The AERO Science Framework
and MS / HS Science Framework Progressions Matrices

Introduction:

Project AERO was launched with the goal of ensuring that challenging, standards-based curricula and meaningful assessments would become the common experience for American students overseas. A major part of this project involved writing and disseminating K to 12 standards for many subjects, including science, for schools around the world. This was a multiyear process and the standards were embraced by international schools around the world.

In 2013 the final draft of the Next Generation Science Standards (NGSS) was released. These new standards reflected many of the pedagogical approaches, such as progressions, that had been woven into the AERO science standards. They also covered much of the same content as the AERO science standards. Recognizing that these standards support the mission of Project AERO and align in many ways with the AERO science standards that already existed, Project AERO is restructuring the AERO Science Framework to align with the NGSS. The AERO Science Framework aims to identify bundles of performance expectations at each grade level, and support those bundles with anchoring phenomenon, enduring understandings and essential questions. Additionally, Project AERO supports schools in their transition to the AERO Science Framework through teacher training and live binder and web-based resources.

While there may be shifts in the order in which students encounter content during their K – 12 science education, there is a great deal of overlap between the content from the previous AERO Science Framework and the content in the new AERO Science Framework. Additionally, the ideas of crosscutting concepts and science practices are not new and have been a part of science education frameworks for many years. What makes these standards different than previous science standards is their three-dimensional nature – every K-12 standard has these 3 elements, or dimensions, written into it. For an overview of the AERO Science Framework standards and more information about their three-dimensional nature, click here.

The AERO Science Framework Progressions Matrices:

As mentioned in the AERO science framework introduction, the concept of progressions has been a fundamental building block of all AERO standards. The development of understanding over time is a foundational concept for each of the three dimensions of the AERO Science Framework. These three dimensions are the science and engineering practices (SEPs), the crosscutting concepts (CCCs) and the disciplinary core ideas (DCIs). The DCIs are the content students are expected to know, the CCCs are the many ways we want our students to think about the phenomenon they encounter in the classroom and the SEPs are what scientists and engineers do – and what we want our students doing every time they are constructing understanding of scientific principles through the exploration of phenomena. Engaging students in this way is perhaps the biggest shift teachers will make in their transition to the NGSS, as it requires a major shift in pedagogical approach. At the end of this document you can find a summary table of the eight science and engineering practices.

The student AERO science experience is divided into four grade bands, K-2, 3-5, MS and HS. This is also how each of the three dimensions progress throughout a student's education. As students move through the grade bands, they encounter each of the three dimensions - DCIs, SEPs and CCCs - in increasing complexity and sophistication. Matrices of these progressions organized by grade band are provided in the appendices from the nextgenscience.org website. Appendix E shows the progressions of the DCIs, Appendix F shows a matrix for each of the eight SEPs and Appendix G has the matrices for each of the seven CCCs.

Understanding the progressions for each of the dimensions is key in developing curriculum designed for three dimensional standards. To design effective instruction in each of the dimensions, we need to know what is expected of our students at each grade band with regard to each of the three dimensions. Additionally, progressions help us understand where students are coming from (what they have learned before) and where they are going to in their K-12 arc of learning. Not surprisingly, progressions are also essential tools in the development of three-dimensional assessment tasks.

The AERO Science Framework Progressions Matrices organize and display the progressions of the *standards* across grade bands. The K-HS AERO Science Framework Progressions Matrix *(linked to from the Project AERO homepage)* shows where in each grade band (K-2 and 3-5) students will be encountering each of the standards embodied in the AERO Science Framework and as well displays the standards students encounter in MS and HS. It provides a clear view of how students encounter PEs over time. Because these documents are organized by the disciplinary core ideas, they also allow us to see where in the previous grade band students last engaged with the content, and where they will next be asked to work with these ideas.

The middle school map presented in the AERO Science Framework Progressions Matrices is an integrated model and students encounter the life sciences, the physical sciences and Earth and space sciences each year. The high school map follows a more traditional model and presents biology, chemistry and physics courses that meaningfully connect to the Earth and space sciences across all three years.

There are two AERO MS / HS Science Progressions matrixes:

1. MS – HS AERO Science Framework matrix: this document includes all standards taught from grades 6 – 12. It also specifies which standards are addressed in grades six, seven and eight – and which are addressed in Biology, Chemistry and Physics.

2. MS – HS AERO Science Framework summary matrix: this matrix is a summary document and presents the standard codes that students encounter as they move through middle school and high school. This document does not include the entire language of the standards, just the codes. It does, however, separate out those standards covered in grades six, seven and eight – and those covered in Biology, Chemistry and Physics.

1. AERO Science Framework Progressions Matrix Document (MS-HS)

(asterisks indicate the inclusion of engineering design in the standard)

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AERO Science Framework Progressions Matrix Document (MS-HS)

(asterisks indicate the inclusion of engineering design in the standard)

	Grade 6	**Grade 7**	**Grade 8**	Biology	Chemistry	Physics
Matter and Its Interactions		MS-PS1-1 Develop models to describe the atomic composition of simple molecules and extended structures.			HS-PS1-1, Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms	
		MS-PS1-2 Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.			HS-PS1-2 Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.	
		MS-PS1-3 Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.			HS-PS1-3, Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.	

	Grade 6	Grade 7	Grade 8	Biology	Chemistry	Physics
Matter and Its Interactions		MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.			HS-PS1-4 Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.	
		MS-PS1-5 Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved			HS-PS1-5 Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs	
		MS-PS1-6 Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.*			HS-PS1-6 Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.*	

	Grade 6	Grade 7	Grade 8	Biology	Chemistry	Physics
Matter and Its Interactions					HS-PS1-7 Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.	
					HS-PS1-8 Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.	

	Grade 6	Grade 7	Grade 8	Biology	Chemistry	Physics
Motion and Stability: Forces and Interactions			MS-PS2-1 Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.*			HS-PS2-1 Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration
			MS-PS2-2 Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.			HS-PS2-2 Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.
			MS-PS2-3 Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.			HS-PS2-3 Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.*
			MS-PS2-4 Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.			HS-PS2-4 Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

Motion and Stability: Forces and Interactions	**Grade 6**	**Grade 7**	**Grade 8**	Biology	Chemistry	Physics
			MS-PS2-5 Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.			HS-PS2-5 Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.
					HS-PS2-6 Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.*	

	Grade 6	Grade 7	Grade 8	Biology	Chemistry	Physics
Energy			MS-PS3-1 Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.			HS-PS3-1 Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
			MS-PS3-2 Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.			HS-PS3-2 Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).
	MS-PS3-3 Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.*					HS-PS3-3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. *

	Grade 6	Grade 7	Grade 8	Biology	Chemistry	Physics
Energy	MS-PS3-4 Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.				HS-PS3-4 Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).	
	MS-PS3-5 Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.					HS-PS3-5 Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

	Grade 6	Grade 7	Grade 8	Biology	Chemistry	Physics
Waves and Their Applications in Technologies for Information Transfer			MS-PS4-1, Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.			HS-PS4-1 Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
			MS-PS4-2, Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.			HS-PS4-2 Evaluate questions about the advantages of using a digital transmission and storage of information.
			MS-PS4-3 Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.			HS-PS4-3 Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.
						HS-PS4-4 Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.

Waves and Their Applications in Technologies for Information Transfer	**Grade 6**	**Grade 7**	**Grade 8**	Biology	Chemistry	Physics
						HS-PS4-5 Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.*

From Molecules to Organisms: Structures and Processes	**Grade 6**	**Grade 7**	**Grade 8**	Biology	Chemistry	Physics
	MS-LS1-1 Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.			HS-LS1-1 Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.		
	MS-LS1-2 Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.			HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.		
	MS-LS1-3 Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.			HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.		

	Grade 6	Grade 7	Grade 8	Biology	Chemistry	Physics
From Molecules to Organisms: Structures and Processes	MS-LS1-4 Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.			HS-LS1-4 Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.		
	MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.			HS-LS1-5 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.		
		MS-LS1-6 Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.			HS-LS1-6 Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.	

	Grade 6	Grade 7	Grade 8	Biology	Chemistry	Physics
From Molecules to Organisms: Structures and Processes		MS-LS1-7 Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.			HS-LS1-7 Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.	
	MS-LS1-8. Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.					

	Grade 6	Grade 7	Grade 8	Biology	Chemistry	Physics
Ecosystems: Interactions, Energy, and Dynamics		MS-LS2-1 Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.		HS-LS2-1 Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different Scales.		
		MS-LS2-2 Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.		HS-LS2-2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.		
		MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.		HS-LS2-3 Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.		
		MS-LS2-4 Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.		HS-LS2-4 Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.		

	Grade 6	**Grade 7**	**Grade 8**	Biology	Chemistry	Physics
Ecosystems: Interactions, Energy, and Dynamics		MS-LS2-5 Evaluate competing design solutions for maintaining biodiversity and ecosystem services.*		HS-LS2-5 Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.		
				HS-LS2-6 Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.		
				HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*		
				HS-LS2-8 Evaluate the evidence for the role of group behavior on individual and species' chances to survive and Reproduce.		

	Grade 6	Grade 7	Grade 8	Biology	Chemistry	Physics
Heredity: Inheritance and Variation of Traits			MS-LS3-1 Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.	HS-LS3-1 Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.		
	MS-LS3-2 Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.			HS-LS3-2 Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.		
				HS-LS3-3 Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.		

	Grade 6	Grade 7	Grade 8	Biology	Chemistry	Physics
Biological Evolution: Unity and Diversity			MS-LS4-1, Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.	HS-LS4-1 Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.		
			MS-LS4-2 Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.	HS-LS4-2 Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.		
			MS-LS4-3 Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.	HS-LS4-3 Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.		

	Grade 6	Grade 7	Grade 8	Biology	Chemistry	Physics
Biological Evolution: Unity and Diversity			MS-LS4-4 Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.	HS-LS4-4 Construct an explanation based on evidence for how natural selection leads to adaptation of populations.		
			MS-LS4-5 Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.	HS-LS4-5 Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.		
			MS-LS4-6 Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.	HS-LS4-6 Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.*		

	Grade 6	Grade 7	Grade 8	Biology	Chemistry	Physics
Earth's Place in the Universe			MS-ESS1-1 Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.		HS-ESS1-1 Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy in the form of radiation.	
			MS-ESS1-2 Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.		HS-ESS1-2 Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.	
			MS-ESS1-3 Analyze and interpret data to determine scale properties of objects in the solar system.		HS-ESS1-3 Communicate scientific ideas about the way stars, over their life cycle, produce elements.	
			MS-ESS1-4 Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.			HS-ESS1-4 Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

	Grade 6	Grade 7	Grade 8	Biology	Chemistry	Physics
Earth's Place in the Universe						HS-ESS1-5 Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.
					HS-ESS1-6 Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.	

	Grade 6	Grade 7	Grade 8	Biology	Chemistry	Physics
Earth's Systems		MS-ESS2-1 Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.				HS-ESS2-1 Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor Features.
		MS-ESS2-2 Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.				HS-ESS2-2 Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
		MS-ESS2-3 Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.				HS-ESS2-3 Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.
	MS-ESS2-4 Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.				HS-ESS2-4 Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.	

Earth's Systems	**Grade 6**	**Grade 7**	**Grade 8**	Biology	Chemistry	Physics
	MS-ESS2-5 Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.				HS-ESS2-5 Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.	
	MS-ESS2-6 Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.				HS-ESS2-6 Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.	
					HS-ESS2-7 Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.	

	Grade 6	Grade 7	Grade 8	Biology	Chemistry	Physics
Earth and Human Activity		MS-ESS3-1 Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.		HS-ESS3-1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.		
		MS-ESS3-2 Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.			HS-ESS3-2 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.*	
	MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.*			HS-ESS3-3 Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.		

Earth and Human Activity	Grade 6	Grade 7	Grade 8	Biology	Chemistry	Physics
			MS-ESS3-4 Construct an argument supported by evidence for how increases in human population and per- capita consumption of natural resources impact Earth's systems.	HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*		
	MS-ESS3-5 Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.			HS-ESS3-5 Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.		
				HS-ESS3-6 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.		

Engineering Design	MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.	HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
	MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
	MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.	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, and aesthetics as well as possible social, cultural, and environmental impacts
	MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

2. AERO Science Framework Progressions Matrix Summary Document (MS/HS)

(asterisks indicate the inclusion of engineering design in the standard)

	6	7	8	Biology	Chemistry	Physics
PS1		MS PS1-1 MS PS1-2 MS PS1-3 MS PS1-4 MS PS1-5 MS PS1-6 *			HS PS1-1 HS PS1-2 HS PS1-3 HS PS1-4 HS PS1-5 HS PS1-6 * HS PS1-7 HS PS1-8	
PS2			MS PS2-1 * MS PS2-2 MS PS2-3 MS PS2-4 MS PS2-5		HS PS2-6 *	HS PS2-1 HS PS2-2 HS PS2-3 * HS PS2-4 HS PS2-5
PS3	MS PS3-3 * MS PS3-4 MS PS3-5		MS PS3-1 MS PS3-2		HS PS3-4	HS PS3-1 HS PS3-2 HS PS3-3 * HS PS3-5
PS4			MS PS4-1 MS PS4-2 MS PS4-3			HS PS4-1 HS PS4-2 HS PS4-3 HS PS4-4 HS PS4-5 *
LS1	MS LS1-1 MS LS1-2 MS LS1-3 MS LS1-4 MS LS1-5 MS LS1-8	MS LS1-6 MS LS1-7		HS LS1-1 HS LS1-2 HS LS1-3 HS LS1-4 HS LS1-5	HS LS1-6 HS LS1-7	

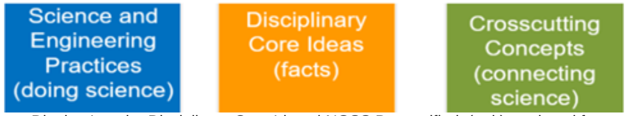
LS2		MS LS2-1 MS LS2-2 MS LS2-3 MS LS2-4 MS LS2-5 *		HS LS2-1 HS LS2-2 HS LS2-3 HS LS2-4 HS LS2-5 HS LS2-6 HS LS2-7 * HS LS2-8		
LS3	MS LS3-2		MS LS3-1	HS LS3-1 HS LS3-2 HS LS3-3		
LS4			MS LS4-1 MS LS4-2 MS LS4-3 MS LS4-4 MS LS4-5 MS LS4-6	HS LS4-1 HS LS4-2 HS LS4-3 HS LS4-4 HS LS4-5 HS LS4-6 *		
ESS1			MS ESS1-1 MS ESS1-2 MS ESS1-3 MS ESS1-4		HS ESS1-1 HS ESS1-2 HS ESS1-3 HS ESS1-6	HS ESS1-4 HS ESS1-5
ESS2	MS ESS2-4 MS ESS2-5 MS ESS2-6	MS ESS2-1 MS ESS2-2 MS ESS2-3			HS ESS2-4 HS ESS2-5 HS ESS2-6 HS ESS2-7	HS ESS2-1 HS ESS2-2 HS ESS2-3
ESS3	MS ESS3-3 * MS ESS3-5	MS ESS3-1 MS ESS3-2	MS ESS3-4	HS ESS3-1 HS ESS3-3 HS ESS3-4 * HS ESS3-5 HS ESS3-6	HS ESS3-2 *	

ETS	MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4			HS-ETS1-1 HS-ETS1-2 HS-ETS1-3 HS-ETS1-4		
Total PEs	15	18	22	27	21	19
	55 + 4 ETS PEs = 59			67 + 4 ETS PEs = 71		

Overview of the AERO Science Framework Standards:

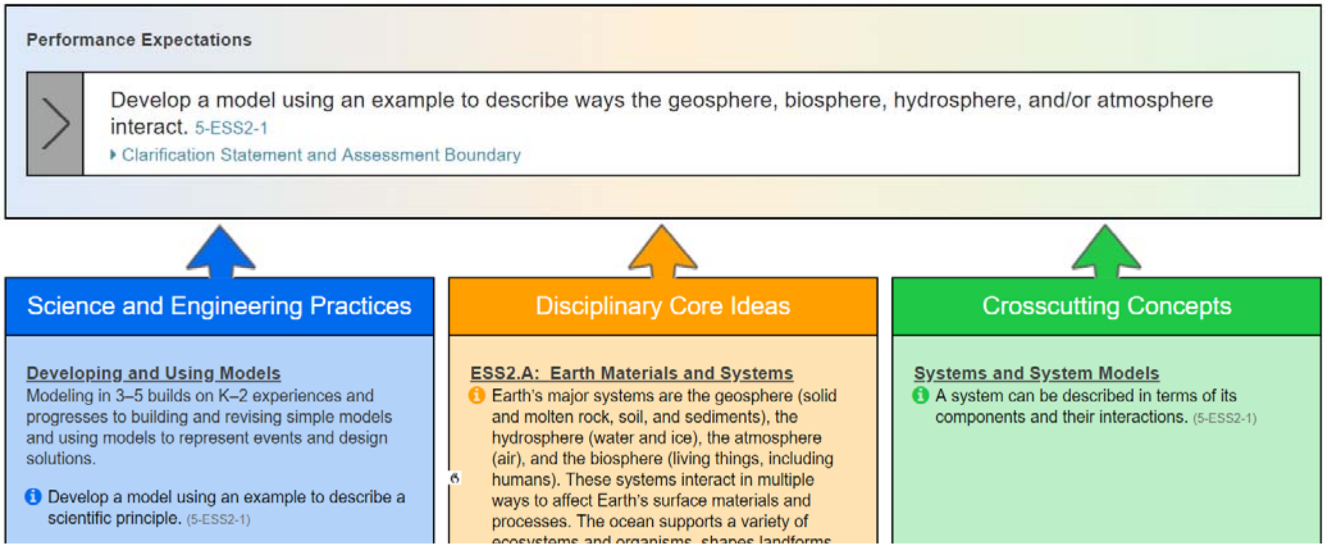
The standards presented in the AERO Science Framework are three-dimensional standards. They inform us as to what students should know and be able to do at the end of instruction for each grade or grade band. The three-dimensional nature of these standards is what most distinguishes these new standards from previous science standards. The three dimensions embedded in each are the science and engineering practices (SEPs), the crosscutting concepts (CCCs) and the disciplinary core ideas (DCIs). In this example below, we can see each of the three dimensions embedded within this grade 5 performance expectation.

Grade 5: 5-ESS2-1 Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.



Digging Into the Disciplinary Core Ideas | NGSS Demystified. (n.d.). -etrieved from https://www.calacademy.org/educators/digging-into-the-disciplinary-core-ideas

If we look at this same standard on the NSTA website, we see the image below. Here we can tell more specific information about each of the three dimensions provided in the foundation boxes, which are blue, orange and green. In this grade 5 performance expectation, the science and engineering practice is “Developing and Using Models.” More specifically, students at the end of this instructional unit or grade need to be able to, “Develop a model using an example to describe the scientific principle.” In the orange foundation box, we are given information about the content, or DCI, students should understand. The crosscutting concept is identified as “Systems and System Models” in the green foundation box and more specific information about the crosscutting concept is provided here as well.



NSTA. (n.d.). Earth's Systems. -etrieved December 17, 2018, from https://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=119

Because these three-dimensional standards are meant to help us design assessment, and we will be assessing our students by asking them to engage with three-dimensional assessment tasks, it is our responsibility to make sure that the teaching and learning that takes place in our classrooms is also three dimensional - meaning that when students are engaging with the content (DCI), they are actively engaged in one of the SEPs and considering their work through the lens of one of the CCC's. This shift to three-dimensional teaching and learning, along with the idea of anchoring all unit instruction in phenomena, have emerged as the key fundamental shifts in planning, instruction and assessment of these new standards.

It is important to remember that the performance expectations specify learning outcomes. They illustrate competencies students should develop as a result of meaningful learning experiences over the course of an instructional unit or year. *The standards are for assessment design, and therefore they have implications for curriculum design and instruction, but they are not curriculum*. Instead, standards are meant to be grouped with other performance expectations to create bundles of PEs that are used collectively to develop NGSS designed three-dimensional instruction (curriculum) that leads students to competency in the standards in the bundle.

The Science and Engineering Practices:

Asking Questions and Defining Problems

A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world works and which can be empirically tested.

Developing and Using Models

A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations.

Planning and Carrying Out Investigations

Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters.

Analyzing and Interpreting Data

Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis.

Using Mathematics and Computational Thinking

In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; statistically analyzing data; and recognizing, expressing, and applying quantitative relationships.

Constructing Explanations and Designing Solutions

The products of science are explanations and the products of engineering are solutions.

Engaging in Argument from Evidence

Argumentation is the process by which explanations and solutions are reached.

Obtaining, Evaluating, and Communicating Information

Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity.

NSTA. (n.d.). Science and Engineering Practices. -etrieved January 23, 2019, from https://ngss.nsta.org/PracticesFull.aspx