the legacy project

Michael Hacker

by Michael Hacker, DTE and Johnny J Moye, DTE

Many industrial arts, technology education, and now technology and engineering education leaders have made their mark on our profession. Their legacy is something that members of the profession enjoy and have a responsibility to continue and build upon.

The Legacy Project focuses on the lives and actions of leaders who have forged our profession into what it is today. Members of the profession owe a debt of gratitude to these leaders. One way to demonstrate that gratitude is to recognize these leaders and some of their accomplishments. The focus in this issue is on Dr. Michael Hacker.

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Co-Director, Center for STEM Research, Hofstra University

Place of Birth: New York City, NY, November 14, 1942

Married to: Brenda Hacker

Degrees:

- Ph.D., Science and Technology Education, Ben Gurion University, Beersheva, Israel, 2014
- Certificate in Administration and Supervision, The City College of New York (CCNY), 1970
- M.S., Industrial Arts Education, CCNY, 1968
- B.S., Industrial Arts Education, CCNY, 1964

Occupational History:

- Co-Director, Center for STEM Research, Hofstra University, 1999-Present
- Research Associate Professor, State University of New York at Stony Brook, 1997-2002
- New York State Supervisor for Technology Education, New York State Education Department, 1984-1997
- Adjunct faculty, Department of Industrial Arts, CCNY, 1970-1978
- Teacher and Chair, Department of Technology, Syosset NY CSD, 1964-1984

Describe your education as you grew up in New York City and how you came to be interested in the profession, early teaching experiences, and later supervision experiences.

Early Days

I am a product of the New York City public schools (PS 152, JHS 52, and Stuyvesant HS). As a piano player and a youngster interested in all things mechanical, I had to choose between attending Music and Art HS, Brooklyn Technical HS, and Stuyvesant HS. After vising all three of these great schools, I was totally undecided when I walked into my guidance counselor's office on a Monday morning. He said, “you chose Stuyvesant, right”? And that’s how that fork-in-the road decision was made—which ultimately led to my career as an educator.

I originally planned to become an electrical engineer, having been an amateur (ham) radio operator since I was 16 years old (still licensed as K2CA) and having worked in Radio Row, the center of the electronics district in NYC, which was filled with "mom and pop" shops. That area was sadly torn down to make way for the World Trade Center (the Twin Towers, destroyed by the 2001 terrorist attack).

However, during my third year of engineering study at the City College of New York (CCNY), I ran headlong into a set of differential equations that brought my engineering aspirations to an abrupt end. I met Professor Julius Paster who inspired me to transfer to the Industrial Arts Teacher Education program.

Who were the primary 1960s and 70s producers of industrial arts/technology education teachers in the State of New York, and what kind of background did those teachers possess?

In the 1960s and 70s, the majority of New York State’s Industrial Arts teachers were graduates of Oswego University, CCNY, and the State University College at Buffalo. A few came from New York University (NYU). Besides courses in the history of education, educational psychology, and some courses in methods of teaching, the curriculum of the day was heavily focused on materials—with additional courses in electricity/electronics, graphic arts, and mechanical drawing. Personal computers were not yet ubiquitous, so there were no computer-based courses whatsoever. It was still very much an Industrial Arts program oriented toward producing secondary school shop teachers.

My 1964 graduating class at CCNY included 200 future teachers! All of these “kids” came from NYC. My mentors during the early years of my teaching career were Professors George Keane and Joel Mansbach (CCNY) and Vernon Tryon (Oswego University), but I learned a great deal from my peers, especially those teachers who were members and leaders of our professional associations: the New York State and Long Island Industrial Arts/Technology Education teacher associations, and AIAA/ITEA/ITEEA.

A Career in Three Phases

My career comprised three phases: secondary school teaching; serving as a New York State Education Department (NYSED) supervisor for Technology Education; and working at the Hofstra University Center for STEM Research (CSR) on National Science Foundation-funded projects.

Phase I: Secondary School Teaching

After graduation, I served as a teacher and department chair in Syosset, Long Island for 20 years. I taught traditional materials-based courses early on, then developed and taught courses in manufacturing and communications; but during most of my 20-year secondary school teaching career, I taught electronics.
In Syosset in the 1970s, we set up a modular teaching approach to enable students to rotate through a series of six activity stations in a 10-week-long communications technology lab. Activity stations included technical drawing (using T-squares and drawing boards), radio troubleshooting (using signal generators and oscilloscopes to trace the signal path), television and video recording, graphics (plate making and offset lithography), photography, and ham radio.

I also ran an after-school ham radio club where my students learned Morse code and electronics theory and spoke to people from many different countries. My students practiced their foreign language skills when speaking to youngsters in other ham operator teachers’ classes abroad and developed an appreciation for different cultures. They learned, for example, that kids in Paraguay went to school on horseback and had never seen snow; and they played chess “over the air” (the chess pieces remained on the board until the next weekly game) with the South African Junior Chess champion (he won, we lost!). At the time, he was the 13-year old son of my ham radio friend Julius Wulfsohn (ZS6BLK), an attorney in Johannesburg.

In 1983, the year before I left teaching to work at the New York State Education Department, we purchased our first Apple II E computer!

You were the State Supervisor of Technology Education in New York at a time that major curriculum efforts were evolving. As a result, you led a major New York effort to produce that generation's curriculum. Please describe the nature of that curriculum, who developed it, and how it was used in the following years.

Phase II: Work at the New York State Education Department
From 1984-1997 I served as a State Supervisor of Technology Education at NYSED. These were years of extraordinary professional growth. Our Education Commissioner spoke of "top-down support for bottom-up reform."

I learned a great deal from Professors Ron Todd (former Chair of Industrial Arts at NYU), and Tom Liao (former Chair of the Department of Technology and Society at Stony Brook University, SBU). The spirited debates I had with these guys and other very smart educators at AIAA/ITEA/ITEEA conferences (Paul Devore, Bill Dugger, Don Lauda, Franzie Loepp, Mark Sanders, Ernie Savage, Kendall Starkweather, Len Sterry, John Wells, Ken Welty, and others too numerous to mention) shaped my attitudes toward reform as our discipline continued its metamorphosis.

While serving at NYSED, I helped lead the transition from Industrial Arts to Technology Education. While defending the transition during the mid-1980s, I felt as if I needed a bullet-proof vest when conducting workshops for our teachers. I knew we were making progress when the shouts from teachers in the audience were directed toward one another, rather than at me!

During that period, I collaborated with my friend Bob Barden, an electrical engineer active in the Institute of Electrical and Electronics Engineers (IEEE), and a fellow ham radio operator. Bob (who became the head of global technology for Deutsche Bank) was responsible for conceptualizing the technological systems approach that underpinned the NYS Technology Education framework. Bob and I co-authored three textbooks in the late 1980s and early 1990s. Collaboration with engineers has been a source of inspiration to me for decades.

I worked closely with NYSED mathematics and science state supervisors and a cohort of exceptional technology educators to help develop the New York State Standards for Mathematics, Science, and Technology. These Standards outlined the content and pedagogical basis for the three M, S, & T disciplines, and included Standards intended to drive relationships among them. The Technology Standard focused on engineering design; systems thinking; tools, resources, and technological processes; and the impacts of technology on culture and society.

Although I managed the development of the first NYS middle school TechEd curriculum, the real credit belongs to the committed teachers who worked on the writing teams. The materials

were further refined and disseminated by a leadership group of teacher-trainers statewide that Ron Todd and I worked with over several years. The curriculum provided contemporary instructional models that enabled teachers to draw upon design-based instructional activities. We called them Technology Learning Activities (TLAs), and they explicitly integrated MST (now STEM) concepts.

What influenced your early decisions to move technology education towards engineering education?

Transition to Technology and Engineering Education. Through interactions with many educators and non-educators, I concluded that "technology" was an amorphous term, not well understood by the general public—sometimes used to mean artifacts (aspirin, chairs), sometimes to mean tools (computers to most people), and sometimes to mean procedures (people talked about the technology of painting with oils, or even the technology of putting together a legal brief). The term "engineering" was more universally understood.

I believed that a transition to Technology and Engineering Education (T&E) would provide a new vision for our teachers; incline new populations (including females) to enroll in our courses and consider teaching careers; and our mission would be more easily understood by the public.

I was persuaded that our teachers were capable of teaching an engineering-oriented program when I researched the competencies the Accreditation Board for Engineering and Technology (ABET) required of undergraduate engineering majors and compared them to the competencies that the National Council for Accreditation of Teacher Education (NCATE) required of undergraduate Technology Education majors. Except for ABET's greater emphasis on mathematics and science, I was stunned by the striking similarities!

During the mid-1980s, along with leaders in our field, engineering professional association executive directors, deans of engineering and other engineering educators, and industrialists, I led the development of the NYSED high school-level Principles of Engineering (PoE) program. That curriculum was completed in 1986 and field-tested in 120 schools. We received NSF funding to convene a national PoE professional development program that reached teachers in 20 states.

My advocacy for the move toward a math- and science-based engineering program was not at all a rejection of technology education; but rather a reconceptualization of its content base and design pedagogy. I always favored keeping the hands-on, project-based instructional methodology that had made industrial arts and technology education popular with generations of students.

Your involvement in numerous National Science Foundation-funded projects has led to the testing and use of contemporary-oriented curriculum materials. Please describe some of the advances that you developed through your research.

Phase III: Work at Hofstra University on National Science Foundation-Funded Projects

My career has spanned 56 years and has been enormously enhanced by what I have learned through writing and conducting projects that were funded by the National Science Foundation (NSF). My collaboration with engineers continues to this day with my Hofstra CSR Co-Director and friend David Burghardt, Professor of engineering at Hofstra, with whom I've co-led many of these projects and co-authored another three texts. Since 1993, we have received over $35M in funding to conduct 14 large-scale projects in support of T&E reform. These have been focused on research, curriculum development, and teacher enhancement. Through these projects, I have been privileged to establish professional and personal relationships with some of our nation's finest classroom teachers; and with extraordinary teacher educators, subject matter experts, researchers, and NSF program officers. A person who has been a mentor and has become a treasured friend is Dr. Gerhard Salinger, an NSF lead program officer for 25 years, now retired. It was Gerhard who opened the pathway for TechEd to receive NSF funding; and because of his contributions to Technology and Engineering education, ITEEA has established a prestigious award in his name.

Among our funded NSF projects have been an NYS Technology Education mentor network; a gaming and simulation project that developed a 3D game to teach concepts of heat flow and structural design and researched the efficacy of virtual vs. physical modeling; a project introducing elementary school teachers to design pedagogy; a project that used engineering design to help raise math and science scores in low-performing middle schools; and a project that developed learning management system-based high school curriculum materials for biotechnology, information technology, and manufacturing technology.

Needed Math. My most recent NSF project was a conference titled "Needed Math" that brought together employers, STEM educators, and mathematicians to determine what mathematics STEM technicians actually need in the workplace. I was driven to conduct the Needed Math project out of the frustration I saw so many young people endure when studying math in school; where they (and often their teachers) could see no relevance in much of the math they were learning beyond middle school. Math, rather than being appreciated for its elegance, too often disenfranchises learners and keeps otherwise able youngsters from scoring well on the SATs and thus limits their college options. Among other recommendations, conferees suggested that educators, in collaboration with industrialists, augment the traditional race-to-calculus mathematics curriculum with a separate new pathway (also rigorous) based on modeling and statistical analysis and solving real-world problems representative of those that students might encounter after they leave school.

Engineering for All. Probably the most impactful NSF project is Engineering for All, (EfA), a five-year $2M partnership with ITEEA. Drs. Gerhard Salinger and Joseph Reed were the Cognizant NSF Program Officers. My Co-Principal Investigators on this project were all highly respected leaders in STEM education: Barry Burke (ITEEA); Sandy Cavanaugh (Canon-McMillan School District in PA); Christine Cunningham (Founder, Engineering is Elementary, Boston Museum of Science); Tony Gordon (Hofstra); Liz Parry (North Carolina State University and ASEE); and Cary Sneider (Portland State University). David Ferguson at SBU chaired our Advisory Board.

EfA curriculum units invite students to develop design solutions to important societal challenges. Two six-week units were developed: *Vertical Farming: Fresh Food for Cities*, and *Water: The World in Crisis*. We were assisted by 22 teachers and 755 students from diverse ethnic and racial backgrounds and geographic locations nationwide to assess feasibility of implementation.

Unique features of EfA include the use of *informed design pedagogy* (page 5); portraying engineering as a potential social good and as a route to sustainability and social equity; revisiting unifying engineering themes (design, systems, modeling, resources, and human values) in different contexts; and actively engaging all students, not just those predisposed to engineering careers, in authentic STEM learning. The intent is to open students' eyes to the roles engineers play in addressing significant global and community-based concerns, address important STEM concepts and practices, and instill the confidence that with continued STEM study, they can make a difference in the world. A short EfA video is at https://www.youtube.com/watch?v=OQkowF2g53Q.

EfA Research and Assessment. EfA conducted a research program led by two outstanding science educator colleagues, David Crismond and Michal Lomask. Design Teaching Standards (DTS), associated assessment rubrics, and model teacher portfolios were developed to define what teachers need to know and be able to do to support students' learning with design-based curriculum. The DTS are organized around three dimensions: design practices, engineering themes, and classroom instructional practices. Video snippets of teachers and students illustrating these dimensions are hyperlinked to the DTS.

ITEEA Advocacy for EfA. Thanks to the active involvement and advocacy of ITEEA leadership, particularly Steve Barbato, Jenny Buelin, and Anita Deck, EfA is now a core component of ITEEA's Engineering byDesign™ (EbD™) program, and curriculum materials are available through the ITEEA's BUZZ online learning management system.

Reflections

What do you consider your most important contributions to the profession? Why?

I have been asked to reflect on contributions I might have made to our field, though I am completely clear in my own mind that I have gained much more from our profession than I have given. It is hard to separate friends from colleagues at this point in my life, and aside from the guys I've been playing music with for 40 years (traditional American and Celtic music—I play acoustic guitar and mandolin), my decades-long friendships with fellow educators define my life.

There are however, some career highlights that might receive honorable mention; and I also would like to offer a few tentative conclusions (adopting design thinking, my conclusions are always tentative!) reached over the years that have now become "soap boxes" from which to sermonize.

Assimilating an International Perspective

International collaboration has been life-changing. I have had the extreme pleasure of attending numerous international conferences and have worked with colleagues from outside the U.S. to plan and conduct three NATO Advanced Research Workshops (in The Netherlands, the Czech Republic and Slovakia, and England); organize a study-abroad tour for U.S. teachers; and collaborate on research.

My colleagues (David Barlex, Tony Gordon, Mike Ive, and Richard Kimbell from England; Dietrich Blandow and Walter Theuerkauf from Germany; Marc de Vries from The Netherlands; and my thesis advisor and dear friend Moshe Barak from Israel) tested my

assumptions, provided new perspectives, and facilitated visits to schools and conversations with classroom teachers and educational leaders internationally. The insights I have gained from working alongside these brilliant and committed educators has profoundly shaped my thinking, particularly about design pedagogy. I often saw in practice that when designing, students were engaging in a fair amount of trial-and-error problem solving—which in and of itself might not be all bad, except that classroom time is limited and we want to reach instructional goals within an allotted time. (Those goals relate to learning about and applying important ideas to generate optimal design solutions that meet criteria under given constraints.)

Informed Design Pedagogy

Enter Informed Design. Informed design is a pedagogical approach that was developed and validated through NSF-funded Projects. It improves upon traditional design methodology by enabling students to enhance their needed knowledge and skill base before attempting to solve design problems. In this way, students propose design solutions informed by prior knowledge and research, as opposed to engaging in trial-and-error "gadgeteering" where conceptual closure is often not attained.

Knowledge and Skill Builders. When engaged in informed design, learners are guided through a progression of *knowledge and skill builders* (KSBs) that prepare them to approach the design challenge from a more knowledgeable base (including learning and applying related math and science knowledge) to improve design performance. The KSBs are short, focused, "just-in-time" activities designed to help students learn important concepts and skills and to identify the variables that might affect the performance of the design. For example, in the EfA Vertical Farming unit, students work through several KSBs in teams: Learning about the need to feed a rapidly growing population; food deserts; pros and cons of hydroponic farming; building hydroponic systems; and using CAD modeling software. These KSBs prepare the students to model the design of a vertical farm

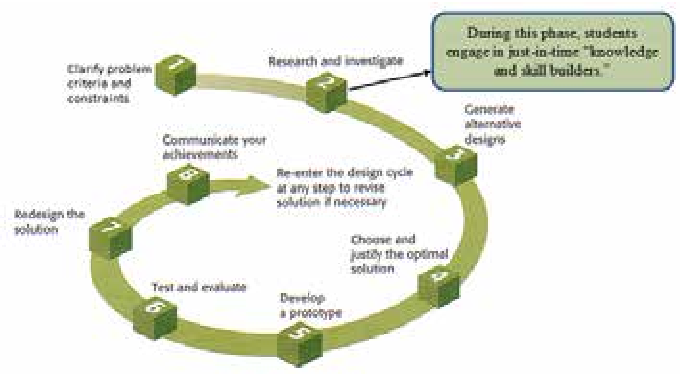

Figure 1. The Informed Design Process

on an existing building using hydroponic systems. Student work on the KSBs also provides evidence upon which teachers can assess student understanding of key ideas.

As such, students' design solutions are "informed" by the knowledge and skills that they acquired prior to designing and constructing their models. My Hofstra colleague David Burghardt and I have refined this approach collaboratively (Figure 1) during the conduct of six of our NSF curriculum development projects.

Soap Boxes

International collaboration and travel have several times led me to Speaker's Corner in Hyde Park, London. It is a place where speakers come to publicly air and debate their views on virtually any subject (these speeches are normally provocative and often highly political). When I speak at conferences, I can't help but bring a soap box or two along!

Soap Box I: Rethinking the Place of Standards in Curriculum Design

Industry standards generally refer to a quantitative level of acceptable performance. Educational standards define what students should know or be able to do. They are not quantitative, but descriptive. As educators, we need to establish learning targets; but what I have come to believe is that we should rethink our zealous devotion to learning standards.

Most Standards documents in the U.S. and globally include hundreds of objectives, benchmarks, attainment targets, performance indicators, etc. It's hard for teachers to check all the boxes, and trying to do so may be counterproductive—in that trying to ensure that all the identified content is taught can detract from students' engagement in an activity that in itself can stimulate interest and inspire open-ended, rigorous learning.

Learning standards have become the coin of the realm for curriculum developers, textbook writers, and assessment developers. Perhaps a case can be made for holding students accountable to standards when high-stakes testing follows instruction; but in our field, not being driven by high-stakes testing can be a net positive, as it enables teachers to more flexibly develop instructional approaches.

After decades of being a *Standards evangelist* (having served on the writing teams for both the NYS and national *Standards for Technological Literacy*/*STL*) I have come to believe that technology and engineering education curricula should be driven by **overarching, transferable, thematic ideas** that are revisited in different contexts, rather than by atomistic standards-based competencies. Overarching and transferable ideas repeatedly referred to in the literature include design, modeling, systems, resources, and human values and are "universals" in STEM education.

A thematically organized curriculum provides a more holistic understanding of T&E and helps solve the problem of the overloaded curriculum. In T&E, we might consider focusing on thematic understandings within interesting and important contexts, and address standards only as they are relevant to the specific design challenge.

Soap Box II: Choosing Socially Relevant Design Contexts

Choosing design contexts wisely will largely influence student engagement and learning outcomes. Today's Generation Z students are affected by global events and want to make a difference in the world. As a case study, the Engineering for All program (previously described) leverages students' interests in social equity and builds awareness of how engineering can address global and community challenges. Engaging learners in important and socially relevant design problems can help them develop dispositions to forge a sustainable future and learn that engineering is a route to engage in socially significant work.

As opposed to starting the curriculum design process with a set of defined learning objectives, we might consider starting with important social contexts that are relevant and compelling (to learners), focus on broad areas of thematic understanding, and address standards only as they are relevant to the specific design challenge. Students who are engaged in their learning will probe deeply and learn with purpose. They may learn content identified within Standards documents, or not; and they may learn content far beyond what was intended by the Standards writers. By promoting learning that stimulates student interest and their "need to know," we facilitate learning opportunities driven by problems that students are invested in solving.

What I hope I've been able to accomplish is to advance meaningful reform in our field, give voice to our teachers, and facilitate their professional growth in service of our students. My classroom teacher colleagues and my project collaborators have been my guiding light since my earliest teaching days and continue to sustain my passion for supporting advancements in our field.

Thank you, Dr. Hacker for your service to the technology and engineering profession and for sharing some of the highlights of your career. Your work and influence have and will continue to guide the profession.

It is beneficial for current (and future) leaders to read about the issues that existed and how they were addressed "back in the day." In a few months the next interview will appear in this journal. If you have a suggestion of a leader to recognize, contact Dr. Moye with that person's name and contact information.

Michael Hacker, Ph.D., DTE, *is Co-Director of the Hofstra University Center for STEM Research. He still carries around his soap boxes. He can be reached at Michael.Hacker@hofstra.edu.*

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