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Recently, I created a link on the Gifted Education Press website that presents important papers by one of the pioneers of gifted education and originators of Differential Education for the Gifted. Virgil S. Ward was a highly innovative professor at the University of Virginia for thirty years. With the approval and help of his daughter, Rebecca Ward who is the legal owner of his intellectual property, I have placed six of his articles on the following link so far: http://www.giftededpress.com/WARDPAPERS.htm. I want to thank her for her diligence and continued dedication to this task, and expect to place more of Ward's papers on this link in the future. Graduate students, professors, teachers, and parents should read these papers to obtain an idea of Ward's initial position on educating the gifted, beginning in the 1950s with his address on The Intellectually Superior Student (1953). He used other papers in the 1960s and 1970s in his graduate student courses, particularly those with his doctoral candidates. Some of these papers were: The Gifted Student: A Manual for Program Improvement (1962), The Role and Nature of Theory in Gifted Education (1960), Systematic Intensification and Extensification of the School Curriculum (1960), and LIFETIME EDUCATION: Propositions for a General Theory of Education for these Times (1967). Ward's major works on gifted education culminated in his axiomatic method, ***Educating the Gifted: An Axiomatic Approach*** (1961) and ***Differential Education for the Gifted*** (1980).

Although there are many books available on creative thinking and problem solving, this one is particularly unique, clever and concise: ***Creativity for Everybody*** (Sparkitivity, 2015) by Kathryn P. Haydon and Jane Harvey. The unique feature of this book is that it summarizes major characteristics of creativity in one page discussions. The cleverness is emphasized by imaginative diagrams and pictures associated with these characteristics. All of these excellent discussions, ideas and graphics are concisely presented in 81 pages. The book appeals to both visual and cognitive ways of thinking so that teachers and students are simultaneously stimulated in both modalities. Some topics covered by Haydon and Harvey are: creativity is shifting perspective, thinking, freedom, essential, and personal; practicing creativity; inquiry; and finding meaning. I highly recommend this book for all individuals who want to be inspired to be more creative and innovative.

Walter Isaacson has written many insightful books on geniuses of creative thinking including Ben Franklin (2004), Albert Einstein (2008) and Steve Jobs (2013). His latest work is a comprehensive and brilliant discussion of the founders, innovators and inventors of the computer, internet and related components such as the transistor and microchip–***The Innovators: How a Group of Hackers, Geniuses, and Geeks Created the Digital Revolution*** (Simon & Schuster, 2014). What is so unique and interesting about this book is that it not only covers the technological inventions in great detail, but also the personalities who produced these innovations such as: (1) Transistor, Semiconductor, late 1940s through the 1950s–William Schockley, John Bardeen and Walter Houser Brattain. All three won a Nobel Prize in Physics; and (2) Integrated Circuit, Microchip, late 1950s through the 1960s–Jack Kilby, Kurt Lehovic, Robert Noyce, Jean Hoerni, and Jay Last. Jack Kilby won a Nobel Prize in Physics.

The articles in this issue concentrate on the following topics:

1. ***Philosophical Studies for Gifted Students*** by Joan Smutny who is the Director of one of the largest programs in the nation located in the Chicago Metropolitan area, The Center for Gifted in Glenview, Illinois. Joan's excellent paper covers many issues related to restoring philosophical ideas as a crucial part of the gifted curriculum such as ethics, compassion, and kindness.

2. ***Teaching Graduate Education Students about Designing STEM Education Programs*** by Harry T. Roman. The author is a retired engineer who teaches graduate courses at Montclair State University in New Jersey, and helps public schools to set up STEM programs. He has written numerous articles on this topic for Gifted Education Press.

3. ***Using the Latest Radio Technology Devices to Teach Gifted Students How to Communicate with Space Vehicles and Astronauts*** by James Popoff. Originally trained as a population statistician, he has devoted many years to designing radio communication devices for use in the gifted classroom. This is a highly technical paper which illustrates the advanced skills and knowledge that gifted students need to acquire in physics, short wave systems, and advanced radio design to communicate with astronauts on Mars and other areas of outer space.

4. ***Great Authors of English Literature and What They Have Said about Tolerance*** by Michael E. Walters. He has written extensively about Humanities Education for the Gifted. His article concentrates on the search for tolerance by E. M. Forster and W. Somerset Maugham in their novels.

Sweet are the uses of adversity; / Which, like the toad, ugly and venomous, / Wears yet a precious jewel in his head. . . – William Shakespeare

I've missed more than 9,000 shots in my career. I've lost almost 300 games; 26 *times,* I've been trusted to take the game-winning shot and missed. I've failed over and over and over again in my life. And that is why I succeed. – Michael Jordan

When in doubt, do something. – Harry Chapin, Musician

Do not be too timid and squeamish about your actions. All life is an experiment. The more experiments you make the better. What if they are a little coarse and you may get your coat soiled or torn? What if you do fail, and get fairly rolled in the dirt once or twice. Up again, you shall never be so afraid of a tumble. – Ralph Waldo Emerson

He that lives upon hope, dies farting. – Benjamin Franklin, Statesman, Inventor, Scientist, Businessman

If you're going through hell, keep going. – Winston Churchill, World Statesman

Maurice D. Fisher, Publisher

Nurturing the Philosopher in Every Gifted Learner

Joan Franklin Smutny

Director, The Center for Gifted Glenview, Illinois

It is my belief that giftedness exists in the heart and soul. –Annemarie Roeper

There is no such thing as being too young to do philosophy, especially for gifted learners. Leta Hollingworth claimed that it is between the years of 4 and 9 that gifted children struggle to find a sense of personal identity (as quoted in Harrison, 2004). Hoffman (1994) conducted interviews with a number of adults who, in recalling early childhood experiences, revealed a rich inner world of spiritual insight and sensibility. They described such phenomena as feelings of profound joy, timelessness, oneness with nature, experiences with a supreme being or life force, extraordinary inner convictions (sometimes contrary to adult belief systems), ability to enter non-ordinary states of consciousness, and a highly developed sense of self.

Gifted children and young people come to us with emotional, sensory and intuitive abilities that deal not merely with thoughts about the universe and spiritual existence, but with ethics, compassion, kindness, intuition, artistry, inspiration, and joy. They have a hunger of the "heart and soul." The 3 year old who loves reading biographies about explorers or the 13 year old who attends science classes at the local university are both on a quest to understand life's deeper mysteries. For these young philosophers, getting more academically challenging instruction does not fill the void. Their interest lies elsewhere.

This "elsewhere," I believe, is the philosophical realm—thinking about large questions, about the nature of reality, knowledge, identity, ethics, and so forth. The pioneer teacher Albert Cullum, who taught the philosophers and great literary figures to fourth and fifth graders, said that students are inspired by greatness and bored by mediocrity. Gifted students have a deep and abiding need to connect with greatness.

The following is a list of qualities that teachers and families have seen in the young philosophers of their lives:

- Interested in philosophical and spiritual questions in advance of their years;
- Inspired by a sense of the wholeness of life (encompassing all beings and the universe) and feeling part of this large whole;
- Profoundly affected by experiences that suggest a new way of thinking or experiencing the world;
- Acutely intuitive about human and animal behavior;
- Deeply drawn toward the creative, artistic and the imaginative;
- Interested in unexplained phenomena—telepathic abilities, near-death-experiences, visions of the future, etc.;
- Disturbed by cruelty, war, and destruction to the environment and inclined to worry about these issues;
- Highly sensitive and compassionate toward others, particularly toward those who are mistreated, troubled or unhappy;
- Able to take strong, courageous stands about ethical issues based on well-reasoned arguments for doing so and in spite of opposition;
- Inclined to sense another, invisible world/pattern/force/intelligence beyond the visible, material one.

Catalysts and Activities

Philosophy is applicable to any field, so you can use a wealth of scenarios and materials in mathematics, science, literature, art, and many other fields to stimulate philosophical discussions in class. This article explores the use of literature and film to explore a number of philosophical questions, but these questions can extend to other fields and opportunities for research. Thomas Wartenberg, Philosophy professor at Mount Holyoke College, has designed a highly creative and stimulating program and web site (Teaching Children Philosophy: http://www.teachingchildrenphilosophy.org/) for engaging students in philosophical thinking.

Teachers engage children in debate and discussion, and help them question how they are thinking: Why do you think that? What is your reasoning? Do you agree/disagree with the points raised by other students? Why or why not?

The book below is one of many introduced on Wartenberg's web site for elementary philosophy students—adapted to the needs and interests of gifted learners. You can select questions and activities to begin a process and then guide the students' discussion, debate, simulation, theater or art response to stimulate in-depth thinking.

***Elvira* by Margaret Shannon**

Philosophical issues: This charming and hilarious book provides an excellent vehicle for examining ontology which deals with existence and identity. Here, gifted children have a great deal to ponder because of their own struggles with being different. Each step of the story is a window into the life of the gifted child whose awareness of difference immediately creates conflicts—not only with peers and adults but also within him/her. The humor in the story inspires laughter which is always a great catalyst for discussion and debate.

Summary of the story: Though to outward appearances like any other dragon, Elvira grows to become quite different from her peers who love nothing more than fighting and eating princesses. Elvira creates daisy chains and designs dresses—a preference that makes her a target for bullying by her goofy, marauding co-dragons. Angered by their taunts, Elvira goes off to live with the princesses who at first fear her but later receive her as a "pet" whom they dress up and upon whom they lavish their beauty products. When Elvira returns to her family and community, they at first think she is a rather "fat" princess (and therefore food!) until she protests. The other dragons, who were rather looking forward to teasing Elvira, instead found themselves so taken with the dresses that she decides to make some for them as well.

Connections to life experience. Gifted children will particularly relate to this story because it addresses the issue of difference in a humorous way. They often wonder why people jeer at those who are different and why one thing is normal and another thing not. They may not necessarily share Elvira's passion for dresses and dress-making, but they can quickly empathize with how different Elvira feels from everyone around her. The bullying of peers when she openly expresses her passion for daisy chains and clothing design can open up the class to a fruitful discussion about individuality and the struggle some people have to follow their own interests when friends and even family members may not understand or approve.

Being Different

The following questions focus on what the children think about being different and about how society treats differences between people. How should difference be addressed in schools, at home, in the world? Through these questions, children can also consider how they would respond to the disapproval and bullying of those who oppose differences. Elvira chooses to leave her community for a while. The impulse to run away is something many gifted learners understand well.

Questions

Did Elvira like being different? Do you ever feel different from other people?
Do you like being different? Why/Why not?
Do you think that picking on somebody who's different is wrong? Why/Why not?
The only way Elvira can stand being different is to leave her home. If you were her friend would you tell her to stay or go? Why?
Do you think running away is the answer? What would you do?

Creative Extensions

- Create a collage that represents your ideas about being different.

- If bullies made the rules, what would their rules be? Write down a "Bully Rule" that everyone in the class must obey [e.g., When the bully enters the room, everyone must do as he/she says. When a bully says or does a mean thing, be silent, do nothing.] Pick one of the rules and, through writing, drawing, or drama, answer the question: What is wrong with this rule?
- Compose a poem about pretending to be someone or something else.
- Choose an animal you would like to have as a companion who could help you cope with being different and write, sketch, paint that animal.

Identity and Conformity

These questions relate to the previous ones, but focus a little more on the idea that difference is in every person, plant and animal. No two living beings are exactly alike, whether they are two kids in a class or two baby birds or two leaves. Young gifted children find this a strengthening as well as fascinating concept. Through these questions, they can explore not only the uniqueness of individuals, but the fact that individuals can be different at different times and in different places. **Questions**

When Elvira returns to her parents after having lived with the princesses, her parents don't know it's her. Do you think you would've known it was Elvira? Why/Why not?
What makes Elvira, Elvira? Is it her fondness for dress-making? Or is it that Elvira feels wrong eating princesses and the other dragons don't? What else makes Elvira, Elvira?
What do you feel is most different about you? What makes you, you?
Do you think everyone is different from everyone else? How do you know?
If no one is really the same as anyone else, than why do you think they pretend to be?

Creative Extensions

- Imagine you are one of the other dragons but you don't really want to eat princesses either. Write/tell/draw a story about yourself as this dragon, how you felt when Elvira moved away and what you plan to do to stop the dragons from bullying you.
- Choose two of something (leaves from same tree, animals of same species) and look at them closely. Do you see differences? Write/draw/talk about them.
- Some differences are big and others are little (e.g., One dragon may have a thinner nose than another which is a small difference; one dragon may eat 100 princesses a week and the other none at all, which is a big difference). What are the differences between you and another person? Or between two other people you know? What differences in yourself do you care about the most (e.g., "My love for frogs" "I can imagine anything.")? Create a collage with words and images to express your thoughts on big and small differences.
- Pretend that you are Elvira. You think it's horrible that your fellow dragons kill and eat princesses and you want them to see that it's wrong. Write them a letter saying why you feel differently about the princesses and why you think dragons should be nice to them. Using the illustrations in the book, you can express yourself through poetry, drawing or painting.

These activities not only feed the hearts and minds of young gifted children, they also provide important links to language arts instruction. Imaginative stories, biographies and historical fiction can all be used to explore questions of identity, justice, the value of kindness, and respect for the environment, and other topics. Becoming more practiced at questioning and probing large concepts not only strengthens thinking skills but helps them stay centered on their own unique concerns and passions in life. Examining the choices Elvira made and the stand she took against the age-old traditions of her kind, children explore how they can do the same, especially when they feel pressured to conform to something they don't believe in.

Film

Tom Wartenberg has extended philosophy teaching to middle and high school students through an online program called What's the Big Idea (http://whatsthebigideaprogram.com/), which uses film clips to stimulate philosophical thinking and debate. For many teachers, finding film scenes that raise specific philosophical questions takes too much time. This program has done all the preliminary work so that teachers need only select a category (e.g., friendship, bullying, lying, peer pressure, environmental ethics) and click onto the film clips which include important questions and present a measure of complexity. Such a program offers a starting point for teachers of the gifted, who can easily add follow-up questions and extension activities to create a higher level of analysis and discussion.

Environmental Ethics

What's the Big Idea website uses excerpts from Avatar, The Day After Yesterday, The Lorax, and others to stimulate debate about humanity's relationship with and responsibility to the natural world. Gifted learners in the middle and high school years often express concern about the environment and enjoy exploring ethical issues related to its use, care, and management. The topic allows for many extensions—other disciplines and activities (see Extensions section).

The Value of Nature

Most gifted learners feel connected to the natural world, though many do not take the time to absorb its blessings or study its fascinating detail. Pondering the essence and meaning of nature—not only for themselves but for the vulnerable ecologies around them—inspires their imagination and critical thinking.

Questions

In The Lorax, the environment is artificial, or manufactured. There are no living trees. Does the fact that they are alive make trees more valuable than those that are not? If so why/ why not?

The Once-ler in The Lorax said that the grey and polluted environment around him was once colorful and lush—full of brown Bar-ba-lotts, Humming-Fish, and wispy Truffula trees. Do you find the natural world beautiful? Is the beauty of nature a reason to preserve it?

What is the value of the natural environment to you (qualities; activities; stories)? Think about how it affects you, what you enjoy doing in it, the different kinds of places you've gone (ocean, mountains, deserts, etc.).

The Once-ler chopped all the trees to fashion a highly versatile garment called a "thneed." Do you think the Lorax did a good job of communicating the value of this world—why it's important and should be protected? Why or why not?

Would you miss trees if they all disappeared? How would you feel living in a world where every tree and plant was "unreal"? What makes a thing real?

The Na'vi in Avatar took from nature and gave back to it. They valued Pandora's rich bounty and know better than to abuse it. They also connected to it spiritually and saw themselves as part of it. Do you ever feel this way in a natural environment you love? If more people saw nature as part of them, do you think they would see it in a new way?

Do you think people need the natural world in order to be happy? Do you think there is something wrong with being cut off from nature? Not experiencing the slower pace, the quiet, the sounds of wind, rain, birds, and coyotes, the feel of cool grass, the pungent smell of the sea at low tide?

Creative Extensions

- Research the potential far-reaching damage from a human activity (e.g., over-logging, degrading water sources, and/or loss of animal and plant species). Design a poster expressing, to you, the value of nature for a specific people, plant, or animal species and the need for action. Create a slogan for the poster that focuses on the problem and the need for immediate action.
- Would you feel you lost something if your world was completely artificial? Imagine returning to a favorite nature place and seeing developments and stores. Write a poem about this.
- Choose an environment close by—a park, a stream, a yard. Sit quietly in it and bring a diary to record what you see, feel, and hear there for a period of a few days to a week. Take pictures, make sketches. Do you notice new things each time you visit? Explore different sized creatures or objects, different textures and substances (a grasshopper, a leaf, a small rock, a tree, a dog, a horse, birds, clouds). Try to understand the behavior of a group of birds or other creatures simply by careful observation. Use your journal to explore the concept of value in the natural world. Did the environment increase your curiosity? Your enjoyment?
- Based on your journal notes, photos, and sketches, create a collage of your experience and what you valued in this place.
- Alternative to the above, draw sketches and/or write a report on how your perceptions or feelings changed as you got to know a favorite park, coast, mountain, or forest.
- Draw on a quote by a nature writer or a movie character to inspire a free verse poem. An example might be Treebeard in Two Towers: "Don't be hasty." What is your experience of time in nature? What might you miss if you hurry?

Humans' Relationship to Nature

Middle and secondary students are deeply attuned to issues of fairness, justice, and the abuse of power. Many ponder the relationship between humans and nature in the industrialized world and express concern about a degraded environment or endangered species.

Questions

People have always depended on nature. Both The Lorax and Avatar show humans taking raw material from the natural world for their benefit. What do you think the films are saying about the mining operation at Avatar or the Once-ler's actions in The Lorax?

What is Selfridge's attitude toward the natural world in Avatar? What about the Once-ler in The Lorax? Do we have these attitudes in our world? Share examples.

How did Selfridge and the Once-ler change the environments they worked in? Are there justifiable reasons for the Once-ler chopping the trees or Selfridge mining for "unobtainium"?

Does is matter if a certain species not essential to human survival disappears forever? (e.g., Some people might say, what does it matter if the spotted owl goes extinct because we have cut down all the old growth forest?) Do you agree or not? Why or why not?

Do you agree that all of nature is here for us to act upon as we wish? Why or why not? Do you believe that human beings should be masters over nature or caretakers of it?

What is the difference between a need and a want? Are there any areas you can think of where people take/use more energy, gadgets, plastics, land, etc. than needed?

What is sustainable development?

How do you balance the needs of humanity for plants, animals, and other materials and the needs of the natural world?

Creative Extensions

- In Avatar, humans are extracting the mineral "unobtanium" in Pandora because humans need it to solve their energy crisis in the 22nd century. Imagine you are in the role of Jake Sully whose job it is to find a way to get the Na'vi to leave Hometree and to report any intelligence he gathers back to Colonel Quaritch. Would you feel morally compromised in this position? What might you have done differently than Sully? Write your own story about how you defected to the Na'vi (or did not, as the case may be).
- Choose an environmental issue that you care about. (Oil company contamination; over-fishing in certain areas; plastics). Research the subject. Write a position piece summarizing the problem, the most recent developments, and what you see as most promising solutions from an ethical point of view—what might be the best course to ensure sustainability for both humans and the natural environment?
- What happens if you ignore the needs of nature? What happened in The Lorax? In Avatar? Imagine your neighborhood hundreds of years into the future. If our society does not reduce pollution, use cleaner energy, and so on, what might it look, feel, sound like? Would there still be trees? Good air to breathe? Birds? Write a poem or create an art piece.
- Do some research on a pioneer environmentalist who foresaw the danger of a certain situation. An example might be Rachel Carson, whose research on DDT and whose brave fight to have it banned helped launch the environmental movement in the United States. Why was her book called *Silent Spring?* How was this powerful metaphor for the poisonous results of widespread DDT spraying in the 1960s? Discuss and write about the experiences these pioneers had with nature and the principles that sustained them.
- Do a simulation with a small group where a local population depends on something from the environment that has become scarce or has been extracted without regard to sustainability (e.g., fish; forests). Assume the role of the locals who need these things or the environmentalists who are worried about long term consequences of unrestrained activity. Write down and debate your viewpoint. Imagine you are a resident, imagine your life there, or, imagine you are a scientist and concerned environmentalist studying this problem and you want to convince the local people that they are harming not only the environment but their own livelihood. After debating, try to create a set of principles both groups could agree upon. What did you learn from the interactions? What misconceptions did you have? What insights? Explore new solutions based on your research and imagination.

Philosophy for the Heart

Without this opportunity to think philosophically, many young gifted learners feel pressured to abandon the most precious part of themselves. K. Dabrowski's (1979) description of the "overexcitabilities" of gifted learners still applies today. They are "delicate, gentle, sensitive, empathic, nonaggressive, industrious, wise though unsophisticated, never brutal, often inhibited, likely to withdraw into themselves rather than retaliate, having deep feelings, idealistic" (pgs. 87-90). Nothing can be more disheartening to a philosophical child than the discovery that high grades, admiration from adults and peers, and success in competitive environments are more important than following one's life path. Philosophy—taught through stories, biographies, films and other sources—can open up their lives in new ways and support the growth of their passions, ideals, and values. The sense of wonder they had naturally as very young children does not wane, but grows into a deep and abiding curiosity, an openness to broader life experiences, and a compassion for all living things.

Response to Claude Money
By Lauren Dauber, grade 10

The honeysuckle sunlight dances on the surface of the water
Solitary, in my boat

Paddling along the crimson tributary
All existence seems to stretch towards the sky
As if grasping for the wisps of clouds
Leisurely drifting
To the Heavens.
I glide aimlessly, no burden on my shoulders
In this moment, the world is at peace
And so am I.

A Tree Aflame
By Marlene Schaff, grade 8

On a hill alone stands a tree
Illuminated darkly from behind
By the setting sun
The sky is aflame with fiery night
Clouds of crimson, vermillion orange.
Below, the sun is a golden stripe
Beyond the hills
The river striated the mirrored colors
Of the burning heavens
The maple surveys the glowing landscape
Complacently, from its perch
As its dark boughs wink
A silent goodnight to the flaming sun.

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Web sites:

Institute for the Advancement of Philosophy for Children (IAPC)
http://cehs.montclair.edu/academic/iapc/

Philosophy for Kids
www.philosophyforkids.com/

What's the Big Idea Program
http://whatsthebigideaprogram.com/

Northwest Center for Philosophy for Children
http://depts.washington.edu/nwcenter/

Kids Philosophy Slam
http://www.philosophyslam.org/index.html

Observations, Insights and Comments on an Experimental Course at Montclair State University (MSU)

Harry T. Roman

Retired Engineer, Inventor, Author, Advisor

Over the last three years, I have been acting as an industry/business representative for a special program at MSU—a unique STEM program grant; a five-year effort sponsored through MSU's secondary and special education department in their teaching college. As part of this effort, we have designed an experimental co-taught summer graduate course for science and math teachers. The initial emphasis of this program was to teach middle school teachers; and is now branching out to elementary school teachers—all showcased in a nearby demonstration school district. As this article unfolds, you will see many applications to the G&T classroom.

As the resident engineer/inventor on the MSU implementation team, I am delighted to see how readily science and math teachers take to the STEM topic. In this effort, we don't use the traditional S-T-E-M acronym. We use "iSTeM" to denote we are "integrating" the curriculum in our approach; and a small "e" to denote we are not about teaching students to become engineers, but rather to adopt and appreciate the power of the inter-disciplinary, multi-dimensional engineering problem-solving/design process. We are also champions of inclusion….iSTeM being for all students.

Here is a glimpse of the engineering process [similar to the invention process] that is used to tackle new design and problem challenges:

-Understand the Problem and the Market for the Solution
-Assemble a Multi-disciplinary Team
-Identify and Understand Design Constraints and Tradeoffs
[multi-dimensional constraints]
-Develop a Specification for Success and Plan of Action
-Creatively Develop the Problem Solution or Design
-Build and Test the Prototype or Pilot System
-Critically Evaluate the Prototype/Pilot to its Constraints
-Revise Prototype/Pilot into a Commercial Product
-Launch the Commercial Product
-Continuously Improve the Product

This process is powerful stuff your gifted students should know and appreciate. Entrepreneurs also follow this taxonomy as they attempt to start new businesses. This process thrives in a diverse team environment, where ideas are freely exchanged and built upon. Team dynamics can profoundly affect the outcome of any problem or new product being considered.

Let me pause to mention our graduate course is primarily team-taught with two main professors/instructors; and invited guest lecturers as well……all in the hope that students experience a diverse variety of ideas, experiences, and opinions about what STEM is and is not.

Part of my involvement at MSU is to also show that: STEM education can serve as a school-to-work paradigm for students by cultivating life-long process skills for solving problems, making graduates valuable assets to hire into high tech companies, and emphasizing how valuable a STEM educated workforce is to a global economy. The average salary for workers in the economy is about $46,000. STEM savvy hires can receive $50,000-$65,000 at the get-go, and more if they have specialized skills, sometimes commanding salaries in excess of $80,000.

Based on my 37-year career in industry as a research project manager, I implemented a variety of new technologies and systems into a high-tech Fortune 500 company. Most of this was accomplished by my leading and directing inter-departmental project teams. For my role in teaching teamwork to graduate students at MSU, I designed a problem-solving philosophy for the class, something I call a "360-degree look-around"…… for teachers to challenge their students as they seek answers to important problems or situations. It's all about asking questions, both hard and soft, when discussing potential solutions, and looking for interfaces between topical areas. I urge teachers to impress upon students the importance of integrating their curriculum when solving problems, and examining various aspects of the solution—like how it is affected by and will affect the:

-Economy
-Technology
-Environment
-Aesthetics
-Society
-Safety
-Regulatory
-Legal
-Political
-Cultural….

and developing from this, a mediated (integrated) solution.

High quality questions asked about a problem to be solved often lead to high quality solutions—something we drill our graduate students about as they confront a capstone team challenge they will present near the end of the 15-week course. Throughout the course, they are also engaged in "content driven design challenges" as homework practice for their team effort. It is important to us that the design challenges not simply be "invention convention" types of activities. Math and science should form the basis of evaluating a problem, and likewise facilitating a solution or design—just like engineers and inventors do. This is a tough thing for students of all kinds, including gifted ones; and it may be just as tough for the teachers, many of whom may be somewhat math-averse.

It's important to note from the 360-degree look-around discussed above that team members in the work-a-day world will most likely be chosen to participate because they will possess the skills needed for the critical questions to be asked in the various areas. The more diverse the team members, the greater the chance for unusual insights and developing creative solutions.

A comment if I may about a variant of STEM, known as STEAM. Our MSU team has no problem with folks who wish to assert this, and we address this in classroom discussions. We are neutral…after all. We did brand our own particular version with iSTeM. Please consider my "360-degree look around" which does enumerate topical areas that could include the arts, especially under the categories of environment, aesthetics, and culture. We have gotten so-ingrained with an emphasis upon subject matter, that when we think about process as a prime driver we have difficulty fully appreciating new concepts like STEM. To many in the humanities, social sciences, and language and fine arts, it seems a minimum-sum game—with math and science in the ascendancy, and their losing status.

Here is how I see it and express it in the classroom. STEM being taught in all its forms across the nation is a temporary, transitional paradigm. The worn-out and now obsolete, 140-year old, 8-slice a day pizza-pie model for education is over. It no longer meets the needs of a 21st century world, and the problem-solving challenges that presents. The new education model is not about who owns which pizza slice. It is about how we can develop a new model that envisions the former traditional slices as enabling content, feeding into an applicability model for how we use all that content (process). And you G&T teachers are uniquely situated in helping to make this transition to a new gestalt; for most likely you and your students engage in more cross-cutting discussions and projects than traditional classrooms.

STEM…STEAM….and Such

Another aspect of this graduate course revolves around changing the way school is taught and how student success might be measured. This always gives rise to spirited discussions and teachers talking about life in the trenches, standardized testing and the lack of opportunities for creativity in the classroom.

Explore in your class and in special assignments how school should be revamped. Yes, be rebels and change the paradigm of school! How would the students like to be taught! Maybe it should be one where enabling content like math, art, music and science are taught together and then applied in studio formats. History, government, and law taught the same way…and so on…and then reformat the clusters so students see how different inter-related clusters affect problem-solving and new product design. In short, stop worrying about who is getting short-changed. The subjects should not drive the educational day. How we can use the subjects for the practical betterment of society should be the new goal. Think about how this kind of viewpoint would change the world and how it would change teaching, testing, and everything we hold dear now about education.

I was very fortunate in my life to have an inspirational high school science teacher in 1964-1966 who completely changed the physics/chemistry experience into a course called “integrated science” where we studied these two subjects every day in double period classes that emboldened us to ask questions and evaluate how all this related to modern life, good communications, and the impacts on society and the arts. I further enjoyed this teacher as a life-long friend and mentor. He was doing STEM and technology education 50 years ago. His last words to me at age 94 as I left his home after a delightful discussion about the future of education were……

“We will change education when we are brave enough to change the way we teach teachers”

These words of Morris Lerner ring in my ears as I teach my graduate students. The word “brave” is relevant, poignant and characteristic of this teacher-rebel who always urged us to ask questions—take nothing for granted—regardless of whatever subject we studied. His advice often centered around:

-Look for the connectedness between things.
-Your subjects do not exist in a vacuum.
-Write clearly and concisely.
-Be precise in the selection of words.
-Good ideas poorly presented go nowhere.
-Always look at how science and technology affect the world—read history.
-Read the biographies of great men and women—see their passion, understand why.

How I loved this man, the one who lit the educational fire deep inside me. I comment in passing: He later went on to become president of NSTA and created Newark, New Jersey’s iconic Science High School where every year their debating team takes high honors. The school is one of the top educational facilities in the state. His quote above is loved by our grad students. [As I write this, I am looking at the photo of Morris above my desk.]

School Experience

Having worked with a number of school districts on a regular basis, I bring fresh experience to the graduate classroom about organizing and mentoring middle school team-based challenges. Let me identify the interesting observations I have made in middle school classrooms, gifted and non-gifted, over the last 9 years.

-***Empower your classroom students to fail—break the punishment cycle for getting the wrong answer***. This mentality is very damaging for risk-taking, the fundamental underpinning of new product development. There are no right answers. Just design responses to the questions asked. Help them to learn about asking powerful questions! The problems we have with technologies today are probably caused by the lack of good question-asking when the technologies were inaugurated years ago.

-Lead…Do not manage student teams! Use a Socratic style, urging teams to dig deeper and have confidence in their own abilities.

-Make student teams keep notebooks of their progress, a chronology of the evolution of their solution…just like the great inventor Thomas Edison, who filled a total of 4,000 notebooks! The notebooks will also promote good, succinct writing. Urge teams to include in these written documents, non-technical aspects of the problem/design that must be considered. It's a powerful way to turn STEM into STEAM.

-Watch your special education and disaffected students, who may light-up brightly at the opportunity to engage head and hands. I have seen this so often, I expect it whenever I do a design challenge at a school. Let these students do their thing. Recently, I spent four days at a 6th grade school, engaging 100 three-person student teams (randomly selected) in a straw tower building challenge. The best teams all contained one or more special education students. the top team built a one-meter structure capable of holding a tennis ball at the top. All three team members were girls…..special education and disaffected. (Our graduate school students, who are actively teaching, had experienced this special education phenomenon in their home schools as well.)

-The topic of invention has a certain cache. Students are mesmerized by folks who are inventors….so invite some to talk to your students and have them bring their inventions into the classroom, whether they be actual hardware, photos, DVDs or virtual models. Have them tell how and why they invented something and especially how they went about it. This is guaranteed to raise the engagement level. I never visit a school without my "Harry's Magic Invention Bag". On one occasion I was invited to visit a G&T intermediate school (grades 3 thru 5). The students were pumped and waiting for me. As I negotiated my way to class, the bells rang and I was spotted as the new face in town, so I obviously was the inventor-visitor they had been promised. Excited squeals went up….."The inventor is here"…… "The Inventor is here" …….and soon I was pinned in the stairwell, surrounded by over fifty smiling faces shouting for my autograph. The teachers had to come to my rescue. It's good to be loved, sight unseen. I had a blast that day with the 5th graders, necessitating a nap after I arrived back home. My wife loved my stories of the questions asked by the rosy-cheeked students.

-One school I regularly visit and have become good friends with the teachers and principal and vice principal does something very valuable. Their students read the book ***Rocket Boys*** (1998). The source of the film is ***October Sky*** (1999) where young students in a West Virginia coal-mining town start experimenting with making rockets out of simple materials and fuels, quickly learning to go higher into the atmosphere; they need some powerful math and chemistry….all provided through the mentoring of an inspirational chemistry teacher. It is a fabulous story for young folks. The teachers I interact with at this school have autographed photos of the man who wrote the book—Homer Hickam, a retired NASA rocket scientist/engineer. It's his story! Talk about adding a STEAM component to STEM. Challenge your G&T students to find other such stories…or write their own short stories.

The Thomas Edison Thing

Edison is becoming a hot topic in schools looking to get STEM integrated into the curriculum, for he truly is the "great grand-daddy" of STEM. His greatest invention is his process of team-based invention or commercial R&D—which is also very similar to the engineering/invention process elucidated earlier. Before Mr. Edison died in 1931, so valuable was this form of commercialized R&D, that every major national company had implemented its own Edison style lab. The original Edison R&D facility has been preserved at his legendary West Orange, New Jersey labs, now incorporated into Thomas Edison National Historical Park, a full-fledged National Park Service site, open to the public.

Edison becomes America's pre-eminent project manager, leading 30-40 teams at a time, pumping out 1093 patents and tons of new products, employing over 10,000 people at West Orange. Silicon Valley east is what it was, 125 years ago. G&T teachers….think of the possibilities of teaching your students about Edison:

-What were his inventions?
-How did it all help society?
-What was the value of his inventions and the industries created?
-Who were Edison's contemporaries and what did they implement?

This is exactly what we encourage our graduate students to think about doing with the students in their classes.

Since the West Orange Labs are just a few miles away from MSU, we convene one evening class at the labs; and since I give numerous lectures there for the general public and serve as a volunteer ranger, I give a comprehensive 2-hour tour of the site and artifacts. How bug-eyed the graduate students become as they learn of the great things Edison accomplished, and how his achievements rumble down to us through time.

Did you know Edison's achievements of yesteryear are responsible for about 10% of the nation's annual economy, or about $1.6 trillion. Some experts believe his work has given birth to one-fourth of all the jobs on the planet. What a testimony to the powerful and far-reaching impacts of STEM as a force for good, and dare I say it….capitalism.

And then there are the famous Edison quotes, from which contain so much wisdom:

"Hell, there are no rules here, we are trying to accomplish something."

"I find out what the world needs. Then I go ahead and try to invent it."

"There's a better way to do it. Find it."

"To invent, you need a good imagination and a pile of junk."

"Our schools are not teaching students to think. It is astonishing how many young people have difficulty in putting their brains definitely and systematically to work.... " [Sound familiar!?]

"I never quit until I get what I'm after. Negative results are just what I'm after. They are just as valuable to me as positive results."

Your G&T students will love his quotes. Explore the wisdom of this man who was essentially home schooled by his mother; and aside from being the penultimate inventor, had a real love for poetry and literature. Decorate the classroom with Edison quotes. We talk about how Mr. Edison can be brought into the classroom all the time in our graduate course. He is a giant well of inspiration for us all. Dig deep into the man. Check out www.edisonmuckers.org, a website about Edison I write materials for the Edison Innovation Foundation, as well as www.pinterest.com/thomasaedison/. You can also tap into the website for the West Orange labs at www.nps.gov/edis/index.htm.

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Developing this graduate course with my co-instructor Vince has been a joyful and fun-filled experience. We are in our second year, with plans aborning for a spin-off course.

G&T teachers out there……get into STEM and begin integrating your curriculum. School is going to change, be ready for it. Make sure you always challenge your students, for the world of business will every day. Equip them to compete and obtain those high-paying jobs-the ones that expand the economy, and increase opportunity for all.

Editor's note—

Harry T. Roman is the best-selling author for Gifted Education Press [GEP], having published nine (9) books as well as thirty-five (35) articles in GEP newsletters. If you like this article, consider purchasing these books directly from GEP or through Amazon:

How an Engineer Uses Math - Real World Practical Examples for the Gifted Classroom in Environmental, Power, and Energy Areas - Middle and High School (2015)**.** Straightforward approaches from Harry's 45 years as an engineer are used to highlight practical applications of math through a variety of engineering disciplines. This is great stuff for the classroom—see how the math works.

Invention, Innovation and Creative Thinking in the Gifted Classroom-Activities & Design Challenges for Students in Middle & High School (2014)**.** Let this book help break the back of conventional problem solving. See the value of teamwork and creativity as you engage your students in Harry's fascinating activities and design challenges.

STEAM Education for Gifted Students! Upper Elementary Through Secondary Levels. Combining Communication and Language Arts with Science, Technology, Engineering and Mathematics (2013)**.** Who says you can't combine language arts into a STEM curriculum? Learn how Harry does it with his many applications and suggestions. Technology and the arts can coexist quite nicely!

Energizing Your Gifted Students' Creative Thinking & Imagination: Using Design Principles, Team Activities, and Invention Strategies - A Complete Lesson Guide for Upper Elementary and Middle School Levels (2008). Stimulating Creativity through Using Design Principles, Team Activities, and Invention Strategies. Harry T. Roman is a Technology and Environmental Engineer. He is an unusual blend of writer, teacher, inventor and engineer, having achieved acclaim in all four categories.

Solar Power, Fuel Cells, Wind Power and Other Important Environmental Studies for Upper Elementary and Middle School Gifted Students and Their Teachers: A Technology, Problem-Solving and Invention Guide (2008). The Fourteen Enriched Chapters in Harry's book are designed to stimulate the Imaginations and Problem-Solving Skills of gifted students regarding environmental issues.

A Strategy for Enlisting Gifted Students as Scientist-Participants in Mars Exploration Using Amateur Radio: Mmars and Gaia Dot Org (Mars Mission Amateur Radio System and Global Amateur Interferometer Array)

Dr. James Popoff, AJ4XI
mmarsandgaia@gmail.com

ABSTRACT

This paper addresses three themes: the history and operational profile of school children communicating with astronauts using amateur (ham) radio; the differing educational tastes addressed by American education and other modes such as the Asian model that may prepare young people for challenging activities, and the combination of educational mode choices and ham radio to enable a new paradigm that is immersive and contextual for gifted education called the MMARS and GAIA project.

The MMARS and GAIA project was first introduced in my book, ***The Young Amateur's Guide To Radio Physics*** (1913-15, Lulu) as a means of combining a multitude of small, cheap, and weak amateur radio stations, which the book guides the reader in constructing, together into a single, powerful virtual transceiver and antenna in order to communicate, using multimedia, with interplanetary explorers.

This is *telepresence*, with perhaps tens of thousands of young amateurs worldwide participating in the breathtaking excitement of *being there* while real exploration is carried out, having earned the "right" to do so by actively producing the GAIA signal.

"Communicating" is just saying "hi" and the novelty soon wears off; but the project (via the book) provides solid training in electronics, elementary through advanced mathematics, and the physics of electromagnetic energy to enable gifted students and interested others to be relevant, *credible*, interplanetary scientific explorers in their own right, and contribute ideas and analysis to the mission on an *ad hoc* basis or otherwise.

The relevant current model for the Mars Mission Amateur Radio System and Global Amateur Interferometer Array is the highly successful ARISS (Amateur Radio on the International Space Station) project undertaken by NASA and the ARRL (Amateur Radio Relay League) and AMSAT with school children worldwide. Goals of the ARISS program include (from the ARRL Home Page, http://www.arrl.org/):

- inspiring an interest in science, technology, engineering and math (STEM) subjects and in STEM careers among young people;
- providing an educational opportunity for students, teachers and the general public to learn about space exploration, space technologies and Amateur Radio as preparation for the event;
- providing an opportunity for Amateur Radio experimentation and evaluation of new technologies;
- offering a stress release outlet and opportunity for astronauts aboard the ISS to do public outreach, as well as providing a contingency communications network for NASA and the ISS crew.

However, to meet the demands of the MMARS and GAIA project, hams will need to deploy innovative mission elements such as geographically-distributed and internet-mediated virtual antenna arrays, multimedia data streaming schemes, and software-defined radios required for reliable telecommunications with *interplanetary* crews. Most of the technology already exists, although the adaptations will be nontrivial. This agenda is extreme in terms of knowledge for even advanced radio amateurs, but it may be the ideal inspirational objective for the youthful energy of our world, especially given augmented tools such as mobile broadband communications and emerging modes of electronically-enhanced youth culture.

INTRODUCTION

How does gifted education stand to be a beneficiary of ham radio?

Gifted education occurs, in contemporary America, in a context of repeated assaults upon "waste" and "fraud" that have pulled back its ambit to the line drawn by common, utilitarian, "three-R's" rote learning (maybe only any *two*-R's at that!). Little in the way of dedicated programming still exists; most gifted facilities, including teachers, have been co-opted for general school use and are time-shared, period-by-period, between gifted-ed classes and general stream classes. The hoped-for infusion of resources following the recognition of STEM formats has only emerged at pace with its introduction in the general stream. Gifted students receive some additional enrichment, a period here and there, and are otherwise treated essentially as general stream students.

The program described in this paper enhances STEM learning, by providing a disciplined, coherent, and a self-directed learning context that may occur *with the student* at any time, that is motivated and directed by inspiring–even heroic- goals, and is fostered in the long history of high achievement, innovation, and public service that is the legacy of American amateur radio.

A problem for gifted education has been the absence of a coordinated agenda that could stand up under difficult conditions and be effective. One area that's sure to continue growing is space exploration, and the potential partnership with amateur radio offers a curriculum within relatively-easy reach, that can foster activities by gifted students that can be originated with them and driven by them. It just takes a little education.

The successful outcome of the MMARS and GAIA project will be well-equipped young technical minds capable of initiating their own scientific explorations and building their own apparatus without (given the ubiquity of knowledge on the Internet) the continued necessity of *any school, anywhere*. This power, for that is what it is, will come with the socializing influence of the traditions of ham radio; our young radio amateurs will be part of the body of rank-and-file technologists of our country, whose organizations and institutions will guide, inspire, and respect them for their achievements.

To begin with small, but effective steps, we need only connect with our local radio amateurs, who are organized in local amateur radio clubs (ARCs) usually under the umbrella of the ARRL (http://www.arrl.org/). To succeed at the full-blown MMARS and GAIA program will require a guide and a sponsor. I will be the guide, using my book, ***The Young Amateur's Guide To Radio Physics*** (1913-15, Lulu), but the sponsors will have to emerge from the boots on the ground; mothers and fathers, aunts or uncles, grandparents, and, especially, the local gifted-ed or science and math teachers *who must also learn this difficult material* to encourage their protégés. But I have been at pains to make it seem easy, so let's get started by introducing some ideas.

Mars Exploration and School Children; A Natural Combination, So Why Is This News?

Why is the idea that Mars exploration and the interest and attention of young people are a certain combination even being discussed as if it were controversial in itself? The answer is there are two principal obstacles to that union: the first is that for speed-of-light communications, there is an inescapable time-delay (3 - 23 minutes one-way at Mars' surface, depending on relative orbits) that confuses us. It obliterates the possibility of what we experience as a *conversation* with its nuances of emphasis, tone, inflection, body language, facial expression, and so on.

Instead, there is what amounts to a series of declarative, perhaps terse, stand-alone "productions" that volley back and forth with huge punctuations of "empty" time. We naturally question whether anyone would actually *want* to communicate with the Mars astronauts for recreation and entertainment under those conditions (and, surely, the Mars astronauts themselves would regard such a "conversation" as onerous and not fun at all).

The second obstacle is no less imposing: the price a single station will pay for sufficient signal strength and receiving sensitivity is prohibitive. Even so, just to keep the price down to the prohibitive level, the amateur must build her or his own apparatus–first understanding esoteric physical and mathematical theory in order to produce or effectively use an existing design, then acquire costly tooling and materials or be lucky and scrounge surplus used apparatus, and finally, master complex manufacturing skills to adapt or maintain the equipment. So the probability that more than a very few individuals, and *any* schoolrooms around the world will ever attain the technical status to achieve an actual *exchange* with the Mars spacecraft is zero!

Solving these problems is the purpose of the MMARS and GAIA project. The reasoning behind the solutions is explained below, then in more detail in attached appendices. Without those solutions, gifted students will wait with the rest of us for managed information packaged by official sources, big science, and commercial media for our consumption.

ONE SUCCESS PROFILE WE MAY EMULATE IS THE ARISS PARTNERSHIP (http://spaceflight.nasa.gov/station/reference/radio/ **)**

Amateur Radio on the International Space Station and ARRL, AMSAT, and NASA: Here is a *relatively easy* first step for gifted-ed and general stream classes to try with the local amateur radio club! Local clubs can be contacted via the ARRL webpage, where their contact information is published.

In 1983 the first SAREX mission flew (Space Shuttle Amateur Radio Experiment), and a sprinkling of astronauts began to appear who had earned their amateur license, and whom we Earth-bound amateurs read about in journals such as QST and CQ. At first, private QSOs (two-way conversations over amateur radio) were the order of the day, although, as always, two-way QSOs were copied by hundreds, then thousands of Earth-bound hams. Amateurs all over the world could have a conversation with an astronaut in outer space while the shuttle passed overhead using a cheap dual-band hand-held transceiver (with 5 Watts of output signal power) and a hand-held antenna pointed at the right direction in the sky!

That same year the National Commission on Excellence in Education published the influential report "A Nation at Risk" that first sounded the alarm about our students' lackluster achievement levels compared with their peers around the world [1]. By 1989, after President George H.W. Bush's education summit with the nation's 50 governors, it was time for a turnaround represented by the President's list of National Education Goals, signed by all the governors. Although the ideas promoted by "A Nation at Risk" had been discussed by John Dewey in 1916 as fundamental to the progressivist movement in education, and had been characterized as "bridge-building" by the student between subjects to find an authentic meaning in science by the constructivist movement that followed in the 1950s and 60s, the notion that children should *do* science was new again in the 1980s and 90s [2].

At first, the inclusion of astronauts with amateur licenses in the MIR station, and aboard shuttle missions, together with simple amateur stations was a novelty, although amateurs worldwide clamored for the coveted "QSL card" proving they had achieved a connection with an astronaut-ham from outer space! Then it was seen as a real boon to the astronauts themselves, who were using that time spent as amateur radio operators for their personal recreation. Finally, the educational benefits were recognized, and Earth-based amateurs became organized volunteers for assisting school classes to have a QSO with a real astronaut aboard the space shuttle or MIR.

Those amateurs donated their own equipment and time, to arrange the event with NASA and personally supervise the actual communications, including the station setup and deploying (and coiling up again afterward!) the antennas and feed lines out the window or up the stairs to the roof. That activity became institutionalized as SAREX and has further led to the educational effort in the ARISS program of the ARRL, AMSAT (international), and NASA. Now the ARISSat-1 concept by AMSAT and Energia, the Russian space consortium, promotes the ongoing participation of schools in constructing and using ground stations to copy telemetry from a radio amateur satellite's space environment, as well as the "traditional" uses of amateurs' satellites, to enjoy QSOs with other amateurs [3].

The broad and growing success of the ARISS program can be a template for a critical amateur radio presence in the coming *Interplanetary Age*. The remainder of my remarks will explain practical strategies to address the principal technical obstacles, and pose ideas to enlist the youthful enthusiasm and optimism of the world's young people by using or emulating that template.

MEETING THE TECHNICAL CHALLENGE

What is it like to actually send a signal into outer space? How can gifted students accomplish such an extraordinary feat at home with their parents supporting the purchase of a radio station? At school, with the public supporting the purchase of a radio station? Or *on their own*, by constructing their own software-defined radio running on the family computer, after earning their FCC amateur license? And

***What* Is A *Link Budget*?**

A *link budget* evaluates the total noise figure and path losses of a particular *link profile* (sending and receiving stations' characteristics, plus the characteristics of the intervening transmission medium). So let's begin by considering the *space* between here and Mars. That is the interval the signals must bridge containing the rigors they must survive.

Illustrative of this is the present cutting edge of amateur practice, Earth-Moon-Earth (EME) or "moonbounce" communications. A moonbounce QSO takes place using very slow-speed Morse code, with each symbol repeated often between stations until each element is confirmed. The stations can be located at the ends of the Earth from each other (or anywhere within the common circle of illumination of the Moon).

Signals are transmitted to the Moon by one very well-equipped and sophisticated amateur station. They bounce off the lunar surface, and are then received, filtered and deciphered by another well-equipped and sophisticated amateur station, which then responds. Only amateurs with a great deal of skill and knowledge, and at least *some* money to burn can tackle moonbounce.

The rigors of moonbounce consist mainly of signal power attenuation, and apparatus-derived and ambient *noise*. Free space path loss is a function of the geometric diffusion of a given quantity of radiant energy with distance from its source; any object illuminated by that radiation will observe that the radiation is stronger if the object is closer, and weaker if the object is more distant from the source. The energy density falls off as $1/R^3$, where R is the distance between the sender and receiver. But there are many, many variables besides that to contend with. The details are provided, for those having a technical interest, in **Appendix One** below.

However, as I describe the global amateur interferometer array below, it will become plain that the participation of an evenly-distributed array roughly the diameter of the Earth would make a signal whose power could produce relatively cheap, noisy, and weak *individual* stations equal participants in the MMARS communications with the current institutional apparatus for Mars telemetry and command links. Where the challenges will lie will be with the controlling software (that I call, for now, the MMARS telco backbone) that coordinates the separate stations into a single powerful transceiver.

A SECOND SUCCESS PROFILE IS THE BROADBAND-HAMNET™

Can We Morph the Multimedia Mesh Concept originally developed by Texas amateurs to a Global Amateur Interferometer Array (GAIA)? Participation in this active research by gifted, creative problem-solving students will give them a solid grounding in computer programming and scripting, and a solid understanding of telephone communications and the Internet; this is a key area of ongoing development for MMARS and GAIA, open to anybody with a good idea, and is the coordinating software we will devise and improve upon together.

The GAIA *daemon* must be resident on all peer members of the synthetic aperture antenna (SAA) that we call the GAIA. As a station joins the GAIA it must be carefully calibrated, with respect to its own clock rate, internal bus parameters, the characteristics of its hop-paths to its nearest neighbors, and geographical and environmental variables described elsewhere so that its behavior is absolutely and instantaneously synchronized with all its station peers worldwide. The local daemon's "link function" will have its parameters populated from local values and then be solved for the local *signal delay*.

The secondary activity of the GAIA daemon will be to serve as a "traffic cop" or *operating system* mediating between the actions of the station peer and the SAA via a global broadband wireless link, called the MMARS telco link. This may ultimately reside in a cloud computing context, but for now it is described as a separate, stand-alone linkage over a telco backbone or the Internet.

As peers, every station will retain its autonomy as a licensed radio station. It will transmit and receive according to its license privileges. When a transmission to the Mars astronauts is desired, several frequencies may be set aside by convention among amateurs for that purpose. While the station peer is tuned to any of those frequencies it will enable the GAIA daemon and "join" the MMARS; the GAIA daemon will activate on the station peer's transceiver. However, in order to coordinate the actions of every member station, unless that MMARS telco link, too, is established by the GAIA daemon, no communication with the Mars astronauts will be possible by any given station. I'll defer the remainder of this discussion to **Appendix One**.

An interferometer such as the GAIA changes the *phase* of some of the combining signals so that all participants' signal energies add constructively, which forces the aggregate radiated power of all the participating stations to focus in a relatively narrow beam (one strong main lobe with residual side lobes and attenuated "rear" lobes instead of the isotropic radiator's spherical pattern) aimed at the antenna of the Mars spacecraft. Individual stations' outputs are combined into one focused beam instead of acting independently as myriad spherically-expanding and attenuating signal sources. Thus, the reduction in signal strength with distance is almost a non-issue.

That is the principle behind our modern phased-array radars, and electronically-steerable dipole arrays in radio astronomy. Phased-arrays are, essentially, interferometers in reverse. The disadvantage of that scheme is that the computational load becomes huge for coordinating all those waveforms in real time! However, we can *distribute the computations to the daemon resident on each participating node*. It polices itself according to a function for accommodating its particular characteristics that is calibrated at its time of joining and that has been monitored and updated since, in order to maintain synchronization at the local level with a *global clock pulse*. That feat is well within the capability of personal computers, and even tablets and smartphones today!

THE TIME-DELAY ISSUE

Imagine a gifted-ed class, having sent a message to the Mars explorers, waiting for periods of up to 45 minutes to hear a reply? Yikes! But, is this only a *Red Herring*?

The time-delay issue is, I think, a red herring. First of all, we must consider that *our perception* of a conversation is a purely psychological construction, an artifact deriving from our particular state of technology. For example, *we* are accustomed to instant messages and virtually real time conversations in business and private communications, but our ancestors were content to use handwritten letters delivered by hand. Letters might take months for their round trip. Therefore, such a "conversation" meant for them, at best, a back-and-forth volley of stand-alone productions that sketched, in great detail perhaps, the correspondents'

positions. Over time they may be said to have constituted a series of poses like the "friezes" of the classical dance phenomenon of the turn of the nineteenth and twentieth centuries.

Today, we adults are also confronted with an ignited revolution in communications entirely devised and understood by our young people that arises out of the gaming participatory environments brought about by virtually universal broadband communications in advanced centers. This constitutes a dynamic society and cultural definition in which authors *again* produce stand-alone "poses" that they then broadcast and that are responded to by wide audiences, who might themselves link the original message with other genera in an ongoing *multilog*.

In a very real sense, those of us not part of the former generation's literacy, nor conversant with the coming generation's multimediacy, are only a moment in time, transferring an enabling technology and we are *not* the future. That will be even more true as our technology expands our economic activities out among the solar system. Communications between Earth and Mars, or Earth and miners among the asteroids, or whatever the context may be, will forever be characterized by the moving time-delay constraint.

So how will this affect our efforts during the transition period while we become accustomed to the changes in state of mind that must occur? Perhaps surprisingly, I can see *little or no practical difference* between our present habits of amateur radio conversation and the techniques that will be necessary for MMARS and GAIA communications. Remember that our GAIA SAA will configure our messages in a transmission queue. My station, AJ4XI, will participate in a "QSO" or conversation between hams that is part of a *stream* of messages and replies that is constantly occurring.

Once a communications session begins, there will be a steady stream of messages and replies to copy, with very little difference in quality of experience compared with what presently happens (*most amateurs spend the majority of their time just listening*). There will be no *perception* of delay whatsoever, as far as I can tell as a senior-level radio amateur with around 25 years' experience, and as a participant in many online chat boards which also provide a pattern for the experience or "feel" of Mars mission QSOs (the most obvious difference will be the expansion from text or audio content to more arresting multimedia signals that will include video and data).

Finally, given ubiquity of mobile broadband, and youth as a target market for commercial technology and retail marketing, I can think of nothing more cool to young gifted people steeped in the intricacies of their idiom than to be participating in a global exercise to communicate with our Mars astronauts, the more so if they are *autonomous* actors, peers with respect to adult co-participants or authorities. The mission profile is completely consistent with declared youth values and observed youth activities. [7].

THE KNOWLEDGE GAP

Are Our Educators Too Timid, Parents Too Ignorant, and Kids Too Soft For This?

In Part Two of this paper, I'll tackle the issues of the fitness of our current educational paradigms to prepare gifted students and others, but especially quite young students from about age 8, through high school and college, to learn and use the necessary knowledge and skills for original, autonomous, and scientifically-relevant participation in interplanetary exploration.

I'll compare the statistical data from classes and schools having similar characteristics from the United States and Japan, and discuss the effects of parenting and the home environment on educational outcomes. A selection from among the potential approaches is in order. Finally, with the recognition of the vast resources available from within the amateur radio community, the rationale for a vigorous response by hams to partner with our gifted students will be outlined in detail.

APPENDIX ONE

The technical background to the MMARS and GAIA concept

It will be obvious to radio amateurs and communications engineers that the mere declaration of a "conventional" use of amateur bandwidth is no guarantee that there will be no other legitimate uses that might potentially be impacted by GAIA communications. Two items of note in that respect are: (1) no one will ever interfere with the SAA *transmission*; it will be too powerful for *any* single station to overcome and any additional signal information not strictly part of the GAIA transmission will be systematically treated as noise.

However, (2) as the GAIA transmission will be overwhelmingly powerful for other amateurs already using any of the frequencies in question, and who are not participants in the GAIA, that might in some cases (where station peers are within the signal radius of that active amateur station) constitute "willful interference." That is a violation of the International Telecommunications Union (ITU) treaties to which the United States is a signatory, and the FCC regulations.

Therefore, there will have to be a scheme of *encoding* the transmissions, perhaps using frequency-hopping, such as orthogonal frequency-division multiplexing (OFDM), together with currently-legal encryption schemes such as WSJT that together render harmless the GAIA transmissions to other amateurs around the world wishing to use those "conventional" Mars frequencies.

One additional constraint that militates using frequency-hopping or so-called "spread spectrum" techniques is the danger to aircraft and satellites that fly into the powerful GAIA beam. The center of the beam will vary geographically, so no arrangements can be made to protect airline passengers and satellite electronics other than signal power abatement. Spread spectrum uses brief intervals on any frequency within a broad range to reduce any interference to other users to undetectable levels. This would require coordinating sender and receiver using a "key" which is a legal form of encryption so long as the key is published.

Once the local link function has been populated and the time delay calculated, the GAIA daemon simply supervises the input and output with the MMARS telco link. Instead of a central operating system approach, the MMARS operates on serially-numbered items stored in and retrieved from buffer queues on board the local node. Nodes can each originate transmission messages meant for the Mars astronauts and each node receives messages in reply, but only, in the latter case, as intelligence buried in the signal energy. For transmitting, the local node link function provides a serial number and stores the node's message in an output buffer queue.

The MMARS telco link simultaneously echoes the node's message to every other node in the GAIA, where it is given the same serial number in the node's input buffer queue. In the case of collisions, which can occur locally when the input buffer is sent on to the output buffer, suitable business rules will apply and the conflict will be resolved so that every node has the same number for a given message. Meanwhile, the originating node counts down in sync with all other nodes in the GAIA and from time to time the station transceiver automatically transmits a message from the output queue as the clock triggers its transmission. Those transmissions then occur simultaneously at all other nodes too, as, in the case of electronically-steered transmissions, with appropriate phasing delays built in at the local nodes' link functions.

In the case of received transmissions from the Mars astronauts, the local node stores the received signal and simultaneously echoes it over the MMARS telco link to all other GAIA nodes, which are themselves simultaneously echoing their own received signals to all other GAIA nodes. The *local result* of multiplexing all the versions of the signal will be a clear separation between the linear sum of all signals' intelligence and all the random noise. The signal intelligence is then processed by the local node as normal and is perceived by the amateur as a multimedia communication.

The GAIA transceiver could be modeled on existing experimental networks [4] such as the Broadband-Hamnet™ (formerly the Texas HSMM-MESH™). A high speed multimedia mesh (Broadband-Hamnet™) transceiver consists of a wireless router such as the Linksys™ WRT54GL reconfigured in firmware away from the *Radio telecommunications Act* Part 15 service (consumer and commercial wireless communications), to Part 97 service (amateur radio). The reconfigured router is paired with an input-output device (a smartphone or laptop), and, together with a power supply and antenna constitutes a single "node" in the self-healing mesh network that connects at present between peers using line-of-sight RF signals, and over longer distances using the Internet.

Given that we have free open source software, and inexpensive firmware and hardware at hand, there is absolutely no reason why any two random hams anywhere in the world couldn't set up their own "mesh-works" this very day. It would literally be as easy as setting up a wireless router for your home office and family entertainment center and downloading a few peripheral drivers. It's a small step to experimenting with producing a working interferometer. From this and other nucleation sites we could eventually grow an entire GAIA, assuming the idea becomes an Internet "movement" with broad support worldwide.

With hemispheric participation, the GAIA mesh would have to be "on" worldwide so the turning Earth would continue to uncover new nodes to replace those falling below the horizon. The SETI (Search for Extra-Terrestrial Intelligence) movement produces a free application providing a screensaver and skins, and returning (invisibly to the user) to SETI computations using scavenged free cpu cycles of the host machine, from data communicated to that machine by SETI. A simple adaptation of that idea could serve as a first approximation of the GAIA daemon.

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The Literature of Toleration in the Gifted Education Curriculum

Michael E. Walters
Center for the Study of the Humanities in the Schools

So, two cheers for Democracy: one because it admits variety and two because it permits criticism. E. M. Forster
If there is on earth a house with many mansions, it is the house of words. E. M. Forster
But nothing in India is identifiable, the mere asking of a question causes it to disappear or to merge in something else.
E. M. Forster

Every production of an artist should be the expression of an adventure of his soul. W. Somerset Maugham
I can imagine no more comfortable frame of mind for the conduct of life than a humorous resignation. W. Somerset Maugham
There are three rules for writing a novel. Unfortunately, no one knows what they are. W. Somerset Maugham

I will discuss two British authors who expressed their writing craft as both an art form and a social philosophy. All their concerns and issues are in the forefront of contemporary political thought, and their insights were deeper and more universal. They were not involved with political correctness but with human compassion. Most important, they developed their commitment for toleration because of their own involvement in life. They traveled the world, experiencing many different people and cultures, and ascertaining how human beings can accept each other despite their differences. It is obvious that for contemporary humanity this is a compelling need. These authors came from the same intellectual tradition as John Locke who wrote ***A Letter Concerning Toleration*** (1689). All gifted students should read and reflect upon this work.

The first author is E. M. Forster (1879-1970). In his novel, ***A Passage to India*** (1924), he describes the cultural clash between the British administrators and the Moslem and Hindu populations. Forster shows the insularity of colonial India since the British administrators felt they knew what was best for this colony. (Colonial India was composed of both India and Pakistan of today.) It is very important when reading this novel to appreciate the intolerance between the Moslem and Hindu populations. Therefore, Foster was concerned with tolerance as a human need and not just a political problem. Throughout his life he wrote about the need for toleration among genders, class, cultures and political views including a non-fiction book on this topic called ***Two Cheers for Democracy*** (1951).

The next author is W. Somerset Maugham (1874-1965). ***The Moon and Sixpence*** (1919) is concerned with the struggles of a British artist based upon the life of the French post-impressionist, Paul Gauguin. The protagonist, Charles Strickland, a successful stockbroker in London, decides to give up his secure middle-class life and go to live as a Bohemian in France and its colonies. Strickland learns that the best way he can attain satisfaction is through making paintings of natives in French Polynesia. When we look at Gauguin's paintings, we are really looking at examples of human toleration. He found in Tahiti what he couldn't find in Europe–toleration for form, color and human desire.

Maugham's book emphasizes to gifted students the need for personal toleration in developing their talents and interests. It's important for them to deal with the themes of human toleration, to experience the techniques of these writers, and how they expressed human diversity. It was not a matter of political correctness for both Forster and Maugham, but a respect for human diversity. Their personal lives showed that they had to struggle with toleration for their own diverse needs.

In the Winter 2016 issue of ***Gifted Education Press Quarterly***, I will show how two 19th century American authors, Nathaniel Hawthorne and Herman Melville, also represent this literature of toleration.

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