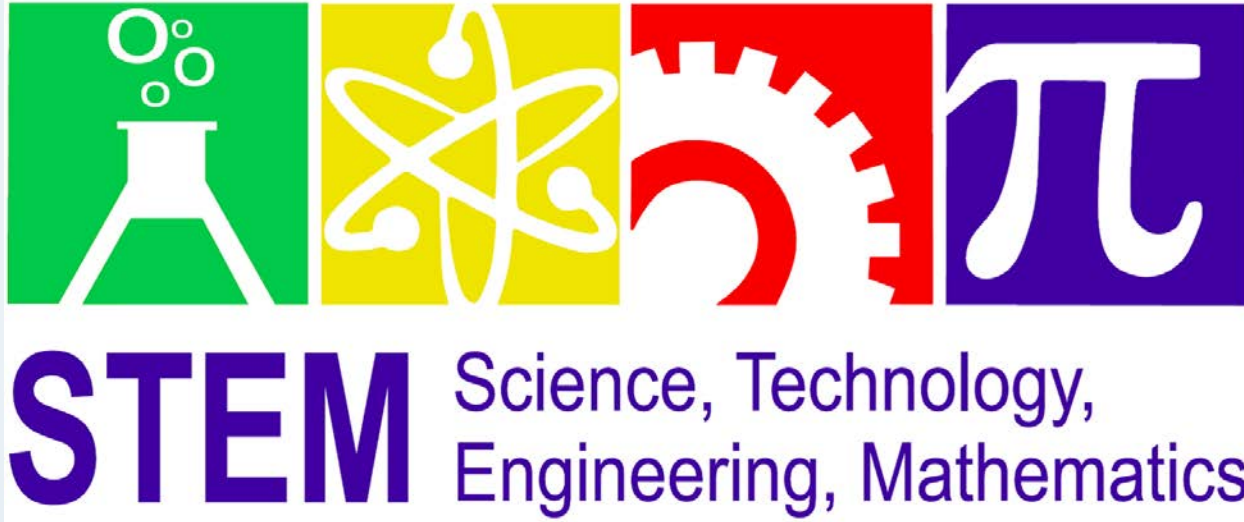


Building STEM in Bernards Township



Brian Heineman, Director of Curriculum and Instruction

Michael Fackelman, Supervisor of Fine and Practical Arts

Matt Hall, Supervisor of Science and Technology

Kristen Wolff, Supervisor of Mathematics

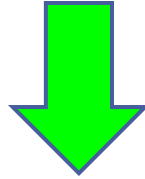
The District STEM Committee

- District committee consisted of staff and administration from both Ridge and William Annin
- Representation from building administration, as well as teachers from the Mathematics, Science, and Practical Arts Departments
- Developed recommendations which were used in detailing the district STEM plan

Special Thanks to the Entire Committee

- Frank Howlett
- Gina Donlevie
- David Aufiero
- John Brum
- Mark Dotta
- Mark Galesi
- Lauren Tan
- Matt Hall
- Michael Fackelman
- Karen Hudock
- Adam Torrisi
- Nick Beykirch
- Mary Beth Gakos
- Mike Levy
- Dave Petersen
- Matthew Potter
- Kristen Wolff
- Steve Isaacs

District Goal - Increase the district's ability to prepare students for college, career, and 21st Century success.

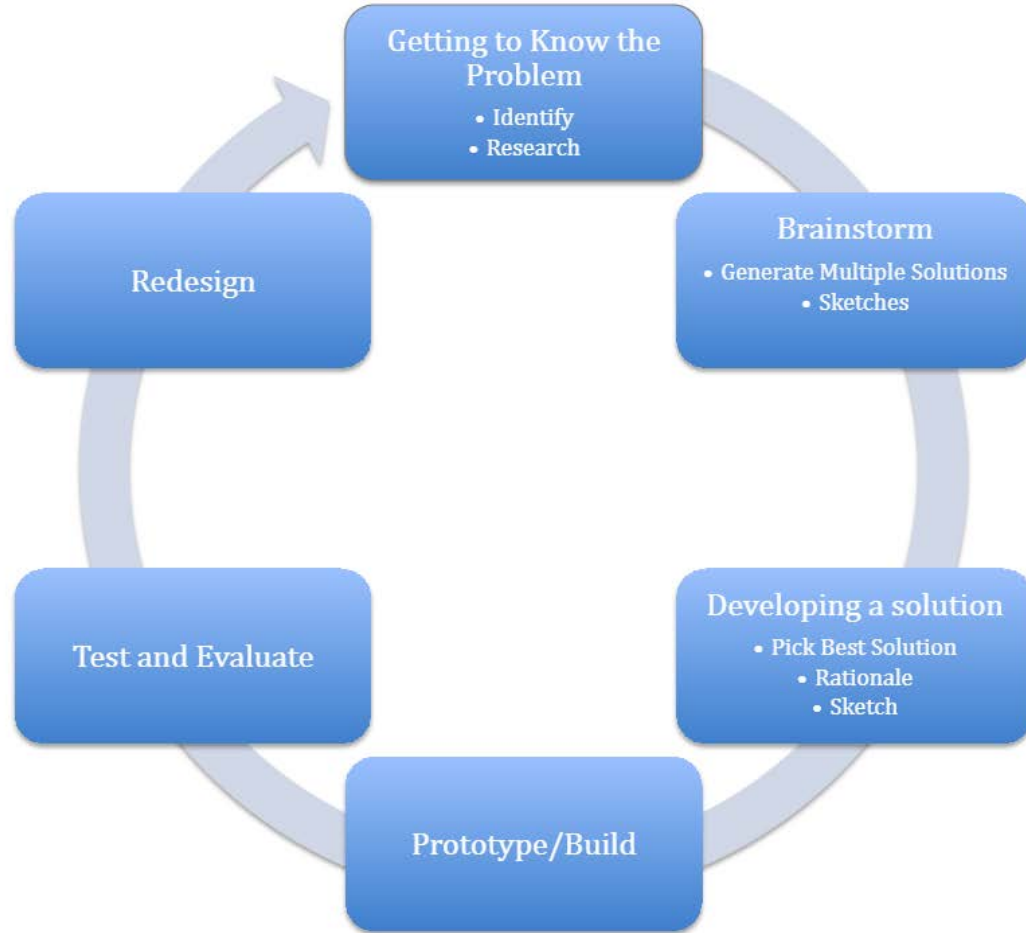


Goal of STEM Initiative: To provide a fully articulated K-12 STEM program that allows students to strengthen their problem solving skills, work collaboratively with others, and become creative divergent thinkers.

STEM Research and Resources

- Chris Anderson - *TCNJ - Director of iSTEM initiatives*
- Seann Dikkers - *Ohio University - Makerspaces*
- NJ Education Computing Conference
- International Society for Technology Education (ISTE) Conference
- Carolyn Malstrom - *Project Lead the Way*
- *Visits to local and regional schools*

Engineering Design Process Loop



Best Practices in STEM Programs

District Visits

Morristown

- 'Academy' model within a comprehensive public high school (enrollment ~1500)
- Targeting mid- to high-ability level students
- Two class sections of students (~50) participate per grade level (last year = 100 applicants)
- Currently transitioning to STEM from a biomedical focus
- Key components of STEM courses:
 - Most are electives
 - Open to students outside of STEM academy
 - Some carry Honors weight.

Morristown

- All 9th graders, in program, required to take introductory STEM research course
- Required field experiences and summer institute
- Strong research component
- Tracks for: Biomedicine, Engineering, Architecture, Sustainability, and Computer Science
- Partnerships with various companies and higher ed
- Program coordinated by STEM Supervisor

Philadelphia Science Leadership Academy

- Magnet School Model (Public School System)
 - How do we learn?
 - What can we create?
 - What does it mean to lead?
- Partnership with Franklin Institute
- Accept approximately 125 students a year
- 1 to 1 laptop program
- All classes Heterogeneous
- Grade level themes: Identity, Systems, Change, Creation

Philadelphia Science Leadership Academy

- Cross-cutting themes connect different courses
- Standards-based testing
 - Assessment retake policy
- Application and interview process for acceptance into the program
 - Based on engagement and interest, not just grades

Philadelphia Science Leadership Academy

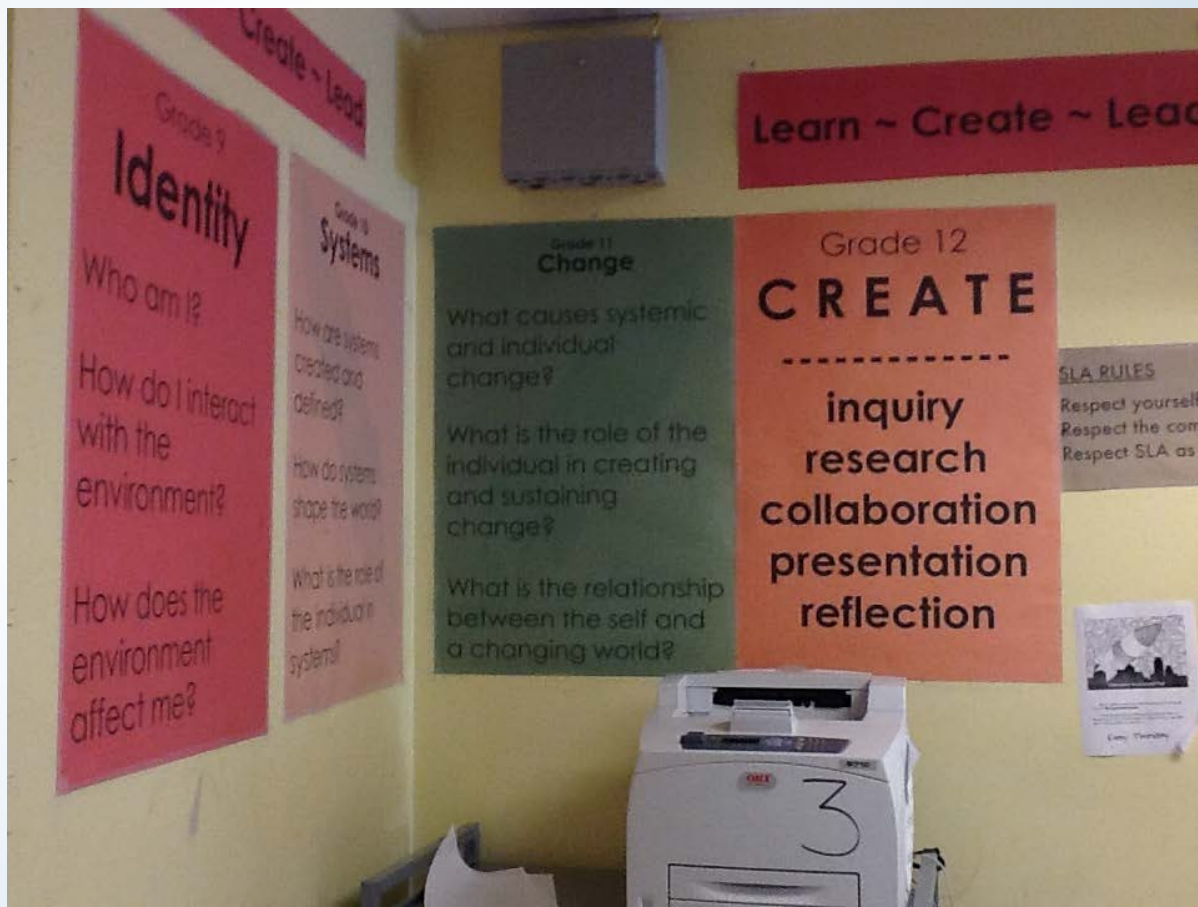
Cross-cutting themes for each grade level:

9th Grade - Identity

10th Grade - Systems

11th Grade - Change

12th Grade - Create



Vision map - posted in the staff workroom common area

Learning 2.0
 @Chris Lehman
 #MSEP11
 Creating the schools we need

SUGGESTIONS
 Language matters
 We teach kids
 Let Professors teach
 Students

META COGNITION
 Silos No!
 Lenses Yes
 Projects, Homework, Class Participation, Tests & Quizzes

Tech Games
 Creator
 Research
 Collaboration
 Presentation
 Networking
 Thoughtful wise kind
 Goals
 Organize!

My Bites
 Why this matters
 1 My kids - worries
 2 Teachers know something is wrong
 3 The students

Data Driven ed only as good as the data
 Teaching is humbling
 We are too historical

Scary
 Thought what do we need to
 What do we need to

Passionate real work that matters now!

OXYGEN
 Community based!
 Have them build something
 Tech should be like
 Be humble
 Build systems
 necessary practices that support your values

Things are different?
 Deliver instruction
 Kids need adults
 Don't Ban Cell Phones



SLA Standard Rubric

	Design 20	Knowledge 20	Application 20	Presentation 20	Process 20
Exceeds Expectations 20 - 19					
Meets Expectations 18 - 16					
Approaches Expectations 15 - 13					
Does Not Meet Expectations 12 - 0					
Totals:					

Teaneck

- TEAMS - Technology Enriched Academy for Math and Science
- Program created in 2002
- All courses in the program are considered honors courses
- Runs partially on a separate bell schedule with two 85 minute periods in the morning
- All courses have separate sections for students not in the academy
- Faculty member coordinates the program

Teaneck

- Application process requires good grades, recommendation, essay, and interview
 - 80 applicants for 40 spots
- TEAMS graduates require 4 years of math, science and computer science
- Freshman year “TEAMS freshman orientation” class focused on problem solving
- Embed and require participation in STEM competitions

Watchung Hills Regional High School

- Project Lead the Way - National Program
 - <http://www.pltw.org>
 - Pre-engineering program that offers potential college credit
 - Integrated LMS via Canvas
- Not a cohort based academy model
- Has multiple program options at WHRHS:
Engineering, Architecture

Commonalities of Successful STEM Programs

- Partnerships with outside experts
- Common vision - Constantly communicated
- Focus on Science, Math, Technology, and Entrepreneurship (Creation)
- Theme approach to connect across disciplines
- Program branding / Identity
- Project-based
- Focus on application of learning, relevancy, real world and career path

Equipment



Equipment



Ridge High School Program Recommendations



Ridge STEM Vision and Goals

Vision: PAINTING THE PICTURE.....

- School-within-a-school – an academy model
- Curriculum will be purposefully integrated, focused on project-based learning
- Relationships/partnerships between key stakeholders including students, parents, school leaders, universities, and corporations
- We will be a MODEL program with an enthusiastic, dedicated, passionate team of teachers that INSPIRE students

Ridge - STEM GOALS

- Attract a diverse group of passionate, enthusiastic students who are transformed into capable, informed, and CREATIVE problem solvers who become leaders in universities and industry
- Develop the necessary tools, technology, infrastructure to support and grow the program

Ridge High School Proposed Model

- A four year, cohort based, academy model
- Three courses of study - Computer Science, Engineering, and Sustainability
- Application driven enrollment - consideration based on interest and motivation, not solely based on grades
- Utilizes national programs like Project Lead the Way and AP as well as internally developed courses

Ridge High School Proposed Model (Continued)

- Most Academy courses will be open to all Ridge High School students
- 2 Day summer orientation program
- Open Makerspace available to all students
- Cohort will be scheduled in common mathematics and science sections

Academy Flowchart

Grade/Program	Computer Science	Engineering	Sustainability
9	<ol style="list-style-type: none"> 1. Computer Science and Software Engineering (CSE) 2. Design and Creation 	<ol style="list-style-type: none"> 1. Introduction to Engineering Design (IED) 2. Design and Creation 	<ol style="list-style-type: none"> 1. Introduction to Engineering Design (IED) 2. Design and Creation
10	<ol style="list-style-type: none"> 1. Computer Science Applications (CSA) 	<ol style="list-style-type: none"> 1. Principles of Engineering (POE) 	<ol style="list-style-type: none"> 1. Principles of Engineering (POE)
11	<ol style="list-style-type: none"> 1. AP Computer Science 2. AP Seminar 	<ol style="list-style-type: none"> 1. Civil Engineering and Architecture (CEA) 2. AP Seminar 	<ol style="list-style-type: none"> 1. Environmental Sustainability (ES) 2. AP Seminar
12 Not included on Flowchart = Current Math and Science core courses	<ol style="list-style-type: none"> 1. Computational Problem Solving (CPS) 	<ol style="list-style-type: none"> 1. AP Physics C 	<ol style="list-style-type: none"> 1. AP Environmental Science

STEM Electives

- Robotics I and II - redesign (Semester, 2016)
- Game Design and Development (Semester, 2016)
- Entrepreneurship and Modern Marketing (Semester, 2016)
- Sustainable Design (Semester, 2017)
- Simulation and Modeling (PLTW - SAM, Semester, 2017)
- Cybersecurity (PLTW - SEC, Semester, 2018)

Project Lead the Way (PLTW)

- Currently in over 6,500 schools nationally
- Partnered with Lockheed Martin, NASA, American Institute of Aeronautics and Astronautics (AIAA), Chevron, 3M, College Board, and multiple universities
- Recommended as an exemplary program by the U.S. Department of Education

Project Lead the Way (PLTW) Cont.

- Research and Evidence-based curriculum
- Activity-, problem-, and project-based learning experiences
- Possible College-level recognition
 - Admissions preference
 - Course substitution credit
 - Many College and University affiliates
- Requires schools to offer a three year program

AP Connections

- All options in the STEM program have 2 integrated AP courses
- The new AP Seminar course will provide opportunity to tie in relevant research and is paired with another AP or PLTW course
- Seniors will have the option to take AP Research to graduate with the AP Seminar and Research Certificate or the AP Capstone Diploma (Requires passing 4 additional AP courses)

Non Academy Options

- Any 3 year progression of Project Lead the Way courses will result in completing the PLTW Pathway
- AP Seminar and AP Research are available to all students and can be combined with other AP courses or PLTW courses
- Any of the above can be combined with various STEM electives based on the student's schedule

Academy Flowchart

Grade/Program	Computer Science	Engineering	Sustainability
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12 Not included on Flowchart = Current Math and Science core courses	<ol style="list-style-type: none"> 1. Computational Problem Solving (CPS) 	<ol style="list-style-type: none"> 1. AP Physics C 	<ol style="list-style-type: none"> 1. AP Environmental Science

Application Process

- Anticipate a starting cohort of 60 students
- Application will require both a written response and a personal interview in Winter of grade 8 for the STEM Academy
- Grades and achievement will be considered, but are not the primary driver
- Demonstrated interest, written application, and interview will be most important

Anticipated Costs - Staffing

- STEM Program Coordinator - Part teaching, part program management
- Additional teaching staff - Hard to determine, but may increase due to new courses being added
- Makerspace Advisor - 3 Season stipend
- Costs for staffing the student applicant interview process
- Staffing for 2 day summer orientation program
- Training for AP and Project Lead the Way (Approx. \$3,000 per teacher per course)

Anticipated Costs - Facilities

- Classroom space and need for renovation will be determined by the Ridge schedule
- Increased availability of science and technology classrooms would keep potential renovation costs down
- At a minimum, it should be anticipated that one room would need to be converted to a STEM classroom and Makerspace:
Dedicated manufacturing room/lab to set up 3D Printer station, CNC station, Laser Cutter station

Anticipated Costs - Equipment

- 2 MakerBot Replicator 3D printers Cost: \$9,000
- 10 VEX Robotics Kits Cost: \$15,000
- 2 Phantom 2 Vision + Drones: \$2500
- CNC Machine: \$7,500
- Materials testing equipment
- Metal fabrication equipment
- Project Lead the Way: \$5,000 - Includes PTLW Learning Management System, PLC's, Software Licences, Ongoing Teacher PD, reporting tools, and tech support

William Annin Middle School Program Recommendations



WAMS STEM Vision and Goals

Vision:

- A dedicated space (rooms/area) with appropriate resources
- A flexible schedule for teachers and students. A core group of students
- The program would not have curricular limitations but exploratory obligations

Goals:

- Accessible to each student interested in the program
- Foster a love of learning through exploration/creation/design
- Incorporate this program seamlessly into our “school-within-a-school” philosophy

WAMS Proposed Model

- Grade 6 and 7 - Redesigned Technology and Computer cycles (Design Process Loop)
- Grade 8 - Cohort based model linking a new STEM elective with grade 8 science and potentially math
- Open Makerspace before and after school; Makerspace study hall tied to technology cycles and 8th grade STEM elective

Application Process

- Anticipate a cohort of 25 students for 8th grade elective
- Application will require both a written response and a personal interview in winter of grade 7 for 8th grade program
- Grades and achievement will be considered but not the primary driver
- Demonstrated interest, written application and interview will be most important

Anticipated Costs - Staffing

- Makerspace Advisor - Stipend for before/after school
- Additional teaching staff - Should not increase if limited to one cohort in grade 8
- Lunch period staffing costs
- Costs for staffing the student applicant interview process

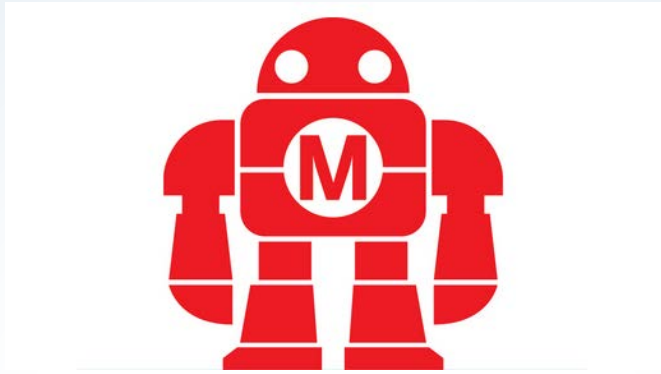
Anticipated Costs - Facilities

- It should be anticipated that one room would need to be converted to a STEM classroom and Makerspace:
Dedicated manufacturing room/lab to set up 3D Printer station, CNC station, Laser Cutter station
- This process will begin this year with Room 100

Anticipated Costs - Equipment

Computers - \$1,600	3D Printer* - \$4,500
Laser Cutter* - \$20,000	3D Replicator Mini* - \$1,400
Vinyl Cutter* - \$1,900	3D Replicator* - \$6,500
Computer Numerical Control (CNC) wood/metal machines* - \$3,100	Makerbot Digitizer* - \$800

**Purchases will be driven by course design; cost is per unit*



The Maker Movement

"The Maker movement has brought the pre-1970s world of basement workshops and amateur tinkering into the digital age." — *The New York Times*

The Maker Movement

- Individuals/Groups creating products
- “Making” can be anything:
 - Computer Code
 - Metals
 - Textiles
- Supports:
 - *Application* of knowledge
 - Creativity and Innovation
 - Critical Thinking and Problem-solving



<http://www.adafruit.com/images/1200x900/14-00.jpg>

The Maker Movement

- New tools and technology have created opportunities for new modes of learning:
 - 3D Printing / Prototyping (Makerbot)
 - Robotics (Lego Mindstorms, Vex)
 - Programmable Microcontrollers (Arduino, Pololu)
 - Visual Programming Languages (Scratch, Alice)
- Note: The focus is process and product

The Maker Movement

WAMS IDEA Lab Makerspace





- Contain a wide variety of equipment and consumable for students to work on projects that may or may not be related to academic work
- Provide a location for students to work during non-class hours (Extra-curricular)
- Provide a training location for staff on new methods of instruction (Professional Development)
- Can be made available to the public as a community to school connection (Workshops)

Cost Per Makerspace

WAMS	RHS
Makerbot 3D Printer (Qty: 4) - \$18,000	Makerbot 3D Printer (Qty: 4) - \$18,000
Makerbot 3D Mini Replicator (Qty: 4) - \$5,600	Makerbot 3D Mini Replicator (Qty: 4) - \$5,600
Makerbot Replicator Z18 (Qty: 1) - \$6,500	Makerbot Replicator Z18 (Qty: 1) - \$6,500
Makerbot Digitizer (Qty: 1) - \$800	Makerbot Digitizer (Qty: 1) - \$800
CNC Machine (Qty: 1) - \$3,100	CNC Machine (Qty: 1) - \$3,100
Vinyl Cutter (Qty: 1) - \$1,900	Vinyl Cutter (Qty: 1) - \$1,900
	Epilog Laser Cutter (Qty: 1) - \$20,000
\$35,900	\$55,900

Cost Per Makespace - **REVISED**

WAMS	RHS
Makerbot 3D Printer (Qty: 4) - \$18,000 \$9,000	Makerbot 3D Printer (Qty: 4) - \$18,000
Makerbot 3D Mini Replicator (Qty: 4) - \$5,600	Makerbot 3D Mini Replicator (Qty: 4) - \$5,600
Makerbot Replicator Z18 (Qty: 1) - \$6,500	Makerbot Replicator Z18 (Qty: 1) - \$6,500
Makerbot Digitizer (Qty: 1) - \$800	Makerbot Digitizer (Qty: 1) - \$800
CNC Machine (Qty: 1) - \$3,100	CNC Machine (Qty: 1) - \$3,100
Vinyl Cutter (Qty: 1) - \$1,900 \$0	Vinyl Cutter (Qty: 1) - \$1,900
	Epilog Laser Cutter (Qty: 1) - \$20,000 \$0
\$35,900 \$25,000	\$55,900 \$35,900

Timeline for Building STEM

Year 1 (2014-15): Formed STEM Committee, Visitation of STEM programs, Reviewed K-12 programs and courses to identify current level of STEM integration, Researched STEM topics and Makerspaces, Develop AP Computer Science course (Summer 2015).

Year 2 (2015-16): Propose grade 6-12 course additions and removal of outdated courses, budget for courses, review personnel. Update Program of Study for 6-12. Staff training - identification and implementation as needed 6-12. Investigate possible facilities upgrades at WAMS and Ridge High School. Planning and budgeting for facilities upgrades. Investigate and suggest K-5 changes to incorporate more STEM pedagogy. New course curriculum writing in summer of 2016 (Year 1 STEM courses and grade 6 cycles).

Year 3-6 (2016-17/2019-20): Implement STEM Academy Program year 1. New course curriculum writing in summers (Year 2-4 STEM Academy courses, grade 7 cycle, grade 8 elective and science). Staff training in summer of 2016 and beyond as needed. Facility upgrades in summer of 2016.

Benefit to School and Students

- More focused and robust course options for all students in grades 6-12
- Specific, cohort based offerings for students with a high interest in STEM
- Makerspace concept benefits all students
- Cohort based concept promotes collaboration among staff and students
- Academy model demonstrates viability of cross content course design
- Meets district's goal and national standards