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WORKING FOR AN INNOVATION DEAL USA IN THE 21ST CENTURY
TRABAJANDO POR UN TRATO DE INOVACIÓN EEUU EN EL SIGLO XXI
为实现 21 世纪美国创新之政而奋斗

HISTORY OF THE VISION

by Edward Locke (Gosingga-Daicin Mergen-Dasan Sakda)

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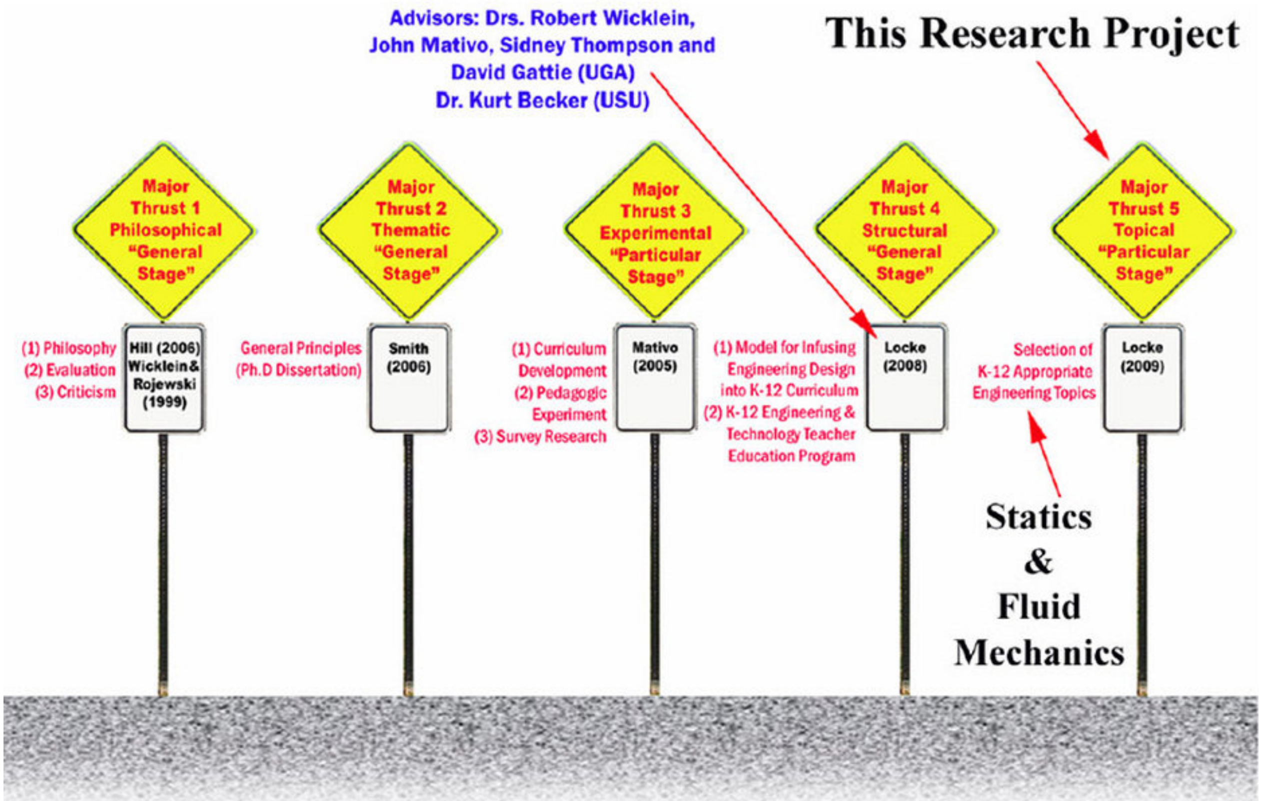


The Proposed Model for K-12 Engineering and technology Education is NOT the product of my personal "genius," but a critical step in the continuum of research and development work completed by many scholars and professionals in the field. This illustration shows the endeavors and contributions of professors and scholars at the University of Georgia, which have laid a solid foundation for my own research on the issue. In fact, the only major contribution that I have made is the concept of "pre-calculus level engineering topics," which provides a criteria for the selection of K-12 "age-possible" engineering knowledge content.

The publication of my Vision Paper, its inclusion on the website of the Institute of Educational Sciences, the research arm of the United States Department of Education, and the development of this website, are outcomes of a long journey of my personal struggle, the assistance of others who helped me with great generosity, and inspiration of other professionals in the field of STEAM education.

My immigration to the United States and start of STEAM career and teaching at Santa Ana College

I came to Los Angeles, California, with an F-1 Foreign Student Visa on October 28, 1986, and became a Citizen of the United States in 2000. I studied Industrial Product Design, a hybrid program that combines arts and design with engineering drafting technology, and graduated from

California State University Northridge in 1994 with lower-division courses transferred from Los Angeles Valley College, Los Angeles City College and Los Angeles Pierce College. I then started to work as a designer for several companies and institutions as well as local clients.

Back in the Fall Semester of 2000, I was recruited by Professor Susan Sherod, Chair of the Engineering Department at Santa Ana College as a part-time instructor and started teaching engineering graphics; I then started a career of teaching engineering technology. At Santa Ana College, I received generous help and advice from supervisors and colleagues, including Professor Don Deely, Professor Susan Sherod, Professor Ralph Caldin, Patricia Waterman, Mike O'Louphlin and others. I also took courses from several professors to increase my teaching capabilities, at several community colleges in Southern California, including Santa Ana College, El Camino College, Pasadena City College, Los Angeles Trade-Technical College, Cerritos College, Los Angeles City College and East Los Angeles College. My course works cover mechanical engineering, computer animation and digital arts. They are all related to industrial product design, an interdisciplinary program of study integrating arts and technology.

My graduate studies at CSULA and enrollment in engineering and technology programs at local community colleges

While teaching part-time and occasionally working as a free-lance designer, I pursued my graduate studies at California State University Los Angeles, in the Department of Technology, College of Engineering, Computer Science and Technology, and graduated in 2007 with a Master of Arts degree in Industrial Technical Studies. My graduate thersis/project include a college-level textbook on using 3D modeling tools in Autodesk Inventor to solve engineering descriptive geometry and sheet-metal design problems, which is now available online at my SuniSea Products website (the URL of the hosting page is http://suniseaproducts.weebly.com/free-online-descriptive-geometry--sheet-metal-design-textbook.html). This textbook includes many learning modules with step-by-step instructions on using 3D modeling and Flat Pattern as well as other tools to solve descriptive geometry problems with 3D CADD technology, which previously required tedious procedures of primary, seciondary and tertiary auxiliary views, and thus, can help engineers and designers to save time by about 50%. I was told by a librarian of John F. Kennedy Library at California State University Los Angeles, that my thesis/project, which is more than 1,000 pages and bounded in three books, is the longest among all Master's degree thesis at California State University. The completion of this thesis/textbook project also gives me an opportunity to learn how to develop textbooks for college and high school students.

In addition to my graduate studies at California State University Los Angeles, I started to take courses in CADD (computer-aided drafting/design) using AutoCAD, Inventor, CATIA, SolidWorks and SolidEdge, 3D modeling and animation using Maya and 3ds MAX, as well as mathematics, chemistry, physics, and mechanical engineering courses leading towards a Bachelor of Science degree in Mechanical Engineering, at the above-mentioned local community colleges in Southern California. These course works gave me a systematic professional training on digital technology for industrial product design and presentation, and for 3D modeling and 2D drafting related to mechanical engineering, which substantially improved my ability to teach engineering design technology and to pursue a career in consumer product design. In addition, my course works in mechanical engineering have prepared me for my research for the development of a K12 engineering curriculum, which is the mission of this website.

My selection as a NCETE (National Center for Engineering and Technology Education) Fellow and the birth of a dream

In 2007, while completing my Master's degree in Industrial Technical Studies at California State University Los Angeles, I was encouraged by Dr. Don Mauruzio and Dr. Virgil Seaman to apply for a National Center for Engineering and Technology Education Doctoral Fellowship, The goals of the Center include (1) conducting research to define the current status of engineering design experiences in engineering and technology education in grades 9-12; and (2) building leadership capacity by developing a collaborative network of scholars who work to improve understanding of the process of learning and teaching of engineering design in technology education. I am proud and humble of being one among a total of 18 scholars chosen for the program. I resigned from my part-time teaching position at Santa Ana College and joined the program and went to the University of Georgia to pursue my graduate studies at the College of Education. During that time, I know that enrollment at engineering and technology undergraduate programs by domestic students in American universities was in decline; thus, I was dreaming about a way to reverse this trend by making high school students better prepared for university-level engineering programs, by introducing them to engineering and technology starting at K12 level. Based on my previous course works in lower-division engineering studies, I found out that a substantial portion of topics in lower-division engineering courses, such as statics, strength of materials, material science, engineering economics and others, only require pre-calculus level mathematics skills and high school level knowledge in physics and chemistry as pre-requisites. Thus, I came up with an assumption that some of these topics could be tried at high schools through pedagogic experiments to determine their suitability for K12 students. If high school students could master some portions of engineering knowledge content that are traditionally covered at college and universities, this could facilitate high school graduates' initiation into college-level engineering programs, and thus, possibly increase the number of domestic students enrolled in engineering programs in American universities.

At the University of Georgia, I took a variety of graduate courses that help me to understand the theories and practices of K12 engineering and technology education. In addition, I studied educational philosophy, leadership models, and issues of race or ethnicity, gender and social classes in K12 engineering and technology education, All of these have built a solid foundation for my attempt to propose a possibly viable model for the incorporation of engineering content knowledge into K12 curriculum, As quoted in my research projects, advocacies, practices and research outcomes of many well-established scholars have profound impact on my endeavors. The most important of these include Dr. Robert Wicklein's idea of using engineering design to bridge mathematics and science, Dr. John Mativo's Animatronics pedagogic experiment at Ohio State University, Dr. Roger Hill and Dr. Jay Rojewski's analysis of the conditions of education in the United States. In addition, I got a solid professional training in currivulum development from Dr. Betye Smith's courses.

A fundamental shift of paradigm in my understanding of human progress

At the philosophical level, the friendly but sometimes controversial debates about race, ethnicity, class and other social issues as they relate to educational system in the United States with professors and other graduate students, including African-American scholars, such as Deborah William, have all broaden my perspectives, pushing me to move beyond my previously well-maintained paradym of Adam Smith economics, John Dewey's model of pragmatic American education, Winston Churchill's model of international system, free enterprise, free trade and Globalization, and others that I believed to be the best essence of Anglo-American civilization, to accept a more critical but re-constructive framework for human progress integrating economic growth with concerns for social justice, ecology, peace and harmony among the nations, and application of appropriate technologies. In Dr. Robert Wicklin's class on educational leadership, the model of servant leadership has been discussed. The Seven Pillars Of Servant Leadership (Leader Serve Model) include the following items:

1. A Person of Character (maintains integrity, demonstrate humility, serves a higher purpose)
2. Who Puts People First (displays a servant's heart, is mentor-minded, shows care and concern)
3. Skilled Communicator (demonstrate empathy, invites feedback, communicates persuasively. "If you want to be listened to, you should put in time listening"- Marge)
Piercy)
4. Compassionate Collaborator (expresses appreciation, builds teams, negotiates conflict)
5. Has Foresight (visionary, displays creativity, exercises sound judgment)
6. Is a System Thinker (comfortable with complexity, demonstrate adaptability)
7. Leads with Moral Authoriry (granted by others)

The above have been used as a general ethical framework in the development of my Vision Paper and in the gradual implementation of the vision. In my understanding of the model of servant leadership, a leader should be one who look at the situation from a holistic perspective, taking into account all factors involved, the past, existing and future interests of all parties concerned, one who is respectful of the traditions and heritage of the people while courageously working towards the renewal of the existing conditions. I myself subscribe to the eclectic philosophy of progressive-conservatism, which allows time-proven traditions to be continued through continuous and gradual self-renewal, such that, quantitative changes smoothly but eventually evolve into a genuinely revolutionary change that offer all parties concerned a win-win arrangement. A genuine leader should be non-partisan, unbiased and placing the interests of the whole society above the interest of any particular social class, institution or ethnic group.

Another concept that has great impact on my philosophical thought is the concept of appropriate technology, a topic of writing and lecture by Dr. Robert Wicklein. Prior to my graduate studies at the University of Georgia, I am basically a believer in modern Western-developed technology, convinced that technological progress could improve human conditions with no stop. By taking Dr. Wicklein's classes, I have to agree that in reality, technology alone does not guarantee human progress; it is the appropriate use of appropriate technology that does the job. This new understanding is important, and it has been achieved through fierce debate with other scholars and intense internal soul searching.

The impact of existing models of K12 engineering and technology education

During the International Technology and Engineering Educators Association's 71st Annual Conference held in Louisville, Kentucky (2009), two participants from Australia presented their country's model of K-12 engineering education. From my understanding, theirs is basically based on traditional essentialist pedagogy, emphasizing formula-based computational skills, but include some design projects as well. In Australia, some states also have established clearly-defined standards for K12 engineering knowledge content. By comparison, popular models of K12 engineering education in the United States, such as Project Lead the Way and Engineering by Design, is using "project-based learning" pedagogy that focus on context of design project, not on the study of a well-connected body of scientific principles and formula-based predictive computational skills; thus, students graduating from these programs do get interested in engineering from hands-on experience, however, what they learn has little connection to engineering courses offered at college level. In addition, these models have little connection with the way mathematics, physics, chemistry and other science courses have been taught in K12 classrooms. Many teachers at high schools and colleges that I have personally met complained that these programs have been developed not by teachers with years of pedagogic experience, but by "outside" commercial firms "looking for marketing opportunities", and that they "have nothing or little to do with real engineering education."

It is hoped that many ideas explored in the Vision Paper could provide answers to the problems in the current practice of K-12 engineering education using the above-mentioned popular models, as discussed in the authoritative report issued several months later, on September 8, 2009, by the Committee on K-12 Engineering Education established by the National Academy of Engineering and the National Research Council, titled Engineering in K-12 Education: Understanding the Status and Improving the Prospects, which included the absence of cohesive K-12 engineering curriculum and the lack of well-developed standards, issues that have been already addressed in the

Vision Paper.

In my personal opinion, one of the most serious shortcomings of the existing "project-based-learning" type of K12 engineering curriculum, besides the absence of cohesiveness and lack of standards, is its disconnection from the reality of K12 system and its time-proven pedagogic traditions. Students at K12 level are struggling to master the basics of mathematics, physics and chemistry, have no basic understanding on how things work in engineering; yet some of the programs expect them to do "engineering design," in a "trial-and-error" manner, which is not only beyond their level of cognitive maturity but also a waste of time. Instead of "engineering design," simple projects of everyday consumer product design using CADD software might make more sense. While recognizing that the above critical comments made by engineering faculty at grass-roots as well as the authoritative evaluation made by the report of the Committee on K-12 Engineering Education established by the National Academy of Engineering and the National Research Council, titled Engineering in K-12 Education: Understanding the Status and Improving the Prospects are valid in most aspects, I believe that the above popular American models do have great merits in terms of (1) assembling relevant skill sets into learning projects, and this could be an important component of K12 engineering learning process; and (2) getting high school students interested in pursuing engineering careers, although things learned in the programs have very little connection to college-level engineering courses. Besides these "project-based-learning" models, there are chartered schools that try a variety of approaches including traditional essentialist pedagogy. At Gwinnett School of Mathematics, Science and Technology, a chartered school that allows flexibility for design of curriculum and schedule to facilitate its own vision, Dr. Chuck Lockert pioneered teaching real topics of engineering in a more organized way to K12 students. From my personal visit to his classrooms, it is obvious that students do learn real skills that are connected to engineering teaching at college level.

It is obvious that for a viable K12 model of engineering education, a balanced approach is needed. On the one hand, traditional essentialist approach in mathematics and science courses should be preserved; on the other hand, John Dewey's pragmatic approach and project-based learning do have a role to play as mid-term or final projects, and as whole semester-long courses in the graduating year. My Vision Paper fully describes this balanced approach in a futuristic model of K-12 engineering and technology education, which tries to integrate all realistic and positive elements from previous model, using three strategic ideas or conceptual frameworks to link everything together:

(1) **Pre-calculus mathematics as criteria for pedagogic experiment**: We could assume that, because engineering is basically applied science and that the learning of science (physics and chemistry, etc.) is based on the mastery of mathematics skills at different grade levels, that at high school level, most students already mastered pre-calculus level mathematics skills, therefore, we could identify those engineering topics from the traditional college level engineering textbook, try them out in high school classrooms through pedagogic experiment (preferably at chartered schools), compare the high school students' learning outcomes with those of the college students, and thus, test the suitability of the topics for inclusion into high school engineering and technology curriculum.

(2) **Disadvantaged school districts as the launching ground**: Despite of all remedial policies such as Affirmative Actions and Federal or state assistance, we still have a lot of school districts that are economically, culturally and academically disadvantaged; and due to complicated reasons, this disadvantage is unlikely to disappear soon. The development of K12 engineering and technology curriculum is relatively new, and it will take a long period of time to get things done in a correct manner. In order to make sure that whatever engineering topics need to be included in high school curriculum, they would be widely applicable to the majority of America's K12 students, regardless of economic status, cognitive ability and past records of actual academic performance, we would be better off trying them out at a few carefully selected disadvantaged school districts first; if they can be mastered by disadvantaged students, then we could assume that they could be equally or more comfortably mastered by students from advantaged school districts. This assumption is more or less based on "common sense". After we try the selected topics across all selected schools, we could then compare the outcomes and develop strategies for remedial actions for those "difficult" topics that students from better-performing school districts could master, but students from disadvantaged school districts fail to do so.

(3) **Community colleges as the strategic linkage**: The community college system is one of the greatest institutions of higher learning that has contributed to America's scientific and technological development. It makes higher education widely available to average citizens and provide an economical instrument for life-long learning. All developed countries have "high end" institutions of higher education, however, the community college system in the United States makes the nation unique in terms of making higher education affordable to all. In engineering and technology education, East Los Angeles College's Engineering Department offers a variety of

Associate in Science degrees, Certificates of Completion, "2 + 2 Transfer" programs, which greatly facilitates students' chance to succeed in academia. Community colleges could play an important role linking K12 system with four-year universities. In addition, compared to four-year universities, they are more flexible offering new courses related to emerging technologies such as CADD (computer-aided drafting/design). Four example, for an engineering design software such as CATIA, SolidWorks, or AutoCAD, four-year public universities usually offer one course, but community colleges could offer three to four courses, to allow students to get more detailed and extensive training.

The publication of my Vision Paper

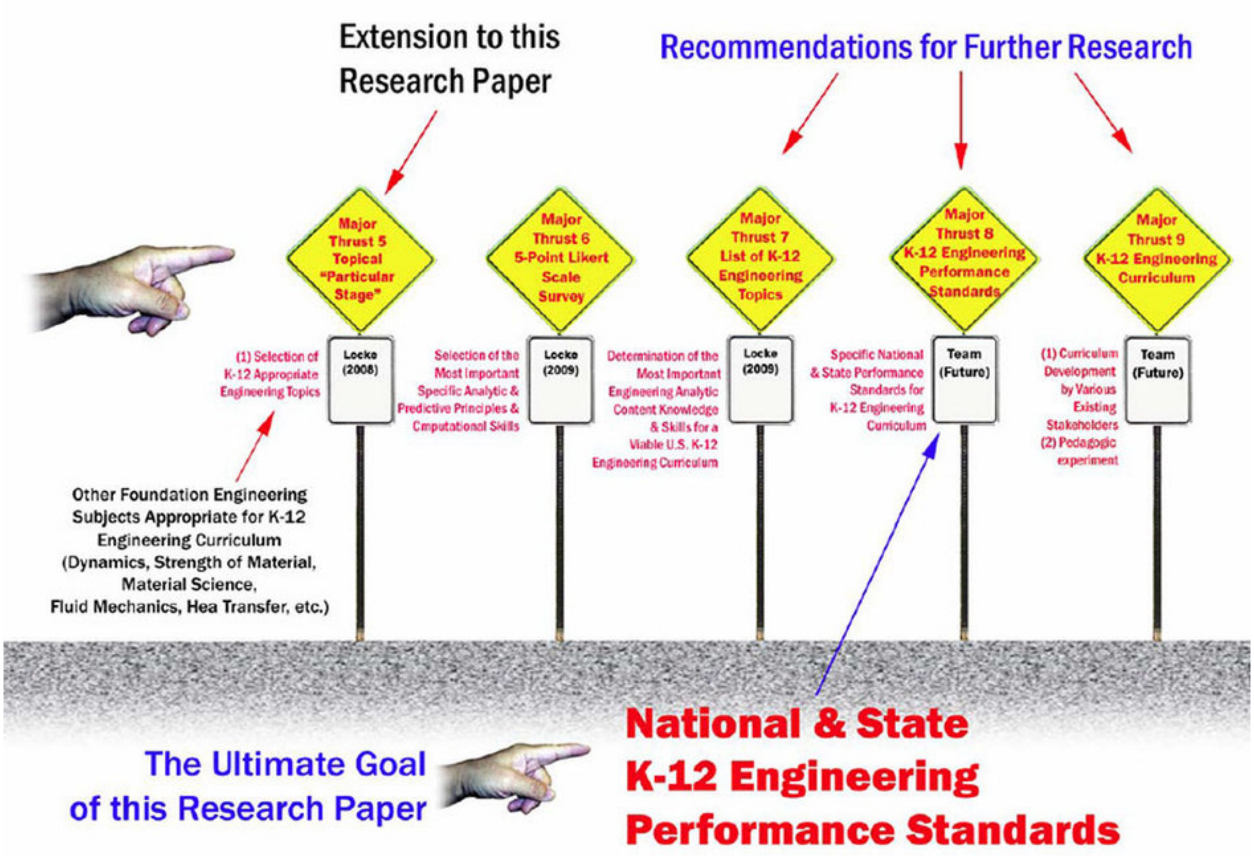
The basic frameworks and methodologies used for the formulation of the Proposed Model for a Streamlined, Cohesive, and Optimized K-12 STEM Curriculum with a Focus on Engineering have been constructed during my graduate studies at the University of Georgia. They haves been presented to professors at the College of Education and the Driftmier Engineering Center, including Dr. Robert Wicklein, Dr. John Mativo, Dr. Roger Hill, Dr. Myra Womble, Dr. Sidney Thompson, and Dr. David Gattie, ant to the State of Georgia Department of Education officer Mr. Ron Barker, to Mr. Gary Guan, a leader of the State of Georgia Republican Party, and to Dr. Chuck Lockert, a pioneering K12 engineering teacher at The Gwinnett School of Mathematics, Science and Technology; they either offered friendly and constructive criticism or encouragement and advice. I have visited the Gwinnett School of Mathematics, Science and Technology and was impressed by the achievement there in teaching high school kids real-world engineering topics. I also highly appreciate Mr. Ron Barker's encouragement; we have met twice, once at the University of Georgia, and the second time at his office at Georgia Department of Education. In September 2009, right after my graduation from the University of Georgia with an Education Specialist degree, I got an accident and injured my left hand; during my recovery, I wrote my Vision Paper and got it published in *The Journal of Technology Studies*, a peer-reviewed scholarly journal associated with Virginia Institute of Technology (Winter 2009 Issue No. 2).

After II returned to Los Angeles, I presented my ideas to local engineering and science professors; Professor Jose Ramirez and Professor Kamyar Khashayar at East Los Angeles College are the first to provide political and administrative support, Professor Artin Davidian, Professor Humberto Gallegos at East Los Angeles College, and Professor Miguel Moreno at Los Angeles Trade-Technical College, a former NASA Scientist, are the first to support my ideas.

The selection of Linus and Social Enterprise models for the implementation of the Proposed Model for a Streamlined, Holistic, Cohesive, Optimized, Life-long, Adaptive and Re-adjustable K-12 STEAM (SCHOLAR K-12 STEAM) Curriculum with a Focus on Engineering

Proposed Model for a Streamlined, Cohesive, and Optimized K-12 STEM Curriculum with a Focus on Engineering, now including an arts component to be called "K-12 STEAM (science, technology, engineering, arts and mathematics) Curriculum" because arts, and especially applied arts or design, is an important component of innovative education to translate scientific, engineering and technological achievements into everyday consumer products, could be better realized through the Linux and Social Enterprise models, in terms of its research on possible topics and development of FREE online instructional materials, initial financing for pedagogic experiment and application to K12 settings across the Nation. The details of this implementation process could be found in the Planning & Progress Report of this website. Central to the adaptation of the Linux and Social Enterprise models in the gradual implementation of the SCHOLAR STEAM K12 Plus Project is the integration of volunteering and grant-based research, of potential funding from the government and the eventual establishment of an independent foundation for its financing at local level.

Drawing valuable references from the Linux and Social Enterprise models, the development of the Streamlined, Cohesive, Holistic, Optimized, Life-long, Adaptable and Re-Adjustable K12 Engineering and Technology Curriculum will incorporate the following vital component: (1) volunteer works of dedicated professional; (2) volunteer works of students from under-represented minority groups, such as members of the student chapters of the National Society of Black Engineers (NSBE), the Society of Hispanic Professional Engineers (SHPE), the Society of Mexican-American Engineers and Scientists (MAES), American-Indian Science and Engineering Society (AISES), and the Society of Woman Engineers SWE); (3) research projects and pedagogic experiments financed by grants from government and private sources; and (4) support from non-profit organizations, civil groups and corporations.



This illustration shows the proposed step-by-step implementation plan for the Proposed Model for K-12 Engineering and Technology Education, as explored before I graduated from the university of Georgia in 2009.

East Los Angeles College, a successful model of engineering, technology and art education, with an extensive outreach to local K12 schools

My experience with community colleges in Southern California is very positive. I am especially impressed by two programs offered at East Los Angeles College. One is the engineering program led by Professor Jose Ramirez, the Department Chair. Over the years, the Engineering Department at East Los Angeles College has developed one of the most comprehensive set of Associate of Science degrees, Certificates, and "2 + 2 Transfer" programs which allow students to complete all required course works for the first two years of their undergraduate engineering programs at East Los Angeles College, be certified, and then transferred to four-year universities to complete their degrees, starting right at the third year. These "2 + 2 Transfer Programs" lead students towards many Bachelors of Science degrees in many engineering and technology fields, including Industrial Technology with

Emphasis in Manufacturing/Design or in Electronics, Electrical Engineering with Specialization in Computer Engineering, Civil Engineering, Engineering with Specialization in Manufacturing Engineering, and Mechanical Engineering. In addition to the above offerings, the Engineering and Technology Department at East Los Angeles College is also very active in outreach to local high schools. Professor Jose Ramirez, Professor Kamyar Khashayar, and Professor Artin Davidian are actively promoting engineering curriculum at local high schools. Professor Humberto Gallego came up with an English-as-a-Second-Language to Engineering Pathway Program to help first generation immigrant students to enroll in engineering programs.

The other is a set of Associate of Arts degrees and Certificates in Multimedia, Animation, Desktop Publishing, and Arts Graphic Communications offered at the Art Department, which feature industry-standard software (Photoshop, Illustrator, InDesign, Flash, Fontographer, AfterEffects, Premiere and Maya), and courses designed for real-world professional practice.

The idea of "2 + 2 Transfer" has persuaded me that the community college system could offer great hope for improving engineering education in the United States; and I believe that the application of the most current version of industry-standard software is of vital importance in this process.

East Los Angeles College has a very diversified student population coming from many different ethnic backgrounds, including Latin, African, Caucasian, Chinese, and many other "hyphenized" Americans and International students. The successful engineering and technology programs at East Los Angeles College contributes to the increase of the number of under-represented minorities in the fields of engineering and technology.

When I returned from Georgia to Los Angeles, California, I enrolled in mechanical engineering and graphic design courses to get myself ready for the development of online K12 level engineering instructional materials. I started to discuss ideas about a pre-calculus level K12 engineering curriculum with professors of the Engineering and Technologies Department. They generously offered advice and support. Professor Jose Ramirez, the Department Chair offered his managerial and organizational skills in establishing a network of local schools for the endeavors, Professor Kamyar Khashayar offered valuable advice on K12 engineering curriculum, Professors Artin Davidian, Humberto Gallegos, and Hrair P. Shekerjian also offered valuable encouragement. In addition to support from Engineering and Technologies Department professors, some administrative staff also offered help; they include Mrs. Mariá Eléna Yepes (Learning Assistance Center Director), Ms. Elizabeth Arroyo (Learning Assistance Center Instructional Aide), and Ms. Maria Calpito (Resource & Institutional Development Specialist). With the support from Professor Jose Ramirez, I wrote the first draft of a grant proposal for the 2012 Discovery Research K12 Grant from the National Science Foundation; the Engineering and Technology Department held a one-day meeting for its refinement at technical level, Mr. John Rude (RIDO Grants Director) at East Los Angeles College Administration added the budget plan and get the approval from the top leaders to submit the grant proposal (NSF-STEM Engineering Pilot Study, No. 7227154/1223114, January 11, 2012). Although the proposal did not get approved, I have decided to continue research on the issue, especially the first part of the grant proposal, which is to initially determine and select K12 age-possible engineering topics from selected textbooks currently used in college-level undergraduate engineering programs. This is done on the basis of revised versions of the Linux and Social Enterprise models, which integrate volunteering with small grants. The outcome of this research led to the creation of this website.

Freedom and opportunities! You will have the right to a high quality K12 science, technology, engineering, arts and mathematics (STEAM) education!

¡Libertad y oportunitades! ¡Usted va a tener el derecho a una K12 educación de alta calidad en ciencia, tecnología, ingenería, artes y matematica (CTIAM)!

自由和机会！你们将拥有接受高质量的、贯穿幼儿园到中小学阶段的科学、技术、工程、艺术和数学教育的权利！