Foreseeing Electrical Engineering Technology - Expectations in the 21st Century

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Abstract

If we knew what was going to happen in the future, we obviously would change our actions. For instance, we might go out and buy the next winning lottery ticket, or we might invest in an obscure stock, which is going to increase in value tremendously. Likewise, if we as electrical engineering technology educators knew what the engineering marketplace was going to be like in the future, we could better design our courses and properly prepare our students.

What will the electrical engineering field be like in the future? What should our students prepare themselves for? What should we, as educators, be teaching the future engineers and technologists? An insight with leaders in the electrical engineering field presents a picture of what the engineering profession will be like in the next five years. With this knowledge, we as electrical engineering technology educators can improve our curriculum and better prepare our students for a meaningful and prosperous career and future.

Introduction

Take a step forward, into the 21st Century. Let us look at the beginning of a well-connected day in the life of a systems engineer, starting with this teleconferencing session.

The smiling face on the videophone said, “Thanks for this morning’s conference” and a second later the Internet transmission ended. Jim, a systems design engineer at The XYZ Corporation smiled back. The daily video conferences with England in the morning and with Japan in the afternoon served to keep everyone well briefed.

He thought to himself, “the concept of connected corporations is fine but it’s still that good face-to-face communication and the personal relationships that it nurtures that ultimately will determine our team’s success”. Even though it took less than a second to connect to anywhere in the world, he realized that understanding cultural differences was vitally important in sharing design information.

The digital subscriber loop (DSL) line into his home office provided integrated voice data and video transmission at an astounding rate; his workstation included a media processor that was programmed for a wide variety of functions, including the ability to conduct high-quality video conferences, such as the one he just had.

The new millennium was a fresh beginning in many ways. The fundamental concepts of “job”

and “office” had changed. For Jim, a newly graduated electrical engineer, working from a home office was better than the long unproductive commute that his father used to do every day.

His performance and compensation was not measured by his title or position any more, but by his ability to accomplish the tasks at hand. His “old job” had been replaced by an annual employment contract. He had become a “contract” engineer. A billion new consumers, mostly from the emerging “third world” nations, had propelled the electronics industry forward, spending over a trillion dollars annually on new products. Almost a third of that trillion went to ICs. The markets for small, customized, consumer electronics had exploded, and skilled engineers with a reputation for leading global development teams were in high demand. If this current project were successful, it could position him for another contract with a larger role in product definition.

The “widget program” that he was a part of was well on the way to success. The design was being completed well under schedule, thanks to being able to work “around the clock”, utilizing the services of many key people and the resource information centers from around the world. Each team member was an expert in his or her own field. Being able to bring these people together was the main factor in meeting the design schedule.

It was also to be environmentally friendly, that is, as part of the design specifications, every part of the product was to be recyclable. Consumers, as well as the corporate world, had finally realized that using the earth’s resources wisely was not only good for their living standards but it was economically beneficial to their profits.

Background

Why did I give the above hypothetical scenario? What can be deduced from the teleconferencing session and Jim’s thoughts? Every part of the above scenario has come from feedback and predictions from someone who is knowledgeable in that field.

In the coming 21st Century, for many jobs that do not require the specialized needs of expensive or massive laboratory equipment, e.g. clean rooms, environmental chambers, specialized testing facilities, direct interfacing with the manufacturing facility, etc., working in the home will be as natural as working in the “office” or in the “lab”. Simulation tools will play a key roll in the “networked” home office environment. There will no need to be “stuck in the office”.

Even today, the IBM Storage Systems Division in San Jose, CA. has found that with the use of simulation software, much of which was executed over “home networks”, the development of magnetoresistive (MR) disk drive heads was sped up to a rate of four or more per week; many times faster than the building and testing cycle of a couple of months that it used to take.[1]

Society will also become more concerned about the ecological effects that our industrial products can have. An engineer’s responsibility will reach out into that arena, as corporations realize that being ecologically responsible will also bring them added monetary benefits.

The following statements come from leaders who are connected with seeing that their industry's growth matches the above hypothetical scenario.

Critical Areas for Consideration

On Telecommunications:

"Enhancing the communication of the members of the design team can be more important than any other contribution" said Bill Schulze - Product Marketing Manager - Hewlett Packard Corp., Colorado Springs Division.[2]

Along this line of thought, David Nagel, President of AT&T Labs, in an article about telecommunications,[3] had these prophetic remarks:

"There's been a lot of excitement, and not just a little hype, about the coming revolution in communications. People say the merger of the Internet, personal communications, and entertainment will completely change our lives. And they are right. The transformation of commerce by the Internet - already well under way - will bring the world's goods and services to our doorstep with an efficiency only hinted at today."

"Scientists and engineers at AT&T Labs are working to take the next key steps that will weave this exciting technology into the fabric of our lives. Take for example, all those different telephone numbers, cell phone numbers, beeper, fax and business numbers you have to remember or write down for each of your acquaintances.

AT&T Laboratory scientists today, are working on technology to allow each of us to be reached by a single identifier - callers may even be able to say "Call Jane" or "Fax this to Joe". We will always be in touch, whether we're in a car, office, home, on a plane, or on a distant continent. If we don't want to be disturbed, our caller will be provided with a variety of easily used options for leaving a message or how to reach us another way at another time."

He goes on to say, "When we have conquered the barriers of time and distance, there will remain one formidable challenge: language. In less than a decade, you'll be able to speak in English (or any other language you choose) to people half a world away - or half a block away - and your words will be translated into the language of their choice. Scientists in our new research center in Florham Park, New Jersey, have already developed prototype systems that translate spoken English into Mandarin , and run easily on a laptop computer . So, making a connection across an ocean, or across a culture will be as easy as speaking into your communications device. You will have many ways to access high quality, two-way, real-time data, voice and video communications - your phone, TV, pager, laptop or other computer."

On Green Engineering:

Dr. Amory Lovins of The Rocky Mountain Institute had these comments about the engineer's role in the environmental issues.[4]

"The essence of good or even great engineering is to do more with less. The engineer's contribution to efficient utilization of resources is probably the most important single need in our technical system today. It will have the most far-reaching benefit for society. Engineers will be rewarded for practicing elegant frugality."

"Using our resources more productively will bring us a number of benefits. For example:

1) We'll live better - improved efficiency also means improved quality.

2) We'll slow down the depletion of our natural resources and pollute less.

3) This will lead to a safer and cleaner world.

4) Corporate profits will be increased due to material cost savings and reduced environmental remediation costs."

On Information Redistribution:

Electronic technologists will have the ability to access enormous bodies of knowledge and be able to control the global distribution of that information. This will be of greatest benefit to those entrepreneurial start-up companies. Being the largest corporation in a particular segment or industry will no longer guarantee success. The companies that attempt to remain totally isolated will die.

With the increase in mass memory size and faster network servers, remote design locations will increase in number. Data books and data sheets will become obsolete as technology discovers faster ways to retrieve and share technical information. Central depositories for sharing information will become common place. An example of this today is the Virtual Socket Interface (VSI) Alliance. [5] Formed from a common understanding of a looming bottleneck for the continued rapid evolution of the electronics industry, the alliance's charter members, which now include more than 125 companies from all segments of the electronic industry, recognized that the means to design larger and larger ICs that would meet the growing demand for more and more complex electronic systems did not exist.

The ability of the semiconductor industry to manufacture multimillion gate ICs has far exceeded it's ability to design all the IC components from scratch, and still meet the faster time to market requirements that consumers are demanding. The Virtual Socket Interface (VSI) allows companies to reuse system-level macros, megacells, and software modules from various internal groups or multiple external sources. The availability of these virtual components will allow more time to be spent on architectural design and validation. It will also provide for faster integration of hardware and software blocks for systems on silicon using deep sub-micron technologies.

Participating in this alliance are EDA vendors, intellectual property providers, semiconductor

vendors and system houses from Europe, Asia, and North America. By defining, developing, authorizing, testing, and promoting open standards and specifications relating to data formats, test methodologies and design interfacing methodologies, the goal of the VSI Alliance is to make easier the mix-and-match of existing functions from different sources onto a single silicon chip; thereby making possible true system level ICs. This would make system level chip design easier and faster, much like the combining of different IC functions from different vendors onto a printed circuit board that we do today.

On Analog Design:

"Cutting down the cycle time and increasing productivity, with individual digital and analog designs being the targets for increased use of mixed signal designs, are the future" said Behrooz Abdi, IC Design Manager, Communications Segment IC Division, Motorola Inc.[6]

He feels "there will be more global design teams, domestically and in Europe and Asia, with communications open between sites 24 hours/day; design will be around the clock with improved video-conferencing, virtual design reviews and with the ability to move complete schematics around the sites electronically."

He also feels that "the semiconductor industry is evolving from being a component vendor to a solution vendor. The designers of the future must understand the system and be able to focus on their customer's success; their skills will range from function designs to systems designs so as to be able to comprehend and solve the customer's problem."

"In five years, the new systems engineer designer will have to work with both analog and digital; therefore a lot more RF, wireless, and data communications theory will be needed all around. Digital communications will be extremely important. DSP talents will be critical where all must be able to understand and write some of the embedded software; the key to "mass customization" will be with the customer programming the different functions."

To be trained for the jobs in five years, Abdi believes "the engineer will need a good grounding in device physics, digital processing, and good analog design basics." To him, "it is increasingly clear that schools are not teaching systems knowledge and the curricula must change."

Robert Dobkin, Vice President of Engineering, Linear Technology Corp. [6] also sees changes in testing as an area the semiconductor engineer should explore. The trend, that Dobkin sees, "is that customers will want more and more custom IC's." His advice for the future design engineer is "to study analog." "It doesn't matter what type, as long as it's analog," Dobkin says, "Then figure that you don't know anything for the next five years."

"In the next five years, the turnaround time for a new IC will be 30 to 50% of what it is today. Targets will be one year, while product life will be about five years for standard products and about two years for custom products. Simulation tools will greatly cut down on these increased product development cycle times."

On Team Work

According to Winfred Phillips, ASEE President, "The image of the lone engineer sitting in the lab or office, laboring diligently and largely in solitude to design a new product or process, will also fade. Teamwork is now the watchword, and in an increasingly global marketplace, teamwork will be expected on an international level." [7]

"In the future, there will be few areas where there is room for a lone genius." So said Bruno Murari of SGS-Thompson Microelectronics. [8] "Behind this change lies the development of integrated-circuit technologies that allow for the integration of an increasingly large part of a system on a single chip. Even in smart power IC's, teamwork and cooperation are essential for all but the simplest of circuits. What these different types of circuits have in common is the complexity of design and the reliance on more than one design engineer to develop the chips."

"To design an accelerometer sensor for an automobile airbag, for example, demands expertise in acoustics to deal with resonance problems. The design team for an inkjet printer head needs players skilled in the fluid dynamics of droplet formation."

"Bringing together such a diversity of talents in a single laboratory is rarely practical. The industry is seeing a trend towards a virtual design team, which spans national and corporate boundaries, much like the Internet. It also must come from the excitement of working with people of many nations and different cultures."

While all the talk about working at home, "brainstorming will still be needed on a white board" according to David Robertson a Senior Design Engineer with the High-Speed Convertor Group of Analog Devices. [6] "Design engineers will be grouped into teams, with a design team increasing from the current average of about three to six or seven. These will be built up from a pool of generalists and specialists. Some work will be possible at home and the breakthrough may well come in California, because of the traffic."

Robert Dobkin of Linear Technology Corp.[6] is also a believer that "real engineering requires interaction. Teamwork will be important, with up to five members per team." Linear Technology has two design centers and they grow and develop "where we can grow, because it is hard to move people to the Bay Area. Communication with other design centers will then be through video conferencing and speaker phone conferencing."

Conclusion

Historically schools taught the fundamentals and then pushed the new graduates into the working environment (real world) to find out what is really happening. In the future, corporations will expect the new graduates to be able to start working right away, with very little training. That is, to be immediately productive, to hit the ground running. Schools and Universities will have to spend more emphasis on systems design.

I foresee the time when:

- Engineering positions will be changed from a “salaried” position to a “project” oriented position.

- Improvements in connectivity will continue to enhance the working environment of the electronics engineer. With the World Bank estimating that more than 50% of the world’s telephone service will be wireless by the year 2010, countries that focus on deploying such technologies, will be in the forefront.

- Teamwork will become the watchword, and in an increasingly global marketplace, teamwork will be expected on an international level. Will our engineers be able to work effectively on multinational teams?

As we go about our profession as engineering educators, plan our courses, and advise our students, we must keep one question in the forefront: Are we preparing students to be 21st century engineers? The challenge is greater than ever before, and engineering educators must be better and broader than ever. What is being done to increase the instructor’s knowledge about the increases in technology? We owe our students and the technical competitiveness of this nation no less.

[1] “Simulation System helps IBM cut disk development time”, R&D Magazine, January 1998

[2] Schulze, Bill “The Continuing Evolution of the Modern Engineer”, Electronic Design, January, 6 1997

[3] Nagel, David “Telecommunications: 2000 & Beyond”, Newsweek , January, 1997

[4] Dr. Amory Lovins “Green Engineering: Designing For a Brighter Future”, Electronic Design, January 6, 1997

[5] VSI Alliance, 15495 Los Gatos Blvd., Suite 3, Los Gatos, CA 95032 – (408) 356-8800

[6] Abdi, Behrooz, Dobkin, Robert L., and Robertson, David “Experts Forecast Major Changes in Analog Design in Five Years”, Electronic Design, January 6, 1997

[7] Phillips, Winfred “21st Century Questions”, ASEE PRISM, January 1997

[8] Murari, Bruno “System-On-Chip Technologies Call For a New Breed of Engineers”, Electronic Design, January 6, 1997

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