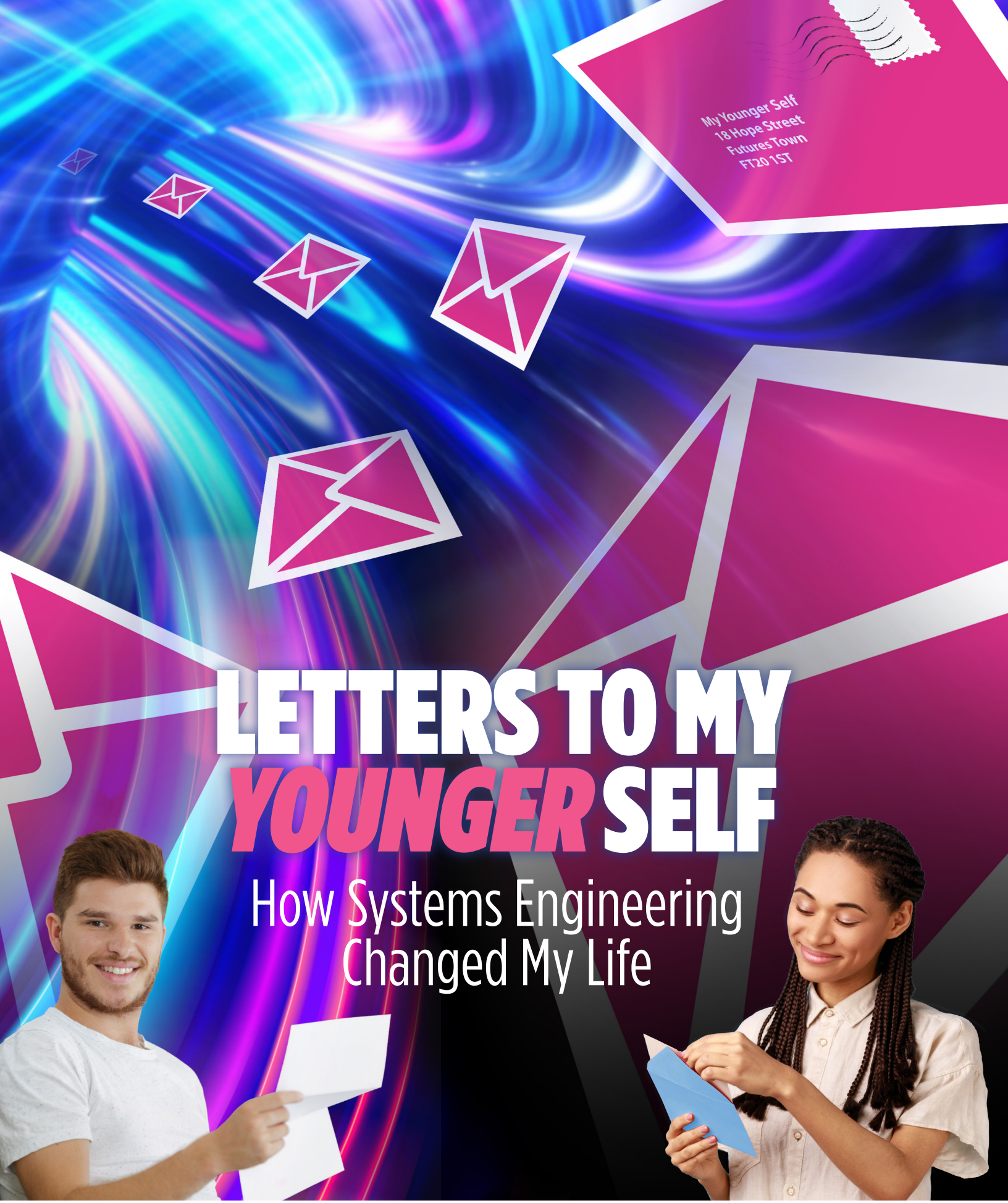


LETTERS TO MY *YOUNGER* SELF

How Systems Engineering Changed My Life

Editors: Alice F. Squires, Lisa Hoverman, David Long

Letters to My Younger Self

How Systems Engineering Changed My Life

Edited by Alice F. Squires, Lisa Hoverman and David Long

Proudly Sponsored By

As a Women-Owned Business, SPEC Innovations has made it its mission to encourage women to thrive in stem and leadership roles since 1993. SPEC Innovations is a leader in systems engineering services and software and is dedicated to investing in the future of women in systems engineering. We hope 'Letters to My Younger Self' encourages a new generation of women to come forward.

Cynthia Mahugh-Dam, CEO of SPEC Innovations

International Council on Systems Engineering (INCOSE)

This INCOSE Publication was prepared by the International Council on Systems Engineering (INCOSE).

ISBN 978-1-937076-09-2

Contents

06	**About the Publication**
07	**Foreword** by Kerry Lunney
08	**Dedication**
09	**Virginia Aguilar** *'Sueña en grande, trabaja duro'*
12	**Eileen Arnold** *'A Journey of Passion'*
15	**Heidi Davidz** *'Systems Engineering as a Natural Home'*
18	**William Donaldson** *'Thoughts About the Road Ahead'*
21	**Ian Gibson** *'All Change! The Ultimate Evolving Career'*
25	**Stueti Gupta** *'Be Uncomfortable with Comfort Zones'*
28	**Heidi Hahn** *'A Random Walk Through Life'*
31	**Cecilia Haskins** *'Oh, the Places You'll Go!'*
33	**Lisa Hoverman** *'There and Back Again: A System Thinker's Letter'*
36	**Randall Lliff** *'WB9IRF calling WB9IRF, Please Come In…'*
40	**Serge Landry** *'Shaping Your Journey Through Life'*
44	**Lefei Li** *'Our Wonderful 'System' Journey'*
47	**David Long** *'Looking from Technology and Parts to Humans and the Whole'*
51	**Kerry Lunney** *'Exploring Your World Through Systems'*
54	**Roger McCowan** *'Exploring the Exciting World of New, Novel, and Complex'*
57	**Dorothy McKinney** *'Experimenting to Kickstart Your Learning Journey'*
60	**René Oosthuizen** *'A Message to Younger ME - A Systems Engineering-Inspired Guide to Wisdom'*
65	**Erika Palmer** *'Systems at any Age'*
68	**Bill Parkins** *'Making the Connection: A Systems View of an Engineering Journey'*
71	**Ramakrishnan Raman** *'The Futurist's Dilemma'*
74	**Federica Robinson-Bryant** *'A Testament to Persist'*
78	**Ad Sparrius** *'"…we are what we repeatedly do. Excellence, then, is not an act, but a habit;" Will Durant'*
82	**Alice Squires** *'Making Your Place in the World'*
85	**Heinz Stoewer** *'Space Exploration and Systems Engineering, a wonderful challenge for a young engineer'*
88	**Celia Tseng** *'An Immigrant's Perspective'*
90	**About INCOSE and EWLSE**

About the Publication

About the Book

Are you thinking about what the future will be like? “What should I be when I grow up?” is a question we can ask ourselves at any age! While the path may wind and many adventures await along the way, systems engineering is one field that is open to those from many different disciplines including science, technology, engineering, and mathematics (STEM). This eBook is a compendium of letters from around the world, written from system engineers in the field to their younger selves, to give a glimpse into the life they have lived and the insights they have gained along the way. Please enjoy this diverse set of perspectives as to what it is like to be a systems engineer!

Acknowledgments

The editors would like to gratefully acknowledge INCOSE and its members for their support to publish this book, to the marketing team for their guidance and support, to the letter authors for taking on this new initiative and persisting through the many updates, changes, and requests over time, and to the associate editors: Virginia Aguilar, Roger McCowan, Bill Parkins, and Federica Robinson-Bryant for their excellent work. The editors would especially like to thank those, both now and in the future, who have shared in the enthusiasm to get the word out about the importance of this endeavor.

Foreword

There are many pivotal moments in one's life but often without reflection, they may remain unrecognised. What a loss this could be! In the world of systems engineering, interactions are vital for the success of a system. So too, is the sharing of wisdom gained and experienced earned by those who enable these solutions.

This book is a wonderful collection of letters written to a younger self. As one of these authors I found the experience quite cathartic, making it possible to accentuate the positive aspects of my journey in the world of systems. In writing to "teenage Kerry", I realised I gained so much more than I had thought, including those moments that were not so spectacular. Each event by itself may not have been memorable, but collectively I can now see the small ripples, propagating outward, contributing to my life experience.

With 25 contributions from 13 women and 12 men representing 9 different countries, such diverse perspectives on systems engineering careers provides excellent guidance for future generations, possibly influencing some to consider a career in systems engineering. Each letter highlights a work-life journey through a personal lens, providing transparency you will not gain elsewhere. The candor of each letter is both entertaining and insightful.

Imparting such knowledge to others is a means of "paying it forward". You will find something engaging, and something to ponder on from each letter. The credibility of this group of authors provides immense value to the reader. Working in systems engineering is challenging. The expectation is very high for system solutions to perform well, interact with other systems, to be safe, secure, sustainable, resilient, providing a great user experience. It is also very rewarding to be part of such a system delivery or service.

No matter where you are in your life or career there will be a topic in a letter that you will relate to. This simply translates to "you are not alone", others have had similar experiences. These letters share those pivotal moments of each author, whether it relates to overcoming obstacles, working with talented colleagues, finding that mentor, celebrating achievements, recognising what a career in systems engineering meant, to name just a few. If you are uncertain in what you are doing, or feeling isolated or vulnerable in your current working life, just pause and read one of these letters. I guarantee you will be re-energised.

When writing my own letter, I pondered on the question "if I had known what I know now, would I have changed my course?". Guess what – the answer is no! I may instead have been more impatient to make things happen. I may have worked in different industries. I may have invested in learning different technologies. What I do recognise is personal hindsight is very powerful. Each of us have a journey to tell. To next generations - you have your own pathway to tread. Mark this collection of letters as a compass to help provide direction.

You do not need to read all the letters at once. You may wish to read a letter or two over time. Just find those hidden gems that resonate with you - this is what is important.

Enjoy the letters – I know I did.

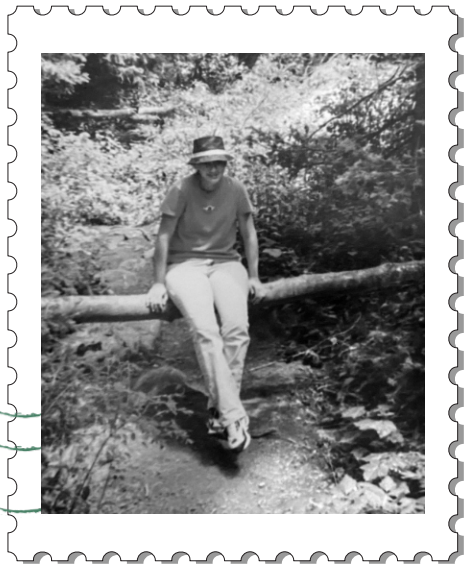
Cheers,
Kerry Lunney
INCOSE President 2020-2021

Dedication

This book is dedicated to you and the future of a better world through a systems approach.

"In memory of Bill Parkins, one of the most genuine and creative leaders in the world of Systems. He was inspirational and supportive to all, a champion of diversity, and an advocate for empowerment of women in his field. Thank you Bill for sharing your journey with us."

Kerry Lunney



Virginia Aguilar

Sueña en grande, trabaja duro

Virginia has a large extended family and most lived nearby when she was younger which exposed her to a wide variety of activities. There was no shortage of things to fix, clean, build or animals needing care and doing these things often required creativity and problem solving. These experiences laid a foundation for technical roles in the nuclear and aerospace industries, both of which include fascinating and complex system problems. She is an INCOSE Certified Systems Engineering Professional, has held individual and leadership roles, and currently serves as Associate Director of Systems Engineering within a Fortune 500 Company.

Dear Virginia,

As you look toward the future, there are more questions than answers. Do I go to college? Where? What major? What is the cost? Should I move? Can I get a good job? Will I excel? Will the work be interesting? Will it provide the life I want? Etc.

Even though you may craft realistic goals and future scenarios none of them will match how it actually unfolds. Pursuing engineering will be rewarding, but not in the exact ways you imagine. You will learn that success is measured by more than correct calculations, design excellence, patents, or inventions of new technology. Your career will be different than you envision, and you will be exposed to fascinating concepts, new technology, challenging problems while working alongside impressive people.

For perspective, this letter is written from a time and place where you work as a systems engineer for a company with the mission of making the world a safer place. You are married with 2 kids, 2 dogs, and living in a lovely home in a community rated as one of the best places to live in the state. You have both a Bachelor's and Master's degree and maintain a professional certification. Life is quite different from that of your parents and grandparents. You feel lucky to be engaged in work you are passionate about that makes a difference and provides the opportunity to inspire others.

This does not mean everything will be easy. Your background and gender will at times make you feel like an imposter or out of place in engineering organizations. At the same time, your unique perspective brings value to the domain. Innovation is often the result of making new connections, and the fact that your life experiences are different from many in the field provides the opportunity for you to make connections that others cannot. For example, at one point you were working an experimental campaign to study shockwaves when a major roadblock was encountered. The experiment required a thin material that would separate liquid from gas. The team struggled to find something that would work, and many alternatives were tried without success. Expensive, exotic materials were evaluated, and university faculty were consulted to provide expertise on material properties and identify suitable alternatives. All seeming like dead ends. Until, in off hours, you had a bit of an Ah-Ha moment in the kitchen. While baking cookies you noticed an oil drop on a sheet of wax paper that sat on top of the paper. This behavior was exciting given the problem with the experiments. You took it to the lab to test it, and sure enough, low cost wax paper, readily available in grocery stores solved the engineering problem. The experiments were able to resume due to the connections of these seemingly unrelated activities. It was also very unlikely anyone else on the team would be baking and be able to make that same observation and resolve the roadblock

"Innovation is often the result of making new connections, and the fact that your life experiences are different from many in the field provides the opportunity for you to make connections that others cannot."

Another difficult part of your journey will be dealing with bias and cultural norms. Acknowledging your own personal biases, developing confidence, and learning from others will help you grow and successfully navigate in the field. Over time, you will develop inner strength, technical expertise and self-confidence.

You will find a natural resonance when you are introduced to the concept of systems thinking and embrace the principles and practices of systems engineering. Believe it or not, you'll be considered many things including a subject matter expert, mentor, manager, project guru, course instructor, go-to problem solver, strategic advisor, and technical leader with the opportunity to inspire and influence others.

A common misconception is that a systems engineer is either responsible for IT infrastructure or requirement writing in the defense sector, but that is not a complete definition. It is inherently cross-functional and applicable in a variety of domains. Early career experiences will be a bit disappointing as tasks are geared toward specialization within a single engineering domain such as mechanical and electrical engineering. You chose engineering because of the applied, practical nature of it and due to the need for cleverness or ingenuity. It is in the intersections or spaces between disciplines, where you will find interesting problems needing clever solutions. This is part of the appeal of systems engineering. It requires a balance of holistic or big picture thinking and being detail-oriented. One of the competencies of a systems engineer is the ability to traverse levels of abstraction. Said in simpler terms, when faced with a problem you think about "breaking it down and building it up" while appreciating the inherent relationships and interconnections. Seeing a big picture and breaking it down into a collection of interconnected entities is a core part of systems engineering. This in combination with other key concepts will draw you to the International Council on Systems Engineering (INCOSE), trigger your interest to learn more and ultimately lead you to fulfilling work. You will be proud to be a Systems Engineering Professional (SEP).

This letter has provided only a glimpse into the future but be assured along your journey there will be plenty of technical and social challenges. Overall, it will be fun, fulfilling, and worthwhile to have an engineering career. At times you will get up early or work late; you will spend time in various forums including lectures, meetings, labs, conferences, outdoors, behind a desk, and speaking in front of groups. (As an introvert this is hard to believe, but it is a skill you will learn). There will be tasks that are mundane, others hazardous or exhilarating. For example, you will over pressurize (blow up) metal containers, work on a 30 feet tall shock tube, use lasers and x-rays, fly in small airplanes and see the glow produced by Cherenkov radiation – which is beautiful. As you move through these endeavors, remember to appreciate those beautiful moments, learn continuously, be confident and do not shy away from being vulnerable or uncomfortable. Those are times of growth which will help you achieve more than you can imagine from your current time and place.

Yours truly,

Virginia

Eileen Arnold

A Journey of Passion

Eileen P. Arnold, Fellow of INCOSE, INCOSE Expert Systems Engineering Professional (ESEP), and past Project Management Professional (PMP) has enjoyed and thrived for almost 40 years as an aircraft electrical systems engineer, weapons systems engineer, and mentor to other engineers. She discovered in the mid-1990's her passion had a name - systems engineering, a transdisciplinary way of thinking. Eileen is a recipient of the MFESTS Charles W. Britzius Distinguished Engineer Award and has been an active INCOSE volunteer and author since 1996, holding a variety of INCOSE international, Heartland Chapter and North Star Chapter positions in addition to her earlier IEEE technical chair volunteerism.

Dear Eileen,

You are not yet aware that you will become a systems engineer someday, possess the skills of a systems thinker, or even care as long as your career is currently satisfying. Until you have gained exposure to the systems engineering opportunities either through a concerted effort to become an educated, experienced systems engineer, or a series of organizational needs assignments, you won't know what you love to do, what you are good at, and what you really don't care to do. Perhaps this letter will aid in shedding light on what systems thinking and systems engineering entails so that informed decisions will guide your career in an adventure of great pride that will fuel your inspiration when you look back at where your career has ventured! Each person's path to becoming a Systems Engineer is unique, as are most people's journey through life. As engineers we also share common experiences that aid in our shared growth.

You have always been a systems thinker but didn't realize what a systems thinker is until later in life. Your initial undergraduate and graduate degrees were in music and geography (which translates to "earth study"). You learned the physical sciences; geology, oceanography, climatology, weather, astronomy, biology; to name a few. These contain system constructs. You were taught about the interactive influence between these systems and modeled their interactive behaviors. You learned about cultural interactions with the physical world; legal battles over water rights and animals harvested legally and illegally across political boundaries, migrations of people and the cultural influence of these populations. You have a strong desire to have a holistic view about the earth and the external influences of the universe. Others have similar holistic beginnings into the foray of systems thinking, although rarely would geography be the path! English, psychology or sociology, or project management have led others down a systems thinking path.

After several semesters of statistics at the graduate and undergraduate levels, you will experience a void in your education; a solid grounding in mathematics! For fun after graduation, sign up for a math class which you have always enjoyed! As it turns out, people often pursue engineering after recognizing the enjoyment and success mathematics brings them. Systems thinking is still an option for many that do not embrace mathematics. For more fun, sign up for an electronics class, an additional perceived curiosity and a short coming of your life's education to date. Since math is a forte of yours, why not commit to pursue yet another degree, this time in electrical engineering?

"You will be smitten! Systems engineering will become your passion, one in which you spend copious amounts of volunteer hours, perfecting, with hopes of making the world a better place for others."

After working as an engineer, you will notice that the titles "Engineer" and "Systems Engineer" are handed out freely even though a degree may not be in engineering or systems engineering. In fact, you will notice that in some cases, the title of Systems Engineer is bestowed on software engineers and non-engineering degrees who may not show signs of systems thinking. Why, you ask? Because engineering jobs entail such a wide variety of skills that may not require mathematics or systems thinking skills in their job descriptions. Activities such as requirements elicitation, validation, project management and test activities use systems thinking and/or engineering skills dependent on the context and mix of other team member skills.

Your first employment after 15 years of college and the birth of your three children will be as a hardware electrical engineer with an aircraft avionics supplier. What an amazing experience lies ahead! Expect to learn software engineering, an invaluable skill, on the forefront of the computer revolution!
As a lone female in a man's world, you will be assigned isolated technical development tasks across the system. The systems engineering seed of working across a system provides insight into both the hardware and software of the entire system. You will overhear your Director telling your boss, "Get her out of that position! She has small children! She shouldn't be traveling!". Your boss will reply, "But she is the only one that knows the system!" You still won't consciously have an awareness of your love for systems engineering, although the overheard comment will spark a realization that you indeed love knowing about the entire system of interest and its interfaces. You will gladly be consumed by the increased engineering knowledge, project management knowledge, and aircraft standards development knowledge as you travel the world, immersed in non-US cultures.

In 1995, you will have a unique opportunity to develop requirements for twelve aircraft instrument variations with differing customers. To save cost, try your hand at creating one software requirements document for all twelve instrument variations. Create and group the common requirements and unique requirements of each offering as feature sets. You will discover and fall in love with product-line engineering (PLE) before knowing what it is called. The document will be a huge success with the software people clamoring to join your program!

A well-known software author will further spike your curiosity about systems engineering and a continuation of applying cross-discipline concepts to life cycles. "Begin with the end in mind" is a basic principle applicable to envisioning what the system could be at the end of the development life cycle with an eye towards how the system will perform over time. The hands-on experience of piloting an aircraft with the equipment you had a role in developing will teach you the importance of experiencing what your customer will experience.

You will discover the International Council on Systems Engineering (INCOSE) and what it means to be a systems engineer. Experiencing your first INCOSE Symposium, will be beyond your wildest expectations! What an amazing venue experience! The attendees will be talking the systems engineering language, a language you already know, but for which you have limited exposure. The desirability of knowing a little about multiple key disciplines, along with taking advantage of colleague inquisitiveness and sharing best practices provides the joy needed for a successful career!

You will be smitten! Systems engineering will become your passion, one in which you spend copious amounts of volunteer hours, perfecting, with hopes of making the world a better place for others. Embracing the principles of systems engineering will be your ticket to a phenomenal career. Systems engineering opens eyes to the multitude of concepts needed for tools, techniques, and systems thinking perspectives that translate well to improving the quality of life around the world. It opens eyes to the value of experiencing the products colleagues have a hand in developing! Experiencing your system contributions firsthand will shape your career and life. I encourage you to take your career to the next level and join in the fun of Systems Engineering!

Enjoy your journey!

Eileen

Heidi Davidz

Systems Engineering as a Natural Home

Dr. Heidi Davidz is an Intelligent Systems Engineering Subject Matter Expert in the Innovation and Capabilities Office at ManTech. She was inspired to pursue Aerospace Engineering in elementary school when Sally Ride became the first American woman in space. She spent many years studying hard, earning a B.S. in Mechanical Engineering, M.S. in Aerospace Engineering, and Ph.D. in Engineering Systems. Living in 10 states across the USA, Dr. Davidz has had many interesting adventures and jobs in her career, including studying under world-renowned scholars, running rocket engine hot-fire tests, working on a lunar lander, and influencing international Systems Engineering practice.

Dear Younger Heidi,

There is an interdisciplinary field called systems engineering which focuses on how to design and manage complex systems from the beginning to the end of their life. It involves understanding the big picture and working with diverse teams to integrate technical details and accomplish the system purpose. Systems engineering is a key part of my career, and I would like to share guidance with you on what I wish I had known and what I would do differently to navigate the systems engineering journey.

I wish I had known about systems engineering much earlier. Children often possess what we call systems thinking, which is a broad view of how pieces fit into a system. This contrasts with traditional analysis and teaching, which studies systems by breaking them into separate elements. Formal training in systems thinking felt like coming home to a very natural way of perceiving the world.

In graduate school, a new faculty member who had just joined the university first introduced me to systems engineering. She was a former president of the International Council on Systems Engineering (INCOSE), and she helped guide my graduate studies toward the study of systems engineering. The structure was a good match for me. I enjoy understanding the broader, holistic view of a problem space before getting into the details of a problem.

The same wise graduate school advisor noted how important a professional society can be. She said a professional society can be a second family throughout one's career. This has proven true with INCOSE. Throughout career changes, INCOSE has provided a continuing source of support and professional development. A robust professional network is invaluable. Mentors both inside and outside one's organization are important. They open doors that may not be obvious, and their coaching and guidance are invaluable.

"A professional society can be a second family throughout one's career. This has proven true with INCOSE. Throughout career changes, INCOSE has provided a continuing source of support and professional development."

For my doctoral work, I studied how to accelerate the development of senior systems engineers by interviewing 200+ engineers. It was so interesting to see the enablers and barriers for these individuals. However, I did not completely appreciate some of these lessons until I had experienced them myself as a practitioner. Theoretical work is very different than hands-on experience.

I wish I had taken time for a post-doctoral appointment after completion of my doctoral studies. An industry salary is alluring, though a post-doctoral appointment provides time to thoroughly document one's doctoral work. I wish I had authored a book about my empirical work to promulgate the findings more broadly. On the positive side, systems engineering is a career field which appears to have no shortage of job opportunities.

As a practitioner, I learned how systems engineering is a balance of process and product. The systems engineering process is not an end in itself, but a mechanism to support development of a system. One does not want to blindly cling to process, losing sight of program and product needs. A situation may require tailoring. Context-specific product knowledge paired with rigorous process understanding is powerful.

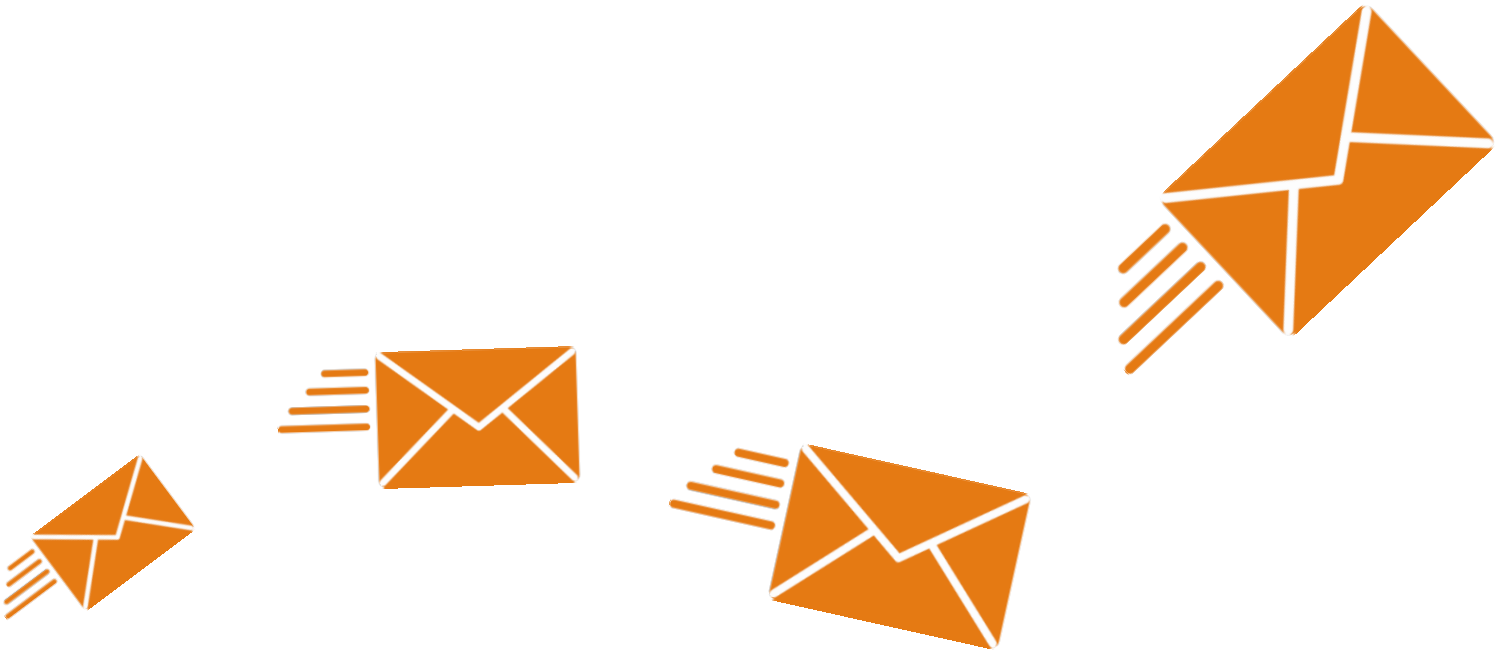
Systems engineering is often misunderstood, even by those assigned to the discipline, so having one's own firm understanding helps. Those who do not understand the power of systems engineering can underestimate its importance. Immersed in an overwhelming workload with conflicting priorities and an unrelenting program schedule, real-world systems engineers may work in non-ideal situations. It is extremely rewarding to navigate that complexity to use systems engineering to positively impact products which change the world.

Now that I am past the half-way point of my career, another piece of advice I found valuable is to be a "reflective practitioner." This person practices in the field, but also actively contributes to the literature and state-of-the-art. Reflecting on the practice of the discipline helps one practice more effectively.

Be confident in your abilities. Surround yourself with a dedicated support system. Good luck!

Best wishes,

Heidi



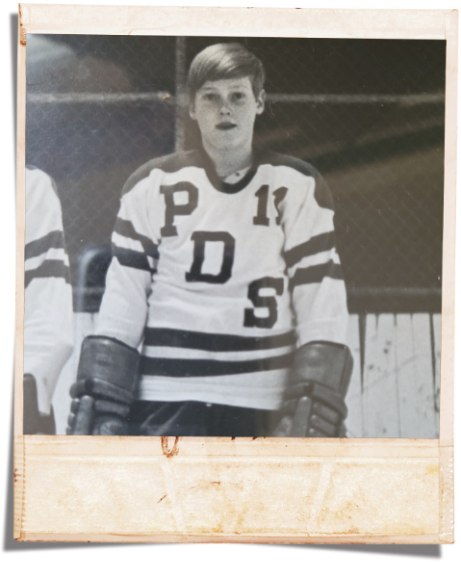
William Donaldson

Thoughts About the Road Ahead

William (Willy) Donaldson came to systems thinking early, as his father gave him all the early systems texts from von Bertalanffy, Churchman, Checkland, Ackoff, and others. He often wondered if this was for inspiration or punishment, as few he met along the way shared this worldview. Happily, as he traveled the road from industrial engineer to business executive and CEO, and back to systems with a doctorate in systems engineering, he has found many more like-minded people. Willy is a Professor of Management and has over 35 years of experience as a Board member and Chief Executive.

Dear Younger William,

I am writing you this letter on a plane as I fly back from a conference in Florida talking about systems thinking and systems engineering. I know you are rolling your eyes and thinking all I ever talk about is systems; however, hear me out. As I age out of currency and the mainstream, I remember one of my favorite old sayings from Benjamin Franklin—"Life's tragedy is that we get old too soon and wise too late." I hope you can improve upon this condition a little by heeding the following advice.



You trained in systems engineering. That is a great start. Keep learning about systems, especially socio-technical systems (complex adaptive systems). However, spend more time on the systems part of systems engineering than the engineering part. The engineering tools and techniques will change, and this will make it hard to stay current, but the systems will be the tough part. Complex systems can be very vexing, and the hardest parts may often have nothing to do with engineering.

All the systems you live in and most of the systems you will work on will be socio-technical systems. Socio-technical systems can be incredibly frustrating, and most of the frustration will come from the social aspect—the people—not the engineering tools or technology. People will do irrational things and use the system to their advantage. Or they will keep doing what the system led them to do, if only because it is "the way we have always done it!" Find the fascination in your frustration. The system, and its occupants, will not care about your frustration, and your frustration may blind you to the real system dynamics. Observe the system and learn to sense the system's rhythms and, as Donella Meadows says, "dance with it."

To learn systems and to learn to dance with them, you will have to be patient and listen. But first, learn to listen. Excellent listening, empathic listening, as Steven Covey calls it, is a rare and elusive skill. Study it and practice it. There is a methodology I learned from an old mentor. It goes, Listen, and you may Learn. If you learn, then with your systems view, you can Help the person with their challenge. If you help that person with their challenge, they will ask you to Lead them (LLHL). To do this well, you will first have to check your mental models, motives, biases, and beliefs. You see, most of us listen with our response track playing in our head, filtering what we hear, ready to deliver our payload of knowledge. For a systems thinker, this is a dangerous trap. What you are dealing with in systems thinking is each stakeholder's mindset (worldview, perspective, point-of-view). You are working with people's minds, not technology, not resources, their thoughts!

"To learn systems and to learn to dance with them, you will have to be patient and listen. But first, learn to listen."

As a systems thinker, you are rare. Most people have not trained in systems or are willfully blind to them and their impact. Hopefully, this will change as humans realize how powerless we are in the face of most socio-technical systems. But for now, prepare yourself for resistance from the system and its occupants. You see, you are also a teacher and guide, not just an engineer. All we can hope to do is teach others to see the system as we do and come to a shared mental model of the system. Only when we collectively view the system the same way, can we, and they, make the trade-offs the system will inevitably demand. But people are stubborn, and they will defend their current view of the system and the benefits or incentives they

derive from the system. They will even cherish the comfort of familiarity over changing a defective system. Irrational, I know, but these are people.

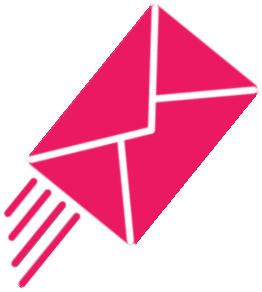
Does a lot of this advice sound like it comes from the social science disciplines, far removed from engineering? It does. So, what to do? Study and learn to love the social sciences, they swamp the engineering disciplines in many socio-technical system dynamics.

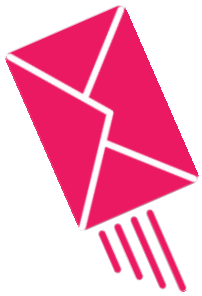
Finally, as a systems thinker, you must be able to scale from abstract to specific and take your system co-occupants with you. That takes leadership, followership, and people skills that are rare to start with and even more rare in engineering programs. Just because it is hard, does not give you an excuse. Systems are hard. People are hard. People and systems together are “wicked” hard.

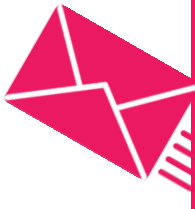
Reading the above, you might reconsider your choice of career. Do not. You live in and work on fascinating structures (systems) that affect the most people in the world. We need you. The world needs you. You wanted to be a systems engineer? Be one!

With great hope for your future, I wish you the best.

William







Ian Gibson

All Change! The Ultimate Evolving Career

Ian is a chartered engineer and enterprise architect with over 20 years' experience, primarily in the Defence industry. His early career included integrating networked command and control systems into a single-seat fighter aircraft, designing the interface between a missile defence system and its host ship, and working on various electronic warfare projects. He has always wanted to get things to work (or understand why they didn't), and rapidly gravitated towards understanding that most problems that exist in any complex enterprise are at least as much about people as they are about technology. Nowadays he has a roving consultancy role.

Dear Younger Ian,

I am glad we had this chance to meet. The moment you signed up for that Systems Engineering degree it was always going to be more of a rollercoaster ride—in a good way—than you might anticipate right now. You will learn about things that will surprise you and do tasks that may not make sense to you right now, but you will end up leaning heavily on when you are on your own advising clients.

There is so much to share with you. I'm not really sure where to begin, perhaps somewhere in the middle… If you want to develop a rounded appreciation of systems engineering, then you should experience some variety—apparently, it is the spice of life. Developing systems thinking as a "habit of mind" builds upon a knack for approaching situations from various viewpoints. But let us not walk before we can run. You need to start your career somewhere, and often a good way to go is with a highly reputable engineering company, many of these organizations serve as major or key contractors for government organizations.

Working for such an engineering company gives you a certain freedom—the ability to step into deeply technical problems and make your mark with finding a solution. Problems will not always just fall into your lap, but often the difficult problems just need someone who thinks a bit differently to take them on and solve them. When I say "differently," I mean what has become known as the "paradoxical mindset"—simultaneously thinking about the big picture and the intricate details. Playing with the knowns, the unknowns, rotating, squeezing, and stretching them until they fit together. Working for an organization in this space often supplies a situation where you can relatively well define your problem space, but the solution space is fairly open.

Speaking of solution space… now there is a phrase. Sooner or later your carefully crafted requirements will hit the harsh reality of design and implementation. Suddenly, your world will be full of exasperated people imploring you to say "what" you are trying to achieve rather than "how you will do so with particular hardware and software." You will find this transition vital for sharpening the mind and learning how to develop better models, write better requirements, and define better trials.

While we talk about solutions, let us take a moment to talk about real hardware. Take every opportunity to see the current solution, and ideally crawl all over it. Whilst seeing the current solution can bias your thinking, it also gives you an unparalleled opportunity to understand the problem space from the users' perspective. Take advantage of experiences out in the field, such as spending time on airfields and working on assembly lines or in maintenance workshops; these will provide a strong reference point. Similarly, try arranging visits to test sites, spend a day observing training exercises on a cold and muddy plain, or negotiate a visit to the operations room several decks down on a warship with current crew members as guides. Spending time in the field will provide invaluable insights into the real problems users face. As always, I am sure you will look through open eyes and maintain an enquiring mindset when looking at previous solutions.

Now let us move on a little and talk about boundaries. Specifically, let us talk about the customer-supplier boundary. At some point you will find yourself working on the client side. Suddenly it will all look a bit different. You will have previously become comfortable with converging on a solution, and now you will need to work on understanding problems. Where you were previously working as a modeler, now you need to

become an architect. Where ambiguity was your enemy, now it is your favourite dance partner. Integration, testing, and evaluation used to just involve proving you had properly realized your ideas, and now it has turned into a much wider concern with all sorts of messy human interactions. You will not have the luxury of time to dig deep into every aspect of the problem, but you do have to work on a much wider scope. Finally, and this may be the critical bit, your relationship with boundaries will change. As a contractor you need to lock down boundaries as early as possible in order to limit your exposure to risk. On the customer side, you need to leave the boundaries as open as possible for as long as possible to avoid closing out potential innovations. Everything looks different when you approach the same boundary from a different perspective.

Are you still with me? The point is it is all still systems engineering but the rules just change a little as you move across and stand in a different place. Your engineering skills still matter, but now it is your systems thinking skills that need to take centre stage. Another area you will undoubtedly dabble in is project management.

As a child you probably did not dream of growing up to be a project manager, but in the workplace not only will this start to look like an attractive career option, but project management is a discipline systems engineers need to understand in order to be effective. As a child, nothing was more fun than playing with LEGO. Building cool new things, taking them apart, and turning them into different things. What could be more fun? Weirdly enough, playing with LEGO teaches you about a wide variety of systems engineering principles—modulatory, reuse, scalability (after all, LEGO are compatible with Duplo & Megablocks), open architectures (it all fits together), off the shelf procurement (literally, in toy shops), and even mission analysis (every box includes an example scenario on the front). But let us not forget the reality. Every box came with instructions, and in those instructions was a bill of materials and a work breakdown structure. From our very earliest days we experienced the reality that anything vaguely complicated needs planning and documentation to build it.

Soon you will learn if you want to progress in your career, you will have to be able to take on project management and programme management roles. This could be with a big “P” on a major project, or more likely to start with a small “p” on a series of smaller tasks. It is not difficult, but requires a different perspective, with more focus on getting people to deliver outputs and outcomes to agreed timescales and costs, rather than exploring technical possibilities. You will need to take on a tough balance between facing outwards to the customer and other stakeholders, facing inwards towards the team, and facing upwards towards the business. You will need to learn to let go of some things but develop a keen sense of when to step in and grip things before they start to go awry. It is perfectly okay to ask for advice and guidance when you start taking on leadership roles, and you will find it is often worthwhile to reflect on the leadership and management styles of people you have worked with over your career. If someone is always organized with a clear view of the whole project, consider asking them how they do it and what tools they use. If someone is really good at estimating, then try sitting with them and asking them to go through how they built up the work breakdown structure. If someone is good with stakeholders, then carefully observe what they do and ask them about their strategies and approaches. More often than not it will turn out to be simpler than you were expecting but carefully crafted. As with many things, becoming good at project management comes with practice and experience, and it is almost inevitable there will be times where you end up smoothing things over with a disappointed customer whilst striving to get your team performing and your project back on track. Who knows, if you become good at engaging with stakeholders, develop a flair for visualising the end-to-end task, and learn how to estimate technical effort, maybe you will find yourself involved in sales and business development.

Sales involvement can be as simple as jumping into a whiteboarding session to sketch out how to deliver a task to the client. If you are a good technical writer, you might quickly find yourself drafted to write sections of a proposal that will sell the solution to the client. This is not just about writing a college assignment though—

everything you write is part of a business commitment, should you be successful, so careful with those words. One of the best things about sales involvement is you can start to shape your own destiny, rather than waiting to hear what your next assignment is. Over time, a record of strong delivery on tasks you were a part of, quite possibly taking on more responsibility each time, may have the beneficial effect of making you into a sought-after figure in the customer community. It is a bit of a cliché, but people buy from people. Building rapport with the stakeholders, demonstrating interest in their problems, acting with integrity, providing solutions, and delivering on your promises are all things which will improve your standing with the customer. Suddenly, you may become a lynchpin of winning follow-on work.

At some point you may need to brush up on your consultancy skills. “Rule #1 The customer is always right. Rule #2 See Rule #1”. Well…, maybe…. It is their money, it is usually their problem, and their approach is something they spent time thinking about. Of course, sometimes that thought process does not always lead them to the most obviously advantageous place, so they often need a little bit of help. Most importantly, never forget it is their problem not yours, so you always need to try and find a position to speak from where you can demonstrate credibility and aim for a win-win situation. Use critical thinking but avoid being unduly critical. Join the dots, or better still, coach the client so they can join the dots with you. As you gain better understanding, seek to unpack the problem but do not lose sight of the all-important “So what?” Build relationships, and if you cannot for some reason, make sure you at least build mutual respect. Trust and goodwill go a surprisingly long way when you need to get things done, but both need to earned first. Expect some bruising encounters with stakeholders, and never shy away from using the whiteboard as a tool to achieve consensus. Systems Engineers need to be able to draw meaningfully whilst talking to strangers!

Do all of this passably well and you might find yourself in charge of things: small teams, big teams, small projects, big projects, departments, maybe even businesses. Suddenly you are in a new value system where the business aspects increasingly overshadow the technical aspects. Hopefully, you have paid attention during your consultancy engagements and picked up a few pointers on what actually matters to decision makers in business situations. Framing backed up by defensible facts and a good narrative becomes critical. Grand ideas generally do not get enough time to really take root, unless you can be a little bit subversive in how you take them forward.

What more can I say? It is your career, so own it, enjoy it, and make it worthwhile. Embrace new challenges, new domains, and new approaches—there are a lot of other people out there doing cool things in interesting ways that you can adopt and adapt for your needs. Learn from other disciplines, they often bring complementary perspectives, but try not to lose sight of why taking a systems approach is so important. At times it will be frustrating and disappointing, but these moments will be dwarfed by the moments of clarity and elation where you get your head around something truly important and unlock (or indeed unblock) a problem in a way that enables everyone else around you to make progress… and in many ways, that is something all systems engineers aspire to do for their stakeholders.

Wishing you the very best of luck as you embark on your journey. Enjoy the ride but don't forget to get the job done.

Warm Regards,

Ian

Stueti Gupta

Be Uncomfortable with Comfort Zones

Stueti Gupta is a techpreneur, co-founded a knowledge consulting company assisting organizations towards integrated digital engineering. She has a diversity of experiences from shop floor to nano fabrication lab creating MEMS devices. She completed two tenures as the President of INCOSE India Chapter. Stueti co-founded SWE Pune Affiliate and has held various leadership roles in Society of Women Engineers locally in India as well as in global initiatives. She received the SWE Distinguished Award in 2016, first one from India to receive the award and received the 2021 WE Local Most Engaged Award for her efforts towards advancement of women in engineering.

Dear Younger Stueti,

I hope my letter finds you in the best of health and spirits. I am writing to you from the future and I want you to know that I am so proud of you. I am so proud of you for always being optimistic, having the empathy with people in general, making the best of the situation. That you are able to connect the dots easily, such as making introductions among friends and also ascribing why these individuals should connect. You have the ability to identify value in interactions and interconnectedness. Your thinking ability is attributed as systems thinking in engineering. Business landscape will evolve and be fundamentally different in a decade's time and that's why continue to nurture these traits that together are going to prepare you for leadership.

Remember the following:

That you have never been intimidated by change. You grew up in different cities, changed schools, made new friends easily, learned different languages and enjoyed food from around the globe. During school years it was a joy to know how amiably you would exchange your lunch box with your friends who loved north Indian food for the south Indian dishes they brought along. It is a great thing that wherever you go you will be adaptable to new things, open to experiment and will carry memories and feel joy reminiscing.

"Progress is impossible without change, and those who cannot change their minds cannot change anything." - George Bernard Shaw

That over the years with lots of moving and your father traveling often you have acquired several life skills. Including learning new languages, managing not just the day-to-day chores but also finding your way at the bank for instance. Definitely there are pot-pourri of experiences that you reminisce and would bring in the sense of how far you have come. Your parents have taught you just enough skills to manage both household and outside chores. These learnings will help you accept new ways of living and thriving with what is available.

"There are skills we can take wherever we go in life, no matter what we do." - Millie Hogue

That you bring passion about tasks, projects, and leadership. Right from school years you have been volunteering to coordinate events. Your leadership across various initiatives have touched many lives and inspired many to further make a difference.

That you are still the one who loves to plan the get togethers, potlucks and keep in touch with your family and friends. Remember how during study leaves during school years, you would often be found near the telephone calling up one friend after another to catch up. And leave your mother worried if you will fail in one subject or the other. Thanks to her relief you managed to get through to one of the best engineering colleges in India. It is this attitude of yours that will always help you stay connected to the roots. So continue to spread the love and garner energy from your support system.

"Family - like branches on a tree, we all grow in different directions, yet our roots remain as one." – Author Unknown

That is very powerful to be comfortable with the uncomfortable. When you observe something like this at the workplace or personal life, express it to people around you. Don't feel uncomfortable in doing so. Think of a career as a systems engineer! I think you would love the interdisciplinary nature of it to develop systems or propose solutions. It also requires good interpersonal skills.

"Think of a career as a systems engineer! I think you would love the interdisciplinary nature of it to develop systems or propose solutions. It also requires good interpersonal skills."

Note that systems thinking has been influenced by your growing up years and your priorities, life experiences have helped you acquire this skill. It is not natural for everyone to get big picture thinking. As you look to your future success, continue to work hard as there is no substitute to that. Read, don't have to be a voracious reader, but reading is going to give wings to your thoughts.

"The more that you read, the more things you will know. The more that you learn, the more places you'll go." - Dr. Seuss

I hope this letter gives you the nudge and much needed confidence that things are fuzzy during any transition phase but BE YOURSELF. Reflect on your optimistic approach to any situation from the past, appreciate your agility, adaptability and acknowledge your yearning to learn and grow yourself, it is nothing but positive. I hope you love yourself just the way you are and keep smiling just the way you do!

Never Settle, From your older self,

Stueti

Heidi Hahn

A Random Walk Through Life

After graduating high school, Heidi Ann Hahn attended GWU, studying Botany. Although she was interested in it, the real reason she chose Botany was to be able to attend school away from home – she was an only child whose Dad wanted her to attend Penn (which had no Botany major!) and live at home. Fast forward to graduate school, where she completed a Ph.D. in Industrial Engineering and got her first introduction to systems engineering. She served in various systems engineering roles (human factors engineer, lead systems engineer) throughout her 35-year national laboratory career; she is an Adjunct Professor of Engineering Management.

Dear Heidi,

To be completely honest, I did not set out to be a systems engineer, it just happened that way. I started my academic career as an industrial psychology major. Having been interested in clinical psychology during high school, I pursued an internship at a private mental hospital after my junior year and another at a public institution once I was in college. The politics of it bothered me – people who really needed help weren't getting it, and people who perhaps didn't need residential care, but could afford it, were. At about that time, I took a class in industrial psychology from Dr. Thelma Hunt, who was both a medical doctor and a Ph. D. psychologist. An internship with her showed me how the concepts I had been learning in my clinical classes could be applied in another domain. While working on my Master's degree in industrial psychology, though, I realized that I was being trained to be a personnel director, which I decidedly did not want to be!

The school I was attending had a Human Factors Engineering program run out of the Department of Industrial Engineering and Operations Research (later renamed Industrial and Systems Engineering; alas, the year after I graduated). That was more to my liking, so I jumped ship. I would not really recommend changing majors between your Master's and Ph.D. – it made for a six-year graduate school experience and had me taking engineering fundamentals with freshmen and calculus concurrently with the controls class I needed it for – but it worked out OK for me. Two of my professors were guys named Blanchard and Fabrycky, and it was because of them that I even came to know what systems engineering is. It was the elegance of the system life cycle that got me hooked.

What I realized after a while was that, while I was not yet a systems engineer, I was, and had always been, a systems thinker. My husband, a physicist, is one, too. Maybe that is why we like each other! We have had many debates about whether systems thinkers are born or made – a little of each, I think – but that is a subject for another letter.

My first professional position was as a human factors engineer. It was a great first job because I got to try many different assignments and find out what I liked and did not like so much. I liked doing research, especially on the subjects of human reliability and operator responses to emergency situations. I did not like ergonomics. So, when I came to my present employer and became manager of a human factors group, I avoided, as much as I could, taking on ergonomics projects. It is not often that one gets to choose one's assignments, so when I had the opportunity, I took it.

"What I realized after a while was that, while I was not yet a systems engineer, I was, and had always been, a systems thinker. My husband, a physicist, is one, too. Maybe that is why we like each other!"

Given my industrial psychology background, it was only natural that I would get pulled into doing organizational design work. That is when it hit me! The stuff I had learned in school about "work and motivation" and "holistic management" was not going to help me design a labor relations function for the institution or develop a governance structure and processes for the senior management group. I needed the discipline of systems engineering for that:

- What functions need to be accomplished?
- Who are the stakeholders and what are their interests?
- What does the wiring diagram (aka org chart) look like? Is a flat organization more efficient than a hierarchical one? How many layers are needed to accomplish the goals?
- What kinds of components (people, facilities/equipment) should be used as building blocks? Which tasks should be done by people rather than automated?
- What other entities does the entity under consideration interface with? What kinds of information/work products do they exchange?
- How will I measure performance?
- And so on…

Since no good deed goes unpunished, after I designed the labor relations (LR) function, I found myself in the Human Resources department running the LR group. One thing led to another and I eventually became, you guessed it, the HR Director. Nevertheless, systems engineering saved me. The institution was implementing an enterprise-wide resource planning system at the time and I was responsible for reengineering HR processes. Having applied systems engineering methods to the HR reengineering project quite successfully, I was recruited to the project as the lead systems engineer to apply the same disciplined process to the other functional and technical areas of the project. So, systems engineering rescued me from the fate I had hoped to avoid all those many years ago when I changed majors for my Ph.D.!

If this all sounds quite random, it was! I never thought I would find myself in the position of having to provide career counseling to anyone (since I was so bad at it for myself) but I now run a pipeline program for undergraduate female engineering students where I do just that. I tell them that if something interests them and is worthwhile doing, they should go for it. Painstaking career planning may just be overrated. It often unravels anyway, which can lead to feelings of disappointment and unworthiness. Instead, seize the opportunities that cross your path as I did and have a pleasant and productive adventure.

Best wishes,
My Older (and I Hope Wiser) Self,

Heidi

Cecilia Haskins

Oh, the Places You'll Go!

Cecilia is an American living in Norway and recently retired. Her career included over 30 years as a practicing systems engineer and over 20 years educating the next generation of engineers on the importance of systems thinking. She joined INCOSE in 1993, and has held a variety of leadership and other volunteer positions within INCOSE, and continues to be active with mentoring and authorship. Her educational background includes degrees in chemistry, business, and eventually a PhD in systems engineering. She attributes much of her success to her parents, her educators, and her willingness to try new ventures and work with others.

Dear Cecilia,

This is a letter from the future to encourage you to follow the path you chose for yourself at age 15. Since a very young age, you have been listening and understanding stories from Pa about his work in the fledgling computer industry. Even if you were not aware, you gravitated toward the highly systemic way that he analyzed almost everything. And you are discovering that you have a talent for the same type of thinking. However, you are ahead of the educational curve, so it will not be possible to major in anything "computer" during university. Your natural tendency to see the relationships of small parts that make a whole has given you a fondness for chemistry – so follow your inclinations and father's advice to take a natural science – and major in chemistry at college. You will discover over time, as you meet others, that chemistry majors have a special aptitude as systems engineers. Accept advice to round out your scientific learning with courses about business, and plan to take your MBA before taking full-time employment since the business domain will be your initial application area as a computer professional.

You will not hear the term 'systems engineering' for another decade, by which time you are well into your career, but you will behave like a systems engineer from the beginning. Use every opportunity to learn new things throughout your career. And indulge your natural predilection for teaching by sharing your new knowledge with colleagues. Both sharing and practice are the best way to fasten theory to reality, which is your preferred mode of operation.

As for other decisions that you will encounter, I can only say, "*follow your heart*" and always choose integrity over any other incentives. Make your own path and remember that it is easier to ask for forgiveness than permission. I adopted a mantra to "*release the three-year-old trapped within*" and this has served me well. I wish for you, as I have experienced, a life that exceeds all expectations!

Lovingly from the future,

Cecilia

"Use every opportunity to learn new things throughout your career. And indulge your natural predilection for teaching by sharing your new knowledge with colleagues."

- Cecilia Haskins

Lisa Hoverman

There and Back Again: A System Thinker's Letter

Dr. Lisa Hoverman is a wife and best friend to her husband Jason, and mother and best friend to her sweet son Logan. Lisa is a trained biochemist, earning her PhD from the University of Pittsburgh (home city!). A life-long systems thinker, and serial entrepreneur, with INCOSE, Lisa found instant connection and an organization she will serve for life. Lisa's life is fulfilled by spending time with Jason, Logan and their boxer, Rasputin, in grand and serene West Lafayette, IN. She enjoys helping clients or employers in the STEM spaces make a difference in the world through one of her many companies.

Dear Lisa,

I think you were always a systems thinker. You could always see the end before you began and then started making lists and plans on how to get there. What were the requirements? Who were the people who cared? What was the purpose of that end? What were the steps one needed to take to reach that goal or purpose? You loved the process. Researching the requirements was always enjoyable for you. You always learned more.

Sadly, the word engineer will not be in the vocabulary of anyone you know. You will not know any engineers growing up, but that does not matter. The brightest people you know or think you know, are doctors and scientists. Your mother's education as a nurse only fuels this. From an early age, you know you will be a doctor or scientist. You have quotes in both your elementary and junior high memoirs stating that this would be your occupation.

You will pursue that goal earning a PhD in Biochemistry without stopping through the education cycle – the scientific method challenges you, as will math, and while everything else may come easily to you, take time to learn from the hard, and that you do not want easy in this aspect of your life. After you obtain your PhD, though you will not know it yet, you follow the advice you will later learn from the best systems engineers, who are those who are passionate about what they do and lead a diversified lifestyle, engaging in wider pursuits such as scuba diving, sailing, fox hunting, pilot, becoming business owners and leader – try to learn to respect yourself for these and cherish the lessons they each deliver.

As a business owner you will venture into the realm of writing grants for large government projects and systems, and you will love it. You will thrive in the throes of large consortia proposals (chaos) leading the team to a common story about a solution (ahem, system) with strong win themes, and a story for a clear and compelling solution, sometimes for the betterment of your country – if you can, take time to think about this system and how you work out the process – you become sought after for it. In these, you will suddenly find yourself surrounded by bevies of engineers who seemed to have landed themselves strange project management roles. Given your own unique path, it will curious, but does not seem that odd. This is where I encourage you to start to pay attention.

During one of your most diverse and changing time periods you will meet your first bona fide systems engineer. This individual's systems thinking permeated everything they did, from carefully, thoughtfully answering questions to delivering careful systems reviews on projects you work together.

This leader introduces you to an organization needing an editor, called INCOSE. You become an editor for their *INSIGHT* magazine. The articles fascinate you as they touch on the most relevant and crucial challenges of our time, with logical, systematic approaches. The articles chronicle how engineers really help our society reach the modern pinnacles. You will eventually contribute beyond editing to write for the magazine.

Your connection to INCOSE will fill something in you nothing had before – you have obtained a PhD, pursued many risk-associative passions, have friends and experiences that are magnificent – you have a husband– the most stellar human you know – also a systems thinker, yet, you had been searching. It is not editing for *INSIGHT* that impacts changes in your life. It is when you first virtually (2014) and then physically attend the INCOSE International Workshop.

The International Workshop immersed you in and surrounded you with individuals who were systems thinkers. You wake up – and you will know, maybe as you always knew, that you are a systems thinker and it was with this group of professionals that you want to work, possibly forever. You will be with OmegaAlpha viewers constantly, and it is akin to being at your own wedding with everyone you love, trying to discuss everything important to you all at once. It can be overwhelming, but in a profound way. These are the people with whom you had always wanted to work. You will become an INCOSE member and volunteer, and you will not look back. This is where Systems Engineering changes your life. You found the group of people that you will do important work with. It is work you will do for no wage, but for eternal good – for you, and for others. From this group you have chosen family, life-long friends, and profound mentors.

There are many times you consider going back to become a systems engineer, or to get a Masters or second PhD in Systems, and I am not sure you will not, but with a seven year old son, whom you love, fly with, build with, and ride with, there is time for that. For now, you are grateful to learn from the INCOSE masters, and cultivate an environment for him that allows his systems thinking and engineering to flourish. Your affinity for and choice of Montessori education for him bolsters that – and his systems thinking. You hope he will pursue engineering – systems engineering – in fact.

As I write this, the world is in a post-quarantine status, with COVID-19 spreading across the globe as the worst pandemic in your lifetime to date, and it has been going on for 2 years. The global economy is hovering towards recovering from the worst it has ever been – we hope. Right now, the great systems and complex thinkers of the world are coming together to act – we need them, we need you, right now. We will also need you and the rest of the systems thinkers to move us forward when the pandemic finally ends, which may be as far out as another year out.

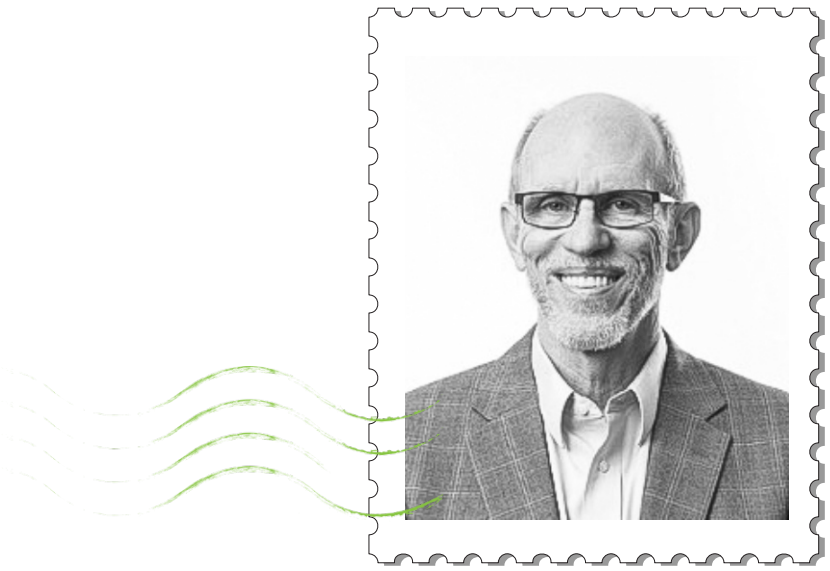
"As systems engineering changed your life, you are looking for ways to share that with others. You will help change their lives too."

You and your colleagues will do important work in INCOSE during the pandemic, serving on the INCOSE Board. This will enable sharing with INCOSE members and the world the great work the INCOSE Corporate Advisory Board (CAB) members do to aid in alleviating the Pandemic on social media, and in many of our publications.
You will be busy, doing a lot for INCOSE, and that will spill into new opportunities not yet imagined. However, you will love it, and you will not give it up. As systems engineering changed your life, you are looking for ways to share that with others. You will help change their lives too. Keep on. There is work to be done, and it is worth doing. You do not do it all perfectly, but fortunately, you have a lot of systems thinkers surrounding you, and they help guide you to a best solution. Keep on that path.

I look forward to updating this letter to you in a few years. I raise my glass with you to a better world through systems approaches!

I love you,

Lisa



Randall Lliff

WB9IRF Calling WB9IRF, Please Come In...

Randy grew up on a farm and was operating / maintaining heavy equipment long before his thirteenth birthday. By 16 he had his ham radio license and was building his own equipment from scavenged television sets. At 22 he was a member of the Advanced Development Group at McDonnell-Douglas Astronautics, and by 30 he was the youngest senior manager in Martin-Marietta Denver Aerospace history. The common arc throughout has been a fascination with how things work – and work together – that led to helping launch INCOSE and a diverse career in aerospace, scientific, telecom, medical and consumer markets.

Dear Younger Randy,

It is your older self here, just writing to share a few tips you might find useful. Feel free to use or ignore any of it as you see fit. (That is the most important tip of all!)

First, I remember what it was like in college—defined tasks, tight deadlines, lots of structure, and clear expectations. As strange as it may seem to hear it, college was the easy part. The sheer richness of possibility that follows can seem overwhelming, as is the pressure to get out there and start making money. It is also a wonderful period of life, so enjoy it to the fullest!

Second, the world you grow into will be both the same and different than the one I experienced. The same in that people will always matter more than "stuff," different in that human priorities and means of interaction shift in profound new ways. The good news is that all you need to do is open yourself to new ways of sharing ideas, everything else will sort itself out, naturally.

It will be helpful to read this letter more than once, and at different points in your career. As you grow with each new experience, so does your ability to recognize points you might find valuable

Trust your gut.

You may not know it yet, but the systems engineering that takes place in your mind at a subconscious level is already a great guide and will get better with experience. If something does not seem right, even if you cannot put a specific name to the problem, trust your gut and keep looking. You will also know the right answer many times even before analysis proves it to be the best choice. I suggest you be humble about that ability and verify it through analysis whenever possible, but do not be afraid to run with your feelings. They may not be perfect, but they will be close enough to make solid progress while you figure out the rest.

Caution: Some things that are legal seem far less acceptable when judged through the lens of your own conscious. Be prepared to put your employee badge on the table and walk away, if necessary, to keep yourself from being pulled into a hopeless mess, or to keep a client from doing something blatantly illegal and later blaming you for the act. These are not hypothetical concerns, take it as fact that someone will test your sense of right and wrong at some point.

Confirm what someone means when they say "Systems Engineering."

Systems engineering is a wonderful field, filled with enormous opportunity, but the title is still recent and is a catch-all for a lot of different things in the wild. In the best cases, it is the name given to a role that uses structured design methods to guide the creation of something cool you can be proud of forever. Those are the roles you want even if the organization does not yet know to call it systems engineering.

Avoid any culture in which "systems engineer" means the person that keeps the office network operating, back up the file server from time to time, and help program people's phones for them. That is all important work for someone no doubt, but I guarantee you it is not as much fun as real systems engineering!

Spend some time in the "ilities".

There is a tendency for systems engineers to look down on those who are in supporting functions such as training or reliability as being less important. (It is a reaction to "real engineers" looking down on systems engineering!) Try to avoid this tendency, there is tremendous value in the knowledge these domains hold. That wonderful product you just envisioned only counts if people also know how to use it and it works when they need it.

A year spent improving reliability, maintainability, or other supporting functions as your primary task makes it a lot easier to integrate those skills as a secondary task later in your career. You will see them as interacting systems to perfect, not simply random inputs added to a list of requirements.

"I suggest you be humble about that ability and verify it through analysis whenever possible, but do not be afraid to run with your feelings."

You will also discover there are "miniature versions" of systems engineering scattered throughout the supporting disciplines. Designing the system that supports a system is also design experience. It should not be too surprising that integrated logistics support analysis looks and feels a lot like requirements analysis in general!

Spend time learning to tailor.

Not learning to make clothes for people but learning how and when to make the necessary adjustments that enable a finite body of systems engineering process knowledge to support an infinite number of unique development circumstances. You only become a true systems engineer once you can diagnose the needs of a given development effort and prescribe a proper remedy.

Resist becoming a blind tool or process follower. Tools and processes are great, but it is the function those tools and processes perform that is their source of value. Staying open to alternate technical means is always a smart systems engineering practice! It is easy to consider yourself an expert once you can speak in arcane vocabulary, but true experts take the time to translate all those fancy terms into common sense language their audience will recognize.

Try being a Project/Program Manager (P/PM).

You will find the P/PM system of tasks and resources uses different terms but behaves a lot like the technical systems you design. Trying out P/PM is an opportunity to explore not only a career broadening option, but also an excellent chance to discover for yourself how fundamental, and thus broadly valuable, the principles that drive systems engineering really are.

Since every systems engineer has at least one P/PM somewhere in their world, it also helps to be able to speak the language even if you decide not to pursue the P/PM track!

Be patient.

Dates are artificial, especially important in business but worth forgetting entirely when scoring your life. Score yourself against your own potential rather than the apparent progress of other people. You will see people overlooked who deserve to advance, and others seemingly without a clue move ahead of you. Ignore them. It is not a race if everyone gets to choose their own path.

Being patient does not mean putting up with barriers or outright injustice. The message here is about not bailing before you fully capture an opportunity for learning. Growth matters, dates do not. Focus on doing, and accomplishments will find you at the right time.

Be helpful.

Yes, you should be helpful because being helpful is good and all that. There is also the powerful WIIFM (What's In It For Me) dividend of connecting with your own skills when you share them with someone else. Teach, mentor, develop teams, present professional papers; doing anything that requires you to share what you have learned with others offers this benefit.

Keep it simple. The earliest lessons are the hardest for you to remember and seem trivial, but those same lessons are also the hardest and most important for newcomers to learn. There is a deeply renewing magic in the shared excitement people feel when they first discover the potential of systems engineering.

Over the years it is possible you will find this shared excitement about the potential of systems engineering to change the world ends up being the most rewarding aspect of your career. That is certainly the case for me, and why I appreciate this opportunity to help in any way I can!

All the best,

Randy




Serge Landry

Shaping Your Journey Through Life

Driven by an insatiable quest for learning, Serge Landry graduated from three Universities, leaving his beloved countryside to bigger cities. Drawn into teaching to complement his scholarship, he was bitten by the travel bug leading him to South East Asia, lecturing at the University in Malaysia. He then joined the industry, engineering big projects, in Defense, Emergencies Management and Transport. He subsequently moved on to Research to push the boundaries of the possible. From his consulting firm, he now actively lectures, contributes to complex projects while also sharing System Engineering across Asia Oceania as INCOSE Director for the sector.

Dear 22-year old Serge,

A grand-mother's wish.

In a few years from now, our beloved grandmother will share with us the following wish: "*I wish I could re-live this life knowing all the things I now know.*" She will obviously not be able to do that, but it is my hope the content of this letter will equip you with the wisdom only a lifetime of experience can bring. My dear young self, here is my gift to you and to all those who are on their journey through life.

You are a confident and courageous young adult who had to live through a lot of challenges in your early years, both happy and sad. Despite all the obstacles, you are the first one in your community to have successfully achieved a university education. While it is true you have grown strong from this eventful early part of life, from your rich countryside community heritage to the faster moving cities, these early achievements pale in comparison to what you will be able to achieve moving forward.

An intriguing discovery.

That American Software Engineering book you just read, with a section on systems engineering, will influence the writing of your first lecture at your new University. And these new insights will also profoundly affect the direction of your life moving forward.

It is only after you embark in your journey through industrial projects and involve yourself in building larger and larger systems that you will fully comprehend the importance of what this book introduced.

When a single point of view is not enough.

Working on big projects, you will quickly realize your time and resources are too limited to be able to pursue individual perfection. Instead, the art of tackling such challenges will lie in defining what constitutes the 'good enough,' which will allow the definition of precise end goals to finish the job in a finite amount of time and with a finite amount of resource to the satisfaction of all stakeholders. Listen to the 'experienced hands,' the people around you who will guide you to understand where the good enough lies. In other words, define what success means and know when to stop.
I am indeed very privileged and thankful to one of the domain experts I worked closely with in my first big industry assignment for introducing me to this notion of 'good enough.' This is one of the grounding principles which has guided me ever since that day.

However, the path is not always an easy one. Knowing what to do is seldom enough in itself, you will also need to convince others and that will require perseverance, motivation, and method. At times when the going gets tough, keep in mind you are a contributor to something larger than yourself or the project at hand. A source of great motivation is to direct your efforts to the betterment of mankind; the notion of leaving some form of legacy behind. Hence, the need to share good practices, make your explanation

understandable by all not just yourself, and take the time and effort to convince all stakeholders using demonstrable facts and methods.

Systems engineers, who emphasized the need to justify any effort by recording an unambiguous trail of why we do things at every step of the way have been my mentors. This approach proves completeness on one hand and avoids wasting effort on the other.

Only when this has become part of your regular way of working will you realize you became a fully-fledged systems engineer and the importance it plays in solving big scale problems and, at the same time, the importance it plays in guiding you through your everyday life.

On the importance of teamwork.

No matter how good you are and how much you know, nothing remains the same, you might as well share your gift otherwise it may become outdated as time passes. This will go a long way in the recognition you seek.

I have met some people along the way, trying to hide what they do from others, wrongly believing this will allow them to stay ahead of their peers. In no time, their knowledge became obsolete.

Resist the urge to do it alone in a futile attempt to reap the reward for yourself. Remember you only have two arms and one brain. A much better way is to combine forces with others for optimum impact. I have also experienced the power of small and dedicated teams succeeding where big teams were unable to.

Communication is two ways, so you need to spend time carefully listening. Building your network and trust is essential and communication is a major tool to achieve this. Be yourself but remain humble and help others.

"Diversity fuels fun, passion, and innovation, it satisfies curiosity and enables sharing. It allows us to accept criticism humbly and joyfully. Embrace different opinions for richer outcomes."

I have learnt 'my ideas' are not really my own alone. How did I produce them in the first place? My influence was likely from others, and 'your ideas' will continue evolving in the minds of others. As you only have two hands and limited time, sharing your ideas is the best way for the adoption of a maximum of ideas overall, such as planting seeds for others to nurture. Shaping others and enabling their success is one of the most rewarding things there is.

Embracing diversity.

Keep on embracing your interest for foreign languages and cultures. There are so many things to learn and they all contribute to a diverse kaleidoscope of inter-connected ideas to draw our creativity from.

Systems engineers often see connections between things and concepts which other people may not see. This is a great source for inventions but also for preempting possible unintended consequences when implementing new concepts in everyday life.

Diversity fuels fun, passion, and innovation, it satisfies curiosity and enables sharing. It allows us to accept criticism humbly and joyfully. Embrace different opinions for richer outcomes.

Journey through life.

Choosing a path may appear intimidating. Let your enthusiasm guide you.

Learning, discovering is the way to approach the unknown, and making mistakes is part of learning and improving. You need to explore, measure, and evaluate to chart the path ahead and recording mistakes is an important lesson in continuously improving.

Determination and dedication will allow you to persevere, always asking 'why?' in your innovation journey, while pushing boundaries and accepting both feedback and criticisms at the same time.

"Learning, discovering is the way to approach the unknown, and making mistakes is part of learning and improving. You need to explore, measure, and evaluate to chart the path ahead and recording mistakes is an important lesson in continuously improving."

Keep that childlike curiosity of yours. It will keep you going and absorbing new things as they come. Keep on smiling and be kind to others as you journey together. Choose the things that matter most to yourself and maintain that greater aspiration of contributing to mankind.

Never ending path.

Never think you have reached the end as the path goes on forever bringing interesting things to learn and cherish.

Make sure to follow your heart at all times. I know you, and what you love, even if you do not fully understand yourself yet, and even if you beg to differ. Your desire is to learn and to contribute to the world around you.

There is no destination, just one long, incredible journey. Make every moment count!

Sincerely, with love,

Serge

Lefei Li

Our Wonderful 'System' Journey

Dr. Li is an associate professor in the department of Industrial Engineering, Tsinghua University. He is the Deputy Chair of the department and the deputy director of the Tsinghua Smart Logistics and Supply Chain Systems Research Center. He has been serving as associate editor for the IEEE Transactions on Intelligent Transportation Systems, IEEE Intelligent Systems and Asian Pacific Journal on Operational Research. Dr. Li is the chair of IEEE ITSS Technical Committee on Logistics and Services. He is also the assistant director of the INCOSE Academic Council and the past president of the INCOSE Beijing Chapter.

Dear Lefei,

You may be curious about what you will experience in your future. This letter is written to assure you that the 'better world' you promised to contribute to as a ten-year-old, is one that you are helping to make a reality.

I realize right now your future may seem uncertain. I think that if I share with you, guidance on how we look in the future, and on how we get to the future, you will feel a bit more reassured, and sure to remain dedicated to your academics, passions, and promises to yourself.

Let me share with you a 2021 user profile about you. You have achieved much, primarily, a son, who is 14 years old – a lovely boy, and a wife who loves you and supports you in any aspect. Also, importantly, you are teaching and promoting systems engineering in the best university in China.

As younger me, I know you have no idea at an early age what systems engineering is and why you will be drawn to this profession, but it is a part of who you are – a path you set when you self-proclaimed a promise to yourself at age ten to contribute to a 'better world.'

After graduating from high school, you will be attracted to one of the most popular majors, electronic engineering, for your undergraduate study. The surge of innovations like cell phones, internet, evolving wireless communication, and more encourages you to make the choice. Among all the courses, 'Electronics Systems Design' gives you the 'Aha!' moment – take time to really realize this moment and focus on that – it is about to become the driving inspiration for the rest of your career. Why? It is that interesting assignment of designing a scheduling system for the elevators of a building that make you fully realize what attracts you most in engineering… systems! With this inspiration, and without any hesitation, you change your major to 'Systems and Industrial Engineering' and you pursue doctoral study in the U.S. to work with the best systems engineers in the world.

"As part of this journey through systems, you start actively participating and contributing to INCOSE, the best authority on systems engineering in the world."

During your graduate study, you will be introduced to and guided by two extraordinary advisors, Professor Fei-yue Wang and Professor Wei-hua Lin. Take time to learn carefully from them. They will lead you into the study of the beautiful complex systems world. From this foundation, you begin your early career as a young faculty member; your curiosity about every interesting system is so strong that you extend your research into intelligent transportation systems, logistics systems, and retailing. This broad research base affords you the ability to think critically and carefully about the types of systems and realize your childhood interests.

Unbelievably, in 2021 you are participating in the design of an online hospital and even a smart city (talk about a better world!). Along with digging deep into these specific areas, your understanding of systems and system thinking continues to evolve. As part of this journey through systems, you start actively participating and contributing to INCOSE, the best authority on systems engineering in the world. Collaborating with them, you have promoted Systems Engineering in China and proudly helped thousands of students and engineers to understand, appreciate and adopt the philosophy, processes, and tools of systems engineering

through your lectures, research, and work.

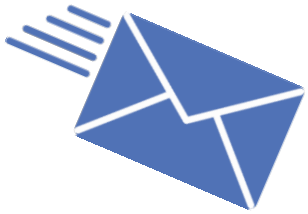
What you don't realize now, and you will not for many years, is that you are a natural systems thinker. With more research and practical experience in as you will age, you transition into the exploration of some other interesting and challenging problems, such as how to understand and design a System-of-Systems, how to integrate design thinking into the process of systems engineering, especially for service systems, and most interestingly, how to identify systems thinking concepts from the Chinese culture, e.g. "*What you do not want done to yourself, do not do to others*"—Confucius. This might perfectly explain the empathy phase to develop the value proposition for our stakeholders.

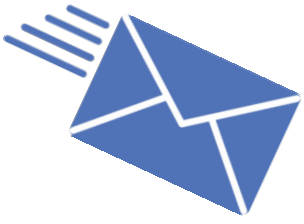
You have a bright systems future. Then again, you always have - after all, you still remember our promise to contribute to 'a better world' when we were 10 years old, right? You have kept that promise and vision alive and clear for us – I am so proud that you proposed this exact term 'a better world' during the INCOSE Vision discussion in 2016, and guess what, the current INCOSE Vision is "*a better world through a system approach*!" We are a living part of systems engineering!

Last but not least, our dad and mum are both very healthy and love us as always. So, nothing to worry about, just keep trying all the possibilities and appreciate what you have and what you are doing.

Yours truly,

Lefei





David Long

Looking from Technology and Parts to Humans and the Whole

David Long is an accidental entrepreneur. After studying engineering at Virginia Tech, he combined his passion for systems engineering with his programming hobby to develop one of the earliest model-based systems engineering tools. From there, he founded a systems engineering company. David is a Fellow and former president of the International Council on Systems Engineering. He continues to work around the world raising systems awareness and helpings others build cool stuff ranging from coffee makers to medical devices to spacecraft and even better companies.

Dear David,

It has been thirty years since I was in school, but every year as seasons change, my thoughts return to the classroom. This year is different though. Those thoughts of school were quickly replaced by thoughts of you – who you are today, the journey you are on, and the person you will become.

With luck, my journey is far from over, but I hope you will indulge me – not as I reminisce but as I reflect. Some things are clearer with time and perspective. Perhaps you could describe what follows as "life lessons" or even wisdom, but that is a bar too high. Instead, consider these thoughts as simple observations with the occasional word of advice. Do with these words what you will – the journey ahead is yours and yours alone. My intent is not to move you from your chosen path. My only wish is that these words be of some assistance as you live life to the fullest and make the most of your opportunities.

The son of an engineer, you have always loved math and science. More than that, you love to learn – something you already recognize about yourself. That learning journey will never end. But there is something deeper, something you know but cannot yet describe. At an age when many are still trying to find their way, you not only know that you want to be an engineer, but you also know that you want to be a specific kind of engineer – a systems engineer. Systems engineers solve exciting problems designing airplanes, putting humans in space, working to make the most of cutting-edge technologies… what could be cooler than that?!

But it is not the cutting-edge technologies (though they are cool), and it is not solving exciting problems (though that is rewarding). It is the way you think or, more specifically, the way you have been taught to see the world. You are not the son of an engineer, you are the son of a systems engineer – and not just any systems engineer, one of the best in the world. He taught you to see things in their context, looking at items, their interrelationships, and their connections. The way he described the world around us highlights those interactions, the cause and effect, the resulting value (sometimes positive value, sometimes negative outcomes). Though he never says so explicitly, he taught you to see the world through the lens of systems.

The way you see things in patterns, connections, and interrelationships is different than the way others have been taught to see and think – not better, not worse, but different. Sometimes this will put you out of step with those who are taught to delve deeply in specific areas, losing sight of context and interrelationships in the process. Respect and value the differences – the value of the two approaches together is better than either approach in isolation. When you feel out of sync, slow down, listen more, then communicate simply and clearly to help bring the best of both mindsets.

With your love of math and science, I know you expect to live your life delving deep into technology. Classified as an introvert, you were told that you favor self and technology over groups and people. Do not be overly swayed by this. There is no clear divide between introverts and extroverts. As with most things, there is a continuum, and you fall somewhere in the middle (what you will eventually learn is called an 'ambivert'). This will become clear to you as you study engineering in college and experience life on your

own. (And do not fret too much about the school you choose. I will simply say that it works out better than you could ever imagine.)

Your university studies will be about engineering and shaping the way you think. More than that, your studies will help you understand and refine the way you learn. After all, learning is a lifetime journey. What you cannot yet appreciate is how one university experience – choosing to be a resident advisor – will impact your path forward. The experiences unlocked on the residential side of campus equal the academic learning in the engineering classroom. The two together – the human and the engineering, the socio and the technical – will position you for opportunities to come.

As an advisor, you see and connect with people in a different way, helping them through challenges they face and celebrating the highs. It will add a new dimension to your leadership experiences (another lifelong journey) and a dimension that is complementary to your systems engineering efforts. Good systems engineering leads not from a position of power but from the perspective of service. Of even greater importance, these experiences will influence your perspective on people, shifting your focus from the technical to the socio-technical. Do not get me wrong – your interest in technology will never fade – but your interest in people, understanding their needs and desires, and crafting systems (technical, enterprise, and social) to address those needs will grow from this point forward.

"Good systems engineering leads not from a position of power but from the perspective of service."

There is much that I could share about your career, but that is a story best left untold – a story for you to write yourself. Understanding the system mindset you bring (a mindset that I believe anyone can develop), and the human dimension (something you should begin to explore as soon as you can) will equip you for fascinating opportunities. The third and last part of our journey that I wish to share is the impact that a volunteer professional organization can have on your life.

Engaging with the appropriate professional body is key to any professional's journey. In the case of systems engineering, that nascent body is INCOSE, the International Council on Systems Engineering. INCOSE is a group of like-minded people seeking to advance the practice and the discipline to "create a better world through a systems approach." That network and the opportunities it creates will shape your life in ways that you cannot predict. The opportunities are technical (connecting with and learning from experts around the world), service (giving to others both in the discipline and beyond), and professional (working alongside committed individuals and growing through volunteer leadership). Reflecting back, the blend of family, university, and INCOSE fundamentally shape the path you take.

You will not reach my point in life without some missteps, but this letter is about reflections rather than regrets. If you will permit, there are a few words of guidance to offer – small things that may be of high value.

- Engineering studies offer little time for other coursework, but math and science alone will not fully equip you for what is to come. Solving technical problems has its challenges, but those challenges pale in comparison to the human dimension. Find time to give yourself some formal foundation by taking a class in psychology or sociology.
- One of the greatest tools in a systems engineer's toolkit is the ability to help diverse groups come together, bringing their insights and perspectives to a common problem. Even more important is helping those individuals see the interactions and interdependencies in the solutions they develop. Good

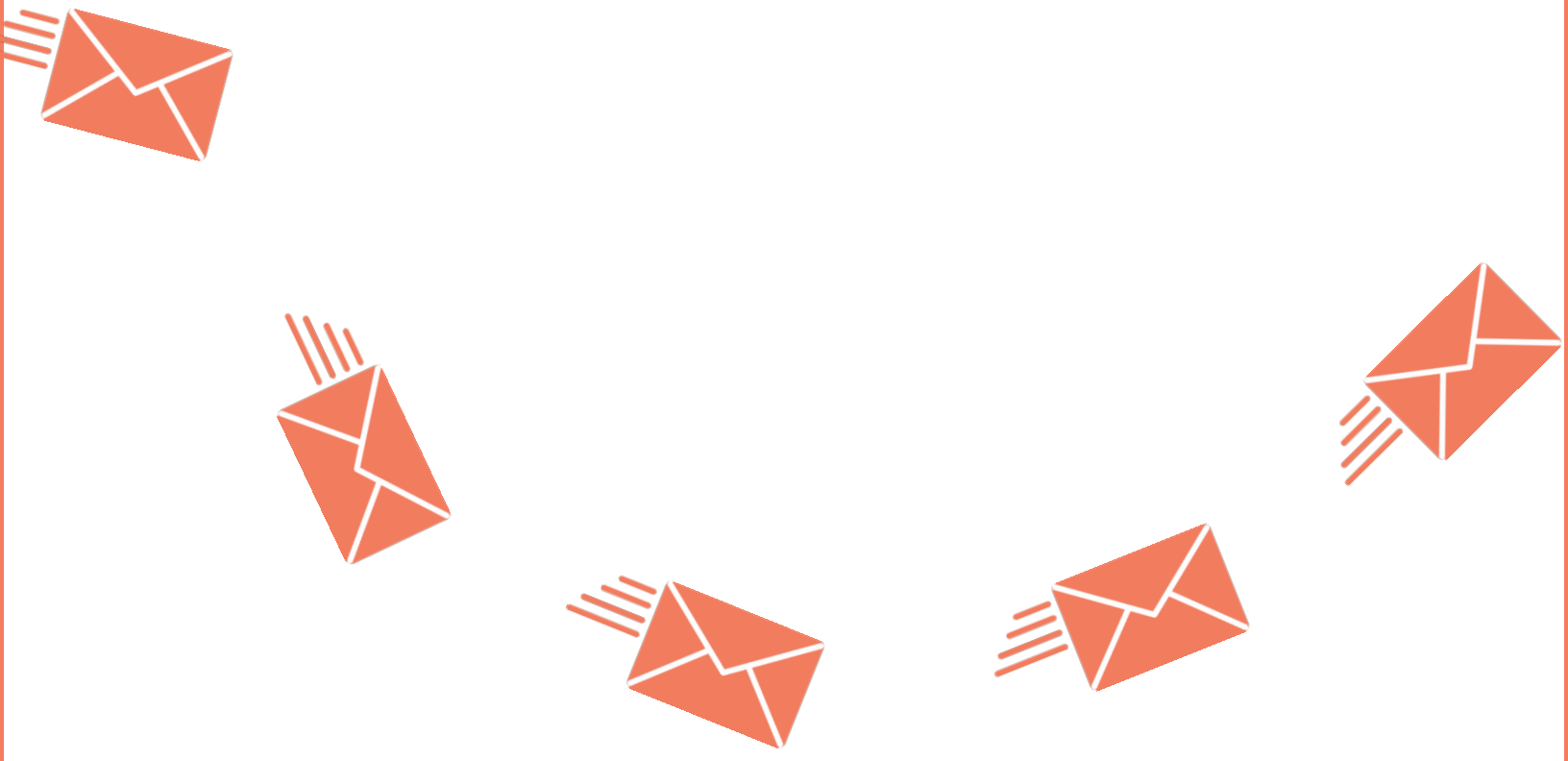
systems engineering reflects the attitude of service, helping to reawaken the systems mindset in others, not to make them systems engineers but to complement and amplify the value they bring.

- The communication classes you take may focus on writing and speaking – both important skills – but the foundation is listening. As a systems engineer and a leader, you must truly listen and hear, eliciting the insights of others and reflecting those insights as you help the group move forward together.
- A colleague recently said, "looking back, I see my life in three stages – first learning, then earning, finally returning by giving back to others and my field." The thought is nice, but there is no need for the divisions. Rather than seeing the world as a series of OR choices, seek the AND. Embrace life-long learning, earn as you remember true wealth is far more than monetary, and return continuously. The Latin phrase 'Ut Prosim' ("That I may serve") is a motto worth holding close to your heart.

Isaac Newton is credited with saying "*we stand on the shoulders of giants*". Your future is bright with tremendous opportunities unlocked by the technical advances of the 20th century. It is up to you to build upon that foundation leveraging the power of the systems perspective. Never be afraid to choose your path and recognize that life itself is a system. Treat it as a complex problem. Form a hypothesis, experiment, gather data, and learn as you move forward. Put simply, probe, sense, and respond, because there is progress even in missteps if you learn.

Best wishes and enjoy the journey ahead,

David



Kerry Lunney

Exploring Your World Through Systems

After wanting to be a teacher, then a medical researcher, Kerry changed her mind on the last day to apply for university, to undertake a bachelor's in electrical engineering, because it sounded interesting. From that point there was no looking back. She completed her masters and other post-graduate studies, spring-boarding to the next opportunity in engineering that surfaced, often with little warning. Kerry was identified as a systems engineer before she knew it herself! Her career has straddled many industries, has led to working overseas (4 times), and has provided a path to positions of leadership, including President of INCOSE.

Hello Kerry,

I am writing this letter to you from a hotel room in Albuquerque headed for Houston tomorrow (yes, I had to check the spelling a few times). I met with amazing people over the last few days, some completing their undergraduate courses like you will (I hope), and others imparting their wisdom and experience from many years in the workforce. Tomorrow will bring additional opportunities and excitement as I meet with more like-minds on system-related topics.

Never did I think I would have the life I do. At school, I knew I wanted a career and a great family, but I did not imagine the journey I am on. My compass surely pointed in a favourable direction.

Knowing your independent streak, here is some advice for you to consider as you map out your future. This letter focuses on "all things systems" to encourage you to pursue a similar career. I have also thrown in a few other points you might find useful. So, let us begin...

If you think you oversee your destiny—think again! My entry into systems engineering was more by accident starting with an unexpected opportunity arising from a ride in an elevator with a senior colleague who saw potential in me. He, in turn, became my champion, and still today I consult with him on systems topics and work in general. It was he who introduced me to the National Council on Systems Engineering, NCOSE (later renamed the International Council on Systems Engineering, INCOSE) and strongly suggested I get involved, by which he meant organise the inaugural conference for Australia! My "initiation by fire" turned out to be one of the best decisions of my life. The takeaway—seek your own champion and doors will open but remember, it is entirely up to you to walk through them.

Do not hesitate to work as part of a global team if you get the opportunity. I have worked on some large system projects in multiple domains, across the world. Not once in my wildest dreams did I ever envisage working in over 12 countries and living for extended periods in 4 of them. Not many other engineering disciplines can offer you this variety. If this is appealing, perhaps working in systems may be for you. I highly recommend it.

Make the most of "unexpected career moments." For me this included working with a seasoned engineer from the Apollo space program and leading multidisciplinary teams located worldwide. I also unknowingly changed the direction of a systems design after a discussion with a very senior executive. The most recent unexpected career moment was being asked to consider running for presidency of INCOSE. These hidden disruptive gems can change your life; so adapt, adopt, and learn.

Your working world is ever-changing so you cannot be static. With the speed of technology, change, the growing interdependencies between disparate systems, and the increasing connectedness of the world, systems-related work keeps evolving with time. I find this balancing of creativity and process, and likewise between art and science, stimulating. Investing in yourself is necessary—no one can do this better for you than you. Start by learning your craft and then only use it as a basis to expand upon, do not rest on it.

In the world of systems, you may find yourself leading, particularly when complexities in the project are great. To aid you, look for those inspirational leaders whose traits you would like to emulate. I found many across the world and in different fields and industries, but I will let you find your own that will best inspire you.

I take pride in working with teams. Tackling a problem is so much easier when it is carried out by "us" not "me." It also makes it fun. I specialise in being a generalist, so my performance often measures on the team's performance. Therefore, contribute to the best of your ability. You cannot succeed in the world of systems without teams, showing positive team dynamics, diversity, and inclusion.

Working in systems engineering as a female I have been in the minority. This may continue in your work time but do not be overly concerned as improvements are occurring daily. Take note: you "will be noticed." Capitalise on this and build on your strengths. Do not lose that "quirkiness" that made you stand out in the first instance.

The perfectionist in me has served me well, particularly when interacting with clients on the systems under development. Knowing when "enough is enough" is also vital. Juggling these two characteristics is important for developing, delivering, and supporting systems. The challenge you need to be aware of is the difficulty you may have in saying "no." Do not let sleep become a luxury rather than a necessity.

In any industry you select to work in, remember to give something back to it. For me, I chose INCOSE with the goal of contributing, influencing, and participating in the evolution of my discipline. In doing so, this gives me great satisfaction both at work and within INCOSE. It is my means of saying "thank you."

Remember family and friends. Without them you will not be you. When I look back there have been times when I have gotten this wrong. Be conscious of work-life balance and invest energy on both sides. I must regularly remind myself.

When you find those times when your work is all consuming or a personal challenge is daunting, do not give up. I have a mantra I have used since I was 17, attributed to Goethe. It goes "*Whatever you can do, or dream you can do, begin it. Boldness has genius, power, and magic in it*." Find one that will work for you.

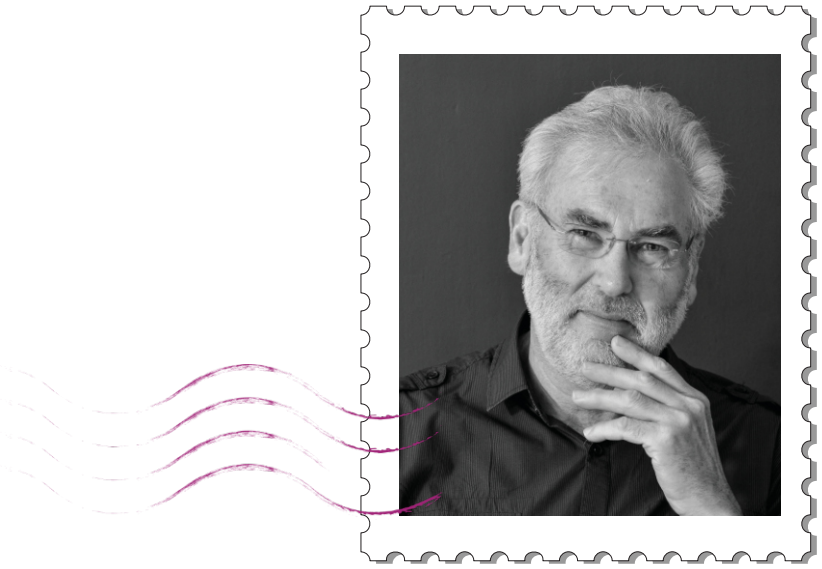
Kerry, if you get the opportunity to work in systems-related fields, make the most of it. You will have opportunities to work on projects large and small, complex and not so complex; you will work with and learn from a wide breadth of experts; you will travel, work, and live in incredible locations around the world if you so choose; and you may even be able to influence the betterment of the world!

I wish you well. Good luck and enjoy the life ahead of you.

Your older self,

Kerry

PS—I expect we will live to a ripe old age as your grandparents have. If so, I may write to you again with a later instalment on your potential life!



Roger McCowan

Exploring the Exciting World of New, Novel, and Complex

At school, Roger McCowan decided to do Engineering – he liked designing things and STEM subjects were more interesting (and more challenging) than other subjects. Roger graduated as an Engineer (majored in Communications) and soon became passionate about Systems Engineering as it aspired to develop holistic (instead of piecemeal) solutions. He co-founded the Systems Engineering Society of Australia and mentored other Engineers. Roger has worked on solutions for air traffic management, road tolling, navy fleet sustainment, over-the-horizon radar systems and others. He has received several awards that acknowledge his passion and enthusiasm for Systems Engineering.

Dear Roger,

Let me tell you about a fascinating journey. It is the journey I have been on, and it is the journey that will unfold before you. The journey is fascinating for several reasons, of which the most notable ones are that it involves engineering and I am yet to identify the destination. This journey is like exploring a new country – there are so many paths to take and things to see and do along the way. It never enters your head to say to yourself "Been there, done that, now what do I do?" There is always something new, novel, and different at the next step along the journey.

Every journey has a starting point. Just as I do not know the destination of my journey, I cannot pinpoint the start. I am sure you are just as fascinated by how and why things work as I am. Consequently, we always relish a challenge. If something was not working properly, I would never baulk at trying to fix it, even if I was unsure about its operation at the outset. Most of the time, I succeeded. Even if things were working properly, I thought of ways to improve them. This might sound odd, but the one thing I really wanted for my career was for it to present challenges along the way. I certainly did not want a job where I knew what I would be doing every day, or even one which provided a few years of varied experience, then virtually repeated those few years many times over for a 40-year "career". You would not want that either.

Although I had already embarked on studying Engineering (majoring in Electronics and Communications), my first pivotal moment that started me on this journey was discovering the etymological link between "engineering" and "ingenuity". I am not a genius, but the prospect of doing work that relied on ingenuity was just too good to pass up.

Communications Engineering is about getting devices and systems to work together. Challenges arose causing ingenuity to become a necessary impetus when people sought to have interworking between devices and systems that were never intended to operate together. In addressing these challenges, I became aware of a field of engineering called "Systems Engineering" which is exactly this: trying to get systems and subsystems to function together as a synergistic whole.

"What I have ultimately uncovered is that we do not know what the future holds, because there are numerous factors that can influence it. This is why I do not have a destination in mind for my journey."

Another pivotal step in my journey was being able to meet the pioneers of Systems Engineering. As part of my undergraduate engineering studies, I was familiar with those who had shaped mathematics and engineering: Newton, Kelvin, Maxwell, Kirchhoff, and so forth. However, they were all long since dead and buried. Upon hearing about Systems Engineering, I was fascinated to find that those who were evolving the body of knowledge on Systems Engineering were alive and well – many of them (Blanchard, Fabrycky, Lacy, Long, etc.) around my own age. Rubbing shoulders with them, talking with them, and making suggestions regarding problems they are wrestling with, as well as listening to their suggestions for the problems I am wrestling with, became a normal undertaking. By doing this, I could be part of something new, something evolving, and contribute to shaping the future. Systems Engineering is continuing to evolve, and you will similarly guide its evolution.

What I have ultimately uncovered is that we do not know what the future holds, because there are numerous factors that can influence it. This is why I do not have a destination in mind for my journey. It is about adapting to what lies before us. More importantly, it is about relying on ingenuity to help ensure that what lies ahead is better than it might otherwise be.

The final fascinating aspect of my journey as a Systems Engineer has been the need to learn about and understand the many fields of engineering – electrical, mechanical, software, environmental, civil/structural, hydraulic, etc., along with other fields of science, economics, and so forth. To be clear, I did not have to learn or understand to the depths of detail that specialists in these individual fields have, but certainly enough to make the best design decisions and judgments to ensure an optimal solution is reached, considering technical risks, system quality, and project cost and schedule.

As a Systems Engineer, you will have an even more fascinating journey, provided you do not just go along for the ride. Be up-front in the driver's seat, deciding which path to take for the journey!

Best wishes for your journey,

Roger

Dorothy McKinney

Experimenting to Kickstart Your Learning Journey

After majoring in English (and accidentally earning a second major in Systems Sciences taking courses which tickled her fancy), Dorothy McKinney worked as a Policy Research Analyst at SRI International. After a year, she concluded that policy work had little useful impact, and she started a master's program in Computer Engineering, and then moved into engineering. She was subsequently hired as a systems engineer before she knew what that term meant (Moliere's character spoke prose without knowing it; Dorothy practiced systems engineering without knowing it). She had various technical and management roles, ultimately becoming Fellow Emeritus at Lockheed Martin.

Dear Dorothy,

I can see that you passionately want to make a difference, and also that you really get a lot of satisfaction from improving both processes (so your efforts and those of your colleagues are more effective) and products (so you provide your customers with results that are more useful to them). Let me offer some insights from my career journey which may be of help to you on your own journey. I did a lot of learning by trial and error, especially early in my career. I learned a great deal, but it took much more time and emotional energy than it could have if I had had these insights sooner. I hope that you can profit from my experiences.

The first insight I would like to offer you is the importance of doing experiments. I discovered that if I did something deliberately as an experiment, with the aim of learning from the outcome of the experiment, I never failed. Oh, I did fail to reach goals I set from time to time, but each time my activity was not a failure, because I was able to learn from it. Framing it as an experiment, I explicitly acknowledged that I did not know for sure how to make my efforts successful, so I was alert for symptoms indicating that my approach needed to change as I proceeded. In contrast, when I was sure I knew how to do something, I was not as watchful for symptoms to show when my approach was not leading toward success. Perhaps the biggest benefits of doing activities as experiments were the emotional consequences — I was much more open to learning, not as defensive about my failures, and more receptive to evidence showing what worked well and what did not work so well.

The second insight I would like to offer is the value that systems thinking has to offer. Many times, early in my career I "solved" a problem, only to discover that my solution caused other problems later on. Taking time to understand the big picture, and how different people, products, systems, and environmental factors relate and interact can make a huge difference. This enables you to ask better questions and come to a more complete understanding of the challenges you face, and also enables you to devise solutions which have a much better chance of immediate as well as long-term success.

The third insight I would like to offer is that for most of us, the best path to career success is discovering the intersection of multiple skills and interests you have. Often, the most successful professionals are the ones who can combine the technical discipline or field in which they have chosen to work with skills and interests from other areas of their lives. For example, an engineer who develops great communication skills (perhaps by supporting community outreach activities for their favorite charity) can be much more effective. Or a designer who develops great illustration skills (perhaps by writing manga comics in their spare time) can be much more effective in communicating important aspects of their designs to customers and management. The delightful consequence of relying on multiple interests and passions for your career success is that your non-work interests and activities can help your career succeed, so you get "career mileage" from many of your leisure activities.

"Consider yourself always to be a work in progress, and so pursue continuous learning, growth and development. Taken together, these offer you the best possible chance for the career you wish to have."

The fourth insight I would like to offer is that there is so much to learn that it pays to be very selective about what you choose to learn next. Learning something which you might need to know someday is very

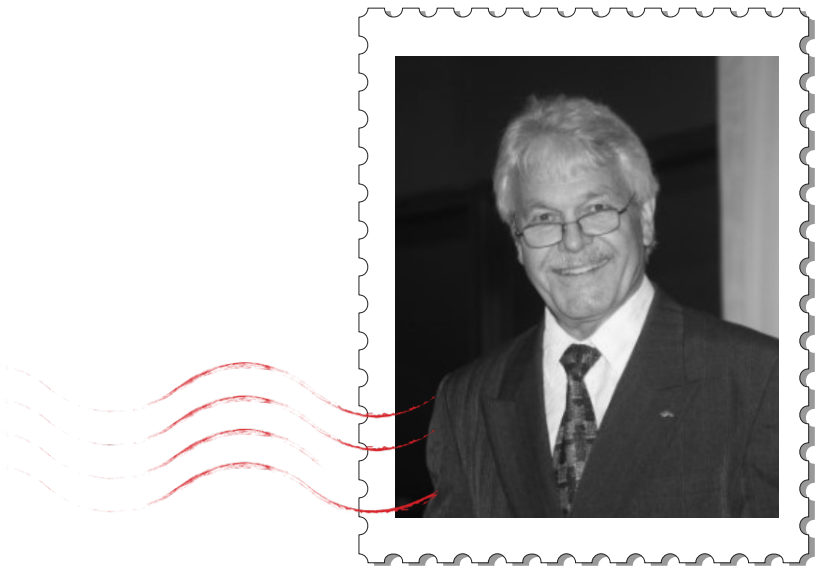
ineffective, because research has shown that if we don't put new knowledge into practice very soon after we acquire it, we do not retain it. The best source of guidance on what to learn next comes from insightful mentors who have deep insight into both your own interests, strengths and weaknesses, and the profession and industry in which you work. The reason you need multiple mentors is that no one person has all of the information and perspectives which would be valuable to you; also, by weighing the input from multiple people, you improve your own skills at assessing information. In contrast to insightful mentors, I discovered that poor sources of guidance about what to learn include:

- What “everybody” says, or public perceptions about what people in a given profession need to know (because by the time the information becomes common public knowledge, the profession has evolved, and effective professionals have moved on to focus on newer knowledge)
- The headlines or advertisements for articles and books (because there are many and most of them advertise themselves as critical for your career progress)

In summary, I think it is very important to take responsibility for your own career development, and find multiple people who can advise you and serve as people you can bounce ideas and concerns off (mentors and friends). Consider yourself always to be a work in progress, and so pursue continuous learning, growth and development. Taken together, these offer you the best possible chance for the career you wish to have.

Your mentor from the future,

Dorothy



René Oosthuizen

A Message to Younger ME - A Systems Engineering-Inspired Guide to Wisdom

René's 41-year engineering career in defence gradually morphed into one with a strong focus on systems engineering. His interest in systems engineering was amplified when he joined INCOSE where he held various leadership and volunteer positions at Chapter, Sector and Central levels. He was honoured to receive an INCOSE Founders Award in 2020. At the onset of his late-life career with many facets, René continues to serve INCOSE and provides Systems Engineering Professional certification training in association with The REUSE Company in Spain. His special interest is Social Systems is his endeavour to contribute to a better world.

Dear Younger Me, René,

Prologue

This letter to you, younger me, reflects on our life journey and how discovering the systems thinking philosophy and systems engineering discipline enables our search for sanity within a troubled society. This is a journey towards wisdom in life and a better world.

Our Early Career Journey

We graduate as an electronics engineer in 1976, complete a Master's in Business Leadership in 1987 and earn a Diploma in Export Management in 1995. Life is kind to us, it deals us a fine hand. The jobs we hold provide huge opportunities to develop, become business-savvy, and exposes us to the bigger world out there. We establish our own consultancy company in 1994, which morphs into a business with a systems engineering focus by 1999.

By societal norms we achieve early-career success. Whilst our primary focus in life was never monetary wealth per se, we are pretty much keeping up with the Jones' by mid-life – our family has a comfortable lifestyle and with residence and vehicle mortgages redeemed, we reach financial independence. Our upbringing, education and career were shaped by societal norms underpinned by capitalistic doctrine and a free market economy.

Life is hectic and driven by our career aspirations and family chores. It turns out that our lovely wife did such a sterling job at housekeeping and raising kids that we would spend a disproportionate amount of time pursuing our career activities. The intoxicating rat race was solidly in control of our life. This reminds me that it was also around this time that we discovered the joy and health benefits of fermented fruits of vitis vinifera and became avid wine lovers!

It is at this point in our life where I take leave of you for a fast-forward reflection on my life journey. Not to fear, I will be back!

My Journey

On reflecting, I realize now our life was pretty much self-centric, shaped by upbringing, early life career choices and subtle indoctrination by mainstream media – constantly bombarded by get-rich-quick schemes and incentives to keep up with the Jones'. Society was something that lingered in the background and could be exploited for our personal gain. It provided a shoulder to cry on when we felt weak or uncertain and in need of shedding a tear.

Success was punted as synonymous with monetary wealth – does being a multi-millionaire at age 35 and retirement at 40 sound familiar? The irony of the matter is that money had become an 'end in itself,' for us, rather than 'a means to an end' for which it had been intended. Society's obsession with monetary and material wealth rather than enterprising and spiritual wealth influenced us in ways we did not want it to – where are the $E=mc^2$'s punted?

But there were many other things that increasingly bothered me. Exploding human population; pollution; wastefulness, throw-away society; poverty; societal disparity between haves and have-nots; the rich becoming richer and proportionately fewer, the poor becoming poorer and proportionately more; human indifference to, and disrespect for other life forms and the environment; the list goes on and on and on...

Clearly these concerns add up to gross global and societal unsustainability, and one did not have to be an Einstein to comprehend this.

We would often contemplate and debate these societal challenges when we had the opportunity to sober up over a glass of wine after an intoxicating day at work. None of these were simple matters and they clearly cross-impacted one another. We were dealing with hugely complex, if not chaotic and wicked challenges. We were uneasy. These deliberations led us to believe that a holistic and systematic approach is necessary to make head or tail. There was a need for a holistic approach, applying Systems Thinking and engaging the disciplines of Systems Sciences and Systems Theory.

There was an emerging awareness and suspicion that the epicenter of the 'uneasiness' conundrum was the egotistical 'me' and the lack of consideration for the impact of 'my' actions….

The Awakening

In 2004 I had the fortune of being introduced to the International Council on Systems Engineering (INCOSE) by a good friend. This was a huge step for me because I had previously shunned societies, questioning their value added – back to the 'what's in it for me, value for money' syndrome. It turned out this society was different, I got traction!

INCOSE turned out to be a breath of fresh air in my systems engineering career. Membership gives access to a wide range of offerings including the Systems Engineering body of knowledge (SEBOK), technical products (the INCOSE systems engineering handbook, guidelines, publications, periodicals, etc.) and services (conferences, workshops, webinars, etc.), working groups, a technical leadership programme, and professional certification. Paramount though, is the opportunity to interact with like-minded systems engineers from all over the globe.

Soon after I joined INCOSE via the local Chapter, I developed an indescribable affinity towards the society, which led to substantial involvement as time went on. Enthused, I attended conferences, workshops, and webinars at Chapter and international levels – these were enriching and exhilarating and before I knew it, I was engaged in leadership roles, first at Chapter, then Sector, and eventually INCOSE Central level – what a journey!

My systems engineering knowledge and depth of understanding of systems further developed during my INCOSE journey. In my efforts to contextualize, I envisioned systems engineering as a Systems Tetrad embracing Systems Thinking, Systems Science and Systems Theory. I found that systems engineering applies a holistic, life cycle-based approach founded on Systems Thinking, Systems Science, and Systems Theory, and is enabled by certain fundamentals, technology, processes, and tools. This led me to realize that the systems engineering discipline is ubiquitous and applies to engineered, social, and natural systems domains.

I came to realize that the everyday perception of systems engineering has a strong association with human-engineered systems. It was thus not surprising to me to realize that human-engineered systems are best understood and able to demonstrate the value of systems engineering. Natural systems possess a wealth of systems wisdom, which I have seen in recent times captures increasing attention of the systems theorists. However, it is social systems that aroused interest and inspired my inquest into the 'uneasiness' conundrum.

Perplexed by the latter, armoured with deeper insight into the Systems Tetrad, and driven by a quest for a better world, I embarked on a journey to better understand the dynamics and behaviour of social systems. The journey was enriched by numerous interactions with like-minded systems engineering and INCOSE colleagues and friends across the globe.

I have this observation to share at this juncture: "A system comprises interacting components, contained by a boundary that separates it from an external environment. A system impacts on, and is influenced by, the

environment. Interaction between system components give rise to an emergent system behaviour determined by the 'integral' rather than the 'sum' of its components."

Everything we can conceivably imagine is a system – systems exist at all scales, from sub-atomic particles to the entire universe itself. Systems differ in complexity – the Cynefin framework defines five domains, namely simple, complicated, complex, chaotic, and disordered. I had a hunch that social systems are extraordinarily complex, bordering on chaotic and vulnerable to disorder.

I concluded that we are facing a wicked problem, because complex and unpredictable human beings are the basic system components of social systems.

Mother nature was pretty much under control until the advent of human supremacy and the onset of the technology revolution. The latter brought social advancement, but at huge cost, including unintended consequences such as population explosion, and societal disparity and polarization. The situation is exacerbated by socio-politico-economic evolution fuelling undesirable human traits such as self-centricity, greed, excess, wastefulness, discrimination, and disregard for other life forms.

Inspired by INCOSE's vision 'a better world through a systems approach' I set sail on the 'uneasiness' conundrum voyage. I did not have the luxury and wherewithal to delve into theory and literature available on social systems, hence, I took a clean slate approach adopting the 'keep it super simple' (KISS) principle. I was under no illusion that my voyage would lead to The Solution to global challenges but was hoping it would seed a Game Changer initiative contributing towards a better world.

In my deliberations it seemed reasonable to consider 'me' as point of departure. Furthermore, as a system component 'me' interfaces and interacts with many other 'you' beings surrounding 'me' in concentric spheres of influence. With 'me' in the centre and projecting outward, the four spheres of influence represent family, friends, society, and environment, the latter including all other forms of life (fauna and flora) and inanimate objects. 'Me' and the four spheres of 'you' collectively represent 'we'.

It struck me like a bolt from the blue that I had stumbled upon an obvious yet extremely fundamental truth, ME + YOU = WE. Simple at face value, but immensely impactful, I had stumbled upon my $E=mc^2$, which I dubbed the MEWE© principle! It postulates that ME interacts with, and therefore impacts on, every other MEWE sphere of influence. An important characteristic is that ME impact has the potential to proliferate exponentially via social networking. Conversely of course, WE impact ME.

Systems engineering is a process-driven activity with emphasis on doing the right thing right, the first-time round. To achieve this, the INCOSE Systems Engineering Handbook defines various technical processes. One process, namely 'stakeholder needs and requirements definition' resonates with MEWE. ME interacts with each sphere of influence in terms of message content (the what) and message tone (the how). The message content relates to ME needs, whilst the message tone relates to ME-WE interfaces.

Based on the foregoing it is a no-brainer that ME needs impact hugely on WE, and that in a strained world, restraint in ME needs will reduce demand and alleviate pressure on resources. In systems engineering vernacular, needs relate to requirements. It is a well-known fact that ill-considered and poorly defined requirements are a, if not the, primary cause of failed engineered systems, whether it be performance deviations, cost overruns, or delivery delays. The same applies to social systems and, alluding to the 'what' and 'how' above, I believe 'ME needs' and 'ME-WE interaction' are fundamental keys to unlocking a better world.

Imagine the cumulative impact on WE if every ME need were reduced by even a small margin. Systems engineering guidance teaches that needs should be defined mindful of functionality, life cycle cost, and disposal. Imagine the impact that critical thinking based on these criteria could have on the ME footprint on WE. For example: family planning mindful of run-away global population growth, poverty, and unemployment; household and transport needs based on utility rather than pampering ego and keeping up

with the Jones'; utilizing technology to switch some business events and recreational activities from physical to virtual. Cherishing a minimalistic lifestyle would be for the greater benefit of WE. ME should strive to be a net contributor to, and not to become a burden or sponge on society.

Respect starts at home, with ME. It is called self-respect, without which it is impossible to respectfully interact with WE. The latter implies not only that the content be transferred efficiently, but also that it be conveyed in a manner that respects the other party to the transaction. It is the latter that often creates the barrier to effective interaction. There is a subtle difference between reacting to a stimulus, which is typically immediate and driven by emotions, and responding, which is considered, more thoughtful and backed by reasoning. Respect favours response over reaction. Little things count, for example reacting to an e-mail addressed to multiple recipients and merely click the 'Reply All' button instead of responding selectively to those concerned.

Having adopted the keys to a better world I am convinced that ME needs tempered with systems engineering-guided critical thinking, as well as respect for and thoughtful interaction with WE, can make a difference in the quest for a better world. I re-imagined myself from being 'the centre of the universe' to being 'in the centre of the universe' – a world of difference!

My association with INCOSE enriched my life immensely. It provided the opportunity to experience, listen and learn. It inspired me and provided the wherewithal to explore the labyrinth in pursuit of a solution to the 'uneasiness' conundrum. It humbled me and enhanced my life journey towards wisdom! I switched from ME-centrism to WE-centrism… I found resolve.

My Message To Younger Me

I encourage you: have a sustainable world, an equitable society, and respect for all life forms as your vision in life and ensure that your life mission resonates with it. Down-tune fixation on monetary and material wealth and up-tune your quest for wealth of the soul. Strive towards a worthy legacy, your $E=mc^2$, and refrain from lauding yourself based on worldly acclaim and possessions.

Think holistically and conceive of yourself as a small cog in a huge machine. The latter does not imply irrelevance, as malfunctioning of a small cog could cause catastrophic failure of the machine. Embrace systems engineering in all deliberations, it is not rocket science, but merely formalizes common-sensical fundamentals! Apply critical thinking to everyday life, make systems engineering a way of life.

Embrace the MEWE principle. Respect yourself and your position in society. Deliberate ME needs, their impact on WE, and be sensitive to how you relate to WE. Think WE-centric, not ME-centric.

Your needs translate to requirements, which in turn relates to demands on all MEWE spheres of influence. Think utility, not keeping up with the Jones'. Ask yourself, when is enough, enough? Think life cycle, how will you dispose of your earthly stash when you scale down.

Your actions impact multiplicatively on each successive MEWE sphere of influence and have the potential to cause either good or bad. Bear in mind that every action has a reaction. Exude compassion and be respectful in every interaction. Refrain from reacting to stimuli from WE, take the time to respond. ME can make a difference and rub off on WE towards making the world a better place!

Knowing that you are an avid wine lover, you will relate to the age-old adage that 'life is too short to drink bad wine.' Picking up on these words of wisdom, I would like to leave a concluding remark with you, namely 'life is too precious to not embrace and live by a systems approach!'

Your partner in life,
Wiser ME,

René

Erika Palmer

Systems at any Age

After finding and exploring many interesting paths, Erika Palmer is now a systems engineer, specializing in social and sociotechnical systems. She has four degrees – all in different subjects, including a Ph.D. in Systems Engineering and Social Policy from the University of Bergen, Norway. Erika is a Senior Lecturer in Systems Engineering at Cornell University and Research Scientist at SINTEF Ocean. Her research is focused on systems theory, social system foundations of systems engineering and systems engineering for sustainability and societal challenges. She is chair and founder of the INCOSE Social System Working Group and INCOSE Grand Challenges lead.

Dear Younger Erika,

Your systems engineering journey will begin like many others – unintentionally. By the time you discover that there is such a thing as systems engineering, you will realize that you have been a systems engineer (or at least a systems thinker) much longer than your CV indicates. I want to write to you in the different stages of your life – from your childhood, to your teenage years, to your college years and beyond. At each stage, there are core skills to focus on that will allow you the flexibility to reinvent yourself as you find new ways to use systems to make the world a better place. I want to reassure you in these different stages to be true to yourself and confident in what you can accomplish.

To 8-year-old Erika: You are busy making grand plans that change by the minute, and you will be happy to know that through ups and downs along the way, you will find success! Focus on learning how things around you work and how to communicate what you learn. Once you learn what it means to think in systems, you will realize that you are already doing it. Your big ideas to make the world a better place, and the structures that are needed to make it work, are the beginnings of your systems thinking journey. Systems thinking will help you bring order to chaos in your sometimes crazy everyday life – systems will help give you a safe harbor. The world can be a frightening place - lose yourself in the fantasy of creating a world that is better for others. The systems you build will make you the superhero the world needs!

To 16-year-old Erika: Life is confusing right about now for you and choosing a direction in life seems like putting a stick in the mud, limiting your opportunities. The paths seem like they are closing when you make choices. While this may be true of some professions, I am here to tell you that becoming a systems engineer means that you can do anything you want. Systems are everywhere! Working with systems is a choice that gives you more opportunities, not fewer. Because systems are everywhere, once you decide to become a systems engineer, you are not going down only one pathway. Your options will grow. Also, you know how math is "your thing," – something that comes easy for you – though you do not yet know how this will be terribly useful in what you choose to do in the future. Trust me, it will be! Focus on STEM as a way to help you understand how things work and how everything is connected through systems.

To 24-year-old Erika: With one degree under your belt in the social sciences, you may feel that engineering is not in your future or that systems are not particularly relevant in what you will end up doing. Not only is this not true, the experience and education you have gained so far are going to be essential to the work you do as a systems engineer later. I know you feel like you are hopping from one thing to another, or when you go far down one path you doubt that it is really for you. Yet each of these experiences builds upon each other to provide a better understanding of the different pursuits and people in these fields. All these different jobs, choices and pathways will end up making you a better systems engineer. Focus on getting as many life-experiences under belt during this stage. You are on the road to making the world a better place that you dreamed about as an eight-year-old.

"Do not be led by other people's ideas of what success is or should be for you. Define your own success."

To the 32-year-old Erika: Now you have a family and are about to embark on a challenging PhD journey. Finding the right mentors along the way has shown you that you wanted to do a PhD; these mentors helped you see that your diverse background can be brought together with systems engineering. It is critical to find mentors at each stage of your life, and to make sure that they are the right mentor for you. This is especially true in the

PhD years. All PhD journeys are difficult, even though they have many positive moments along the way. Yours will be no different, and there will be many people in academia who are toxic and make the journey harder than it needs to be. The most important thing to remember is to believe in yourself, and do not let anyone make you feel that you cannot accomplish this. Because you are now more formally in the world of systems engineering, it will not come as a surprise that systems engineering really is your calling. What you do not yet realize is that you will find your tribe and your professional family in the International Council for Systems Engineering (INCOSE). You will find wonderful mentors and mentor others – INCOSE is a place that will encourage and support your creativity.

"I am here to tell you that becoming a systems engineer means that you can do anything you want. Systems are everywhere! Working with systems is a choice that gives you more opportunities, not fewer."

And lastly, on success: Although this is a message to you at several different stages in your life, you have at every stage felt driven to succeed, even if you did not yet know how you wanted to define this success. Do not be led by other people's ideas of what success is or should be for you. Define your own success. You will always be bored with cookie-cutter definitions of success and the straight and narrow pathways to reach it. I am not the wise elder future self that has all the answers. But I can tell you that it has been a great ride so far!

To enjoying the journey,

Your future self… *Erika*

Bill Parkins

Making the Connection: A Systems View of an Engineering Journey

Bill joined the navy as a 16 year-old as an apprentice electrical craftsman. He became a Systems Artificer, specialising in avionics. A tertiary education in Electrical Engineering, achieving a Bachelor's and a research Master of Engineering degree. Career highlights included engineering roles in surface combatant ships and leadership positions in major projects for the Australian Department of Defence. Bill attended several INCOSE International Symposiums in the early 1990s. He joined INCOSE in 1993, was a founding member of the Systems Engineering Society of Australia and became an Expert Systems Engineering Professional. Bill is the Immediate Past President of SESA.

My Dear Younger Bill,

As you develop into adulthood, you will be guided by the interests and occupations of your family and your local community. You will find your natural sporting ability will provide an avenue for meeting friends and becoming a team player (early systems thinking), which will be an important attribute for your future career.

Your academic interests will include history, economics, and science but you deeply desire to focus on topics relevant to engineering, mathematics, and physics. Although these subjects require a lot of study, you achieve outstanding results which stimulates you to want to learn more.

You will discover the term 'Systems' which is used in multiple subjects but has the same concept which you will find intriguing. Good teachers, instructors, and lecturers will motivate you to work to expand your knowledge and transform you into a 'Systems Thinker' and help you progress to achieving your undergraduate engineering qualification. You will find mentors in your early working career to help you develop your technical and interpersonal communications skills – grow these relationships and learn from these mentors. The lessons they offer are key to becoming a successful engineer in systems. Your early work activities will be guided by experienced engineers, and you will apply yourself to perform engineering tasks in projects, as you do, listen, watch, and learn best practices that you can use for the future to produce and lead others to develop superior systems. As you progress in your career, the project scale and scope will increase along with your responsibilities, it is important to draw on the lessons learned from your mentors in systems; it is also important, as a systems thinker to keep listening and learning to your stakeholders, mentors, and mentees. You will have the opportunity to interact with other disciplines and broaden your knowledge with study leading to qualifications in project and financial management – cherish these, as they will work to influence and enhance your systems thinking.

From the groundwork that you have laid for yourself in your early experience and education in engineering and management, you are now poised to seek systems engineering opportunities in industry, as a subject matter expert, for your own company. As a senior consultant, you will provide guidance on systems engineering, you will draw on your past learning to inform clients on techniques for management of systems engineering processes and the application to the control of subcontracted work during systems development. You will bring value to the domain, specifically in the tools-based approach to requirements management and specification generation. Take time to learn from the experience of working with other companies, cultures, and personality types. This will provide you an appreciation of what techniques to apply in different situations as you grow your business to achieve success.

"You will learn that conceptual solutions require the creation of views of the system based on an understanding of stakeholder needs and constraints and then communicating those views in a format that all stakeholders can understand and contribute to, as the project plans are produced and accepted"

One of the highlights of your career, and where you will form both professional and personal ties will be gained by attending the INCOSE International Symposium (IS), where you will hear from experts in many areas of systems engineering. The personal relationships established at the IS will help you greatly contribute to the community of interest in systems engineering in your local community.

The basis you have in systems engineering is strong, but you are always learning. Take the time with each customer to learn. As an example, during an Integration and Test phase of a major project, you will learn the importance of managing change to product baselines, which is critical to developing interfaces with other systems and platforms. This lesson of managing change to product baselines will bring further success to you in serving future clients or stakeholders.

This lesson attracts your focus to the definition phase of projects and working with business development teams. As you work in this area, engagement with stakeholders in the development of conceptual solutions and planning for the execution of projects will be an area you will find that you excel in. You will learn that conceptual solutions require the creation of views of the system based on an understanding of stakeholder needs and constraints and then communicating those views in a format that all stakeholders can understand and contribute to, as the project plans are produced and accepted. This is an important lesson, and you will be part of the systems engineers who first start to promote use of and use a system engineering tool in conjunction with performance modelling tool to demonstrate the expected behaviour of a system to the customer. This is a phenomenon that will change the discipline of systems engineering, and you will be an important player in this.

You help to introduce the systems engineering life cycle planning phase, a standards-based systems engineering process to ensure all aspects of the system lifecycle are addressed by an integrated project team including technical, operational, management, and support specialists. This is a testament to the hard work and study you put in to achieve your technical qualifications – later in life you realize the time you took to learn, listen to mentors, and inculcate the best lessons, provided the basis for further expanding your career as a technical leader and mentor. You come to realize that your work in setting up teams, career development of team members, and communicating with a diverse range of disciplines and competency levels, is personally and professionally satisfying and stimulating.

Enjoy the rewarding and enjoyable systems engineering profession.

I wish you increased luck on your journey,

Bill

Ramakrishnan Raman

The Futurist's Dilemma

Excited by technology and mystified by complexity, Ramki embarked on his industry career at Honeywell post his engineering masters. Gaining significant experience while designing complex avionics and industrial automation systems, Ramki established himself as an internationally recognized systems engineering expert. He became the first INCOSE CSEP from India, received an INCOSE Outstanding Service Award, became ESEP certified, published many papers, in addition to completing his PhD. He served as Technical Program Chair in notable international conferences, and remains active in INCOSE, IEEE and SAE. As a guest faculty in prestigious universities, he cherishes interacting and learning with budding engineers.

Dear Younger Ramki,

This is a letter from "Older Me"—from some time in the distant future…!!

At some point you will find yourself at a crossroad, deciding how to further progress in your career, and systems engineering is coming up as one of the options—should you, or should you not? This choice is daunting, and often viewed as—"is depth or breadth better?" Should you continue and develop as a deep specialist in a specific domain/technology, or should you broaden your capability by gaining knowledge of other disciplines and bringing in the broader picture of systems? As I have spent most of my career on systems engineering, I would like to share my perspectives.

To begin with, these are some of the traits I have found to make successful systems engineers: (a) always excited to solve new problems, (b) possessing the knack of surfacing unproven assumptions and assertions, (c) an aptitude to pick up new information/new ideas, (d) willingness to face many unknowns and still progress, (e) arriving at simple solutions for seemingly complex problems, and (f) exhibiting strong interpersonal/communication skills.

Why are these unique for systems engineers? It is because, a systems engineer will interact with experts across multiple disciplines outside of the area of systems engineer's expertise. Just imagine—if you need to complete engineering degree programs of four years each in mechanical engineering, electrical engineering, and computer science engineering, by the time you get good expertise in all these disciplines through formal education, it might be time to retire! Although you cannot do them all, you had at least one specialist technical area to use as a foundation for broadening into systems engineering. You need that for credibility in dealing with other specialists, in addition to having a strong technical base in the system of interest. And systems thinking gives you the foundation for appreciating the key nuggets of various disciplines that matter for the system of interest. While specifying and designing complex systems, you would need to exercise tradeoffs on many aspects and arrive at a balance among multiple conflicting scenarios across different disciplines. And you should expect to maintain the "technical conscience" while making the tough decisions; enough to build real world impactful complex systems.

To reiterate, systems thinking and "big picture" perspective are the distinguishing value-added factors the systems engineer possesses—factors which individual discipline engineers might often lack. Systems engineers develop the power of abstraction as applied to multi-disciplinary knowledge, but aptitude of science, engineering and mathematics helps.

As a systems engineer, you get to build a superior differentiated knowledge of the system as a whole and be the "conscience" keeper of the system objectives. Your knowledge on how the different constituent elements of the system come together to provide value, and your scheme encompassing the various technical factors that go into the design and development of the system, will be highly appreciated. Your "power" of approximate calculations and "thumb" rules will serve as a niche perspective which might even awe discipline experts. And despite all this unique differentiation you will have as a systems engineer, your ability to present it as a picture of team effort will mark your success.

And now, coming to the other side—will a systems engineer's journey be a smooth one as a cruise? No…!! Rest assured there are going to be many challenges, many troughs. Well, one point of view is challenges are what makes a systems engineer learn, and a positive approach to each challenge invariably leads to the possible solutions. However, challenges are at the core of any engineer's career, and after each challenge, the systems engineer needs to emerge smarter and wiser.

"As a systems engineer, you get to build a superior differentiated knowledge of the system as a whole and be the "conscience" keeper of the system objectives."

In these days, we subject systems to ever increasing footprint of product functionality, inter-connectivity, and differentiation. This results in an exponential increase in complexity associated with modern systems. Many challenges will surface due to lack of knowledge, assumptions, "unknown unknowns," and you must be willing to proceed despite them, watchfully. That is the core which one cannot teach in classrooms, but that one must experience and live through. When you encounter a challenge, leverage the same as an opportunity to further engage your capabilities and expand beyond what you thought was ever possible.

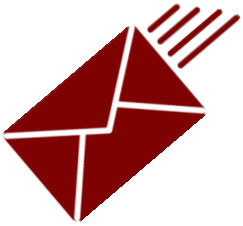
As a systems engineer, I always keep reminding myself to observe with an open mind, abstract the aspects that matter, surface "unknown" knowledge gaps, contemplate on the right questions to ask and problems to solve.

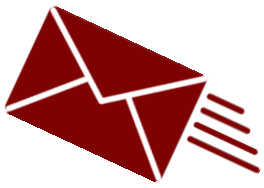
Hope this helps you in arriving at a suitable decision when you reach the crossroad.

Wishing you the best…!!

Best Regards,

Ramki





Federica Robinson-Bryant

A Testament to Persist

Federica Robinson-Bryant is a systems engineering professor that integrates systems thinking across her roles as a parent, a professor, and an engineer. Her career includes experiences as a renowned contractor, a systems engineer for the federal government and ultimately a professor and administrator for a systems engineering graduate program at a leading university. She sees every opportunity as set “among the elite” of organizations, people and problems. Federica enjoys creative arts and new experiences which abound in her field. Each engagement presents opportunities to establish and build relationships, learn and share intellectual prowess, and find fulfillment in the work tackled.

Dear Young, Vibrant and Curious Self,

Look around, do you see it?

Collections of elements seamlessly aligned to form the products you love, the experiences you seek, and the organizations you tend to engage. All laced with some nescient level of complexity – interconnections, dynamic behavior, varying perspectives and so on. On a daily basis, you are engaging with some abstraction of a system or system of systems, making your journey ahead, one of the most stimulating and flexible paths known to [wo]man.

What is it, you ask? What else could it be, really? Answer: systems engineering.

Systems engineering can be quite elusive for many. Is it a process? A way of thinking? An art? A science? A discipline? All of the above? You will ultimately adopt the relative understanding of the latter. It involves the conceptualization, design, integration, implementation, operation, management and retirement of engineered systems. This "system" may involve people, information, products, services, natural components and even a collection of systems. It overlaps with both technical and management disciplines like industrial engineering, engineering management, electrical engineering, human factors, software engineering, psychology, aerospace engineering, and so much more. It is truly a field where you can pursue your passion, given its broad applicability across domains and system types.

It continues to amaze me that an engineering career can be so rewarding. The systems engineering field and its community network is rich and robust. Its multidisciplinary and transdisciplinary nature instigates interactions with all kinds of people, places and things. Imagine all expenses paid work trips to places all over the world like Australia, Hawaii, Africa, California and China. Then imagine being submerged in different cultures, and among countless races and ethnicities that constantly shed insight onto who you are and how you choose to see the world. Now consider having access to masses of diversity in backgrounds and experiences that can be exploited through conference engagements, workshops, research, grants, job searches and more. The possibilities appear to be endless!

Before I get too far along, I must admit that I have reluctantly found myself writing this letter without truly knowing at the outset, whether it is more for the present me, the present you or the future us. I've spent most of my life embracing the notion that persistence through inequity would be my greatest feat. I can't seem to resist replaying lines from the most impactful literary piece for the life I have come to know:

"It matters not how strait the gate,
How charged with punishments the scroll,
I am the master of my fate,
I am the captain of my soul,"

William Ernest Henley wrote in his infamous Invictus poem. Every time I recite it aloud or even think about its meaning subconsciously, I feel it deeper in my spirit. I believe it more. It is different from the type of programming that surrounds me and others like me, thus it is this affirmation that continues to propel me forward.

Yes, I have found myself upon a metaphorical ledge or two, wondering whether to turn back or to pivot slightly from this industrial and systems engineering journey. As a black woman- young (30 something), country (rural upbringing but you know that…) and with 4 kids, affirmations for self-efficacy, or the belief in oneself, are scarce. You are constantly told what you cannot do or should not do. Artificial limits are often defined for you, but I encourage you to push through. Statistics and personal experiences scream silently in your sub-conscious that you do not belong; find the courage to reject the insinuation. Ensure that your desire to penetrate deep inside the vessel of industrial and systems engineering is unmoving. You are charged with finding ways to confront the system, show the system's agents something different and participate in the system's behavior, because the system must receive this stimulus to react and change.

I am sure you have already begun to see the world through a blurred and conflicting lens because there are so many opportunities to see it for what it is for you versus others. I cannot pretend that it is not hard or was not hard. It is! It was! There will be times when the faintness of the affirmations are not enough to dispel the myth that you cannot be successful. Be careful not to adopt the "glass half empty" view because with this, you will defeat yourself. Instead, make a conscious effort to embody resilience, persistence, tolerance and passion despite any circumstances. You will find that these "soft skills" as they call them, are your most valuable skills.
Yes, these isolating realities may seem hard to balance but Henley said it best,

"Beyond this place of wrath and tears
Looms but the Horror of the shade,
And yet the menace of the years
Finds and shall find me unafraid."

This is also where having a secret weapon is critical – a mentor. Our family does not have a similar academic or professional background so some challenges that you will face will be outside of their scope. I encourage you to be open to help, acknowledge when help is needed and to accept the help of authentic leaders across the field. They may actually be total strangers that live far away but technology has a way of mitigating the challenges of distributed interaction. I found my most significant systems engineering mentor by chance. I read an article and wanted a little more information about the work. I reached out to the author and a beautiful relationship organically blossomed. This person pulled me into her inner circles, maximizing my exposure to different people and efforts and ultimately, served as my biggest cheerleader. Be on the lookout for good people, and weary of those that aim to use you, as there will be more of the latter; the impact of a good mentor has proven invaluable. Getting back to Henley, this stanza seems appropriate:

"In the fell clutch of circumstance
I have not winced nor cried aloud.
Under the bludgeonings of chance
My head is bloody, but unbowed."

I do apologize for rambling but it felt necessary to provide context and mindset before adding more insight into my systems engineering journey. In case you are wondering, I am a systems engineering academic. I am a newly tenured, associate professor and past program administrator for the systems engineering, graduate program at our institution. Our formal education is in industrial and systems engineering (yes, you have earned a doctorate degree in engineering young woman!), you hold several systems engineering certifications and have practical work experience on a number of system types across several domains.

Here is what happened: As I navigated the collegiate space and learned a little more, I changed my major a few times before coming to engineering. Exploration among the engineering disciplines offered at the school revealed a catalog description that read like déjà vu, as I thought I was reading my biography or psychoanalysis results. I had a pre-existing, industrial engineering mindset and now there was a career option that would exploit it. I found a love in the work and possibilities, got involved in research and learned that it was a viable option to continue on through the master's and doctorate levels. This is where I formally met systems engineering and again, déjà vu. The notion of systems thinking, a concept characterized as holistic, interrelated, integrative, dynamic and transdisciplinary, is how we think. Even in what people may consider a simple problem or a rudimentary decision, your process will suggest otherwise. Varying levels of abstraction, multiple perspectives, mental models, finances, temporal considerations, optimization, and so much more are constantly running across your mind like Olympic sprinters seeking the gold medal. You simply cannot help it. You are an innate and habitual systems thinker.

Your formal career as a systems engineer actually began at a Department of Defense organization that manages the acquisition of a range of training systems for the US Army and other military entities. You served as a systems engineer for multiple systems of interest (SOI) across the live, virtual and constructive training domains during your tenure. You also earned a systems engineering certification from the Defense Acquisition University to help build on your academic foundation from a more industry-specific lens. In this role, you were very fortunate to be immersed in military and federal government culture with a goal of learning as much as possible over several years.

As you move forward, I recommend that you keep this in mind: the systems thinking and systems engineering mindset is not yet "normal". Your unique frame will add layers onto problems and issues that will likely result in a better outcome in the long-run but will also face resistance and opposition in the interim. I cannot tell you how to turn your superpower off or if there is ever a need to do. I guess time will have to reveal.
In an attempt to highlight the core of who you are, I do feel it necessary to end this letter with the missing stanza of Henley's poem (it is actually the first stanza), so I will leave you with this sense of completeness:

"Out of the night that covers me,
Black as the pit from pole to pole,
I thank whatever gods may be
For my unconquerable soul."

If you take away nothing else, consider this: This world of engineering and systems engineering is not an isolated bubble and by its very nature is integral in everything around you. It is one of the most opportunistic disciplines because of its adaptability across domains. It is where interest and expertise collide. It is where the impossible is broken down into the possible. It is where ambiguity and complexity become defined. As you navigate this systems engineering journey for yourself, remember that the key to success does not lie solely in your academic preparation or technical experience. It requires that you accept the things that you cannot change (for now at least), embrace all that is within you and work hard to establish your place, refine your frame and reap your rewards. The system is watching and waiting for stimuli. Your family and friends are watching, learning and being motivated to try different things. And you, each day, are morphing into the multi-faceted and dynamic being you are destined to become.

To our future,

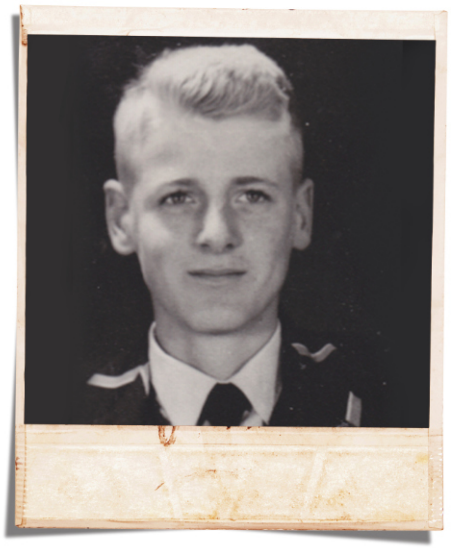
Federica

Ad Sparrius

"...we are what we repeatedly do. Excellence, then, is not an act, but a habit;" Will Durant

In 1982, after seven years studying various engineering degrees, and thirteen years working in product development, Ad Sparrius started developing and teaching post-graduate system engineering courses. What precisely that was was not clear, but everyone wanted to learn about it. Many years later Ad created and managed the annual Greatest Young Systems Engineer of the Year Challenge; where young means less than three years after a degree. Six challenges have been completed and 93 young engineers have now learnt the basics. He was elected Fellow of INCOSE in 2020, "for advancing Systems Engineering practice, principles and education in South Africa".

Dear Younger Ad,



I am writing to give you some unasked-for advice on your future career; in the hope that unasked does not become ignored.

You will remember a chilly night in October 1957 when your parents took you outside to see a rapidly-moving flashing star called Sputnik 1. That undoubtedly was a historic moment—you are a child of the space age! There was never a question of you not attending university. You had thought either medicine or physics, until someone mentioned electronic engineering as the backbone of the space age, and that sounded pretty amazing! You graduated with a bachelor's degree in science and a bachelor's in electronic engineering from the University of Stellenbosch. Your first job was at a state-owned enterprise called the Council for Scientific and Industrial Research. Apart from research, the CSIR's mission was also to develop a high-skilled workforce. Consequently, they sponsored you to obtain a master's degree in electrical engineering at the University of California, Berkeley. That year-and-a-half stay in California opened your eyes to a much wider world than you ever experienced before. You are also one of the few South Africans who has a degree certificate signed by Ronald Reagan! Your course selection provided a foundation for whichever speciality you would later wish to follow.

You returned to the CSIR after obtaining the master's degree, and worked a few years in product development. You had a glorious time, alongside many young, shockingly-clever, enterprising and highly-original engineers. But I recall you had to present an informal seminar on the intricacies of proving matched filters and correlation were essentially identical signal processing methods. You had a hard time explaining that—you had mastered all the mathematics, but lacked a visceral understanding of both methods. And it is that visceral understanding of first principles that explains things. There is a crucial lesson in that—it is fairly easy to pass courses at university by memorization, but to truly understand something you need to go much deeper. For instance, you still have not figured out electrical machines, not to mention chemistry! That will require developing a deep understanding of first principles. Take your time, start by listing your assumptions, and then systematically investigate each one and eliminate all unneeded assumptions until you reach a self-evident foundation. Remove all intellectual short cuts. You can do it—you are just too intellectually lazy to think that deeply.

Carl Sagan said it best in 1995: He foresaw *"pseudoscience, and superstition, but especially a kind of celebration of ignorance,"* while the world slid, *"almost without noticing, back into superstition and darkness."*

You have a habit of thinking about your future in terms of your team. That is a misconception, since every team inevitably splinters sooner or later—even the most successful break up—just think Beatles. Your career will be very personal, at the resolution of a single individual—you. Understand a career needs to be opportunistic and unexpected things happen, for instance corporate bankruptcy, personnel layoffs, technological disruptions, and more. Those events will destroy a brilliant career plan. Always adapt yourself to circumstances as they change.

And whilst we are personal, stop being so bloody arrogant. You consider yourself to be exceptional, and of course you are. But so is everyone else. You may be better at some things than others, but inevitably you will also be worse at some different things than the rest. There is a place under the sun for everyone. Why

not allow others their own place? As Joan Didion wrote: “Why do you always have to be right? Why do you always have to have the last word? For once in your life just let it go.” Become more sensitive to the feelings and emotions of other people—you are not the only one with feelings!

Will your bachelor’s degree be adequate? Of course not, you should at least obtain a master’s degree in engineering—that is what modern high-technology industry demands. Should you then pursue a doctorate or an MBA? That depends on your career objectives. A PhD will provide a narrow but deep insight into one particular area, but an MBA will provide a broad basis for whatever you might wish to pursue. A professor who taught as an MBA faculty once told me a PhD would be a specialization in engineering, but an MBA would be a de-specialization of engineering—and there is merit in that statement. There is also merit in de-specializing since the half-life of electronic technology is short and shrinking. Of course, if you ever would like to enter academia, a PhD would be a prerequisite.

A professional in any field of knowledge is responsible for his or her career. Join the appropriate professional society, INCOSE for systems engineering. Attend annual conferences. Publish conference papers and journal papers. Attend seminars and tutorials. Learn how to network. And give something back to the profession by mentoring the youth. Mentoring is an extremely powerful technique, and not appreciated enough. In the future, individuals who are the first in their extended family to have completed secondary school let alone university, will enter the profession. They have no experience in an office as a workplace. Everything is unfamiliar. Our business culture is usually western, but that can create serious cultural conflicts. In traditional societies the elder recognises the young, and may invite them to speak. The young should never speak out of turn—that would be insubordinate. And the young should never look the elder straight into the eyes, even whilst greeting—that would be defiant. But in a western culture it would be dodgy to not act like that. Without sustained help from mentors, many youth could fail right at the beginning of their career, almost on the first day. They will need to learn how to perform in the business culture. Understand these situations and help where you can. Mentoring is extremely valuable both for the mentee and for the mentor.

“Without sustained help from mentors, many youth could fail right at the beginning of their career, almost on the first day. They will need to learn how to perform in the business culture. Understand these situations and help where you can. Mentoring is extremely valuable both for the mentee and for the mentor.”

One issue that makes systems engineering especially interesting is the need for an intimate interface with customers and other stakeholders. All engineering problems exist within cultural, economic, political, social, and enterprise environments. Out of that context a problem emerges, as well as the constraints to its solution, that may be partly solvable by an engineering system. A good systems engineer needs to deeply understand both the customer and stakeholder environments. The best way to do that is to embed yourself in those environments. For instance, if you need to develop a system associated with astronomy, become an amateur astronomer and volunteer to help professionals with observations. That will not make you an astronomer, but you will rapidly learn the terminology and the basic concepts dominating astronomy. In my experience, in a contest between people or between concepts, the winner is usually the one who has done the most homework. Part of that homework is to be well-informed about many things, and that demands a wide interest and voracious reading. Over and above technical journals and magazines, you currently read The Economist on a weekly basis. Good. But you need to read more—why not add the monthly Scientific American and the National Geographic? It is a wide world out there—how else can you be aware of what is happening?

You should of course read the technical literature. But do not forget about standards. Every profession develops generally-accepted international best-practice standards as the framework for professional practice, for instance ISO, IEC, and IEEE standards. Those standards regularly go through reviews to keep them up to date. Study those standards and master their content. Their development needs professional advice—participate in standard generating bodies, since you possess valuable and applicable knowledge.

The life blood of your career will consist of communication—both written and oral. If you do not capture the attention of an audience in the first few seconds of a presentation, you will never capture it. Few have that skill inherently, but it is fairly easy to learn. Join Toastmasters to learn how to make a presentation, especially unprepared presentations. Learn to be comfortable in front of an audience, and it will help you for the rest of your life.

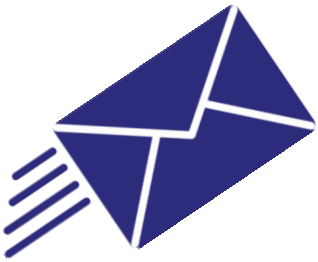
As in any profession, your name and the reputation attached to it will be crucial. You can easily, in a single ill-considered act, destroy a reputation that took twenty years to build. Learn the principles of ethics, and act accordingly.

To summarize: Don't memorize but get a visceral understanding; Mentoring is extremely valuable to both mentor and mentee; Deeply understand customer and stakeholder requirements; Read widely in many areas; and Be ethical in everything you do.

Best of luck with your career!

Yours Truly,

Ad



Alice Squires

Making Your Place in the World

Alice Squires' love of systems, long-term view, and desire to make a difference drove her to experience challenging roles in industry and academia. She earned degrees in Electrical Engineering, Business Administration and Systems Engineering; worked on satellite payloads and semiconductors and unmanned aerial systems; and taught graduate courses in systems engineering, project management, leadership, performance management and systems architecture. She is an INCOSE certified Expert Systems Engineering Practitioner and founded a group that advocates for women leaders in systems engineering. She loves to write and seeks to make a difference in the world.

Dear Younger Alice,,

I know there are times you struggle to find your place in the world.

I am writing from nearly forty years into the future to reach you during one of these times, a few months after you graduate with a Bachelor of Electrical Engineering. You have been enjoying your career as a hardware designer. You are part of a large group of incoming electrical and mechanical engineers that IBM hired from universities across the United States. As much as you love so many things about engineering – the analytical approach and technical detail – and you greatly appreciate the friendship and support of your peers, you cannot help but sometimes feel that the field of engineering is a lonely place for a woman. At times you are reminded that you are different from everyone else, that you are the only woman in your department, and the only newly hired engineer / scientist married with children. However, you also believe that you are on the leading edge of change where the floodgates will open, and many more women will be attracted into the world of engineering. Hold onto that belief, it may simply take longer than you think for that dream to come true.

And for those times that you feel like there is nowhere that you belong, what I can tell you is that there will come a day when you look back and see these difficulties as stepping stones. This is a necessary part of your journey through life. The struggles of today help you find your path. Usually, when you are not spending time with your family, you are focused on interesting and challenging work projects and trying to make a difference in the world. I know how important making a difference is to you. Over the last several decades, I have learned some things that might help you along the way and are worth sharing.

First and foremost, your belief that with hard work, patience, and practice you can do anything you set your mind to, will serve you well. You can drive the change that you seek. When you challenge yourself to take on projects that you are not sure you can successfully complete, it is true that you open yourself up to failure. It is also true that you open yourself up to learn new things and see the world in a new light. The key is to focus on support from those who believe in you and to ignore those who minimize your contributions or the voice in your own head that tells you that you are not good enough. Think about those times when you were better than you ever thought you could be. Remember how you excelled in graphical design, control systems theory, and logic design at the university. Think about how engaged you were in the content, how you enjoyed the problem solving, and how you taught your friends that struggled with these topics. This is who you are.

"And for those times that you feel like there is nowhere that you belong, what I can tell you is that there will come a day when you look back and see these difficulties as stepping stones. This is a necessary part of your journey through life."

Next, continue to realize the importance of pursuing your own dreams and not those voiced by others. It is the philosophy of systems engineering that will help you make sense of your world and your place in it. Your long-term views, your love of learning, and your desire to empower others will lead you to see the alignment in your beliefs and the principles of systems engineering. You apply many of the principles of systems engineering when you combat the pressure to make short term progress at the

expense of the more important longer-term goals. You may feel alone in your approach and ideas at first, but the value of your longer-term systems view is realized by others, in time. You will soon learn that systems engineering focuses on how the actions taken today in the design of the system will determine the impact of the system far into the future.

From there, keep focusing on the relationship with your customers and their needs Understanding "the voice of the customer" – in systems engineering terms – will not only serve your current projects but also result in new future opportunities. Through these experiences you will see first-hand the value of strong positive relationships and a service mindset. Starting with solving the right problem, continuing with agreement on the requirements over the life of the system, and ending with building the right system, a strong customer relationship will provide the system stakeholders with solutions that will endure.

And finally, fuel your desire to teach others from the heart; your passion for teaching will be both welcome and sought after. Your systems view is contagious and will provide a framework and mindset to help others learn. You will find that you can apply your approach not only to teaching systems engineering but also leading and managing organizations, projects, and teams – all systems in their own right. You will be able to demonstrate system effectiveness through a lens of organizational effectiveness, project success, and high-performance teams. With experience, you will gain a deeper understanding of the interconnectedness of everything across both space and time, and you will realize how that understanding can help to better predict system behavior and make sense of the world. Ultimately you will find that systems engineering provides a framework that supports your goal of making a difference in the world.

What I would like to leave you with is the idea that it is not about finding your place, but rather about making your place in the world. And the great parts about creating your own path are the people you meet, the challenges you overcome, the memories you create, and the positive differences you make in the lives of others. Having a systems view and focusing on the longer term are an essential part of who you are. You will make an impact on the world and it will be awesome. Time to get started!

Good luck and pleasant journey, yours truly,

Alice

Heinz Stoewer

Space Exploration and Systems Engineering, a Wonderful Challenge for a Young Engineer

Coming from a family with almost exclusively engineers my passion and destiny was predetermined. Nothing interested me more than constructing and building toys, airplanes, or “moving machines”. Working on bicycles and later cars became a hobby. Physics and science fascinated me ever since school. When the opportunity arose to enter the early space business it was the perfect challenge which, as a young engineering graduate, I embraced with enthusiasm and dedication.

Human space developments from Post-Apollo to Spacelab and the ISS saw many of my sweat drops. Today scientific exploration and the commercial “New Space” developments continue to inspire me every day.

Dear Young Ambitious Heinz,

Where do I begin? What advice do I give you for the world today? The best approach may be to lead you through some of your experiences as a systems engineer.
Your career, even though considered successful by most, did not develop in a straightforward manner. However, mistakes are part of growing up, even professionally. What immediate lessons should you draw from this? Learning from your failures, coupled with an insatiable **curiosity about learning new things** every day in your private and professional life, may be the two most important ingredients for professional (and private) success and happiness!

One of your most admired early superiors, Ludwig Boelkow, a founding father of Airbus, told us when assembling our young space project team: "I know you do not have any space experience and **you will make mistakes**, but please do not make the same mistake twice." You should realize at these times no one in Germany had any space experience apart from the German Peenemuende rocket team which left Germany post World War II to help American and Russian colleagues create their space programs. Wernher von Braun, the architect of the Saturn Apollo Moon rocket, is the most famous member of this early Peenemuende team.

A key characteristic learnt during your early professional years was **do not be afraid to take risks.** Our superiors pushed us to be courageous, to trust our engineering education, and develop a sound gut feeling for the right answers. Waiting until you have all the facts together often means you will miss the train.

Your first job was a "project engineer" in Munich. In the words of your project manager: "you have studied technical physics, you know a little about every engineering discipline, so try to see to it that this rocket design fits together." Today we would call such a function systems engineering, but that term was then unknown in Germany. If I could do it differently, my earnest recommendation for your first job is you get your feet into one engineering discipline in some depth, learn what it takes to realize a project or system and then "grow horizontally" into neighboring disciplines before you aspire to become a systems engineer. Soon you left a great job in Germany and **moved to the USA** without a job, but hoped to join the incredibly inspiring Apollo/Post Apollo program. It admittedly took some insane courage (according to your friends and colleagues), but if you do not have courage and do not want to accept risks while you are young, then when? There was neither internet, nor e-mails, or web meetings, not even a fax for looking for a job abroad. Cross-Atlantic travel was plainly unaffordable for a young engineer and was an adventure with many unknowns. Trans-Atlantic telephone calls could easily cost a day's salary and telegrams were not an effective communication.

Confidence in the almost endless opportunities, which so much characterized the **American spirit of that period**, eventually paid off. Three job offers, all in California, made your dream come true. Some professionally exciting and successful years followed. You were still the youngest of your steadily growing project teams, but so what? Courage rewarded and challenge met! Your extremely **gifted boss, your "chief engineer"** knew all the ins and outs of systems engineering and followed the Einstein idea: "make everything as simple as possible, but not simpler." This is when you learned a systems engineer needs to "see through" complexity. He or she must attempt to strongly **simplify** associated trade-offs and create sound solutions which other disciplines can also understand, relate to, and embrace in the broader context.

This is even more valid today for highly complex systems, systems of systems, and for any project phase, be it development, system deployment, or operation.

Your longing for Europe, including family and friends left behind, motivated you to stay in touch with European space. But were you ready for your **next "big job"?** Could you be responsible for building the foundations for "Human Space" in Europe, at the technical center of the European Space Agency, ESTEC, in the Netherlands? You accepted the challenge to lead the development of the first European Space Laboratory at the age of 33 and became the first program manager for "Spacelab" which would substantially augment the space shuttle capabilities in orbit. One of the first actions was to build up robust systems engineering capabilities to deal amongst others with the myriad of Spacelab—Shuttle interfaces. You also insisted industry must build up such a capability. This could well have been the engineering breakthrough which ensured the success of this program.
Our biggest problem was that **Shuttle and Spacelab,** both complex and interdependent machines, were in parallel development phases. This led to constant negotiation on changing interfaces and operational interdependencies, a true **systems engineering and management** challenge for all involved!

In the end Spacelab became one of the most successful international space cooperation projects of its time. Many nations took part in more than 20 joint missions. Spacelab also built the foundations for Europe to become a strong **partner of the International Space Station**. Finally, what advice can I still offer to benefit your career? Key ingredients are:

- Foremost, a **sound engineering education** which is your entry ticket for any engineering and for any systems engineering job!
- **Curiosity** and a drive for carving out simple sustainable systems solutions
- **The talent to facilitate** a system balance between the many diverging interests and characteristics of today's complex system projects
- **Attention to business needs**
- **Team management and communication** skills

These five go a long way! In our modern world as systems engineers or project managers you are never alone. You continuously receive challenges to (functionally) lead and support teams for **everyone's success**. If you have the courage to stand by your well-grounded professional convictions and are prepared to accept bold challenges, you will succeed!

One final matter, my young aspiring systems engineer. Life is not about work and career. It is about living in harmony with those closest around you, with nature, with sports, with interest in people and other cultures. Of course, work, status, and money are important elements of such a harmony, but they must not preoccupy your life. Life comes down to finding the right **balance between work and life**, finding your proper way to being content and thankful for the opportunities life offers. There are many exciting opportunities around you every day. Grab them and be grateful about being able to live on this beautiful blue dot in our Universe! And let us all contribute to make our planet **a better place** every day of our life through the wise application of well reflected systems solutions solving mankind's needs such as the ones described by the United Nations seventeen Sustainable Development Goals.

Stay honest and true to yourself, fight for your engineering principles and be considerate to other people's needs and thoughts!

Heinz

Celia Tseng

An Immigrant's Perspective

Celia Tseng is a Systems Engineer with an interest in model-based system design and architecture. She started her career designing a rapid antigen testing system for biological weapon and infectious disease detection in early 2000, which evolved to today's rapid COVID-19 antigen testing. She has applied her systems engineering expertise in various aerospace and defense systems, including radar design, command and control system, missile and missile defense system, and air traffic control system. Celia earned a Masters in Systems Engineering with Cornell University, is an INCOSE Certified Systems Engineering Professional, and co-chairs the Digital Engineering Information Exchange working group.

To my 12-year-old self in Hong Kong, from 36-year-old self in Tucson Arizona, United States of America…

Dear Celia,

Right now, your life has just turned upside down as our parents announced that we are emigrating to Toronto, Canada. For the last few years you have said goodbye to a handful of friends whose parents made the choice to return to their countries of origin. Now it is your turn to say goodbye and venture into a completely foreign world, wondering if the years of English classes that you took will be good enough to prepare you for school there. I can tell you now that you do not need to worry about your English – you will be kicked out of the English as Secondary Language (ESL) class on your first day of school because you already speak fluent English.

You will not believe the opportunities that you will be able to pursue because of this trans-Pacific move. Your intellect and curiosity in math and science will lead you to design many systems that make our world a better place and lead you to this beautiful family you have now. Your participation in high school science competitions will ultimately lead you to the man you will later marry. Your desire to help your relative who struggled to control diabetes will lead you to conduct research on a painless drug delivery system with the best scientists in the world. The events of 9/11, although horrifying and upsetting at the time, will inspire you to conduct undergraduate research to reduce the detection time of biological threats from weeks to hours, and lead you to pursue an engineering career in the defense industry. Your desire to bring your then-fiancé home from war safely will lead you to become one of the first engineers to apply model-based systems engineering and cutting-edge technologies for the rapid design and fielding of systems that save lives. You will occasionally hear from soldiers about how the systems you designed saved their lives, and it is the most satisfying feeling in the world.

There will be plenty of struggles along the way. There will be many times during your science and math classes when the subject is difficult, and you doubted if you should continue. Contrary to popular belief, struggles and failures do not mean that you are not "cut out" to be an engineer; it is a normal human experience as you learn and grow in your expertise. Do not let your self-doubt creep in during times of struggle; learn and grow from it. You may also feel like you don't belong in a career path dominated by males, and struggle to find mentors you can relate to. Do not be afraid to chart your own course in your career and stand for your own beliefs and values. A career is not a rigid sequence of advancements like the education experience from kindergarten through 12th grade, and everyone's career experience is unique to them. Trust in your instincts and follow your curiosity, and you will be well on your way to a great career and a great life. And lastly, always say thank you. All these seemingly impossible accomplishments are possible because of a great support network cheering for you every step of the way. Take the time to build and nurture a community that will support, encourage, and inspire you, and together you will create a bigger positive impact than you can ever dream of or imagine.

Follow your heart,

Celia

About INCOSE and EWLSE

The International Council on Systems Engineering (INCOSE)

The International Council on Systems Engineering (INCOSE) is a not-for-profit membership organization that develops and disseminates the transdisciplinary principles and practices that enable the realization of successful systems. INCOSE is designed to connect systems engineering professionals with educational, networking, and career-advancement opportunities in the interest of developing the global community of systems engineers and systems approaches to problems.

INCOSE's mission is to "address complex societal and technical challenges by enabling, promoting and advancing systems engineering and systems approaches."

Founded in 1990, INCOSE has over 20,600 members and associates spread across 65 chapters worldwide.

For additional information about INCOSE visit www.incose.org.

Empowering Women Leaders in Systems Engineering (EWLSE)

EWLSE's mission is to create an open systems engineering environment welcoming to all; promote the demonstrated value of women as systems engineers and leaders; engage women in engineering and systems engineering at all levels of education around the world; and enable increased participation and retention of women in systems engineering leadership.

EWLSE's vision is to live in a world where women and are men equally represented as leaders in systems engineering.

For additional information about INCOSE visit www.incose.org/ewlse.

Are you thinking about what the future will be like? “What should I be when I grow up?” is a question we can ask ourselves at any age! While the path may wind and many adventures await along the way, systems engineering is one field that is open to those from many different disciplines including science, technology, engineering, and mathematics (STEM). This eBook is a compendium of letters from around the world, written from system engineers in the field to their younger selves, to give a glimpse into the life they have lived and the insights they have gained along the way. Please enjoy this diverse set of perspectives as to what it is like to be a systems engineer!

INCOSE

A Publication by The International Council on Systems Engineering

ISBN: 978-1-937076-09-2