FAIRYTALES*

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Once upon a time, when it was still of some use to wish for what
one wanted, ...

> ... there lived a King and Queen who had a daughter who
> was lovely to behold, but who never laughed.

Or perhaps:

> ... there lived an old fisherman by the side of a sea
> that had hardly any fishes in it.

If you are like me, you are already hooked. You are ready to
abandon all talk of computers and electronic technology and
professorships, and settle in to hear a fairy story. Their
attraction reaches almost all of us.

They let us enter in upon an enchanted world. Magic abounds,
though always in special ways. Animals talk, and not only
animals but trees and bridges. Villainy is there, certainly
danger. There are trials to be overcome -- usually three of
them. But there is always the happy ending. The spell is broken
and the Princess smiles and marries the youth who made her
laugh. The old fisherman gets the Jinni back in the bottle with
the top on. And happiness is ever after, which means at least
for a little while.

The experts tell us that fairy stories are for childhood. That
they contain lessons for the crises of growing up, and that
their universal attraction comes because they deal with what is
central to this universal time of life.

> Like Hansel and Gretel, we have to leave home and find
> our own way.

> Like Jack, in the story of the beanstalk, we can bring
> home the bacon if we persevere, even if our parents don't
> think we can.

> But there was more, if you remember your Jack. First he
> escaped back home with a bag of gold. But Jack and his
> mother used up the gold, showing that one success is not
> enough.

> Then he made a second trip up the beanstalk to the
> Giant's castle. This time he came home with the magic hen
> that lays golden eggs, so he now had a technology for
> satisfying his and his mother's wants.

> But even so, material things are not sufficient for the
> full life. So on his third trip Jack brought home the

golden singing harp, symbolizing the higher things of life.

Or like the Princess with the Frog King, we must learn to keep our word and embrace what we find disgusting and ugly, to discover that it contains our heart's desire.

The experts notwithstanding, fairy stories are for all of us. Indeed, this is true, if for no other reason than that today we are all of us children with respect to the future. We do not know what is coming. It is as new to us and as incomprehensible as adult life is to child. We find ourselves troubled and fearful at the changes taking place in ourselves and our society. We need the hidden guidance of fairy stories to tell us of the trials we must over come. To assure us that there will be a happy ending. Whether fairy stories have been written that speak to the heart of our own adult crises is unclear. How would we, the children, ever know? Perhaps we must get along with the fairy stories we have. We could do worse.

But even more, fairy stories seem to me to have a close connection to technology. That the aim of technology, when properly applied, is to build a land of Faerie.

Well, that should come as a shock! The intellectual garb of the modern academic is cynicism. Like a follower in a great herd, as surely as I am an academic, I am a cynic. Yet, I have just uttered a sentiment that is, if anything, straight from Pollyanna.

In point of fact, within the small circle of writers who manage to put technology and fairy stories between the same covers, the emphasis is always on the negative, on the dark side. The favorite stories are those that trouble.

Like the Sorcerer's Apprentice, who learns only enough magic to start the broom of technology hauling water from the River Rhine to the cistern, but who cannot stop it.

Like the Jinni in the bottle, where the story is never permitted to go to the conclusion in the Arabian Nights, with the Jinni snookered back into the bottle, but is always stopped with the Jinni hanging in air and the question along with it -- Can we ever put the Jinni back? Or will there only be ink all over the sky 'til the stars go out?

Like the many stories of the three magic wishes, in which, promising infinite riches just for the asking, they are always spent, first on foolishness, second on disaster and third on bare recovery.

As in the Monkey's Paw, the old couple's first wish was for 200 pounds. That was foolish. The second wish was for the return of their just killed son. That was

disaster. The third wish was to send their son back to his opened grave to try to recover for themselves a world where life could go on.

But I see it differently. I see the computer as the enchanted technology. Better, it is the technology of enchantment. I mean that quite literally, so I had best explain.

There are two essential ingredients in computer technology. First, it is the technology of how to apply knowledge to action to achieve goals. That is, it provides the capability for intelligent behavior. That is why we process data with computers -- to get answers to solve our problems. That is what algorithms and programs are all about -- frozen action to be thawed when needed.

The second ingredient is the miniaturization of the physical systems that have this ability for intelligent action. This is what Angel Jordan, my co-Whitaker Professor, has been telling us about. Computers are getting smaller, and cheaper, and faster, and more reliable, and less energy demanding. Everything is changing in the right direction together. The good things do not trade off against the bad ones. More speed does not mean more dollars. Smaller size does not mean lower reliability. On any given date, these tradeoffs that the economists so dearly love, of having to chose between painful options, certainly do hold. But come back next year and everything is better: smaller, cheaper, faster, more reliable, less energy.

Thus computer technology differs from all other technologies precisely in providing the capability for an enchanted world:

> For brakes that know how to stop on wet pavements.

> For instruments that can converse with their users.

> For bridges that watch out for the safety of those who cross them.

> For streetlights that care about those who stand under them -- who know the way, so no one need get lost.

> For little boxes that make out your income tax for you.

In short, computer technology offers the possibility of incorporating intelligent behavior in all the nooks and crannies of our world. With it we could build an enchanted land.

All very good. What about the Sorcerer's Apprentice? That comes about because of two half-fallacies. The first half-fallacy is that technologies are rigid and unthinking. Start the broom off carrying water and it does just that and not something else. But every computer scientist recognizes in the Sorcerer's Apprentice simply a program with a bug in it, embedded in a first generation operating system with no built in panic button.

Even with our computer systems today, poor things as they are, such blunderbus looping is no longer a specter.

Exactly what the computer provides is the ability to not be rigid and unthinking, but rather to behave conditionally. That is what it means to apply knowledge to action: it means to let the action taken reflect knowledge of the situation, to be sometimes this way, sometimes that, as appropriate. With small amounts of computer technology -- that is, with small amounts of memory and small amounts of processing per decision -- you often can't be conditional enough. That is certainly the story of the first decades of the computer revolution. It was too expensive and involved too much complexity to create systems with enough conditionality. We didn't know how and couldn't have afforded it if we had. Consequently, many applications were rigid and unthinking. It was indeed a Sorcerer's Apprentice who seemed to run the computerized billing service.

However, the import of miniaturization is that ultimately, we will be able to have enough capability for conditionality in a small enough space. And the import of our scientific study of computers is that we will know how to make all the conditionality work for us. Then the brooms of the world themselves can know enough to stop when things go wrong.

The second half-fallacy behind the Sorcerer's Apprentice is that technologies by their nature extract too high a price. That is a message of the recent literature of political ecology. Our technologies inevitably demand that we use up our precious world. There is rather abundant evidence for this view. Here in Western Pennsylvania, the price to the enchantment of our countryside from taking our coal by strip mining is only too much in evidence. Less in our awareness, because it was so thorough, was what the loggers did to Western Pennsylvania. Not once, but thrice, within forty years they swept the hillsides almost bare. The hot scalding breath of a dragon could hardly have done better for desolation.

But all is not inevitable. Ecologically, computer technology itself is nearly magic. The better it gets, the less of our environment it consumes. It is clean, unobtrusive, consumes little energy and little material. And as we push it to higher peaks of speed and memory, it becomes more of all these things. For deep technical reasons this has to be. There is no way to obtain immense amounts of processing power by freezing technology at some cost in dollars, material and energy per unit of computation, and then just buying more and more of it, consuming our wealth and our environment. Instead, for a long time to come, as we get more and more of it, the less will it impact our environment.

Even more, the computer is exactly the technology to permit us to cope intelligently with the use of our other resources. Again, by providing us with distributed intelligence, it can let us keep track of the use and abuse of our environment. And not

only of the destruction that we ourselves visit on our world, but also that which nature does as well. Mt. Vesuvius was hardly bound by any antipollution ordinances posted on the walls of ancient Pompeii.

In sum, technology can be controlled, especially if it is saturated with intelligence to watch over how it goes, to keep accounts, to prevent errors, and to provide wisdom to each decision. And these guardians of our world, these magic informational dwarfs, need not extract too high a price.

But I said that the Sorcerer's Apprentice was guided by half-fallacies. I did not dismiss the view totally. Because, of course, in fairy stories there are great trials to be performed before the happy ending. Great dangers must be encountered and overcome. Because also, in fairy stories, the hero -- the one who achieves finally the happy ending (and it is as often a girl-child as a boy-child) must grow in virtue and in mature understanding. No villians need apply for the central role. The fairy story that I am indirectly spinning here will not come automatically and we must earn it.

Where are we now? We are not at the end of the story, though we are surely at the end of my talk. In fact the fairy story is hardly past its "Once upon a time". Still, I wish to assert that computer science and technology are the stuff out of which the future fairy land can be built. My faith is that the trials can be endured successfully, even by us children who fear that we are not so wise as we need to be. I might remind you, by the way, that the hero never has to make it all on his own. Prometheus is not the central character of any fairy story, but of a tragic myth. In fairy stories, magic friends sustain our hero and help him overcome the giants and the witches that beset him.

Finally, I wish to express my feeling of childlike wonder that my time to be awake on this earth has placed me in the middle of this particular fairy story.