MA Draft Revised MS-HS *Technology*

Based on *A Framework for K-12 Science Education* (NR
Please direct comments, suggested ed
The standards and strand maps ar
(*) denotes integration of techn

1. Engineering Design

Grade 6

Grade 7

3-5-ETS1-1 (gr. 3)

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution. Inlcude potential impacts on people and the natural environment that may limit possible solutions.*

3-5-ETS1-2 (gr. 3)

3-5-ETS1-4 (MA) (gr. 3)

Math: 8-G 3.

7-G 1

MS-ETS1-2. Evaluate competing solutions to a given design problem using a systematic process to determine h well each meets the criteria and constraints of the proble Use a model of each solution to evaluate how variations in one or more design features, including size shape, weight, or cost may affect the function or effectiveness of the solution.*

MS-ETS1-5 (MA). Create visual representations of solutions to a design problem. Accurately interpret and apply scale and proportion to visual representations.* [Clarification Statement: Examples of visual representations can include sketches, scaled drawings, and orthographic projections. Examples of scale can include ¼'' = 1'0'', 1 cm = 1 m.]

MS-LS2-5 (gr. 7

3-5-ETS1-6 (MA) (gr. 4)

MS-ETS1-7 (MA). Construct a prototype of a solution to given design problem.*

6-SP 5.

6-SP 4.

3-5-ETS1-3 (gr. 4)

MS-ETS1-4. Generate and analyze data from iterative test and modification of a proposed object, tool, or process t optimize the object, tool, or process for its intended purpos

MS-PS3-3 (gr. 7)

/Engineering Strand Map (12/20/13)

RC, 2012) and adapted from the *Next Generation Science Standards* (2013)
lits, and questions to: mathsciencetech@doe.mass.edu.
e available at: www.doe.mass.edu/stem/review.html
ology/engineering through a practice or core idea.

Grade 8

Technology/Engineering (Grade 9-10)

(GEOM) G-MG 3.

HS-ETS1-1. Analyze a major global challenge to specify a design problem that can be improved. Determine necessary qualitative and quantitative criteria and constraints for solutions, including any requirements set by society.* [Clarification Statement: Examples of societal requirements can include risk mitigation, aesthetics, ethical considerations, and long-term maintenance costs.]

(GEOM) G-GMD 4.

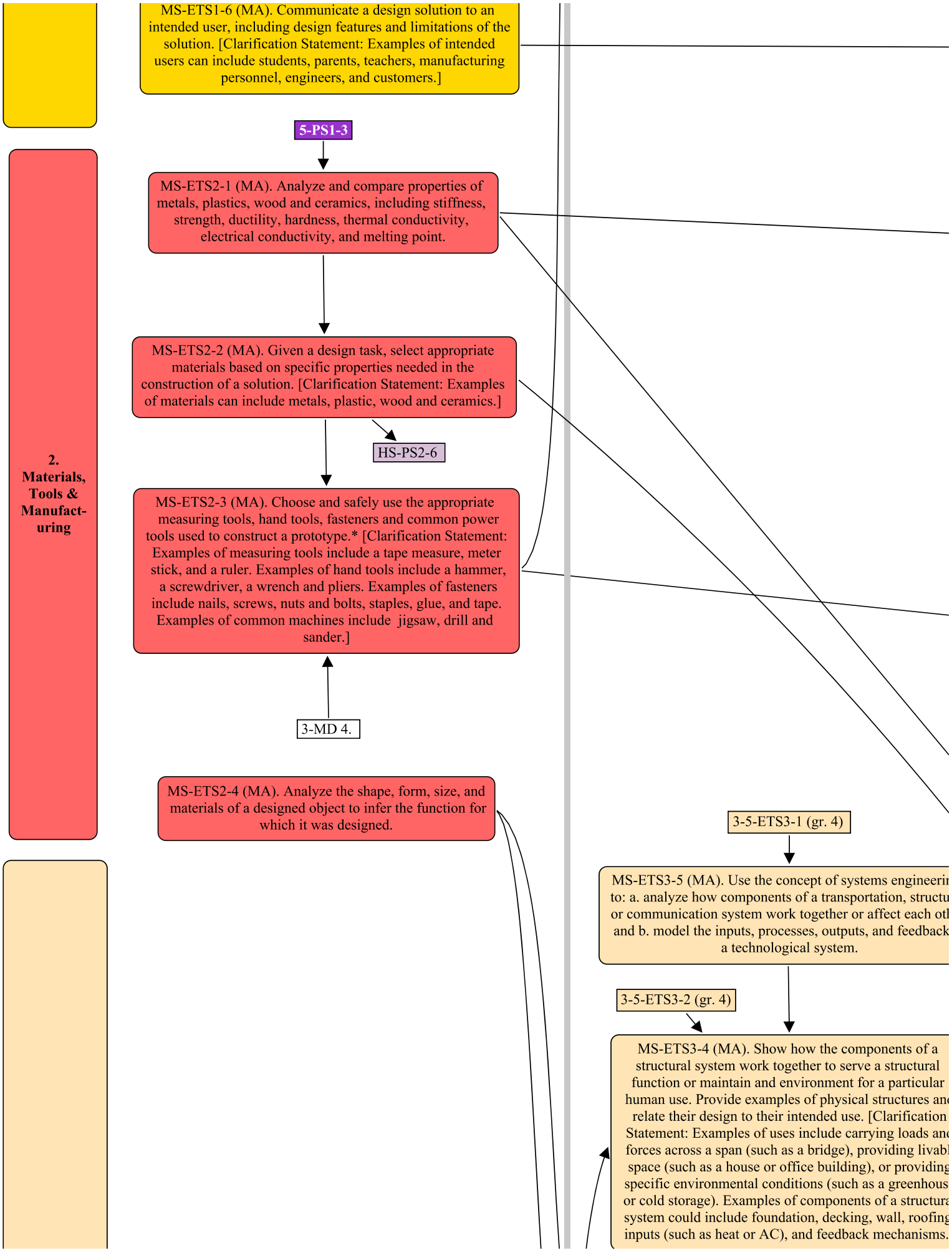
HS-ETS1-5 (MA). Plan a prototype or design solution using orthographic projections and isometric drawings, using proper scales and proportions.*

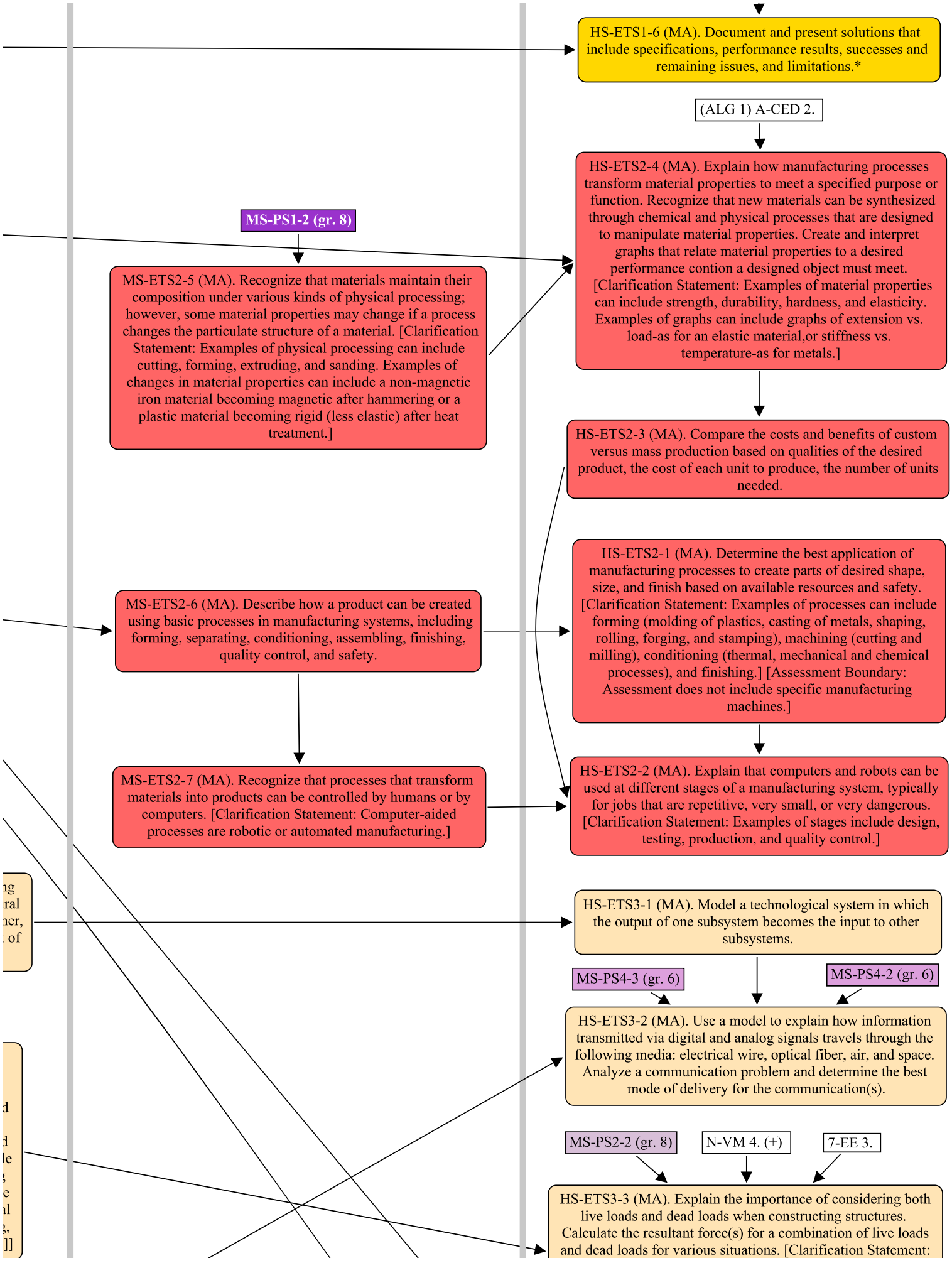
HS-ETS1-2. Break a complex real-world problem into smaller, more manageable problems that each can be solved using scientific and engineering principles.*

(Alg 1) S-ID 9.

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, aesthetics and maintenance, as well as social, cultural, and environmental impacts.*

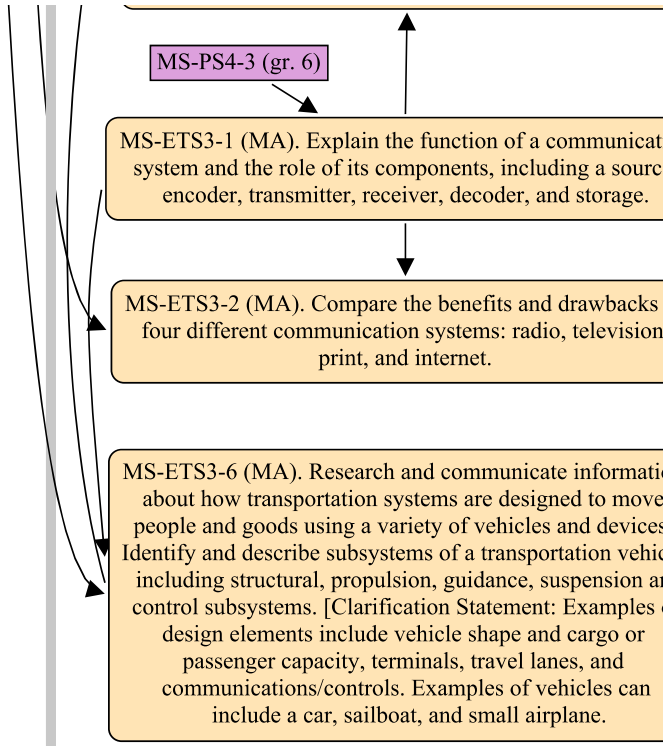
HS-ETS1-4. Use a computer simulation to model the impact of a proposed solution to a complex real-world problem that has numerous criteria and constraints on the interactions within and between systems relevant to the problem.*

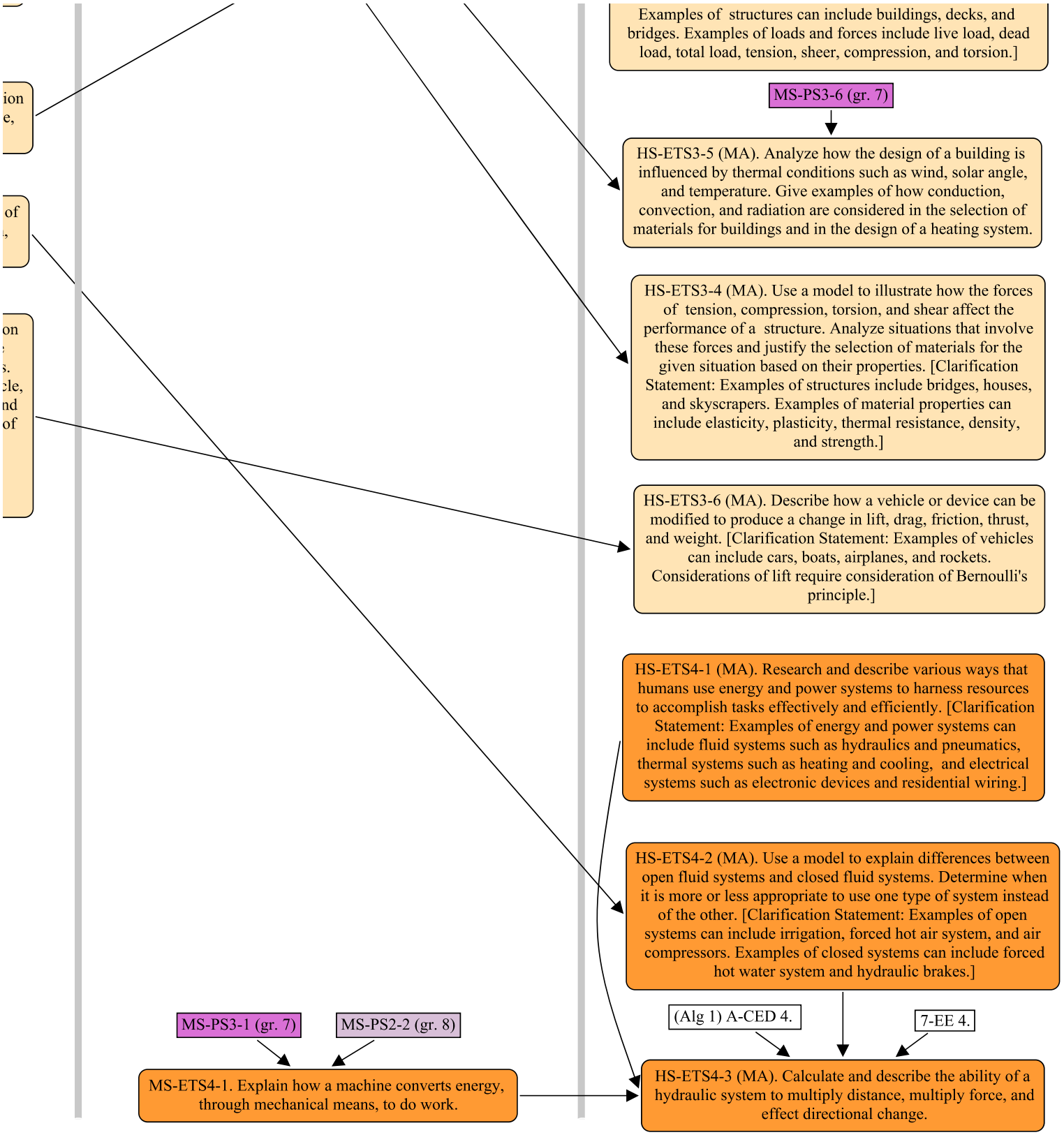

MS-ETS1-6 (MA). Communicate a design solution to an intended user, including design features and limitations of the solution. [Clarification Statement: Examples of intended users can include students, parents, teachers, manufacturing personnel, engineers, and customers.]
5-PS1-3
2. Materials, Tools & Manufact-uring
MS-ETS2-1 (MA). Analyze and compare properties of metals, plastics, wood and ceramics, including stiffness, strength, ductility, hardness, thermal conductivity, electrical conductivity, and melting point.
MS-ETS2-2 (MA). Given a design task, select appropriate materials based on specific properties needed in the construction of a solution. [Clarification Statement: Examples of materials can include metals, plastic, wood and ceramics.]
HS-PS2-6
MS-ETS2-3 (MA). Choose and safely use the appropriate measuring tools, hand tools, fasteners and common power tools used to construct a prototype.* [Clarification Statement: Examples of measuring tools include a tape measure, meter stick, and a ruler. Examples of hand tools include a hammer, a screwdriver, a wrench and pliers. Examples of fasteners include nails, screws, nuts and bolts, staples, glue, and tape. Examples of common machines include jigsaw, drill and sander.]
3-MD 4.
MS-ETS2-4 (MA). Analyze the shape, form, size, and materials of a designed object to infer the function for which it was designed.
3-5-ETS3-1 (gr. 4)
MS-ETS3-5 (MA). Use the concept of systems engineeri to: a. analyze how components of a transportation, structu or communication system work together or affect each otl and b. model the inputs, processes, outputs, and feedback a technological system.
3-5-ETS3-2 (gr. 4)
MS-ETS3-4 (MA). Show how the components of a structural system work together to serve a structural function or maintain and environment for a particular human use. Provide examples of physical structures an relate their design to their intended use. [Clarification Statement: Examples of uses include carrying loads an forces across a span (such as a bridge), providing livabl space (such as a house or office building), or providing specific environmental conditions (such as a greenhous or cold storage). Examples of components of a structura system could include foundation, decking, wall, roofing inputs (such as heat or AC), and feedback mechanisms.


HS-ETS1-6 (MA). Document and present solutions that include specifications, performance results, successes and remaining issues, and limitations.*
(ALG 1) A-CED 2.
HS-ETS2-4 (MA). Explain how manufacturing processes transform material properties to meet a specified purpose or function. Recognize that new materials can be synthesized through chemical and physical processes that are designed to manipulate material properties. Create and interpret graphs that relate material properties to a desired performance contion a designed object must meet. [Clarification Statement: Examples of material properties can include strength, durability, hardness, and elasticity. Examples of graphs can include graphs of extension vs. load-as for an elastic material,or stiffness vs. temperature-as for metals.]
MS-PS1-2 (gr. 8)
MS-ETS2-5 (MA). Recognize that materials maintain their composition under various kinds of physical processing; however, some material properties may change if a process changes the particulate structure of a material. [Clarification Statement: Examples of physical processing can include cutting, forming, extruding, and sanding. Examples of changes in material properties can include a non-magnetic iron material becoming magnetic after hammering or a plastic material becoming rigid (less elastic) after heat treatment.]
HS-ETS2-3 (MA). Compare the costs and benefits of custom versus mass production based on qualities of the desired product, the cost of each unit to produce, the number of units needed.
HS-ETS2-1 (MA). Determine the best application of manufacturing processes to create parts of desired shape, size, and finish based on available resources and safety. [Clarification Statement: Examples of processes can include forming (molding of plastics, casting of metals, shaping, rolling, forging, and stamping), machining (cutting and milling), conditioning (thermal, mechanical and chemical processes), and finishing.] [Assessment Boundary: Assessment does not include specific manufacturing machines.]
MS-ETS2-6 (MA). Describe how a product can be created using basic processes in manufacturing systems, including forming, separating, conditioning, assembling, finishing, quality control, and safety.
MS-ETS2-7 (MA). Recognize that processes that transform materials into products can be controlled by humans or by computers. [Clarification Statement: Computer-aided processes are robotic or automated manufacturing.]
HS-ETS2-2 (MA). Explain that computers and robots can be used at different stages of a manufacturing system, typically for jobs that are repetitive, very small, or very dangerous. [Clarification Statement: Examples of stages include design, testing, production, and quality control.]
HS-ETS3-1 (MA). Model a technological system in which the output of one subsystem becomes the input to other subsystems.
MS-PS4-3 (gr. 6)
MS-PS4-2 (gr. 6)
HS-ETS3-2 (MA). Use a model to explain how information transmitted via digital and analog signals travels through the following media: electrical wire, optical fiber, air, and space. Analyze a communication problem and determine the best mode of delivery for the communication(s).
MS-PS2-2 (gr. 8)
N-VM 4. (+)
7-EE 3.
HS-ETS3-3 (MA). Explain the importance of considering both live loads and dead loads when constructing structures. Calculate the resultant force(s) for a combination of live loads and dead loads for various situations. [Clarification Statement:

3. Technological Systems

4. Energy & Power Technologies




Examples of structures can include buildings, decks, and bridges. Examples of loads and forces include live load, dead load, total load, tension, sheer, compression, and torsion.]
MS-PS3-6 (gr. 7)
HS-ETS3-5 (MA). Analyze how the design of a building is influenced by thermal conditions such as wind, solar angle, and temperature. Give examples of how conduction, convection, and radiation are considered in the selection of materials for buildings and in the design of a heating system.
HS-ETS3-4 (MA). Use a model to illustrate how the forces of tension, compression, torsion, and shear affect the performance of a structure. Analyze situations that involve these forces and justify the selection of materials for the given situation based on their properties. [Clarification Statement: Examples of structures include bridges, houses, and skyscrapers. Examples of material properties can include elasticity, plasticity, thermal resistance, density, and strength.]
HS-ETS3-6 (MA). Describe how a vehicle or device can be modified to produce a change in lift, drag, friction, thrust, and weight. [Clarification Statement: Examples of vehicles can include cars, boats, airplanes, and rockets. Considerations of lift require consideration of Bernoulli's principle.]
HS-ETS4-1 (MA). Research and describe various ways that humans use energy and power systems to harness resources to accomplish tasks effectively and efficiently. [Clarification Statement: Examples of energy and power systems can include fluid systems such as hydraulics and pneumatics, thermal systems such as heating and cooling, and electrical systems such as electronic devices and residential wiring.]
HS-ETS4-2 (MA). Use a model to explain differences between open fluid systems and closed fluid systems. Determine when it is more or less appropriate to use one type of system instead of the other. [Clarification Statement: Examples of open systems can include irrigation, forced hot air system, and air compressors. Examples of closed systems can include forced hot water system and hydraulic brakes.]
MS-PS3-1 (gr. 7)
MS-PS2-2 (gr. 8)
(Alg 1) A-CED 4.
7-EE 4.
MS-ETS4-1. Explain how a machine converts energy, through mechanical means, to do work.
HS-ETS4-3 (MA). Calculate and describe the ability of a hydraulic system to multiply distance, multiply force, and effect directional change.