TECHNOLOGICAL CHANGE AND EMPLOYMENT IN THE INFORMATION ECONOMY: THE EXAMPLE OF QUEENSLAND

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This paper presents the results of a study which identifies the extent of the Queensland information sector and assesses the role of information technology within it. In terms of employment, the information sector in Queensland in 1981 comprised about 36 per cent of the State's labour force. Information technologies are diffusing rapidly and widely into all sectors of the Queensland economy. Their impact on organisation and employment are investigated.

Keywords: technological change, employment, diffusion, information sector, information economy, information work, Queensland

INTRODUCTION

Economies have traditionally been analysed in terms of three broad sector groupings: primary (agriculture and mining), secondary (manufacturing), and a huge and amorphous residual — the tertiary sector (service activities). More recently, with growing awareness of the emerging post-industrial, information-oriented, knowledge-based economy, itself associated with the increasing pervasiveness of intelligent electronics, analysts have recognised the efficacy of defining separately a fourth sector, the information sector.¹ This definition involves isolating from the traditional three sectors those activities involving the production, processing and distribution of information, as well as the information infrastructure. Included in the information sector are all office activities, the media, computer and telecommunications industries, education and research and development activities.

This paper reports on a study which sought to discover the size of the Queensland information sector, and to assess the role of information technology within it.² The study was commissioned by the Department of Employment and Labour Relations of the Queensland Government. Most information sector studies have been of national economies.³ This study is one of the first regional information sector studies.⁴ Across the OECD, member countries report that about one third to one half of their labour forces are in the information sector.⁵ Most of this growth has occurred since World War II. Australia, too, is progressing towards an information society, and there is need for public and policy awareness of this development. Queensland appears to be the first State to recognise this. Intangible information is becoming the prime resource in wealth creation, and information technologies based on microelectronics are becoming increasingly pervasive. Economic policy which fails to recognise these long run developments — which continues to focus on the traditional tangible activities of agriculture, mining, and manufacturing — is likely to be irrelevant to the means by which most wealth is produced and most employment created.

METHODOLOGY

The study had two objectives. First, it sought to identify, and determine, the size of the Queensland information sector from census data. Secondly, it surveyed business firms in order to assess private industry's experience with information workers and information technologies.

(i) Defining the Information Sector

Defining the information sector in an economy involves distinguishing those activities concerned mainly with the production. processing or distribution of information. One might expect that most information activities originate in the existing service sector.⁶ This is, in fact, the case, but the other two traditional sectors (primary and manufacturing) also include an information component. The information sector itself contains primary and secondary elements. Primary information activities comprise all industries that sell information services in the market or produce information machines. Included here are such diverse manufacturing and service industries as printing and publishing; computers, telecommunications and post; mass media; finance, insurance and business services; and education. Secondary information activities are those performed in-house by organisations outside the primary information sector — the office functions of industry and government, as well as research and development activities.

The information sector can be defined on an occupation basis, or an industry basis. Because of data restrictions and the limited resources available to the project, this study focused on defining the Queensland information sector via the occupation basis only. Information occupations were determined from among the 389 occupations comprising the Australian Classification of Occupations.⁷ To make

this study consistent with, as well as comparable to, overseas studies, guidelines utilised in this process were the OECD Inventory of Information Occupations,⁸ and to some extent the International Labour Office (ILO) standard classification.9 In determining information occupations, the OECD includes both occupations in which the primary purpose is the output of produced, processed or distributed information, as well as those occupations engaged primarily in installing, operating and repairing the machines and technologies used to support the creation and handling of information. Of course, all occupations involve some information activity and so the inclusion or exclusion of entire occupational units on the basis of primary purpose is somewhat arbitrary. Resources permitting, this study would have sought to devise a more refined method of defining the information sector, based on the degree of information intensity of all occupations. However, for the present purpose the OECD method has been used to identify a total of 126 information occupations from the 389 occupations in the Australian Classification of Occupations.¹⁰ Census data were then analysed to determine the size of the information sector on an occupation/ employment basis.

(ii) Survey of the Private Sector

After a detailed pilot study, a questionnaire was sent to firms of varying size across all sectors of the Queensland economy. It had been hoped that the Department of Employment and Labour Relations or the Australian Bureau of Statistics would have been able to assist with names and addresses of a representative sample of Queensland's firms (or a list from which a representative sample could be drawn), but problems of scope, format, conditions and timeliness of access precluded such assistance. Consequently, address labels for the sample were obtained from a business organisation. Peter Isaacson Publications Pty. Ltd., the publishers of the Kompass Register of Australia — a business directory. The Kompass directory provides a total of 1,330 self-listed commercial and industrial organisations operating in Queensland and covers a wide cross-section of firm size and industrial activities. The total was culled back to 1,299 by eliminating government and semi-government organisations. A further 91 firms were found to be no longer operating, were unable to be contacted, or were covered by the responses of other firms. After removing these, the usable population became 1,208 firms. It should be emphasised here that the sample used in this study is not claimed to be random, nor is it necessarily representative of Queensland industry; rather it was the only sample available. However, the sample was sufficiently large and varied and the response great enough to give results which, if not conclusive, are strongly indicative of important, and hitherto neglected, developments in the Queensland economy. Because of the complexity of the survey form, the unconventional nature of the questions it asked, and the diversity of the group surveyed, a poor response had been anticipated. However, after one reminder, 615 usable returns were received — a 51 per cent response.

Respondents employed about 69,000 persons, or about 9.5 per cent of people employed in Queensland private industry. The study was partly concerned with a comparison of the performance of the manufacturing sector with that of the bulk of the Queensland economy. Accordingly, there was a substantial and deliberate difference between distribution of employment in this sample of firms and the employment pattern in the whole Queensland economy. Over half the employment in the sample was in the manufacturing sector: less than 20 per cent of private sector employment in the whole economy is in that sector. Mining employment was also overrepresented in the sample, and, correspondingly, nearly all other employment categories were under-represented.

EMPLOYMENT GROWTH AND THE QUEENSLAND INFORMATION SECTOR

(i) Employment Growth

In popular conception, the Queensland economy is heavily oriented towards natural resources, concentrating on mining (coal, copper, bauxite), agriculture (livestock and crop production), downstream manufacturing (for example, the aluminium industry at Gladstone and sugar refining), with some light industry. When the tertiary sector is considered at all, it is usually in relation to the construction and tourist industries. In the 1970s there was considerable State government emphasis on enticing major manufacturing projects to locate here. This involved huge complementary investments in infrastructure, such as the power stations at Gladstone and Tarong.

Over the last decade, employment in Queensland grew by 34 per cent, or just over 240,000 jobs.¹¹ Surprisingly, less than 5 per cent of these new jobs were generated in agriculture, mining and manufacturing. The tangible goods sectors have shown little employment growth and are declining in relative importance in the economy overall. Together these sectors now employ only about one quarter of Queensland's labour force. The growth sectors in Queensland over the last decade have been the service and information activities. Community services (health, education, welfare) enjoyed a massive growth, as did a key information industry — finance/business services. Indeed, community services provided almost a quarter of all new Queensland jobs over the 1971-81 period, while wholesale and retail and finance/business services together were responsible for roughly another quarter of all new jobs.

These developments were mirrored in workers' occupations. Those occupations involving the production or processing of tangible goods declined in relative importance in the State's labour force over the past decade. The most information-intensive occupational categories (professional/technical, administrative/managerial, clerical) were responsible for about 40 per cent of all new jobs created over the 1971-81 period. Females accounted for the bulk of this growth.

Educational qualifications may be taken as an indicator of improvement in human resources. The shift to services and information activities in Queensland is associated with such improvement. In 1971, slightly over one quarter of the Queensland labour force had some sort of educational qualification.¹² By 1981, this proportion approached a third of a much larger labour force. University degrees are still fairly rare in most occupational categories. Indeed, by 1981 only 4 per cent of the Queensland labour force possessed a degree. In Australia as a whole, 6.7 per cent of the labour force possessed a degree in 1981.¹³ By comparison, about 17 per cent of the U.S. labour force had a degree in 1978.¹⁷ According to Barry Jones, this sort of comparison implies that Australia is "ceasing to be intellectually competitive. ..".¹⁵

Major occupation group	Total employed	Information workers	Per cent information workers
Professional, technical	110,168	73,472	66.7
Administrative, managerial	46,684	46,684	100.0
Clerical	151,362	151,362	100.0
Sales	89,605	21,093	23.5
Farmers	79,262	112	0.1
Miners	7,646	285	3.7
Transport, communication	51,076	9,097	17.8
Tradesmen, labourers	258,304	19,252	7.5
Service, recreation	80,515	786	1.0
Armed forces	13,785	1,442	10.5
Inadequately described	64,422	· _	
(TOTAL) Total adequately described	(952,832) 888,410	323,585	36.4

TABLE 1

Information Intensity of Major Occupation Groups, Queensland, 1981

Source: List of information occupations; and 1981 Census, Table 74.

(ii) Information Sector

Persons employed in information occupations in Queensland in 1981 are shown in Table 1. They are also presented as a proportion of the total workers in each occupation group as well as in the labour force as a whole. Thus the total employed in information occupations amounted to 323,585 persons, or about 36 per cent of the Queensland employed labour force in 1981. In comparison, the information labour force for Australia in 1977 has been estimated to be about 30 per cent of the total labour force.¹⁶ The information sector comprised about one third of the labour force in most OECD countries in the 1970s.¹⁷

Most information activities originate in the existing service sector, but the tangible goods sectors also include an information component; for example, office activities in mining and manufacturing. Figure 1 below presents the traditional industry groupings in terms of their information intensity. The industry that deals in money — a form of purely symbolic information — the finance/business services industry, has the highest proportion of information workers, while agriculture has the lowest.

(iii) Information Workers in the Firm

The survey of Queensland industry confirmed that firms employ large numbers of information workers and that their share of total employment has rapidly increased. They accounted for about 38 per cent of employment in the firms in 1973. Ten years later, information workers comprised 44 per cent of firms' employment. Not surprisingly, non-manufacturing firms reported a greater proportion of information workers than manufacturing firms — about half of their total workforce, in fact, compared with about a quarter in manufacturing firms. That both sectors should report steady increases in the prevalence of information workers is quite consistent with other work on the information sector. It is important to remember that information workers, although more common in the tertiary sector, are by no means limited to that sector. They play an important role in both the primary and secondary sectors.

The typical information worker is not a highly educated person operating a computer. A clerk is more representative of information workers — about half of the Queensland information labour force is engaged in basic clerical activities (Table 1). In hiring information workers, firms considered on-the-job experience to be much more important than formal educational qualifications.



FIGURE 1 Information Intensity of Queensland Industries, 1981

DIFFUSION OF INFORMATION TECHNOLOGY

The survey confirmed that the equipment of modern information technology¹⁸ is diffusing rapidly and widely into all sectors of the Queensland economy¹⁹ (Table 2). Greatest penetration has been achieved by the established telex technology, though there would seem to be little scope for the continuation of its rapid growth rate as this technology is now reaching saturation level. A majority of firms also

have private automatic branch exchange equipment, and that technology seems to have more potential for further adoption. A third of respondents use mainframe computers (even if based interstate or overseas), but the growth rate of these has been eclipsed by the adoption of first minicomputers and then microcomputers.

	Percentage of firms indicating usage (or expected usage) of equipment.				
	1973	1978	1983	(1990)	
Mainframe computer	10	20	34	(38)	
Minicomputer	4	15	36	(51)	
Microcomputer	3	4	23	(52)	
PABX (private automatic branch					
exchange)	23	35	54	(67)	
Word processor	1	4	19	(61)	
Data modem/acoustic coupler	1	8	24	(49)	
Telex	26	45	63	• (70)	
Point of sale terminal	0	1	4	(18)	
Robots	0	0	2	(18)	
Facsimile	0	2	7	(37)	
Videotex	0	1	6	(40)	

 TABLE 2

 Growth of Information Technology Use in Queensland

Source: Survey

Only about one fifth of firms currently use word processors, but nearly two thirds of firms expect to be using this office technology by 1990. Fourteen firms were found to be using robots, but about one third of manufacturing firms expect to be using them by 1990.²⁰ Other studies have commented on some of the reasons for the rapid diffusion of information technologies: the need to raise productivity in the office sector, rapidly improving technology at lower prices, and aggressive marketing strategies of suppliers.²¹ But perhaps the main reason is an increased demand for information. As society becomes more complex, people perceive an increased need for timely and appropriate information.²² According to Neuberger,

The larger the number of participants in the economic process, the greater the division of labor, the more complex the technological processes, the wider the assortment of goods and services an economic system produces, the more information intensive the economic process becomes.²³

ORGANISATIONAL EFFECTS OF INFORMATION TECHNOLOGY

Firms were asked to comment on a number of aspects of their use of information technologies. They may, of course, have found difficulty in segregating technology from the many other factors likely to influence such major matters as profitability and employment. Furthermore, consequences are likely to depend on just what technologies are in use, and on the characteristics of the firms using them. We have argued elsewhere that the way firms choose to use their information technology is critical to its impact on the firm.²⁴ The technology is not in itself deterministic; it does not dictate its own function within the firm unless the firm is sufficiently passive to allow it to do so. Interaction of new technology with the organisation of the firm will demand change in that organisation, and probably change in the technology too. The whole is a dynamic process characteristic of the adoption of all technological change, but which is particularly evident in the rapid adoption of new information technologies.

Effect on	Total firms	Increase		Decrease		No change	
		No.	Per cent	No.	Per cent	No.	Per cent
Overall efficiency Product or service	456	416	91	5	1	35	8
quality	450	313	69	4	1	133	30
Profits	448	242	54	14	3	192	43
Organisational flexibility	448	313	70	23	5	112	25
Employment levels Performance of new	452	60	13	132	29	260	58
tasks	445	303	68	7	2	135	30

TABLE 3

Reported Effects of Use of Information Technology

Source: Survey

Firms were quite certain that their organisation gained substantial benefits from information technology use, with the clearest benefit claimed being in overall efficiency (Table 3). There was also thought to be a substantial increase in product or service quality, organisational flexibility and in the ability to perform new tasks. However, firms were much less certain that their technologies led to increased profits.²⁵ It may be that, in the current economic climate, information technology was seen as incapable of overcoming the many obstacles to increased profits; or it may be that cost reduction and improvements to the internal functioning of the firm are more

immediate goals than increased profits; or it may be that information technologies are so ubiquitous that they provide little competitive edge to be translated into profits. As one small engineering firm observed:

Information technology has improved our efficiency in the administrative field, it has not reduced staff levels or increased profits just kept us up with our competition. In other words we would have dropped back without it.

More dramatic comment came from a small firm in the business services sector:

The consequence of not using the word processing equipment now available to me would be to close down the business due to market forces created by competitors already employing this kind of technology.

Technological intensity seems to affect strongly firms' perceptions of the benefits of information technologies. Detailed analysis of returns showed that the more technology a firm has, the more it thinks of technology as leading to increases in efficiency, quality, profits, flexibility and the performance of new tasks. This could reflect simply the fact that the more technology a firm has, the more experience it has had, and the more opportunity to adapt to gain the benefits. Newer users, on the other hand, may still be struggling to obtain benefits. Another perspective, though, is provided by Horton:

. . . data never seems to get costed out like the other resources and assets do. It is **assumed** that the value we get from using data outweighs the cost we incur in acquiring, handling and storing it.²⁶

EMPLOYMENT EFFECTS OF INFORMATION TECHNOLOGY

Many firms saw the use of information technologies as responsible for reduction in employment levels, although the majority thought there had been no effect, and some attributed an increase in employment to the use of information technology. The actual employment over the 1978-83 period of those firms responding to the question on the employment effects of information technology confirms their judgement. Those reporting a decrease experienced a decline in employment of 1,611 jobs. Of course, other factors affect employment, but survey firms apparently attribute some of this decline to the effects of information technology. On the other hand, the majority of firms which reported no employment change attributable to information technology experienced an actual increase in employment of 3,740 jobs over the 1978-83 period. Firms reporting an increase actually did show an increase of 3,518 jobs. The net employment experience over 1978-83 of all these firms, then, was an increase of 5,642 jobs. Unfortunately, the above figures bring us no closer to a precise measurement of the employment effects of new technology in the economy. This is not surprising given the diversity of information technologies, the multiplicity of their uses, and differing management styles, industries and organisations.

Manufacturing firms were much more likely than nonmanufacturing to see information technology resulting in lower employment levels — about a third of manufacturers saw this happening, but only a quarter of non-manufacturers. This difference could be attributable to inherent differences in the characteristics of the two sectors, and/or simply differences in the way that manufacturers perceive the use of new technology. Management in manufacturing may view new technology simply as something which allows it to cut costs, particularly labour costs. As one large manufacturing firm put it:

This corporation will continue to develop information systems to . . . replace non information as well as information workers — further reduce staff.

The view that new technology allows the production of better products, or new products and the associated penetration of new markets, may be less widespread in manufacturing.

An Information Research Unit study of technological change in the insurance industry supports the proposition that direct employment effects can depend on the way firms choose to use the technology.²⁷ Insurance firms associated technological change with reduced staff numbers, and increased staff numbers with a growth in demand for insurance services. There was apparently little awareness of the importance of technological change in meeting both the demand for existing insurance services and new services. It is conceivable that insurance companies could exploit their technological capability to offer new goods and services to established markets and to penetrate new markets with both these and the industry's traditional products. However, there was little evidence that the Australian insurance industry was using its considerable technological base for anything other than the provision of traditional goods and services to traditional markets. Under these circumstances, technological innovation is indeed likely to be labour-saving, and employment levels in this industry are very likely to fall. These remarks may well be pertinent to manufacturing industry.

Productivity increases which allow the displacement of labour may be harder to achieve in non-manufacturing industry than in manufacturing. Difficulties in achieving productivity gains in the service and information sectors may be partly attributable to what we have elsewhere called the 'xerox effect' - information technologies may be eroding overall information efficiency.²⁸ New information technology is adopted by the organisation to perform specific, normally traditional, tasks; however, the technology typically has the capacity to perform quite a number of other, often new, tasks. The more tasks the technology performs, the more strain is placed on the existing structure of the organisation and the greater is the necessity for the organisation to adjust and adapt - otherwise information will be produced indiscriminately and will be used inefficiently. Changes in organisational structure to make use of newly available information may be difficult and expensive.²⁹ However, if the organisation fails to adapt, the efficiency with which it handles all its information may be impeded, with consequent reduction in productivity. Respondents' comments illustrate the difficulties often encountered in this adaptation process:

Our computer took approx 12 months . . . to come on line, and not 6 months as advised by the computer company . . . staff connected with the installation experienced nervous tension and in Payroll area a traumatic experience would be an apt description!

Briefly, a computer installation is an experience I would hesitate to repeat, and is definitely not the simple operation the computer wizz kids would have us believe.

... we regret that we wasted some 18 months of endeavor and are only glad that we had the sense to run a parallel hand system. We were ill-advised by incompetent self appointed experts in this field.

Normally the market mechanism would weed out organisations that failed to adapt, unless competitors are experiencing similar difficulties,³⁰ or firms are sheltered from competition. This may well be the situation. Indeed, the Vice-President of Xerox Information Products Group, has argued that:

Transformation from the office of today to a more efficient office of the future seems elusive, and the hypothesized result is by no means assured. Movement towards our new goal turns out to be more difficult and complex than the changes that were necessary for industrialization.³¹

If the 'xerox effect' is occurring, then concern about the effect of information technologies on employment levels is hardly likely to reach the heart of the problem. Indeed, the problem becomes not the utopian one of how to distribute excess wealth, but the old familiar one of how to create it. This is likely to involve the creation of new types of organisation, as well as new forms of measurement, so that output fully reflects increased information input. Employment levels are dependent on ability to make economic use of information. Contrary to popular belief, new information technology does not compensate for inability to use information efficiently. In fact, it seems to aggravate that inability, and that situation — especially if its existence is scarcely recognised — has very serious implications indeed for employment levels. Some respondents did appreciate that use of information technologies does not automatically imply productivity increases:

Information Technology is becoming more prevalent in our company at present — as a result more information is readily at hand but surprisingly, the output per man hour has not changed dramatically — the information worker now spends more of his/her time looking after information itself...

We now know more about why profits are down, however have no one to correct the problem as they are all reading reports produced by reports produced by reports.

CONCLUSION

The most important finding of this study is that an information sector exists in Queensland. This is confirmed both by available statistics and by firms whose activities are responsible for its existence. The advantage of the information sector concept lies in the greater understanding of what is happening in the economy that such definition allows. The information sector has been growing, and growing rapidly, at a time when other sectors of the Queensland economy have been stagnating. The information sector has been creating jobs while other sectors have been reducing their employment. The information sector has been both the source and the destination of much of the new technology which is so radically altering the ways in which our economy and society function. Finally, the information sector employs well over a third of all employed Queenslanders: it is twice the size of the recognised manufacturing sector and almost four times the size of the primary sector. Not to take the information sector seriously is indefensible.

The survey indicates that information technologies have been rapidly adopted in the Queensland economy: it says nothing about rates of adoption elsewhere, nor about whether greater benefits have been achieved elsewhere. The latter is a particularly problematic issue. The mere acquisition of information technology does not necessarily secure increased efficiency. Information is an unusual sort of good, and difficult to handle and produce efficiently. While new technology may well reduce the production cost of information, the technology may not have the same effect on a more major and often unrecognised cost of information — its consumption cost. In fact, new information technology may well inadvertently increase the consumption cost of information and even reduce overall efficiency. Such issues are clearly of fundamental importance in an information economy, and deserve further research.

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