

Tips for Success (aka Wiki of WIN!)

The following sections contain tips that will help you be successful in this class and in industry.

Suggested Approach:

Immediately:

1. skim entire document reading each bold point; read text of any points that are of particular interest to you
2. read [Suggestions from Mike & the TAs](#)

Before Design Report 2:

3. read [Tips for Working Effectively in a Group](#)
4. print [Group Meeting Templates](#) for every planned meeting

Before Design Report 3:

5. review [Tips for Working Effectively in a Group](#) one more time
6. read [SolidWorks Tips](#)
7. read [Common Project Failures](#)

When Design Report 3 is submitted and prototyping commences:

8. read [Tips for Working Efficiently on the Project](#)
9. review [Common Project Failures](#)

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Suggestions from Mike & the TAs

1. **Read effectively.** *Actively scan* documents for general information prior to reading the detailed content (especially headers and the first sentences in paragraphs). This gives you context for understanding and allows you to skip sections that are not pertinent. Additionally, *read sitting upright and when you are most alert.*
2. **Don't procrastinate.** It's easy to underestimate the time commitment for this course. The course really starts off at a fast pace, increases even more until the time the third design report is due, and then slacks off—the exact opposite of other courses you have taken. *Be proactive to stay on top of the assignments* so you don't become overwhelmed.

Regarding manufacturing, *create an accurate yet aggressive project schedule.* If you don't work at an aggressive pace, you will not have adequate time to test your designs at the end of the semester. There are no additional work times available outside the assigned lab periods.

3. **Find a balance between quality and time invested.** In the beginning of the course, the TAs work with you to make two parts with high accuracy and good surface finish to show the full capabilities of the equipment. However, *most part features do NOT require high accuracy or good finish!* This is one of the primary roles of the part designer: to determine how good either of these must be. *Use larger tolerances and looser surface finish specifications whenever possible to reduce manufacturing time.*
4. **To receive good advice, ask good questions.** The TAs have seen lots of ideas succeed and fail; their job is to stimulate discussions so you can generate a list of pros & cons for the decisions you will make, not to make the decisions for you. *TAs will match the level of effort you invest in the project.* For example, asking a TA *how to mount a wheel to a motor* will generate little response, since this is a topic directly covered lecture. However, asking a TA *if a particular design you sketched is a good idea, or of sufficient thickness, or a wise material choice* will elicit a helpful response. In short, *if you act helpless, the TAs will too.* The TAs are a great resource, but you must approach them with specific questions which show you used the provided course resources.
5. **Apply what you learn in this course to your career choice.** If you don't find the course interesting and challenging, if you have problems working effectively in a team, or if you have trouble comprehending the fundamentals taught in this course, you probably should not pursue a job in engineering design. Figuring out what you don't want to do is every bit as important as discovering what you do. You will be working far too many hours each week for many years to not do something you are truly passionate about. Despite how much money you make, it cannot make you happy if you don't like your job! *Mike came to UF and started this laboratory for the primary purpose of helping students find their passion. If you aren't yet sure what that is, he invites you to talk so he can help. Everyone has talents and gifts; however, finding the right type of job that uses them can be challenging!*

Tips for Working Effectively in a Group

Working together efficiently does not just happen; it requires discipline and active leadership. Learning how to work effectively in a group is one of the most challenging aspects of this course, as well as industry. The following tips offer proven methods to promote cooperation.

1. **Communication is key when it comes to teamwork.** *Learn to listen* as well as you speak; give every member's ideas the same consideration you give your own. **Resist the urge to interrupt.** Clarify your understanding by summarizing other members' comments. If your members seem hesitant to express themselves, take the lead by voicing your own ideas. Saying what is on your mind will demonstrate to your group members it is okay to take risks and it will encourage a positive group dynamic. **Clear and direct task assignments and evaluations are essential** for tasks to be completed properly within the allocated time frame.
2. **During the design phase, everyone should share tasks.** Since **all** design work must conclude before manufacturing can commence, everyone must **work on the design together** to do the best job possible in the allotted time. **Everyone** should participate equally on the design work and CAD modeling/assembly; that means **everyone** models parts, **everyone** makes drawings, **everyone** checks drawings and **everyone** works together to complete and check the calculations and written portions of the design reports. Do not let anyone use the excuse *I'm not very good with CAD*. If you hear that from team members, assign them extra work since they need the practice; or ask if they are planning to mention that weakness during their interviews as well. **Reward results, not excuses.**
3. **All team members should participate equally in the design phase and thus understand how every part of the final design works.** If you don't know, ask questions until you do. When asked a question about your group's design, if anyone replies *I don't know how that works; I didn't design it* they will be asked to stop working until they do. **Participate equally and take ownership and pride in the evolution of your group's final design.**
4. **During the manufacturing phase, everyone should work on separate tasks.** Each member of your group received the same training, so **everyone** should be capable of manufacturing **any** parts for the robot with the help of the TAs. If any part of the project requires a second set of hands or a reminder about how to use a piece of equipment, ask a TA. **Do not work in pairs on the machines or to perform the same assembly task, because the second person is just wasting time he/she could spend doing something more useful and helping increase the amount of time the team ultimately has for testing.**
5. **Failing to plan is planning to fail.** Groups that don't plan their work and work their plan will have little or no time for testing; **the results will not be impressive.** Take even the small assignments seriously. If you don't, you will fall behind and become overwhelmed. **Stay on track** and invest genuine effort into the design; doing so will pay dividends in the later portion of the course.

6. **After planning your work, work your plan.** The best plan is useless if not executed well. Set a *regular weekly meeting time(s)* outside class to discuss exactly what each member should do during the next lab and what help you'll need from each other and the TAs. *Adhere to a consistent meeting time each week to maximize team attendance.*

Many students waste the first 15 minutes of lab just getting started each week, so *come to lab prepared*: review specific tools and materials you will need and bring questions to the TA hours prior to your lab session. *Prepare paperwork like CAD drawings, budgets, schedules and purchase orders outside of class* so you can maximize your time in lab measuring, manufacturing, assembling and testing.

7. **Never accept excuses.** If your team falls behind, discuss how you're going to work more effectively. **Clearly identify anyone who is not working diligently or is behind on their tasks.** *Never accept excuses from group members or their behavior will only get worse* when they see it's okay not to accomplish their part of the project. Rather, (in a respectful manner) *be open* with one another; *place blame where it belongs* (i.e. coming to a meeting unprepared, procrastinating on an assignment, not reading directions, etc.) and *agree on a solution*. Most of us miss a deadline on occasion; it's how we deal with the missed deadline that distinguishes good workers from bad; *accepting responsibility is crucial*. If you realize you're not going to make a deadline, inform your team in advance so it can shuffle resources to get the work done. *Showing up to a meeting or lab without your part(s) of the assignment complete is unacceptable and disrespectful.*
8. **Maintain good team meeting documentation.** Unfortunately, it's not uncommon to find that someone in your group doesn't care about what he/she is doing. As stated in tip #7, this situation is best resolved by clearly communicating to this person their failure to accomplish the assigned tasks and making it clear that he/she is expected to do an equal part of the work load. If their behavior doesn't change, disciplinary action is required (i.e. [poor peer evaluations](#) in the course, poor feedback to their boss or manager in industry, etc.). For this to be an effective tool, you must document problems encountered with team members. **Everyone is required to keep notes of each meeting: what topics are discussed, what tasks are assigned to whom and the associated deadlines, as well as who doesn't attend, who has excuses and who didn't accomplish their assigned work from the previous meeting(s).** At the end of the semester, if there's an isolated case of someone just having a tough exam week and not completing one task, it can probably be disregarded, as it will happen to the best of us. **If, however, a member habitually has excuses, submits assignments that are half complete or of poor quality, rarely attends agreed-upon team meetings, always leaves meetings early, claims to not be good with CAD, manufacturing, writing, etc., then list this on the peer evaluations submitted in the course.** Remember the shortest pencil is longer than the longest memory, so maintain accurate notes during the semester. Note taking is often an effective tool because the observation that others are keeping notes about poorly performing team members is enough of a deterrent for behavior modification, which is the desired outcome: for everyone in the group to invest fair and equal effort toward completing the assignment. You can download the required and effective [meeting template](#) off the course website.

9. **Use a collaborative work sharing system** like [Slack](#) to share files, deliverables, meeting notes, and assignment progress with all your teammates. Programs like this combine file sharing capabilities of [Dropbox](#) with collaborative communication tools common in [Google Suite](#) to give your group a powerful way to stay connected and on top of each week's deliverables. A few hours spent early in the project implementing a few of these intelligent communication tools can greatly reduce the length of weekly group meetings, while simultaneously increasing their efficacy.

Group Meeting Template

This meeting template will help your group remain organized week to week as well as identify members who regularly fail to perform assigned tasks. Each group member must fill out one of these sheets individually during each of your planned team meetings for submission as noted in the Design Report Template. Doing so will either encourage members who are not doing their assigned parts of the group project each week, or it will help me assign the grade they deserve at the end of the semester.

Date: _____ **Group No.:** _____ **Member's Name:** _____

Member(s) NOT in attendance:

Tasks NOT completed since last meeting (and member responsible):

Tasks to be completed for next meeting (and member responsible):

Questions for Mike (392-3496 / mjb@ufl.edu) / TAs:

Miscellaneous notes (use reverse side as necessary):


SolidWorks Tips

The following tips offer suggestions for working more efficiently with SolidWorks. The goal is to help you communicate your ideas more effectively.

1. **Know your tool.** Your effectiveness in SolidWorks, like any other tool, improves when you understand its capabilities. Review the [SolidWorks Resources](#) available under the Project Resources submenu on the main course webpage.
2. **The internet is your friend.** If you think that SolidWorks *should* do something or the way you are doing something seems overly difficult, use a search engine to check if there is a better way. *Quite often 15 minutes of research can save hours of frustration.*
3. **Use SolidWorks' sheetmetal tools for sheetmetal parts.** SolidWorks has a built in sheetmetal tool that allows you to create bent sheetmetal parts and flatten them (or vice versa) as required for the detail drawings of sheetmetal parts. Some video tutorials are available under the [SolidWorks Resources](#) page on the course website.
4. **Build (sub)assemblies from the bottom up.** Create simple subassemblies that are mated into more complex subassemblies and eventually into the full robot assembly. Doing so allows individual team members to work simultaneously on the assemblies (each on a different, unrelated sub-assembly) and simplifies creation of (sub)assembly drawings later. Many groups consciously avoid using proper subassemblies in CAD because they (incorrectly) feel it adds time to their work, when that couldn't be further from the truth! *Use (sub)assemblies liberally, as doing so makes your lives so much easier when working with multiple teammates on fairly large assemblies.*
5. **Spend adequate time organizing.** I have never heard a group comment, "We just spent too much time organizing," but have frequently heard (and experienced) the opposite. Create a clear file structure for part and assembly storage, employ logical naming conventions, and use organized part numbering conventions. Always avoid duplicating files.
6. **Use Dropbox carefully.** There is no requirement to use Dropbox for this course, but many groups intelligently choose to do so. Dropbox stores files in different locations on different computers (your various Dropbox folders) while SolidWorks records the file locations *of the files as of the last save*. If the file path changes (which it often will using Dropbox on different computers), SW will not be able to locate the files and will lose data like exploded views. One solution to this problem is to designate a consistent file path on each team member's computer for SW files such as C:\EML2322L\... . Duplicate the Dropbox files into this location prior to editing them and copy updated files back into the Dropbox folder.
7. **Use reference geometry such as planes, lines, and points to facilitate proper mates.** This topic should have been covered in the CAD course, but it's a common area of weakness with new designers. When drawing a part you should always think about how it attaches to other parts and include necessary reference geometry to facilitate mating. Failure to do so is probably the leading cause for incomplete, unrestrained mates. Once all mating is

performed, one simply turns off the associated reference geometry under the View menu to unclutter the final assembly.

8. **Mating to a sketch.** Elements in part model sketches (lines, points, etc.) can be mated within an assembly model. To make part model sketches visible, right click them in the feature tree (on the left of the screen by default) and click the glasses. This will hide / show the sketch. Sketches can be created in a part model solely for mating in an assembly model. This is often used for aligning the caster wheel along the simplified 80/20 extrusion.
9. **Implement configurations for assemblies with dynamic parts.** Multiple configurations for a part or an assembly can be created to reduce the total number of files created for the same part. For example, various lengths of 80/20 can be generated by extruding the same cross-sectional sketch to different lengths, or a lifting arm can be mated in different orientations to show the full range of motion. Each configuration will suppress or unsuppress specified associated features or mates.
10. **Use mechanical mates to maintain dynamic assemblies.** Mechanical mates are another powerful tool which can allow you to visualize the full range of motion of the dynamic portions of a design. By implementing mechanical mates such as gears, slots, or hinges, an assembly can be fully defined (as is good practice) while still allowing the relative motion of certain parts which will better allow your TA to provide adequate feedback during design review. A good example of when to use mechanical mates is a moving arm, for which you would need to check clearances throughout its designed range of motion.
11. **Use the simplified 80/20 part model or print your assembly drawings on B-size sheets.** A [simplified part model of 80/20](#) is provided for use on the course website. The simplified model does not contain [the four grooves and associated tangent edges](#), so it prints a lot cleaner on A-size (8.5x11") sheets and it also speeds up rendering of the complete assembly model. So we recommend using the simplified version for your project, or planning to print your assembly drawings on B-size (11x17") sheets for clarity.
12. **Edit the tolerance table.** The standard tolerance table provided on the drawing templates may not suit all of your parts. This table can be edited by right clicking the sheet drawing area, selecting "Edit sheet format," and then editing the text in the tolerance table. To resume editing the drawing, right click the sheet drawing area and select "Edit sheet."
13. **Aligning dimensions in drawings.** Aligning dimensions in drawings improves the readability of your drawing. Select multiple dimensions in a drawing. Right click any of the dimensions and hover over "align." The dimension alignment choices are listed. Choose the appropriate alignment.
14. **Using layers to hide unwanted sketch elements.** SolidWorks supports drawing layers. Drawing layers act like transparencies on which details of a drawing are kept. Each layer can be formatted (color, line style, thickness) and hidden. If you require sketch elements (points, lines, etc.) to be added to your drawing to properly dimension it, these elements will, by default, appear when you print the drawing. Placing the unwanted elements in a layer and hiding that layer will prevent the elements from appearing when printed. To use layers,

enable the layer toolbar (right click the toolbar area and select “layer”). Click on the  symbol on the layer toolbar to open the layer properties. Create a new layer and call it “hidden” so you remember to hide it later. Color the hidden layer red so it is obvious when something is on that layer. Select a dimension, point, or line and change the layer toolbar dropdown menu to “hidden.” The dimension, point, or line is now on the “hidden” layer. Again, open the layer properties. Click the lightbulb next to your hidden layer. Click OK. Everything on that layer is now invisible (but still present). CAUTION: pay attention to the layer dropdown while creating new drawing elements. If your hidden layer is shown, all new elements are automatically placed in the hidden layer.

15. **Custom properties.** Custom properties are user defined properties that belong to a part model or assembly model and can be accessed by other files that reference that part / assembly model. To access, create, and edit custom properties, click file, select properties and navigate to the “Custom” tab. A common use of custom properties is to simplify creation of proper bill of materials (BOMs). For example, the “Item No.,” “Part/Assy No.,” and “Part/Assy Description” columns of the BOM can reference the custom properties of the parts and subassemblies present in the drawing.
16. **EML2023 computer lab.** If you have problems running SolidWorks on your personal computer you can use the workstations in the 3D printing lab on the 3rd floor of MAE-B.
17. **Effectively communicate with your TA.** The TAs have seen a lot of ideas succeed and fail. Their job is to stimulate discussions so you can generate lists of pros and cons for the decisions you make. Therefore, it is essential you communicate well with your TA. 3D PDFs can facilitate communication by allowing others to quickly view and rotate part or assembly models using Adobe Acrobat. To generate 3D PDF files, click Save As... >> Select PDF as File Type >> Check 3D PDF checkbox.

Common Project Failures

The following guidelines offer suggestions for preemptively mitigating common failures experienced during assembly, testing, and the course competition.

1. **Not applying background research.** Groups often fail to apply the background information to the design of their device. Considering the center of gravity of the design will reduce the device's propensity to topple over ramps or any uneven ground, and will allow for a better estimate of the normal load, and thus the traction, on the drive wheels. Failure to consider the materials used for different applications can result in higher manufacturing times as well as greater cost. The background research is not intended to be a robotic exercise, but rather each topic covered is designed to stimulate thought when progressing through a design.
2. **Failing to note the competition environment.** The arena layout and any obstacles are given in the first week of the semester with associated dimensions, and should be analyzed prior to design. Following the modeling phase, these templates should be implemented to determine the feasibility of the design and anticipated competition route. Size, speed, and controllability considerations should be made to elevation changes, narrow spaces, and the required tasks.
3. **Not taking motor speed and torque calculations seriously.** Groups which do not take the time to seriously evaluate the drive and lifting torque of their chosen motors often suffer detrimental consequences when their designs cannot traverse arena obstacles or their lifting motors become back-driven by the applied loads. Similarly, groups often note that they "did not expect their device to be this fast/slow." After you have calculated your values, develop some physical understanding of your results; this will help to mitigate surprises later on, and will allow you to ensure your results are realistic, and desired.
4. **Not considering storage requirements.** Your device must fit within a 17" x 12" x 15" container at the end of each weekly lab session. Parts not completely within the fully closed container incur a penalty. The CAD model of your design can be used to determine if all of the components will fit within the container, or if certain parts, often large sheetmetal parts or assemblies, should be split into multiple parts.
5. **Failing to use 80/20 efficiently.** An advantage to using 80/20 is the ease with which it is assembled and disassembled, but adding additional T-nuts within a bounded length of 80/20 often requires disassembly of multiple components. Thinking about which components must be removed for storage, where additional brackets may be needed, or which subsystems may need more adjustment during testing, can help you decide how the extrusions and brackets should be fastened relative to one another.
6. **Failing to maintain rigidity by implementing brackets.** Single points of contact created by the use of one button head cap screw in a 90° angle bracket at each end of a length of 80/20, often act as pivots when large loads are applied. Implementing additional (flat or angle) brackets to the design can greatly increase the structure's rigidity and resistance to falling apart.

7. **Not testing subsystems early.** Often a simple cardboard model will give valuable insight into the merits, or demerits, of a design concept prior to manufacturing. Once a design is selected and manufactured, it is often useful to test subsystems independently, as changes and modifications are more easily implemented before the entirety of the system has been manufactured and assembled.

8. **Improperly tightening fasteners.** Failing to properly tighten fasteners can result in a group's inability to complete a competition round should a motor shaft slip in a hub or a frame twist under loading. All fasteners required for mechanical engagement with a motor shaft (i.e. set screws tightened on the flat portion of the shaft and Entstort nuts tightened to engage splines fully), and all brackets should be completely secure during assembly, and should be checked again prior to competition.

Tips for Working Efficiently on the Project

The following tips offer suggestions for working more efficiently on the course project. The goal is to execute your designs as quickly as possible while ensuring your safety.

1. **Continue to plan your work and work your plan.** For this phase of the project ensure your group meets regularly before lab to review individual task assignments so everyone comes to lab ready to start working immediately. The most prepared groups get first choice of machines in the lab, so use this to your advantage. In addition, remember it is rarely productive to pair up members on tasks in the lab (such as creating motor mounts, wheel hubs, assembling the robot frame, or building manipulators); if assistance is needed, take advantage of the TAs. The final and perhaps most helpful tip for planning your work and working efficiently is to bring part drawings to office hours and discuss with a TA how to make each part so you are well informed and prepared when you come to lab that week.
2. **Complete paperwork outside of lab so you can maximize the time spent during lab working on the project.** Complete purchase orders and engineering change notice forms outside of lab and come to the TA office hours (or email your TA or Mike) to get your questions answered before lab rather than during lab. This enables you to complete your project sooner and maximizes the time available for testing and modifications.
3. **Print working copies of drawings for reference in lab.** Project prototyping begins the week groups submit their revised DR3 in lab. Consequently groups need to print working copies of detail drawings for all non-OTS (i.e. custom) parts manufactured in lab and all assembly drawings, since the original drawings will be in the design report notebooks and therefore unavailable for reference. Bring copies of **all** non-OTS detail drawings each week in the event equipment bottlenecks necessitate unplanned schedule changes.
4. **Use 80/20 wisely.** If using 80/20 for your design, use a tape measure and your cut list to try and find the pieces you need already cut to length. Be reasonable with your tolerances, as most pieces don't require ± 0.020 " tolerances on their lengths. If you don't find the pieces you need, locate the next larger size and minimize the amount of material cut off each piece (so longer pieces are reusable for many semesters). When cutting 80/20, mark cuts offline (i.e. away from the bandsaws) on a worktable with a sharpie and cut multiple pieces at once by stacking up to four pieces in the vise horizontally. Combining 80/20 cuts with other groups also saves time, as does using the second bandsaw setup in the lab for 80/20.
5. **Familiarize yourself with the hand tools provided in the laboratory toolboxes.** Many students coming into the course have not worked with many hand tools, so we put together a [brief overview of the common hand tools provided in each laboratory toolbox](#).
6. **AWJ manufacturing.** [If your parts qualify](#), take advantage of the opportunity to submit them for manufacturing using the AWJ process. [As you can read](#), AWJ is an automated method for cutting precision sheetmetal parts that cannot be easily manufactured using the manual equipment in the lab. If you take time to submit parts for manufacturing using this

machine, you must follow the submission instructions noted in the [AWJ Design Guide](#), or your parts will not be cut and you will have to make them manually.

7. **Sheetmetal tips. (1) Bring printed sheetmetal templates to lab.** The required sheetmetal drawing template includes an unfolded view of the part. Print and cut out a full scale drawing and bring it to lab to greatly reduce the time required to layout the part on the sheetmetal blank. **(2) Use the digital calipers on the sheetmetal table to measure the thickness of sheetmetal (wear gloves because the sheetmetal is SHARP).** **(3) Always use the smallest piece of material that is large enough to make your desired part** (small pieces of leftover sheetmetal are located in the plastic bins under the sheetmetal table). **(4) Use a magnet to check if a workpiece is made of steel.** Please let the TAs help.
8. **Study for the tapped hole quiz so you can use the CNC milling machine to drill and tap the holes in the face of your second wheel hub.** Review the [Example Tapped Hole Quiz](#) with your group and ask any questions. When you reach the point where your group is ready to drill and thread the holes in your second hub, each member will be given a tapped hole quiz (with a different fastener size than the example linked above). If every member passes, the TA will help your group use the CNC for creating the threaded holes; otherwise, your group must make the holes using one of the manual milling machines, as you did earlier in the semester. Prepare for the quiz so you can save your group 30 minutes of work.
9. **Understand how the testing procedure in the lab works and plan accordingly.** The newer-style control boxes with the PlayStation transmitters operate on different frequencies, which means groups can test as soon as they are ready and without interruption from other groups. This ability to test independently and simultaneously is a significant change from previous semesters when only one group at a time could test and groups were forced to share controllers, so use this additional testing time to your advantage. We also provide simple switch boxes which allow groups to test basic function of motors without using a control box.
10. **All groups will have exactly the same amount of work time for the project.** To be fair to every student in the course, no group will be allowed additional work time outside of class, as completing the objective within the allotted time is a project objective. Groups are welcome to come to TA hours to work on the “administrative” portion of the project (i.e. POs, ECNs, part redesigns, design modifications, etc.) or to practice on the machines, but robot parts cannot be worked on outside of your formal lab period. Likewise, do not open your storage bins before your lab period formally starts and stop work in time to put your project away and on the shelf before your lab period formally ends.
11. **Have a backup plan in case a machine you need is being used.** Again, our common goal is to get your designs prototyped as quickly as possible. However, sometimes the machine you need may be occupied by other students. Relevant examples are the mills and lathes during the first week of manufacturing when 4 groups in each section need to make motor mounts and wheel hubs. Because of equipment limitations it will sometimes be necessary to work on a part out of sequence so you can make progress on the project until the machine you need is available. In these cases please let a TA know so they can ensure you have priority access at the next available machine opening (even if it’s the following week). If your group is inconvenienced by this more than once, please let Mike know so he can better schedule future semesters; he wants you to have a good experience and values your feedback.

12. **Don't rely on only "your" TA to answer questions.** There is a lot happening in the lab during the prototyping phase, as up to 16 students may be working on 16 different tasks and machines! ***ALL TAs are available to answer ANY questions you have***, so don't feel like you need to wait for YOUR TA every time you have a question. Yes, your TA will be the most knowledgeable about your design (and as such, is probably the best to ask about design changes), but ALL the TAs are knowledgeable and always eager to help. (At least they should be, or we need to find new TAs 😊!)