Open access • Journal Article • DOI:10.1109/MAP.2003.1252815

20/sup st/ century engineer-entrepreneur — Source link

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Institutions: Wilkes University

Published on: 19 Dec 2003 - IEEE Antennas and Propagation Magazine (IEEE)

Topics: Entrepreneurship, Knowledge worker, Critical success factor and Professional development

21st Century Engineer-Entrepreneur

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Abstract

The emerging facts from the successful organizations, including universities, indicate that the real source of power in a knowledge-based economy is in combining technical prowess with entrepreneurship. This paper first highlights missing links in the aptitude and attitude of an engineer in combining technical knowledge with sound decision-making and effective entrepreneurship. Second, it discusses the gaps in traditional college education and their remedies through outcome-based curricula. Third, it presents the distinction between leadership and management with reference to new models espoused in the Theory of Constraints (TOC). Fourth, it outlines the skills needed for the professional development of an individual to transform him or her from a traditional quantitative/verbal thinker to a future-oriented visionary by redirecting the whole-brain thinking. Finally, critical success factors in the development of an effective and efficient knowledge worker for the 21st century are enumerated.

I. Introduction

Change is in the air for all organizations from *seeking training* to *seeking wisdom*.[1] The change is the only constant that traditions do not survive. Organizations are now discovering transformed rules and responses to the realities of the competitive marketplace. A university, like any other organization refusing to respond to the needs of the dynamic world in a timely manner, can become a beautiful higher education *museum* if its brain bank does not respond in ways that match the creative far-sighted vision of global leaders. New knowledge, new opportunities, new technologies to serve our teaching and administration, new industrial/business partners in research and innovation, and new institutional structures in advancing our mission are required in the new economy. These elements can make dramatically a new engineering school responsive to the needs of the twenty-first century workplace, while securing core goals and virtues in a hierarchical socio-economic system.

Strategic planning is now becoming a norm to reap the benefits of advancing technologies and innovations. Those organizations that resort to reactive planning—only when trouble appears at

their doorsteps—are toying with extinction. A strategic plan requires everyone in an organization to examine his/her workplace and workspace for potential problems and opportunities that may arise. A leader in a knowledge-based organization should move away from a pre-occupation with control and capital to a prizing of creativity, from a process-focus to a passion-focus, and from an industrial-focus to a focus on creativity and innovation (C&I). Organizations that embrace the C&I paradigm are thriving. Those that fail to embrace the C&I paradigm are evaporating.

A recent survey of business executives and managers[1] indicates that highly successful engineers are not only academically astute, but also possess entrepreneurial skills. Going back in history, the most admired technological achievements of the twentieth century include electricity, transportation, and information processing. During the past couple of centuries, the development of the internal combustion engine and electricity had a lasting impact on human civilization. These technological achievements have enhanced the standard of *living* (material comforts) to unexpected heights. The next revolution that will create genetics, nano/micro-electronics, and robotics (GNR) technologies will put demands on engineers to improve the standard of *life* (subtle communication with living organisms of all kind) as well. It should, therefore, be no surprise that GNR technologies will open a constructive dialog among professionals in all fields, researchers in basic sciences and humanities, and strategic planners at the government level looking after the interests of their constituencies. The National Nanoelectronic Initiative (NNI) undertaken in the U. S. is one such interactive dialog that is on going among academia, industry, and government personnel. Countries are competing to reap the fruits of these technological breakthroughs through the transfer of technology for societal needs. The human genome project is revealing the secrets of DNA code by unveiling the sequence of 3 billion letters and 80, 000 genes. One of its surprising findings is that at the DNA level, there are no identifiable distinctions among races and genders. Research at the crossroads of biomedicine and nano-engineering is expected to reveal amazing breakthroughs in joining humans and machines as knowledge and information processors. The 21st century will reveal many secrets as professionals in various disciplines synthesize their findings. As said by Bordogna,[19] 21st century professionals will need to be astute makers, trusted innovators, change agents, master integrators, enterprise enablers, technology stewards, and knowledge handlers. The environment in which they are brought up will play a major role in their total development.

Ironically though, no asset is so vital, yet so poorly understood and managed, as the C&I capabilities of an organization. This paper is designed to provide insights and guidelines to start and grow these resources. From Accountants to Zoologist (A to Z or anything in-between), one can learn how to turn potential into performance by becoming a leader in one's own domain. The role of leadership in developing strategic directions is in discovering the channels through which we retrieve and process large amount of information. Computers and diverse expert teams are supplementing an individual brain in developing thinking processes that will shape and reshape the future of a given constituency. Psychologists are researching the way in which the brain produces the phenomenon of consciousness as well as the way we translate insights from neuroscience into more productive learning.[2] It is becoming important to understand the impact of the involvement of business experts in developing processes, procedures, or technologies.

For example, how can one add $3 billion dollars to the economy simply by adding dot.com to the name? All these developments require a mixing of talents, markets, and communications in varied forms. This situation will force academia to create engineers, who are excellent communicators, have commitment to lifelong learning, are adept in facing the increasingly diverse world, and are able to not only adapt to change but also are influential in driving change for years to come.

II. Missing Links

A number of surveys of employers' views of graduates has indicated that serious gaps exist in professional training through traditional college education. Some of these gaps are in the following areas:

- ✔ Developing integrity and honesty
- ✔ Knowing how to learn
- ✔ Listening
- ✔ Being responsible and learning self-management
- ✔ Problem solving
- ✔ Decision making
- ✔ Creative thinking
- ✔ Reading
- ✔ Communicating orally
- ✔ Welcoming diversity

Shifting paradigms in academia—the sources of knowledge creation—require us to address filling these gaps in professional training.

Critical question posed by Hissey[1] to a knowledge worker is: "What added value do you bring to the organization beyond the technical skills, experience, and knowledge that you possess?" He conducted interviews with executives, government planners, and academics in several countries of the world. One of the findings of his interviews is that 21st century professionals no longer afford to merely play the role of innovators without taking into consideration the big picture or changing scenario as society's needs change in utilization of inventions and innovations. In the academic setting, professionals do acquire solid technical education, logical thought process, good work ethics, and computer literacy. In Hissey's research,[1] they miss out several important professional skills. These include: written and oral communication aptitude, marketing-related knowledge, and familiarity with business and financial matters. Above all, Hissey points out that the higher level traits of identifying corporate/societal necessities and healthy personal attitudes are missing in working professionals. The academic organizations can fill these missing links by including entrepreneurship as a part of the core while making use of extensive technological innovations that are being reported. This techno-entrepreneurship (or technopreneurship in short) is being integrated in curricula of professional programs in Australia and Asia where economic success depends on continuous supply of entrepreneurial knowledge workers.

III. Engineering the Techno-Entrepreneurship

Engineering the future of an organization requires knowledge of all workers giving the concept of self-directed work teams (SDWTs). Engineering is distinct from science in turning scientific ideas into reality by creating consumable items or services. Scientists study the world as it exists. However, engineers create a world that never existed. In this creative process, resources required in their varied forms are inter-dependent. Technopreneurship—an agglomeration of technology and entrepreneurship—is a new paradigm for working professionals, innovators, and strategic planners. It is not a product but a process of synthesis in engineering the future of a person, an organization, a nation, and the world. We live in a finite world where natural resources are limited and human wants insatiable. Even if we have an infinite supply of resources, we are still constrained by the number of hours in a day, limited availability of required skills that change with time, diverse value systems, conflicting political environments, etc. With these limitations, it will be important for us to identify presence or absence of markets that will consume our products or services over a given period of time. Often a tradeoff among resources (ideas, labor, land, capital, and entrepreneurship) is needed to enhance capabilities that will result in enhanced throughput, now and in the future. There are two important factors for the success of a technopreneur. The first and crucial factor is the know-how (brainware or knowledge or available technology) that answers the question "How?". Even if we have know-how, we still have to face the societal concerns when many other factors and questions come into play before undertaking a new project: *whether*, *what*, *why*, *when*, *whom*, *where*, and *how much*.

If technopreneurship becomes all technique and technology, it will make us more materialistic ignoring that we are human beings. If there is very little understanding of the higher human purposes that the technology is striving to serve, we will become victims of our own creation. In the spirit of providing service to the community, we must decide what is to be done to develop new products and services, cut costs, increase productivity, turn waste into environment-friendly products or assure its safe disposal, etc. Moreover, products or services must be trustworthy, reliable, safe, and add value to humanity.

The liberal arts hold the key to the development of these traits in an elite professional. The interpretations and definitions of liberal arts are as numerous as the number of institutions and even departments in a given institution. In the light of this disagreement, it is always a good idea to return to basics. The traditional liberal arts consist of two components:

- ✔ *Quadrivium:* Arithmetic, Geometry, Astronomy, and Music
- ✔ *Trivium:* Grammar, Rhetoric, and Logic

The first component is more technical in nature while the second involves more human interaction. These were the accomplishments of a liberally educated person in ancient civilizations. Modern liberal arts embrace many soft subjects. The choice depends on the politics of one's organization. Recent technological advances and global competitiveness has changed and broadened the nature of liberal arts to embrace humans and machines.

Immersed in liberal arts, organizations are organic. The organizations of the future must rely on nurturing people and their aspirations through agricultural paradigms. These growth-oriented green paradigms require strategic thinkers to base their decisions on the needs of real people both in and out of an organization. Synergy of technopreneurship among people in an organization requires clear understanding and sharing of values in order to gain commitment from all those involved. Various components of a shared-value system for an organic organization include[3]:

Goals and Objectives: Identification of what is to be done (desired state) and when to obtain desired results (timeliness).
Principles and Policies: Defining the constraints within which results are to be established.
Resources: Identification of the human, financial, technical, or organizational support available to reach the desired state.
Accountability: Setting up standards of performance, time of evaluation, and method of measuring progress.
Consequences and Contingencies: specifying and evaluating the consequences of our actions within the value system of society and the organization. This includes judgments based on ethical and moral principles of human behavior.

Outcome-Based curriculum development must follow these steps systematically. A flowchart of developing such a curriculum is outlined in input and output loops in Figure 1.

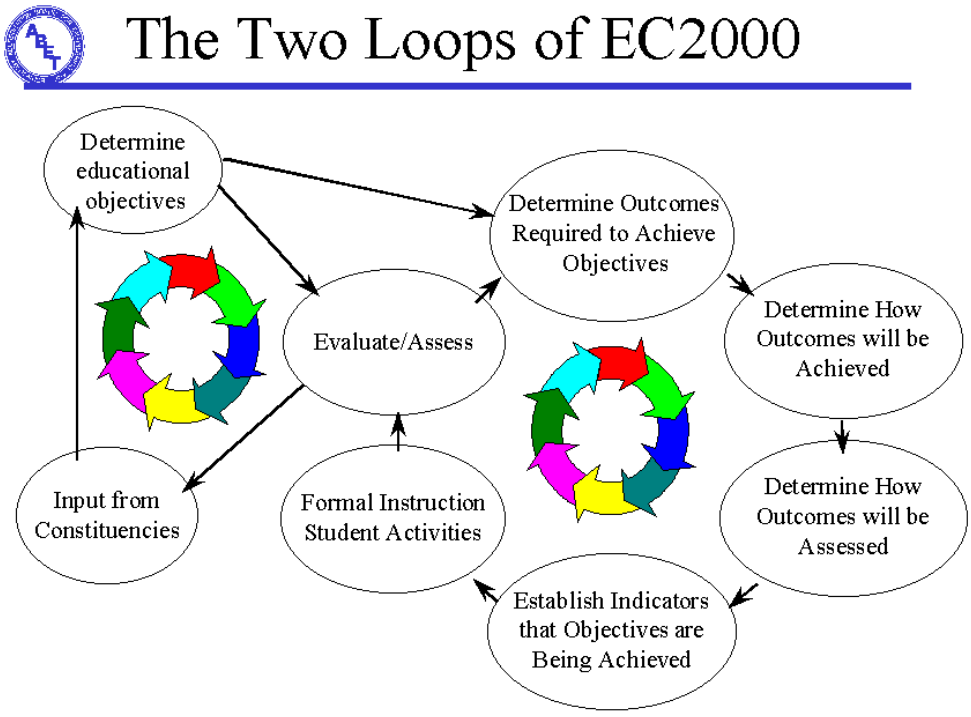

Figure 1: Two-loops model of development (input)-assessment (output) of knowledge.[6]

IV. Knowledge Engineering

Knowledge engineering requires us to assess the usefulness of knowledge or ideas in productivity enhancement, standards of life improvement, uncovering the hidden treasures of Nature, or usage for other destructive/constructive purposes. Even with constructive ideas, there are a lot of social questions to be considered. For example, the effect on society when computer intelligence exceeds the capabilities of human intelligence is yet to be seen. As synthesis of the artificial and the natural processes occur, we will transform the ways we communicate and guarantee prosperity to those who possess knowledge in its varied forms. The following are examples of questions that arise as we expand our regime of knowledge-based economy: Would artificial machines be entitled to the same constitutional guarantee of rights as human beings? How to program these machines to be responsible for their actions? Would killing an intelligent machine provoke the same emotions in a segment of society that laments cruelty to animals? What will happen to the spiritual world? The future engineering schools must address these issues as strategic programs are designed for the future.[4]

The governments and professional organizations are defining new metrics for measuring success. State governments in the U. S. are asking state-supported universities to show outcomes of their support to receive future funding. Regional accreditation boards are posing the same questions to schools and colleges. With this simple, yet radical, change in focus from input to outcome, accreditation criteria aim to get faculties to overhaul their teaching methods and curricula. The criteria are even sparking international educational reform. Many non-U.S. institutions (Singapore universities are good examples) want their programs awarded the status of "substantial equivalency" to U.S. programs, so their graduates can more realistically aspire to jobs anywhere in the world. The origin of this outcome-based reform can be traced back to early 90's when industrial leaders, strategic planners, and academic spearheads got together to define the outcomes of the education in the new economy. The message of their meeting was that the education of the future must be relevant, attractive, and connected to the needs of society at large. Considering this paradigm, the U. S. Accreditation Board for Engineering and Technology (ABET) in its well-researched *ABET Engineering Criteria 2000*[5] (EC2000) proposed that the spirit of technopreneurship be integrated within the curriculum of all programs. It forces universities to develop a process of assessing learning outcomes of programs that are consistent with the original mission of the institution. The Criteria can be easily adapted to embrace all disciplines. The desired attributes or outcomes for graduates of a baccalaureate program include an ability to:

- ✔ apply knowledge of mathematics, science, and engineering.
- ✔ design and conduct experiments, as well as to analyze and interpret data.
- ✔ design a system, component, or process to meet desired needs.
- ✔ function on multi-disciplinary teams.
- ✔ identify, formulate, and solve engineering problems.
- ✔ understand professional and ethical responsibility.
- ✔ communicate effectively.

- ✔ be educated broadly in order to understand the impact of engineering solutions in a global/ societal context.
- ✔ recognize and engage in life-long learning.
- ✔ know contemporary issues as these arise.
- ✔ use the techniques, skills, and modern engineering tools necessary for engineering practice.

Teaching—the scholarship of promulgation—has been at the heart of performance appraisal with little concern to whether or not the transmission of knowledge (the signal) has been received—with a very little noise—at learner's end so that the signal-to-noise ratio is high. The focus is now shifting from assessing teaching to assessing learning. A debate is on going among those assessing programs for their efficiency and effectiveness. The efficiency is the rate at which a student learns. The effectiveness is long-term retention of ideas, their relationships with other disciplines, and their easy portability to related disciplines and constantly changing real world situations. Same focus is valid when evaluating societal impact of scholarship in other domains: discovery (research), integration, and application. The ABET not only proposed the core attributes desired, but also provided guidelines on how to develop and assess programs, as summarized in the flowchart of Figure 1. In the input loop of Figure 1, universities are challenged to collect data (data engineering) on the needs of a constituency being served. Next, they integrate core attributes with those needs (information engineering). In the output assessment-based loop, they evaluate the effectiveness of their programs by studying impact on a person, the organization the person works for, and long-time retention or transferability as the person progresses towards over 40 years of his working lifetime (knowledge engineering). As in any innovative process, there is a great deal of scepticism on assessing outcomes. A dynamic learning is based on three components: integrated curriculum, societal and industrial interaction, and flexible structure.

Bringing about changes in people and organizations to implement these ideals is not simple. It requires momentum, proper attitudes, skill levels, perceptions and vision, and mindset change. Knowledge organizations must have the zest for adventure, for taking a risk, for doing something that no one has done before. Professionals in the American universities find it easier to try experimental programs. However, the paradigm while suggesting changes to bureaucrats in other parts of the world is always the same: "We do not want to change because we are afraid of making expensive mistakes." As Lincoln and Edison have shown with their innovations, failure sometimes leads to success. Lincoln's life was full of failures before he was elected President and gave a new paradigm for democracy that is quoted all over the world: "The government by the people, of the people, and for the people." Edison was asked: "How does he feel after failing so many times in making a light bulb." He replied, "I have discovered hundreds of ways on how not to make a light bulb." The more professionals learn not to fear failure, the more likely they are to succeed in their decisions. This willingness to take risks is one of the traits leaders and strategic thinkers must have. The support and understanding of the public and bureaucrats is crucial in any innovative process. Pareto Principle states that 80% of the problems evaporate when 20% of the core sources giving problems are identified. The real challenge is to find those 20% sources. Here comes the need for effective leadership with a far-sighted vision.

V. Emerging Leadership Styles

At one time, management and business books were divorced from technical realities. They were full for philosophical recipes of human interaction and development. In the last few years, the trend has changed. Business books now read like novels and technical ideas are presented with a sense of humor. *Dilbert Principle*[6] followed by *Do Living Wage Ordinances Reduce Urban Poverty?*[7] by Scott Adams—a computer engineer by profession—was a blockbuster of the late 90's. Adams postulates the presence of the Dilbert Principle at the workplace where 'incompetent knowledge-blind workers are promoted directly to management or decision-making positions without ever passing through the competency stage.' Here is the need for high ethical and moral standards. The first 150 years in independent America were dominated by character ethics full of integrity, humility, fidelity, temperance, courage, justice, and patience.[7] The years after World War II were dominated by personality ethics: public image, attitudes and behavior, skills and techniques that lubricate the process of human interaction. One aspect of this change is a positive mental aptitude and attitude; the other is purely manipulative (discovering new techniques for other people to like you). In training working professionals on ethics, the emphasis should be on finding ways to build strong character in professionals or the organization they serve with the intent to build trust and enhance trustworthiness among the stakeholders. After all, economic and political systems are ultimately based on a moral foundation. This principles-based leadership[4] approach not only enhances our effectiveness, but also creates a healthy society that will judge professionals by their contributions to humankind. Applied ethics teach problem solving by examining cause and effect relationships and analyzing cases by analogies. As an example, the **VCR** framework[9] developed at Carnegie-Mellon university, considers the **v**alues and **v**irtues (V's) of a person and an organization, provides a way for one to evaluate **c**onsequences and prepare **c**ontingency plans (C's), and more importantly puts the burden of **r**esponsibility on those who claim **r**ights (R's). A leadership style that analyzes decisions based on a VCR analysis will create a win-win atmosphere for all stakeholders.

The Goal[10] —written in a novel form—is targeted towards enhancing the throughput of an organization, a goal which requires managers to understand the constraints (or bottlenecks) in the decision-making process. It is the first book in a sequence of four books, the other three being *It's Not Luck*[11], *Critical Chain,*[12] and a newly released volume *Necessary But Not Sufficient.* The series propagates a socratic method involving dialogue between a teacher and a pupil in the tradition of *gurukula* (home of the teacher) system practiced in ancient India. The character Jonah, the guru-scholar, leads a plant manager, Al Rogo, to identify bottlenecks (or constraints) as the capacity of the plant can never be greater than the capacity of a bottleneck. The series chronicles a transition from crisis management to the implementation of the Theory of Constraints (TOC), both in professional and personal life. It supports the TOC solutions in shortening the production cycle and problem solving by Thinking Processes by mapping cause and effect relationships and selling the solution to a hostile non-trusting audience. It explains how the TOC and Thinking Processes work equally well in business, politics, and family disputes—offering peace or profit without compromise. In most organizations, pressures mount as managers strive to achieve local optima at a departmental level instead of organization-wide

optimum. After going through paradigms suggested in the series, the reader analyzes a customer's perception of value, designs a package of benefits addressing true value, and discovers synergy on how the whole can be greater than the sum of its parts. One can then demonstrate how to eliminate root cause(s) of problems to reach goals by common sense that is not always common. A TOC solution is based on the stakeholders' analysis that includes:

People: Their perceptions, motivations, values, habits, skills, and talents.
Formal Organization Structure: That evaluates physical environments, available technology, possible strategies, current and desired infrastructure, policies, and procedures.
Informal Organization: That analyses the culture, values and norms emerging from the interaction between people, the organization and world outside the organization.

The metrics required to measure success in a throughput world are only three: throughput, inventory, and operational expense. Throughput is the rate of production (or credit hour generation in a university setup) that also dictates the money coming into an organization. A synchronous organization will synchronize throughput with market consumption rate. Just-in-time is becoming a paradigm to consider in enhancing throughput, reduce inventory (or students who are unable to graduate in four-years slot or leave as being unsuccessful or are not able to find employment on graduation in a university setup), and reduce operational expense by synchronous output. Inventory can become a serious liability. Although cost accountants put inventory in the "asset" category when balancing their sheets or raising funds, a rapid advancement of technology can turn the disposal of obsolete products or gifts into a serious liability. Operational expense is the money the organization pays out for throughput to happen—that is, to turn raw materials into products needed by a market (or to turn matriculated students into graduates and successful alumni in an academic environment). Following the TOC approach, Harris Semiconductor in Mountaintop finished its 250-million-dollar 8-inch silicon wafer processing plant in record time of 13 months, substantially below the industry standard of over two years.[13] However, it failed to follow a C&I paradigm for its engineers and fell back in the marketplace, selling its assets to Intersil and again to Fairchild.

Emerging leadership/management styles are invariably based on an engineering paradigm:

- ✔ Understanding the complexity of group dynamics while working as a member of the team to which task is assigned (self-directed work teams).
- ✔ Organizing data in order to get useful information and then putting that knowledge to make effective decisions.
- ✔ Analyzing need and economic factors consistent with values of society.
- ✔ Generating and evaluating alternatives.
- ✔ Communicating ideas to peers and public-at-large.
- ✔ Using resources effectively (enhancing production capability PC) and efficiently (enhancing production P). PC/P balance is a must to derive optimal benefits.

In the next section, we discuss how a human brain can turn into an entrepreneurship savvy one by following a model proposed by Ned Hermann and extensively discussed by Lumsdaines.[2]

VI. Entrepreneurial Brain

In spite of the vast number of innovations in information technology, the human brain remains an incredible information processor and a remarkable knowledge manager. In any organization, people either produce, manage, or lead.[14] However, a true leader has to perform all of these roles. Whole-brain thinking (See Figure 2) is a must for envisioning the future while designing a strategic plan. Ned Hermann[2] divides the brain into 4 quadrants: two on the left (quadrant A and B) and two on the right (quadrant C and D), as shown in Figure 2. The left half works more with logic, words, structures, and analysis. In contrast, the right half works more with emotions, pictures, whole entities, relationship among parts, and synthesis. The left half is sequential and time-bound (masculine), the right is holistic and time-less (feminine). In Asian philosophy, these two aspects form the yin-yang (feminine-masculine) combination. Most of us are trained to be quadrant A thinkers who think in terms of numbers and words. Quadrant B thinkers are task-oriented and result-driven. Quadrant C and D thinkers think in terms of systems or images, relying heavily on holistic model of a situation. A number of activities can be designed to move a Quadrant A thinker (knowledge worker) to a Quadrant D designer (entrepreneur).

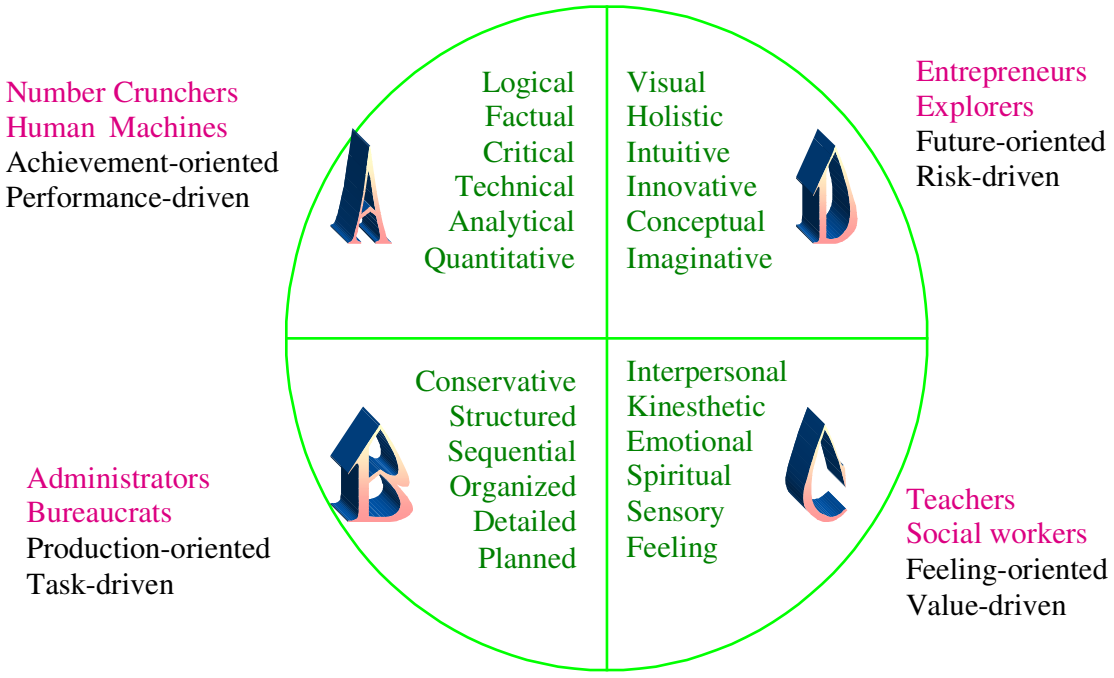

Figure 2: Four-quadrant model of the human brain (adapted from Ref. 2).

Professions requiring Quadrant A dominance are those of lawyers, engineers, computer scientists, analysts, bankers, and physicians, practicing external activities. Quadrant A thinking can be enhanced typically by the following activities:

✔ Undertaking case studies.

✔ Collecting data, information, and judging ideas.
✔ Dealing with hardware and things, not people.
✔ Living in the present (carpe diem).
✔ Undertaking research using scientific method.
✔ Reading textbooks and example problems.
✔ Undertaking library searches.
✔ Making hypothesis/theory and testing.

Quadrant B dominant professions, with procedural activities, are those of: administrators, tactical planners, bureaucrats, and bookkeepers. Enhancement of learning in this quadrant is typified by the following activities:

✔ Following directions, e. g., in a recipe book.
✔ Testing theories to find out missing links.
✔ Using programmed learning and tutoring.
✔ Planning projects, schedules, and execution.
✔ Listening and keeping detailed instructions.
✔ Meeting deadlines with no people concerns.
✔ Practicing new skills repetitively and writing how-to manuals.

Teachers, nurses, social workers, and musicians are interactively involved with people and are dominated by quadrant C thinking. The required skills for these professions can be enhanced by the following practices:

✔ Listening to and sharing ideas to generate motivation and enthusiasm.
✔ Keeping journal to record feelings and spiritual values.
✔ Traveling to meet and explore people-oriented activities.
✔ Respecting others' rights and points of view.
✔ Learning by teaching, touching, and feeling.

Entrepreneurs, explorers, playwrights, R&D personnel, detectives, and artists are dominated by Quadrant D thinking (internal creativity). The persons desiring the enhancement of this type of thinking are recommended to practice the following activities:

✔ Looking at the big picture and the context.
✔ Participating actively, simulating, and asking "what-if?" questions.
✔ Respecting multiplicity and aesthetics.
✔ Brainstorming for and playing with wild ideas.
✔ Exploring un-obvious facts and figures.
✔ Thinking about present and future trends.
✔ Synthesizing to come up with innovations.

At an individual level, one can obtain mastery in any of these quadrants by continuing applications of the stated activities. However, an organization exists by whole-brain thinking and planning. Diversity is a byword by which to create an organization. The making of an organization, therefore, requires a diverse group of people each with strong bents in one of the four quadrants, but with a considerable overlap to interact with people with dominance in other quadrants. Explorers and detectives define the problem and explore the markets. Artists create ideas that can be translated into reality by engineers by careful evaluation. A producer will implement the solution, e. g., in manufacturing environments. A judge will judge the effectiveness of an idea in a socio-legal system and find ways to protect the intellectual property. Leaders emerging from these self-directed work teams turn out to be effective and efficient strategic planners. They facilitate interaction so that creativity will flourish and provide an environment for ideas and technology convergence. Such leaders comprise knowledge organizations with a multinational character.

Leadership in a knowledge organization deals with direction (production capability) while management deals with speed (production). Leaders derive their strength from the top line: vision, mission, values, effectiveness, and moral principles. They are dominated by Quadrant D thinking. They develop this thinking by their own effort and in their own style after going through stages of quadrants A, B, and C, usually in the same order. A manager (Quadrant B thinker) persists in dealing with routine factors (bottom line): efficiency, cost-benefit analyses, logistics, methods, procedures and policies. A courageous leader will climb the tallest tree in a jungle (unknown territory) and cry: "wrong jungle!" even though he is advised to be quiet as his team cruises through the wrong jungle and progress is being reported in terms of mileage covered. It sounds like a familiar scenario in an organization. In short, a manager persists in doing things right at several points of time, while a leader is immersed in developing processes that will do the right thing at the outset, eliminating recurrent troubles that may drive an organization to a point of bankruptcy.

VII. Transformation—Renewal

Some of the new capabilities that are shaping the future of workplace are: terascale, nanoscale, complexity, cognition and holism.[19] Terascale will enhance the capabilities of computers by at least three orders of magnitude, which will allow us to understand, for example, the complexity of the human genome. Nanoscale will take us three orders of a magnitude below the devices existing today. Moreover, nanotechnology will allow us to manipulate one molecule or atom at a time. Complexity—sometimes referred to as management of chaos—has been defined as an edge of chaos where new ideas and innovative genotypes are silently transforming status quo. Because of new knowledge, methods, and tools, we are on the verge of a cognitive revolution that may dwarf the information revolution, necessitating the understanding of the brain as a cognitive element. Holism refers to new capabilities to put things together so that the whole is greater than the sum of its parts.

According to the management guru Tom Peters, every organization has Brahma—the Creator, Vishnu—the Preserver and Shiva—the Destroyer (of ignorance!). Once an organization is

created, Vishnu takes over. Within a few years of creation, most organizations lose sight of their mission and essential role. They become focused on efficiencies or doing things right rather than on effectiveness or doing the right things. In any organization, it is Shiva who is to be protected to enhance effectiveness and destroy obsolete practices so that the renewal takes place. Vishnu-the manager's style of operations is transactional. Vishnu demands compliance because of his nurturing ability. Shiva-the leader's style is transformational. Shiva starts a dialog with people in the organization so they affect change as context of the organization changes. In making a case for transformational-renewal processes, Stephen Covey[17] strongly advises us to moving from dependence to independence and on to inter-dependence. It is inter-dependence that is highly valued in a world where information travels at the speed of light. This inter-dependence can truly teach us the value of teamwork in a multicultural and multilingual world. In defining this inter-dependence, Deepak Chopra[18] defines success as much more than wealth. True success means material and financial wealth, enjoyment of life's journey, continued expansion of happiness, and the progressive realization of worthy goals.

A fully functioning global person with a knowledge of the self, the job, the organization, the environment, and the world can very well understand the value of developing strategic directions and with this knowledge develops the power of sound decision making. A principle-centered training in this paradigm is a process—not a product. As said earlier, this process follows an engineering model—first, gather and diagnose the data; second, select priorities, values, and objectives; third, identify and evaluate alternatives; fourth, plan and decide on action steps; and fifth, compare results with original goals and objectives. *Nishkam Karamyoga* is a discipline of work without a sole desire for material benefits. It teaches us that we should do our work because it is a good thing to do. Our reward is not in results, but in the doing. We should not fear failure or crave success. We should just enjoy the total immersion in work. The practice of this principle, without the sole motive of reaping fruits here on earth or in heaven, is the highest form of professional excellence. Strategic leadership is, therefore, not an act, it is a habit of managing ideas (brainware) for personal and professional development.

Strategic directions or decision-making processes are becoming more demanding and more complex. This requires knowledge-based organizations, e. g. universities, to produce strategic thinkers who will have lifetime skills for success in a rapidly changing global environment. A strategic thinker must have the vision to see where thoughts can converge to create strategic decisions for the future. While debate rages on how to affect and implement a strategic plan in industry, academia, and government, almost everyone agrees that strategic development is a good thing to do. A planning process flexible enough for the industrial needs of the day yet rigid enough for fundamental human values is not merely desirable but imperative for excellence in competitiveness, productivity, and system design. As a single person is unlikely to have all the desirable traits, the concept of self-directed work teams (SDWTs) is catching momentum. An SDWT can view a strategic development as a development of a seamless coherent system with interconnected levels or stages.

Utilizing C&I advantage of an organization is a must to survive in a knowledge-based economy. Good C&I practice of problem solving requires synthesis of ideas from various disciplines,

thereby capitalizing on and contributing to one's CREATIVITY: **C**ombine, **R**everse, **E**xpand, **A**lter**, T**inier, **I**nstead of, **V**iewpoint change, **I**n another sequence, **T**o other uses, and **Y**es! yes! (affirm new ideas). Creativity is busting the conventional mental blocks and playing with imagination and possibilities. That is, leading to new and meaningful connections and outcomes while interacting with ideas, people, and the environment. Creativity gives us new paradigms to engineer the direction of the organization we now work for, will work for, or will create for others to work for. Knowledge and entrepreneurship put together will make us ready for, and responsive to the needs of global society and hence will aid us in the strategic development of an organization, a nation, and hence the world. The Digital Divide existing between poor and prosperous communities can hopefully be fulfilled by the creative use of the brain bank.

VII. Final Word

Where do we go from here? Many channels exist in creating innovations by following the C&I paradigm. The core of the paper is condensed in the following words of advice that will enhance the value of entrepreneurial training:

Planning and Leadership: Launch an Operations Priorities Plan (OPP) for the next five years under the banner *ambitious, achievable, and assessable*. Elect your leaders carefully based on the merit of their ideas, not on the basis of friendliness, affiliation, color, creed, bias and the like. Ask insightful questions to prospective leaders at social gatherings and formal interviews. Identify those core sources from which problems emanate or may emanate in the future. Get facts before the planning process acts.

Creativity and Innovation: Review your infrastructure to create schools of thought where ability to synthesize ideas takes precedence over all other factors to allow creativity to flourish. Review modular system of your organization. A module, e. g. a committee or school or department, is an integral and valuable part of our collegial culture and is at its *best* is a model of effective teamwork. At its *worst*, however, it may prove to be a costly and inefficient ritual, which we are extraordinarily tolerant of in our otherwise strong performance-based culture. Plan your overall infrastructure to fire synergy so output is larger than the sum of its parts. Do not wait for crisis to happen to affect this change. Enhance your creativity by practicing whole-brain thinking as a member of a self-direct work team (SDWT). Demonstrate and assess the outcome of your actions. Our ability to survive and thrive in the competitive environment will depend on our ability to adapt to and manage our resources in response to the changing world outside our circle of influence. Competitive excellence is not an act. It is a habit and a process of managing ideas. Make total quality management, continuous process improvement, and reduced cycle time a habit in your academic, personal, family, and community life.

Programming the Microprocessor in Your Head: A human brain still is the best microprocessor around. Do not underestimate its power. Rather, enhance its power by encouraging whole-brain thinking. Breed diversity in synthesizing artificial and natural intelligence. Organize data to get information, and put knowledge to draw useful inferences from information. Learn to swim in the sea of information and dive for knowledge—the core values. Be a fully functioning global

person with knowledge of the self, the job, the organization, the environment, and the world. We are confronted by insurmountable opportunities. The choice is ours: distinction or extinction. Go for distinction by changing attitudes and aptitudes so you can surmount the barriers to capture opportunities in the unforeseen world. Or go for extinction by turning away from opportunities in the unforeseen world behind insurmountable barriers. Even if we choose to go for extinction, we should do it creatively (creative destruction of ignorance!) so renewal is a natural process, perhaps turning an extinction into another distinction, albeit a rewarding one.

Acknowledgment

One of us (VKA) wish to express his deep appreciation to the University of Western Australia for an award of Sir Gledden senior visiting fellowship and to Wilkes University for granting sabbatical leave for the Fall 2000 during which time this work was completed. Thanks are also due to Nanyang Technological University (aspiring to be the MIT of the East) for giving VKA an opportunity to interact with so many wonderful strategic planners picked from prestigious institutions around the world to engineer the future of NTU. We are fortunate to be able to offer a number of courses on techno-entrepreneurship and exchanging ideas during our travel. Many of the ideas in this paper are a direct result of our interactions with diverse group of people, too numerous to name here, during our travel around the world. We thank them all for sharing their wisdom with us which in turn we are sharing with our engineering colleagues in other parts of the world.

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