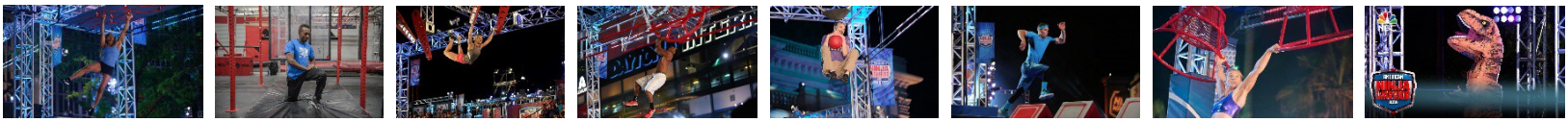


ES 2502 B'18– Stress Analysis Term Project

American Ninja Warrior Obstacle Design

Submission 1 – Design and FBDs

Introduction:

American Ninja Warrior (ANW) is a television show based on the Japanese show "Sasuke" in which competitors complete obstacle courses that test their strength, agility, and endurance. For this project, you and your team will be developing, designing, analyzing, and pitching an ANW obstacle of your own design with the intent to sell that obstacle to the obstacle selection committee at ANW headquarters. When designing your obstacle, you should consider the ways in which you want to test the competitor (e.g. upper body strength, lower body strength, balance, agility, other). Your obstacle does not need to incorporate all of these physical feats, but you will be highlighting your design's features in your pitch to the obstacle selection committee.

For submission 1, you and your team will be developing your obstacle design and drawing the FBDs that could be used to analyze your design. You will need to decide if you require 2D or 3D FBDs to fully describe your obstacle. All of your assumptions/decisions must be clearly stated in your design documents and/or your FBDs.

Design Requirements:

The objective of this project submission is to give you and your teammates the opportunity to apply the skills you are learning in ES 2502 to a real world design challenge. You may base your design off of an existing obstacle which you modify, or you may develop an entirely new obstacle. You should include a sketch or graphic of your design with your submission. When your obstacle is in use, your final design should allow you to analyze axial stress, torsional shear stress, and bending stresses (both normal and shear). This means that your design must experience the following load types:

1. Axial tension or compression
2. Torsion (moments about the longitudinal axis of part of the structure)
3. Moments (moments about axes other than the longitudinal axis of the structure)

Your design needs to be developed to be used by a person. So the geometries and loads that you choose must be based on human geometry/scale. These values can be based on background research or personal experimentation. All research and experimentation must be documented in your submission documents. A properly formatted bibliography and in text citations should be used to document your research. Photographs should be used to document your personal experiments.

Your may model your designs using hand sketches or computer software (CAD or graphics). Your FBDs should be fully labeled with coordinate systems, lengths, and angles. You should include a minimum of 3 FBDs including an overall FBD of the system you design, a FBD that allows you to analyze an intermediary portion of your system, and a FBD of an element that you expect the person to interact with in your design.

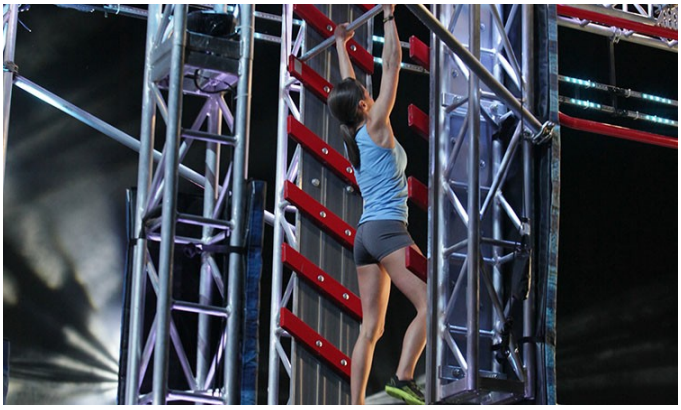
Example:

Here is an example to show you some of the FBDs that could be drawn, that meet the project requirement minimums, using the Salmon Ladder obstacle.

FBD 1: Overall system. This FBD would include the towers holding up the ladder, the red ladder pieces, the bar, and the forces applied by the user. In this FBD the compression in the towers could be analyzed.

FBD 2: A red ladder piece in which the bolts behave as pins in 2D holding the piece in place and the load from the bar is applied. In this FBD there would be pins that could be analyzed as well as the bending applied to the red ladder pieces.

FBD 3: The bar alone with the loads applied by the user and the reactions from the ladder. In this FBD there is the bending of the bar as well as the torsion on the bar due to the friction acting on the bar at the points where it interacts with the ladder.



For your own design, you will have different FBDs to draw and analyze, but this should give you a sense of how to select the FBDs that you may want to draw for your system.

Teams and Team Roles For Submissions:

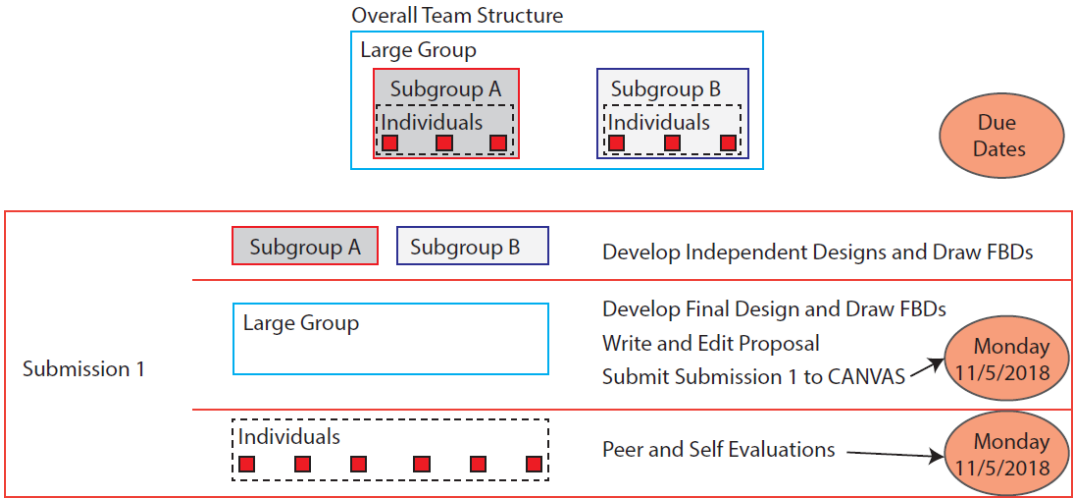
The graphic below displays the Subgroup and Large Group Roles for Submission 1.

Submission 1: Both subgroups will independently develop an obstacle design including all necessary geometries, loads, and FBDs. The large group will work together to develop a final design based off of the two subgroup designs. This may be a combination of designs or picking one group's design and further refining as a large group. One written proposal will be created based on the final design. It may be practical for a few members to complete the writing, so if you do not complete the writing, you are expected to edit the written work.

Late submissions will be accepted with 10% credit reduction of credit for each day late. (i.e. if you submit after the deadline, you will receive up to 90% credit. If between 24-48 hours late, you will receive 80% credit. Late submissions after 48 hours will not be accepted.)

Peer and Self-Evaluations: For each submission, each team member must fill out the peer and self-evaluation form on CANVAS in order for the team to receive a grade for the submission. It is highly encouraged that you work with your team mates throughout the project to give them in-person feedback on their performance in the group. These evaluations will be used as a way to assess each student's individual contributions to each of the submissions.

You will receive full credit for a timely and thoughtful response to the provided questions. Late evaluations will be accepted with 25% credit reduction of credit for each day late. (i.e. if you submit after the deadline, you will receive 75% credit for your thoughtful response. If between 24-48 hours late, you will receive 50% credit.)



Deliverables:

For Submission 1 you will be delivering the following content using the template provided on CANVAS (the peer and self-evaluation will be submitted individually through a CANVAS survey).

- Written proposal from large group
  - The proposal is written to the obstacle selection committee at ANW. It may be written in terms of a traditional paper or as a letter. It should include a description of your obstacle, the ways in which people would use it, the ways in which it could be incorporated into an obstacle course, why your obstacle would appeal to the viewing audience, and other elements of your choosing. This has a maximum length of 2 pages.
- Final design and FBDs from large group
  - The design should include at least one graphic/sketch of the design showing the dimensions that you plan to use. All research and/or measurements that you made in developing your design should go into this section. If you are unaware of how to check for reference credibility or how to properly format your bibliography, check out the library website for further information.
  - The design should clearly indicate the ways in which the obstacle is connected to the outside world (its boundary conditions), the ways in which a user would load the design when in use, and the ways in which components of the design apply loads to each other when the obstacle is in use.
  - At least 3 different FBDs for your system when in use. These FBDs should describe loading scenarios in which you could analyze uniaxial tension/compression, bending, torsion, and pins. Not all FBDs must include all four, but all three loading types and the pin loading must be in at least one of the FBDs.
- Original design and FBDs from each subgroup
- Individual submissions of peer and self-evaluations
  - This is submitted separately on CANVAS and is not part of the team submission.

Rubric:

Category	Exceeds Expectations (95% ±5%)	Meets Expectations (85%±5%)	Acceptable (75%±5%)	Needs Improvement (50%±25%)
Obstacle Design (10 points)	Research showed a high level of knowledge of the design space including: - User interaction with the obstacle - Obstacle interaction with the surrounding world -Interaction between components within the obstacle	Research showed a reasonable level of knowledge of the design space including: - User interaction with the obstacle - Obstacle interaction with the surrounding world -Interaction between components within the obstacle	Research showed a reasonable level of knowledge of the design space in two of the three areas: - User interaction with the obstacle - Obstacle interaction with the surrounding world -Interaction between components within the obstacle	Research showed a lower level of knowledge of the design space. Only one or two of the following were incorporated into the design. - User interaction with the obstacle - Obstacle interaction with the surrounding world -Interaction between components within the obstacle
Obstacle Geometry and Loading (10 points)	Appropriate geometries were used to allow for human use of the obstacle. Appropriate loading conditions were used. Loads were only neglected when appropriate assumptions were used to justify this choice.	Appropriate geometries were mostly used, allowing for human use of the obstacle and/or appropriate loading conditions were mostly used. Loads were only neglected when appropriate assumptions were used to justify this choice.	Appropriate geometries were mostly used but choices may impact human use of the obstacle. Appropriate loading conditions were mostly correct. Loads were mostly only neglected when appropriate assumptions were used to justify this choice.	Appropriate geometries were not always used. Loading conditions were often incorrect. Loading conditions were often incorrect. Assumptions were not properly made to justify neglecting loads.
FBDs (15 points)	FBDs are fully labeled and clear.	FBDs have minor errors.	FBDs have major errors.	FBDs are omitted or cannot be read.
Written Proposal (10 points)	Writing is strong, formal, and clearly conveys a logical message.	Writing is somewhat strong and/or somewhat formal and/or conveys a message, but it is not completely clear.	Writing is weaker and/or informal but a message, while possibly not completely clear, is conveyed.	Writing is weaker and/or informal and/or a clear logical path cannot be followed.
Draft Work (5 points) – these points <u>may</u> be allotted differently to each subgroup	Draft work (Design and FBDs) completed by subgroups A and B is included and shows that a large effort was made by both subgroups before developing a large group design.	Draft work (Design and FBDs) completed by subgroups A and B is included and shows that some effort was made by both subgroups before developing a large group design.	Some draft work (Partial design and/or partial FBDs) completed by subgroups A and B is included and shows that some effort was made by both subgroups before developing a large group design.	Minimal draft work (Partial design and/or partial FBDs) completed by subgroups A and B is included and shows that little effort was made by both subgroups before developing a large group design.