

Massoud Amin, director of the UofM's Technological Leadership Institute (TLI)

Bridge business/engineering skills gap to focus on key growth sectors

A Civic Caucus **Focus on Human Capital** Interview
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Present

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Summary

Minnesota must focus on industry areas where it can be excellent, according to Dr. Massoud Amin, director of the University of Minnesota's Technological Leadership Institute (TLI). Those are the foundational areas in which the state is really competitive: smart power and energy, security, sustainable water, sustainable agriculture, public health and the environment. Accomplishing such focus on Minnesota's major industry sectors will require shared responsibility between the private and public sectors. Amin says that to move through the stages of discovery, development and delivery in these critical areas of focus, we must forge alliances among key stakeholders and then collaborate with and execute through them.

Key stakeholders include government partners, who must supply government funding and research; academic partners, who must supply basic and applied research, and talent development; and industry partners, who must supply industry funding, technology transfer and commercialization, and talent deployment. He says we must find the "sweet spot" between basic research and industrial development.

He advocates a strong focus on energy technologies to develop and enhance electrical smart-grid capability in Minnesota. He believes smart grid benefits individuals, society, economic growth and the environment. He points out that Minnesota is sixth in the nation on smart-grid patents.

He discusses the important role of the TLI in developing human capital through its master's degree programs and short courses aimed at bridging the gap between business and engineering. These programs develop local and global leaders for technology enterprises and empower industry executives and leaders to leverage technology to drive business development. TLI offers three Master of Science programs: Management of Technology, Security Technologies and Medical Device Innovation. A fourth program, in energy technologies, will begin in 2016. TLI's graduate-program alumni and alumni of its short courses work in over 400 different businesses, mostly in Minnesota.

Biography

Dr. Massoud Amin, professor of Electrical & Computer Engineering, holds the Honeywell/H.W. Sweatt Chair in Technological Leadership, is a University Distinguished Teaching Professor, and, since March 2003, has served as director of the Technological Leadership Institute (TLI) at the University of Minnesota.

Amin works on enabling smart, secure and resilient infrastructures. He is chairman of the IEEE Smart Grid, serves on the board of directors of the Midwest Reliability Organization (MRO), where he chairs the hearing committee, and is chairman of the board of directors of the Texas Reliability Entity (TexasRE). From 1998 to 2003, Amin held several positions at the Electric Power Research Institute (EPRI) in Palo Alto, Calif. In the aftermath of 9/11, he directed all security-related research and development at EPRI as well as grid operations and planning, energy markets, and risk and policy assessments. During his tenure there, he led the development of over 24 technologies that were transferred to industry. He is considered by many to be "the father of the smart grid."

Prior to his time at EPRI, Amin was associate professor of systems science and mathematics at Washington University in St. Louis, where he was also associate director of the Center for Optimization & Semantic Control. He holds B.S. (cum laude) and M.S. degrees in electrical and computer engineering from the University of Massachusetts-Amherst and M.S. and D.Sc. degrees in systems science and mathematics from Washington University.

Background

As part of its current focus on Minnesota's competitiveness, the Civic Caucus invited Massoud Amin, director of the Technological Leadership Institute (TLI) at the University of Minnesota (U of M), to discuss the work of TLI in helping to resolve the state's current and future human-capital challenges.

TLI is a self-sustaining interdisciplinary center at the U of M, founded in 1987 with an endowment from the Honeywell Foundation. As a university-wide institute, it is housed in the U of M's College of Science and Engineering. Its mission is to develop local and global leaders for technology enterprises and to empower executives and leaders in their strategic vision to leverage technology to drive business growth. The TLI faculty includes seven professors who hold endowed chairs in-house and 64 senior faculty members from eight colleges and three centers at the U of M, industry executives and government leaders. The faculty members represent a broad spectrum of scientific, technological, business, law and social disciplines.

TLI provides three interdisciplinary professional graduate degree programs and is developing a fourth:

- Master of Science (M.S.) in the Management of Technology (MS-MOT), a four-semester program aimed at transforming engineering, science and other technical professionals into business leaders. In addition, a minor in management of technology is available to any graduate student at the U of M.
- M.S. in Security Technologies (MSST), a 14-month program designed to shape tomorrow's analytical and risk management policymakers and innovators. A minor in security technologies is offered to master's-level and doctoral-level students in related fields.
- M.S. in Medical Device Innovation (MS-MDI), a 14-month program designed to prepare students to anticipate, navigate and manage complex innovation challenges in the global medical-technology industry.
- M.S. in Energy Technology Innovation (name TBD), which will begin in 2016.

TLI also offers two programs at the undergraduate level, as well as short courses, in addition to tailored research and consulting services in the area of technological foresight, leadership and management. The Institute also offers customized management and leadership short courses for tech-based industries and organizations. Its 1,300-plus graduate-program alumni and 2,450-plus alumni of short courses are employed in over 400 enterprises.

Discussion

Research by MIT economist Robert Solow shows the transformative power of technology: it drives over 60 percent of the U.S. GDP. "Technology refers to any application of science, from physical to biological to mathematical sciences. This is the engine for our growth and innovation, particularly in Minnesota, which began with milling and has extended to high-tech in the last 150 years" said Massoud Amin.

TLI aims to develop leadership capacity in full-time technology employees in order to turn them into leaders and executives. Amin said TLI bridges the gap between business, policy, and engineering. Among

the 678 Master of Science in Management of Technology (MS-MOT) alumni, 34 percent have become executives within five to seven years after graduation and 54 percent have become senior managers.

The MS-MOT program requires a minimum of five years of work experience, including management. On average, MS-MOT students have been working for 10-13 years. All have bachelor's degrees, about 17 percent have master's degrees and about 10 percent have Ph.Ds. Most students are between ages 29 to their late 40s, with the oldest student so far at age 69. Amin said the MS-MOT program has about 30 graduates every year and retention and on-time graduation rates of 100 percent since 2006. There is a four-to-one male-to-female ratio in the program, which Amin said TLI is trying to change.

"We recruit all the time," Amin said. As an example, for the MS-MOT program, TLI gets 480 inquiries each year, although some are from overseas, which a very few are admitted, he said. The Institute encourages about 150-170 people to come to information sessions for each program. It then encourages about 35 or 40 people to apply for each program. Amin said he and a colleague interview in person all of the applicants for each of TLI's programs to make sure the program aligns with their long-term career vision and potential.

TLI's expertise is in an area that typically no single college or department can handle. For high-tech companies, business success is all about mastering the *gray zone* - that area of the company where business, engineering, science, technologies, and strategy and policy converge.

TLI's skill set includes technology foresight and forecasting, innovation, strategic management of technology, new product and business development, science and technology policy, and intellectual property. With an eye on helping high-tech firms maximize their growth potential, TLI shows high-tech companies how to move more adeptly within the *gray zone* by exploring ways to: assess and map technology strategies, maximize intellectual property assets, marshal technologies, stimulate innovation, commercialize ideas globally. Because of this, the Institute takes an interdisciplinary approach. It assembles faculty and programs from the U of M's College of Science and Engineering, Carlson School of Management and Humphrey School of Public Affairs among others. Amin said every endowed chair has deep industry and executive experience.

The founding of TLI followed reports in the early 1980s that the U.S. was losing its competitive edge. "Our high-quality manufacturing was falling behind Japan; we were under threat from the Soviet Union and other adversaries," Amin said. "At that time several reports, including *Made in America* by the MIT Commission on Industrial Productivity, were warning of an alarming slowdown in the country's productivity growth and a subsequent failure of American industries to compete globally. Among the reasons cited for this troubling situation was America's inability to turn R&D efforts into marketable new technologies. Another reason given was the failure of the country's educational institutions to properly prepare necessary human capital for this competitive, high-tech world," Amin noted.

"I had witnessed the same conviction in the United States and many established and emerging economies throughout the world: that the wealth of nations is not limited by land or minerals; it comes predominantly from 'the acquired abilities of people, their education, experience, skills and health,' according to Prof. Theodore Schultz, economist and another Nobel Laureate, in his 1981 book, *Investing in People: The Economics of Population Quality*. Closer to home, Minnesota was ranked number 1 in our nation in 1970 in the use of technology. Today, these trends persist combined with added global complexities and at a faster pace while many regions and nations have learned, adopted, and improved on our innovation model to power economic growth."

"To provide precise numbers, in the U.S. scientists and engineers working in R&D make up about 75 out of every 10,000 people employed. U.S. spending in R&D accounts for about 2.5% of the GDP, yet the results rippling outward from the investments in technology, and its related educational base, accounts for perhaps 50% of the past growth of the American economy. I don't mean to overstate the roles of science and

technology. But nations that invest in those fields of human capital do better economically than those nations that do not. This aspect also provides a strong foundation for our "soft power" to help improve quality of life across the world."

"MIT created the first MS-MOT program in 1981. However, in 2001, after 20 years of a world-class program, the MIT engineering faculty decided to move the program to MIT's Sloan School of Management. There, in 2003, the program became just a one-year fellowship. TLI's MS-MOT program, created in 1987, was the first in the nation at a public university. We remain committed to the same vision of developing leaders for technology-intensive enterprises in Minnesota and beyond that founded TLI.

"In Minnesota, the Honeywell Foundation and the University of Minnesota's College of Science and Engineering teamed in 1987 to address the challenges. Through a generous endowment from Honeywell Foundation, program planners led by the seasoned faculty and administrators from the College of Science and Engineering, with unique industry and academic leadership expertise, together with their counterparts from the Carlson School of Management, began crafting the vision for the Technological Leadership Institute (TLI) and its flagship Master of Science in the Management of Technology (MOT) program. Their goal was to create a graduate program that teaches full-time working professionals in technology-intensive sectors, to lead their organizations by traversing the frequently disparate functions of a company's technical and business micro and macro operations and strategies," Amin added.

By 1989, the University of Minnesota's MOT program was born and formally approved by the Graduate School, the Provost, and the Regents of the University, thereby becoming the first MOT program established at a public university in the United States.

TLI exists to develop leaders for technology-intensive enterprises. Technology is any application of science, not just information technology, Amin stressed. He noted that former Honeywell CEO Dr. Jim Renier, who serves on TLI's board, has said that it's easier to take scientists and engineers and teach them business and leadership than the reverse.

All of TLI's programs have to be academically excellent, industry-relevant, self-supporting, and aligned with mission of the U of M as a Land Grant University. Amin said each program needs a minimum of 22 students to break even. "We build programs to last, with a long-term view of Minnesota's strategic needs," he said. On that front, 98 percent of TLI's alumni are in Minnesota. It's a multi-pronged approach to talent development, to human capital development in Minnesota," Amin said.

"The mission and goals of all TLI programs, including the MOT program, are achieved by carefully selecting candidates through a rigorous interview and selection process, and developing in our students a comprehensive and applied "360-degree" skill set for leading in technology-intensive environments. This is combined with the highest standards for selection and retention of exceptional faculty and staff. Our program enjoys a vital ecology of innovation through a highly-supportive network including: 1) Leadership at the University of Minnesota and the College of Science and Engineering's Dean; 2) sustained positive impacts of MOT alumni and students in their organizations; and 3) stakeholders in the broader local and global community," he added.

He added: "In 2009, the International Association of Management of Technology (IAMOT) requested that the University's MOT program curriculum, along with programs at five other schools across the globe, be assessed and used as a basis to set worldwide curricular standards." As a result of the IAMOT accreditation evaluation, the following key elements of the MOT program were identified:

- **Industry focus:** The Technological Leadership Institute (TLI) was founded in 1987 with an endowment

from the Honeywell Foundation to develop leaders for technology enterprises. There has been a successful partnership with over 290 companies and numerous public and private organizations.

- Program content and credit distribution: The content and distribution of credits in the MOT program are: 1) Business foundation: 24% of total credits; 2) Strategic management of technology: 62% of total credits; 3) Leadership: 14% of total credits
- Technical oversight and ownership: TLI and the MOT program are within the University of Minnesota's College of Science and Engineering, a home to internationally-recognized faculty and research. Thus, the MOT program is primarily overseen by technically-oriented faculty while also benefitting from interdisciplinary contributions and collaborations with senior faculty from business, policy, and law.
- Admission requirements: At least five years of technology-based work experience (class average is approximately 12 years) and leadership potential or experience is required for admission. This requirement enriches the highly interactive classroom learning environment for both faculty and students.
- Accelerated, executive format: The MOT program schedule is based on an executive "lockstep," four-semester graduation schedule that allows students to maintain a full-time work schedule.
- Small class size, cohort structure, and study groups: Each year the 30-35 students in the class advance through the program as a cohort. Students are assigned to 4-6 member study groups. Both the cohort and study group structure of the MOT program directly affect the exceptional retention and graduation rates noted below.
- Faculty-to-student ratio: The class size provides an exceptional faculty-to-student ratio and the cohort structure and interactive classroom provide additional student-to-student knowledge gain.
- Responsiveness to student and industry feedback: The director of graduate studies meets monthly with class representatives to discuss potential program improvements. In addition, student evaluations of each class and instructor are carefully reviewed.
- Graduation rates: The program features lead to exceptionally high graduation rates. The MOT program graduates one class per year in the spring, with the retention and graduation rates of 100% since 2006.

Two-thirds of TLI students have deep technical expertise. "That part is absolutely necessary, but insufficient," Amin said. "Our program adds to that experience human leadership abilities, team abilities, conflict management, deep knowledge of business and innovation fundamentals, and value creation. Over the 21 months in the MOT program, we turn the students into innovation leaders."

TLI develops operational leaders through its M.S. programs in medical device innovation, security technologies, and, starting in 2016, in energy technology innovation. It develops strategic leaders through its MS-MOT program. "We are very focused, from the very beginning, on industry," Amin said.

He added: "One of the keys to success in dynamic technology-intensive industries is leadership agility, that is, the ability to anticipate or adapt to unpredictable circumstances and complex environments in ways that benefit both external and internal stakeholders. While some technological challenges are science and engineering problems to be solved, many of the challenges of innovation and profitable growth are complex dilemmas to be resolved with no single "right" answer. Agile leaders must master the "genius of AND" as they lead progress

by orchestrating an effective combination of continuity AND change to thrive given the dynamics in their external AND internal environments. Agility requires both cognitive intelligence AND emotional intelligence; technical expertise AND an understanding of organizational system dynamics; clear focus and direction AND the ability to adapt quickly and effectively in the face of pending or unexpected environmental change; confidence and conviction AND openness and humility. Effective technology leaders now have to be "deep generalists" with deep technical knowledge in one or more disciplines AND the business and people skills to build and adapt effective, adaptive organizations."

He added that "conflict is inherent in dynamic environments where "steady state" is not an option. The most effective leaders embrace conflict as a natural and expected part of progress, and as a potential source of innovative/disruptive ideas. They consciously engage key stakeholders early and often to intellectually understand and debate changes that are needed and acknowledge and manage the emotion or "psychological transition" that is inherent in the process of change. This ability to identify and actively engage key stakeholders in both the intellectual decisions AND the cultural/emotional transition that naturally accompanies change is a key differentiator of the best/authentic leaders in dynamic environments."

"As an example, our alumni's impacts in all aspects of our states' high-tech industries including instruments or medical equipment, security, energy and power, electronics, defense, chemical, industrial equipment, information, food, transportation areas, are outstanding. Their successes today are beyond expectations, thanks to the early visionaries who developed the MOT program over 25 years ago and to the high-tech leaders who continue to support it. Members of the TLI faculty continue to be among the "best of the best," as are the high-tech professionals who enroll in TLI programs each year."

The MS-MOT program costs \$74,000, inclusive of all books and materials as well as international travel.

During the 1990s, Amin said, the majority of students were supported by the companies where they worked. Now most companies do not feel the responsibility to fully support their talent pipeline, even though nearly all TLI alumni who were fully supported by their employers have remained with the sponsoring company assuming increased leadership roles. Currently, many organizations only offer support of around \$6,000 a year, which is required by law. He said many students not supported by their companies move on to other companies or some even become entrepreneurs on their own after completing the program. Nearly five percent of MS-MOT graduates eventually start their own companies."The MS-MDI and MSST programs, 14-month accelerated programs, cost about \$38,000 and \$34,000 respectively. However, these are also subject to similar financial burdens for our students."

Amin added "with regard to human capital investments, another important perspective is provided by Mr. Michael Wright (former COO/President of Entegris and author of an excellent book "the New Business Normal"). I recently accompanied Mr. Wright, who is a senior fellow at TLI, to Rochester to speak about global strategies for technological innovation coupling with science and engineering as an engine for positive growth opportunities in business and society. Because the pace of global change is accelerating, the long-term strategic view of business becomes a vital consideration. Rather than a traditional focus on maximizing short-term profits, the long-term view allows leaders to better consider the impact of emerging trends. They can then make the necessary course corrections to remain a viable player.

"As the world opens, the value of education continues to rise, and 'intelligence and knowledge workers' will play an even greater role in development of technological innovations and in the success of businesses. For leaders, the importance of knowledge means pursuing learning with a passion, since understanding the changing environment demands a constant stream of information and a tolerance for ambiguity and volatility.

"Enterprises and individuals that make the investment in research and development are in the position to advance and launch technological, process, and business innovations. I highly recommend reading the book

Ten Types of Innovation; the discipline of building breakthrough, by Larry Keely, on business process innovation. Increasingly, Wright says, technology developments will emerge from collaborations among coalitions of companies, universities, national labs, and government agencies. This 'open research model' allows companies to leverage assets. If you are innovative, you will find new directions."

Graduates of programs throughout the U of M's College of Science and Engineering have founded 4,150 companies still active worldwide. In a 2005 survey, with responses from 15,000 College of Science and Engineering alumni, 3,024 reported founding one or more companies, with 4,150 active companies worldwide, with global revenues totaling about \$90 billion, 2,600 of them in Minnesota. Those 2,600 companies employ 175,000 people in Minnesota and have annual revenues of \$46 billion.

Minnesota has three times the intensity of biomedical device innovation than other regions. "We generate more bang for the buck than anywhere else," Amin said.

There are four foundational areas in which Minnesota is really competitive:

- (1) the security area, including pandemics, food safety and cyber security;**
- (2) nanotechnology/biotechnology/information technology;**
- (3) sensors and controls applied to a wide range of applications;**
- (4) Energy and Clean Tech areas (including Smart Grid technologies, where we rank 6th in the nation in intellectual properties owned by Minnesota companies).**

"This is the legacy of Honeywell, Control Data, Cray Research and Medtronic," Amin said. The biggest 'bangs' have been in biosciences, medical devices, and health care, he said. On top are energy and power and agricultural technologies. These are all areas in which Minnesota has strong foundations."

The faster you can gather, collate and synthesize information, the more successful you will be. Amin said we must figure out how to enable kids to access real information and to develop the ability to communicate, think critically, and to analyze data. "That's what's missing," Amin said.

Minnesota could be world class in nano-based smart-sensor technology in the fields of smart devices, med-tech, security, energy and agriculture. Amin said innovations coming out of the U of M have huge potential for the future.

Minnesota needs an about-FACE: Focus, Alignment, Collaboration, Execution.

- **Focus on areas where we can be excellent.** Those include: smart power and energy, security, robotics and automation, advanced materials, sustainable water, sustainable agriculture, public health, and environment, Amin said. "We need diversity in our economy, and to enable progress in a strategically risk-managed approach, choose a few well-aligned vectors of innovation and growth. Don't just focus on one area, as the Silicon Valley and Route 128 near Boston did in the 1960s through the last decade, while successful but subject to boom/bust cycles" he said.
- **Align key stakeholders.** Amin said that in order to move through the stages of discovery, development and delivery in the critical few areas of focus, we must forge strategic alliances among key

stakeholders: government partners, academic partners and industry partners.

- **Collaborate and Execute through these key stakeholders:**
 - Government and foundation partners, who must supply government or mission-aligned funding for education, research, and development;
 - Academic partners, who must supply basic and applied research and talent development; and
 - Industry partners, who must supply industry funding, advice, technology transfer and commercialization, and talent deployment.

Amin described a "Valley of Death," where, for several decades, there has been a rapidly increasing gap in the funding for and execution of basic research and of applied research and development. To correct this, he said government agencies and labs and universities must invest in and carry out not only basic research, but also applied research. Additionally, they must reduce red tape and engage a much wider range of stakeholders, from different backgrounds of gender, race, sexual orientation, and socioeconomic status, to become players in this global competition. Industry. Meanwhile, we must also supply advice and potential funding for basic research, and certainly for applied research and development. "We must find the sweet spot between basic research and industrial development," he said. "Look at every innovative organization; that's what they do, and that is not limited by national origin, race, gender, other factors that often divide us. It is about asking, "why not?"; it is about intellectual curiosity, persistence, resilience, honesty, gumption and passion, to create and bring positive change to the world."

More of the same is not an option, if long-term relevance matters. "If we always do what we've always done, we'll always get what we have always gotten" Amin said. Rather, he contends, the U of M must engage in a process of due diligence to see what can be improved in its development of technology.

The U of M would like to partner with the Minnesota Colleges and Universities (MnSCU) system. In fact, Amin pointed out, TLI has created a cyber-security course for seniors and graduate students in partnership with the U of M and Metropolitan State University, a MnSCU institution. Each university will be allotted 15 students for the course. "TLI is more agile by design," Amin said. "as a UofM interdisciplinary unit, partnership is our primary mode of operation and thus we're not bound by traditional constraints."

Accomplishing the focus on Minnesota's major industry sectors will require shared responsibility between the private and public sector. Although it might seem good to have one person as the coordinator or leader, Amin said, we need this shared responsibility. "We have the opportunity to create clusters together," he said. "But we need innovative partnerships with business and foundations."

The area of energy technologies would be a good place to start. Amin said this effort must engage the U of M, 3M, Siemens, Cummins Power, Eaton, Honeywell, and energy/utility/telecom stakeholders in the public and private sectors, among others, in pushing forward the development of smart-grid technologies in Minnesota. A smart grid is a modernized electrical grid that uses digital information and communication technology to gather and act on information, such as information about the behaviors of suppliers and consumers, in an automated fashion to improve the efficiency, reliability, economics and sustainability of the production and distribution of electricity.

The overlay of sensors, communication, automation and security in a smart grid, Amin said, improves the electrical system's resiliency, reduces outages, reduces cost to customers and enables integration of renewable resources. "Smart-grid technology makes the whole system work better and smarter in a proactive

way," he said.

Every dollar spent on developing smart-grid capability generates \$2.30 to \$6.00 in economic activity.

Amin said smart-grid technology reduces power outages, which cost \$80 billion to over \$180 billion across the country. He pointed out that the upper Midwest has 92 minutes of outages per customer per year, which is the lowest in the country. These outages are only those caused by system failure or human failure; they don't account for outages caused by extreme weather or natural disasters.

He said smart grid reduces the lower end of the cost of outages by \$49 billion a year nationally. It reduces CO2 emissions by 12 to 18 percent by 2030, and improves efficiency by about 4.5%, saving another \$20.4 billion a year.

"Smart grid benefits the individual, society as a whole, our national/energy/environmental security, and it enables economic growth, as the U.S. DOE Smart Grid Investment Grants (SGIG) across all fifty states over the past four years, have proved," he said.

Minnesota is sixth in the nation on smart-grid patents, but we need a more formal organization to move these ideas forward.

"The growth opportunity is huge in smart-grid technology," Amin said. "We have the capability to be a leader in this area." He said smart-grid development and technology could create 60,000 government jobs and even more private energy security jobs in Minnesota in the next three to five years.

"We spend more in dog food research than in electrical power research," Amin said. "People don't focus on smart grid technology, because we are victims of our own successes in other areas. We are too focused on the past, as most mature industries and societies tend to be."

The consequences of not focusing on our strengths will be an aging workforce, no economic growth, lower population and a lower birthrate. Amin pointed out that milling was the original impetus for the development of automation in Minnesota. "We should focus on the big challenges that really matter, while realistically assessing their short-, mid- and long-term benefits," he said. "We must ask, 'What difference can we make globally? Where are the areas in which we can be excellent? As George Day taught us, we must ask ourselves 'is it real, can we win, and is it worth it (RWW)?' If so, we must judiciously align our efforts and resources with those few vectors of innovation and economic growth while regularly and transparently assessing progress toward our objectives."

Developing smart-grid technology is one way to move forward on the broad collaboration we need to focus on the important industry sectors in Minnesota. Amin said we should take a two-pronged approach:

1. Follow-up on the October 2014 report of the state's Clean Energy and Economic Development Initiative, a cross-agency, industry-focused project to develop a strategic plan of action to align state economic development and clean energy development strategies and policies. The report, *Minnesota Clean Energy Economy Profile*, names smart grid as the number-one priority in this strategy. The state and industry should do four pilot smart grid projects in Duluth, Rochester, Morris and either in a portion of the Twin Cities or with electrical cooperatives elsewhere in the state. The projects would be aimed at creating smart, secure and green micro smart grids.

2. Connect and engage with people of all ages and backgrounds to help them understand the technology and the benefits of smart grid development. This is important to develop and sustain a capable, smart, and confident pipeline of individuals from kindergarten to post-retirement.

Use smart grid as the moon shot was used in the 1960s. Amin said we must develop many paths of

innovation and a "can-do" attitude to move smart grid technology forward in Minnesota and beyond to the global market.