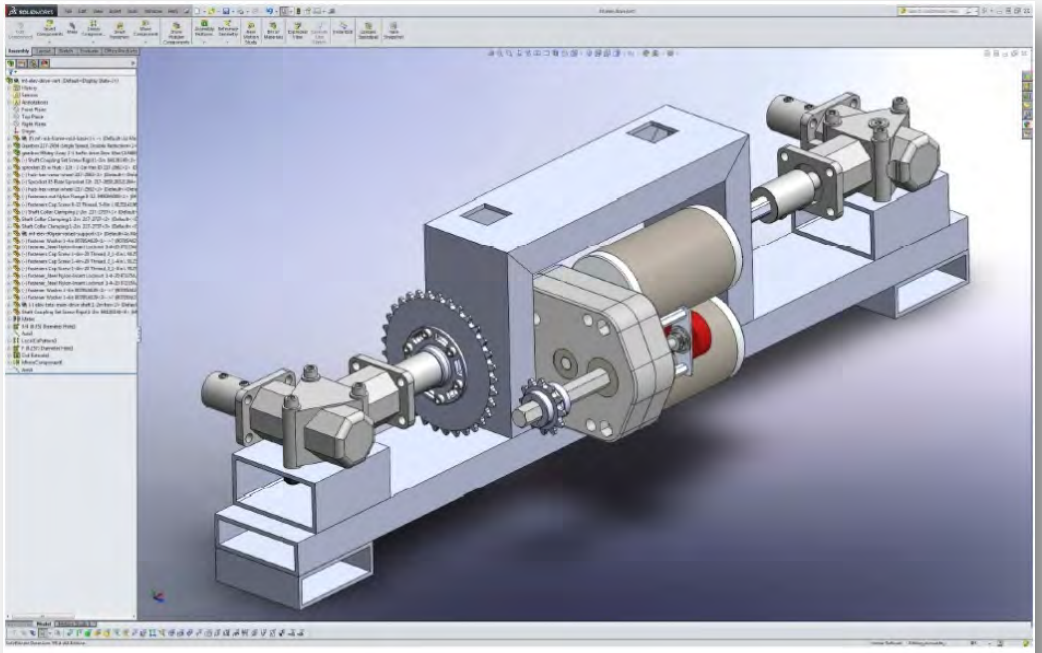
APPENDIX UL6-1

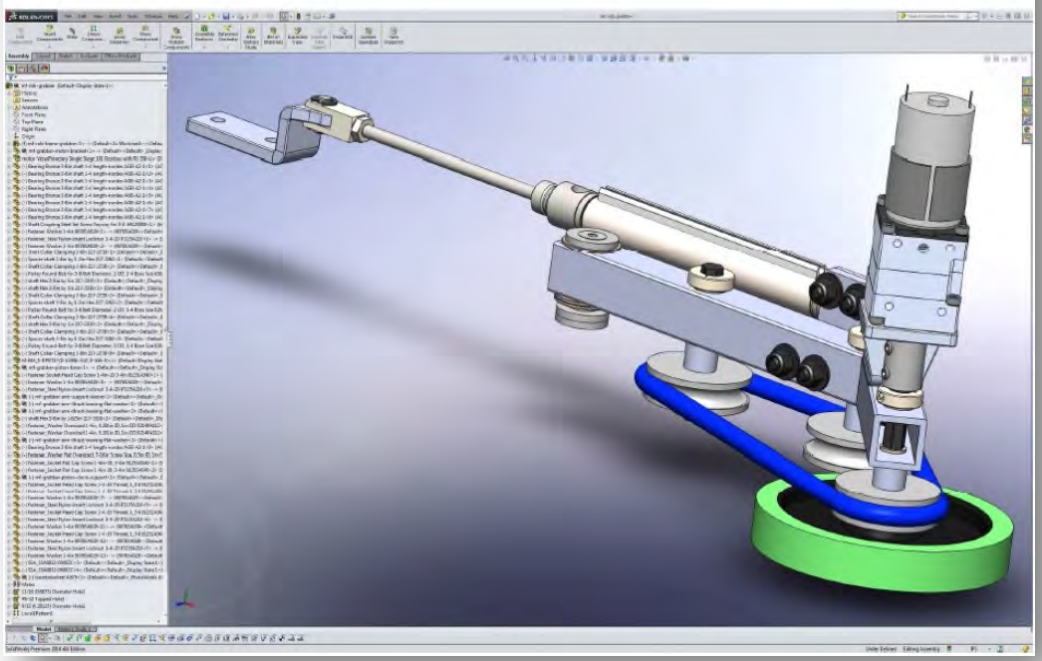
These are the sub-assembly parts you will bring all together into a master assembly.

SUB-ASSEMBLIES - FRAME AND ELEVATOR

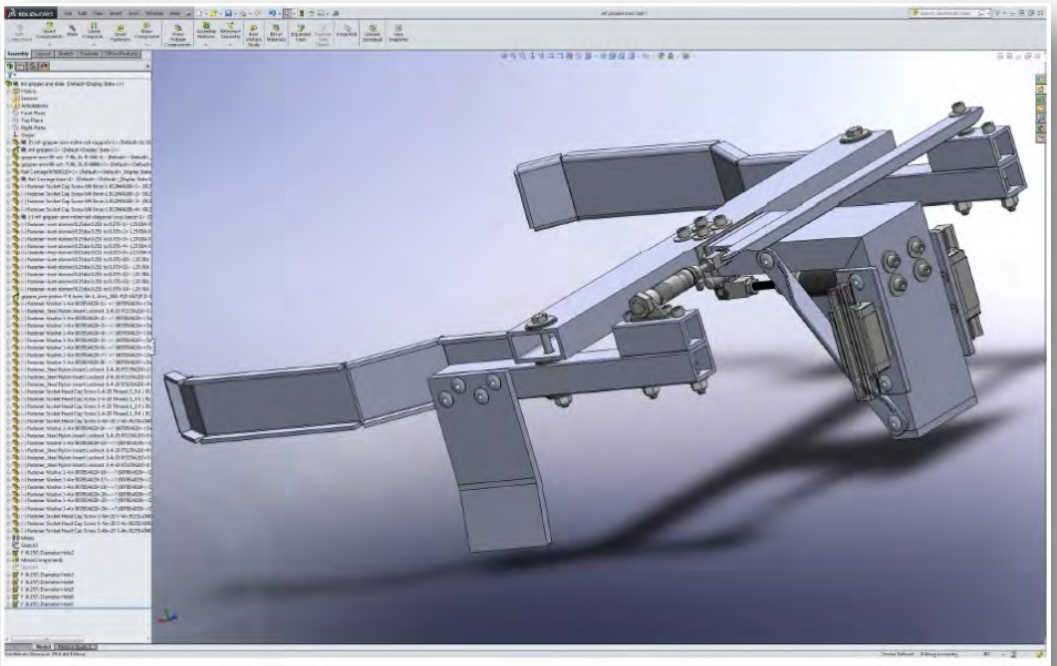


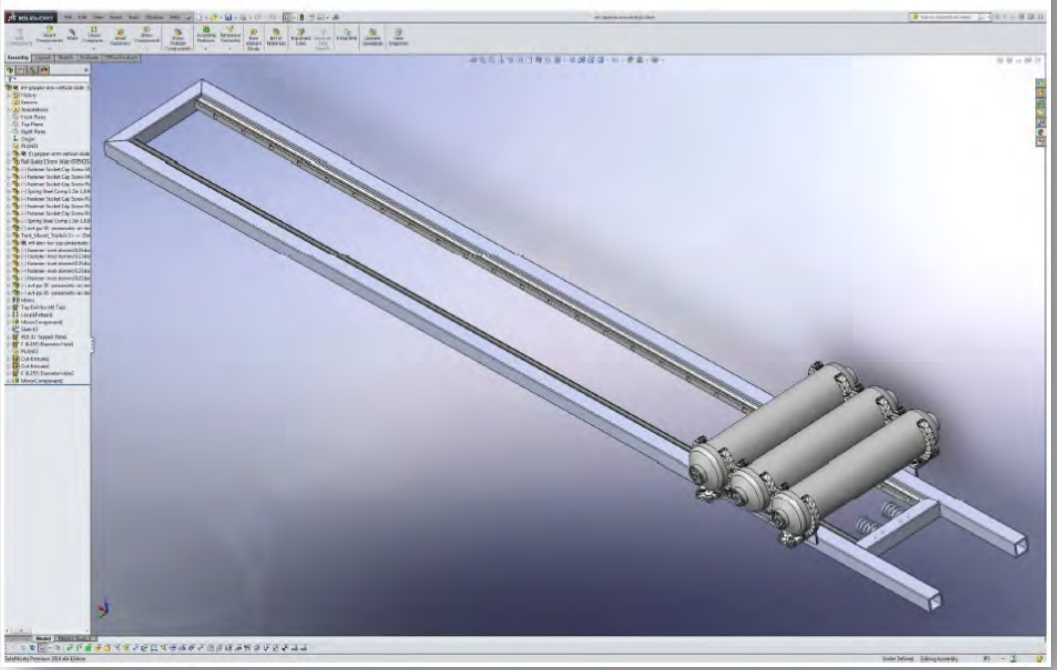
SUB ASSEMBLIES - FRAME AND ELEVATOR





SUB-ASSEMBLIES - FRAME AND ELEVATOR





APPENDIX UL6-2

These are some sample renderings of the finished model.

RENDERING SAMPLE 1

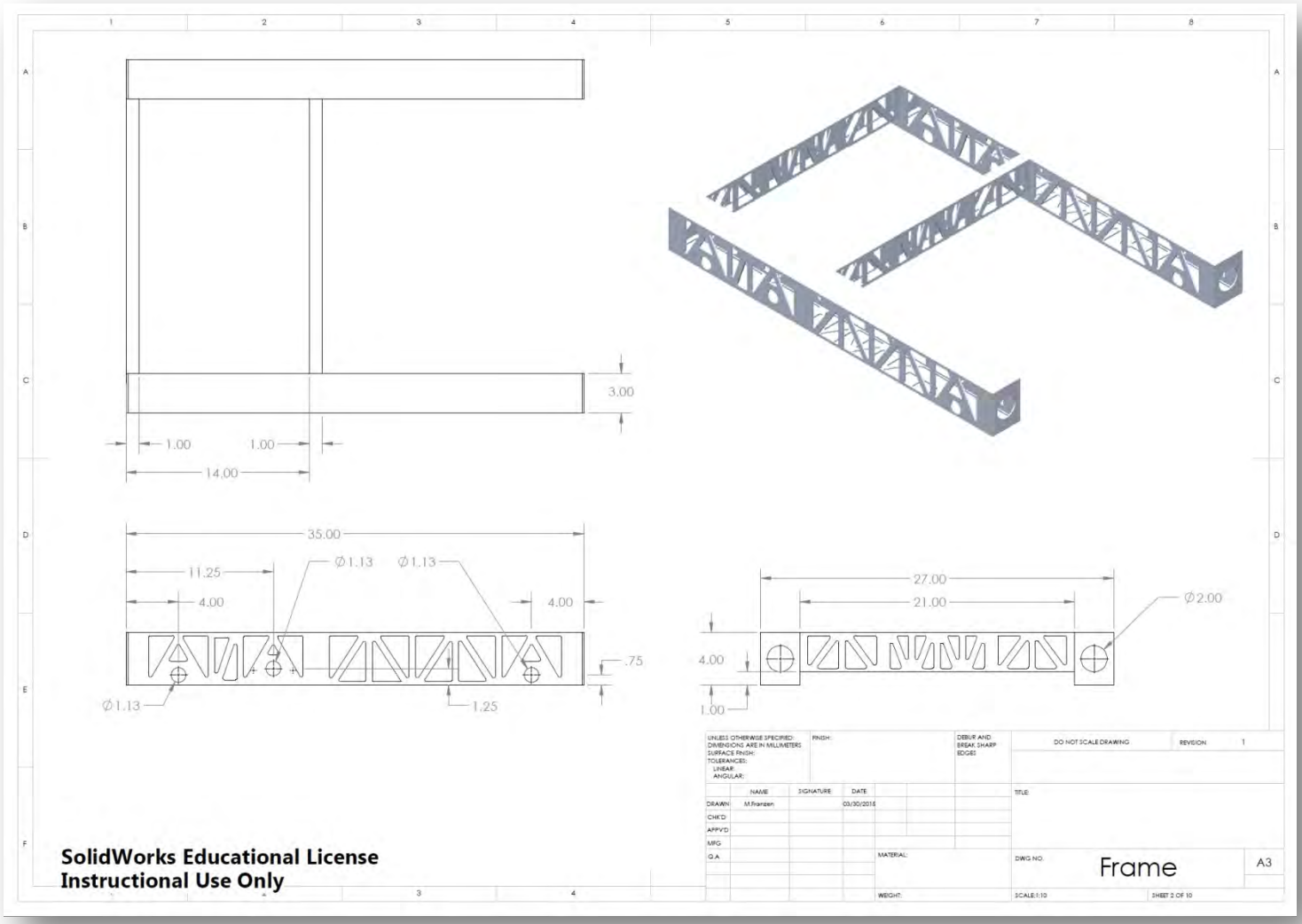
RENDERING SAMPLE 2

RENDERING SAMPLE 3

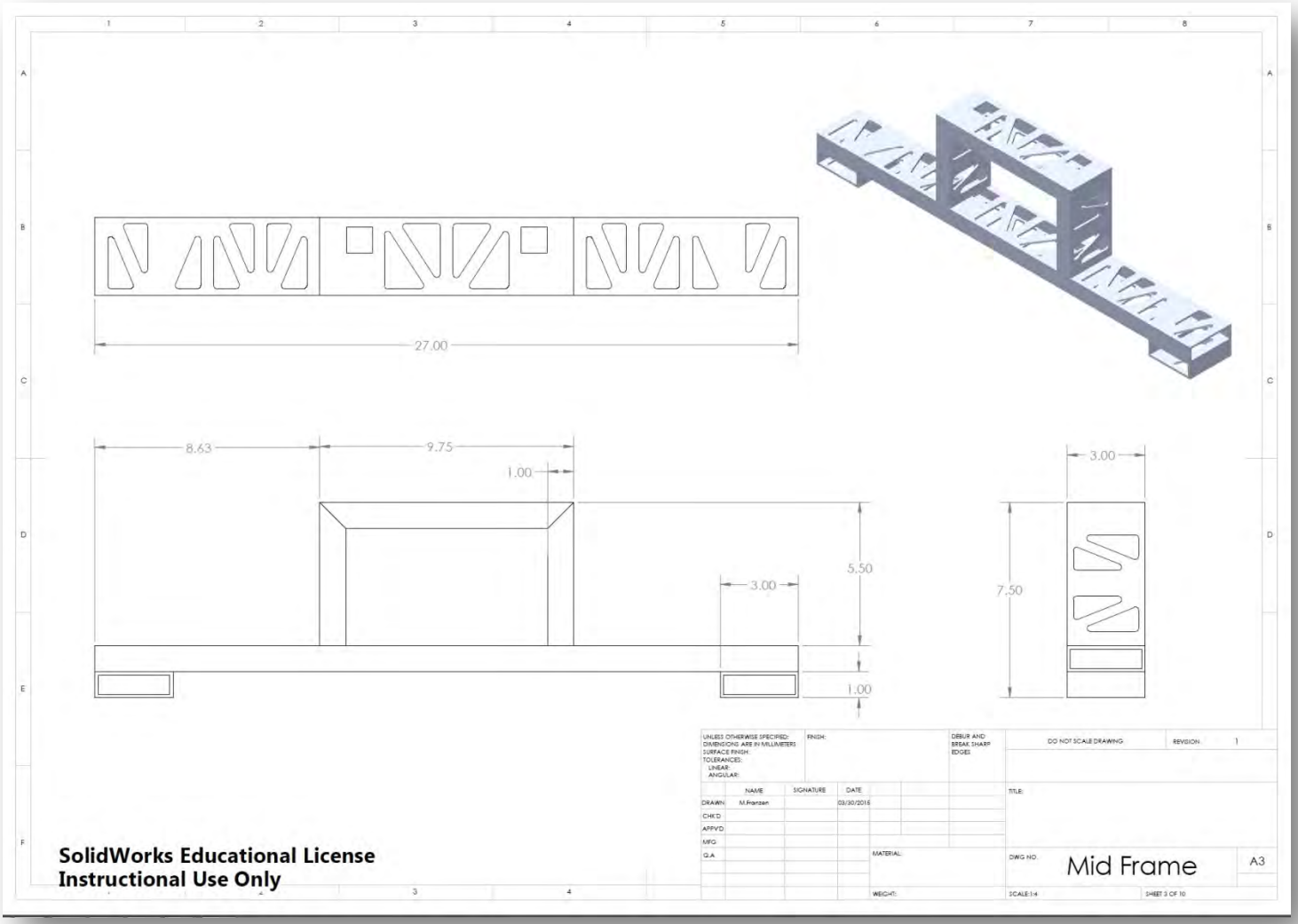
APPENDIX UL6-3

Final orthographic CAD drawings showing assemblies with Dimensions

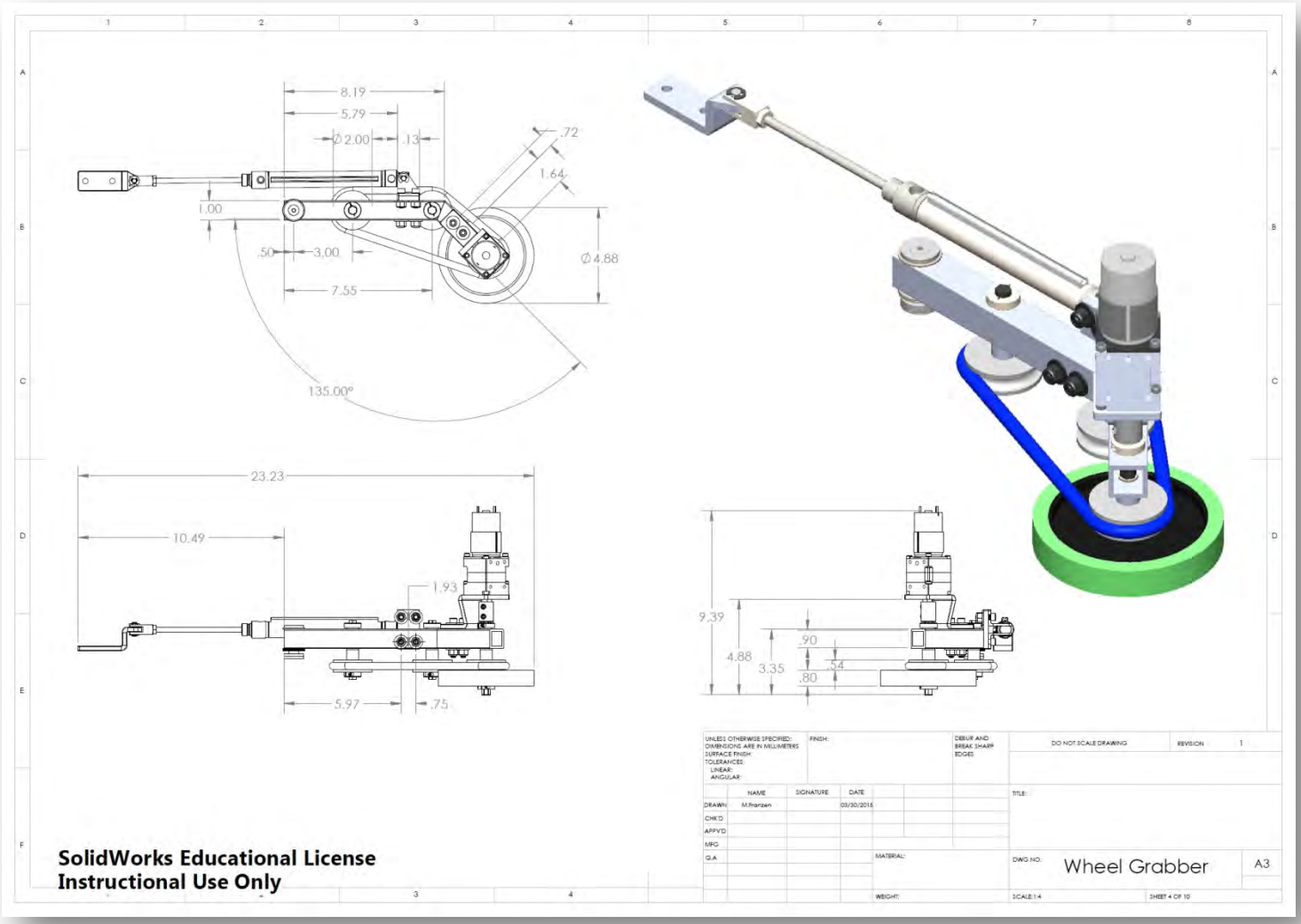
ORTHO/ISO DRIVE FRAME



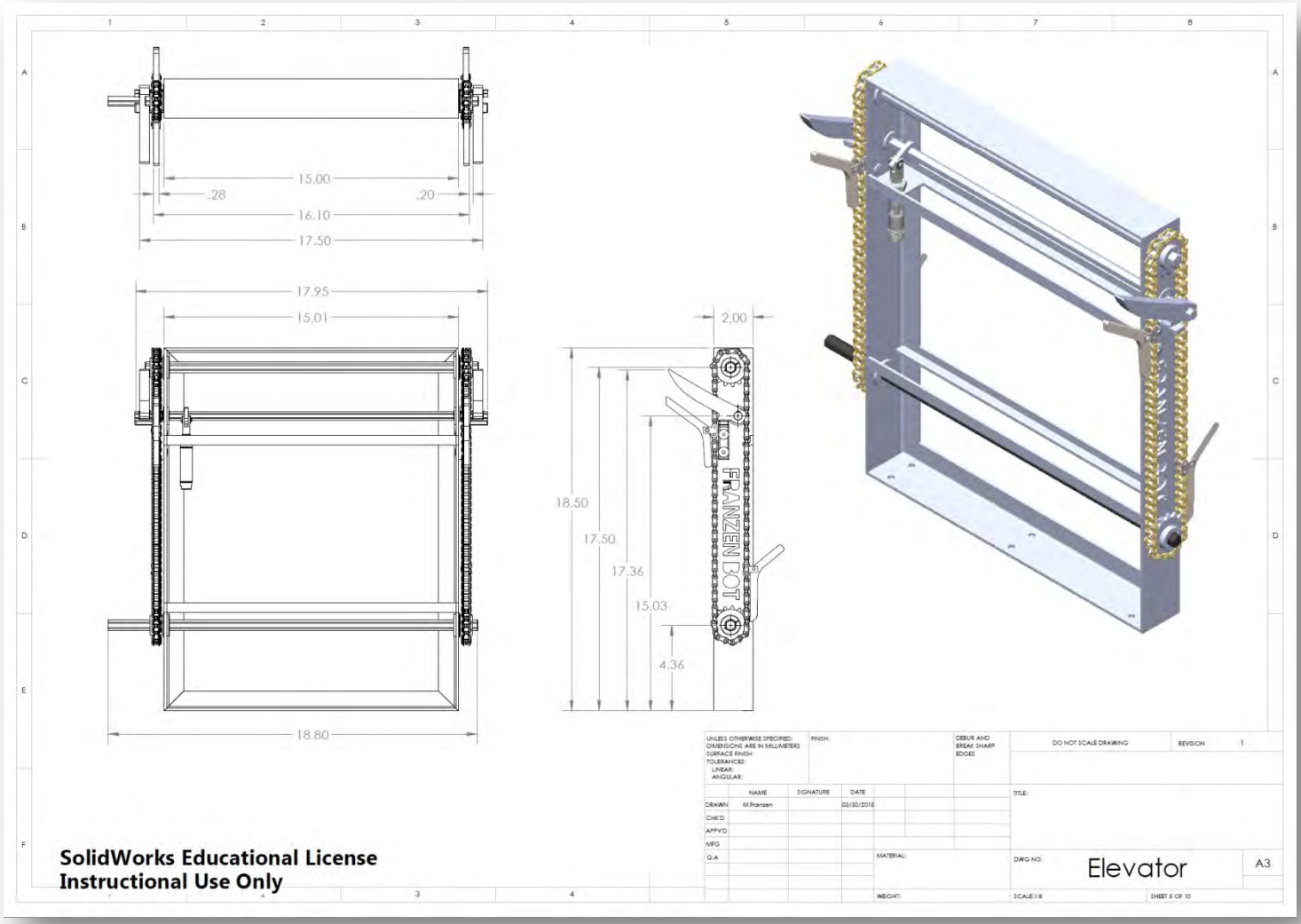
ORTHO/ISO MID FRAME



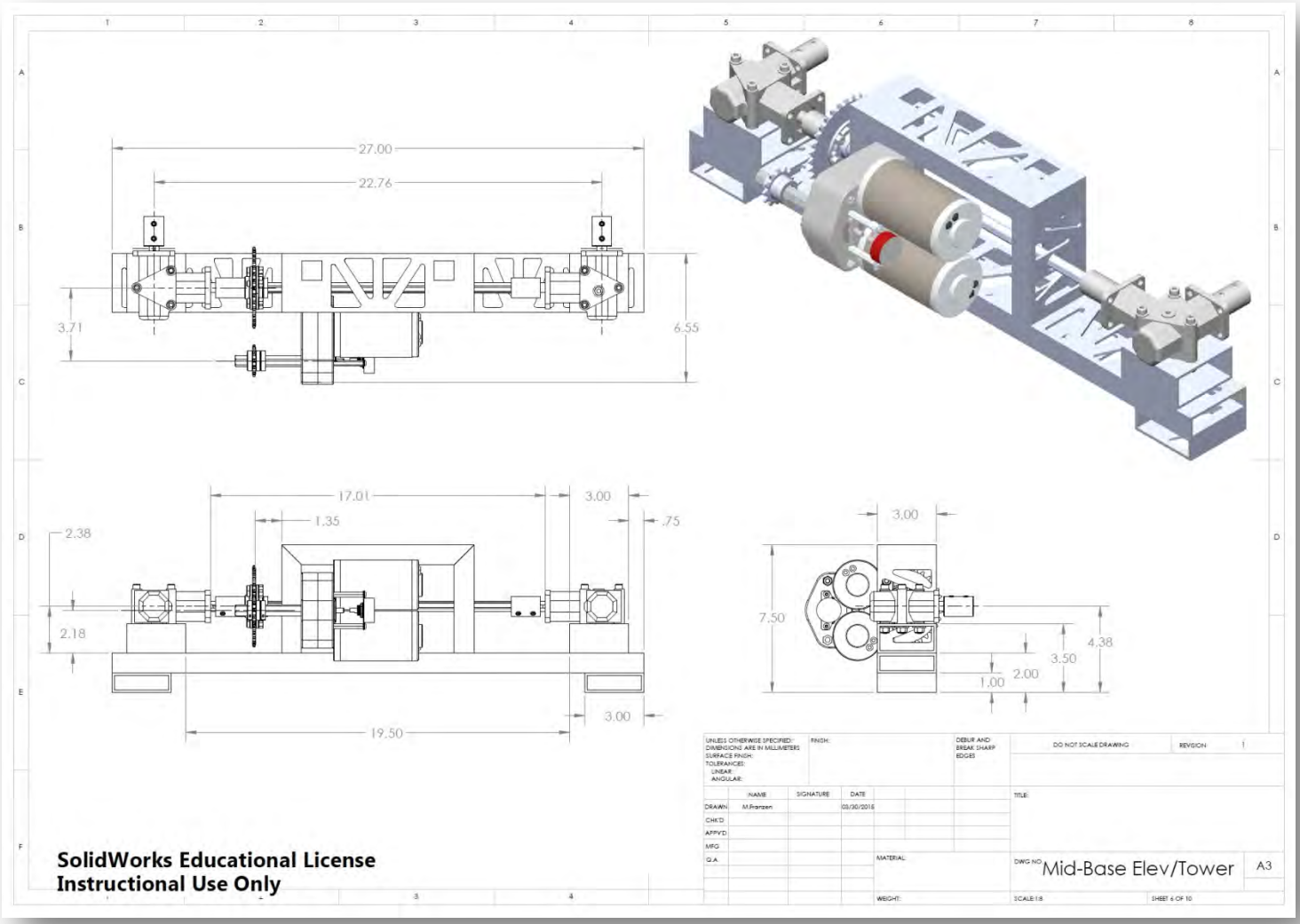
ORTHO/ISO TOTE GRABBER



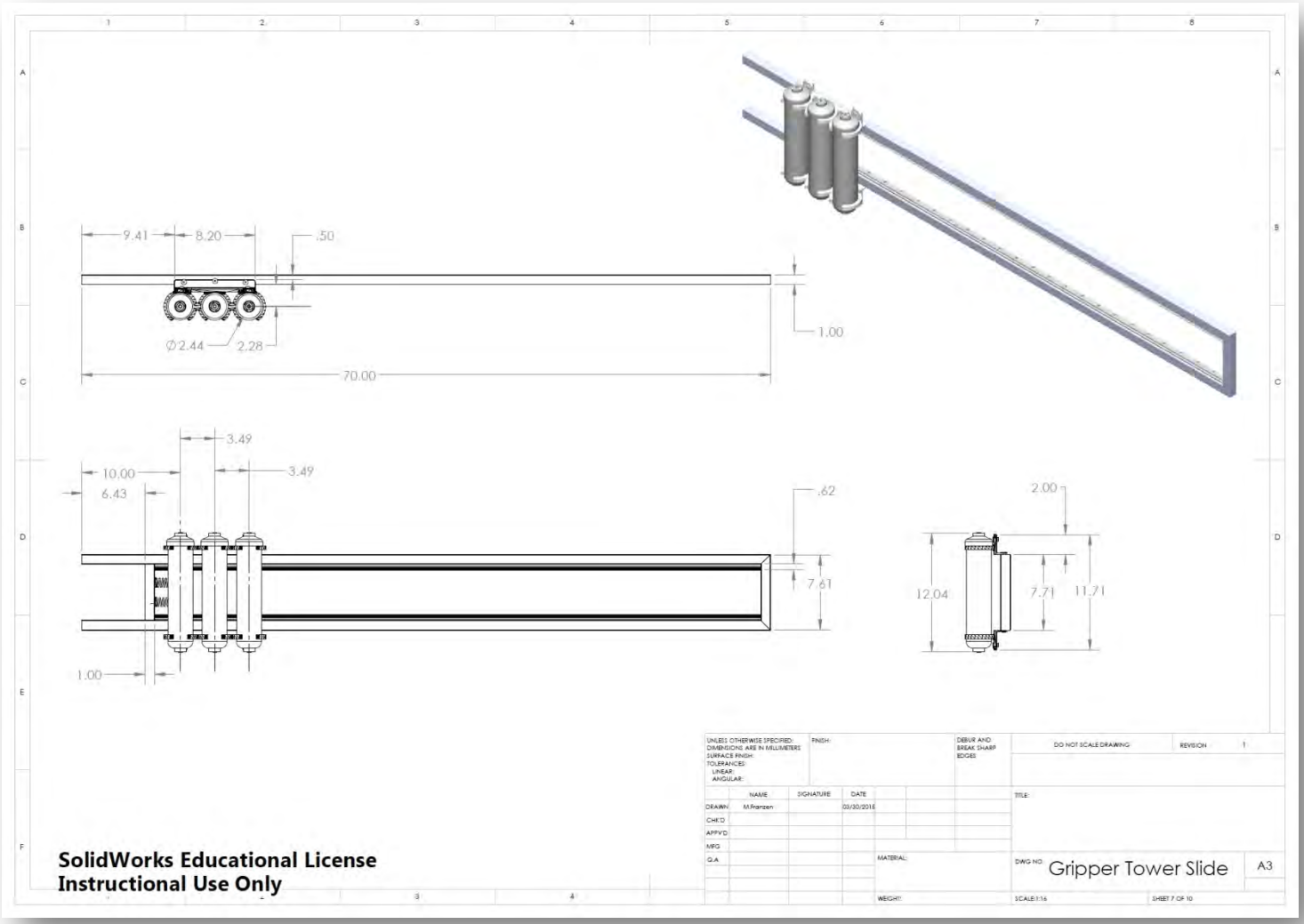
ORTHO/ISO ELEVATOR



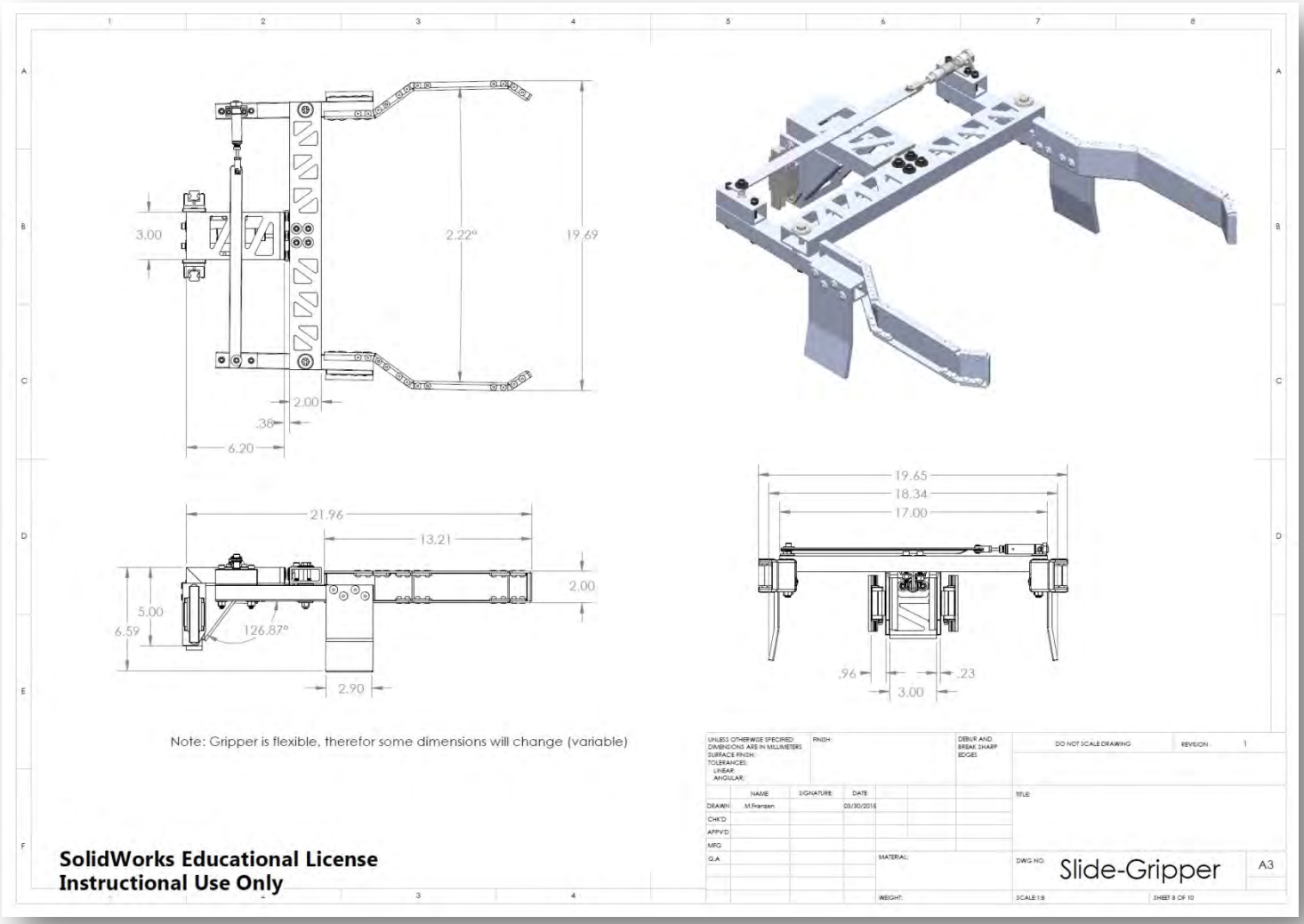
ORTHO/ISO MID BASE DRIVE/TOWER SUPPORT FRAME



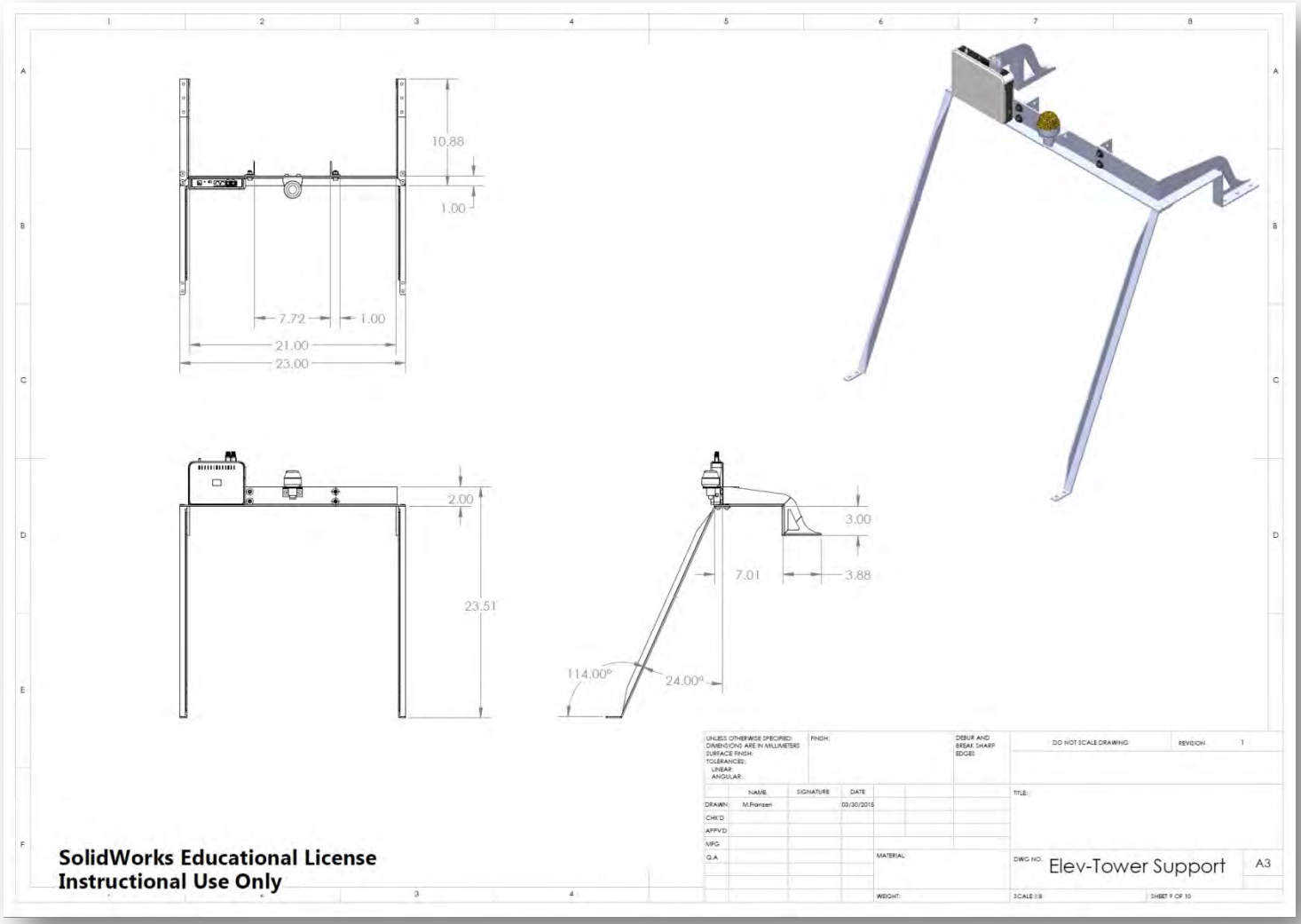
ORTHO/ISO TOWER GRIPPER SUPPOT RAIL SLIDE



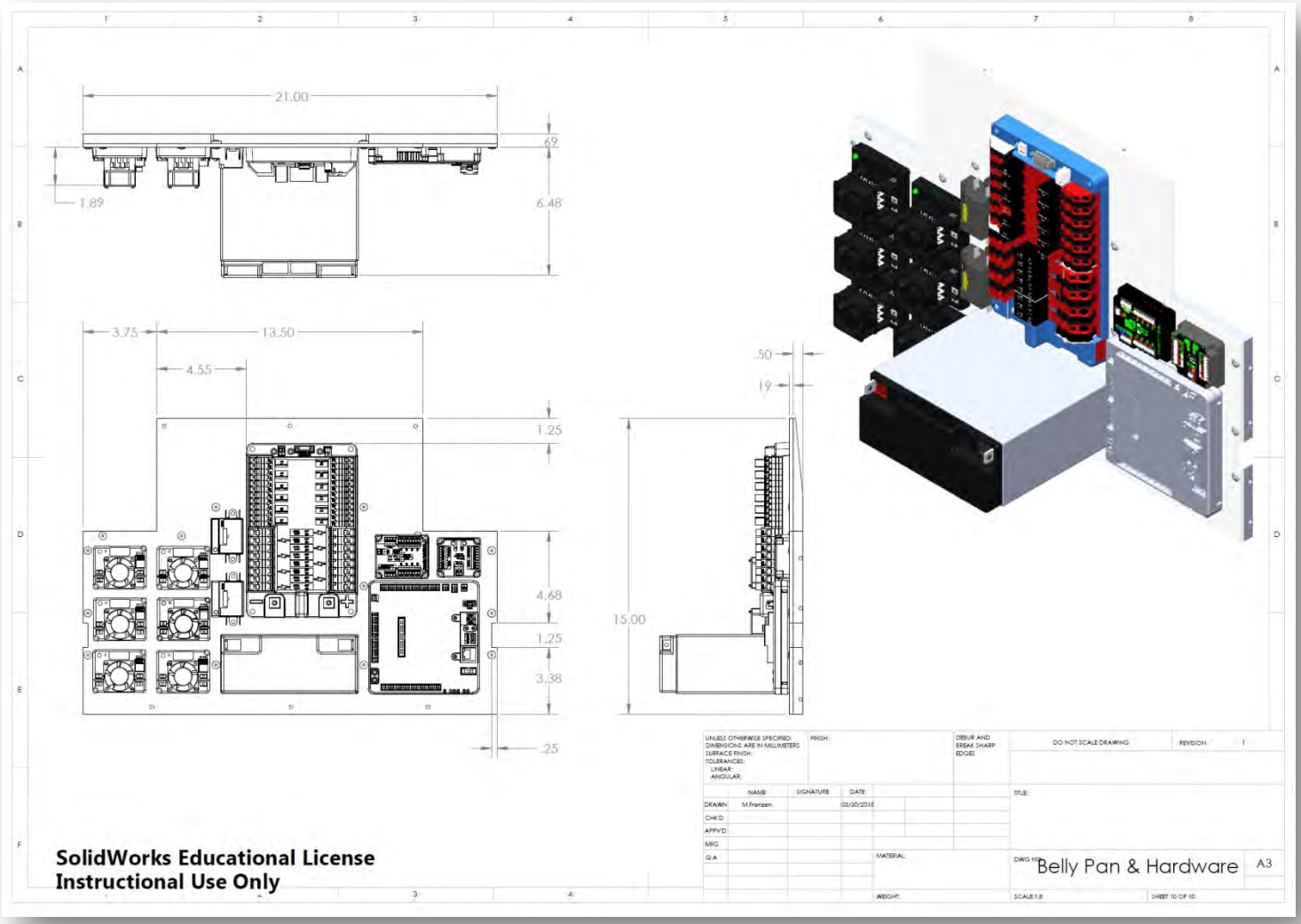
ORTHO/ISO BIN GRABBER



ORTHO/ISO ELEVATOR/TOWER UPPER SUPPORT FRAME



ORTHO/ISO BELLY PAN



APPENDIX UL6-4

The following assessment-checklist tools are for students and teacher to use throughout unit 6 for activity support.

CHECK LIST SAMPLE ROBOT MODEL

Technological Design
A Challenged Process of Ideas to a Working Solution

Name: _____
Date: _____

SAMPLE ROBOT ASSEMBLY MODEL CHECK LIST

This is a check list for ensuring you follow the right steps and check that you have completed all of the tasks. Check it off, if it is done ☑

(Ass > assembly, S-ass > sub-assembly, Twr > tower) Peer Marker Name:

#	Task	Description	Self	Peer	Teacher	Weight
1	Elevator S-ass	Is it fully defined, located correctly, fastened down, and mirrored properly?				
2	Grabber arms S -ass.	Is it fully defined, located correctly, fastened down, flexible joint, and mirrored properly?				
3	Mid frame s -Ass.	Is it fully defined, located correctly, and fastened down?				
4	Tower rail build	Parts - weldment sq. tube, built with pneumatic reservoir tanks and slides				
5	Tower rail s-Ass	Is it fully defined, located correctly, and fastened down?				
6	Gripper s-Ass	Is it fully defined, located correctly, fastened down, with a flexible joint?				
7	Upper twr/elev. build	Parts - weldment angle, holes, 2 tower brackets, 1 light bracket, 2 angle deck supports				
9	Upper twr/elev. S-ass	Is it fully defined, located correctly, and fastened down?				
10	Belly pan build	Parts - weldment angles, sheet metal poly, framed in properly, rivets				
11	Belly pan S-ass	Is it fully defined, located correctly, and fastened down?				
12	C-frame brackets	Parts - 2 L-shaped frame supports by elev. and mid frame, build, mated, fastened				
13	Chain/belt patterns	Part & pattern chain links for mid base elevator drive sprockets				
14	Assorted components	Parts - signal light, compressor, and radio				
15	Patterned frame holes	Extruded cuts - base, mid frame, and gripper, text extrude and engraving on elevator				

Name: *Michael Franzen*, File: 2015-04-07_mfranzen-A-for-L-checklist_s-ass *Page 1 of 1*

CHECK LIST CUSTOM ROBOT MODEL

Technological Design
A Challenged Process of Ideas to a Working Solution

Name:
Date: _____

CUSTOM ROBOT ASSEMBLY MODEL CHECK LIST

This is a check list for ensuring you follow the right steps and check that you have completed all of the tasks. Check it off, if it is done ☑

(Ass > assembly, S-ass > sub-assembly, Twr > tower) Peer Marker Name:

#	Task	Description	Self	Peer	Teacher	Weight
1						
2						
3						
4						
5						
6						
7						
9						
10						
11						
12						
13						
14						
15						

Name: *Michael Franzen*, File: 2015-04-07_mfranzen-A-for-L-checklist_c-ass-checklist Page 1 of 1

CHECK LIST SAMPLE ROBOT DRAWINGS

Technological Design
A Challenged Process of Ideas to a Working Solution

Name:
Date: _____

SAMPLE ROBOT DRAWINGS CHECK LIST

This is a check list for ensuring you follow the right steps and check that you have completed all of the tasks. Check it off, if it is done ☑

(Ass > assembly, S-ass > sub-assembly, Twr > tower) Peer Marker Name:

#	Task	Description	Self	Peer	Teacher	Weight
1	Frame	Ortho/ISO, line & shaded views, scaled, spacing, info block filled out, proper standards all overall & key detail dimensions by features, placement, organized, centre marks/lines				
2	Mid frame	Ortho/ISO, line & shaded views, scaled, spacing, info block filled out, proper standards all overall & key detail dimensions by features, placement, organized, centre marks/lines				
3	Tote grabber	Ortho/ISO, line & shaded views, scaled, spacing, info block filled out, proper standards all overall & key detail dimensions by features, placement, organized, centre marks/lines				
4	Elevator	Ortho/ISO, line & shaded views, scaled, spacing, info block filled out, proper standards all overall & key detail dimensions by features, placement, organized, centre marks/lines				
5	Mid base drive/tower	Ortho/ISO, line & shaded views, scaled, spacing, info block filled out, proper standards all overall & key detail dimensions by features, placement, organized, centre marks/lines				
6	Tower gripper rail	Ortho/ISO, line & shaded views, scaled, spacing, info block filled out, proper standards all overall & key detail dimensions by features, placement, organized, centre marks/lines				
7	Bin gripper	Ortho/ISO, line & shaded views, scaled, spacing, info block filled out, proper standards all overall & key detail dimensions by features, placement, organized, centre marks/lines				
9	Elev/tower sup frame	Ortho/ISO, line & shaded views, scaled, spacing, info block filled out, proper standards all overall & key detail dimensions by features, placement, organized, centre marks/lines				
10	Belly pan	Ortho/ISO, line & shaded views, scaled, spacing, info block filled out, proper standards all overall & key detail dimensions by features, placement, organized, centre marks/lines				
11						
12						
13						
14						
15						

Name: *Michael Franzen*, File: 2015-04-07_mfranzen-A-for-L-checklist_s-dwgs-checklist Page 1 of 1

CHECK LIST CUSTOM ROBOT DRAWINGS

Technological Design
A Challenged Process of Ideas to a Working Solution

Name: _____
Date: _____

CUSTOM ROBOT DRAWINGS CHECK LIST

This is a check list for ensuring you follow the right steps and check that you have completed all of the tasks. Check it off, if it is done ☑

(Ass > assembly, S-ass > sub-assembly, Twr > tower) Peer Marker Name:

#	Task	Description	Self	Peer	Teacher	Weight
1	Frame	Ortho/ISO, line & shaded views, scaled, spacing, info block filled out, proper standards all overall & key detail dimensions by features, placement, organized, centre marks/lines				
2		Ortho/ISO, line & shaded views, scaled, spacing, info block filled out, proper standards all overall & key detail dimensions by features, placement, organized, centre marks/lines				
3		Ortho/ISO, line & shaded views, scaled, spacing, info block filled out, proper standards all overall & key detail dimensions by features, placement, organized, centre marks/lines				
4		Ortho/ISO, line & shaded views, scaled, spacing, info block filled out, proper standards all overall & key detail dimensions by features, placement, organized, centre marks/lines				
5		Ortho/ISO, line & shaded views, scaled, spacing, info block filled out, proper standards all overall & key detail dimensions by features, placement, organized, centre marks/lines				
6		Ortho/ISO, line & shaded views, scaled, spacing, info block filled out, proper standards all overall & key detail dimensions by features, placement, organized, centre marks/lines				
7		Ortho/ISO, line & shaded views, scaled, spacing, info block filled out, proper standards all overall & key detail dimensions by features, placement, organized, centre marks/lines				
9		Ortho/ISO, line & shaded views, scaled, spacing, info block filled out, proper standards all overall & key detail dimensions by features, placement, organized, centre marks/lines				
10		Ortho/ISO, line & shaded views, scaled, spacing, info block filled out, proper standards all overall & key detail dimensions by features, placement, organized, centre marks/lines				
11						
12						
13						
14						
15						

Name: *Michael Franzen*, File: 2015-04-07_mfranzen-A-for-L-checklist_c-dwgs-checklist

Page 1 of 1

CHECK LIST POST ROBOT REPORT

Technological Design
A Challenged Process of Ideas to a Working Solution

Name:
Date: _____

POST ROBOT REPORT CHECK LIST

This is a check list for ensuring you follow the right steps and check that you have completed all of the tasks. Check it off, if it is done ☑

Peer Marker Name:

#	Task	Description	Self	Peer	Teacher	Weight
1	Report outline	Title page, project rational, challenge statement, design criteria, procedure notes, conclusion, materials, drawing/illustrations, references, journal log descriptions.				
2	Title page	Cover page, report name, author, school, course, instructor, date, and related image.				
3	Project rational	Reason for, scope of, purpose of project and how you will assess design solutions.				
4	Challenge statement	Identify the situation and challenge briefly.				
5	Design criteria	What factors or criteria did you base your design on and why.				
6	Procedure notes	In-depth steps in the design process to how you got to the solution.				
7	Conclusion	Learning in the process – new skills, knowledge, & attitudes, and future considerations.				
9	Materials	List all related materials and costs. Tools and equipment needed to fabricate.				
10	Drawing/illustrations	Include all related sketches, drawings, illustrations, and images labeled with descriptors.				
11	References	List all support resources and sources used to complete in MLA format.				
12	Journal log	Daily journal/log of key steps, dates, and hours				
13						
14						
15						

Name: *Michael Franzen,* File: 2015-04-07_mfranzen-A-for-L-checklist_post-rob-rpt

Page 1 of 1

APPENDIX UL6-5

The following is a sample robot design project and post robot design report.

SAMPLE ROBOT DESIGN PROJECT

Senior Design Project

2015 FIRST FRC Robot Design

Robot Features

* Six tote stack capacity with bin
* Gripper tower slide stablizes totes and bin
* Lightweigt aluminum chassis
* Front tote grabber, grabs totes wide or narrow
* Rear omni wheel for optimal turning control
* Two-CIM-powered elevator drive
* Four-CIM tank drive system
* Elevator tote lifts, mechanically synced on both sides
* Ground clearance clears scoring platforms
* Robot designed and built in CAD

Attached

* Robot design brief
* Sketches and roughs
* Rendered pictures
* Screen captures during build
* Assembly drawing files

By Michael Franzen

Technological Design — Michael Franzen
A Challenged Process of Ideas to a Working Solution — Date: March 2015

Robot Design Brief

A lot of planning went into making sure this robot is aligned with the competition game rules. As such several iterations were needed to ensure field elements such as noodles, scoring platform, totes, and recycling bins, were overcome. Below is a quick description of the game, explanation of robot functions, and final thoughts

Game Description

Recycle Rush is name the 2015 FIRST Robotics Competition game. It involves picking up and stacking totes on scoring platforms, putting pool noodles inside recycling containers, and putting the containers on top of scoring stacks of totes. There is also a coopetition possibility to also gain points. The game is played in autonomous and tele-operated. Autonomous is a 15 second period (of a total of two minutes total) where the robot may act on its own where robots can gain points by moving into the auto zone and/or bring yellow totes, and/or recycle bins into the auto zone for different points. Teleoperation is the balance of the game where students participate with supply totes, noodles, robot driving to gain points by stacking totes with the bins.

Robot Design

Robot main function during Teleoperation is designed to quickly grab a green recycling bin either standing up or sideways. Sideways it will have to approach the bin from the bottom side in order to fit into tote space staking chamber area and the gripper controlled by two pneumatic actuators, one for the 90 degree angle about a hinge and the second actuator for gripping the bin. Once bin is gripped, elevator will push both the gripper assembly (attached with bearing slide) and the recycling bin up to the secondary tote latch. At this point the robot can start collecting the totes. Grabbers in the front of the robot have rubberized sticky wheels and urethane round belt to pull totes into stacking chamber. Because grabbers are also controlled by pneumatic actuators, they will be able to grab bins wide or narrow without having to adjust approach. The elevator system with sensors and encoder can control the location of the chain-linked tote-lifts to pick up bins once they are in the chamber. As the elevator lifts the first tote, it will push the bin, the gripper system up until the secondary tote latch "catches" and then there is room in the tote chamber for the grabbers to pull another tote in and allow the elevator again to lift another tote, again and again until there are 6 collected.

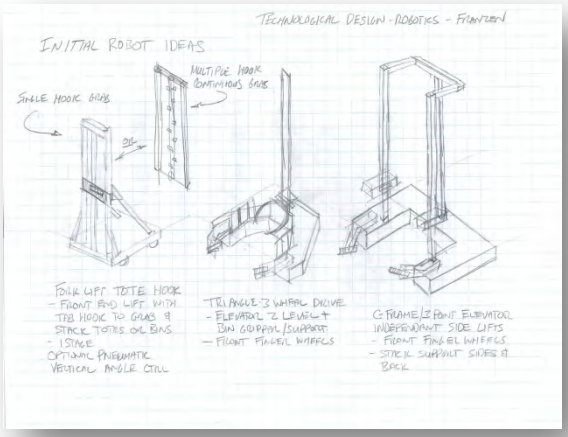
The robot frame was the first part created and was designed to house the elevator tote pick-up area and house large format wheels. With the large format wheels, it allows the robot to clear the scoring ramps when traveling over them. Omni wheels were put on the back to improve the turning ability especially with front weighted down with totes with tank type drive train. The tower and elevator would have a 3- degree lean towards the back of the robot to allow totes to lean against the tower while the gripper holds the bin on top and the top tote, thereby stabilizing the six-high stack and significantly reducing the chance of stack falling.

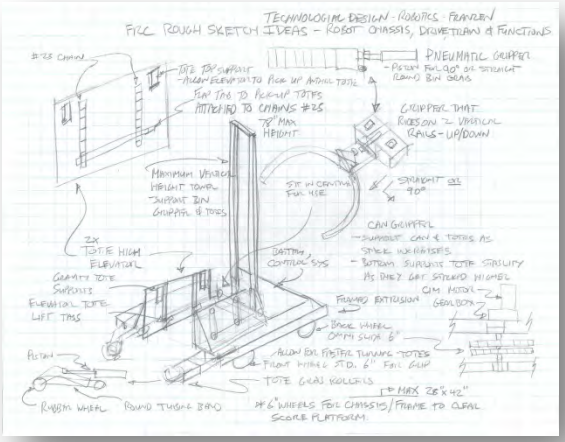
An additional design function could be to build 2 tall mini expandable arms to grab two green recycling bins during autonomous mode. This would allow robot's team access to more points in theory than the other team. Using sensors, during autonomous mode, the robot could collect the three yellow bins to the scoring zone for additional points.

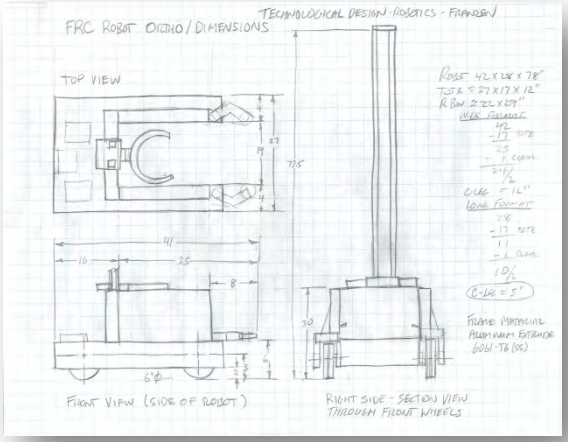
Final thoughts:

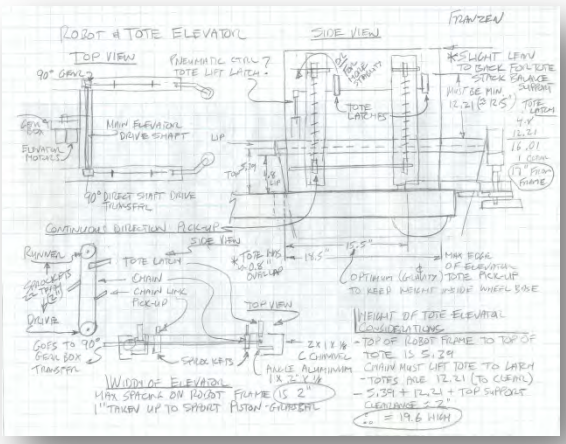
As this robot is very detailed and fully built in CAD, the model for my computer system was taxing and building the last components took a lot longer to complete because of the enormous amount of parts and data. I had some issues with Bimba actuators in assemblies when they were set to flexible (for design prototyping to see how parts behave), somehow caused other mate issues. This was an amazing project with lots of work accomplished and lots of learning acquired through the first time use with SolidWorks.

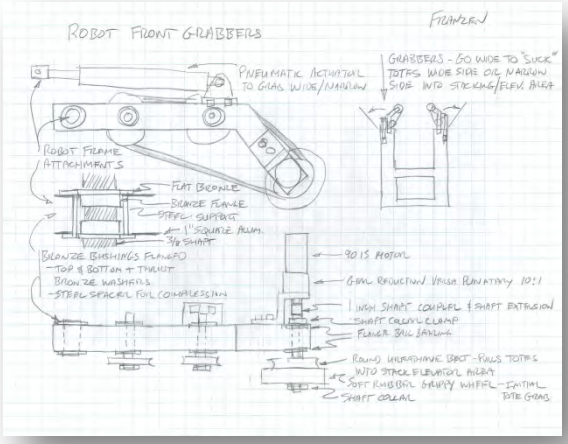
Name: Michael Franzen, File: 2015-04-07_Franzen-TD-11-Course Profile — Page 1 of 1

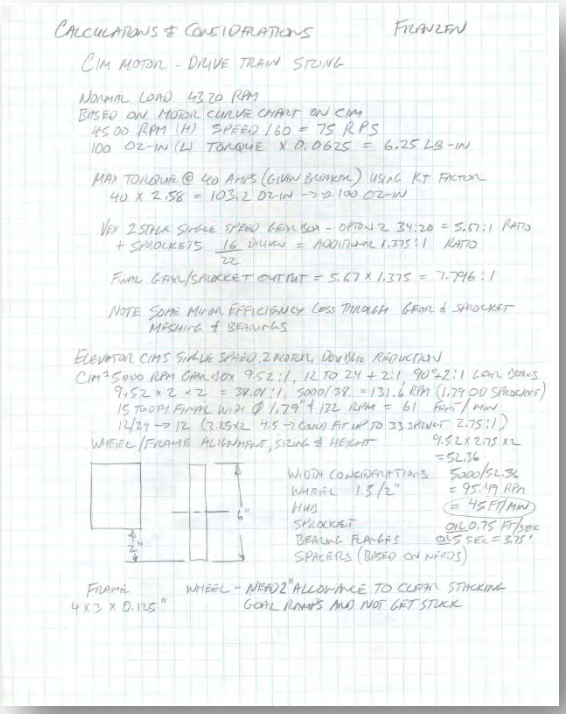


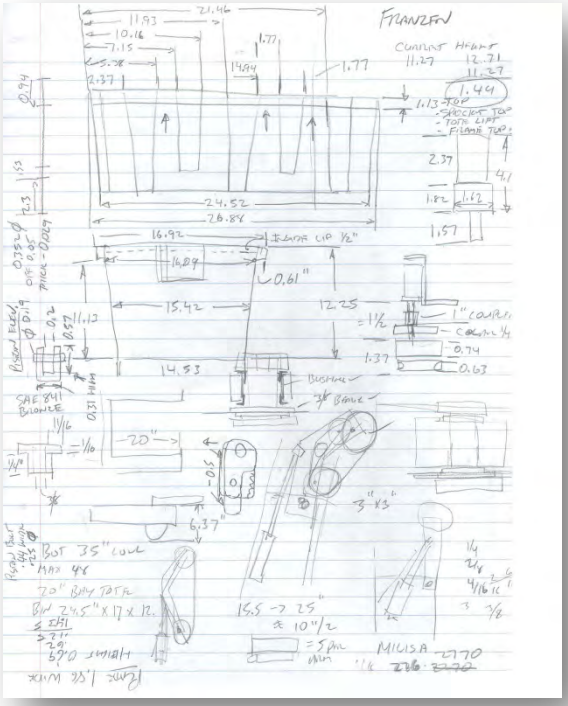


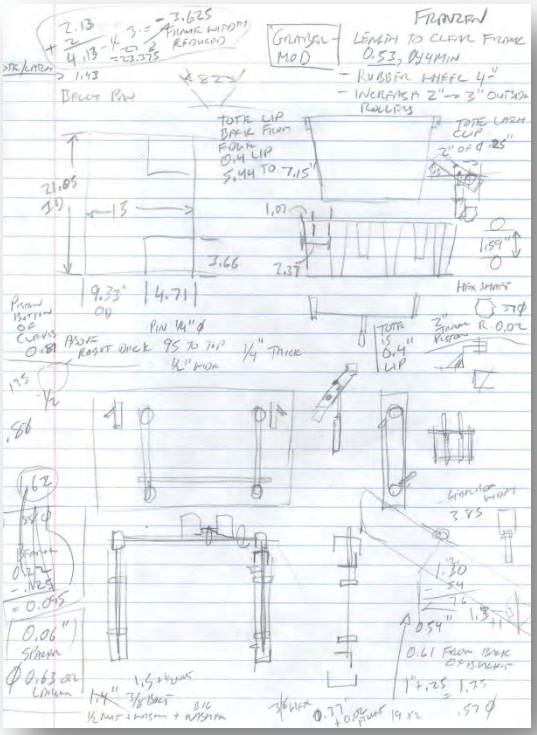


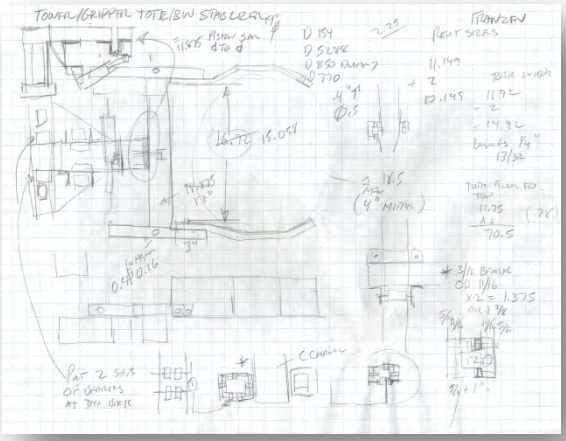

ROBOT & TOTE ELEVATOR
FRANZEN
TOP VIEW
SIDE VIEW
PNEUMATIC STYLE TOTE LIFT LATCH
MAIN ELEVATOR DRIVE SHAFT
90° RIGHT SHAFT DRIVE TRANSFER
CONTINUOUS ROLLER CHAIN PICK-UP
RUNNER
TOTE LATCH
CHAIN
CHAIN LINK PICK-UP
DRIVE
GOES TO 90° GEAR BOX TRANSFER
SPROCKETS
WIDTH OF ELEVATOR
MAX STROKE ON ROBOT FRAME IS 2"
1" TAKEN UP TO SHORT PISTON-CYLINDER
OPTIMUM (QUALITY) TOTE PICK-UP TO KEEP HEIGHT INSIDE WHEEL BASE
HEIGHT OF TOTE ELEVATOR CONSIDERATIONS
- TOP OF ROBOT FRAME TO TOP OF TOTE IS 5.39
- CHAIN MUST LIFT TOTE TO LATCH
- TOTES ARE 12.21 (TO CLEAR)
- 5.39 + 12.21 + TOP SUPPORT CLEARANCE = 2"
= 19.6 HIGH

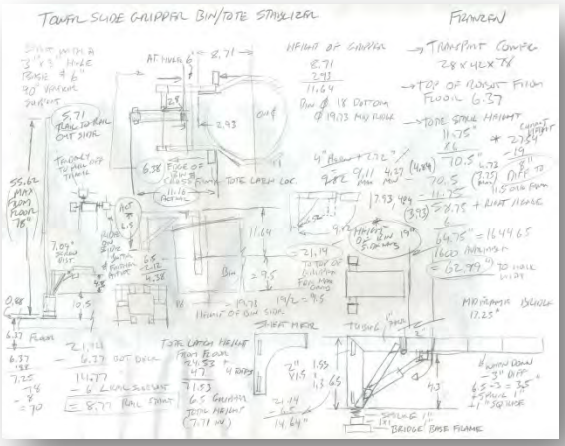

ROBOT FRONT GRABBERS
FRANZEN
PNEUMATIC ACTUATORS TO GRAB WIDE/NARROW
GRABBERS - GO WIDE TO "SUCK" TOTES WIDE SIDE OR NARROW SIDE INTO STACKING/ELEV. AREA
ROBOT FRAME ATTACHMENTS
FLAT BRONZE
BRONZE FLANGE
STEEL SUPPORT
1" SQUARE ALUM.
3/8 SHAFT
BRONZE BUSHINGS FLANGED
- TOP & BOTTOM + THRUST
BRONZE WASHERS
- STEEL SPACER FOR COMPRESSION
90 IS MOTOR
GEAR REDUCTION VARIES PLANETARY 10:1
HIGH SHAFT COUPLER & SHAFT EXTENSION
SHAFT COLLAR CLAMP
FLANGE BALL BEARING
ROUND UNDERHANG BOT - PULLS TOTES INTO STACK ELEVATOR ALIGN
SOFT RUBBER GRIPPY WHEEL - INITIAL TOTE GRAB
SHAFT COLLAR

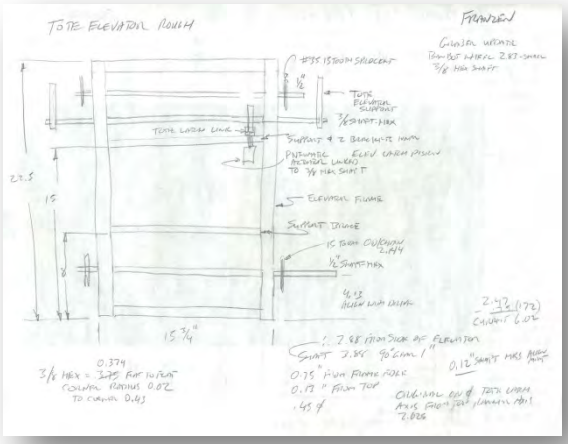

CALCULATIONS & CONSIDERATIONS
FRANZEN
CIM MOTOR - DRIVE TRAIN STUFF
NOMINAL LOAD 4370 RPM
BASED ON MOTOR CURVE CHART ON CIM
4500 RPM (H) SPEED / 60 = 75 RPS
100 OZ-IN (L) TORQUE X 0.0625 = 6.25 LB-IN
MAX TORQUE @ 40 AMPS (GIVEN BREAKER) USING KT FACTOR
40 X 2.58 = 103.2 OZ-IN --> 100 OZ-IN
VEX 2 STAGE SINGLE SPEED GEARBOX - OPTION 2 34:20 = 5.67:1 RATIO
+ SPROCKETS 16 DRIVEN = ADDITIONAL 1.375:1 RATIO
22
FINAL GEAR/SPROCKET OUTPUT = 5.67 X 1.375 = 7.796:1
NOTE SOME MINOR EFFICIENCY LOSS THROUGH GEARS & SPROCKET MESHING & BEARINGS
ELEVATOR CIMS SINGLE SPEED 2 MOTOR, DOUBLE REDUCTION
CIM 5000 RPM GEARBOX 9.52:1, 12 TO 24 + 2:1, 90°2:1 CHAIN SPEEDS
9.52 X 2 X 2 = 38.01:1, 5000/38. = 131.6 RPM (1.79:00 SPROCKET)
15 TOOTH FINAL WITH @ 1.79" 1/32 RPM = 61 FPM / MIN
12/24 --> 12 (2.25x2 4.5 --> COULD FIT UP TO 33 SPROCKET 2.75:1)
WHEEL/FRAME ALIGNMENT, SIZING & HEIGHT
9.52 X 2.75 X 2 = 52.36
WIDTH CONSIDERATIONS
WHEEL 1.5/2"
HUB
SPROCKET
BEARING FLANGES
SPACERS (BASED ON NEEDS)
5000/52.36 = 95.49 RPM = 45 FT/MIN
@ 0.75 FT/SEC @ 5 SEC = 3.75'
FRAME 4 X 3 X 0.125"
WHEEL - NEED 2" ALLOWANCE TO CLEAR STACKING GOAL ALWAYS AND NOT GET STUCK

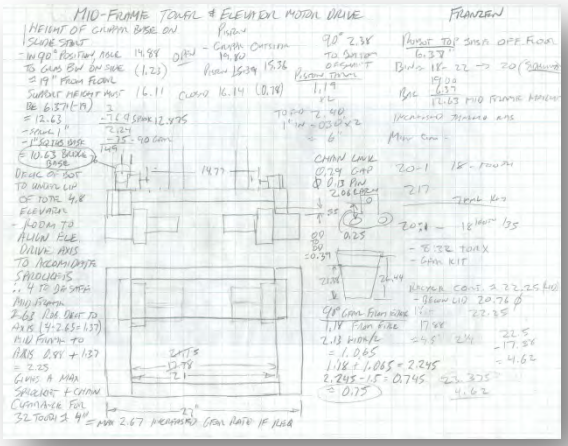

FRANZEN
11.93
21.46
10.16
7.15
5.38
2.37
1.77
19.94
24.52
26.84
16.92
16.29
0.61"
15.42
12.25
11.12
14.53
BUSHING
20"
6.37
BOT 35" CUBE
MAX 48
72" BOT TOTE
BW 24.5" X 17 X 12.
15.5 - 25"
± 10"/2
MILLS A
CENTER HEIGHT
12.71
11.27
1.44
1.13 TOP
- SPROCKET TOP
- TOTE LIP
- FLANGE TOP
2.37
4.1
1.82
1.42
1.57
0.74
0.63

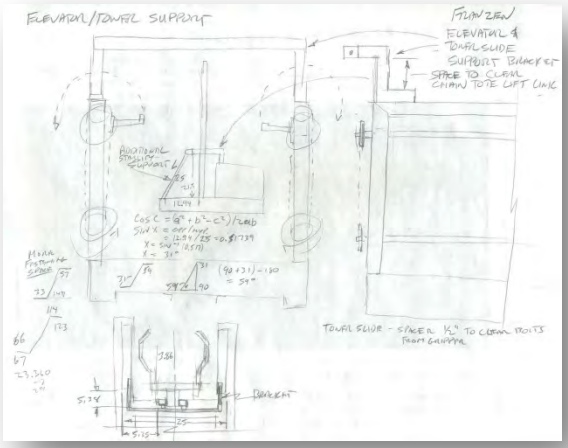


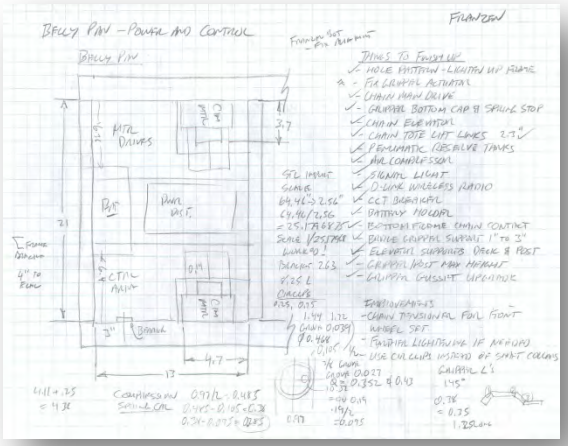


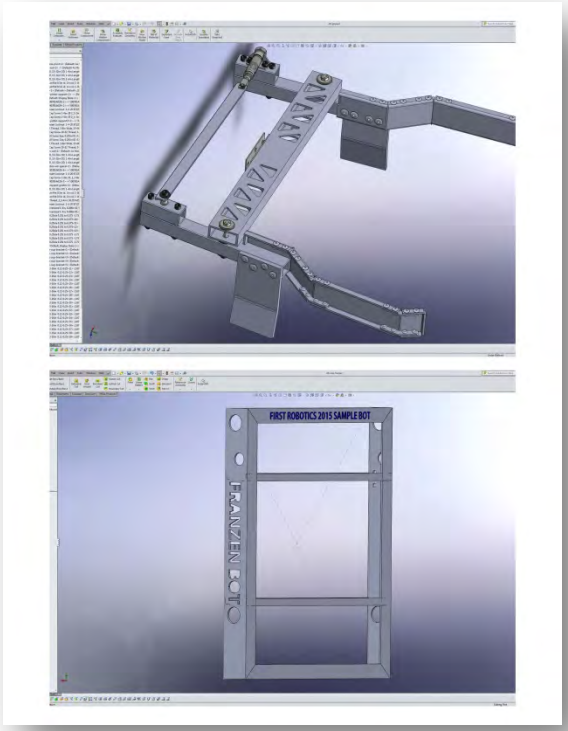


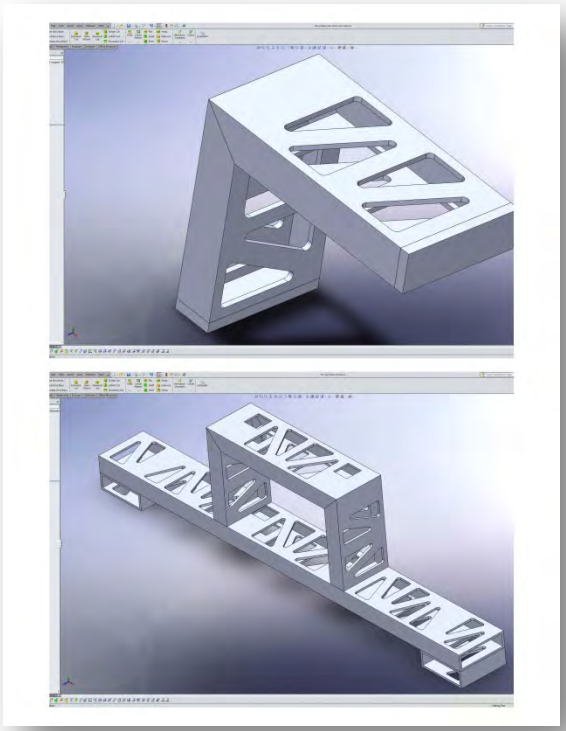


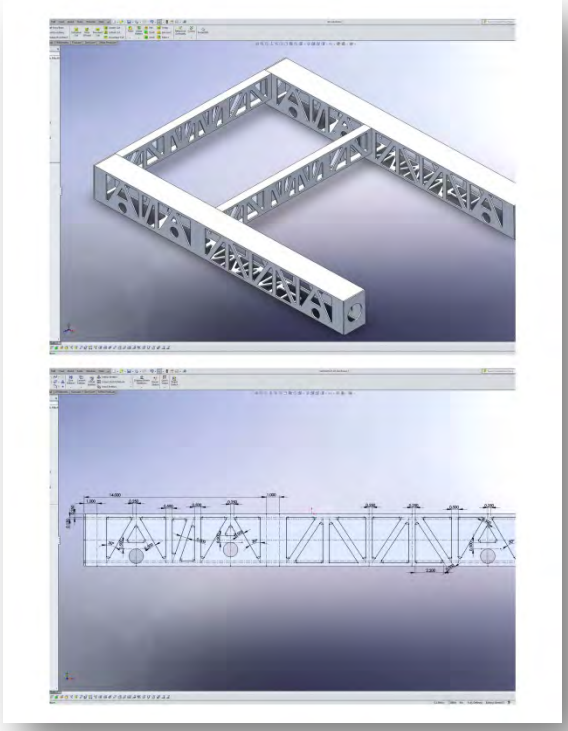

MID-FRAME TOWER & ELEVATOR MOTOR DRIVE
FRANZEN

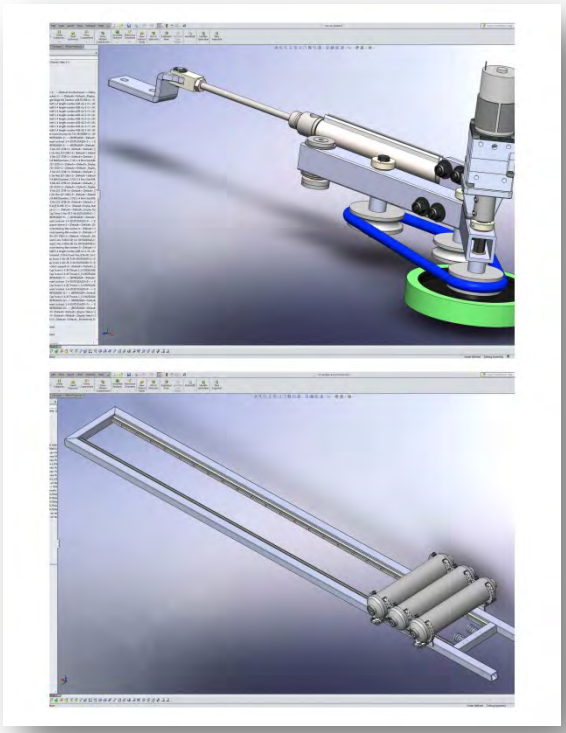

ELEVATOR/TOWER SUPPORT
FRANZEN

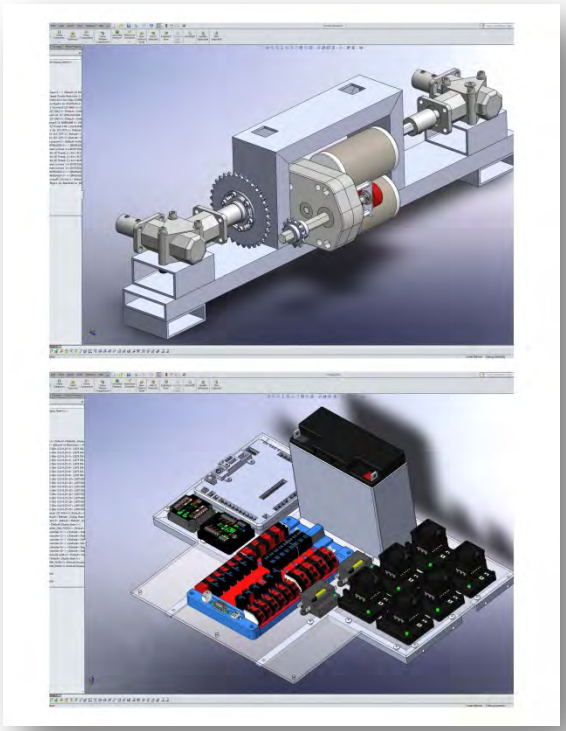

BELLY PAN - POWER AND CONTROL
FRANZEN

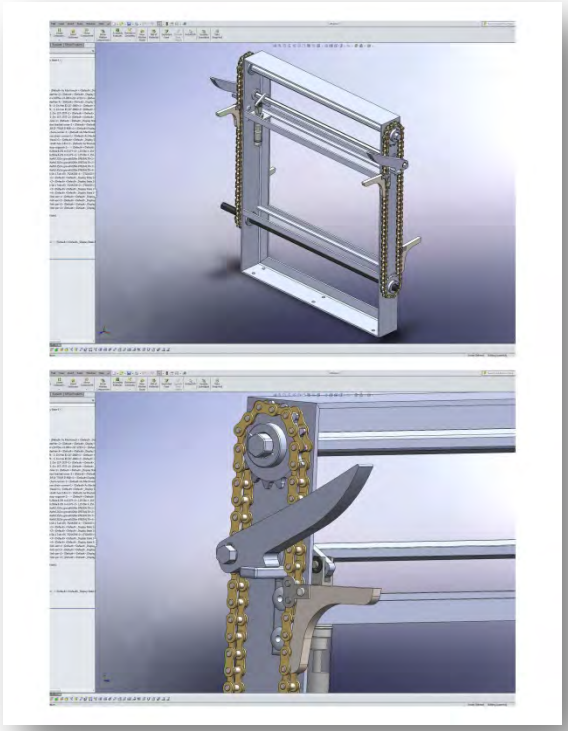

FRANZEN
FIRST ROBOTICS 2015 SAMPLE BOT
FRANZEN ROBOTICS

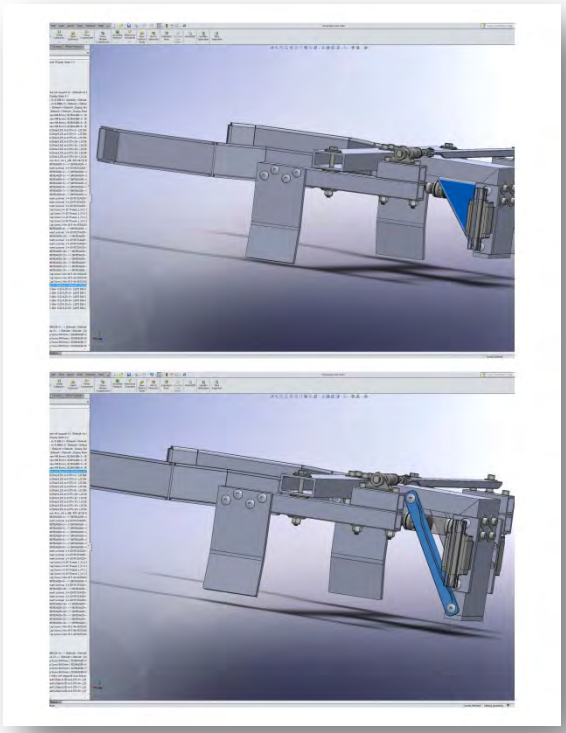


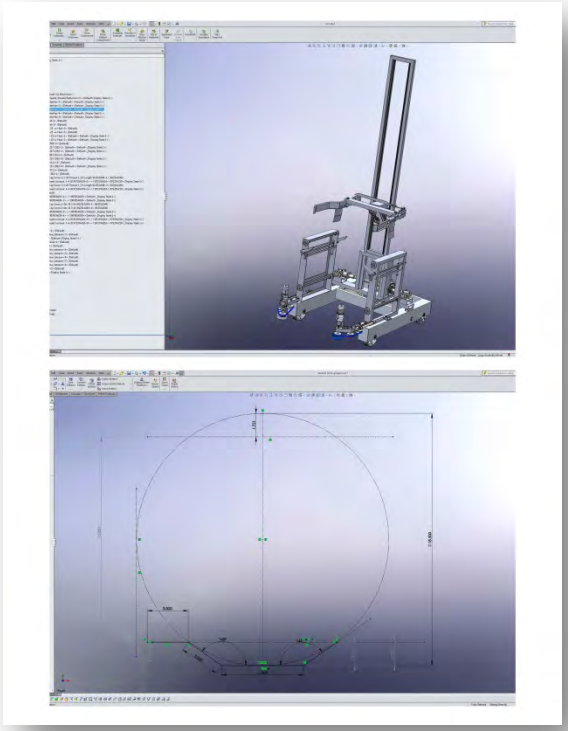


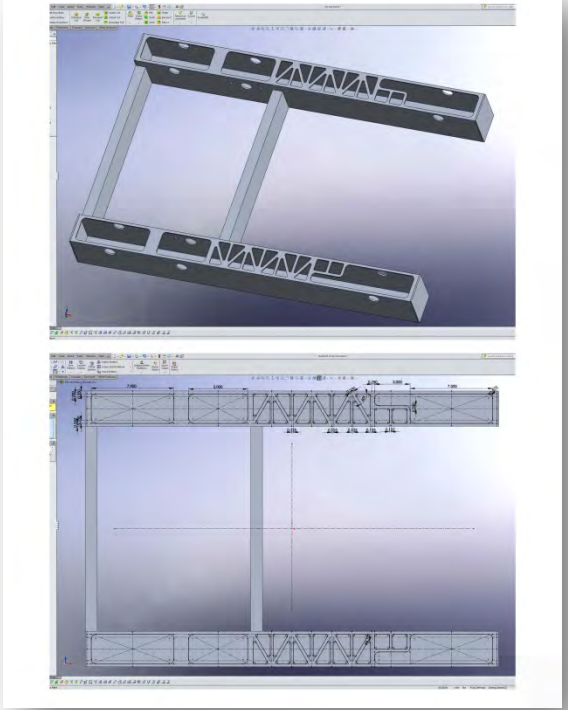


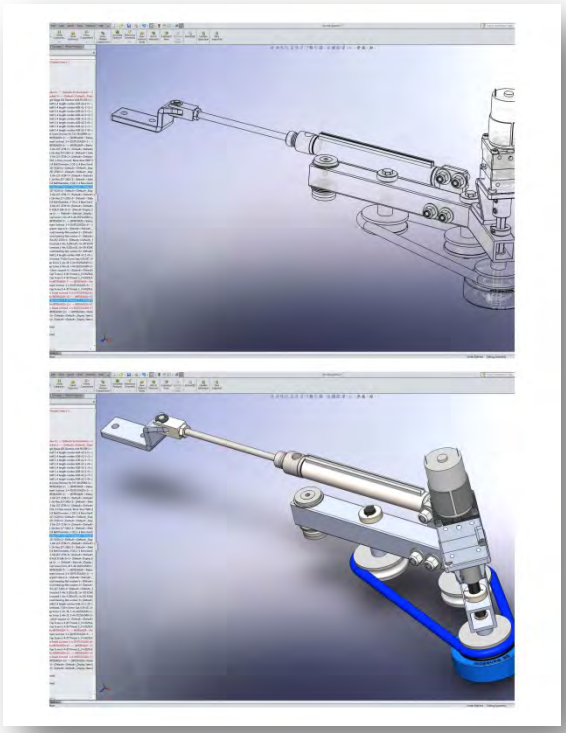


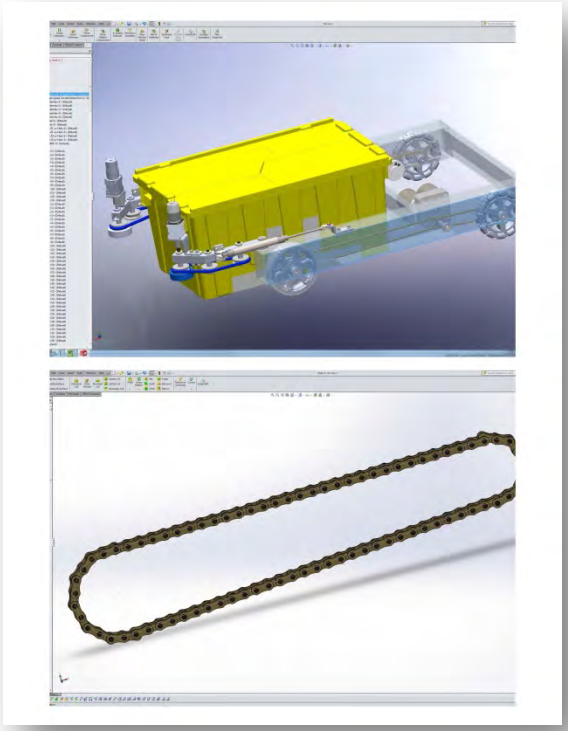


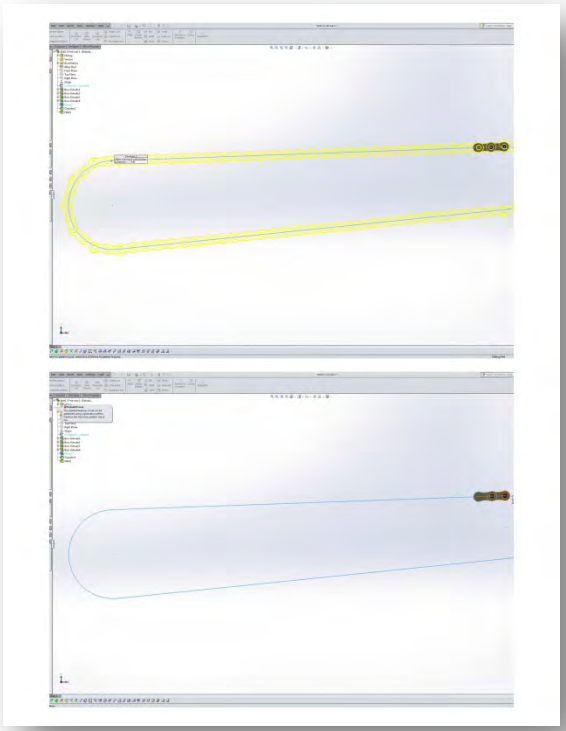


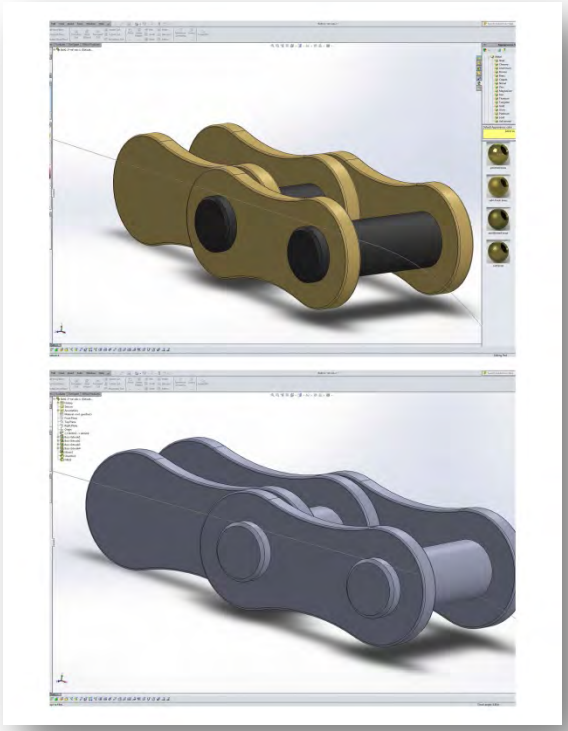


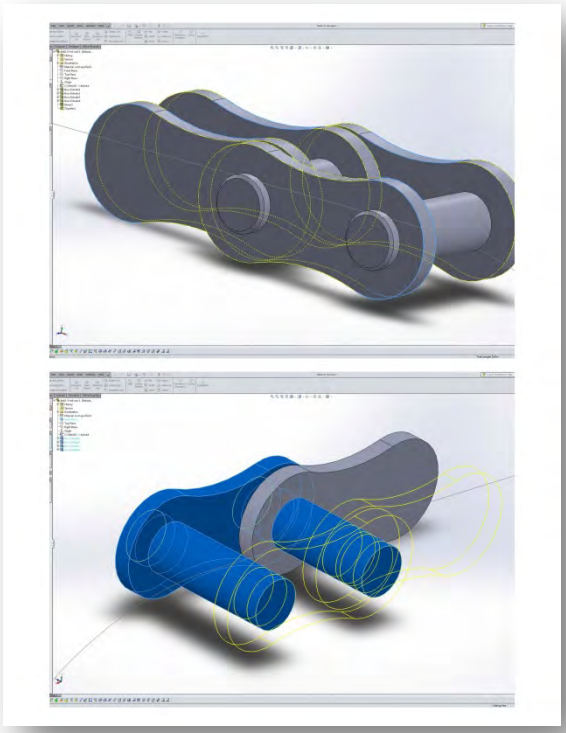


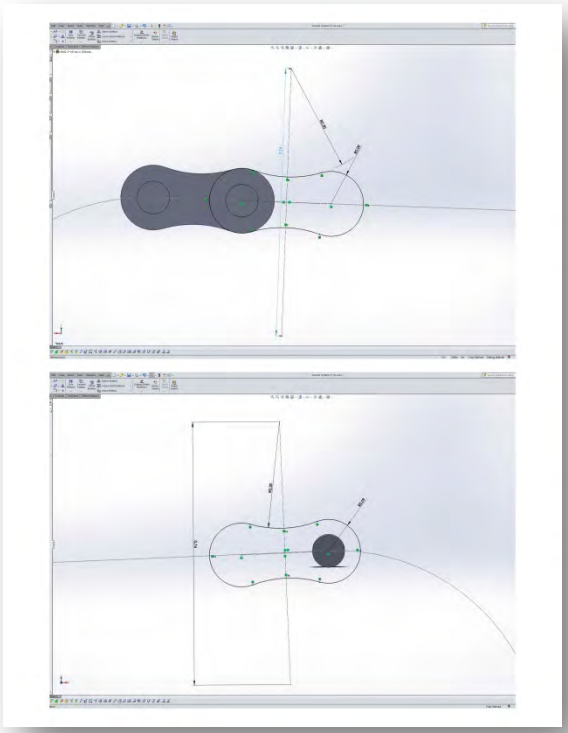


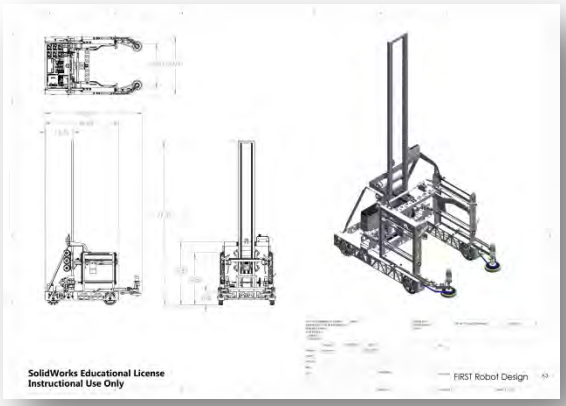








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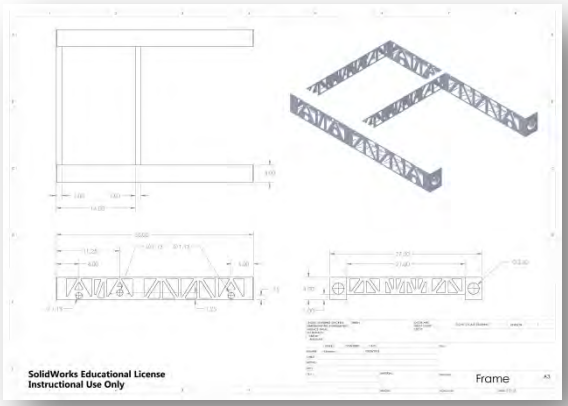
FIRST Robot Design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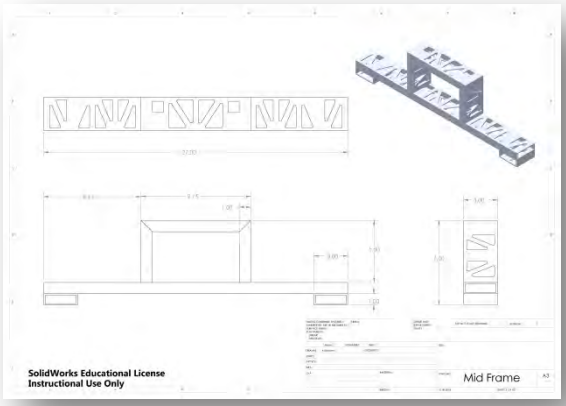
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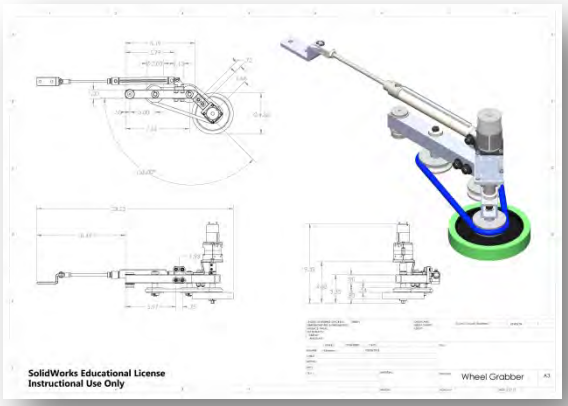
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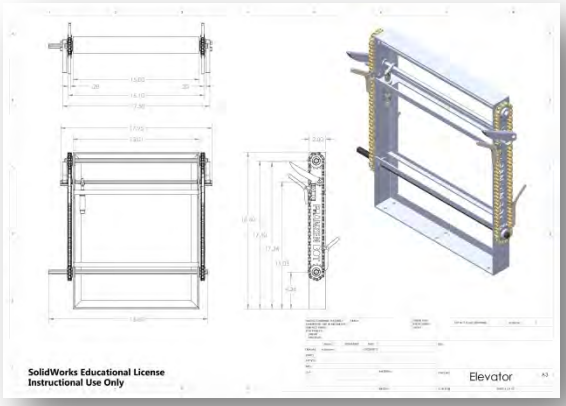
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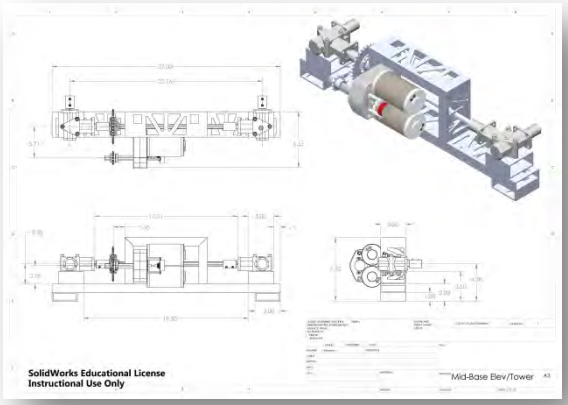
Elevator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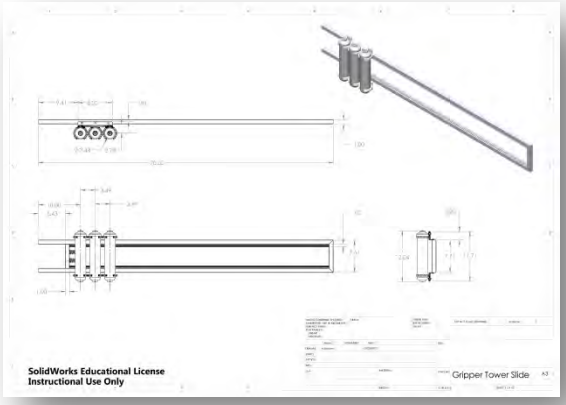
Mid-Base Elev/Tower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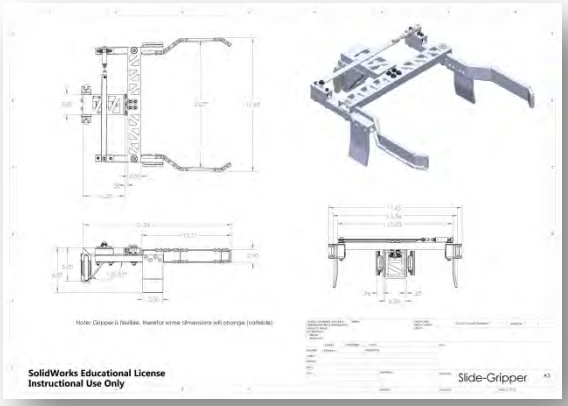
Gripper Tower Slide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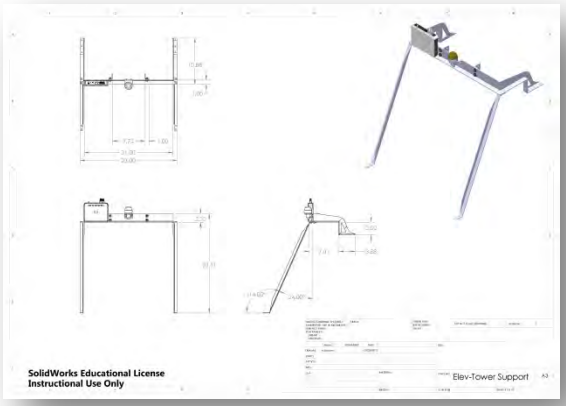
Slide-Gripper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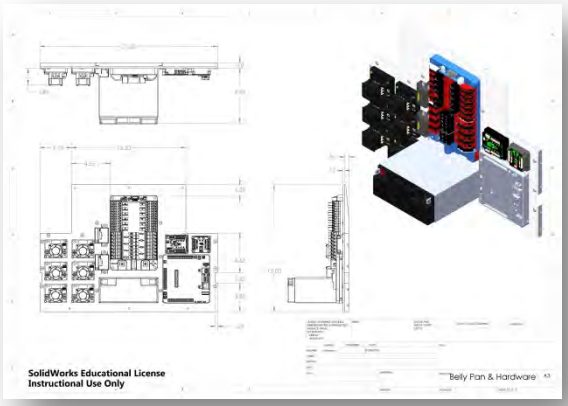
Elev-Tower Support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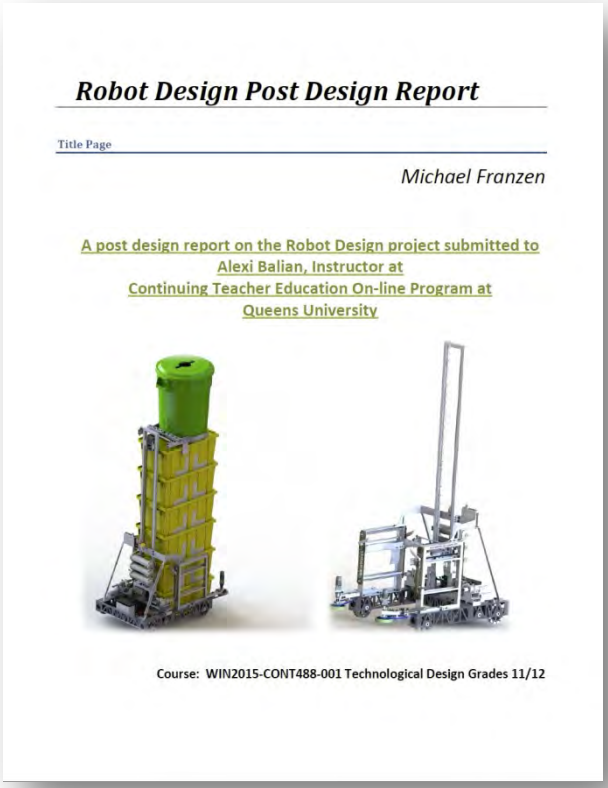
Belly Pan & Hardware

SAMPLE POST ROBOT REPORT



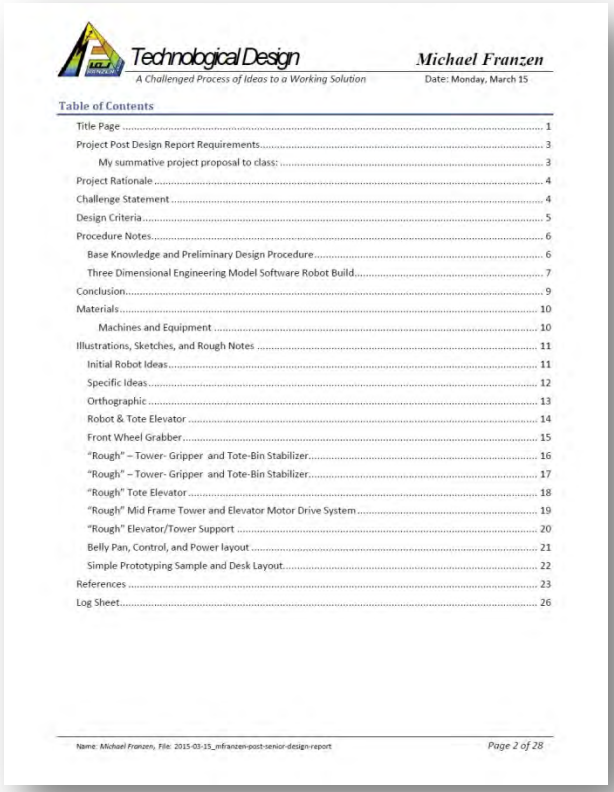
Robot Design Post Design Report

Title Page

Michael Franzen

A post design report on the Robot Design project submitted to
Alexi Balian, Instructor at
Continuing Teacher Education On-line Program at
Queens University

Course: WIN2015-CONT488-001 Technological Design Grades 11/12



Technological Design — *Michael Franzen*
A Challenged Process of Ideas to a Working Solution — Date: Monday, March 15

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Project Post Design Report Requirements

From the module:

In this module, you will demonstrate the following design-related skill sets in one complete project:

- sketching,
- Orthographic drawing,
- Technical drawing,
- Perspective drawing,
- Measurement,
- Marketing / promotion, and
- Virtual model making.

Deliverables: A completed Summative Project that demonstrates the Design Process, by delivering a completed artefact and documentation through the post design report.

The Post-Design report should include the following:

- Title Page
- Project Rationale
- Challenge Statement
- Design Criteria
- Procedure Notes
- Conclusion
- Materials
- Drawings or illustrations
- References
- Log Sheet

My summative project proposal to class:

From our discussions you may have heard me speak about FIRST Robotics a few times and that we also have a program that supports that at our school. A great way for me to support students in this program is to create some new resources and curriculum to support them and the program.

This year for the FIRST robotics competition is a competition called Recycle Rush. The task is to lift and stack totes on to scoring platforms and then capping those totes with recycling containers and disposing of pool noodles.

I will design a robot for the competition with a function to be able to pick up these totes as its function and model it in SolidWorks.

Future curriculum units will use this project to build up to, through a process of steps/stages in design and building of the frame/chassis, drive train, electronic components location and placement, possible pneumatics, and a design of the function - something to allow the robot to pick up the totes. The intent is to create an educational support process from start to finish that students can use to support their process and learning. As with our requirements in this assignment, the following key elements will be part of this process:

- Sketching,
- Orthographic drawing,
- Technical drawing,
- Perspective drawing,
- Measurement,
- Marketing / promotion, and
- Virtual model making

Project Rationale

The intent of the Robot Design project is to allow me to acquire additional design skills, knowledge, and values to further support teaching at the senior level with Technological Design. With my past teaching experience in this area, I am taking this opportunity to learn more related information in this area, refine my teaching depth and understanding, and gain/refine new skills with design tools and areas.

Challenge Statement

Design a robot for the 2015 FIRST robotic competition with functions to accomplish game tasks in this year's game, researching key topics related to this process, using the design process, and actively participating in this process from basic sketches to a final design using a SolidWorks.

Design Criteria

This project has required that I take into account several areas to consider during my robot design project. The following is a brief overview of robot challenge requirements.

Information gathering through the programming stage will allow accurate requirements and needs met for the design to be successful. Following a proven process of steps will ensure that all design considerations are met, such as research, idea generation, sketches, orthographic, perspective, measurements, marketing and also creating it in a virtual three-dimensional environment.

Recycle Rush is name the 2015 FIRST Robotics Competition game. It involves picking up and stacking totes on scoring platforms, putting pool noodles inside recycling containers, and putting the containers on top of scoring stacks of totes. There is also a coopetition possibility to also gain points. The game is played in autonomous and tele-operated. Autonomous is a 15 second period (of a total of two minutes total) where the robot may act on its own where robots can gain points by moving into the auto zone and/or bring yellow totes, and/or recycle bins into the auto zone for different points. Teleoperation is the balance of the game where students participate with supply totes, noodles, robot driving to gain points by stacking totes with the bins.

Based on the above, the game manual, and rules a robot must be legally able to effectively stack totes and bins effectively in a short period of time. The robot design must be able to complete these tasks in order to gain points and win the game. This is done with a team of three on each side of the field to stack as much as possible to gain maximum points. This can be done in several ways by using an engineering design process. Coming up with appropriate functions and drive train from scratch is the challenge. Having knowledge of motors, electrical, hardware, machining, science, game understanding, etc. are important in order to complete this challenge.

Having there-dimensional software is key to being able to diagnose, communicate effectively, and design accurately a practical and pleasing design. This also allows all parties involved to see exactly how the design is progressing throughout the design process. This also has designers think more in three-dimension, allows for easy updates and modifications prior to robot construction build.

Procedure Notes

Base Knowledge and Preliminary Design Procedure

Below are the steps that I took in general to complete the robot design. The procedure/steps below could be used towards a check list and/or rubric for students in their design process. Depending on students and resources, other applications such as Creo, or Inventor could also be used. Having background experience in mechanical design principles and techniques is very helpful in this process. The following general steps cover the robotic design process and steps that should taken to complete this task:

1. First to review a base line of common robot types that teams have used in the past, comparing drive trains and different functions such as arms, grippers, gear boxes, wheels, rotating joints, frames, and elevators through white papers, image galleries, discussion boards, and the internet
2. Review the competition rules, regulations, and support information so that you have a complete understanding of the game
3. Come up with a strategy and prioritize what key function(s) are important to gain the most amount of points and what mechanical mechanisms could be used to accomplish this
4. Brainstorm lots of different ideas on how to best accomplish your strategy
5. Create some rough sketches of several different ideas to narrow down to specifics to share with your peers for further ideas and feedback
6. Refine and prototype major concepts needed to prove working success and effective function
7. Finalize key ideas on paper through detailed sketches in isometric and orthographic views
8. Using a 3D modelling program build your robot starting with the frame, then the drive train, then your function(s)

Three Dimensional Engineering Model Software Robot Build

When creating robot design using a 3D modelling design software program, there are several steps to consider as you build your virtual design. The following points break down the key components you will want to consider as you go forward from your hand sketches and ideas. There are a lot of online tutorials, videos, and guides online that detail steps, below will just outline some key things you should be aware of. These steps are based on SolidWorks, but should be able to apply similar steps/suggestions in other similar programs. The **key points bolded and underlined** are for your convenience:

1. **Starting up the program for the first time**, you may want to take the time to familiarize yourself with the options of the program by checking the option settings. Setting up common file locations, folders for your custom files, templates, etc.
2. Create **templates** that work for you with appropriate standards set, starting with part files, later assembly files, and finally drawing sheets. This will help you in saving you repetitive set-ups every time you create a part file for example. Examples could be; using a specific standard such as ISO or ANSI, screen background colour/image, units of measure, etc.
3. **Importing** is pretty straight forward. You should spend your time building custom designs and not making common parts that you can download. Some cases you may only be able to get a standard file which you will have to import. This is a two-step process, the program will look at the file and interpret the graphical data and then the second step is to recognise the different components such as revolve, extrude, ribs, etc. Once this is done you can save the part as the programs proprietary file format and allow you to work with and edit that file if needed.
4. **Part files** primitive geometry. Normally you make several part files to make up an assembly or end design. All part files start with you making a **2D sketch** and in some cases a 3D sketch if needed. You will need to reference dimensions, properties, and characteristics of that sketch to fully define what you are trying to make. It is possible to over define which the program will not like at all. You can get away with under-define sketches, but it is not recommended as your drawing may get messed up later from other component definitions. Once you have it fully defined, confirm with checkmark, and then you will be able to **create 3D**. The most common tool is the extrude tool where you will give your object thickness or depth from the Features section. Features section includes a number of other related feature tools such as revolve, loft, sweeps, holes, etc. that will help you create your part.
5. **Assembly files** are where you bring all of your part files into to allow you to attach each using constraint tools or also commonly known as mates. Assemblies can also have sub-assemblies giving you the ability to organize your project by multi-piece components
6. **Drawing files** is the third major type of file, which is used to create drawing information that you can print to communicate to the builder or manufacturer the information needed to make that design. They allow you to share/communicate your design in a clear, organized, and concise manner.
7. **Sheet metal** is another extension to the part tool that allows you to make projects related to the sheet metal industry. More robots designed by students today are using this method to keep their robot light. Sheet metal parts are made similar to regular parts but

have a toolbox of related feature tools that lend themselves to making sheet metal type parts

8. **Weldments** are also parts files, as it takes profiles of an object and stretches them out the length of your line sketched. It has multiple joining feature tools to quickly make up just about anything you can imagine. You can make up your own profiles very easily and reuse them over and over. For example rectangular tube, rod, hex shaft, or even Bosch can all me made quite easily. One key thing with weldments is you can put several parts together with-in the single part file, i.e. make the entire robot base frame in one part
9. **Other great possibilities** you may want to experiment with motion , animation, exploded views, virtual material/design testing, sustainability, and simulations

The above are some of the basics, but there are many other procedures that can further be explored, as this program has a lot of features, tools, and options.

Conclusion

The robot design project is a great is a great vehicle to allow students to go through the process of learning all about related topics and their importance to the community. Students get the opportunity to learn about mechanical means, techniques, operation, mechanisms, engineering design process, sketching, diagrams, design principles, robot characteristics, drawing types, three-dimensional engineering software and how to draw and communicate realistic virtual designs to for the build. Project challenges can be easily adjusted to suit the level of students, school resources, and time frame.

For me, I chose to work with SolidWorks, as I never used it before until this project. I have worked with other similar programs such as Inventor and Creo. Making a robot from scratch for this year's completion was enlightening. I was not expecting it to take as long as it did, partially because I was learning a completely new program and having to familiarize myself closely with this year's game, rules, and current resources. Each year these programs get more powerful and feature rich with what they can do. Virtual testing and prototyping is a lot easier and dead accurate. I have with other programs built many things after designing them. I have found one thing for sure, is that everything just fits, as it would have already had to fit virtually.

With these programs getting more user-friendly, students in High school are more able to use these programs and use them as a major support tool, but must keep in mind that it is a tool and not an end to a means, meaning the design process, idea generation, and solving for a creative solution is still key. It is sure nice to "pull up in a fancy CAD program" to show off your wining solutions/ideas with impressive accuracy and precision.

I feel that I have learned a lot here, pushed my envelope further than I expected, and enjoyed being able to familiarize myself with SolidWorks throughout this module. I am excited to find this to be another great asset to share with students down the road.

Materials

Materials are key in robotic design with this competition as weight is limited and strength is needed to compete competitively. It is interesting that 3D CAD programs have really vested their efforts into materials to support a number of options such as reporting and record keeping, sustainability calculations and feedback, analysis, and simulation. Common term in mechanical simulation is Finite Element Analysis (FEA) which is used to predict material and product performance through linear, non-linear, thermal, air, etc.

There are several materials that can be used in a robot and really depends on your needs and design. In a lot of cases aluminum is very common for its strength and weight capacities. Steel is used sparingly as it is heavy, but very strong. Wood such as plywood and birch and plastics such as polycarbonate are quite common. Printing parts with a 3D printer will give you ABS, a very durable and by printing with it can be made into many different shapes.

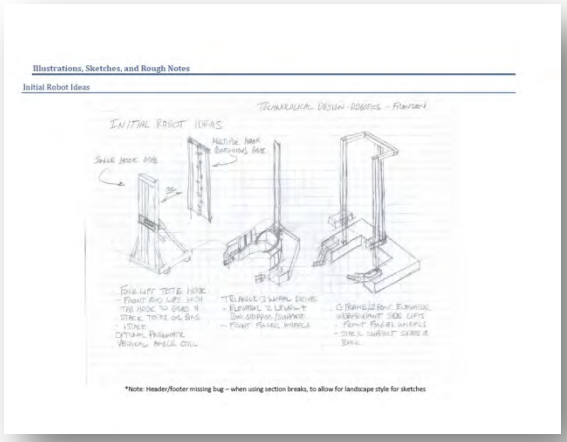
Here is a list of materials that have been planned to be used on the robot design:

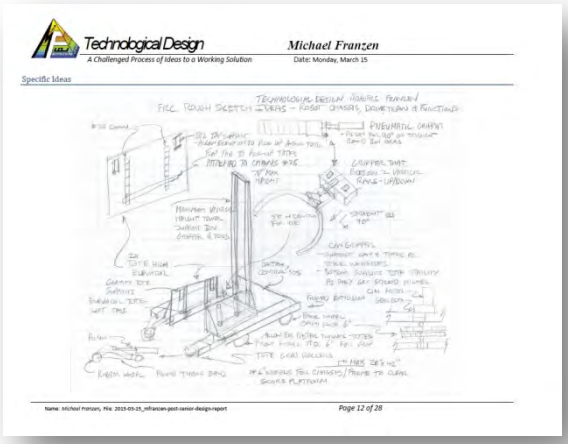
- Aluminum sheet, bar, angle, and tube of various sizes as my number one material
- Steel for bearings, gears, and some shafts
- Polycarbonate Lexan for belly pan
- Steel for a lot of the fasteners and slide bearing track
- ABS for pneumatic reservoir tanks
- HDPE (high density polyethylene)
- Assorted plastic for parts used such as wheels, supports, and brackets

Machines and Equipment

As mentioned before, having mechanical background and working with materials is very helpful for Technological Design for reasons of material selection and material process. Understanding the process of how a part is made helps the designer come up with a design that can be made easily. Common machines that we have used and probably would use for this robot could be:

- Sheet metal sheer and break
- Plasma CAM (when it's working)
- Wire EDM and water jet (off site)
- 3D printer
- Milling machine
- Band saw
- Lathe
- Welder
- CNC router milling table
- Air pneumatic rivet gun
- Drill press and hand drill
- Miter and Chop saw
- Table saw
- Grinder
- Assorted/related hand tools


Illustrations, Sketches, and Rough Notes
Initial Robot Ideas
INITIAL ROBOT IDEAS
*Note: Header/footer missing bug – when using section breaks, to allow for landscape style for sketches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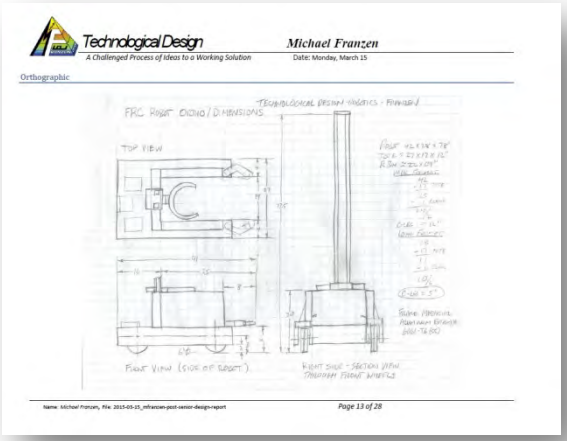
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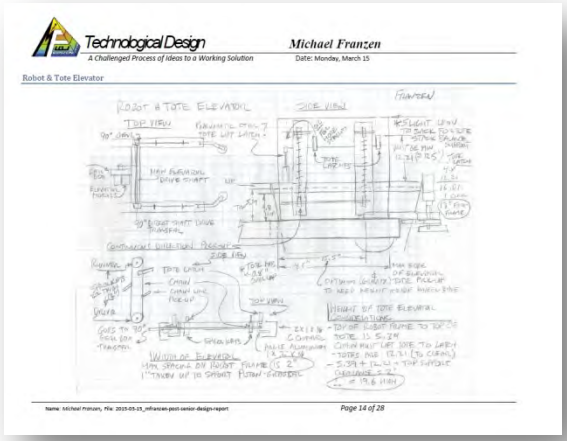
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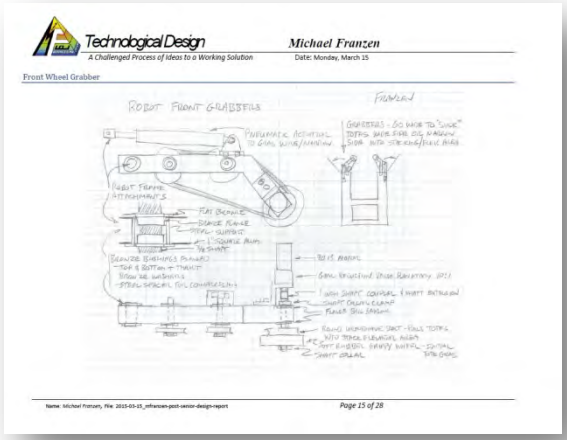
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ROBOT FRONT GRABBERS
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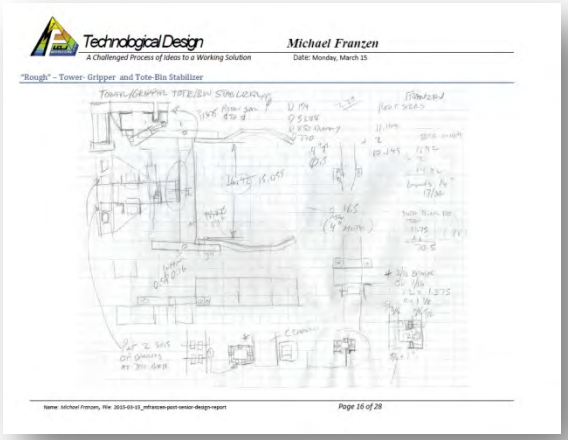
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"Rough" – Tower- Gripper and Tote-Bin Stabilizer
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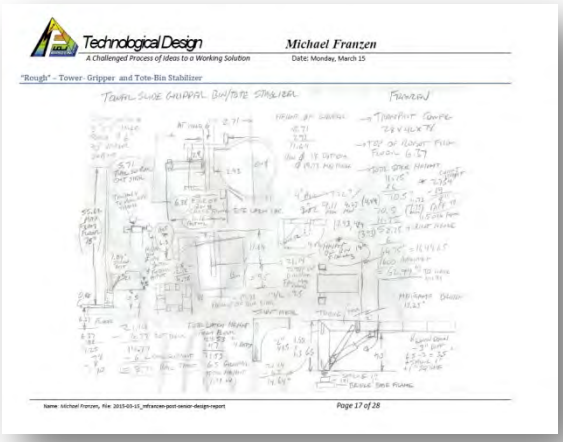
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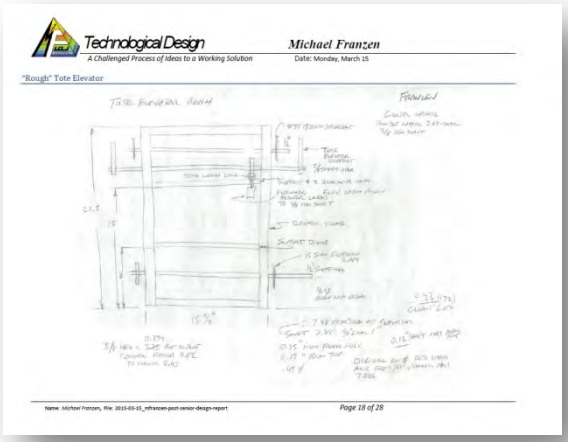
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"Rough" Tote Elevator
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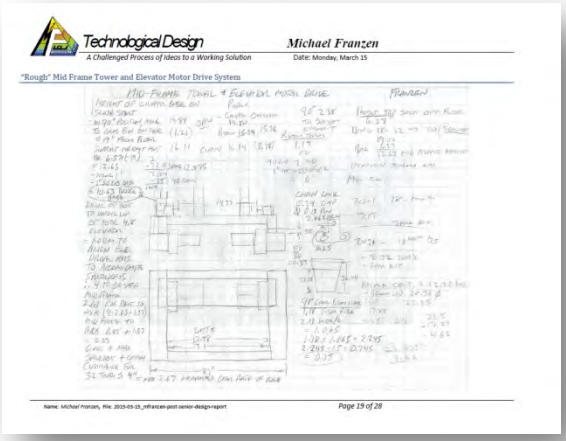
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"Rough" Mid Frame Tower and Elevator Motor Drive System
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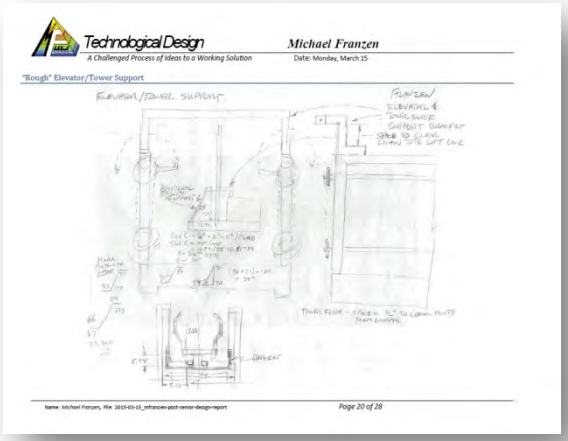
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"Rough" Elevator/Tower Support
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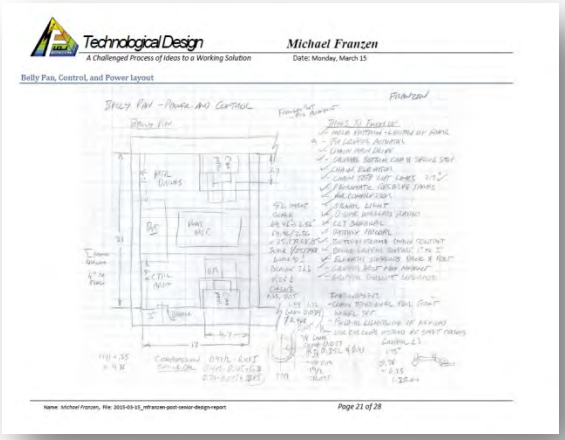
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Belly Pan, Control, and Power layout
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Simple Prototyping Sample and Desk Layout
Here is a sample prototype made out of paper looking at linkage, angels, sizes , rotation and reach.
This is a great addition to CAD program – 3D Space Mouse, I wanted to voice that this gives you amazing control on your CAD work.
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*Note: Header/footer missing bug – when using section breaks, to allow for landscape style for sketches

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I will mention here that all the references that were supplied with the modules are not included here, but did make use and reviewed each of them also and in a lot of cases followed similar links for more in-depth related information. References are listed in alpha order.

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Note: Cites created using EasyBib online citation service in MLA standard format

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Log Sheet

Note: I have not included my daily input on the discussion forum as this is already done and expected. Log entries have general entries. Time spent learning new program was spent as I progressed with project.

Dates	Hours	Description /log input
March 1, 2015	2	Submitted my Senior project for approval to Alexi,. Made several responses to discussion forum and started to look at some FIRST robotic completion documents
March 2, 2015	2	Did some research on both SolidWorks and FIRST Robotics and posted about my Senior project in discussion forum
March 3, 2015	2	Reviewing Tutorials on SolidWorks, replied to discussion posts
March 4, 2015	2	Organized researched information into topic areas for SolidWorks and FIRST robotics
March 5, 2015	2	Tutorial sessions on part building, some sheet metal, and weldments
March 6, 2015	5	Tutorial session on parts and assemblies and another one weldments. Went to FRC GTRC at Ryerson to see completion (4 hours), talk to teams, and see robots
March 7, 2015	4	Looked at what other teams are doing for their designs, gathering resources, curriculum support, and started creating rough sketches, watched steam of finial competition at the FRC GTRC
March 8, 2015	3	Finished rough sketches of some robot designs, specific robot with details, and an ortho 3 view with some calculations, reviewed some more single video tutorials, discussion forum
March 9, 2015	2	Researched and downloaded gear box, wheels, bearings, sprockets, hex shaft, chain, decided on spacing needed for frame profile, wheel alignment, wheel height clearance, responded to discussion folder, worked on templates for part and assembly files
March 10, 2015	3	Reviewed FRC competition manual for specific details, worked on robot frame, weldment profiles created, frame partially built, gear box calculations for drive system
March 11, 2015	3	finished off a basic frame and started to put together wheels, gearbox, sprockets and spacers
March 12, 2015	2	Had to re-adjust wheel location, fixed an alignment issue and continued research and started working on details on elevator, but then focused on front wheel grabbers

March 13, 2015	2	Created chain links for drive wheels and continued with wheel grabber. Created a paper prototype to sort out angle, piston size, wheel size and researched urethane round belt
March 14, 2015	4	Had to go back and lengthen arm on grabber and the finish off tote grabber, started to work on elevator frame. After designing up the first one, I ended up heavily editing it, had issues and thought it was something I did but it was the Bimba actuator that was causing a chain of errors
March 15, 2015	5	Finished most of the elevator and started to work gripper. Created more sketches and lots of calculations, alignments with robot and bin. Tricky with tote sizing, bin sizing, and elevator spacing. Ended up having to modify frame with, which lead to other issues that had to be fixed
March 16, 2015	4	Continued to work on gripper, designing actual sizing in program, continued with sketches, notes and calculations to ensure that everything will work, found the right piston for gripper operation and 2nd piston for 90 degree bin pick up
March 17, 2015	4	Gear calculations on mid frame motor to drive elevators to figure out final gear ratio plan, adjusted location in design where motor and tower base would sit on bot
March 18, 2015	4	Mid frame base to hold elevator drive motor created and approximate height of top base to be adjusted later, brought in gear box, hex shaft, 90 degree gear boxes, checked for alignment with elevator to establish height of build and maximum sprocket size for increased torque and slower speed
March 19, 2015	3	Tower slide with steel runner and bearing carriage slides put together with 1 inch square tubing, calculation of height of tower taking in account gripper assembly
March 20, 2015	5	Ended up creating a brand new elevator model that was lighter, more open, and would allow bin to tote stack cavity on bot. Created longer latch mechanism and upgraded the shaft drive to 1/2 in to match drive put in earlier
March 21, 2015	5	Gripper 90 degree hinge, miter end, and actuator relocated and adjusted. Problems again with actuator - allow free movement and it causes all kinds of problems with lock up, of whole assembly, like the actuator on the elevator. Redesigned actuator location to maximize length of travel with shortness of gripper to mitre elbow, modified miter support angle bracket, ended up taking it out altogether and putting two sheet metal gussets instead

March 22, 2015	3	Created chain links for elevator main drive and elevators. Had to design and make a custom tote latch link for lifting totes created a upper frame to support elevators and tower with back support brackets
March 23, 2015	3	Worked on belly pan for controls, power, and electronic hardware - researched and downloaded which components I needed to install in the belly pan. New controller from National instruments - import three different ways to see which was best. Step file worked the best
March 24, 2015	2	Finished creating holes on frame and key areas to lighten up frame and made two brackets for extra support and strength. Had a lot of small issues to take care of such as rivets some missing fastening. Created text extrudes on elevator, reinforced gripper with small brackets to stiffen up and increase strength
March 25, 2015	2	installed signal light with custom bracket, battery bracket, air compressor, air tank reserves with a custom 3 tank support bracket, cct breaker and pneumatic solenoids
March 26, 2015	1	cut out more holes on mid frame to lighten up, researched springs for stopper when gripper drops back down once stack is left cut out extra material on cross gripper support, computer very slow with all components together in model- several minutes just to open file and installed fasteners from upper frame to tower
March 27, 2015	1	Started post senior report and worked on template for created drawings for robot and major assemblies and added some rivets for the belly pan below
March 28, 2015	5	Worked on post senior report, drawings and created some renderings of the robot
March 29, 2015	4	Finish off Post senior repot project