Technology Education is not a new concept; it has been around since the early 1900s. However, it was known as manual arts, manual training, and industrial arts education during most of the twentieth century. In recent decades, school systems have been sporadic in how they offered programs, especially during the middle school years. For example, Baltimore County Public Schools (BCPS) went through a program-reduction phase over a decade ago. At Stemmers Run Middle School for instance, the “shop” classes closed twelve years ago, and the classroom went unused, with equipment being reallocated to high schools or stored. Now there is a revival happening in Baltimore County, and the programs are returning to middle schools.

Every middle school program in Baltimore County was shuttered or scaled back in some way. The equipment was either stored, removed, or just left in place. With programs starting up, each school is at a different place, but every program needs to start someplace, and not every program will start the same way. When starting a program, be sure to take stock of what you have, what you know, and where you want to be. Picture the journey you want your students on and what you want them to accomplish. Next, roll up your sleeves; it is time to work!

Seems easy, right? Not really, the Stemmers Run (SRMS) engineering education journey began in the
spring of 2016 when a teacher was asked to start a new program at the school. The principal and teacher sat down to determine what the vision was for the program and to gauge what needed to be done and what resources would be available for the teacher to use.

One thing had to be in place for the teacher to pull this off. He had to trust that the principal wanted the program to work and that he could make the program work for students. Trust is essential to success in education. According to Brewster and Railsback (2003), trust among educators lowers the sense of apprehension about new and uncertain tasks associated with reform, and we are in the middle of a reformation in integrated STEM education. Trust is also essential for educators to have people to bounce ideas off of and to help them problem-solve as issues or problems arrive (Brewster & Railsback, 2003).

The Process

Taking Stock
Stemmers Run is not a Title I school; it is not a magnet program; it has a modest enrollment, which equates to little or no extra money to start a new program. The classroom was used as a metal shop but over the years had become the junk-collection room, with no tables, few chairs, no equipment, and closets overflowing with years of clutter. The budget for the next school year had already been set, and there was no assurance of funding.

Every veteran teacher has the same thought at this point, “You want me to do this with nothing?” Being a teacher often means being told to do the near impossible with limited resources. Every new program will feel the same way at some point. Every teacher feels the frustration and weight when a new curriculum comes about.

Comfort Level
First and foremost, a teacher new to engineering should gain knowledge and comfort with the engineering design process.

More comfort equates to more advantage. A teacher who is new to engineering should also learn about IDEO, design thinking, and project-based learning.

Secondly, a teacher new to engineering should also get comfortable with the technological literacy standards for their state. Knowing where you need to go will be a big help in planning. It is helpful to build the journey students need to go on in order to effectively learn the skills needed.

The teacher at Stemmers Run has taught for fifteen years, with experience in kindergarten through ninth grade general science. He has also taught in three states using state standards to form curriculum and has helped to update curriculum to utilize Next Generation Science Standards (NGSS). Additionally, he has been on the curriculum writing teams for science and engineering programs for Baltimore County Public Schools.

Students, on the other hand, must be considered to have no experience in the formal design process and will likely have little comfort with the way they will have to think and approach projects. The journey for the new program will have to help change the culture of the student body and school.

The End in Mind
Gauge your initial situation and understand where the comfort level is. The next step is determining the goals of the program. It’s easy to say the goals are the technological literacy standards put in place by the curriculum designers (Grubbs & Strimel, 2016). As a teacher you need to look beyond the standards to determine what the students need to walk away with. They need to have some mastery of the standards, but what is needed?

Students should be able to use the engineering design process to solve challenges and issues they may face (Grubbs & Strimel, 2016). They need to be able to apply the skills and knowledge learned in other classes in a real way. They will need to understand the importance of engineering design notebooks as organization tools and records of their thoughts and processes. Students will need to learn how to manage their time wisely and, most importantly, how to work together to creatively solve challenges.

Find a Support System
Building relationships with other teachers, administrators, students, students’ parents, and the community is important for program success. A new relationship can take time to build (Brewster & Railsback, 2003), no matter the circumstances or positions. It is important to keep an open mind and be open to expanding outward to build a fully functional and effective support system.
Recommendation 1: In Your Building
Remember the phrase, “Hope for the best; prepare for the worst,” when starting a new program. The worst being running out of supplies, running out of ideas, moving too fast, moving too slow, getting off topic, and/or someone getting hurt. When you are overwhelmed or not comfortable, it is easy to think of how things can go wrong and doubt your success. Create a support system to ensure your success. After all, you cannot be an island in today’s education world and be successful.

Start with your administration. Make sure they are behind you and want your program to be successful. Build relationships with other teachers in your building. This will give you others with whom to bounce ideas around and problem-solve, especially teachers who teach similar classes (e.g., science teachers, art teachers). Relationships in your building should be the first priority for your support system.

Recommendation 2: In Your District
Support doesn’t just come from inside your building, though. Take part in all the training and professional development opportunities that you can. By doing so, you will begin to create a network of support with teachers outside your building. Getting to know the central office staff in charge of your curriculum department is also a good idea, as they can lend the most support with curriculum questions, material needs, and provide direction on where to find the resources you may need for your program. You should also use email as a way to communicate with other teachers around your district or in nearby districts to again have a support system with which to bounce ideas around and for help when problems arise.

Recommendation 3: In Your Community
Do not build your support system from district employees alone. Reach out to the parents of your students. Parents are the best place to get information about motivating students and for ways to help students improve in class. You can also receive support from students by giving them surveys on what works and doesn’t work for them in your program.

Reach out to local businesses for support as well. Perhaps they can donate some of their products for students to look at and reverse-engineer, have their team members come and talk about their careers, or allow students to see their facilities as a field experience. The sky really is the limit. The more people who can help you reach your students, the more the students will gain, and the more success they will have.

Challenges
Every new program will face challenges. According to Layton (2017), technology education programs in middle schools face four big challenges. She states that the challenges are: a lack of time, keeping students engaged, classroom management, and outdated resources (Layton, 2017). While these present challenges to any teacher, a seasoned veteran may consider them as part of the job. Finding the right approach in a situation is the art of teaching.

Over the course of a year, teachers face many challenges. Some will be small, and some will be large. All teachers experience them, but how they handle them can gauge their success. Your program may start with bare bones, similar to SRMS. The SRMS engineering program began with two teachers trying to figure out where to go, but there are solutions out there to overcome or manage the challenges teachers may face (Layton, 2017).

The teachers had to figure out what projects or challenges students would face, what supplies were needed, and what tools students would need to have access to. They had to obtain machines and supplies and get students to start buying into this way of thinking. Getting students to change the way they think will be the biggest challenge throughout the year.
Engineering notebooks are very hard for students to grasp. Make these easier: start off giving students a scripted design process that asks them to fill out information as they go. It is very helpful to use the same vocabulary, number of steps, and sequence each time in the beginning. Find a way to store them in your room or use a foldable system. Order a little more than needed, as it is preferable to have leftovers than not enough. Lastly, with challenges, be as proactive as possible.

Successes

Success can be measured by looking at where you started in the beginning and where you end up by the end of the year. The criteria for success is set by the teacher’s expectations and those of their superiors. Educators are often most critical of themselves. Three objectives can be used to evaluate a program. First, provide information that shows that the program reached or exceeded expectations (Fisher, 2010). Second, determine any problems with the program and possible solutions to avoid them in the future (Fisher, 2010). Lastly, examine the procedures and activities used over the course of the year and decide what worked, what needs to be tweaked, and what needs to be changed (Fisher, 2010).

SRMS’s program survived its first year and is now a growing program with a bright future. The students are beginning to see that they can apply what they learn in other classes to things they can do in the real world. They are helping to internalize learning and make things more meaningful.

To date they have acquired a band saw, disc sander, foam cutter, air compressor, shop vac, 2-3 scroll saws, 3 saw horses, 2 drill presses, miter box, 8ft maglev track with power supply, Kelair air launcher system, PVS rocket launching setup, and multiple hand tools in each of their two engineering classrooms. There are 27 Vex IQ Robots and an afterschool robotics club. The program also has a display case at a school entrance for everyone to see a wind tunnel.

The success of the program helped teachers to acquire these items. The more success they showed, the more they were able to ask for and receive. One applied for a “Maker Space” grant for SRMS that allowed for the purchase of 12 additional robots. The principal found ways for the program to purchase tools and supplies as the year went on, and the program director was able to find what the school could not purchase, in addition to supplying two competition robots and another 12 classroom robots for the program. The teacher learned that it didn’t hurt to ask, and the worst that could happen was being told no or to find another way. One teacher was also able to attend the 2018 ITEEA international conference because of his success and desire to learn more and get more ideas to help the program.

SRMS’s successes were seen through its students’ work and the way the classrooms operated. In Baltimore County, SRMS is considered a “lighthouse school,” which means it was the first to get a computer for every student and comes with an expectation that it push forward to try new things to make its programs more student-centered and authentic. Staff must think outside the box and, if possible, get rid of the box altogether. With this designation also comes a somewhat open-door policy, as there are visitors from around the district and from around the country who visit the school and classrooms on a regular basis. It also helped to share what the students were doing by regularly posting their work and classroom activities on Twitter.

Without a doubt, the students surprised the teachers with what they could accomplish. Once they were allowed to build anything they wanted out of at least 80% cardboard (as long as they provided detailed sketches and measurements). One group made a fully functional foosball table; one made a working pinball machine; and one made a working claw machine. It was surprising how well students took to detailed drawings of their designs of prototypes and how quickly they became comfortable using power tools. The teachers were impressed with the conversations and how discussion of their projects went from, “that’s cool,” to “what will that really do.”

These students know how to use the design process and used the skills developed in our classes and in their other classes as well, particularly science and math. They have an understanding that has created the foundation for next year that can now be built upon and improved.
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References


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This is a refereed article.

Photos 5-7: (L-R) Foosball table using cardboard construction with army men toys for players and wooden dowel rods and real foosball soccer balls; Cardboard pinball using foam elements and a ping pong ball; Bryan Thanner, Principal of Stemmers Run Middle School, trying the “Cardboard Claw Machine” built with an “s” hook and string with plastic zip ties on prizes for catching.

Photos 8-10: (L-R) Drawing the final design before building a prototype; Student using a drill to create a space to place a mast for a sail car; Student using a foam cutter to shape the cabin of a maglev model.