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A MONTHLY REPORT BY ESTHER DYSON

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CHRONICLE: DO YOU KNOW WHAT I KNOW?

Now that spreadsheets are a fairly mature market and most of the fighting is for market share, Lotus is about to announce a technology that could radically improve its position in the cutthroat spreadsheet market. No, it's not a Windows version of Improv, which lets an individual do awesome things with the data on his own, but rather a new technology/feature for 1-2-3 called Chronicle, which lets an individual share not just his data but his assumptions with others. Chronicle was championed and developed within Frank King's R&D organization by Irene Greif, formerly with MIT, and her team. It's part of the solid groundwork King leaves to John Landry.

The basic concept is simple: How do you get the software to maintain the conflicts and dependencies in scenarios 1, 2 and 3? How do you combine Juan's assumptions on costs (he's the purchasing agent) with Alice's knowledge of customer price elasticity (she's the one in the field)? What's the bottom line if Russia does better than expected but Italy does worse? Suppose you want to go back to your earlier pricing model but keep your current sales forecasts? Suppose you charged the overhead to the chairman's office instead of applying it to the widget department; how would operating costs look then? What if we scrap the intelligent widget project and invest in pens? The permutations and combinations of different people's assumptions and scenarios can rapidly become incomprehensible -- and impossible to manage.

The Chronicle technology fits in between a file manager, which treats each spreadsheet as a monolithic object, and a database, which de facto treats each cell of a spreadsheet as a discrete data element. Working within a single spreadsheet, the technology manages a set of modules that can be selected and combined to compose a spreadsheet. It manages the integrity of each assumption-set and controls conflicts among them just as a database maintains the integrity of *data* elements, with each item a discrete piece. That is, it does not eliminate the conflicts, but keeps them from messing up the whole -- much as Alice could believe eight impossible things before breakfast behind the looking-glass.

Was that BDG1B or BDG2A? JUAN2 or ALICE4?

Just as a database guards data, Chronicle guards scenarios, keeping them safe from changes by unapproved people and random edits. An assumption-set is an explicit, defined object, just like a database record; once created it can be changed only through defined procedures. Thus Chronicle "knows" \implies

HAPPY HOLIDAYS!

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about assumptions and replaces informal schemes whereby users proliferate different versions of a spreadsheet by altering a line or two and storing the results under different names. In this traditional approach, knowledge about the assumptions and their interconnections is only in the users' minds -- and sometimes they forget.

Rather than create an entire new spreadsheet for each permutation of scenarios, Chronicle keeps all the interacting scenarios straight in a single, consistent (or at least conflict-managed) spreadsheet. The software can create any combination of assumptions on the fly. That saves space, which is a minor issue. More important, it ensures consistency and manages the assumptions explicitly; you can tell which and whose assumptions underlie any particular set of figures.

Technically, the idea is quite simple. A spreadsheet is composed of a number of modules, each consisting of a number of alternatives. The user simply chooses which set of modules/assumptions he wants to work with. Of course, actually managing this in a way that's friendly, foolproof and intelligible (and compatible with 1-2-3) has taken Lotus considerable time.

Manage conflicts; don't resolve them

The details on Chronicle are still hazy; it will be shipped as part of the next release of 1-2-3 for Windows, due sometime next year. The first version will allow a person to maintain his own range of assumptions. Several users can also add their assumptions/scenarios into a single spreadsheet stored on a server. Future versions will manage different users' versions across a network, using the Notes database as the server. (Of course, it's also useful as single-ware; after all, the first person you want to share assumptions with is yourself, over time, through moods, mind-changing meetings and unpredictable events.)

Although we have seen only a pre-release version, not the finished product, here's more or less how it works: A user can select from a picklist of alternative assumptions for each possible set of assumptions, and assemble a spreadsheet to reflect any mix of assumptions. Chronicle manages defaults, locks assumption sets and manages conflicts. You can categorize assumptions by who made them, by date, or by user-defined titles such as A, B and C; strong or weak; with or without spinoff; before and after; or even "Suppose we hired Larry."

We could also imagine all sorts of clever little tricks in the user interface, easily borrowed from the 1-2-3 auditor tool (but don't look for them in the first release). For example, Juan's assumptions could appear in blue on the rows listing costs, with Alice's in orange on the sales line. At user request, all the figures derived from either Alice's or Juan's assumptions could be highlighted in their color.

From personal productivity to a shared world

Why is this so exciting? There are a number of reasons. First of all, it will be a good way to sell groupware, which is not an application, but a feature of an application. Chronicle should help potential users discover the point of groupware, which is not to do new things, but to help them communicate about traditional tasks through the medium of the task informa-

tion itself. Adding Chronicle to 1-2-3 will help groupware look not exotic but useful.

The market for Chronicle is promising, since there's an installed base of spreadsheet users on networks out there; it's the equivalent of turning on a capability everyone is primed to use, rather than selling a completely new capability. People are already doing most of what Chronicle does, but not automatically; moreover, they already have the data in their computers. By contrast, adopting most other groupware tools will involve wholesale moves from paper (or even the ether of people's minds and conversations) into electronic form. That is, if you start to use Notes, for example, there will be a long start-up period where you have to install Notes, put data and documents into it and get people to use it. That's not the case with Chronicle, which can work with all the 1-2-3 and perhaps Excel and Quattro spreadsheets out there.

More importantly, Chronicle will help users to model the increasing complexity of the world and the proliferation of information. You don't need to resolve the conflicts; just manage them until time or decisions allow you to discard some scenarios. Spreadsheets used to be a single-user item; now they are increasingly used by people to share and communicate information. The bottom line is not the only significant information; people also need to know the range of assumptions and their possible impacts.

As illustrated in Phil Salin's essay below, costs are not as simple as 1-2-3. They reflect not only material costs and easily measurable factors, but also a range of assumptions about the rest of the world. The opportunity cost of any particular investment or action is the value of any other investment or action forgone in its favor; in effect, it's all the paths not taken.

Reflecting the uncertainty of reality

The most interesting impact of Chronicle may well be psychological, even though it looks straightforward and ideology-free: After all, it's just a spreadsheet extension. In fact, although Chronicle allows for a default scenario (the single assumption-set you begin with), it explicitly illustrates life's uncertainty: There's no single world view. Any spreadsheet is simply a selection of assumptions, each electronically equivalent and as easy to represent as any other. Moreover, the spreadsheet no longer represents a single person's worldview; it's a group effort, reflecting not summarized, homogenized consensus, but the individual assumptions and the collective uncertainty of the group of people that created it. Chronicle makes it easier for you to change your mind or to acknowledge someone else's point of view -- and to recognize the possibility of doing so.

COSTS ARE IN THE EYES OF THE BEHOLDERS

Following a longstanding but infrequent tradition (the last time was Mitch Kapor on software design in February 1988), we are printing an interesting commentary by someone else that merited printing rather than paraphrasing. In this issue, Phil Salin looks at the related issues of costs and assumptions and information -- a suitable counterpoint to Chronicle, which helps users make sense of increasing amounts of conflicting data by organizing it into sets of possibly conflicting assumptions.

Fundamentally, the more you know about the world at large, the more you know about the world at home. In particular, information technology can change our assessment of the costs of our actions by letting us examine the alternatives more closely. Cost is not just an accounting issue. In fact, it's a global concept, the obverse of value; it's the bottom line on which we base decisions. As outlined below, it includes not just objective, physical criteria, but personal preferences, risk assessments, ethical judgments and a world of alternatives. Cost measures not just what we do, but what we don't do.

Opportunity costs

The traditional view of costs is that they are tangible and quantifiable -- so much input, so much labor and so forth. Even accounting costs are relatively tangible -- items such as depreciation or allocation of overhead.

But there's also opportunity cost, the cost of alternatives forgone: What could you have earned or achieved if you applied the same resources some other way? In a sense, traditional costs measure the inputs you use against the output you can generate with them; opportunity cost measures the potential value of everything you don't do. It's a much larger range of possibilities, fraught with assumptions, risks and alternatives that are hard to know about, much less quantify. You can't lower the opportunity cost of a single investment directly, but you can lower opportunity costs overall by choosing a better investment of the same resources. But reducing opportunity costs isn't just a matter of knowing alternatives; taking advantage of that knowledge also requires an ability to find resources and negotiate with their suppliers.

Transaction costs

In an orthogonal framework is the concept of transaction costs -- the costs of making a transaction, sometimes independent of the size of the transaction. They are frequently the costs involved in assessing and taking advantage of alternative opportunities rather than sticking with a permanent relationship. Many of them are information-intensive: finding a source of supply, checking a reference, bargaining with the seller, arranging credit. As Nobelist Ronald Coase articulated, transaction costs have a powerful impact not just on profitability, but on the actual structure of an economy.

Computers and transactions: the power of information

The third section of Salin's essay uses this context of cost-analysis to assess the impact of computers and information networks on our ability to get information to assess opportunity costs and to make transactions more

effectively. Information technology comes into play in three ways: It makes it easier to analyze and model costs and opportunity costs; it makes it possible to find out about alternative uses of resources, thus making it easier to assess opportunity costs (or to pick more fruitful ways of applying funds); and it lowers the transaction costs involved in finding and perhaps using the alternatives.

ABOUT PHIL SALIN

Salin is an intellectual with the drive to try out some of his ideas. In the early Eighties, he was in the rocket-launch business, as founder and first president of Arc Technologies/StarStruck, the first US company to design, develop and launch a privately financed rocket. Salin and his associates played a major role in the privatization of the satellite-launching business. His earlier work as an economist at a think tank helped lay the groundwork for the breakup of AT&T and the subsequent explosion of competition and innovation in the US telecommunications market. He has also worked as a stockbroker and as a programmer at Bechtel Financing Services, where he invented something much like a spreadsheet in the mid-Seventies.

Since 1984, Salin has been working on the American Information Exchange, the embodiment of many of his ideas about information markets (see Release 1.0, 7-90). In 1988, AMIX became a subsidiary of Autodesk, which has financed development of the software. Currently, the company is offering several pilot information markets, which allow users to ask for, offer and bid for both existing documents and custom research and consulting on a variety of topics.

PHIL SALIN: COSTS AND COMPUTERS

Just as the 19th and 20th centuries saw a steady fall in power costs and an increase in availability of powered machines, the late 20th century is seeing a rapid fall in information costs and transaction costs -- and a concomitant rise in the availability of information and the possibility for transaction-oriented rather than command-oriented industrial organizations (see Release 1.0, 6-89, 9-91; and various articles by MIT's Tom Malone on market coordination vs. hierarchies).

So far, the major impact of these lowered costs of information and transaction has been felt by single individuals using pcs, or by corporate departments performing a limited range of information processing functions on mainframes such as accounting or payroll. One-way information media have also been dramatically affected, with the rise of desktop publishing and soon desktop video.

Over the next 5 to 15 years, the costs of handling customized information transactions between individuals and organizations are also going to drop steeply. New capabilities will emerge which take advantage of these falling transaction and information costs, with major implications for business, science, and society.

With spreadsheets, anyone can now afford the time and money to perform detailed numeric and financial modeling of any interesting problem or complex

business situation. The rapid spread of more effective financial literacy, due to low-cost personal computing, may soon become almost as important as the spread of written literacy many centuries ago. Individuals are becoming more powerful in understanding the implications of financial numbers and assumptions which formerly only accountants and financial types had the time to think about in detail -- or in the abstract.

Short term, the quantity and diversity of information available at low cost is overloading almost everyone; but this imbalance will not be permanent. Demand fosters supply, and increasingly clever and effective ways to use computers to filter and prioritize information flows will emerge and continually improve.

Overall, business and social activity rests on a foundation of information and transaction costs, not always explicitly recognized. As computers lower and change those costs, standard ways of doing business, politics and almost everything else will be strongly affected.

PART I: COST CONCEPTS -- SOME IMPORTANT DISTINCTIONS

Before discussing transaction and information costs, it is necessary to consider the overall concept of cost.

Traditionally, the theory of costs in economics has been a deep muddle.¹ In fact, a cost assessment is a measurement of a number of factors; it is the result of an (information) activity, not an absolute value. Costs are more subjective -- dependent on the thoughts, plans, and values of individuals -- and uncertain -- dependent on unknowable factors and probabilities -- than traditional economics, traditional accounting or traditional English-language use of the term "cost" recognizes.

Measurement: an action by an actor, not just a result

People tend to ignore the particulars of a cost assessment; they want "just the facts." But like all measurements, a cost assessment has several components that affect the results: someone doing the measuring (or some instrument, such as an accounting system designed, fed and operated by fallible humans), something being measured, some method of measurement, various estimations of market values and other factors, and a particular time at which the assessment is made. Confounding most discussions of cost is the notion that there is only one right measurement to make -- as if there were only one ratio or figure worth looking at on a balance sheet.

Just as people never agree completely on value estimates, people also normally and naturally disagree on cost estimates, for the same reasons: Both kinds of estimates are inherently uncertain, fluctuating and personal. Even when people think they agree on costs, they're often confused and don't realize it. The agreement is often mere coincidence of end results, with completely different methodologies, assumptions and values underneath.

¹ Nobel Prize-winning economist James Buchanan wrote a perceptive book on the subject more than a decade ago, "Cost and Choice." But the teaching of economics as a science, and of cost accounting as a business technique, hasn't been much affected.

Every once in a while, the confusions about cost do surface: in business with protracted arguments about how profitable particular products are; and in politics, with public arguments about cost estimates or assessments made by defense contractors or universities and billed to the government.

One man's money cost is another man's benefit

There are at least four different concepts of cost, all useful. Most people (including specialists) tend to mix them up in conversation and in formal analyses, leading to bizarre miscommunications. Let's consider a single economic transaction, and the differences will become clear.

Imagine that I'm very thirsty for a Coke. It takes me 10 minutes to drive to the nearest store and drive back, plus 5 minutes in the store. I spend 50 cents for the Coke. What did the Coke cost me?

Money Cost

The simplest, most intuitive, and most common concept of cost (Money Cost), is that the Coke cost me 50 cents. This is how much cash changed hands in the transaction.

Accounting Cost

The second, also common concept of cost (among cost accountants and business managers, at least) is Accounting Cost. Accounting Cost would estimate that the Coke cost me 50 cents plus the value of my time (labor used in obtaining the Coke), plus the cost of wear and tear on my car (equipment used in obtaining the Coke). If the labor market values my time at \$43,000 a year, that's \$20 per hour, or \$5 for 15 minutes. If my car costs \$18,000, and is depreciated over 6 years, that comes to \$3000 per year. Add in \$1000 a year in maintenance, gas and insurance, and let's call it \$4000 per year. If I drive for 1 hour per day, that's 365 hours per year, or about \$12 per hour. Ten minutes' driving comes to \$2 of car costs. Total Accounting Cost of the Coke: \$7.50.

Personal Cost

The third concept of cost is not commonly well articulated, but it is just as important as the other cost concepts. I call it "Personal Cost." Personal cost takes into account the fact that individuals differ in how they value, think or feel about various aspects of a transaction. Suppose I enjoy taking my car for a drive, getting out of the house, moseying over to the corner drug store for a few minutes... Maybe it's worth \$6 to me to take a break. So now the net cost to me of buying a Coke is \$7.50 - \$6 = \$1.50, i.e., that's the personal cost as I see it. My accountant may see it differently: He has less information than I do about my values, plans and preferences.

On the other hand, somebody who absolutely *hates* driving or having their concentration broken just to buy a beverage may consider it worth \$6 *not* to have to get in the car and go to the store for a Coke. So for this person, the cost of the Coke is \$7.50 + \$6 = \$13.50.

People include personal cost assessments in their decisions and recommendations all the time; they make these assessments consciously and explicitly for big purchases such as vacation homes, luxury cars, business trips with a personal component such as seeing friends or visiting museums. For small things, almost nobody consider personal costs consciously. But unconsciously, we take personal costs into account all the time in personal and business transactions.

Consumer (and occasionally business) choices based on personal costs may look irrational to outsiders and be discounted by them. However, personal costs properly reflect real preferences; people make rational decisions based on personal costs in order to maximize their own satisfaction. Yes, preferences (and personal costs) can be affected by advertising; they are also a function of peer pressure, education, childhood experience, substance abuse -- everything that affects individuals' needs, wants and preferences. But they are real and economically valid.

Thus, for a given person at a given time, there is only one right answer to the question, "What is the personal cost of making this purchase?" -- although it may not be quantifiable, explicit or even conscious. Each person is the exclusive, authoritative judge of his own personal costs, judged at a point in time. Of course, one's advisers or partners may make a different prediction: "You'll be sorry" (the Coke produces indigestion, or the drive to the store results in a car crash). But even so, while one's original estimates of personal costs may be in error, one's estimates after the fact are still one's own, unique and unchallengeable: "I would have paid \$5000 not to buy that Coke, had I but known..."

"Business" personal costs

Business decisions affect different individuals in a business differently. Often, people adjust their recommendations to try to minimize personal costs of a business decision. Examples of decisions where it's easy to see the importance of personal cost components include: location of a new office; commitment to a new R&D project; mergers and acquisitions; hiring decisions. Note that conflicts of interest are not always strictly financial -- or apparent even to seemingly well-informed observers.

Opportunity Cost

An orthogonal concept of cost is well understood by economists and business people, but it is also difficult to measure (although for different reasons): Opportunity Cost. What could I have done with that 15 minutes and 50 cents instead of buying a Coke? Perhaps I could have spent 15 minutes inventing a popular tune (one chance in 50 of being worth \$10,000; so worth about \$200 in expected value), or talking to my ailing aunt (for some people, costs \$50; for others, worth \$50), or putting in overtime at work (\$30/hour at time-and-a-half rates, \$7.50 -- wow, real money!). So the Opportunity Cost I place on those few minutes varies depending on what alternative uses I could envision for that time; in the examples above, the range is from approximately +\$200 to -\$50.

Let's shift to a larger-scale example, and the crucial implications of opportunity cost become clearer: Assume I have \$1 million to invest in one of three possible new products, each costing \$1 million in accounting cost.

But product A appears likely to produce \$1 million in profits, product B appears likely to produce \$11 million in profits, and product C appears likely to produce \$111 million in profits. So the opportunity cost of developing product A with respect to product B is \$10 million; I would have made \$10 million more if I'd produced product B instead of product A. And the opportunity cost of product A, the *same* product, with respect to product C is \$110 million.

Now wait a minute. How can the same transaction, investing \$1 million in product A, have two different opportunity costs?! Isn't cost a single number, which reasonable people can agree on?

What you don't know may hurt you -- and cost you!

The difference is not just differing personal costs or subjective attitudes; there are also objective factors involved, based on access to information. Imagine that you know about Product A and Product B, while I know about Product A and Product C. The opportunity cost for you of developing product A is \$10 million. The opportunity cost for me of developing product A is \$110 million. Same product, different knowledge in our heads, different (known) opportunity costs. It's that simple.

But then again, these alternatives may also not be assessed accurately, nor may you know the risks involved. Even when two parties can agree about which alternatives are worth considering, they may not agree about the probabilities of success -- and those probabilities may differ for each company considering the alternative. Each brings different resources and skills to the table, and each has had different experiences.

Certainly, it's fair to say that the more you know, the more accurate your assessment will be. Still, there are other issues to consider, such as the risks and difficulty of producing product C: Is it really worth \$111 million? If so, it should be easy to get someone to fund it. And in the real world, you'd probably get so much competition so fast that actual profits would be much closer to the original \$1 million. (That's what efficient information markets are all about.)

You could lose the whole world with each step

The opportunity cost concept inherently pertains to *perceived* alternatives and the *perceived* value of those alternatives. Made by fallible, limited humans, these perceptions are always limited in range and subject to all kinds of errors. As one widens one's vision to include all physically possible alternatives, the inherent dependence of opportunity cost assessments on information becomes clear. With \$1000 plus complete information, anyone could build a multi-billion-dollar fortune in the world's capital markets in a few weeks. In this case, the "actual" opportunity cost of investing that money in a savings account (or in almost any other plausible investment) instead is billions of dollars.

It ain't what you don't know; it's what you know that ain't so

Assessing money cost, accounting cost, personal cost, and opportunity cost involves increasing degrees of subjectivity or individual interpretation and judgment.

Prices: A reflection of ALL the costs

One place where people often get confused about costs is differential (value- or opportunity cost-based) pricing. Current stock quotes during market hours are priced much higher than "15 minute-delayed" ones. The money or accounting cost to the stock exchange of providing each is presumably the same. But the opportunity costs are quite different: Stock-market professionals need current information, and are willing to pay for it. Accounting cost is far less than it's worth to the buyers.

The same thing comes up with air fare pricing. While the huge variations in airplane ticket prices are hard to understand in terms of accounting cost, they reflect an effort to segment customers in terms of opportunity costs. Some customers value their time highly and their money less, especially when a last-minute trip may allow them to take advantage of a lucrative business opportunity. By contrast, vacation travelers may be able to plan ahead but want to keep to a budget. While airlines like people to book ahead so that the airlines can plan capacity, the real aim of yield management is to segregate people who can afford to pay from those for whom the restrictions are worth the opportunity cost (see Release 1.0, 2-89).

Lacking such an understanding of the relation between prices and opportunity costs, economic populists and demagogues often argue that businesses should charge accounting costs (plus a small amount of profit) for goods and services. This is tantamount to ordering businesses to ignore potential opportunities. It implicitly assumes a world of no change and no new opportunities, a world in which any observer (or government) can know all the alternatives open to a business and can do a better job of running it than those in it.

Unfortunately, the idea that businesses "ought" to charge accounting costs for goods and services is deeply entrenched in many people's thinking. Imagine if the same notion was applied to beauty and talent: One ought not to charge what people are willing to pay for it, but only the money or accounting costs associated with it. Authors would sell their books for the cost of word-processing and paper and perhaps their time, at average market rates for authors.

It's amusing -- or distressing -- to note the asymmetry of how we perceive our own cost assessments vs. those made by others. Whereas the prices I charge for my products always reflect my assessment of my opportunity costs -- i.e., I charge at least as much as I could obtain elsewhere (or I sell something else) -- I nonetheless tend to assume that my suppliers do or at least should charge only their accounting cost plus a modest markup.

But of course that's not so. The 50 cents charged for the Coke represents not just the cost of the 10 teaspoons of sugar, 12 ounces of carbonated water and flavorings, a bit of aluminum can, labor and equipment costs, plus transport costs, overhead and capital cost. It also represents the opportunity costs (alternatives forgone) of every party along the way, from Coca-Cola to the local bottling company, the distributor, the retail merchant and the merchant's landlord.

Money Cost, money which changes hands in a transaction, is not usually a matter for interpretation.

Accounting Cost involves deciding which consequences of a transaction to take into account and which ones to ignore, and how to value them (normally at "market" rates). People rarely disagree on whether a car was used, or how long the car was used, or how to estimate the car usage cost. So people can often roughly agree on accounting costs associated with a transaction. More problematic are issues of attribution and relevance: Who's responsible for the costs of a package-tracking system? Customer service, or the field employees who keep losing packages? What about bringing your nonworking husband to a business meeting at a resort; is that a business expense?

Personal Costs are harder to estimate, and inherently vary from person to person. People can lie or they can be confused about their own personal cost assessments. For example, I might anticipate huge personal costs of a business relocation -- long commutes, unpleasant location, but find instead that I enjoy the daily drive with no one to bother me. Or I might find the opposite; my children start to misbehave and have troubles in school. Also, my personal costs are not easily known by others.

Opportunity Costs are inherently hypothetical and are thus *assessed* subjectively (although not in the same sense personal costs are). They involve the comparison of alternatives that are assessed differently by each person or team dependent on its particular knowledge, resources and capabilities. There's no one right way nor purely objective criteria to assess potential alternatives and associated risks -- until after the fact. Assessments vary as much as people vary in their knowledge, skills, motivations and specializations. Note that opportunity costs include all three kinds of costs -- money, accounting and personal -- as they apply to each alternative.

Opportunity costs typically show great variation among individuals, and between expectations and after-the-fact assessments. One person may perceive that an investment in a new offering will produce four times her investment in two years. Another person may expect only a doubling in two years. In fact, the stock may drop in half in two years. Retrospectively, both parties see the opportunity cost of not putting the money into a savings account as very large.

PART II: COSTS OF ENGAGING IN A TRANSACTION

The costs of engaging in or preparing for a transaction are Transaction Costs, attributable to the transaction but not really to the item purchased itself. These are the buyers' costs of getting and the sellers' costs of delivering the goods, and of finding each other. (The seller's transaction costs appear as part of the buyer's money cost, one way or another.) Transaction costs can be money costs (the bus fare for a trip to the store to buy some equipment, to cite a new example), accounting costs (reimbursed labor costs for the time on the bus and the time spent buying the equipment) or personal costs (if the employee made the trip on his own time). A transaction also has opportunity costs: How could you have otherwise spent the money, resources and time it took you to accomplish the transaction?

Transaction costs also include the costs of assessing opportunity costs -- that is, deciding which product to purchase or which transaction to engage

in. These include the cost of buying and searching through a catalogue to assess alternatives, the time and money cost of calling stores to find out who has what, or perhaps a fruitless visit to a store that is sold out. They also include the cost of taking advantage of that knowledge -- bargaining with suppliers, arranging for delivery, checking on a supplier's claims, premiums for guaranteed access and so forth. (Many of these expensive activities are themselves transactions involving the purchase of information.)

The lowering of transaction costs can have important market impact, mostly in making markets more efficient. For example, customers' ability to find out quickly and inexpensively lowest-price supplier of 1-2-3 Release 3.0, or which of the current moderate-priced 386 clones have the least setup and maintenance hassles, affects their choice of suppliers, and ultimately the fortunes of those suppliers. Purchasing shifts from the nearest retail outlets to the best recommended phone-order discount warehouses. (Indeed, many European customers now purchase their software by mail order from the US, counteracting suppliers' higher European prices.)

Moreover, as Nobelist Ronald Coase pointed out, transaction costs can influence economic structures on a grand scale. Firms are essentially a means of lowering transaction costs: Instead of finding and negotiating with suppliers and workers on a daily basis, a firm forms long-term relationships with them by owning production facilities or hiring workers -- perhaps at the opportunity cost of getting the best ones as needed. Aside from manufacturing efficiencies, many economies of scale are a function of transaction costs that can be spread across a broad base of activity.

But as transaction costs decrease (because of greater access to information as described below), there's less need for rigid vertical integration, since smaller firms (or more autonomous units of larger ones) can work together almost as efficiently through market transactions. Meanwhile, the transaction costs are more than offset by the units' greater ability to stay nimble and to find and acquire the most entrepreneurial suppliers and workers.

For example, Compaq and Dell

On the other hand, these factors can work in mysterious ways. Take the cases of Compaq and Dell. For years, Compaq operated successfully on the strength of a powerful, well-trained dealer channel that supported its products and delivered them to customers. Now, however, those dealers seem to represent an unnecessary "transaction" cost rather than added value. Customers can deal with Dell directly, through the media of telephone, fax and electronic mail. So rather than encourage small firms (the dealers), in this case, reduced transaction costs would seem to eliminate them, as customers take on the reduced transaction burden themselves and deal directly with suppliers. (Frequently, customers can also support themselves out in the information market rather than through an ongoing, single-transaction but high-cost service contract with a single dealer or VAR; they can find and purchase required support information as needed by telephone, bulletin board or other on-demand services.)

Information as a special case

For an expensive piece of equipment, transaction costs will normally be a small fraction of the total costs. But for low-priced services or goods

such as the Coke mentioned earlier, it's quite common for the total transaction costs to exceed by far the amount of money that changes hands from buyer to seller, and merely looking at that amount to analyze a transaction can be quite misleading.

But this is the normal case for information transactions. Much information is very time-consuming (read expensive) to find out about and track down, especially exactly when you need it, but not that expensive to purchase. A single issue of Byte costs only \$3.50 from the newsstand. Assuming 10 articles per issue, each article has a money cost of only 35 cents -- a fraction of the labor cost of finding out whether it's Byte or PC Week you want, and which issue. Then you have to add in the cost of finding it somewhere, because the right issue is probably no longer on sale. Searching online or in a CD-ROM also costs time as well as money, plus a share of the labor costs of learning to use these systems, subscription fees for the databases and the costs for the equipment required.

Then you have to consider the probability that the information you're seeking is available at all. Does anyone know it? Has he written it down somewhere? And then there's the probable cost of not tracking down the information? What if I make a mistake? Or spend two years reinventing the portable widget? Or buy a product with a well-known bug? In other words, what's the opportunity cost of not knowing my opportunity cost?

All these issues apply to decisions about whether and how to obtain desired information, and what to look for. Ultimately, whenever the transaction costs associated with information (as with other goods and services) drop, the result is:

- a decreased tendency to create information or perform research oneself (make instead of buy);
- more use of information in general;
- greater reliance on the lower-cost information media, as opposed to other, still expensive sources.

But since transaction costs are a greater part of the total for information than for most manufactured goods, the impact of decreasing transaction costs is greater. When these costs are high, as they often are, people don't buy otherwise useful information. The information's not worth the total cost. As transaction costs drop, people shift from reinventing and making information to buying it, and from doing without to purchasing more and better-quality information....

PART III: INFORMATION COSTS, TRANSACTION COSTS AND COMPUTERS

Computers are about to radically lower all three kinds of transaction costs -- money costs, accounting costs and personal costs -- associated with buying, obtaining, selling and providing information, for both business and personal purposes. This in turn will assist people in accurately assessing their opportunity costs -- and in lowering them by choosing to exploit the most appealing opportunities.

The ability to buy or obtain exactly the information you need, when you want it, in the form you want it, is about to explode at a speed unmatched since

the invention of printing. In part, this will result from recipients's increased ability to filter, prioritize and customize their traditional "one-way" information sources -- books, magazines, radio, video, CD-ROMs -- as they shift to electronic form (or at least can be selected electronically, as with an online library catalogue).

But the era of primarily one-way information flows, rooted in one-way information transmission technologies, is coming to a close. The era of significant two-way information flows (fax, e-mail, electronically mediated and facilitated conversations, cyberspaces) is about to take off. (In fact, the telephone is a better model of the media of the future than the television.)

With widespread access to highly effective low-cost two-way information media, attention will shift to obtaining the best possible information for one's purposes (tailored clothing), rather than "one size fits all" information. Customers can directly find the specific information they want, or they can find someone willing and especially able to provide it.

How can computers lower transaction costs and information costs?

The development of two-way information media is intimately tied to the proliferation of computers and low-cost telecommunications, along with automated tools for handling the information -- both text and transactions.

First, computers, networks and software can lower the amount of money and time it takes to find out if a particular piece of information is available, at a price worth buying, anywhere in the US (soon) or the world (eventually). They will allow information seekers to broadcast their requests (as many people already do within companies over internal networks). Equally, they will allow information providers to list their information and services through a variety of electronic media. Buyer will meet seller electronically, using a variety of software tools to make the best matches.²

Second, they can lower the price which an information provider needs to charge for specialized or general-purpose information. Computers can greatly lower the costs to specialists of obtaining, maintaining, preparing and delivering their specialized information. And they can also broaden the supplier's market, enabling him to lower unit prices (however one measures the units).

Third, they can increase the ease and speed with which an information purchaser can save, transmit or manipulate purchased information to make it useful to others (say, to show to his boss, client or work associates).

Fourth, they can extend the same benefits to contextual information regarding the information under consideration and its providers. For example, it will be easy to find third-party comments and reviews of potential information sources, and complaints or references.

Fifth, they can extend the effective division of labor in information creation and use. An effective nationwide market in information means that

² One such example is Salin's own American Information Exchange. -- ED

people spend less time reinventing the same wheel, and more time designing and producing diverse wheels for diverse purposes. (This has interesting resonances in the dispute over the legitimacy of copyright and patent protection for software and other intellectual property. One argument against such protection is that it stifles innovation and free expression; see my "Freedom of Speech in Software." On the other hand, an effective source of information about existing innovations and inventions, coupled with an effective market for licensing and reusing such intellectual property, could encourage broader use of the innovations and more work on further innovation, while discouraging redundant effort. But right now, we are suffering from an archaic information system in the US Patent and Trademark Office; see Release 1.0, 8-89.)

The opportunity cost of living in 1992...

Overall, these developments will foster the emergence of novel forms of finance, contracting, polling, and decision-making. In essence, a fluid, transaction-oriented market system, with two-way feedback, can be extended to cover more of our lives, crowding out monolithic, mostly government bureaucracies. Here are just a few examples:

By 1995, computerization will make it possible to finance businesses and business proposals directly through electronic solicitations.³ For the first time, it's easy to raise at low cost \$1 million from 1000 investors prepared to take frequent high risks (for occasional high rewards) with small sums of money. The ubiquitous availability of low-cost contextual information about prior business experience of new business promoters will help discourage rip-offs. E-mail and electronic publications will lower the cost of communicating with investors regarding follow-on investments or non-monetary assistance, and will help investors stay current on the businesses they are investing in. Also, investors will be able to communicate with each other, making shareholder control and oversight more of a reality.

By 1995, it will become possible to finance non-profit projects and organizations directly through electronic solicitations. Contributors to "worthy" causes will be able to monitor more closely the activities of the organizations they are funding, and to choose more effectively among alternative worthy causes. Emphasis will shift from evidence of meaning well to evidence of actual results. Giant, bureaucratic charitable organizations will lose out to more entrepreneurial and focussed organizations and projects.

³ *The major barrier to all this becoming a reality even sooner than 1995 is not technology, but overly constraining laws designed to protect widows and orphans from investment fraud. These laws fail to differentiate between naive individuals who might invest major parts of their net worth in high-risk ventures, and adults who knowingly risk small sums in high-risk ventures. It's particularly perverse that modern governments encourage people to risk small sums in unproductive public lotteries, while discouraging them from risking small sums in innovative businesses. If we're serious about shifting our society from its current obsession with something-for-nothing and zero-sum, competing-special-interest-oriented public policies to more investment, savings, productivity and results-oriented public policies, here's an especially good place to start.*

We may see the rise of market-based charity, where you measure (and invest according to) the returns even if you don't personally receive the benefits. In fact, the Wall Street Journal recently noted the rise of a number of for-profit consulting firms devoted to raising the efficiency and productivity of philanthropic organizations.

By 1995, a network of computer-mediated consulting and sub-contracting will come into use and foster the trend to smaller numbers of employees per business; instead, they will rely more on subcontractors hired as needed for specialized purposes (see Release 1.0, 9-91). Individuals will increasingly specialize and participate in nationwide markets for their particular expertise. In 1995, almost anyone, not just the media or large companies, will be able to find and call on specialized expertise.

By 1995, the days of the overly general poll will be over. Computer-mediated polls will allow those who answer questions to add extra detail to their responses -- and those responses will be available to people trying to interpret what the poll really has discovered. Text tools will interpret even non-multiple-choice responses. Additional queries or follow-on polls will be easily addressed to respondents of a previous poll, to see how their responses vary with (for example) different phrasings of questions or after major events. Respondents to polls will be able to receive payment for their responses, to encourage a greater response rate and more serious attention to responses. (Frequent responders, who may be trying to skew results, could be identified -- all within the limits of stringent privacy protection, of course.)

...with respect to the year 2000

By 2000, the days of thinking that a 51 percent vote for candidate X means that the public has endorsed every position which candidate X might take will be over. Voters will register their preferences on specific issues. Individuals will be able to publish their preferences on an ongoing basis, and sell the results to interested organizations (see Release 1.0, July? 1991). Silent majorities will become more visible, and it will become easier to see the complexity of public opinion instead of painting it black and white. It will also be easier to distinguish between the views of self-styled spokesmen for interest groups, and the views of members of those interest groups.

Wide and quick dissemination of analyses of government programs and proposed laws will provide the public a clearer, more detailed picture of government activity -- and just how much of it is overpriced, underperforming, based on wishful thinking, beneficial only to a special interest or otherwise simply not worth the costs. Earmarking of taxes by individuals for specific programs or expenditures will become feasible, and the allocation of benefits will become clearer. Diverse watchdogs (private citizens and policy groups which specialize on particular issues) will scrutinize every proposed pork-barrel project even before it comes out of committee. This will force effectiveness in government activity, as ineffective government programs and laws will be linked to those who advocated or voted for them.

Whether voters will actually respond -- whether they will stop voting for individuals who make popular statements and then increase taxes and support inappropriate expenditures anyway -- is hard to guess. But there's great

value to better information regarding the probable costs and benefits of proposed and existing laws and of government programs. The overall realism of public opinion might actually be affected.

Throughout the 1990s, the overall opportunity costs of business, philanthropic and personal action will decrease as people gain the knowledge to take advantage of the best alternatives. Fewer important alternatives will be overlooked, and important but previously overlooked alternatives will be discovered and evaluated sooner. A fluid, more effective, lower-cost market for information will make market inefficiencies less likely and shorter in duration. Innovation and competition will develop more quickly in promising areas; the costs of products will drop more quickly in response to intensified, better-informed competition and customers.

At its root, improved information means improved returns on investment for society overall, although above-market returns for any single investment become less prevalent. There will be less sheer waste. Fewer organizational dinosaurs will be able to persist in activities which were invalidated years earlier; information will reach their brains more quickly. Within such giant organizations or among smaller firms, the speed of information access, evaluation and integration will improve significantly. And smaller organizations will have ready access to diversity and quality of information sources formerly only available to large organizations with large budgets.

Also by 2000, multiple cyberspaces will have emerged, diverse and increasingly rich. Contrary to naive views, these cyberspaces will not all be the same, and they will not all be open to the general public. The global network is a connected *platform* for a collection of diverse communities, but only a loose, heterogeneous community itself. Just as access to homes, offices, churches and department stores is controlled by their owners or managers, most virtual locations will exist as distinct pieces of private property. But unlike the private property of today, the potential variations on design and prevailing customs will explode, because many variations can be implemented cheaply in software. And the "externalities" associated with variations can drop; what happens in one cyberspace can be kept from affecting other cyberspaces.

Purveyors of large online cyberspaces such as Prodigy will begin to conceive themselves less as a shopping mall or a single community, and more as an infrastructure supporting diverse communities with differing tastes, values, habits and ways of interacting with each other. There's lots of different ways to do business or conduct romances by phone or in a meeting. The same will be true in cyberspace. Many people will be part of several communities, just as people now identify themselves with a workplace, a bridge club, a parents' group and perhaps a software user group.

Finally, by 2000, the global economy will become a global information economy as well. I can buy and sell information with individuals in Japan, Holland, Czecho-Slovakia, China and Russia almost as easily and inexpensively as with individuals in the US. Many communities of economic and other shared interests will expand beyond national boundaries. What will happen to different economic regulations, protectionism and other vestiges of nationalism? I look forward to the answer.

-- Phil Salin

SOURCES AND RESOURCES

Phil Salin, Chris Peterson, American Information Exchange, 1 (415) 856-1234; fax, 1 (415) 856-4123; e-mail, peterson@markets.amix.com
Irene Greif, Lotus Development, 1 (617) 577-8500; fax, 1 (617) 693-5561
Thomas Malone, MIT Center for Coordination Science, 1 (617) 253-6843; fax, 1 (617) 258-7579

For further reading:

"Freedom of Speech in Software," by Phil Salin, submitted to the US Patent and Trademark Office, 1991.

Various articles by Thomas Malone

Remember to sign up for PC Forum, February 23 to 26 in Tucson!

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- December 10-12 *Fifteenth international online information meeting - London, UK. Sponsored by Learned Information (Europe) Ltd. Contact: Tina Lardent, 44 (865) 730275; fax, 44 (865) 736354.
- December 15-18 Hypertext '91 - San Antonio, TX. Third international conference on hypertext. Sponsored by ACM. Call Janet Walker, (409) 845-0298, e-mail leggett@bush.tamu.edu.
- January 23-24 Fourth annual software support conference - San Francisco. Sponsored by the Institute for International Research. Call Audrey Wu, (212) 826-1260 or (800) 345-8016.
- January 26-29 *Demo '92: The annual personal computer industry product review and demonstration - Palm Springs. Sponsor: P.C. Letter/Industry Publishing. Call Tracy McGee, (415) 592-8880.
- January 27 Massachusetts Computer Software Council Annual Meeting - Newton. With Digital's Ken Olsen. Call Joyce Plotkin, (617) 437-0600.
- January 28-30 *Windows & OS/2 conference - San Jose. Sponsored by PC Week and CM Ventures. Call John Bourgein, (415) 601-5000.
- January 29-31 ComNet '92 - Washington, DC. Sponsored by World Expo. Call Anne Marie Clark, (508) 777-6006.
- February 4-6 Technology investment symposium - New York City. Sponsor: Goldman, Sachs & Co. Call Christine Verri, (212) 902-2085.
- February 5-7 Fielded applications of intelligent software technologies '92 - Toulouse-Labege, France. Sponsor: Image International. Call Philippe Rouzet, 33 (61) 390676; fax, 33 (61) 392431.
- February 11-13 *NetWorld 92 - Boston. Sponsor: Bruno Blenheim. Call Annie Scully or Mark Haviland, (800) 444-3976 or (201) 569-8542.
- February 18-21 Seybold Publishing Conference - Boston. Sponsor: Seybold Seminars. Call Beth Salder, (310) 457-5850; fax, (310) 457-4704.
- February 20-23 TED3 - Monterey, CA. Sponsor: Technology Entertainment Design. Speakers: Bill Gates, John Sculley, John Warnock, Jaron Lanier. Call Richard Saul Wurman, (212) 219-8993.
- February 23-26 **EDventure Holdings PC (Platforms for Computing) Forum - Tucson, AZ. New alliances and new technology lead to "A New Landscape." You read the newsletter; come meet the players and try their tools. Call Daphne Kis, (212) 758-3434.
- March 2-6 OpCon West - Santa Clara. The west-coast session of Softletter's twice-yearly conference for operations managers. Call Tom Stitt, (617) 924-3944.
- March 10-15 *Founding workshop in adaptive computation - Santa Fe. Sponsor: Santa Fe Institute. Call Ginger Richardson, (505) 984-8800.
- March 11-18 Hannover Fair CeBIT '92 - Hannover, Germany. Sponsor: Hannover Fairs USA. Call Donna Peterson Hyland, (609) 987-1202.
- March 18-20 *Second Computers, Freedom and Privacy Conference - Washington, DC (in the lion's den). Sponsor: Computer Professionals for Social Responsibility, Electronic Frontier Foundation. Contact: Lance Hoffman, (202) 994-4955; fax, (202) 994-0227.
- March 18-21 *SPA spring symposium - Seattle. Call Karen Johnson, (202) 452-1600.

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