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Life, Love, and Intellect

Information and communications tools ought to be just the thing to improve intellectual and social life. For the 20 million of us worldwide, and growing 20 percent a month, electronic mail offers a way to interact with other people that is fundamentally different from any that we've had before. Virtual friends ask a thousand of each other what to do to make comfortable a child with chicken pox, how to cook a rattlesnake. They take advantage of expertise spread around the globe, ask advice on buying truffles in Paris (bring francs), camping in Morocco (don't). This week a gang of professionals is having a long debate on email on whether long debates on email are any good. When the technology comes home, you too will send electronic notes to your lover, your sister, your next-door neighbor, and your child's teacher.

Math

Sadly, the majority of the population avoids mathematics like herpes. But math is really good stuff. With algebra you can figure out how much sugar you need in chocolate mousse for eleven when you have a recipe for six. With calculus you can calculate how much you'll have for college in thirteen years, five months if you save $117.60 a month at 3.62 percent. People used to have trouble with simple arithmetic. Most don't anymore because calculators help so well. The same thing will soon happen to algebra and calculus.

Calculus, like other mathematics, is a kind of tool for doing mental work. With a set of rules and tricks, pencil and paper, a person can do

wonderful things. But the tools are so hard to use that only very smart, highly trained persons find them useful. I think that all can change.

The spreadsheet is a harbinger but not good enough yet. For figure 9.1 I wanted to fit a standard growth curve, like compound interest, to my data on the efficiency of eight text editors introduced at various times, so that I could calculate the average improvement per year and graph the result. My spreadsheet program contains such a facility, but here's an (only slightly unfair) excerpt from its instructions:

Syntax

GROWTH (***known_y's***,*known_x*'s,*new_x*'s,*const*)
...

The array *known_x*'s can include one or more sets of variables. If only one variable is used, *known_y*'s and *known_x*'s can be ranges of any shape, as long as they have equal dimensions. If more than one variable is used, *known_y*'s must be a vector (that is, a range with a height of one row or a width of one column).[1]

I couldn't make it work in an hour and a half of trying, so I did the problem with a calculator in ten minutes. I maintain that the difficulty isn't necessary. My fantasy version does something like this:

Put the numbers you already know in two columns, one for the *X* values, one for the *Y*s. Here's an example:

Year (X)	Accumulated Savings (Y) at Unknown Rate
1990	$100
1995	$163
1992	$117

I do one just like the example. It says "OK."

It asks, "What's the smallest *X* you want a *Y* value for?"

I say "1973."

It asks, "What's the largest *X* you want a *Y* value for?"

I say, "2000."

It says, "The average growth rate was 9.4 percent. Do you want a plot?"

I have another hunch. I think most people would find simulation programs easier to use than regular math (Landauer 1988). For example, instead of using calculus to find out how much of your mortgage payments for the first ten years was interest, the program lets you type in the amount of the loan and the percentage interest, then click a button once for each payment period to have the program multiply by the percentage, cumulate the interest payments, and subtract each from the balance. It would be much easier to set up the problem, the operation most people find hardest. If you tried to do it this way by hand, you'd have to do 120 multiplications and subtractions for a ten-year period, and you'd probably make mistakes. The computer won't.

Standard Disclaimer: It won't work—not until it is based on thorough task analysis in a realistic setting, not until it's mocked-up and tried and revised, then again; then prototyped and tried and revised, then again; then experimentally implemented and evaluated and revised, then again.

Education

How many times did teachers tell you that all you need to know is how to use the library? Did you believe them? Did you stop studying textbooks and just rely on visiting the library? No. Using the library is too hard, slow, and unreliable. Someday we'll solve this problem, and on some fronts we've made exciting advances. Recall some of the SuperBook experiments. Statistics and chemistry students taking open computer exams scored A's while classmates with traditional books got C's. Chemistry students found needed facts seven times as fast with the computer. The balance for them had already shifted. Given the availability of such tools, students will rely on finding more and learning less. Just how much of this we can get away with is a deep question for research. You can't learn much chemistry without knowing much chemistry. But you certainly can do more chemistry without knowing as much as you do now if you can find out what you need to know more easily. Where will it end? I don't know, but somewhere different and better than where we are now. For analogy, look at what calculators have done to arithmetic. Soon, people with their computer partners by their sides will be much more knowledgeable than people have ever been before.

Creativity

The mind things that computers will amplify won't be limited to boring scholarly activities like math and chemistry. Most kids love to draw until they find out they're not good at it; grown-ups love to invent tunes when no one can hear. So far, we have computer-aided tools for drawing, composition, and performance that are sometimes interesting in the hands of experts, but they don't do much for the average person. These systems have received almost no UCD, no performance analysis of what it is that ordinary people want to do, what they find hard, and what would help them, almost no iterative design.

When it happens, you and I will be able to draw lifelike portraits of our cousins, animations, and cute cartoons of our pets. We'll produce decent home movies. We'll be able to compose, God forbid, rap songs and set them to what passes for music and play them as loud and often as we want.

Entertainment

Engrossing games by, through, and with computers are already here, captivating millions of players, filling billions of hours that might otherwise be wasted. They will get even better. Commercial versions of chess programs play as well as most human opponents want them to. Email schemes let you find a pick-up game of GO or gin rummy with a human (or so you think). Dungeon and dragon games, endless adventures and mysteries in the bowels of the computer's imagination, amuse masses. Versions that involve multiple players and multiple machines interact with each other day and night across the Internet. Here, if anywhere, the programmer inventors have found things for people to do with computers that can't be done without, that are truly original, popular, and profitable (especially in the guise of video games). So far, most of the players tend to be young, nerdy, and male. The future, with easier computers used by more people, will see more games loved by the average kid and grandma too.

Books and entertainment will change too. A book will spring into life, it's illustrations animated and singing, showing videos of helicopter

flights over the Amazon basin where great trees are bending and characters are developing. But I don't know, really, how much of the envisioned multimedia, over our 500 channel interactive cable, is going to be really nice. People know a lot already about how to string the fibers and chop the data into bytes, but there is precious little knowledge of what will please. Following that tradition, here's another little idea.

People have already started writing computerized books,and the *New York Times* has started reviewing them (apparently by hand). Some take advantage of the fact that the computerized plot can go 4, or 512, different ways, depending on which menu button the user clicks. Here's my idea. (I don't know if it's original.) In my computer-based murder mystery, you the reader choose anyplace in the world to be, any character to be watching and listening to, like a fly on the wall, at any time during the story. But you can't be two places at once, and you can't go back. Reading such a story would be fun because your chance of solving the mystery would involve constant active decisions and luck. Writing such a story would be also be a lot of fun—and work. It could be realistic and engaging with graphics and multimedia; place your alter-ego character in pictured places, and the computer lets you see and hear only what you really could. Computers can do stuff like that. The publisher could make these books profitable by charging you again every time you went through it. Someone could rewrite *War and Peace* in the same style. Follow every one of the dozens of characters for every hour of their lives during the Napoleonic Wars. It could expand to 20,000 pages, maybe more, still easily stored on the hard disk of the computer I just bought.

Standard disclaimer.

Enough

I won't go on. The story of the human race is one of ever-increasing intellectual capability. Since our early cave-dwelling ancestors, our brains have gotten no bigger, our hands no more nimble, but there has been a steady accretion of new tools for intellectual work—how to grow crops, domesticate animals, build shelters, paint paintings. It includes governing and inspiring and, unfortunately, waging wars. It includes how to build and operate airlines, television sets, and football teams. This shared ca-

pacity was first manifest in language, later in writing, math, and science, and in the huge collections of experience and discovery stored in books and libraries. By comparison with our forebears, each of us has become a genius. The human mind is not housed in an isolated block of tissue in a person's skull. It draws on the whole wealth of stored human knowledge and the whole power of our shared mental tools. The growth of this mental power is not over. In relative terms, it has probably just begun. Computers offer so much more than mere language and mere marks on paper. They will make our mental powers appear to our great-grandchildren the way those of chimpanzees appear to us today.

Standard caveat.

Notes

Chapter 1

1. For the U.S. national account, we should also debit a substantial sum for the education and public research support of the academic computer scientists and engineers who have invented and developed much of the technology, although a large portion can be assigned to presumably valuable military applications. [15]

2. There was a large jump in productivity in 1992—a growth rate of 2.9 percent for the year—followed by a collapse in the first two quarters of 1993 and a jump forward in the third. It is too early to tell if we are seeing harbingers of the long-awaited turnaround or temporary fluctuations resulting from massive layoffs. What the world is after, of course, is sustained productivity growth coupled with high levels of employment and total output. If the measure is output per person or output per dollar of capital goods, the bad news continued unabated through 1993. Thus the apparent improvement, if permanent, reflects a greater ability to sustain the same output while working less. Previous productivity gains have both increased output and decreased work hours, thus improving standards of living. [15]

3. Maddison and Thor apparently used different measures of prices for the same goods in the various countries to equate GDP figures. Figure 1.3 combines data from these two sources to extend the years covered. As a result the absolute numbers could have small errors, but the overall pattern is not affected. Using 1990 price indexes, productivity in France and Germany had surpassed that in the United States in 1990 (McKinsey Global Institute 1992). However, Thor (1994) concludes that the United States is still ahead in purchase power per work hour although trailing badly in product per person measured by exchange rate dollar values. [18]

4. The recent report by McKinsey Global Institute (1992), coauthored by a blue-ribbon group of economists, looked closely at international differences and concluded, with apparent surprise, that the overall lead of the United States in productivity had not narrowed significantly in very recent years (the 1990 data in figure 1.3 come from this report). In 1950 France and Germany averaged only