Unit Plan:

Grade 7 Structure and Forces

March 2, 2005
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Focusing Questions:

- How do structures stand up under load?
- What forces act on structures?
- What materials and design characteristics contribute to structural strength and stability?

Unit Summary:

Structures can be found in both natural and human-constructed environments, serving a variety of purposes and taking a wide range of forms. In learning about structures we will investigate the properties of the different materials used in the structures, and will have the opportunity to test the materials under various loads and forces. You will explore the different ways that structural components are configured and then explore the forces involved. You will then have the opportunity to investigate the effects of the structure’s configuration and forces on its structural strength and stability. You will also examine construction methods used in the past and the present, and learn how science and technology link together in developing safe and efficient designs that meet human needs.

Rationale:

The unit starts by providing students with working knowledge for the different structures because it is important to lay down a solid foundation of knowledge and then build on the ideas. We will explore a variety of structures with examples from everyday life, and apply the knowledge by building a straw bridge able to support a rolling golf ball. Then we will be looking at practical issues of manufacturing structures that meet the needs of humans and the main factors used when deciding what type of structure to build, and what type of materials to use. I am planning to use open discussion time so students can explore their own ideas about building structures. From there we move onto discussing the different fasteners used to hold structures together and look at their benefits and drawbacks. I feel that it is important for the students to build up knowledge of how to perform evaluations within the safety of the classroom.

If we are on schedule we will look at structures from various cultures and ages to see how they differ from those the students are familiar with in everyday life. My hope is to stretch the students thinking beyond what they see in our environment. We will progress to forces and loads placed upon a structure, and then we will be looking at some of the forces and testing ideas to gain a deeper understanding of what it means to have a force applied to a structure. I will give the students at least one hands-on activity each week because they need opportunities to learn through their senses and Gardner’s multiple intelligences. I have planned review times each week that have questions that are formed around various levels of Bloom’s taxonomy. The final unit project is to have the students build a model of a reverse bungee for a traveling carnival. I believe that this project will give the students an opportunity to amalgamate all the knowledge into a practical application that will be both challenging and fun for the students. My greatest overall priority for this class is to provide a safe place for students to explore the various topics and feel good about learning science.
General and Specific Learner Outcomes
Outcomes for Science, Technology and Society (STS) and Knowledge

Students will:
1. Describe and interpret different types of structures encountered in everyday objects, buildings, plants and animals; and identify materials from which they are made
   - recognize and classify structural forms and materials used in construction (e.g., identify examples of frame structures, such as goal posts and girder bridges, examples of shell structures, such as canoes and car roofs, and examples of frame-and-shell structures, such as houses and apartment buildings)
• interpret examples of variation in the design of structures that share a common function, and evaluate the effectiveness of the designs (e.g., compare and evaluate different forms of roofed structures, or different designs for communication towers)

• describe and compare example structures developed by different cultures and at different times; and interpret differences in functions, materials and aesthetics (e.g., describe traditional designs of indigenous people and peoples of other cultures; compare classical and current designs; investigate the role of symmetry in design)

• describe and interpret natural structures, including the structure of living things and structures created by animals (e.g., skeletons, exoskeletons, trees, birds’ nests)

• identify points of failure and modes of failure in natural and built structures (e.g., potential failure of a tree under snow load, potential failure of an overloaded bridge)

2. Investigate and analyze forces within structures, and forces applied to them

• recognize and use units of force and mass, and identify and measure forces and loads

• identify examples of frictional forces and their use in structures (e.g., friction of a nail driven into wood, friction of pilings or footings in soil, friction of stone laid on stone)

• identify tension, compression, shearing and bending forces within a structure; and describe how these forces can cause the structure to fail (e.g., identify tensile forces that cause lengthening and possible snapping of a member; identify bending forces that could lead to breakage)

• analyze a design, and identify properties of materials that are important to individual parts of the structure (e.g., recognize that cables can be used as a component of structures where only tensile forces are involved; recognize that beams are subject to tension on one side and compression on the other; recognize that flexibility is important in some structures)

• infer how the stability of a model structure will be affected by changes in the distribution of mass within the structure and by changes in the design of its foundation (e.g., infer how the stability of a structure will be affected by increasing the width of its foundation)

3. Investigate and analyze the properties of materials used in structures

• devise and use methods of testing the strength and flexibility of materials used in a structure (e.g., measure deformation under load)

• identify points in a structure where flexible or fixed joints are required, and evaluate the appropriateness of different types of joints for the particular application (e.g., fixed jointing by welding, gluing or nailing; hinged jointing by use of pins or flexible materials)

• compare structural properties of different materials, including natural materials and synthetics

• investigate and describe the role of different materials found in plant and animal structures (e.g., recognize the role of bone, cartilage and ligaments in vertebrate animals, and the role of different layers of materials in plants)

4. Demonstrate and describe processes used in developing, evaluating and improving structures that will meet human needs with a margin of safety

• demonstrate and describe methods to increase the strength of materials through changes in design (e.g., corrugation of surfaces, lamination of adjacent members, changing the shape of components, changing the method of fastening)

• identify environmental factors that may affect the stability and safety of a structure, and describe how these factors are taken into account (e.g., recognize that snow load, wind load and soil characteristics need to be taken into account in building designs; describe example design adaptations used in earthquake-prone regions)
• analyze and evaluate a technological design or process on the basis of identified criteria, such as costs, benefits, safety and potential impact on the environment

Skill Outcomes (focus on problem solving)

Initiating and Planning
Students will:
Ask questions about the relationships between and among observable variables, and plan investigations to address those questions
• identify practical problems (e.g., identify a problem related to the stability of a structure)
• propose alternative solutions to a practical problem, select one, and develop a plan (e.g., propose an approach to increasing the stability of a structure)
• select appropriate methods and tools for collecting data to solve problems (e.g., use or develop an appropriate method for determining if the mass of a structure is well distributed over its foundation)
• formulate operational definitions of major variables and other aspects of their investigations (e.g., define flexibility of a component as the amount of deformation for a given load)

Performing and Recording
Students will:
Conduct investigations into the relationships between and among observations, and gather and record qualitative and quantitative data
• research information relevant to a given problem
• organize data, using a format that is appropriate to the task or experiment (e.g., use a database or spreadsheet for recording the deformation of components under different loads)
• carry out procedures, controlling the major variables (e.g., ensure that tests to determine the effect of any one variable are based on changes to that variable only)
• use tools and apparatus safely (e.g., select appropriate tools, and safely apply methods for joining materials; use saws and other cutting tools safely)

Analyzing and Interpreting
Students will:
Analyze qualitative and quantitative data, and develop and assess possible explanations
• compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs, line graphs and scatterplots (e.g., plot a graph, showing the deflection of different materials tested under load)
• identify and evaluate potential applications of findings (e.g., identify possible applications of materials for which they have studied the properties)
• test the design of a constructed device or system (e.g., test and evaluate a prototype design of a foundation for a model building to be constructed on sand)
• evaluate designs and prototypes in terms of function, reliability, safety, efficiency, use of materials and impact on the environment
• identify and correct practical problems in the way a prototype or constructed device functions

Communication and Teamwork
Students will:
Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results

- communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means (e.g., produce a work plan, in cooperation with other team members, that identifies criteria for selecting materials and evaluating designs)
- work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise

**Attitude Outcomes**

**Interest in Science**
Students will be encouraged to:
Show interest in science-related questions and issues, and pursue personal interests and career possibilities within science-related fields (e.g., apply knowledge of structures in interpreting a variety of structures within their home community; ask questions about techniques and materials used, and show an interest in construction and engineering)

**Mutual Respect**
Students will be encouraged to:
Appreciate that scientific understanding evolves from the interaction of ideas involving people with different views and backgrounds (e.g., recognize that a variety of structural forms have emerged from different cultures at different times in history)

**Scientific Inquiry**
Students will be encouraged to:
Seek and apply evidence when evaluating alternative approaches to investigations, problems and issues (e.g., report the limitations of their designs; continue working on a problem or research project until the best possible solutions or answers are uncovered)

**Collaboration**
Students will be encouraged to:
Work collaboratively in carrying out investigations and in generating and evaluating ideas (e.g., accept various roles within a group, including that of leadership; remain interested and involved in decision making that requires full-group participation; understand that they may disagree with others but still work in a collaborative manner)

**Stewardship**
Students will be encouraged to:
Demonstrate sensitivity and responsibility in pursuing a balance between the needs of humans and a sustainable environment (e.g., consider the cause-and-effect relationships of personal actions and decisions)

**Safety**
Students will be encouraged to:
Show concern for safety in planning, carrying out and reviewing activities (e.g., readily alter a procedure to ensure the safety of members of the group; carefully manipulate materials, using skills learned in class or elsewhere; listen attentively to safety procedures given by the teacher)
### Assessment Plan:
**Grade 7 Unit D: Structures and Forces (Science & Technology Emphasis)**

<table>
<thead>
<tr>
<th>Science Program Outcomes</th>
<th>Instrument/Method</th>
<th>Date</th>
<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STS-Knowledge</strong> 1 types of structures ;</td>
<td>*Quiz #1 - multiple choice, short answer, true/false</td>
<td>March 24</td>
<td>20%</td>
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<tr>
<td>2 forces within structures</td>
<td>(*ED 3608 Test)</td>
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</tr>
<tr>
<td><strong>STS-Knowledge</strong> 3 properties of materials;</td>
<td>Quiz #2 - multiple choice, short answer, true/false</td>
<td>April 25</td>
<td>20%</td>
</tr>
<tr>
<td>4 processes for structures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Skill CT 2 work cooperatively with team members</strong></td>
<td>• Anecdotal assessment of cooperative teamwork skills - rubrics</td>
<td>varies</td>
<td>10%</td>
</tr>
<tr>
<td><strong>STS-Knowledge</strong> 1-2 evaluate designs;</td>
<td>• Assignment #1 – Golf Ball Bridge p. 277/ plan- rubric, data, questions #1-5</td>
<td>March 9</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Skills IP-2 propose solutions /develop plan; PR 2 carry out procedures; AI-4, 5 test &amp; evaluate designs;</strong></td>
<td>• Assignment #2 -Traditional Structures p. 294/poster-rubric /questions #1 –3</td>
<td>March 18</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Skills IP-1 research information; AI-1 display data</strong></td>
<td>• Assignment #3 – Examining Forces p. 310 Parts 1 &amp; 2, data tables- rubric/ questions #1 &amp; 3</td>
<td>March 22</td>
<td>10%</td>
</tr>
<tr>
<td><strong>STS-Knowledge</strong> 1-3 structures from different cultures</td>
<td>• Assignment #4 – Paper Olympics p. 325, plan, data table, evaluation, improvements-rubric</td>
<td>April 13</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Skills IP-2 develop plan; PR 2 carry out procedures; AI-4, 5 test &amp; evaluate designs; 6 correct problems</strong></td>
<td>• Assignment #5 – Egg Drop of Doom /checklist</td>
<td>April 20</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Skills IP-3 select methods and tools; PR-1 research information; PR 3 carry out procedures; AI 2 apply findings; AI-4, 5 test and evaluate designs;</strong></td>
<td>• Assignment #6 –</td>
<td></td>
<td></td>
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<tr>
<td><strong>Attitudes SI apply evidence to evaluation of design; S concern for safety</strong></td>
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<tr>
<td><strong>Attitudes SI apply evidence; S concern for safety</strong></td>
<td></td>
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</tr>
<tr>
<td>M  Week of Mar 7-11</td>
<td>T  Lesson#1 (55 min)</td>
<td>W  Lesson#2 (55 min)</td>
<td>R  Lesson#3 (55 min)</td>
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</tr>
<tr>
<td>No science</td>
<td>Intro to unit. Video: Bill Nye; Pgs 266-269 text</td>
<td>Types of structures pg 270-278</td>
<td>Golf ball bridge 30min</td>
</tr>
<tr>
<td>Bring materials for golf ball bridge activity</td>
<td>Close with discussion of unit opener</td>
<td>Activity pg 275-groups</td>
<td>Testing 15 min</td>
</tr>
<tr>
<td>Book library time for wed/computer time Thursday next week</td>
<td>Hand out materials list</td>
<td>Intro to golf ball bridge activity</td>
<td>Use rubric</td>
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</tbody>
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<thead>
<tr>
<th>M  Week of Mar 14-18</th>
<th>T  Lesson#5 (55 min)</th>
<th>W  Lesson #6 (55 min)</th>
<th>R  Lesson #7 (55 min)</th>
<th>F  lesson #8 52 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>No science</td>
<td>Pg 283-287 text</td>
<td>Joints/fasteners pg 290</td>
<td>Complete Traditional Structures activity</td>
<td>Presentation of posters and findings (Open forum style) Rubric</td>
</tr>
<tr>
<td>Bring knitting/plywood</td>
<td>Activity: purpose of running shoe</td>
<td>Activity: traditional structures pg 294-295</td>
<td></td>
<td>Review</td>
</tr>
<tr>
<td>Hand out study guide for quiz next Thursday</td>
<td>Show rubric</td>
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<tr>
<th>M  Week of Mar 21-25</th>
<th>T  Lesson #9 (55 min)</th>
<th>W  Lesson #10 (55 min)</th>
<th>R  Lesson #11 (55 min)</th>
<th>F  Good Friday</th>
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<tbody>
<tr>
<td>No science</td>
<td>Mass and force pg 298-301,304</td>
<td>Crush it! activity Pg. 302-303</td>
<td>Quiz 20 min</td>
<td>No classes</td>
</tr>
<tr>
<td>Bring materials for Crush It! Activity</td>
<td>Eg. In Science in Action pg 281</td>
<td>Review</td>
<td>Begin forces, loads and stresses pg 305-308</td>
<td></td>
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<tr>
<td>Week</td>
<td>Monday</td>
<td>Tuesday</td>
<td>Wednesday</td>
<td>Thursday</td>
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<tr>
<td>Apr 4-8</td>
<td>Lesson #12 (55 min)</td>
<td>Forces, loads and stresses pg 305-308</td>
<td>Activity: Examining forces (do as centers)</td>
<td>Lesson #14 (55 min)</td>
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<tr>
<td></td>
<td>No science</td>
<td></td>
<td>Chart-homework</td>
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<td></td>
<td>Materials for both activities.</td>
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<td></td>
<td>No review this week</td>
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<tr>
<td>Apr 11-15</td>
<td>Lesson #16 (55 min)</td>
<td>Paper Olympics pg 325</td>
<td>Paper Olympics continued</td>
<td>Lesson #18 (55 min)</td>
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<tr>
<td></td>
<td>No science</td>
<td>Rubric</td>
<td>Evaluation of construction for homework</td>
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<td></td>
<td>Materials for activities</td>
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<tr>
<td>Apr 18-22</td>
<td>Lesson #20 (55 min)</td>
<td>Firm foundation, rapid rotation pg 336-343</td>
<td>Activity: Drop of Doom pg 344-345</td>
<td>Lesson #22 (55 min)</td>
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<tr>
<td></td>
<td>No science</td>
<td>Rubric</td>
<td></td>
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<td></td>
<td>Materials for activities</td>
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<tr>
<td>Apr 25-27</td>
<td>Lesson #24 (55 min)</td>
<td>Quiz #2 20 min</td>
<td>Discussion quiz-Q &amp; A time.</td>
<td>Lesson #23 (52 min)</td>
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<tr>
<td></td>
<td>No science</td>
<td>End of Practicum</td>
<td>End of Unit!</td>
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<td>Mark quiz in pm.</td>
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Materials:

March 8: Video, Bill Nye the Science Guy – Structural Engineering, overheads of bridges
March 10: Golf ball bridge – per group: 20 large plastic drinking straws, 15 paper clips, 30 cm masking tape, 1 golf ball, scissors
March 15: Runner, dress shoe, knitting, plywood
March 16: posterboard – 1 per group
March 23: Crush it! activity: per group - 15x30 cm wood piece, force meter, safety goggles (at least 4 of any of these – bricks, bunch of pennies or some type of small consistent weight, flat bottom ice cream cone, Styrofoam cup, paper muffin tin liner, ping pong ball, blister packaging, shell shaped pasta, walnut shells, paper cones), newspaper
April 5: Modeling internal forces – plasticine
April 6: Examining forces – marshmallows, fine tip felt
April 7: Bend and Break – silver paper clips (2 per student)
April 12: Paper Olympics - glue guns, glue sticks, white glue, plywood 20x20 cm, string
April 15: Building a balanced Balcony – per group: 15 large plastic drinking straws, 5 recipe cards – large, masking tape – 30 cm, safety pins – 6, staples, paper clips – 5, Styrofoam cup, modeling clay (250 g), thread – 60 cm
April 21: Drop of Doom – students bring in their own supplies depending on what their group decides to use. Hammer, screw drivers, finishing nails, small screws, plywood (for work area)

Learning Resources:

Texts:

Video:

Internet:
Lesson Plans:  Grade 7.  Unit D.  Structures and Forces

Lesson #1    March 8, 2005 55 minutes

STS-Knowledge
1. describe and interpret different types of structures encountered in everyday objects, buildings, plants and animals; and identify materials from which they are made.
   1-1 recognize and classify structural forms and materials used in construction
   1-5 identify points and modes of failure in natural and built structures

2. investigate and analyze forces within structures, and forces applied to them
   2-2 identify and measure forces and loads

Objectives:
Students will:
• identify examples of different kinds of structures
• identify forces acting on structures
• describe reasons for the failure of a bridge

Materials:
Video, Bill Nye the Science Guy: Structures Episode
Chart for coded students
Overheads of Tacoma Narrows Bridge
Overhead of chart
Overhead markers

Introduction: (3-5 min)
• We are starting a new unit that I will be taking you through for my time here. Open your textbook to page 267, and let’s look at the pictures.
What is the name of the unit?
What do these two pictures have in common relative to our unit of study?
• Tell students what they will learning in the unit (chart) and today (board outline)

Body: (20 min)
• Introduce video – how it will show the interaction of structures and forces. Tell students to pay attention to the different types of structures and see if they can find out if certain structures are best suited for certain stresses.
• Show video.
What were some of the different types of structures?
What are some of the benefits/drawbacks of the structures in the video?
• Show pictures of Tacoma narrows bridge on overhead.
Why do you think this bridge failed? (looking for ideas that demonstrate thoughtfulness)
What was the force the engineers didn’t take into consideration? (wind)
What could they have done to fix it? (looking for ideas that demonstrate thoughtfulness)
• Read aloud page 266.(3-4 min) Place chart on overhead. (provide chart on paper to coded students).
• Have students brainstorm in groups of 2-3 for answers to chart questions. (3-4 min)
• Have students return to seats and we will discuss answers as a class. (5-7 min)
  (encourage all answers and look at further discussion to probe thought if answers aren’t
  on track). Remind students that the questions on the chart are the focus of the unit.
• Read pages 268-269 (4-5 min) and highlight concepts students will need to know (for
  metacognition – have students plan for what they will be learning).
• Tell students that there will be an end of unit project. Read Reverse Bungee Drop of
  Doom (pg. 344-345) Advise of the changes in the specifications (30 minutes to
  complete, must advise me of supplies being used).

Closure: (2-3 min)
Reiterate that there are structures all around us that have different forces acting upon
them.
• Think about the video and the pictures and the different forces acting upon them, and
  for homework identify and describe in your notebook at least three structures of different
  types in Lethbridge (e.g., on way to school). Be prepared to share with the class
  tomorrow.
• Tomorrow we will begin with looking at different types of structures and the ways they
  can be classified.

Lesson #2 Grade 7  Unit D – Structures and forces
March 9, 2005 55 minutes

STS-Knowledge
1. describe and interpret different types of structures encountered in everyday objects,
   buildings, plants and animals; and identify materials from which they are made.
   1-1 recognize and classify structural forms and materials used in construction
   1-4 describe and interpret natural structures, including the structure of living things and
   structures created by animals

Objectives:
Students will:
• describe the various types of structures
• state the functional benefits of each type
• give examples of each type of structure.

Materials:
   overhead pictures
   manipulatives – feather, coal, egg carton, sea shell, Ziploc bag, fruit bowl,
   skeleton
   overhead transparency/ markers
   golf ball bridge activity for resource students
**Introduction:** (3-5 min)

Yesterday we looked at a video and some overheads about different structures and some of the forces applied to them.

*What are some of the structures we looked at?*

*Were there similarities in any of the structures?* (encourage the discussion to move toward being able to classify the structures for better understanding)

**Body:** (45 min)

- Open text book to pg 270. Read aloud up to “Classifying structures” (stress definitions: structures, function, stresses, forces)
- In groups of 2-3 come up with a way of classifying the objects on pg 271. (3 min)
- Return to class – *What were some of the classes you grouped the objects in?*

*What is good about your classification system? What is confusing about it?* (encouraging students to see the variables involved in classification systems)

- Explain important points from text (have handout for resource students)
  - Natural structures: not made by people. E.g. feather (has definite shape – purpose: insulation, protection, flight) e.g. sand dunes (characteristic shape – made up of many grains – purpose: home for small animals, role in desert ecosystem.)

*What makes something a natural structure?* (not made by people)

- Manufactured structures: built by people – many modeled after natural structures e.g. fish net – spider web; parachute – dandelion seed; Velcro – cockle burr; umbrella – mushroom

*Why might we have manufactured structures?*

*How is a manufactured structure different from a natural structure?*

- Structures can be classified by how they are built
  - Design: how it is put together, shaped, and the materials that make up the structure.
    - 3 kinds: mass, frame, shell
  - Mass structure: mad up by piling up or forming similar materials into a particular shape or design.
    - Mountains, coral reefs
    - Snow sculptures, brick walls
    - Omelet, cake, bread
    - These structures are held firmly in place by their own weight – some of the material can fall away and it still stands.

*What is another example of a mass structure?*

- Shell structure: objects that use a thin, carefully shaped outer layer of material to provide their strength and rigidity
  - Igloo, egg shell, cardboard box, egg carton, food can, pipes, clay pots, parachute, balloon, clothing, bubbles
    - They are completely empty
    - Require very little building material
    - The shape spreads force through the entire structure – each part supports only a small part of the load, complete structure can be amazingly strong.

- Frame Structure: have a skeleton of very strong materials, which supports the weight of the covering materials.
  - Houses, office buildings
- Ladders, snowshoes, spider webs – only a frame.
- Umbrella, auto, boat – frame is hidden
- Drilling rigs, steel bridges – frame is left exposed

*When would a shell structure be more beneficial than a frame structure?* (looking for answers that demonstrate thoughtfulness)

- Certain frame structures have special design challenges:
  - Tents, communication towers, buildings, bridges – need anchoring, braces, or many parts have to fit together perfectly
- Mix and match structures: e.g. football helmet (shell and frame)
  - Used to improve stability
  - Hydroelectric dams – mass outside, frame inside to house generators
  - Airplanes – metal frame – needs extra strength to support weight of engines – metal shell
  - Domed buildings – frame and shell
  - Warehouses – frame (steel columns) and concrete walls (mass)

- Review the key points *(5 min)*: What do the following mean *(own words)*: structure, function, forces, stresses
  
  **Give own/new examples of:** Natural structure, manufactured structure, mass, frame, shell, mix and match

  **What kind of structure is a balloon? A concrete parking block? A human skeleton? A dome tent?**

  **What combination types are represented by these pictures?** *(show overhead pictures)*

  - Look at “Picture a Frame” on pg 275. In groups answer the questions 2 (all parts) and 3. Don’t need to write them out formally. *(3 min)*
  - Take up answers as a class *(3 min)*
  - Turn to pg. 276. Read over instructions to activity, highlighting the differences in what we will be doing *(e.g. 30 minute time limit.)*
  - Have all students sketch a tentative idea for a bridge and bring it to class tomorrow.
  - Must have sketch so that you have an understanding of what is being asked of you tomorrow for the bridge. *(Provide resource students with handout of example of bridge structure design)*
  - If time left over, allow students to work on sketch.

**Closure: (2 min)**

- Reminder *(board)* students need to have bridge sketch completed for tomorrow
Lesson #3  Unit D  Structures and Forces
Grade 7  March 10

STS-Knowledge
1. demonstrate and describe processes used in developing, evaluating and improving structures that will meet human needs with a margin of safety.
   4-1 demonstrate and describe methods to increase the strength of materials through changes in design

Skills IP: ask questions about the relationships between and among observable variables, and plan investigations to address those questions.
   IL-1 identify practical problems
   IL-2 propose alternative solutions to a practical problem, select one, and develop a plan

Skills AI: Analyze qualitative and quantitative data, develop & assess possible explanations
   AI-3 test the design of a constructed device or system
   AI-4 evaluate designs and prototypes in terms of function, reliability, safety, efficiency, use of materials and impact on the environment

Attitude - Collaboration work collaboratively in carrying out investigations and in generating and evaluating ideas

Objective:
Students will:
• develop a plan for a model bridge following pre-specified criteria
• construct a bridge according to the plan
• test and evaluate the bridge against the pre-specified criteria
• describe improvements to the bridge design based on test findings
• work collaboratively with group members to develop and carry the a plan

Materials:
Per group: 20 large drinking straws, 15 silver paper clips, 1 pair scissors, 1 golf ball, 30 cm masking tape, 1 ruler
Rubric for activity-overhead copy also.
Examples of different ways to connect straws
Overhead of assigned groups

Introduction: (3 min)
• Raise your hand if you have you sketch for the bridge idea completed.
  *Can anyone tell me why I asked that you have the sketches completed for today?*
  (looking for general understanding of the process involved in design, as well as understanding that a design done at home saves time today, and to be a productive member of your team)
• *Who wants to share their sketch and ideas for a bridge design? (get a sample)*
• Refer to outline and objectives of today’s class (board)
**Body:** (47 min total)

- Explain instructions for activity, highlighting the changes that we have from the book (will put these up on the board)
  
  What materials will we be using? What is listed, except changes on board
  
  Can we use anything else? No
  
  Can we use less than we’ve been given? Yes
  
  Which design specifications must be met for your bridge to be successful? What is listed on the rubric.

- Each person has one job: materials person, specifications checker, trial run technician, design artist, golf ball dispenser (if only 4 people, golf ball dispenser goes to materials person).

- Show list of groups (I made groups -on overhead sheet).

**Any questions?**

- You have 30 min from now. Begin. **Set timer.**
  
  - As students work on activity, move around the room checking designs and making anecdotal notes of group activity – is there anyone who is not contributing? Answer questions, bring around examples of how to attach straws together and show each group individually
  
  - Ensure you provide groups with a countdown so they can plan their time accordingly.

- Demonstration time: (15-17 min) Which group would like to test their bridge for us first? Allow each group to test bridge.

- Ask students if they feel group has met requirements of bridge building. If no, why not.

**Closure:** (5 min)

- Comment on positives of group work seen:
  
  - Cooperation
  
  - Thoughtfulness – considerate of others ideas and suggestions
  
  - Positive comments

  Was this activity as easy as you first thought? Why?

- Complete evaluation questions on page 277, #1-4 for homework. We’ll discuss them tomorrow.