A TELECOMMUNICATIONS INFRASTRUCTURE IS NOT AN INFORMATION INFRASTRUCTURE

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We are now living in the Information Age, where information-handling activities, taken, together, are the dominant claim on resources. The infrastructure needed to make this socio-economic system work is much more than the phones, switches, cables and satellites of the telecommunications engineers and the telecommunications equipment industry. The other complementary resources are a mix of people with skills, organizational capital, markets, a legal framework, regulatory institutions, and, especially, information stocks. Our concept of capital has to take in this mixed bag of resources.

A focus on the social and economic implications of the growth of codified knowledge may well contribute to understanding the complex processes of change given new emphasis by the Information Age. One way of tackling this task is to develop a taxonomy of information, based on its economically significant characteristics, to replace the general purpose concept now in wide use.

Keywords: capital, information, infrastructure, taxonomy, telecommunications.

Information is essentially social - specialization in information activites is the major manifestation of the modern division of labour - and it can be transmitted, for example, genetically, culturally, economically (as in goods) and electronically. Therefore, telecommunications, interpreted as the range of technology from POTS to Internet, is only part of the overall national and international infrastructure. A focus restricted to telecommunications, ignoring both the interactions between telecommunications and the other elements and the other elements themselves, can be seriously misleading in decision-making and policy formulation and execution. It leads to understatement of costs, funding requirements and time to reach targets; to shattered dreams of profits and power; and to misallocation of resources and misdirection of research.

Analytically, the equation of TI and NII/GII is a failure to come to grips with the central issues involved in the economist's concept of capital. As Schumpeter told us, the stock of capital "is neither homogeneous nor an amorphous heap. Its various parts complement each other in a away we readily understand as soon as we hear of buildings, equipment, raw materials and consumers' goods. Some of these parts must be available before we can operate others; and various sequences or lags between economic actions impose themselves and further restrict our choices; and they do this in ways that differ greatly according to the composition of the stock we have to work on".[1]

Once we accept the idea that information, information-handling skills, organizational capital, information technology and culture as the accumulated problem-

solving capability of society have the characteristics of capital, we have to reckon with the implications of Schumpeter's reasoning. Telecommunications technology is not a tap to be switched on or off as policy dictates; and the other elements and expecially the cohesiveness of the II cannot be outsourced at short notice.

Intellectually, these problems parallel "the general difficulty of incorporating information and knowledge in a mechanistic scheme...In sum, the mechanistic metaphor excludes knowledge, choice, purpose and qualitative change of a more complex and irreversible kind".[2]

In the context of telecommunications and its role in economic and social development, major actors on the stage have preferred to take refuge and comfort in rhetoric with buzzwords like competition, convergence and infrastructure. In each case definition commands little attention.

MISSING ELEMENTS

The wisdom of the NTIA 1993 *Agenda for Action* is sadly missing from most other contributions relating to II or the information superhighway. That document relied on an "expansive meaning" which combined the fully integrated physical components used to transmit, store, process and display voice, data and images, and "other elements": the information itself, applications and software, network standards and transmission codes, and "[t]he people...who create the information, develop applications and services, construct the facilities and train others to tap its potential".[3]

This catalog tends to be attenuated in more recent works. See, for example, William Drake in his recent edited volume: "The computerized telecommunications networks, customer interfaces, services and applications that make up the...NII...of today are the heart of an increasingly integrated communications and information business, which is one of the largest, most dynamic, and rapidly growing sectors in the world economy, valued domestically [in the US] at $718 billion in 1993".[4] The influential 1994 Computer Science and Telecommunications Board report, *Realizing the Information Future: The Internet and Beyond*[5], acknowledged that a broader conceptualization of the II might embrace information generation as well as transport but tended to focus on integration and interoperability. Anderson *et al.*, *Universal Access to E-mail: Feasibility and Societal Implications*[6] goes beyond the narrowly economic and technological to discuss civic networks and even the international implications for global democratization but still restricts the scope of resource and cost requirements.

The difficulties of achieving a broader conceptualization seem greater now that there is increasing reliance upon market forces. While the market is a powerful and far-reaching information system, it has major limitations. Stiglitz's Wicksell Lectures, which he intended to provide an overview of the current state of the economics of information, has a superb discussion of those limitations, which stem from information being a commodity but only to a limited extent.[7]

Unfortunately, this is not recognized by those in powerful positions. Reed Hundt, FCC chairman, speaking at *Telecom'95* in Geneva last October insisted that information services were like any other commodities, e.g., soap or software; there was

no reason the government should run a grocery store; and, for good measure, he added that economics was like physics. At the January PTC in Honolulu, the World Bank's Chaparro indicated a belief that information costs were tending to zero - despite the Bank's own published statistics showing the large and growing share of information occupations in the total workforce; and presumably despite IUI research showing that even manufacturing firms now find the bulk of their costs are information costs.

What elements should be included in this broader conceptualization? I shall not attempt a comprehensive coverage. The most significant omissions appear to be information stocks, organizational capital and human capital.

The information stock has long been recognized as capital[8] and some go so far as to treat all expenditure on information as investment.[9] Much earlier English economist Marshall had expressed briefly and eloquently the world's dependence on "ideas", as opposed to "mere facts", which, if destroyed, would take us "back to poverty";[10] and more recently, in the context of new growth theory, Romer has modernized Marshall's thesis by adding a mention of computers.[11]

All too often there is a failure to build on such simple dichotomies as ideas *vs* facts, or tacit *vs* codifiable information to develop a rich taxonomy of information befitting the information economy. Despite the pioneering efforts of Machlup[12] and his followers[13], information tends to remain a general purpose, low cost lubricant, facilitating efficient market operation. A detailed taxonomy of information goods and services paralleling that of manufactured goods in the industrial economy is needed urgently. I shall return to this as a research priority.

Organizational capital[14] or information-handling competence generally - what Marschak sought to convey with his title, "Economics of Inquiring, Communicating, Deciding"[15] - is a further major omission, not only from II but from economic theory. "To admit that organizational/economic competence may be scarce undermines a very large body of neoclassical economic theory".[16] But the critique is not new and it has been sustained. Variable inputs of organization and information were acknowledged thirty years ago, the firm lacking knowledge of the optimum combination of those inputs[17] and Nelson has emphasized repeatedly that there is no recipe book of optimum resource combinations.[18]

Such capital embraces the administrative and innovative structures of the firm as well as the institutions of the economy and society. These should be added to the roads, bridges, ports, airports and teleports usually included in II. If we add property rights, why stop there? Why not include all the other institutions that have been found necessary to the functioning of the economy?

Of the missing elements, human capital is the most widely recognized. However, research has tended to see the amount of such capital as simply a function of cumulated training time. There has been a lack of interest in measuring management capital, innovative capital, or political capital. Where, for example, are the studies of research capital and the impact of technological change, especially of IT, upon its productivity?

Several general aspects might be noted. The broader conceptualization takes in

infrastructure located in both public and private sectors. The complementarities raised by Schumpeter may be a great importance. There will also be substitution possibilities, ranging all the way from ATMs replacing bank-tellers to the conversion of tacit into codifiable information. (Here I might digress to point to the current and considerable efforts to convert traditional knowledge, e.g. of the properties of plants, into trade secrets.) As a final general aspect I add that these are all evolutionary processes. In making haste, we may well overlook major road-blocks and yet-to-be-invented institutions and technologies.

SOME IMPLICATIONS

1. Reported declines in public sector infrastructure may be misleading if excluded elements are being substituted for elements included and if public and private sector outlays are being interchanged. This would seem to apply to the II case, especially in telecommunications.

2. There are major difficulties in the way of applying optimality thinking to information usage. We tend to start with cost effective notions and then try to go on to Pareto efficiency. As the range of choices widens and the information requirements grow, "we may easily slip again into the sea of undecideability".[19]

3. If the II is to command a greater share of investment, much more effort will have to be directed to research into information processes. Here a major problem is that the boundaries between economic and technological and between technological and organizational are increasingly blurred.[20]

4. The additional elements in the broader conceptualization put a premium on comparative studies in conditions that differ widely in the composition of II. These studies need to relate to countries and regions; to communities of interest in which demand for communication and information are generated.[21]

RESEARCH PRIORITIES

The Growth of Codified Knowledge

A new perspective on the role of information, and hence on the demand for communication and information services, in the changing pattern and extent of economic growth might be achieved by combining several elements from recent analytical efforts: information as a factor of production, a taxomony of information, and the broader conceptualization of infrastructure which includes institutions and a focus on competence, both individual and in the learning organization.

To marshall these elements, which are currently but mistakenly being treated as separate analytical initiatives, it might be helpful to invoke as a unifying thesis a significant substitution of codified for tacit information, induced by a relative change in costs resulting from the combined effects of technological change in communication and computing.

"Tacit" has been given many meaning, e.g., "not written" or "cannot be articulated". It may be best treated as information acquired, stored and used in the course of experience and remaining inextricably interwoven with human and organiza-

tional contexts. In contrast codified information is neatly packaged, transmitted, taught and learned.

C/T substitution is not new; it is as old as language and publication. We might contend, however, that it has progressed to the stage of fundamentally altering the morphology of the process of economic growth.[22]

Within the growth process, expanded demand for communication arises from three sources:

1. Information-intensive growth of the system: more participants, greater division of labour, more complex technological and organizational arrangements, and a wider assortment of goods and services.

2. Growth of critical mass communities of interest within which communication generates communication. This takes in spatial changes ranging from local to international.

3. Increased capability of crossing borders, be they economic, cultural or political; disciplinary or tribal within disciplines; local, national or regional. Crossing borders is in itself innovation, with costs of learning and coordination, and requiring new forms of competence but creating new internal conflicts. New coalitions have to be formed and new institutions created. Costs, benefits and power may be redistributed.

C/T substitution applies to all three sources, but its ease would appear to differ greatly across them. In order to gain some sense of the extent of the differences and the characteristics of significant sub-sytems, it would be useful to conduct a series of case studies. These might include:

(i) Evolution of product and industry standards
(ii) Design and operation of EDI systems
(iii) Electronic publishing
(iv) Evaluation and accounting process
(v) Tacit information-intensive activities.

A Taxonomy of Information

The C/T substitution project would call for the development of a taxonomy of information replacing the present general purpose concepts of information with more specific notions of kinds of information. In effect, this would be an application of the characteristics approach associated with the name of Lancaster to information.

Some potentially important dichotomies have emerged, e.g., tacit *vs* codified information; work-related *vs* social communication, and there are some well-established distinctions from economics, e.g., consumption *vs* investment. What we need to identify are characteristics that are economically significant. The cost of information will depend upon the frequency of observation, the static or dynamic nature of the information, the frequency with which it has to be updated, the degree of accuracy, the promptness with which it must be made available, the complementary information required, and the universality of its distribution.

Here I wish to acknowledge the important contribution made by the Canadian IDRC (International Developmnent Research Centre) which has asked us to go back to fundamentals in our attempts to grasp the profound transformations being fuelled by the events of the information revolution.[23] The IDRC teams have adopted a characteristics approach and have also made use of an input/output framework. They have been critical of the emphasis on short-term outputs.

In a recent exercise[24] the participants identified key issues and concerns in their investigation of the impact of information on development:

Definitions
Context descriptions
Stakeholder involvement
Benefits and costs
Validation
Sampling
Causality
Longitudinal studies
Assignment of ordinal values
Opinions, expectations, reality.

These were then ranked on two criteria: the relative importance of each issue to the further development of impact assessments and the relative ease of implementation of approaches to adressing each issue. These yielded "opportunity maps" setting importance against ease of implementation.

Participants who work "in the field" considered the assessment of costs along with benefits to be the most important issue, although they considered implementation more difficult than the nonfield respondents do. Both considered the definitional issues relatively important and easy to implement. Nonfield respondents considered context descriptions more important than did field respondents but also more difficult to implement.

Clearly all this research needs to be interdisciplinary. However, as Streeten pointed out, the calls for interdisciplinary research are made with monotonous repetition but little is done about it. He put this down to a lack of clarity and "the fact that the only forum where interdisciplinary studies in depth can be conducted successfully is under one skull, and that such skulls are scarce".[25]

The three reasons he offered for interdisciplinary, multidisciplinary or supradisciplinary work are important;

i. A practical problem may call for drawing upon and applying several disciplines;

ii. Certain assumptions, concepts or methods, hitherto applied in one, yield illuminating results when applied to another.

iii. It may be that for a particular time or place the justification for having a separate discipline does not hold.

But in each of these, "crossing borders" is involved[26] and the innovation may be hampered by organizational obsolescence.[27] Occasionally innovation occurs and

has lasting effects, with the creation of a new discipline. But crossing borders takes more than meeting or publishing together.

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