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Globalization of Science

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"If we were to go back 100 years and ask a farmer what he'd like if he could have anything, he'd probably tell us he wanted a horse that was twice as strong and ate half as many oats. He would not have asked for a tractor. Technology changes things so fast that many people aren't sure what the best solutions to their problems might be." —Philip J. Quigley, former CEO of Pacific Telesis

A bachelor of science degree hardly makes one an expert in the particular science studied during undergraduate courses, let alone an expert in "science" or "technology" as a whole. But in the same way that a farmer 100 years ago could not begin to imagine how technology so far away from him could influence him in the future, we now have little knowledge of how other fields could influence our narrow area of specialization in the future.

There was once a time when one person could know it all: in the times of the ancient Egyptians and the old Greek philosophers, it was possible for one person to be knowledgeable not only in philosophy, but also in mathematics, chemistry, medicine, astronomy—any combination of the fields studied at that time. Individual laymen could be self-sufficient: they grew their own food, built their own homes and stitched their own clothes. Now, individuals have limited expert knowledge in a specific field, shallow general knowledge in some other fields, and little knowledge they can utilize without enlisting the help of others specialized in solving particular problems. With time, our knowledge as humans has expanded so much that one can hardly be an expert in, for example, a science like physics itself, but can only be an expert in a tiny aspect of a single category of physics, if one can be an expert at all. A medical doctor can only be an expert in a specific field of medicine, and would usually know little more than the basics of other fields. The concept of "division of labor" and specialization has grown to encompass almost everything, be it a study or an application of science and knowledge in general. Scientific discovery and creation of technology based on science are divorced from commercialization of this technology, so that the technology expert and the marketing expert work somewhat separately.

Of course, being an expert in any one field allows one to delve into this field and expand on the knowledge obtained by predecessors, slowly enlarging what we, as humans, know about this field and how we can use this new information to our benefit. But after a certain amount of knowledge has accumulated, we may reach a "saturation" of information, where what we learn becomes only incremental to what we already know, and how we use it only becomes marginally more useful than what the generations before us have left as a legacy.

So does this mean that the rate of growth of technology will suddenly decrease after its incredible acceleration recently? That there is nothing really "new" that can be discovered or invented? In 1899, the Commissioner of the U.S. Office of Patents, Charles H. Duell said: "Everything that can be invented has been invented." He was most definitely wrong in his prediction, and a statement like that in our time would be unthinkable. But how will we move ahead in new and different directions? How will we maintain technological advances that can really make a significant difference from the generations before us? More than just using energy more efficiently, curing diseases in a shorter amount of time, and connecting computers to the Internet faster, how is technology going to bring revolutionary changes?

With the growing concept of "globalization" being applied to economic trade, a true "globalization of science and technology" could result in revolutionary changes rather than mere evolution from our existing state. A trend that seems to have started now, is to move back to the idea of collecting all our knowledge and science in one place: but definitely not in one individual, since that would be inconceivable with the vast depth and breadth of knowledge we have today. The way to do this is for scientists from different fields/areas and different countries to collaborate openly, with the support of corporations and governments, to make radically new advances in technology that will benefit mankind, to work together for one goal and to share in the benefits. And this does not just mean that the experts from Microsoft should collaborate with those from IBM to improve computer technology, but more along the scale of the chemists in Europe collaborating with the computer specialists in Silicon Valley and the farmers in Australia to create something none of them could have dreamed of separately. There are already many examples of how this has been applied, and how it has made amazing differences and created new fields that overlap among several areas.

One clear example of the interaction between very different fields of study is the emergence of a field combining biological/medical research in neurology and neuroscience with discoveries about basic learning in the brain obtained from psychology studies, to simulate human learning and attempt to imitate the way a human brain works on computers that now possess the speed and processing capabilities to handle this. This new field is known as artificial neural networks (commonly referred to in the computer science field simply as "neural networks"). Neural networks are a relatively "new" technology falling under the Artificial Intelligence field of Computational Intelligence.

A great move away from the traditional computer paradigm of digital models, in which all computations are manipulations of the famous "0"s and "1"s, artificial neural networks work by creating connections between the computer-equivalent of the nerve cells or "neurons" in the human brain. These artificial neurons simulate the behavior of the neurons now discovered by biologists, and the neural network deduces complex associations between variables so that in time, and with special treatment, it "learns" in a way similar to the way psychologists and biologists now believe a young child learns. The creator of the artificial neural network can create a neural network that learns something he, a human being, knows very little about, and has no clear method of teaching to another human being. If no one in the computer science field had shown any interest in the new advances in biology and psychology, and had not been inspired to try and simulate the new discoveries on human intelligence on a machine, the quest for an "intelligent computer" would be closer to science fiction than the reality it seems to be approaching today, if admittedly on a smaller scale than predicted by science fiction writers like George Orwell.

Added to the variety of disciplines contributing to the existence of current-day neural networks, are the diversity of fields in which neural networks can be applied, including classification of complex graphical patterns, prediction of extremely difficult trends such as stock market prices, and voice recognition. Applications of neural networks are increasing, as they become more widespread, and new neural network types with different capabilities are invented almost every week!

A new technology that is also utilizing advances in neurobiology together with computers to benefit humans is "Hybrid Brain-Machine Interfaces" or HBMIs, a technology that MIT's "Technology Review" magazine predicted would take the world by storm in the very near future. The basic goal pursued by those studying and developing HBMI is to gain a better understanding of how the brain works when issuing commands to our body parts, and to use this knowledge to embed systems allowing brain-control of machines possible. So far, some scientists have been able to direct signals from a monkey's individual neurons to a robot that mimics the monkey's arm movements in real time.

If HBMIs become commercial, they have the power to enable paralysis sufferers to control machines or perhaps regain control of their own body parts. In some experiments, neurologists have already succeeded in implanting systems in the brains of paralysis sufferers that allows them to move a pointer on a computer screen, and more success could come very soon.

Regardless of how widespread HBMIs become, they are adding invaluable insight into how the neurons in our brains actually work, which, despite recent advances, is still a mystery. This is an example of how a field can draw from several scientific discoveries to create a new technology that, in its experimental stage, is starting to contribute back (full circle) to the fields it has been built upon.

What is clear from these examples (and there are many more) is that when knowledge from different disciplines is combined, the innovation's end result is a far cry from what could have been achieved if we had merely stretched our knowledge within one field. True, there is probably much more to be discovered and created within each specialized field, and the paradigms we follow now can be challenged by new knowledge, but larger leaps can be made when we broaden the meaning of collaboration, co-operation and globalization. More than simply waiting for specialists from different disciplines to be inspired by each other, allowing them to actively work together and influence each other could be the key to a new wealth of knowledge. With better global communications crossing the distance barrier between specialists of the same field, we can now bridge the gap among all the very different disciplines and truly globalize science and technology.

If we put aside politics and pride, stop trying to prove that "this country invented that"and "this field is the father of that", we could create a global scientific community that will in the end, benefit us all in ways we had never imagined, ways as unexpected as the tractor's benefit to the farmer.