Our Profession Needs a Reminder

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Follow these axioms of educational strategy to succeed in the emerging e-world.

Along each axis—vertical, lateral, and longitudinal—we must pay attention both to learning and to forgetting.

Human knowledge decays, and the detritus must be disposed of periodically; otherwise, it piles up in the brain and hinders optimal decision making. This applies to wisdom in both professional and everyday life. When technology changes, optimal solutions change as well. For example, in silicon technology, a carry-lookahead adder is faster than the ripple-carry adder for all except the shortest word lengths, but in GaAs technology, a ripple-carry adder might be faster for word lengths as large as 16 or 32 bits.

The decay of useful knowledge is inevitable in high-technology computing, where half of what we knew 18 months ago is now worthless, a kind of inverse Moore’s law.

Learning about younger generations can inspire us with the enthusiasm needed to cope with technology and application changes. Knowledge about other cultures helps us port algorithms, procedures, and methodologies from one field to another. Languages are especially important. Knowledge of English is sufficient for business transactions, but to reach the hearts of others, we must know the local languages as well. When deciding what foreign languages to learn, maximize the value of the formula GNP/DFH, where GNP = gross national product and DFH = distance from home.

In the longitudinal dimension, intelligence relates to foresight: the ability to anticipate problems that might create loss or opportunities that might create benefits, to be prepared for the future, and to minimize loss and maximize benefit. This dimension is especially important for achieving fame and fortune. If you anticipate what will be a good transaction scenario, and use the intervening time to become an expert in it, the market value of your expertise could bring you fame and fortune. Foresight is vital in rapidly changing fields, and creative time must not be wasted in nonproductive activities. This third dimension, the most difficult to develop, takes talent, travel, and time. Few achieve it before their strength is spent.

Knowledge Maintenance

Along each axis—vertical, lateral, and longitudinal—we must pay attention both to learning and to forgetting.

In the vertical dimension, intelligence relates to deep professional knowledge. This is what keeps us busy day-to-day, but makes our horizons increasingly narrow. In computer science and engineering, technology changes rapidly and applications change even more swiftly, making narrowed horizons ever more likely. The pressure to stay professionally up-to-date leaves little time for other interests.

In the lateral dimension, intelligence relates to knowledge of other scientific fields, generations, cultures, and languages. It feeds creativity. Knowledge of other scientific fields helps on large multi-, inter-, and transdisciplinary (M+I+T++) projects. Learning about previous generations helps uncover the errors made when technologies and applications changed in the past.

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ity or price; and a conclusion summarizing the performance and complexity.

• Semantic. Each presentation should use symbols compatible with the subject matter’s semantics and describe approaches compatible with the audience’s background. A JPEG picture might be worth 1,000 words, but one good example is often worth 1,000 MPEG movies.

• Syntactical. Each presentation must have a form that matches its essence. For example, if a bullet point in a PowerPoint presentation spreads across two or more lines, each line must be a different thought, with line boundaries and thought boundaries at the same places. An experiment I conducted showed that students scored better on exams if the subject matter was taught using PowerPoint slides based on semantic groupings. This was even more evident in evening classes, when students are tired and less able to concentrate.

Each survey presentation should have 10 sections: introduction; problem description; related surveys; essential difference of this survey; classification criteria; classification obtained by applying the selected criteria; list of examples by classes, with pointers to original sources; elaboration of each example using the same set of dimensions to compare different solutions, dimension by dimension; future trends; and conclusion with lessons learned, positions taken, trends predicted, and a clear indication of who will find the survey important.

There are many similarities between product and service marketing and research and survey presentations. In the computer field, this is especially true. As time goes by, the world is increasingly interested in products and services rather than disciplines and theories.

**General knowledge**

At all times, professionals in computer science and engineering must remember that human knowledge has seven layers and that the professional layer is fairly low on that scale:

- religion
- philosophy
- logic
- mathematics
- sciences
- engineering
- common sense

However, every professional in computer science and engineering knows that the higher the layer they reach in their professional lives, the lower the level they reach in their bank accounts.

**Demonstrating that an idea surpasses anything else in the open literature requires using analytical modeling.**

**Computer knowledge**

Knowing the position of computing knowledge in the layered general knowledge system helps us become more efficient: We should base our creative reasoning on common sense, but should apply philosophy, logic, and mathematics to raise our newly created ideas’ sophistication level.

**Scientific ideas, hypotheses, and solutions**

For each scientific idea, hypothesis, or solution, three issues are important: that the idea be original and built atop some existing solution; that it relate to an important application implementable using modern technology; and that it be potentially better than any other existing idea or solution in the open literature, based on criteria of importance to the research sponsor.

Proving an idea’s originality requires making an exhaustive search of leading societies’ journals and conferences and carefully studying university reports and theses, all while ignoring the relatively useless patents and industry catalogs. Validating an idea’s importance requires connecting it to an urgent need, implementing it using a practical technology, and showing that the importance-to-cost ratio will decrease asymptotically as technology changes. Demonstrating that an idea surpasses anything else in the open literature requires using analytical modeling to show underlying conditions, assumptions, and details; using simulation analysis to show the relevant performance factors; and applying implementation analysis to show the relevant complexity and cost factors, among others.

Computer scientists and engineers often forget that a PhD offers nothing beyond proof that a person can address scientific problems using scientific methodologies.

**Life knowledge**

Advice to children: Make sure to select at birth parents who place your education at the top of their priority list. A good alternative is no parents at all—if you survive, there’s a fair chance you will be more successful than anyone from the first group.

When you rear your own children, set their priorities as follows:

- Ethical strength. If they give their word, it should be kept at any cost, even if conditions in the environment change, and keeping that word becomes difficult, costly, or contrary to their own best interests.

- Multidimensional personality strength. First, ensure their psychological strength by having them mature in an apparently harmonious family. Second, ensure their physical strength by encouraging their participation in an exhaustive athletic program. Third, guarantee their social strength by having them constantly interact with their surroundings in real-problem situations.

- Multidimensional academic strength. First, ensure that they receive a formal education. Second, have them master languages:
Remember, while English is the key to business success, other languages offer the key to winning hearts. Third, ensure that they have a compelling hobby as preparation for keeping busy after retirement. The earlier they develop this, the better. I strongly believe that, after the critical teen years, things turn upside down and ethics form the fundamentals while formal education becomes the mechanism to reach the heights of professional success.

After their formal education ends, your children must leave their native environment—their talents can be fully developed only outside the nest of their own culture. However, after this phase ends, your children should return to their native environment because that is where life will be most compatible with their personality needs. Besides, global success can still be achieved via the Internet. Moving a person's roots from one culture to another is painful and could have tragic consequences in the later stages of life.

Make sure your children understand that what the written word says about them—which will appear in their CV—is less important than what is said about them, which better describes the complete person. Wise people will view a CV and GPA as indicators of intelligence, hard work, responsibility, and motivation, especially when viewed through the conditions in which the person lives and studies. A person who worked during studies to survive and thus has a lower GPA has more credibility than a child of privilege with a higher GPA.

Do not let your children take standard routes, an approach that brings incremental benefits at best. Non-standard routes, if properly selected, can bring extraordinary benefits. Do not teach your children to become good fishers who bring fish for dinner each evening; teach them to become good sailors who bring nothing for dinner each evening, but become rich in some incomprehensible way. Maybe the sailor becomes richer than the fisher because he travels the world more and builds the vital third dimension of human intelligence.

Make sure that when things go wrong, your children have the attitude, “Who knows why this went well for me?” and, when things go superbly, their attitude is “I know this will not last forever.”

When your children must form a team, they should pass the interested candidates through an ethics filter first, then through a personal strength filter whose three dimensions are professional knowledge, multidisciplinary knowledge, and foresight. Then they should apply the academic criteria filter only at the very end, to those who have passed successfully through the ethics and personality filters. Teach your children to know how to learn from their own children, students, or younger team members.

Make sure your children maintain a good balance of work, sports, and hedonism; otherwise, their professional success will make little sense. Too much work can ruin both their physical and mental health. Make sure they have a good source of inspiration at all times. Make sure your children never kill the child in themselves.

You and your children can build on these practices by engaging regularly in multi-, inter-, and transdisciplinary (M+I+T++) conferences, where you can meet people from other R&D fields and which offer these benefits:

- These days, obtaining a large project from agencies such as DARPA or NSF can be difficult unless your proposal has M+I+T++ research elements. Very soon, this will apply to the leading research agencies in Europe and the Far East as well. So, it is important to learn how to talk with researchers from other disciplines, which is what you learn at M+I+T++ conferences.
- Attending specialized conferences gives you predictable feedback, while M+I+T++ conferences give you unexpected and even unimaginable feedback. Surrounding yourself with people from different disciplines makes you more creative. M+I+T++ conferences broaden your horizons, feeding your creativity.
- Specialized conferences surround you with your best friends—who often are also your worst enemies, especially when they evaluate your research proposals—so you must watch what you say; at M+I+T++ conferences you are surrounded by new acquaintances, so you can talk openly and freely, which is an important prerequisite for creativity.

In 2000, this column's editor met with the author at one such conference maintained monthly worldwide, so this column is itself an M+I+T++ product. The author of this column contribution teaches periodically in his native language and the following nine foreign languages, selected according to the previously mentioned GNP/DFH formula, applied to the distance from his home: English, German, Swedish, Italian, French, Spanish, Russian, Polish, and Czech.

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