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INFORMATION TECHNOLOGY, MUDDLING THROUGH,

AND THE POTENTIAL INTELLIGENCE OF DEMOCRACY

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Information Technology (IT) is the rage. Even discounting substantially the hype appearing everywhere from "most-wired" university ratings to the preoccupation with stock prices and overnight millionaires, one has to admit that in many respects things seem to be going quite well for numerous dot.com and conventional companies, for many users of cell phones and email and web browsers, and for most economies around the world.

Yet *Trapped in the Net* by Gene Rochlin, winner of last year's APSA award in the field of technology policy, argues that decision makers in business and industry, the military, and other fields generally are failing to give due regard to the unanticipated consequences of computerization. They are leading technological civilization into a "computer trap" - lured there by promises of powerful, low-cost machinery and rapid networking, but then snared when their organizations become "irreversibly committed to the new capacities and potentials."[(1)] "The increased tightness of coupling, lack of redundancy, and speed of response," Rochlin warns, "will make human intervention or control difficult at best when (and not if) something goes wrong - particularly for those systems whose means and mechanisms of operation are so deeply embedded in the computers that operate them that no human being fully understands them" (Rochlin 1997, 217).

Without directly addressing the conflict between the Jeremiah and the happy denizens of "Information Society," this paper contributes to the inquiry Rochlin catalyzed by offering a conceptually based analysis of decision making about information technology. For IT offers an opportunity to apply and improve political scientists' ideas regarding how intelligent social decisions can be made in the face of great complexity, high uncertainty, and rampant disagreement. Most of the paper discusses contemporary choices and decision processes regarding information technology - with case materials drawn from computer games, telecommunications, and other aspects of IT. The intent is to explore whether the strengths and weaknesses of IT decision making to date appear to fit predictions from political decision theory.

Before turning to the substantive analysis, let me first sketch out a conceptual framework that I will use later in the paper for analyzing decision making regarding Information Technology. I start by summarizing some of the main ideas originally advanced by Charles Lindblom in his 1959 article, "Muddling Through," and extended subsequently in *A Strategy of Decision* (with David Braybrooke). I then distill the essence of more recent work by neo-incrementalist scholars who have extended Lindblom's strategy of decision and applied it explicitly to technological innovation.

I. MUDDLING THROUGH, THEN AND NOW

Lindblom, Simon, and other early contributors to empirically-based theories of decision making started from a recognition that human problems are extraordinarily complex, while our analytic capacities and resources are quite limited (Simon 1955; Lindblom 1959). In that sense, among others, they were Information Society theorists, as well as thoughtful observers of the human condition. They pointed out that:

1) None of us has sufficient knowledge of cause-and-effect to fully understand complex social problems;

2) There is not enough time and money to conduct most of the studies that would be helpful in reducing the ignorance;

3) People do not know all their goals or the tradeoffs they are willing to make among them, and hence could not optimize even with complete information;

4) In part because of the above, humans disagree about almost everything and have no satisfactory analytic method for resolving disparate perceptions and priorities into collective choices (also see Arrow 1951); and

5) Participants in decision making already are overwhelmed with information.

One of the master questions of individual and social life therefore concerns how to proceed sensibly in the face of such serious obstacles. No one understands information as a social phenomenon, much less Information Society, unless s/he can answer that question.

Recognizing that analytic techniques alone could not determine how to bound the scope of a complex problem, Simon found that problem solvers actually proceed according to a cognitive strategy he called "bounded rationality." Limitations of analysis also mean that decision makers ordinarily must "satisfice" rather than optimize in choosing among policy options (Simon, 1955; March and Simon 1958). Lindblom found that political interaction often could evolve sensible tradeoffs and reconciliations among diverse considerations (and diverse partisans) more quickly, cheaply, and effectively than centralized analysis under many circumstances.

Analysis of course plays important roles in intelligent policy making - partisans guide their interactions partly on the basis of analysis, for example. But sensible analysts, Lindblom argued, do not aspire to the impossible task of trying to overcome complexity and human limitations by brute analytic strength; rather they proceed strategically. Lindblom identified one among what he assumed to be several forms of strategic analysis, and called it disjointed incrementalism:[(2)]

1. Limitation of analysis to a few somewhat familiar policy alternatives;

2. Adjustment of objectives in light of the policies potentially available, rather than considering ends in the abstract;

3. More preoccupation with ills to be remedied than positive goals to be sought;

4. A sequence of trials, errors, and revised trials;

5. Exploration of only some, not all, of the important possible consequences of a considered alternative;

6. Fragmentation of analytical work to many partisan participants in policy making.[(3)]

Take particular note of item number 4, the key concept for this paper.

Regrettably, Lindblom's nuanced treatment of social decision making under uncertainty came to be distorted and condensed into the aphorism, "Take small steps." Thus, incrementalism now is perceived as encouraging

gradual changes that are minimally threatening to organized interests....The continued viability of incrementalist thought and practice ensures that definite limits on the boundaries of policy innovation and levels of programmatic support will remain obstacles to those hoping to wrestle with larger and more lasting goals. (Anderson 199x, 118)

Others regret that "environmental decision making ...(is) piecemeal, incremental, and halting" (Ingram et al. 1995, 117). In virtually every such contemporary reference to incrementalism, the small-steps notion predominates.[(4)] In so doing, in degenerating from disjointed incrementalism to simple (or simplistic?) incrementalism, almost completely neglected is the impetus for seeking a strategy of decision in the first place, namely the challenge of coping with uncertainty and with disagreement.[(5)]

An Updated Strategy of Decision: Intelligent Trial-and-Error

To get back to that task, to return to the spirit if not the letter of Lindblom's thinking, one can pick up the inquiry embedded in point number four of disjointed incrementalism: trial and error. I will hazard the guess that every reader of this paper will agree that humans rarely proceed satisfactorily in complex new endeavors except by learning from experience. How can policy analysts, political participants, their organizations, and entire political systems do better at coping with uncertainty as they learn from experience? Is it possible to specify institutional arrangements, procedures, and strategies to make errors less damaging and to accelerate learning? Under what conditions do partisans (and aggregations of them) target their interactions so as to cope better than usual with uncertainty, limited time, and so forth. And under what conditions, or with what approaches, do they do worse than average?

Several scholars influenced by Lindblom's work have been asking these questions, with particular attention to technological innovation. They have attempted to think about ways of getting around three of the main pitfalls encountered in trial-and-error learning: (1) A misguided policy trial may produce unbearably costly outcomes; (2) Policy moves may retain too little flexibility, preventing errors from being corrected readily; (3) Learning about errors may be very slow.[(6)] Intelligent trial and error is a strategy of decision developed to cope with these pitfalls.

Potentially Unacceptable Risks

One of the criticisms of incrementalism was that policy trials could produce unbearable errors, before error-correction could occur. While the problem afflicts all decision theories and practices, not just incrementalism, it is well worth addressing. What do we know about how policy making does and should cope with potentially unbearable risks?

Even in highly uncertain endeavors, it is possible at the outset partly to foresee and protect against some of the worst risks. Homeowners, for example, do not have to calculate the likelihood of their house burning down; merely knowing that it is an unacceptable possibility is enough to warrant obtaining insurance as an initial precaution against catastrophic loss. Likewise, rather than relying entirely on preventing all accidents, U.S. nuclear decision makers required containment buildings around civilian reactors; most of the radioactivity at Three Mile Island was thereby prevented from entering the environment. If the Soviets had taken this precaution instead of assuming impeccable performance by their nuclear plants, the 1986 accident at Chernobyl probably would have had less serious consequences (Morone and Woodhouse 1989). Other tactics would be appropriate for other types of problems, but the basic idea is to take some kind of initial precautions rather than merely hoping for the best. The precautions will not prevent errors, but will make them less costly.

If uncertainty is high and consequences are potentially severe, moreover, it makes sense to take especially stringent precautions. Thus, the U.S. government and a few others restricted chlorofluorocarbon sprays in the late 1970s even though there was no solid, direct evidence that ozone depletion was occurring. Another aspect of proceeding cautiously is to put the burden of proof on advocates of risky activities. Whereas government once had to go to court to prove a pesticide unsafe after it had produced substantial damage, manufacturers in many nations now are required to demonstrate prior to marketing that their products do not pose "an unreasonable risk" (Morone and Woodhouse 1986).

Flexibility

A second problem with trial-and-error learning is that by the time serious flaws become apparent, a policy may have become quite resistant to change -- deeply enmeshed in implementers' careers, in organizational routines, and in the expectations of those comprising a policy network. In framing policy moves, therefore, the odds of ultimate success can be

improved by developing policy options capable of being altered fairly readily, should unfavorable experience warrant.

For example, flexibility is higher when a policy's costs are borne gradually, allowing expenditures to be redirected as learning develops. Pressman and Wildavsky characterize this as "payment on performance" (1974, p. 159). In contrast, if payment has to be made in advance -- as through large, up-front capital investments -- when a program does not work out, investment typically will be irrecoverable, and future options are likely to be unduly limited. NASA's space shuttle illustrates the problem: a launch regime relying on expendable rockets would have been much easier to revamp (Logsdon 1986; Byerly and Brunner 1989; Collingridge 1992).

Flexibility also can be enhanced in many other ways. Phasing in a policy during a learning period is a common practice in business, for example, as when an experimental model is followed by a demonstration project, in turn succeeded by a pilot plant - all before full-scale design and operation. Experimenting in a limited geographical area and/or for a delimited client base obviously makes it easier to reverse course than if a product or service is rolled out across the globe all at once; the states' role as "laboratories" used to be taken as a standard article of faith by commentators on American federalism. Other mechanisms of preserving flexibility include simultaneous trials of two or more alternative approaches, using an existing bureaucracy instead of creating a new, dedicated organization with permanent staff, and many other tactics.

Reducing Barriers to Learning

Policy trials undertaken in the face of high uncertainty almost certainly will need to be modified, so feedback needs to rapidly reach those with authority to make a change. To the contrary, feedback often takes too long, allowing accumulation of unfortunate results. Thus, the harmful effects of DDT were not persuasively documented for a quarter century after the pesticide's initial use; it took many years before there was clear evidence that high-rise public housing complexes have a destructive effect on many residents (Collingridge 1992).

Rather than taking this as an immutable fact of life, partisans can prepare actively for learning by arranging to speed up feedback. After numerous bad experiences from chemicals such as PCBs, vinyl chloride, and DDT, the Toxic Substances Control Act of 1976 decreed that all new commercial chemicals would have to be approved by EPA prior to marketing, partly on the basis of toxicology testing. The Food and Drug Administration long has required elaborate premarket testing and approval of new pharmaceuticals, and medical devices now are subject to such screening. We do not usually think of these requirements as part of an intelligent trial-and-error process; formally, however, the testing is simply a way of speeding up negative feedback instead of waiting for it to emerge naturally, over a longer period and with greater damage.

Realistic?

Is it a utopian hope to suppose that initial precautions, flexibility, accelerated learning, and other strategies of coping with uncertainty might come to be employed somewhat systematically? Each of the elements of intelligent trial-and-error actually is already being applied in various policy areas, though typically not in an explicit or coordinated way. Perhaps the most thorough application to date was in early research on recombinant DNA, the scientific procedures which led to the emerging biotechnology industry. (For reviews of the controversy, see Krimsky 1982; Morone and Woodhouse 1986; and Wright 1986).

Scientists organized a voluntary moratorium on the potentially risky research in the early 1970s, and worked out a regulatory strategy through the National Institutes of Health. Six classes of especially risky experiments were prohibited altogether, and precautions were adopted for the others, varying in stringency according to the degree of risk each type of experiment was believed to pose. The aim was essentially to make the research forgiving of error: special laboratory facilities were used to prevent bacteria from escaping from the research building; and intentionally enfeebled strains of an especially well known bacterium were used for most of the research, so that even if bacteria escaped they would have great difficulty surviving outside the favorable conditions of the lab.

Recombinant DNA researchers proceeded to learn from experience, partly via worst-case experiments aimed for example at finding out whether virulent new organisms might accidentally be created. There was some disagreement about interpretation of some tests, but the great majority of observers found reassurance from the priority testing. Close monitoring of hundreds of ordinary rDNA experiments also provided reassurance. As uncertainty was reduced, more experiments were allowed at lower levels of containment; by the early 1980s, most of the containment requirements were dropped, and no experiments remained altogether prohibited. Wind-borne cross-pollination between genetically modified agricultural species and indigenous species, among other difficulties with biotechnology in contemporary practice, suggest that the precautions were dropped too far, too soon; but the case otherwise is an exemplar of creative learning by doing.

The interaction of the strategies for Intelligent Trial and Error can be seen in a number of large-scale, hazardous technologies. Civilian nuclear power embraced potentially catastrophic safety and financial risks, with inadequate precautions. Learning was bound to be slow, with significant time lags before receipt of persuasive feedback, and trials of such incredible complexity -- up to 10 million pieces of paper for a single nuclear reactor -- that interpretation of errors was almost impossible. And the endeavor was extremely inflexible, with most payments required in advance and massive inertia from a host of supporting public and private institutions, including uranium mining and processing, reactor vendors, utility companies, regulatory agencies, and a combination of government, business, and university R&D for reactor design, development, and radioactive waste handling (Collingridge 1983). It took several decades to find out that giant nuclear power plants would be politically and economically unacceptable in most nations, by which time hundreds had been constructed

throughout the world for several hundred billion dollars. The error was irreversible, learning slow, and the cost enormous. Policy makers could have pursued much smaller reactors, using different designs that would have been less expensive, more flexible, and apparently incapable of catastrophic meltdown (Morone and Woodhouse 1989).

Similar problems can be found in large-scale irrigation projects (Collingridge 1992), military research and development (Woodhouse 1990), high-rise public housing (Collingridge and James 1990), and the U.S. space endeavor (Brunner and Byerly 1989; Collingridge 1990). The common ingredient is that learning is slow and costly when partisans do not press for initial precautions to head off unbearable errors, flexibility to allow error correction, and deliberate preparation for learning from experience.

The above problems and possibilities apply throughout political life. First, since we do not want to step over a cliff while learning from experience, it makes sense to protect against unacceptable risks where feasible. Second, since learning usually takes awhile under the best of circumstances, it makes sense to arrange policy so that it can be changed fairly readily when negative feedback is perceived to warrant. Third, because people and organizations do not automatically learn to do better -- indeed, we often have great difficulty at learning -- it makes sense to prepare deliberately for learning.

Both in principle and in practice, then, intelligent trial-and-error appears to be a workable strategy for many types of decisions. It is not, however, an automatic process that specifies exactly what should be done in any given situation; so all the ordinary work of policy analysis and political choice still must go on. There is frequently a tradeoff between intelligent trial and error as characterized here and the cost of options, moreover: those which promote learning may be more expensive in the short-run. How far to go in employing coping strategies obviously is a political judgment.

The strategies discussed here for cutting the cost of errors and for speeding up learning can be recommended to policy makers in virtually any type of decision process, from the most hierarchical and centralized decision context to the least, from tightly authoritarian to maximally decentralized and pluralist systems. The ITE strategies mainly require common sense, but there is nothing about them that would abjure whatever analytic understanding may be available. Third, responding to the (mis)perception that incrementalism is overly conservative and biased toward the status quo, intelligent trial-and-error eliminates the notion of small steps; and all the strategies clearly can be used to whatever degree is judged warranted. Fourth, to the (accurate) claim that incrementalism ignores threshold and sleeper effects, as do other decision strategies, intelligent trial-and-error explicitly advocates initial precautions against potentially unacceptable errors. Specific precautions can be taken to mitigate the severity of foreseeable risks, and more generic, procedural precautions (such as built-in flexibility to facilitate quick error correction) can be taken even against errors that cannot be foreseen. Fifth, regarding the perception that incrementalism is of use in an unduly limited range of decision contexts, intelligent trial-and-error aims at nearly universal applicability. Finally, to reassure those who perceive incrementalism as insufficiently goal-

oriented, intelligent trial-and-error centers around the goal of learning from experience, at acceptable cost, to attack whatever problems any partisan wishes to place on the political agenda.

Thus, the concept of intelligent trial-and-error supplements and focuses that of disjointed incrementalism; and it is specifically adapted to the task of guiding technological innovation.

SECTION II. INFORMATION TECHNOLOGY SUCCESSES AND INTELLIGENT TRIAL AND ERROR

Decision making about information technology in some respects seems to be proceeding according to the theoretical prescriptions discussed above, epitomized by the Internet and the Worldwide Web. This was hardly a centrally planned endeavor, but rather what some would consider a quintessential example of muddling through. At each step, innovators modified pre-existing ways of doing things, as numerous persons and organizations interacted in a highly decentralized way. Although several visionaries had notions of something like the Web, no one had anything like a plan for what the enterprise would look like at scale. HTML, Java, and other aspects of what became the Web grew up in response to local contingencies, taking advantage of local resources. Most aspects of web commerce were eminently reversible - from modifying a web page to altering the business strategy behind the page; and losses were in many respects sheltered via contained: even if an entity as large and central as AOL had failed - as many expected circa 1997 - the failure of one organization would not have undermined the Internet more generally. For most traditional businesses, the web side of their endeavor initially seemed like merely an incremental addition to business as usual, and if it failed the executives could always depend on the underlying business. At least some of this decentralized mutual adjustment seems to have been facilitated by the open source code on which much of the web is based.[7]

Another match between IT practice and decision theory is that redundancy has been built into the web in at least three respects. First, as with competitive markets more generally, for most products consumers have a choice among providers: Although AOL is the largest Internet Service Provider, it faces considerable competition from major organizations such as MSN and AT&T, as well as from regional and local ISPs that can offer more personal service. If one ISP's performance slumps, consumers can turn to another. The same is true of web browsers: although Netscape and Internet Explorer are predominant, there is fierce competition between them; and other browsers are readily available - and more would be made available if the dominant ones faltered. Search engines likewise proliferate: AltaVista, Yahoo, Google, the list is considerable. Competition to sell products and services on the web obviously is great as well. Most of this is just market-oriented business as usual, of course, and I merely point out some of its advantages (prior to turning to the disadvantages).

Useful redundancy is built into the web in a second sense: just like a spider's web, there is no single strand of the web that is vulnerable to being blown down or otherwise disrupted. If packets of information are blocked at one portal, they can travel a different route to their destination. This was part of the intention of a telecommunications network originally envisioned by RAND researcher Paul Baran and Leonard Kleinrock of MIT in 1961, but never implemented due to resistance from AT&T.[(8)]

Thirdly, the web is redundant in its mode of governance. The web group headquartered in Cambridge, Massachusetts (with satellite offices in London and Tokyo) works by common consent rather than by de jure jurisdiction. If enough of the key participants do not like the way that W3C is doing its business, the organization "would not be a dictator, it would be irrelevant," as one of its executives puts it.[(9)] That quasi-democratic element of web governance arguably constitutes an innovation in social institutions, bringing together as it does businesses, universities, non-profit organizations, and governments. Governments of course also establish laws pertaining to privacy, pornography, taxation, and other aspects of internet processes; courts exercise some oversight, as witnessed by the 140 civil suits now pending against Microsoft by competitors who allege unfair business practices; and law enforcement agencies can (often clumsily) pursue those who behave in ways defined as criminal - whether hacking or fraud or data piracy. Businesses, universities, and non-profit organizations share in web governance in the sense that the way that their members behave in cyberspace helps determine what cyberspace is. All this is so familiar and so mundane that we run the risk of missing it, and a greater risk of failing to recognize how it embodies the great good sense of disjointed incrementalism and partisan mutual adjustment.

A third element of intelligent trial and error, initial precautions, is built into the web in several respects. Although the web emerged more than it was planned, as mentioned above there is a governance structure combining elements of representative democracy, anarchy in the good sense, (possibly benevolent) oligarchy, and other components for which I have no names. No one sat down and figured out how to take initial precautions against web catastrophe, of course; but somewhere between willy nilly and de facto precautions nevertheless have emerged. Privacy and security are easiest to discuss, but they are by no means the only precautions. The web consortium will be releasing later this spring a new privacy protocol known as P3P, which is designed to enhance privacy, as by providing users with greater knowledge of the information that web sites are collecting about them (Feng 2000). This new protocol is the product of a complex set of negotiations and design experimentation, involving computer professionals and privacy experts from many different countries. The most ardent privacy advocates will not find the protocol adequate, and those least concerned may find it unduly restrictive. Compared with existing privacy protections, however, it will be an improvement, and there are other organizations at work on bolder technical means of assisting with privacy. Even existing protections are far better than might be imagined, the product of diverse persons and organizations, working on a wide variety of problems, in many different political jurisdictions. Due in part to emerging mechanisms for European and global integration, the ideas and norms and regulations developed in one problem area migrate to others - as when

the imposition by the EU directive both of harmonized European legal requirements for the fair treatment of personal information and of limitations on transborder data flows outside of Europe forces the U.S. government to recognize that American standards will be examined in Europe and forces U.S. companies to recognize that they will have to respect European legal mandates.[(10)]

Security for credit card usage and for transmitting sensitive information is a second obvious area of precautions relevant to the web. I assume that security is not as good as one might wish, but it is good enough that more than 99 percent of web business transactions work smoothly. And, because credit card companies and securities firms and government policies and insurance companies together provide additional protections for persons and organizations whose financial dealings are compromised, there is a layer of redundancy built into the security precautions.

Other precautions are not specific to the web but are part of the computing world more generally. For example, the electricity required to keep the web in operation is itself part of a redundant, over-designed system of production and shared distribution (in the affluent nations). If one source for electricity goes down, others are available. Whether there is sufficient protection no doubt varies by geographical region, time of year, and other variables; and different observers would wish for different degrees of protection. So my claim is intended to be a modest one: there are some precautions against web inoperability due to lack of electricity.

Backup of information likewise is a standard part of computing for large organizations and for many individuals. Many businesses use multiple servers, so failure in one node will not compromise the entire system. And if a business's web site goes down, many would-be customers still will be able to make contact via phone or fax or regular mail.

Monitoring and learning from experience concerning the Web obviously has been rapid. Businesses have become sophisticated about arranging web sites to make purchasing easy, new businesses such as Amazon.com have sprung into being, and some traditional businesses have learned rapidly from the early innovators. When problems arise, for example from viruses and hackers, new techniques for coping with the problems tend to be developed far more quickly than in many problem-ridden arenas of social life.

In sum, the Web has developed using a fair amount of intelligent trial and error, in part because the circumstances have been unusually favorable for such learning. So many people are watching and problems manifest so visibly that monitoring is easier and feedback is less problematic than in many policy arenas, because it's fairly obvious who to tell. And it is relatively easy to get their attention given all the hoopla about the web, in part because some participants have strong incentives and capacities for learning from experience.

In other words, one way to interpret the successes of IT is to say that participants have behaved in ways that cope well with uncertainty, ways that promote learning from experience. In

important respects, IT innovators and users have worked, mostly unintentionally, via an unimaginably complex series of disjointedly incremental moves, negotiated by decentralized partisans mutually adjusting to each other and to evolving technical potentials.

III. DEVIATIONS FROM THE REQUIREMENTS

FOR INTELLIGENT TRIAL AND ERROR

It is no accident that the successful examples of IT discussed above cluster primarily around facets of IT involving technological and economic matters. "Success" in IT tends to mean effectiveness or efficiency for the immediate user, the one who is developing/selling or buying/using the telecommunications medium or other IT resource. Success tends as well to refer to accomplishing the focal effect sought from the technology in question. What about non-focal effects and third parties? What if the one using the technology does not have much influence over whether to use it - s/he is a pawn of other people's intentions rather than an origin of the activity? How well have IT decision makers patterned their activities so as to learn rapidly about sociocultural problems that may arise in the technologies' deployments?

Perhaps the most successful application of ITE strategies applied to third party and sociocultural risks can be found in the realm of data protection and privacy issues. Finland in one realm exemplifies how far it is possible to go in erring on the side of caution: a complete ban on wiretapping, even by law enforcement agencies. Data sunsetting provisions applied to some French governmental records illustrate a different sort of initial precaution. Less protective is the European Union's 1996 Directive, an approach that looks extremely aggressive compared with the self-regulation strategy prevailing in some realms in the U.S.

Everyone has experienced, witnessed, or heard about unsolicited and unwanted pornography, new methods of defrauding the vulnerable, credit card theft, and on-line stalking, all illustrations of how porous the Web is to invasions of privacy and misuse of data. A recent example drives home the point of how flimsy have been the initial precautions and how difficult it can be to correct errors. As reported on NBC's "Dateline," Scott Lewis of Kent, Ohio, lost a high-level executive position with a medical company, and then spent months not finding a new job despite impressive credentials and a hot job market.[(11)] A private detective acquaintance performed a background check to see if something in Lewis's file could provide an explanation, and found that he was listed as having two DWI and one murder conviction. They went to the police station where the arrest supposedly had occurred, and discovered that the mistake originated with a typographical error of a social security number. The police corrected their records, Lewis went back to job hunting, and still had no success. A new background check turned up the same pseudo murder rap, and a repeat visit to the police revealed that the Sheriff's Benevolent Association had sold their arrest files to an on-line data broker. A trip to the data broker led to correction of their files, followed by a repetition of the cycle. Another

visit to the on-line broker led to the admission that, "We also sell our data." And they professed to have no way of knowing to whom Lewis's file had been sold, and no technology to correct the error even if the data slinky could be traced.

Despite many problems with data protection and privacy, this arena of IT policy also enjoys conspicuous successes - in no small part because so many different partisans care about it and have incentives to address problems that emerge, often before they emerge. On the other hand, the amount of ink devoted to "privacy" also is swamping other sociocultural issues that collectively may be of greater importance. Or, at least, the other issues are more problematic, in part because orphaned and neglected due to the attention paid to privacy and data protection.

To put the point differently, so many different problems are being created as those developing and diffusing Information Technologies undertake a plethora of innovative activities, that it is virtually certain that some reasonably important errors will go unnoticed and/or unattended to for extended periods. There certainly are times in individual and social life where this is just a fact of life, especially in crisis situations; but one of the most important choices people and organizations make - usually implicitly, by default - is whether to embark on activities likely to exacerbate the number and magnitude of relatively neglected considerations. If rapid development of better assistive computer interfaces for multiply handicapped persons threatened unknown and negative synergistic effects among the disability community, for example, I can imagine agreeing to move ahead even in the face of intense opposition.

But let's be serious. How much of the "IT Revolution" has that sort of compelling, urgent rationale? What fraction of the improvements in the quality of life made possible by IT innovations are sufficiently important to justify ignoring side effects, unwanted synergistic outcomes, and effects on third parties? Each of us would have a somewhat different interpretation, of course, but I would hazard the guess that a substantial fraction of humanity would see better computer games, more capable graphics accelerators, bigger and better databases, wider bandwidth, wireless technologies, and the like as falling somewhere in the range between trivial and secondary, between non-necessity and luxury. If that is so, then the pell mell rush to innovate arguably deserves no exemption from the normal requirements for Intelligent Trial and Error. Consider some of the ways that selected IT examples in fact do depart markedly from those simple requirements.

Homely Examples of IT Shortcomings

Email: As is true of market purchases more generally, each user gets to decide whether to purchase and use email software (and the computer apparatus to go with it). What is more, each user gets to decide when to log in and collect email, how much time to spend with each message, and exactly how to respond or dispose of the message. In those respects, email is utterly unproblematic - a perfect example of an unlumpy, non-wicked problem/opportunity.

And yet, how reversible is the choice for an individual, an organization, or a set of them? One instructor of a Information Technology course at a high-tech university refers to beepers and cell phones and laptops in classrooms as "a complete nightmare," and reports "personally killing a lot of my own time on things like email." In addition to the time commitment, the combination of mousing and keyboarding and eyeballing the monitor is more physically straining than I personally feel comfortable with. Is the bursitis and tendinitis in my shoulder due to such causes?: No one knows for sure. My workplace no longer prints announcements of meetings, so unplugging from email would be difficult. Several formal and informal groups to which I belong now send announcements and other materials via email. My children send pictures via email, my grandchildren will exchange email communications but will not write conventional letters, and so forth. I would like to unplug, or at least ratchet down the number of email exchanges, but it has become quite difficult to do so. How many others experience the matter similarly? My guess is the phenomenon is still too new to have many rebels, but that is only a guess because my workplace collects no systematic information on people's reactions: the university administrators, in fact, are striving to move the campus higher on the list of "most wired" colleges. More generally, I see no serious, systematic discussion of the advantages and disadvantages of email, nor do I see a venue where such discussions might take place and achieve any kind of authoritative resolution. Each person is trapped in a web of other people's expectations, and there is no logical place or moment to probe for collective solutions to the matter; it is a form of Catch-22.

Cell phones: I experience cell phones quite differently from email. I like my cell phone, and I like the people I am calling to have a cell phone, but I don't want anyone else to have a cell phone because the ringing and the talking are annoying to me. It seems quite natural for me to receive an important call in the middle of a meeting, but I dislike it when other people receive such calls. It seems fairly natural for me to drive and talk, because I'm a "good" driver; but it is dangerous when others do so, and anxiety provoking when they appear likely to invade my lane. And so forth.

As with email, there literally is no logical place or time when I could get together with those in my calling networks and negotiate a modus vivendi about cell phones - because, even if a handful of us agreed, each of us is enmeshed in networks of others with whom it is impractical to discuss the matter. Some members of these networks are ardent proponents of cell phones, whereas others feel unable to unplug because of their work culture. Whether the best outcome is to leave things as they are, to ban the damn things altogether, or to establish some other limits is not for me alone to say, of course. But if I am right in thinking that there is no viable way to have a collective conversation, or set of conversations, that might lead to modifications in contemporary practice about the matter, to me that indicates something amiss in the social institutions around IT.

Phone menus: Do you know anyone who feels satisfied when telephoning a business to be "greeted" with a multi-layer menu of options, most of which do not apply to the purpose for which one is calling? It apparently makes sense to the business executives who choose to create and maintain such menus, but it does not make sense for most callers. There surely is no

shortage of feedback regarding customer reactions, yet it is difficult to discern much progress in making such menus more congenial to callers. In fact, the wait time to actually have one's issue addressed seems to be increasing rather than decreasing. It used to be that one could pretend not to have a touch-tone phone, and could thereby get quicker attention from a human operator. But with the development of voice recognition software, no longer must a business provide any direct route to a human; instead one now is invited to speak "one" or whatever number in response to the menu prompts. The menu trees seem to be getting deeper and more complex, presumably in order to accommodate more of the issues raised by callers. This satisfies some needs, but at the expense of others. The situation seems to be getting worse despite the fact that many people hate it.

The situation obviously is transitional, and the normal workings of market processes conceivably may lead to correction of what seems to be errors. This would require that customers notice, remember, and direct their purchasing to businesses that create more satisfactory ways of access, and whether customers will put their money where their stated preferences are always is a question only answerable via experience. If the downward trend in helpfulness and competence of store clerks is any indication, customer irritation with service is of no more than marginal utility in nudging businesses to change their practices.

Telephone service: The cost of long distance telephone calls has of course dropped significantly due to a combination of increased competition and technological innovation, some of which has to do with information technology, broadly construed. A substantial fraction of U.S. homes do not have the long distance service that would actually best suit their phone usage, in part because an increasing fraction pay heavy monthly line charges and minimum usage fees out of proportion with the amount of calling they do. Local service in the U.S. has changed little, so the overall result has been good for businesses and homes that make lots of long-distance calls, not so good for most ordinary households.

Cable modems and other high-speed data lines are a great innovation for those who use them, but the cost is high for ordinary homeowners and the services presently are irrelevant for perhaps half the people in affluent societies - and for a substantial majority worldwide. The digital divide is receiving considerable attention among the cognoscenti, and some public officials are doing some things to address it. But even if every home were wired just the same way, the human capital and tastes required to make good use of IT could hardly be distributed evenly. Improving the capacities is bound to increase inequality in a society where the pre-existing dispositions and talents are so unevenly distributed to begin with.

Live satellite transmissions from the other side of the world now are commonplace - from tennis matches to war coverage. It is difficult to determine the social consequences of such instantaneous flow of entertainment and information, but policy makers aver that their behavior in conducting international relations has been forced to adjust to CNN, and it is probable that global consciousness is increased both directly and indirectly via enhanced business transactions and their subsequent effect on jobs and commerce. To the extent that globalization relies on various IT capacities, many of the issues in the globalization controversy

can be seen as partially, indirectly issues of IT decision making: Had IT proceeded more slowly in the second half of the 20th century, globalization almost certainly would have proceeded more slowly. Opponents of hasty, corporate-led globalization arguably ought to be opponents of the IT bandwagon as well.

Productivity: The enormous expenditures on information technology now amount to perhaps $300 billion annually in the U.S., and several times that amount globally. Many of those expending the funds get short-term feedback telling them they are on the right track, leading them to amplify their efforts. And elected officials in much of the world like what they see, or at least fear that their nation will be left behind, leading them to amplify governmental programs that nudge IT forward. University administrators and faculty like what they see, leading them to set up new schools of information technology. And so on. But does the whole damn thing make much sense? Is productivity properly understood really being enhanced enough to justify the enormous expenditures? Are the new goods and services created via IT really worth the effort? Or is it possible that sizeable chunks of IT are better interpreted as transaction costs and externalities?

Economists like Paul Rohmer talk about technology now finally paying off for productivity, but others remain skeptical. Allen Blinder and Quandt propose ten reasons why there is a productivity paradox, including the possibility that in the "information era" the metrics used to track economic growth do not work very well. For example, a well developed system of inventory control may lead to fewer trucks (and truck drivers) because distribution is more rational. The productivity gain is there, but it does not show up in GNP. As I read the literature, the evidence is ambiguous enough that a critic of the IT bandwagon could plausibly construe the pace and much of the IT direction of the past quarter century as a gigantic misallocation of scarce attention and resources.

Equity issues are badly addressed by labor markets, and IT workers are no exception. There is a larger group of highly remunerated, especially in the Dot-com side of the industry, but nothing in IT decision making has been deliberately structured so as to deal with equity issues. (*The Electronic Sweatshop: How Computers Are Transforming the Office of the Future Into the Factory of the Past*, by Barbara Garson, 1989, Penguin Books.)

Cuban reviews the attempts to adopt technology into American classrooms throughout the 20th century. Moving pictures, radio, TV, and other technology-based improvements were loudly acclaimed to herald a new paradigm for education. All attempts failed to make a dent in established curriculum and teaching. Cuban analyzes these failures, and applies his ideas to the current wave of technology edu-euphoria, the computer. (Teachers and Machines : The Classroom Use of Technology Since 1920, by Larry Cuban,1986, Teachers College Press.)

Addiction to monitors. Many of those who use computers most intensively are middle- and upper-middle class, college-educated persons who look down on those lower in the class hierarchy who tend to be heavier consumers of television. One need not claim that there are no differences between staring at a TV and staring at a computer screen - one usually is a more

mentally active activity - to see that there may be more similarities than computer users normally would acknowledge. Refresh rates on contemporary monitors reduce eye strain, and LCD screens almost certainly are superior in that respect and in emission of radiation than were the first several generations of computer monitors. But rates of depression in affluent nations continue to increase, and are highest in the cohorts who grew up most exposed to flickering screens. That is merely a correlation, and there are many other possible causes. Suppose, however, that research a decade from now revealed conclusively that computing does contribute in nontrivial degrees to depression. Would the civilization be able to reverse course?

That is the tip of the problem, of course. As Rochlin, Demchak, and others have pointed out, unintended organizational consequences of computing and other information technologies may turn out to be considerable. It has become unimaginable to operate an airliner or large ship without complex computing embedded in many facets of the machinery, and without air traffic and other control systems external to the machinery.

[Insert here on tanks, and pick a couple examples from Rochlin.]

Where would we expect such issues to be debated? Inasmuch as humans become acculturated to whatever reality they are immersed in, is there any reasonable prospect that such a hypothetical conversation could take a clear-eyed look at the costs, benefits, and alternatives to computerizing everything? And once debated, is there any reasonable prospect of authoritative intervention in prevailing trajectories? I suspect that the barriers to it are high, don't you?

CONCLUSION

This paper obviously constitutes no more than a preliminary, even superficial, recognizance of the vast domain of Information Technology. I have used here such a broad view of the terrain that I almost certainly have missed, and misinterpreted, some important phenomena better understood by experts in data protection or other particular arenas of the technology and the social policies concerning it.

Still, there is impressive support here for the enterprise of political decision theory, for both the successes and shortcomings of decision making for Information Technology display an excellent fit with the predictions derivable from the strategy of decision advocated by Lindblom and his successor-collaborators. The notable accomplishments of IT have come about, I have argued, precisely because decision making conformed to the requirements for intelligent trial and error - the development of the Web in particular constituting a classic example of decentralized partisan mutual adjustment and disjointed incrementalism. The shortcomings and failures to date of IT can be interpreted as failures to conform to neo-Lindblomian decision strategies.

As a technological and economic activity, IT participants and organizations are doing a nearly brilliant job of muddling through using Intelligent Trial and Error. They are erring on the side of caution by funding more start-up ventures and pursuing more lines of RD&D than would be required to innovate successfully. Partisan mutual adjustment is operating at a high level of

diversity and frequency. Iterations are coming rapidly, with version numbers 2.0 and 3.1 now a standard part of the industry. Diverse partisans are monitoring the unfolding experience, there is intense media coverage including by a congeries of newly formed publications and web sites, and those with authority appear to listen and respond to the feedback. Within companies, within industries, and across industries innovative energies are routinely allocated to fix software bugs and other problems, and energies obviously are allocated as well to pursuing promising lines of investigation and commercialization. Disjointed incrementalism is alive and well.

Well, that is, when one looks primarily at the technological-economic side of the matter. Shifting to the sociocultural and political aspects of the Information Technology phenomenon, one does not find the same happy fit with the requisites for intelligent action in the face of high uncertainty and rampant disagreement. To the contrary, IT is proceeding in ways almost ideally designed to frustrate intelligent trial and error.

Three aspects stand out, of which the most significant is the rapid pace of change. So many things are changing so fast that certain kinds of trial-and-error learning are difficult or impossible. By the time that feedback emerges, the forefront of the field may be so different that there is no way to go back and revisit the original decision. The interconnections among the many changing endeavors are incomprehensibly complex, so even if timely feedback emerges it may be impossible to trace the causal chains and determine what changes are warranted. Third, there is little time to reflect on goals other than the most instrumental: "reverse adaptation" of means to ends has long characterized much of technological life, and Information Technology "revolution" is amplifying that tendency.[(12)] Techniques, standards, norms, infrastructure, peripherals, and other ways of doing things form and re-form so rapidly that any given element of the system must conform to the context in which it will operate - and there is essentially never a venue, a time, a motivation, or a competence to discuss and shape the context itself.

Amplifying the damage likely to be caused by rapid scale-up is the absence of containment or other initial precautions that would blunt the worst errors and prevent their spread. Whereas biotechnology, nuclear power, pesticides, and other avowedly dangerous technologies to some degree now are protected by use of containment and other mechanisms that serve as initial precautions, Information Technology lacks this elementary requirement for Intelligent Trial-and-Error Learning. Many people would offer the rejoinder that IT is not dangerous like those other technologies, and I would agree: IT is <u>differently</u> dangerous.

Much IT decision making violates neo-Lindblomian strategies of decision in a third respect: With regard to sociocultural risks, IT is inflexible to such an extent that there is reason to fear that the changes being wrought literally are irreversible. Many technical-economic facets of IT are deployed quite flexibly - as the version 2.0, 2.1, n.x phenomenon attests. Even the Iridium Corporation's multi-billion dollar space satellite system for a failed global telephone network can be scrapped in favor of superior methods, albeit at high cost. For some or many

sociocultural risks, there obviously is no equivalent to scrapping satellites and declaring bankruptcy.

There is a sense in which this paper's insights are not very useful for Information Technology policy making, precisely because they do not conform to the (perceived?) necessity for small, moderate steps preferred in post-industrial politics. After all, one hardly expects the tsunami of Information Technology or the phalanx of IT enthusiasts to worry very much about scholarly quibbles. Hence, it is not very useful to read this paper as policy analysis in the conventional sense of attempting to prescribe a better way to do something.

Instead, it makes more sense to read the paper as a critique and an illustration of the gulf separating political theory and political practice. Much of that gulf no doubt is due to many people's unwarranted disinterest in systematic reflection; but some surely is due to shortcomings in the practice of political science, in particular the sparseness of work over the past generation by political scientists who might reasonably have been expected to take up the challenge laid down by Lindblom: By what decision strategies and social processes can political participants arrange collectively to cope better with uncertainty and with disagreement? Given the centrality of these realities in political life, it is reasonable to ask why more political scientists have not tried harder to figure out how to improve coping practices and processes.

It is reasonable as well to ask why political scientists devote so little attention to technological practice as a form of politics. It is pretty obvious that Lasswell's question of "Who gets what, when, where, and how?" often is determined in large part by what happens in R&D labs, start-up firms, emerging industries, and market transactions involving innovative technologies. Political scientists interested in understanding authority relations may wish to consider whether the discipline's overwhelming focus on governmental politics is as outdated as last decade's computers.[(13)]

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1. Gene I. Rochlin, *Trapped in the Net: The Unanticipated Consequences of Computerization*, Princeton, NJ: Princeton University Press, 1997, p. xii.

2. This is a modified version of a description given in "Still Muddling, Not Yet Through," reprinted in *Democracy and Market System*, Oslo: Norwegian University Press, 1988, 235-259.

3. Step number 6, partisan mutual adjustment, developed more precisely in *The Intelligence of Democracy*, requires low barriers to mutual adjustments among partisans. Barriers that often interfere seriously with the quality of political interactions (and, hence, outcomes) include the privileged position of business, impaired inquiry, self-protective arrangements by which government officials seal themselves off from constituent influence, and political inequality that marshalls some affected interests out of the decision process. See Lindblom and Woodhouse, *The Policy Making Process*, 3rd ed., Englewood Cliffs, NJ: Prentice Hall, 1993.

4. For an extended review and appraisal of criticisms of incrementalism, see Andrew Weiss and E.J. Woodhouse, "Incrementalism: A Constructive Response to the Critics," *Policy Sciences*, 1992,

5. An exception, which does an admirable job of discussing the concept, is Michael T. Hayes, *Incrementalism and Public Policy*, New York: Longman, 1992.

6. This section draws in part on E. J. Woodhouse and David Collingridge, "Incrementalism, Intelligent Trial and Error, and the Future of Political Decision Theory," pp. 134-151 in Harry Redner, ed., *A Heretical Heir of the Enlightenment: Science, Politics, and Policy in the Thought of Charles E. Lindblom*, Boulder: Westview, 1993.

7. Lawrence Lessig "Innovation Regulation, and the Internet," *The American Prospect*, March 27-April 10, 2000, pp. 26-29.

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9. Jean-Paul Abramanti, Conference on Computers, Freedom, and Privacy, Toronto, April 2000, panel on Governance of the Internet.

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11. "Dateline," April 19, 2000.

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13. For further discussion of technology as a form of politics, see the following sources: Langdon Winner, "Do Artifacts Have Politics?," Richard Sclove, *Democracy and Technology*, Guilford, 1992; and Patrick Hamlett, *Understanding Technological Politics*, Englewood Cliffs, NJ: Prentice Hall, 1992.