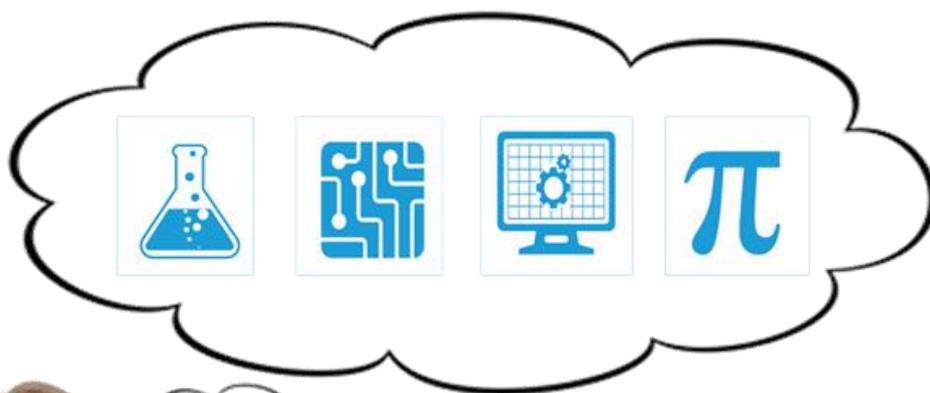


# FESTO

**STEM**  
Making the  
connections in  
secondary  
education



by **Patti Yocius,**

STEM Product  
Manager

**Festo Didactic Inc.**  
[www.festo-didactic.com](http://www.festo-didactic.com)



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## 1 Introduction

Science, Technology, Engineering and Math - the connections between these four subjects are powerful. Students study math and science as separate subjects, and maybe even technology, but what about engineering? These topics are interrelated and influence each other. Without one, the advancement of the other would at some point stop. It's important that students understand the interconnectedness of these four subjects to motivate them to later explore the individual fields more deeply.

An integrated approach to STEM education that focuses on real-world problems allows students to reflect on the problem-solving process. Students learn best when encouraged to construct their own knowledge of the world around them (Satchwell & Loepp, 2002).

Today's STEM education should consist of relevant programs that focus on technology and engineering design based learning while integrating science and mathematics concepts using a project based approach with the goal of providing students the opportunity to optimize solutions for real-world problems.



*In addition, through an integrated approach to STEM education focused on real-world, authentic problems, students learn to reflect on the problem-solving process (Aleman, 1992; Darling-Hammond, 1994; Fajemidagba et al., 2010). More important, students learn best when encouraged to construct their own knowledge of the world around them (Satchwell & Loepp, 2002). It is through integrated STEM projects that this type of learning can occur.*



## 2 The STEM Crisis

It may seem that today every major company, government department, and educational institution is prioritizing STEM education. Programs to encourage and prepare students for STEM careers are being implemented, however, many students are still graduating high school unprepared. Science and math education fails to engage student interests and is not connected to their everyday experiences. Education reform advocates are calling for students to learn complex, cognitive, social and communication skills to develop 21st century skills.

Students need STEM programs that allow them to apply math and science fundamentals to complete projects using the engineering design process. Students must learn concepts related to STEM disciplines in a “learning by doing” environment. When students “learn by doing” they gain knowledge and skills that can be transferred to solve other problems that can help them prepare for post-secondary education and future careers.

Consider the following taken from the Next Generation Science Standards (NGSS), which is a call for:

*...a commitment to fully integrate engineering and technology into the structure of science education by raising engineering design to the same level as scientific inquiry in classroom instruction...and by according core ideas of engineering and technology the same status as core ideas in the other major science disciplines” (NGSS, 2012, 1).*

One critical issue in implementing relevant STEM programs is finding teachers who are adequately prepared to teach STEM content, concepts, and skills using an integrated approach. This is especially true for engineering and technology content which is not normally part of teacher preparation. In order to successfully incorporate engineering into a program, educators must get the proper training. Traditional approaches and learning environments should be reevaluated and programs that include STEM equipment with standards-based, problem-based curriculum must be made available in order to apply science, math, and technology toward engineering design.

### 3 Integrative STEM Education

What exactly is integrative education? In its simplest conception, it is about making connections across more than one discipline. When students are exposed to opportunities to learn math and science with the concepts of technology and engineering in an interactive environment, communication and collaboration skills, as well as interest and competence are attained - which may make higher education more attainable and also contributes to a prepared society.



*Integrative STEM education refers to technological/engineering design-based learning approaches that intentionally integrate the concepts and practices of science and/or mathematics education with the concepts practices of technology and engineering education. Integrative STEM education may be enhanced through further integration with other school subjects, such as language arts, social studies, art, etc. (Sanders & Wells, 2006-2010).*



## 4 Implementing an Integrative STEM Program

Festo offers a turn-key solution for implementation of STEM programs for High Schools that understand the need to incorporate problem-based learning environments into their education system. Our STEM solution allows students the opportunity to explore a variety of technologies, while applying math and science theories and fundamentals.

We understand that some educators are not familiar with the engineering design process or the math/science fundamentals students must apply when solving real-world problems, and for that reason we developed resources specifically for the teacher aimed to increase their knowledge of engineering and technology content and pedagogy, while providing information, hints, troubleshooting, and solutions to all problems presented in the curriculum. This ensures a successful blended learning experience for both the teacher and student.

The Festo Didactic STEM solution focuses on technology and engineering design based learning while integrating science and mathematics concepts using a project based approach with the goal of providing students the opportunity to optimize solutions for real-world problems.

Our integrated approach to STEM emphasizes innovation, problem-solving, critical thinking, and creativity using hands-on training systems that allow students to apply math/science fundamentals to complete projects using the engineering design process. Students learn concepts related to STEM disciplines in a “learning by doing” environment.

The hands-on trainers combined with our project-based, standards-based curriculum introduces a number of relevant technologies and emerging technologies to provide an exploratory STEM experience.



*Integrative STEM education intentionally situates S, T, E, & M teaching & learning in the context of technological/engineering design activity. In contrast, most educators and politicians have (inappropriately) been using "STEM Education" when referring primarily (or solely) to math and science instruction, a practice that marginalizes the T&E components of integrative STEM education... to the detriment of STEM teaching and learning.*

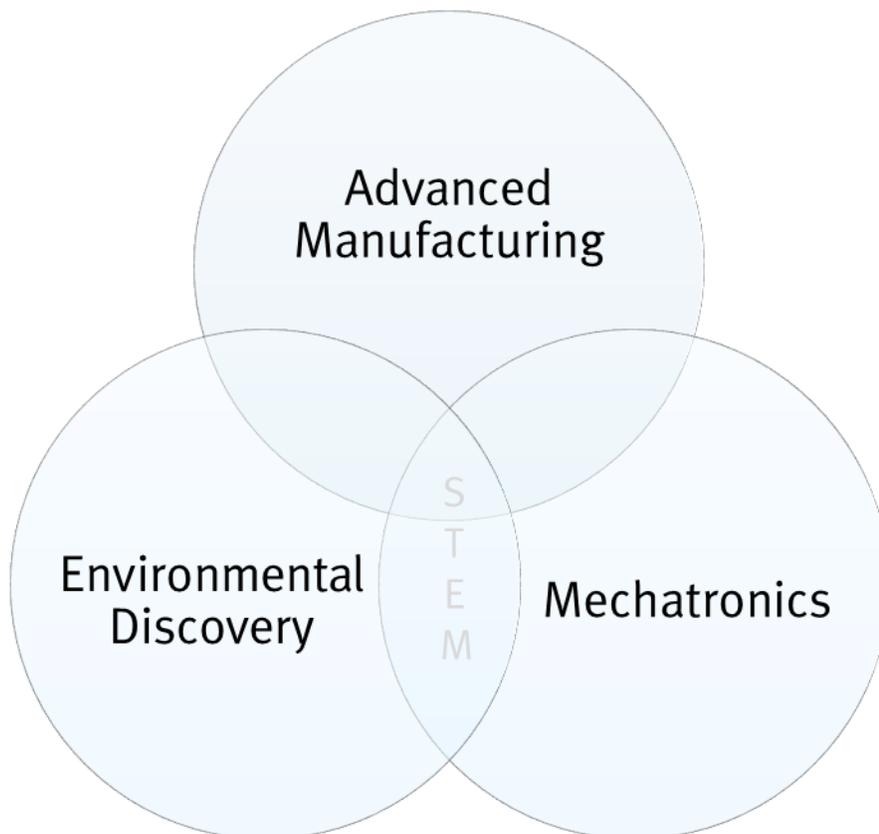


*Dr. Mark Sanders*

## 5 Festo Integrative STEM Overview

We offer knowledge of a number of technologies and emerging technologies.

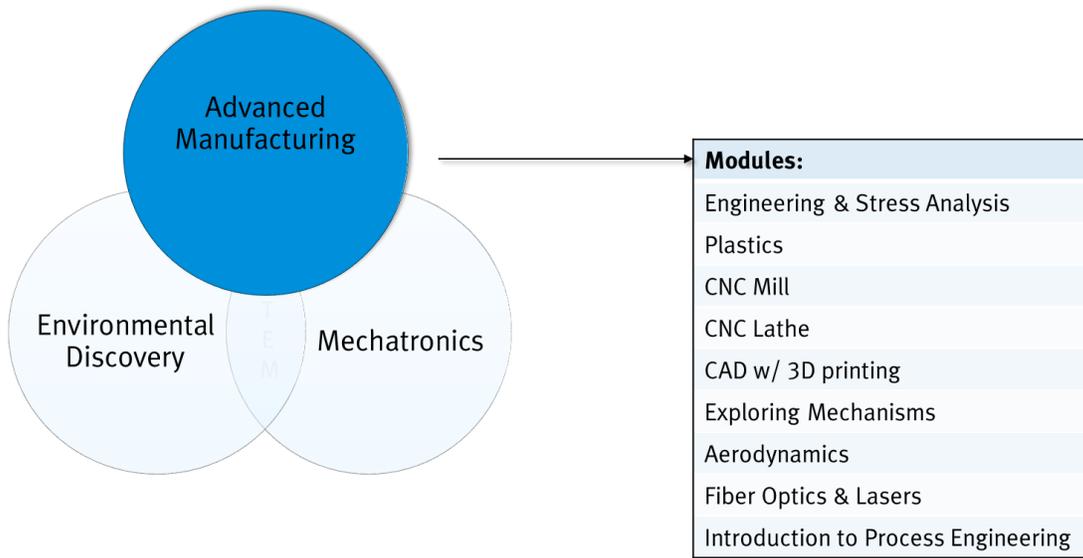
Our STEM solution is flexible and allows for a STEM classroom to consist of an entire lab with modules from all clusters, specific clusters, or a variety of each.



*Each cluster consists of modules related to that topic.*

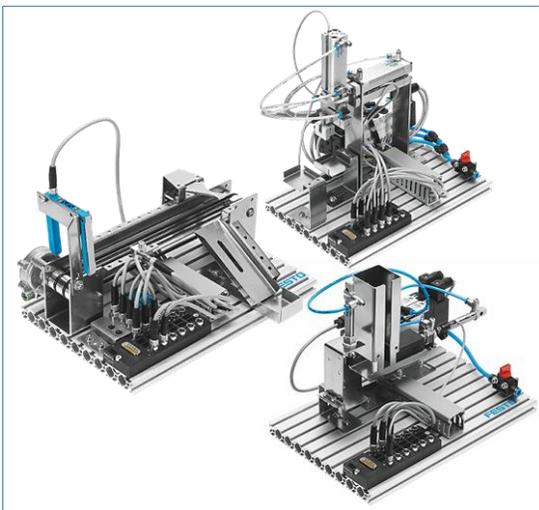
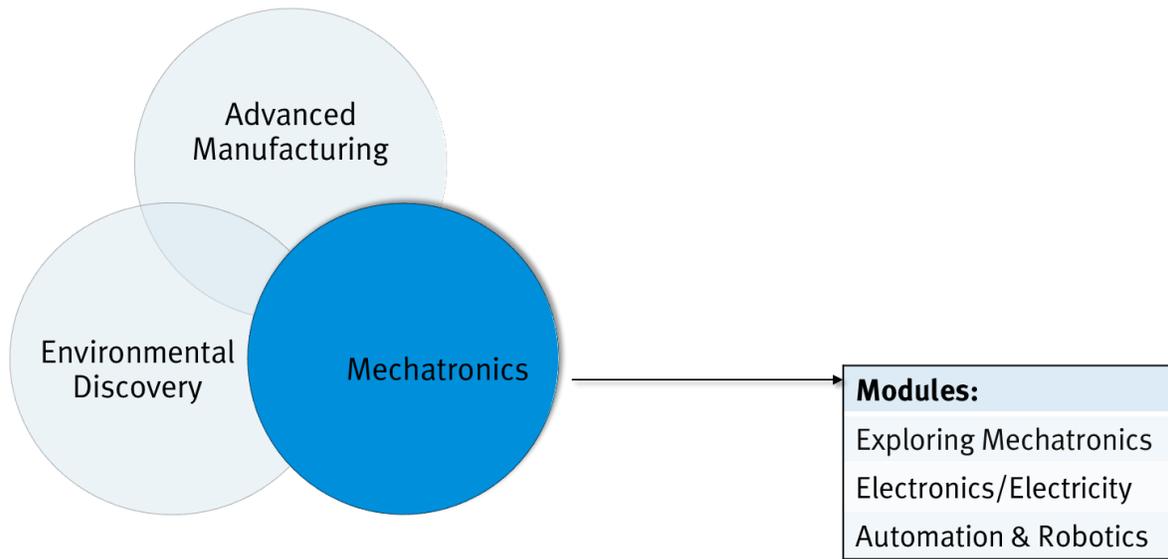
## 6 Festo Integrative STEM – Advanced Manufacturing

The Advanced Manufacturing cluster consists of training solutions that teach the foundation of manufacturing through practical application.



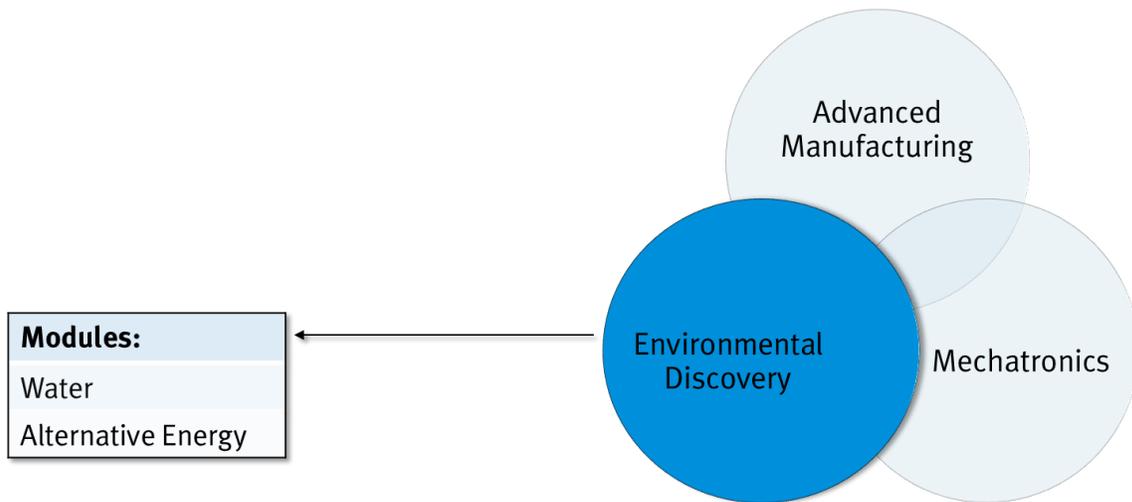
## 7 Festo Integrative STEM – Mechatronics

The Mechatronics cluster consists of training solutions that teach mechatronics topics through practical application.



## 8 Festo Integrative STEM – Environmental Discovery

The Environmental Discovery cluster consists of training solutions that provide environmental discovery through practical application.



## 9 Festo Integrative STEM – Training Approach

Our integrative STEM program consists of a range of pedagogical methods organized to create an essential teaching instrument.

- backward design:
  - Understanding by Design®
  
- traditional learning:
  - SBL (subject-based learning)
  
- inductive learning:
  - CBL (collaborative/scenario-based learning)
  - PBL (problem-based learning)
  
- connect student learning to a mission or purpose:
  - EML (entrepreneurially minded learning)

## 10 Conclusion

Implementing the correct STEM program – one that introduces information and skills in the context of problem solving, consists of hands-on activities using equipment that allows for the exploration of many technologies, and provides a turn-key solution so teachers spend more time interacting with the class and less time learning new content – is essential to help solve the current STEM crisis and to engage learners so they not only become proficient, but also interested in STEM.



Science



Technology



Engineering



Math

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