Engineering Success in “Thrice Exceptional” Students through a Rigorous STEM-focused Curriculum
Who are thrice-exceptional students?

- Those who are gifted or strong cognitively—they thrive in academics
- who are on the autism spectrum or who have special needs—they need support or accommodations
- who have a passion for, or skill at, STEM or some STEM-based activity—they like to take things apart, find out how they move, or make things
How do you measure the gifted or cognitively strong?

- They score well on a standardized tests commonly given to assess for giftedness
- They take AP classes or other advanced classes early (e.g. Algebra 1 and Geometry in middle school, AP Calculus in 10th grade, or have taught themselves programming languages in middle school)
- They score strongly on the WJ-IV; average is 90-109; 110-119 is above average; 120-129 is superior; and 130 and above is very superior
What is the Autism Spectrum?

- Autism Spectrum Disorder is a neurodevelopmental disorder, which often presents and can be diagnosed very early.
- It often affects the onset of language, socialization and play.
- It may be marked by repetitive motions or defined interests.
- Those who are high-functioning are often not affected in all or some of these ways, or to the same degree, and some are highly gifted.
- Some have conditions including anxiety, depression or a learning difficulty.
How does this passion for STEM manifest itself?

- Sometimes the child develops a passion at an early age— for electronics or making.
- Sometimes the child likes to take things apart, or find out what makes them move— often they will collect or hoard things of a specific nature.
- They might be advanced in some specific STEM area— programming languages or mechanics or engineering design.
- They might have a passion and already know a great deal about some area of science, such as paleontology or marine biology.
What is STEM?

- STEM stands for Science Technology, Engineering and Math

- The spirit of STEM has been with us since the early 20\textsuperscript{th} century—industrialization at the time of the Second WW

- And certainly the space race of the 1950s and 60s solidified the growing interest in STEM—from the industrial age to the digital age
The Origins of STEM

• The 1950’s and the Origins of the Space Race
• The Soviets and the first manned space flight
• The threat to national security and President Kennedy’s challenge
• The U.S. and the first human to land on the surface of the moon
• Technology and national security—U.S. Presidents’ successive appeals to the nation
The Origins of STEM II

- STEM was coined in the early 2000s by the National Science Foundation.
- What is science? Science seeks to investigate nature
- Technology is the making of things for human purposes
- Engineering uses the theories of science (math and physics) to benefit mankind
- Mathematics is the language of science—it studies patterns and relationships
Why the Resurgence?

- The lack of science education in the schools
- The lack of interest in pursuing a science career or college education
- The shortage of qualified workers in technical fields
- Rice University study in 2003, 90% of engineers will live in Asia—China is graduating 4x as many engineers as we are
- Employment in science and engineering will increase 70% faster than the rate for all occupations (based on BLS 2006)
The Challenges of Autism
Part I

- Socialization
  - Being able to establish relationships, have compassion, communicate effectively
  - Prevent, manage, and resolve conflict
- Emotional control
  - Having a sense of one’s own feelings
  - Being able to regulate one’s own emotions
- Perseveration
  - Engaging in repetitive tasks
  - Subject to recurrent thoughts
The Challenges of Autism
Part I (cont.)

- Narrow focus
  - Restricted interests and socialization
  - Reluctance to engage outside the range
- Rigid thinking
  - Intolerance of the new—inflexibility to change
  - Inflexibility to opinions and challenging ideas
- Idiosyncratic interests
  - May revolve around kinds of objects or intellectual interests
  - Related to perseveration
The Challenges of Autism Part II

- Challenges to graduating high school—accommodations in school
  - Often have a wide range of services in school
  - Can be in supportive environments including NPSs

- Challenges to graduating college—transitioning without support
  - Often in college there are no supports
  - Academically and socially they struggle with workloads, rigor, and the variety and number of individuals on campus
The Challenges of Autism
Part II (cont.)

- Challenges to finding and keeping a job—accommodations necessary for success
  - The interview process
  - Socialization at work
  - The requirements of the 21st Century—critical thinking, creativity, collaboration
- Accommodations in the workplace
  - Telephone interviews
  - Taking breaks
  - Getting regular feedback
  - Advance notice of changes
STEM and Autism

- STEM workers in demand over the next decade
  - 2012 report by President’s Council of Advisors on Science and Technology—we will need 1 million more STEM jobs over the next decade to maintain a technological edge
  - The under-reporting of demand because many jobs require technical skills though aren’t necessarily presented as tech jobs—e.g. healthcare and theater
  - In 2013, there were 5.7 million STEM job postings, almost half of which were entry level, requiring no bachelor’s degree
STEM and Autism (cont.)

- STEM workers in demand by category
  - 42% of STEM postings are in Healthcare—nurses, physical therapists, medical assistants,
  - 37% in IT—IT support, software developer,
  - 14% in Engineering and Manufacturing—QA, CNC machinist
  - The rest in math and science—data mining, chemists, biologists
STEM and Autism (cont.)

- STEM Skills in demand
  - In IT, software development and programming are in high demand
  - Industrial designers, plumbers, programmers, nurses, accountants all require STEM skills
  - Lab and medical tech jobs are hard to fill
  - Even office jobs that require database management or statistics are hard to fill
  - Knowing coding languages like Ruby, Python are in demand
  - Growth areas like cyber security, where demand heavily outstrips supply
Autism in the STEM workforce

• The unemployment rate for adults with autism is estimated in the 90% range

• Those on the spectrum are very loyal and are team players; they are also very productive

• Microsoft announced a program to hire those on the spectrum in April, full-time

• Walgreens launched a program to hire those on the spectrum in 2007

• Specialisterne run by Thorkil Sonne is a Danish company that is now world-wide—focus on QA, software testing
Autism in the Workforce (cont.)

- SAP, the giant German software company has had a program for those on the spectrum for a couple of years now.
- The Israeli Defense Force has a program which has those on the spectrum analyzing satellite images.
- Ultra Testing started up 2 years ago and employees almost exclusively those on the spectrum—superior visual discrimination.
- Freddie Mac, the US mortgage giant has a program to train those on the spectrum in accounting fields, and financial analysis.
The Ingredients of Success

• Content knowledge is only one ingredient in being successful, but may not be the major component
• 21st Century skills, or ‘soft skills’ are often seen as important or even more important
• A third ingredient is motivation and dispositions
• How important are these skills and attitudes other than content knowledge?
Success and Social-Emotional Skills

• The kindergarten study—the importance of pro-social behavior
  • Social behavior as a predictor of success

• The Harvard study—Intellectual prowess and success
  • Intelligence alone is a poor predictor of success

• 21st Century skills, attitudes and their role in success
  • Beliefs about your ability determine how successful you are—fixed versus growth mindset
What are 21st Century Skills

- **Personal Skills**
  - Being a critical thinker, being creative, being a problem-solver

- **Interpersonal skills**
  - Communicating effectively, being able to work in groups, appreciating diversity, being understanding of others, resolving conflict

- **Creativity**
  - Imagination, implementing innovation

- **Critical thinking**
  - Self-reflection, problem-solving, analytical thinking
21\textsuperscript{st} Century Skills (cont.)

- **Creativity**
  - Being imaginative, being able to implement new ideas, able to imagine other possibilities

- **Critical thinking**
  - Able to analyze and synthesize information, being able to problem-solve, and analyse one’s own assumptions
The social nature of STEM activities

- Science experiments—they are collaborative and require communication by nature; labs often consist of numerous workers; have to make a presentation, write up the experiment, engagement is essential.

- Robotics builds—they are team endeavors requiring collaboration among various functions: electronics, manufacture, programming.

- Real-world projects and assignments—STEM activities most often have a real-world application to the environment, to other humans, to society. They are rarely isolated activities.

STEM and 21st Century Skills
The Social Nature of STEM activities (cont.)

- Makers spaces and innovation labs
  - Maker spaces to learn a skill—3D printing, routing, manufacturing
  - Innovation Lab for robotics builds and competition, for teachers to collaborate on assignments; Most Likely to Succeed

- Projects and presentations
  - Collaborative projects, projects that have a presentation component, and present to the public

- STEM in the community
  - An essential component of STEM is connecting the classroom to real-world problems
Motivation and Engagement

- **Thinking about the future**
  - Goal management, hope and optimism, what do I want to do and be?

- **Self-management**
  - Emotional regulation, self-discipline, how do I manage my own emotions through adversity?

- **Perseverance / grit**
  - Perseverance, goal orientation, can I regroup after a set-back and persist through to success?

- **Self-efficacy and mindsets**
  - Self-efficacy, growth, mastery, relevance

- **Belonging & identity**
  - Belonging, relationship building, personal identity, social capital
Motivation and Engagement (cont.)

- **Self-efficacy and mindsets**
  - How effective are you at achieving your goals, do you have beliefs about yourself that you can grow and develop or are you fixed in terms of your ability?

- **Belonging & identity**
  - Do you have a sense of yourself as part of a larger community, do you have an accurate sense of who you are? Do you have relationships that you can leverage for your own success?
Addendum

• Visual discrimination and its uses
  • Results of testing show superior visual discrimination in those on the spectrum who might have otherwise average scores academically

• These are students who have the ability to make fine distinctions and notice small differences in visual images or in text.

• Uses of this ability include editing text, comparing satellite images, photography, debugging code, assessing software for quality across platforms