CURRICULUM

FOR

ARCHITECUTRE

GRADES 9-12

This curriculum is part of the Educational Program of Studies of the Rahway Public Schools.

ACKNOWLEDGMENTS

Dr. Susan Dube, Program Supervisor of Science/Technology Education

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Subject/Course Title:
Architecture
Grades 9-12

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September 17, 2019

RAHWAY PUBLIC SCHOOLS CURRICULUM

Course Name: Grades 9-12

PACING GUIDE

Unit	Title	Pacing
1	Engineering Habits of Mind	8 weeks
2	Technical Communication Tools: Scaled Modeling	10 weeks
3	Statics/Structural Design	10 weeks
4	Technology Student Association Design Competition	12 weeks

ACCOMMODATIONS

504 Accommodations:

- Provide scaffolded vocabulary and vocabulary lists.
- Provide extra visual and verbal cues and prompts.
- Provide adapted/alternate/excerpted versions of the text and/or modified supplementary materials.
- Provide links to audio files and utilize video clips.
- Provide graphic organizers and/or checklists.
- Provide modified rubrics.
- Provide a copy of teaching notes, especially any key terms, in advance.
- Allow additional time to complete assignments and/or assessments.
- Provide shorter writing assignments.
- Provide sentence starters.
- Utilize small group instruction.
- Utilize Think-Pair-Share structure.
- Check for understanding frequently.
- Have student restate information.
- Support auditory presentations with visuals.
- Weekly home-school communication tools (notebook, daily log, phone calls or email messages).
- Provide study sheets and teacher outlines prior to assessments.
- Quiet corner or room to calm down and relax when anxious.
- Reduction of distractions.
- Permit answers to be dictated.
- Hands-on activities.
- Use of manipulatives.
- Assign preferential seating.
- No penalty for spelling errors or sloppy handwriting.
- Follow a routine/schedule.
- Provide student with rest breaks.
- Use verbal and visual cues regarding directions and staying on task.
- Assist in maintaining agenda book.

IEP Accommodations:

- Provide scaffolded vocabulary and vocabulary lists.
- Differentiate reading levels of texts (e.g., Newsela).
- Provide adapted/alternate/excerpted versions of the text and/or modified supplementary materials.
- Provide extra visual and verbal cues and prompts.
- Provide links to audio files and utilize video clips.
- Provide graphic organizers and/or checklists.
- Provide modified rubrics.
- Provide a copy of teaching notes, especially any key terms, in advance.
- Provide students with additional information to supplement notes.
- Modify questioning techniques and provide a reduced number of questions or items on tests.
- Allow additional time to complete assignments and/or assessments.
- Provide shorter writing assignments.
- Provide sentence starters.
- Utilize small group instruction.
- Utilize Think-Pair-Share structure.
- Check for understanding frequently.
- Have student restate information.
- Support auditory presentations with visuals.
- Provide study sheets and teacher outlines prior to assessments.
- Use of manipulatives.
- Have students work with partners or in groups for reading, presentations, assignments, and analyses.
- Assign appropriate roles in collaborative work.
- Assign preferential seating.
- Follow a routine/schedule.

Gifted and Talented Accommodations:

- Differentiate reading levels of texts (e.g., Newsela).
- Offer students additional texts with higher lexile levels.
- Provide more challenging and/or more supplemental readings and/or activities to deepen understanding.
- Allow for independent reading, research, and projects.
- Accelerate or compact the curriculum.
- Offer higher-level thinking questions for deeper analysis.
- Offer more rigorous materials/tasks/prompts.
- Increase number and complexity of sources.
- Assign group research and presentations to teach the class.

ELL Accommodations:

- Provide extended time.
- Assign preferential seating.
- Assign peer buddy who the student can work with.
- Check for understanding frequently.
- Provide language feedback often (such as grammar errors, tenses, subject-verb agreements, etc…).
- Have student repeat directions.
- Make vocabulary words available during classwork and exams.
- Use study guides/checklists to organize information.
- Repeat directions.
- Increase one-on-one conferencing.
- Allow student to listen to an audio version of the text.
- Give directions in small, distinct steps.

● Assign/allow for leadership roles during collaborative work and in other learning activities.	● Allow copying from paper/book. ● Give student a copy of the class notes. ● Provide written and oral instructions. ● Differentiate reading levels of texts (e.g., Newsela). ● Shorten assignments. ● Read directions aloud to student. ● Give oral clues or prompts. ● Record or type assignments. ● Adapt worksheets/packets. ● Create alternate assignments. ● Have student enter written assignments in criterion, where they can use the planning maps to help get them started and receive feedback after it is submitted. ● Allow student to resubmit assignments. ● Use small group instruction. ● Simplify language. ● Provide scaffolded vocabulary and vocabulary lists. ● Demonstrate concepts possibly through the use of visuals. ● Use manipulatives. ● Emphasize critical information by highlighting it for the student. ● Use graphic organizers. ● Pre-teach or pre-view vocabulary. ● Provide student with a list of prompts or sentence starters that they can use when completing a written assignment. ● Provide audio versions of the textbooks. ● Highlight textbooks/study guides. ● Use supplementary materials. ● Give assistance in note taking ● Use adapted/modified textbooks. ● Allow use of computer/word processor. ● Allow student to answer orally, give extended time (time-and-a-half). ● Allow tests to be given in a separate location (with the ESL teacher). ● Allow additional time to complete assignments and/or assessments. ● Read question to student to clarify. ● Provide a definition or synonym for words on a test that do not impact the validity of the exam. ● Modify the format of assessments. ● Shorten test length or require only selected test items. ● Create alternative assessments. ● On an exam other than a spelling test, don't take points off for spelling errors.

UNIT OVERVIEW

Content Area: Architecture

Unit Title: Unit 1-Engineering Habits of Mind

Target Course/Grade Level: 9-12

Unit Summary:

Students will learn about the engineering way of thinking which enables engineers to come up with solutions to problems and/or improvements to current technologies and design processes. These habits of mind include: creativity, optimism, persistence, systems thinking, conscientiousness, and collaboration. In this unit students will undertake the production of engineering models given varying degrees of technical information to ascertain the importance to technical instructions, as well as learn how to quantify data results in matrices through testing numerous iterations to make quantitative decisions about prototype values.

Approximate Length of Unit: 6 Weeks

LEARNING TARGETS

NJ Student Learning Standards:

- 8.1.5.A.3 Use a graphic organizer to organize information about problem or issue.
- 8.2.8.C.4 Identify the steps in the design process that would be used to solve a designated problem.
- 8.2.2.A.3 Identify a system and the components that work together to accomplish its purpose.
- 8.2.8.C.2 Explain the need for optimization in a design process.

21st Century Life and Career Skills:

- 9.3.ST.6 Demonstrate technical skills needed in a chosen STEM field.
- 9.3.ST-ET.4 Apply the elements of the design process.

Interdisciplinary Connections and Standards:

Science:

- 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.

NJ SLS Companion Standards: Reading and Writing Standards for History, Social Studies, Science, and Technical Subjects:

- RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Unit Understandings:

Students will understand that…

- Engineering notebooks should contain robust data, prototyping drawings, dimensions, construction instructions, and modification and testing results
- Effective modeling requires craft and precision
- Mathematics and science are fundamental to engineering
- Effective team-work requires contentious verbal and visual communication

Unit Essential Questions:

- Why is documentation important to the engineering design process?
- How is measurement essential to technical design?
- How does iteration and testing improve product performance?

Knowledge and Skills:

Students will know…..

- the definition of and engineering notebook
- the definition of a design matrix
- the elements of the design process
- elements of technical design, such as constraints and limitations

Students will be able to …

- create a mechanical model based of given production directions and materials
- create a design matrix to select and optimal design
- analyze data
- document work in an engineering notebook

EVIDENCE OF LEARNING

Assessment:

What evidence will be collected and deemed acceptable to show that students truly "understand"?

- participation in class discussions
- teacher observed participation in a team

- self-critique of teamwork
- culminating individual engineering notebook documenting assigned projects

Learning Activities:

Tentative projects include:
Paper Airplane design and flight competition
Heat-powered boats
Rubber-band powered cars (varying instructions per group to illustrate the importance of detailed documentation)
Various construction activities from *A Beginner's Guide to Constructing the Universe: The Mathematical Archetypes of Nature, Art, and Science* (Schnider)

What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Various/repeated presentations of content in small groups or at the individual level
- Division of teams so that each team has a balance of technical and creative skills
- Production of example documentation to follow as necessary per on-going observed skill levels
- Varied assistance to produce technical documentation necessary per on-going observed skill levels

RESOURCES

Teacher Resources:

- Teacher developed worksheets
- Teacher developed note sheets
- Example engineering notebook from training from *Engineer your World*
- *A Beginner's Guide to Constructing the Universe: The Mathematical Archetypes of Nature, Art, and Science* (Schnider)
- www.P12engineering.org

Equipment Needed:

- Classroom computers
- AutoCAD
- cutting mats
- exacto knives
- Card Stock
- Spreadsheet software
- Cardboard
- Glue
- Rubberbands
- paperclips

- Printers
- PowerPoint
- Class projector

UNIT OVERVIEW

Content Area: Architecture

Unit Title: Unit 2-Technical Communication Tools—Scaled modeling and Drawing

Target Course/Grade Level: 9-12

Unit Summary:

Students will build upon data collection techniques of the previous unit through the development of scaled technical engineering models and drawings which include dimensions and scale. The focus of this unit is mastery of psychomotor building and three-dimensional spatial reasoning skills, as well as acquisition of drawing convention knowledge.

Approximate Length of Unit: 8 Weeks

LEARNING TARGETS

NJ Student Learning Standards:

- 8.2.12.C.5 Create scaled engineering drawings of products both manually and digitally with materials and measurements labeled.
- 8.2.2.A.3 Identify a system and the components that work together to accomplish its purpose.
- 8.2.12.D.3 Determine and use the appropriate resources (e.g., CNC (Computer Numerical Control) equipment, 3D printers, CAD software) in the design, development and creation of a technological product or system

21st Century Life and Career Skills:

- 9.3.ST.6 Demonstrate technical skills needed in a chosen STEM field.
- 9.3.ST-ET.4 Apply the elements of the design process.
- 9.3.12.AC-DES.6 Apply the techniques and skills of modern drafting, design, engineering and construction to projects.

Interdisciplinary Connections and Standards:

Science:

- 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.

Mathematics:

- *CCSS.Math.Content.7.G.A.1*
  Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.

NJ SLS Companion Standards: Reading and Writing Standards for History, Social Studies, Science, and Technical Subjects:

- RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Unit Understandings:

Students will understand that…

- technical documentation requires competency in measurement and craft
- engineering and architectural drawing requires use of various, industry-defined line-weights and symbols to be universally legible within the design community
- computer made drawings can be exported for rapid production

Unit Essential Questions:

- Why does technical drawing require mathematics knowledge?
- How are multiple 2-dimensional views required to represent a 3-dimensional space?
- How does design software streamline effort in the design process?
- Why is documentation important to the engineering design process?
- How is measurement and dimensioning essential to technical design and documentation?

Knowledge and Skills:

Students will know…..

- Conventions of technical engineering drawings
- Varied information is appropriate at different drawing scales
- Basic understanding of mechanics of building models
- elements of technical design, such as constraints and limitations

Students will be able to …

- create scaled, dimensioned plan and elevation views of an architectural space or engineering product per defined criteria
- create spatial model of an architectural space or engineering product per given scale, material and performance criteria

EVIDENCE OF LEARNING

Assessment:

What evidence will be collected and deemed acceptable to show that students truly "understand"?

- culminating individual scaled models and technical drawings per defied criteria

Learning Activities:

Tentative assignments include:
Isovist spatial analysis model
Classroom survey and plan drawing
Cube towers

What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Various/repeated demonstrations of drawing and modeling techniques in small groups or at the individual level (including use of engineering and architectural scale, as well as use of grid matte board as a measurement tool)
- Production of example documentation to follow as necessary per on-going observed skill levels
- Varied scaffolding to produce technical documentation of data necessary per on-going observed skill levels
- Use of Edmentum and AutoCAD individual tutorials

RESOURCES

Teacher Resources:

- Teacher developed worksheets
- Teacher developed note sheets
- Previous student work examples
- www.P12engineering.org
- AutoCAD tutorials
- Edmentum drafting lessons

Equipment Needed:

- Classroom computers
- Drafting boards
- Slide rules
- Engineering scales
- Architectural scales
- AutoCAD
- cutting mats
- exacto knives
- cardboard
- Cardboard
- Glue
- Printers/Plotter
- PowerPoint
- Class projector

UNIT OVERVIEW

Content Area: Architecture

Unit Title: Unit 3—Statics/Structural Design

Target Course/Grade Level: 9-12

Unit Summary:

Students will learn the principles of structural design according to basic forces acting upon a structure: compression, tension, torsion, bending, and shearing and design and create a structure that maximally resists these forces. Structures will be tested to failure and students will analyze testing results.

Approximate Length of Unit: 8 Weeks

LEARNING TARGETS

NJ Student Learning Standards:

- 8.2.2.A.3 Identify a system and the components that work together to accomplish its purpose.
- **8.2.8.C.5.a** Create a technical sketch of a product with materials and measurements labeled.
- **8.2.2.D.3** Identify the strengths and weaknesses in a product or system
- **8.2.8.D.1** Design and create a product that addresses a real world problem using a design process under specific constraints.
- **8.2.8.D.3** Build a prototype that meets a STEM-based design challenge using science, engineering, and math principles that validate a solution.
- **8.2.8.C.6** Collaborate to examine a malfunctioning system and identify the step-by-step process used to troubleshoot, evaluate and test options to repair the product, presenting the better solution.

21st Century Life and Career Skills:

- 9.3.ST.6 Demonstrate technical skills needed in a chosen STEM field.

- 9.3.ST-ET.4 Apply the elements of the design process.
- 9.3.12.AC-DES.6 Apply the techniques and skills of modern drafting, design, engineering and construction to projects.

Interdisciplinary Connections and Standards:

Science:

- 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.

Mathematics:

- *CCSS.Math.Content.7.G.A.1*
  Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.

NJ SLS Companion Standards: Reading and Writing Standards for History, Social Studies, Science, and Technical Subjects:

- RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
- RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS2-1)

Unit Understandings:

Students will understand that…

- Structural modeling requires competency in measurement and craft
- Structural design requires consideration of multiple forces acting upon a structure at once
- Optimization modeling requires testing and revision

Unit Essential Questions:

- Why is craft required in structural design modeling?
- How do constraints affect design process?
- What is efficiency in structural design?

Knowledge and Skills:

Students will know…..

- The definition of the structural forces: torsion, shearing, compression, bending, tension
- The definition of the unit rate of weight held by structure: weight of structure
- The difference between moment and pinned connections in a structural frame design

Students will be able to …

- Create force-resistant structures
- Determine strength ratios of their structural designs
- Use drafting tools to aid in the development of their models
- Analyze design failures and propose optimized solutions from stress testing

EVIDENCE OF LEARNING

Assessment:

What evidence will be collected and deemed acceptable to show that students truly "understand"?

- Preliminary quiz on structural forces
- Iterative models to be tested to failure
- Culminating diagram of final model failure and proposed design improvements

Learning Activities:
Tentative assignments include:
Straw towers
Wooden bridges

What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Various/repeated demonstrations of drawing and modeling techniques in small groups or at the individual level (including use of engineering and architectural scale, as well as use of grid matte board as a measurement tool)
- Production of example documentation to follow as necessary per on-going observed skill levels
- Varied scaffolding to produce effective structural designs
- Use of AutoCAD Inventor to demonstrate forces acting upon basic frame structures and other simulation software
- Selection of groups based on varied technical analysis and building skills

RESOURCES

Teacher Resources:

- Teacher developed worksheets
- Teacher developed note sheets
- Previous student work examples
- www.P12engineering.org
- http://www.ivanmarkov.com/truss-simulator.html

Equipment Needed:

- Classroom computers
- Drafting boards
- Slide rules
- Engineering scales
- Architectural scales
- AutoCAD
- cutting mats
- exacto knives
- straws
- pins
- PowerPoint
- Class projector

UNIT OVERVIEW

Content Area: Architecture

Unit Title: Unit 4—Technology Student Association Design Competition

Target Course/Grade Level: 9-12

Unit Summary:

Students will work in groups and choose one of the following categories from the TSA design competition to participate in:

Architectural Design Participants (one [1] team, or one [1] individual, per chapter) develop a set of architectural plans and related materials for an annual architectural design challenge and construct a physical, as well as a computer-generated model, to accurately depict their design.

Board Game Design Participants (one [1] team per chapter) develop, build, and package a board game that focuses on the subject of their choice. The game should be interesting, exciting, visually appealing, and intellectually challenging. Each team will have to design the packaging, instructions, pieces, and cards associated with creating and piloting a new board game. Semifinalists for the event will set up the game, demonstrate how the game is played, and explain the game's features.

Structural Design and Engineering Participants (one [1] team of two [2] individuals per chapter) work as a team to build a designated structure that is posted on the TSA website. Teams apply the principles of structural design and engineering through research, design, construction, destructive testing, and assessment to determine the design efficiency of the structure.

Transportation Modeling Participants (one [1] individual per chapter) research, design, and produce a scale model of a vehicle that fits the annual design problem.

Fashion Design and Technology Participants (three [3] teams of two to four [2–4] individuals per state) research, design, and create a portfolio and wearable prototype that reflect the theme for the year, which can be found on Themes and Problems. Semifinalist teams participate in a presentation/interview in which they present their garment designs to judges.

Approximate Length of Unit: 12 Week

LEARNING TARGETS

NJ Student Learning Standards:

- **8.2.5.C.4** Collaborate and brainstorm with peers to solve a problem evaluating all solutions to provide the best results with supporting sketches or models
- **8.2.8.C.4** Identify the steps in the design process that would be used to solve a designated problem
- 8.2.2.A.3 Identify a system and the components that work together to accomplish its purpose.
- **8.2.8.D.1** Design and create a product that addresses a real-world problem using a design process under specific constraints.

21st Century Life and Career Skills:

- 9.3.ST.6 Demonstrate technical skills needed in a chosen STEM field.
- 9.3.ST-ET.4 Apply the elements of the design process.
- 9.3.12.AC-DES.6 Apply the techniques and skills of modern drafting, design, engineering and construction to projects.
- 9.3.MN-QA.3 Coordinate work teams to create a product that meets quality assurance standards.

Interdisciplinary Connections and Standards:

Science:

- 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.

Mathematics:

- *CCSS.Math.Content.7.G.A.1*
  Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.

NJ SLS Companion Standards: Reading and Writing Standards for History, Social Studies, Science, and Technical Subjects:

- RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Unit Understandings:

Students will understand that…

- All steps of the design cycle must be followed to create a successful design
- Communication and division of labor are critical to create a successful design problem

- Self-directed research and inquiry are essential to innovative design

Unit Essential Questions:

- How do constraints effect design process?
- How does each step of the design cycle contribute to the overall solution?
- What is constructive critique?
- What constitutes successful teamwork within a competition framework?

Knowledge and Skills:

Students will know…..

- The design cycle
- Their defined roles within a team

Students will be able to …

- Present ideas in an on-going forum
- Critique their own and other teams' process and products
- Develop a design portfolio based on competition requirements

NJ Student Learning Standards:

- **8.2.5.C.4** Collaborate and brainstorm with peers to solve a problem evaluating all solutions to provide the best results with supporting sketches or models
- **8.2.8.C.4** Identify the steps in the design process that would be used to solve a designated problem
- 8.2.2.A.3 Identify a system and the components that work together to accomplish its purpose.
- **8.2.8.D.1** Design and create a product that addresses a real-world problem using a design process under specific constraints.

21st Century Life and Career Skills:

- 9.3.ST.6 Demonstrate technical skills needed in a chosen STEM field.
- 9.3.ST-ET.4 Apply the elements of the design process.
- 9.3.12.AC-DES.6 Apply the techniques and skills of modern drafting, design, engineering and construction to projects.
- 9.3.MN-QA.3 Coordinate work teams to create a product that meets quality assurance standards.

<u>Interdisciplinary Connections and Standards:</u>

<u>Science:</u>

- 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.

<u>Mathematics:</u>

- *CCSS.Math.Content.7.G.A.1*
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Students will be able to …

- Present ideas in an on-going forum
- Critique their own and other teams' process and products
- Develop a design portfolio based on competition requirements

EVIDENCE OF LEARNING

Assessment:

What evidence will be collected and deemed acceptable to show that students truly "understand"?

- Effective articulation of the design problem and articulation of relevant solutions
- Participation in weekly design critique of teamwork and design development
- Culminating portfolio of design elements to be defined by the TSA committee
- Self and teammate evaluations

Learning Activities:

Per yearly defined projects from TSA

What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Various/repeated demonstrations of drawing and modeling techniques in small groups or at the individual level
- Varied scaffolding to produce effective designs
- Selection of groups based on varied technical analysis and building skills, and assistance in selection of appropriate roles within the teams

RESOURCES

Teacher Resources:

- Teacher developed worksheets
- Teacher developed note sheets
- https://tsaweb.org/competitions-programs/tsa/high-school-competitions

Equipment Needed:

- Classroom computers
- Drafting boards
- Slide rules
- Engineering scales
- Architectural scales
- AutoCAD
- cutting mats
- exacto knives
- cardboard
- foamboard
- Elmers Glue-all
- pins
- PowerPoint
- Class projector
- Sewing machine
- fabric