THRIVING IN THE 21ST CENTURY ECONOMY

Transformational Skills for Technical Professionals

Dr. K. (Subbu) Subramanian
President, STIMS Institute Inc.
Lexington, MA, USA

Professor U. Srinivasa Rangan
Luksic Chair Professor of Strategy and Global Studies
Babson College, Wellesley, MA, USA

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Foreword

Engineers were asked the following question in a recent survey: *"How much of a role do you think the government, industry, universities, and professional societies should play in the development of a national lifelong learning infrastructure?"* The results of the survey, reported in the National Academy of Engineering (NAE) publication titled ***Lifelong Learning Imperative in Engineering: Sustaining American Competitiveness in the 21st Century,*** show *that four out of five engineers expect businesses (industries) to play an important or leading role in developing the national lifelong learning infrastructure.* In other words, most engineers seem to believe that *employers have or should have a responsibility to ensure continuous education for their engineers.* Is this realistic in the 21st century, which is likely to be characterized by rapid technological evolution, growing importance of entrepreneurial business models, and the continuing trend of globalization?

In this book, the authors point to an alternative approach for science, technology, engineering, and mathematics (STEM) professionals. They believe that self-help is the best help and thus technical professionals should take ownership of their future in a strategic way, just as businesses and corporations rely on a strategic approach for their long-term survival and success.

In the same report cited above, it was also noted that, "*An overwhelming majority (three out of four) felt that universities and professional societies also have a significant role to play."* Therefore, it is appropriate that ASME Press, one of the leading professional societies for engineers, has chosen to publish this work.

This book is a compilation of the observations of two professionals who have a similar starting point, but have taken different paths in their professional journey for the past three decades. After obtaining his Sc.D. from MIT, Dr. Subramanian has pursued a career in industry. He has worked with many firms, big and small, from steelmaking to high technology. He has also mentored scores of technical professionals from around the world. Professor Rangan got his doctorate from Harvard Business School, and then pursued an academic career, teaching strategy and global business. *Strategic Alliances: An Entrepreneurial Approach to Globalization*, a book Prof. Rangan co-authored, has been named a classic by getAbstract.com, an executive book service based in Europe.

Both these professionals are passionate about looking at the world from the point of view of “what it can be?” rather than “what it has been?” In this book, they have compiled their observations and advice for the future of technical professionals worldwide.

Biographic Sketch

K. (Subbu) Subramanian is the President of STIMS Institute Inc., a Knowledge Integration company. Subramanian has worked for more than 34 years in various positions in the industrial sector. While serving at Saint-Gobain, he conceived and implemented a network of Technology Centers in the U.S., Germany, China, and India, as well as other facilities across the globe. These Applications Technology Centers foster the Core Technology for surface generation processes used in a variety of industries, ranging from Semiconductors, Steelmaking, Automotive, Aerospace, Precision Engineered Components, Bio-medical Components, Ceramics, Optics, LED Lighting, PV, etc. These centers promote innovation and Knowledge Integration through R&D and technology-based alliances with worldwide customers, suppliers, universities, and all other sources of knowledge. These alliances have been used for new product development, technology-driven market development, as well as education and mentoring of technical professionals. Subramanian has published extensively on technical and management-related topics. He holds several patents, many of which have been commercialized. He has presented talks worldwide on various topics, including Surface Engineering, Innovation, Technology-Driven Market Development, and Career Development Strategies for professionals in the Global Economy. Subramanian has published a book titled *The System Approach—A Strategy to Survive and Succeed in the Global Economy,* Hanser Gardner, 2000. Subramanian obtained his B.S. (M.E.) degree from Osmania University, India, and Doctor of Science degree (M.E.) from MIT, USA. He worked at Ford Motor Company and International Harvester Company, prior to joining Norton Company, which is now part of Saint-Gobain. He founded his company, STIMS Institute Inc., (WWW.STIMSInstitute.com) to develop and implement new business models based on Knowledge Integration, Science-Based Industrial Process Solutions, Education and Mentoring of Technical Professionals, as well as to build alliances with technical, academic, and business professionals worldwide. Subramanian is a Fellow of the American Society of Mechanical Engineers (ASME) and the Society of Manufacturing Engineers (SME). His views on life and living can be read at his blog site: WWW.Sipractce.com

Professor U. Srinivasa Rangan holds the Lukšić Chair Professorship in Strategy and Global Studies at Babson College, Wellesley, MA, USA. His teaching, consulting, and research focus on competitive strategy, globalization, and alliances. A recipient of several teaching awards, Professor Rangan has been a consultant as well as a designer and deliverer of executive programs for several firms. He has taught in such programs at Babson, Helsinki School of

Economics, Stockholm School of Economics, Amos Tuck School (Dartmouth), Rotman School (Toronto), Indian School of Business, and Indian Institute of Management, working with senior managers from North and South America, Europe, and Asia in a wide range of industries. He also worked with Professor Michael Porter of Harvard Business School to advise the Indian government on the economic development policies to pursue in order to ensure national competitiveness. Currently, Dr. Rangan serves on the board of an information technology service company in India. Dr. Rangan is the co-author of two books (*Strategic Alliances: An Entrepreneurial Approach to Globalization*, HBS Press, 1995; and *Capital Rising*, Palgrave Macmillan, 2010) and the co-editor of a third (*Global Strategies for Emerging Asia*, Wiley/Jossey-Bass, 2012). His first book was nominated one of the top 30 business books of the year in both the U.S. and Europe and, more recently, was named a management classic. His second book deals with how entrepreneurial ecosystems of countries and global capital flows interact to change the global competitive landscape. The third book looks at how global firms are trying to compete in Asia. Author of several best-selling case studies on global strategic management published by HBS, IMD, and Babson, as well as chapters in edited volumes, Dr. Rangan has also published articles in academic journals. He has been a speaker at several practitioner-oriented conferences and forums. Before moving to academia, Professor Rangan served as a manager in industrial and international finance with the State Bank of India in India and in England. Professor Rangan holds graduate degrees in physics (University of Madras, India), economics (London School of Economics), and business (IMD, Lausanne). He received his doctorate from Harvard University.

Chapter 1

Introduction

This book is about you, your job, and strategies for your career development.

This is not a book about how to hunt for jobs, how to improve your résumé, or how to ace interviews. This book is also not about "How to win friends and influence people," which is explained lucidly by Dale Carnegie in his book; it does not provide training on the art of negotiations to meet your goals. Of course, these are all very important skills, and there are plenty of readily available resources on these topics.

This book is about using all the professional skills you have acquired through years of study in high school, college, and beyond. It is about collating all the knowledge obtained through your work experience. This book is about making you relevant and valuable in a way that is also rewarding.

It is very likely that you spend a lot of time and effort developing strategies for innovation and the success of the business or company you work for. At least you have heard a lot about such strategies to benefit your employer. You have probably learned the tools of Project Management, where the goal is to deliver the end result in a timely and cost-effective manner. You have others—"management"—to watch and guide you. In turn, the management rewards you for your results and penalizes you when they are not produced. But in today's globalized economy, when it comes to your job and career, you are on your own! This book should help you to develop a logical approach toward your career.

The assumption is that you are a professional: someone who gets paid for services offered. There is also an assumption that the professional brings to the job certain skills that are superior to those of an amateur. Most professionals have an academic degree or are certified by a board or agency composed of peers. They belong to societies that address the common needs of a group of professionals. We start with the premise that the professionals of the 21st century do not merely respond to the request for services. Instead, they identify a need, describe it as an opportunity with a solution, develop the complete solution,

implement it, and make sure the impact is fully realized! This book outlines the need for this change in outlook and how to go about that.

The assumption is also that you are a technical professional, i.e., a scientist, engineer, or manager with an interest in physical sciences and their use. While much of the information in this book applies to any professional, we focus mainly on technical professionals. They are generally described as science, technology, engineering, and mathematics (STEM) professionals. We believe this book may serve the needs of all professionals, not just STEM professionals.

Chapter 2 begins with a broad description of the landscape the technical professionals face. We describe an evolution in new business models, thanks to the forces of globalization. In this landscape we do see industrial organizations that need the services of technical professionals. These organizations are also relentlessly focused on creating New Solutions, with the goal of putting these solutions into practice as fast as possible. In parallel, we also see large organizations that are engaged in their constant effort to replicate known solutions. They employ a large number of workers with limited technical skills. Both types of organizations are increasingly separated from each other. They are binary in terms of their goals as well as the worker skills required. The demand for advanced technical skills from the organizations creating New Solutions and the systematic de-skilling of the workforce in large organizations engaged in Replication Solutions have evolved in the last three decades of the 20th century. For 21st century technical professionals, it is a way of life!

The multilayered organizations of the past (where New Solution creation and replication were part of a continuum) are giving way to two sets of flat organizations that have fewer levels of hierarchy. Since these organizations have few layers, and their structure is binary, the career path for 21st century professionals is no longer a well-established progression within a company. Doing your job well in one company and "growing with the company," or staying put in one place for lifelong employment, are no longer the options. Instead, professionals have to be more nimble and entrepreneurial: They will be rewarded for the identification, development, and implementation of a constant stream of New Solutions.

These parallel sets of organizations are also global—employers will be using resources from across the globe as well as serving customers worldwide. In the past, technical professionals could focus on the structure, alignment, and organization of resources readily available through their employers. These employers also relied heavily on their long-term resources—experienced

technical professionals—to create such structure and resources inside the company. With their access to global resources, employers now have multiple pathways to access and create resource structures across the globe. This implies that technical professionals will also require dual strategies: They have to use the employer-provided structures and organizational resources, and also create their own network and resources from global sources!

Thus we see the binary nature of employment and the demand for either well-qualified technical professionals who can create New Solutions, or for low-skilled, low-wage technicians who work in highly structured and standardized assignments focusing on replicating those solutions. This evolution in the binary nature of employment is widespread.

In Chapter 3, we lay out the concept of a Binary Economy.

- Economy 1: Those few professionals who create and implement New Solutions better than anyone else across the globe are richly rewarded (and hence can afford the highest standard of living anywhere in the world). These top professionals are improving sector productivity by using advanced technology based on physical sciences as well as digital tools/applications. Sometimes they also establish new sectors that may provide jobs for a relatively small number of top professionals (locally) or create a larger number of low-skilled jobs elsewhere (globally).
- Economy 2: There is a constant and unending effort to de-skill and de-localize all jobs. This results in tasks that can be automated or accomplished by a large number of low-skill, low-wage workers from low-cost regions across the globe. Technical professionals engaged in these jobs find a constant downward slide in their wages and rewards (tending toward the lowest sustainable wages across the globe).

Such evolution of a Binary Economy is not a chance event. We lay out the economic reasoning for its development in this chapter.

In the Binary Economy, one mode requires technical professionals with high levels of education, advanced technical skills, and certain Transformational Skills to create and implement New Solutions relentlessly and also ensure that their value/merit is recognized. In the second mode, the economy requires many workers with relatively low-level professional skills to replicate (in larger quantities) solutions that are already known. Those with the Transformational Skills needed to identify and seek out value-addition opportunities for New Solutions may find career opportunities and success in the Replication Solutions mode. There is no room for the middle, no room for high-end technical

professionals to tend to partially developed solutions that can mature with time (and continue developing), or high wages for professionals with the skills to execute specific tasks. There is no room for high rewards for anyone who can merely handle general information-driven tasks, their aggregation and dissemination (since 80% of the information is already available through the Internet), search engines, networks, databases, enterprise resource planning (ERP), and other Digital Technology (DT) solutions. In other words, when you hear "the smart is the new rich," the "smart" refers to those professionals with Transformational Skills that they blend judiciously with their academic education and industry/sector specific skills.

In Chapter 4, we describe the sources of knowledge—academic education, industry/sector specific know-how, and Transformational Skills—and their hierarchy as it existed in the early 20th century, as well as how and why this hierarchy was reversed by the end of the 20th century? We conclude that in the 21st century, technical professionals need to use these three sources of knowledge as building blocks, and thus acquire additional knowledge in all three areas as part of a lifelong learning process. Then we proceed to outline these Transformational Skills for 21st century technical professionals.

We begin this chapter with a discussion on the three categories of work: Physical Labor, Information Processing, and Professional Solutions. Technical professionals rely heavily on Professional Solutions on the job. These are the benefits professionals pass on to their employers, which begs the question: "What is a solution?" We distinguish between solutions based on physical and non-physical processes. Physical processes lead to Products, Processes, or Use/Application. These are the means with tangible outcomes, i.e., goods and services enabled by Physical Technology (PT). These are the outputs enabled by technical professionals. Non-physical processes mostly involve information and logistics tasks and related solutions.

By the end of the 20th century, developments in DT were largely applied to non-physical processes. This resulted in enormous improvements in cost and productivity of the non-physical processes used for efficient replication of known physical processes and solutions. These options for investors or employers are likely to continue for decades. The 21st century technical professionals are required to use Transformational Skills to identify, create, implement, and validate the impact of New Solutions based on physical sciences. These Transformational Skills also enable the professionals to develop alliances within the company and the industry, and then aggregate resources available across the globe. The ability to integrate knowledge from all available

resources will transform technical professionals into the Global Intellect, enabling them to deploy their intellectual capital, just as investors benefit from global resources through Global Capitalism.

In Chapter 5, we begin with the Transformational Skills necessary for identification of New Solutions within a company or organization. This starts with a common language that risk-averse investors and managers—who prefer Economy 2 opportunities to Economy 1 solutions—find easy to understand. This type of common language is also necessary to aggregate core capabilities at many levels within the company. We discuss the pathways to identify the core capabilities of individual professionals, their team/departments, and those of the company. We also discuss the approaches available to technical professionals for the orderly integration of core capabilities at all levels through products, projects, and new business development initiatives. Such skills to develop a common language and use them for aggregation of core capabilities are essential to identify and promote New Solutions and their impact. Then we address the Transformational Skills necessary to develop a larger perspective of the technical professionals' job based on such common language: the three-dimensional (3-D) view of core capabilities. These skills are necessary to foster closer alliances within a department or business function, across functions inside a company, as well as for aggregation of core capabilities in the industry. The quest for New Solutions at this stage becomes a constant search for core capabilities at each level and their suitability. New Solutions are needed wherever core capabilities are not adequate or when the available core capabilities are not properly exploited. With these essential skills, an employee can have a greater impact on his/her company as well as the industry.

Chapter 6 describes a set of Transformational Skills under the broad umbrella of knowledge integration. It begins with the description of a solution as an aggregation of physical and service processes. Physical processes are amenable to the laws of physical sciences. All solutions require the basic capability to address each process as "input/transformation/output" system. For this, we describe the System Approach, a methodology that directs technical professionals away from task execution to the definition and resolution of every problem as a system. This approach is essential for utilizing all the skills of all technical professionals to develop or solve the problem as a whole. It guides the professional away from methods only limited to statistical solutions and continuous improvement, and fosters deterministic approaches and science-based solutions with step-change or quantum improvements in outputs as the goal.

In the System Approach, solutions and the "transformation" enabling them are not treated as "black box" or statistical events. Instead, technical professionals are committed to probe the transformation, the physical phenomena behind the processes, using the tools of science and engineering. This increases their need for portable diagnostic tools.

Future technical professionals may have a working arrangement similar to that of today's medical professionals! They may have their own offices with specialized diagnostic tools, some of which may be portable. They will have visiting and/or practicing rights to take care of the "problems" or address the solutions necessary for their employers, just like the working privileges assigned to medical professionals in hospitals. Some of the companies employing advanced technical professionals may be set up as today's teaching and research hospitals. These changes will require technical professionals to deviate from their task-oriented practice of doing what they are asked to do and transform them into system thinkers and solution providers. They will be the true knowledge workers, integrating knowledge from all sources and applying them toward comprehensive solutions for a series of identified needs in rapid succession.

Next, we talk about the arrangement of the core capabilities (the transformers) that are discussed in Chapter 5 as a "T," where the horizontal leg addresses the skills required for breadth and the vertical leg describes the deep knowledge required for every solution. In this model we can describe the physical processes as the core of every solution and service processes as the activities surrounding it. In other words, the domain specific knowledge required for the physical processes is at the core or nucleus of every solution; the service processes (rich with information-related tasks) are domain neutral. This leads us to the concept of developing a technology value chain through integration of Core Technology or domain specific knowledge. The supply chain is a means for integration of information or data through common DT platforms. The supply chain solutions based on DT use are nearly independent of the domain specific know-how of technical professionals. Technical professionals can use the Core Technology platform to build a common ecosystem that connects suppliers, end users, academic research resources, and government policy makers.

After the New Solutions are identified and developed, they should be implemented with identifiable large-scale impact. Today, innovation is pursued in isolated silos of ideas or discovery/research and development (R&D), development (production), and impact (sales/marketing). This leaves technical professionals mostly at the front end of the innovation chain with a deep

disadvantage. They need a model for innovation where the idea is pursued successfully into the development phase and its logical conclusion, leading to commercial impact. This unbroken chain (of idea X development X use) is called End-to-End Innovation. All technical professionals in the 21st century will be required to adapt End-to-End Innovation as an implicit part—as a culture—of their professional practice. Co-creation of value is a well-established innovation strategy for many leading-edge companies. Yet, co-creation is founded on a simple principle: "Do what is good for your customers, which in turn is also good for your company." Technical professionals should adapt the same principle and models at the individual level. We call this Emotional Intelligence for New Solutions (EINS).

Earlier, we described New Solutions (rich with demand for technical professionals' skills) and Replication Solutions (enabled by de-skilled jobs and a low-wage workforce) as the binary modes of the 21st century economy. As a result, professional skills are preferentially required to develop New Solutions in only one of the binary modes. Thus, technical professionals have to find ways to get the attention and resources necessary from employers and investors to focus on such opportunities, They also need the skills to cross over to implement their New Solutions and replicate them in larger quantities, where standardization, structure, and de-skilling of the work (to reduce cost), as well as outsourcing and offshoring are the drivers. Working with ease on either side of the Binary Economy and walking the plank across these modes as required is not natural or easy. The 21st century technical professionals will require unique skills for the flexibility required to achieve maximum impact. In Chapter 7, we describe EINS and how it can be used to foster a culture for End-to-End innovation.

In Chapter 8, the conclusion, we address the role of the investors/employers, management, academia, and national policy makers. Their collaboration and engagement are necessary for a number of reasons. There is an urgent need for society as a whole to drive the growth in Economy 1 in order to mitigate the adverse effects of the growth limited to low-wage jobs in Economy 2—and the resultant slipping away of the middle class. It is also needed as the growth engine for the Economy 2 of tomorrow, essential for the long-term economic vitality and for full employment in the nation as a whole! To expand the opportunities in Economy 1 (create and implement technically advanced New Solutions), society must shift gears. Today, executives in Economy 2 (intent on replicating known solutions and constantly driven to reduce cost, de-skill, outsource, and automate) are likely to sideline anyone with "big ideas" for PT-intensive New Solutions. None of the big ideas—technical, engineering, and scientific solutions—that enabled the U.S. to become the advanced nation would

have progressed if market-driven economics were the sole criteria at the starting gate. The nation that aspired to be the world leader in the 20th century also found the national consensus and resources to put man on the moon, develop the Internet, build interstate highways, dams, and bridges, as well as support advances in medical research. These initiatives helped employ STEM professionals in droves. The 21st century Binary Economy does not give the same degree of freedom and latitude for unlimited funding of such new initiatives. What is necessary is a better balancing of the two modes of the economy between society's desire to be on the cutting edge (and thus create Economy 1 jobs for a larger number of skilled technical professionals) and the need to be economically sound and fiscally prudent by leveraging growth opportunities in Economy 2 (presented by replicating more of the same worldwide). These are the shared responsibility of national policy makers as well as technical professionals. The recently announced U.S. Big Data initiatives, the efforts by NSF to promote Engineering Research Centers, the X-Prize for innovation, all of the above strategies for energy resources, etc., are encouraging signs. On the education front, in addition to teaching technical disciplines and training students on today's industry sectors/systems, we need to emphasize Transformational Skills. Finally, in order for technical professionals to gain the most from their jobs and to align with the limited few Economy 1 opportunities, they need to seek and acquire structured education and knowledge on the Transformational Skills outlined in this book.