

A behavioural measure of information work

Jorge Reina Schement and Leah Lievrouw

Information work is defined from a behavioural perspective, as the manipulation of information, when performed by workers. A set of activities characterizing information work are identified, drawing on *Blooms Taxonomy* as the reference source. Using this measure, the 1977 *Dictionary of Occupation Titles* was content analysed to identify those occupations which could be behaviourally classified as information work. 40% of all occupations were determined to be informational in work behaviour. These occupations were found across all sectors, although they were concentrated in the service sector. Many occupations, old and new, have taken on an informational character.

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¹Adam Smith, *The Wealth of Nations*, American Dome Library Co, 1902, book 1, pp 44-45.

²Fritz Machlup, *The Production and Distribution of Knowledge in the United States*, Princeton University Press, Princeton, NJ, 1962.

³Daniel Bell, *The Coming of Post-Industrial Society*, Basic Books, New York, 1973.

⁴Marc Uri Porat, *The Information Economy*, OT Special Publication 77-12, US
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'I have seen a small manufactory of this kind where ten men were employed and where some of them consequently performed two or three distinct operations.' With these words, Adam Smith set the scene for his famous description of a pin factory, and introduced his observations on changes in English labour patterns.¹ These changes, embodied in the 'manufactory', eventually led to a new social structure, which we have come to typify as industrial. But while this social structure itself eventually became so pervasive as to be taken for granted, the fascination with labour and its patterns continues for precisely the same reasons that drew Adam Smith's attention. The activities which are performed as work are direct reflections of a society's efforts to generate its means of sustenance; hence the continued fascination.

When Fritz Machlup determined the significance of a 'knowledge sector' within the US economy and an emerging elite of scientists and engineers, he set the scene for another radical reconsideration of labour patterns.² More recently, others such as Bell, Porat, Williams, Dizard and Schement *et al* have analysed different aspects of changes in the workforce.³⁻⁷ While these authors propose different explanations for the origins and outcomes of the changes, they agree that the fundamental characteristic of this new occupational pattern is its involvement with information. Information is considered so essential to the broad changes occurring in the workforce, economy, and society that it is often cited as the defining element in contemporary American culture. In other words, some observers have proposed that we are living in an 'information society', characterized by the 'information work' carried out by its members. Some have gone so far as to declare the end of industrial society.⁸

In this paper we review some of the definitions of information work adopted by other researchers and propose a systematic definition of our own that considers information work from a behavioural perspective. This definition arises from the assumption that information manipulation as a primary activity in any work setting is the essential characteristic of all information work. Through a content analysis of the *Dictionary of Occupational Titles (DOT)*⁹ a comprehensive survey of information occupations in the United States was also conducted.

Knowledge producers: Machlup

Fritz Machlup was the pioneer in the study of information work. In 1962

he published *The Production and Distribution of Knowledge in the United States*, in which he asserted that for too long economists had explained away the role of knowledge in economic growth by looking at it as a 'trend factor', that is, as a function of time. He went on to discuss a group of workers that he termed 'knowledge producers', and defined knowledge production as:

any human (or human-induced) activity effectively designed to create, alter, or confirm in a human mind – one's own or anyone else's – a meaningful apperception, awareness, cognizance, or consciousness of whatever it may be.¹⁰

Machlup estimated that for the year 1958, 31.3 per cent of the workforce could be placed in a category of knowledge producers.¹¹

Though Machlup's scheme made a few distinctions among 'transporters', 'transformers', 'processors', 'interpreters', 'analysers' and 'original creators' of knowledge, his principal division was between two major groups: knowledge producers and non-knowledge producers. The knowledge production group was essentially an aggregation of the so-called white-collar workforce and, predictably, included a range of skills and activities peculiar to white-collar workers. Machlup called this aggregation the 'knowledge industry'.¹²

Machlup's choice of task-related categories allowed some comparisons to be made among groups of workers and illustrated his view of changes in the workforce. However, by defining 'knowledge producers' at a very general level, he limited the depth of comparisons that might have been made. By focusing primarily on professionals, he introduced a class bias that obscured the diffuse pattern of information workers in all economic sectors. He avoided defining the particulars of information work with sufficient specificity to allow the systematic identification of these activities throughout the entire labour force.

Knowledge workers: Bell

In 1973, Daniel Bell published his 'venture in social forecasting', *The Coming of Post-Industrial Society*. Bell's theory was based on the recognition that the service sector had become dominant in the economy and that there existed a core of workers in the services who created 'new knowledge' in the following way: 'Knowledge consists of new judgements (research and scholarship) or new presentations of older judgements (textbook and teaching).'¹³

Using his 'new knowledge' criterion, Bell singled out what he considered to be the most important group of workers, which was composed entirely of scientists and engineers. Like Machlup, Bell predicted that this knowledge elite would take the leading policy role in a technologically-based economy. Bell calculated that in 1974 48.6 per cent of the workforce were 'white-collar' service workers, and that 14.4 per cent of these were 'professional and technical' knowledge workers.¹⁴

Bell's narrow definition of 'new knowledge' ignored the possibility that non-professional workers who originate, recombine and apply information might also be producing 'knowledge' or information. While his proposition that a technocracy with an elite class of knowledge creators would become the core of a technologically sophisticated social system carries interesting implications, his restrictive definition of information work limits our understanding of its extent and dimensions within society.¹⁵

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Department of Commerce, Washington, DC, May 1977.

⁵Fredrick Williams, *The Communications Revolution*, Sage, Beverly Hills, 1982.

⁶Wilson P. Dizard, *The Coming Information Age*, Longman, New York, 1982.

⁷Jorge Reina Schement, Leah A. Lievrouw and Herbert S. Dordick, 'The information society in California: social factors influencing its emergence' *Telecommunications Policy*, Vol 7, No 1, March 1983, pp 64–72.

⁸Wilson P. Dizard, *The Coming Information Age*, Longman, 1982, p 2.

⁹*Dictionary of Occupational Titles*, (4th ed), US Government Printing Office, Washington, DC, 1977.

¹⁰Fritz Machlup, *The Production and Distribution of Knowledge in the United States*, Princeton University Press, 1962, p 30.

¹¹Machlup, *op cit*, Ref 10, p 393.

¹²Machlup, *op cit*, Ref 10, p 44.

¹³Daniel Bell, *The Coming of Post-Industrial Society*, Basic Books Inc, 1973, p 175.

¹⁴*Ibid*, p 135.

¹⁵In this article, the use of the term 'information work', rather than 'knowledge work' reflects the greater currency which the former term has gained among information scholars. While each term has a specific focus, and while their meanings do not necessarily overlap, 'information work' has emerged with a more encompassing connotation. Therefore, we used this term for the purposes of developing our categories.

By choosing to approach information work from the perspective of a knowledge elite, Bell reinforced the professional class bias introduced by Machlup and overlooked many functional similarities in jobs across the labour force. Moreover, Bell's 'new knowledge' criterion hinged on a tautological definition: 'new knowledge' depends on the activities of scientists and others who are the sole producers of new knowledge. Since Bell did not incorporate Machlup's more extensive differentiations among information, communications and knowledge in defining his knowledge elite, there remains an ambiguous concept at the heart of his argument. Information is clearly identified as a dominant output of post-industrial society, but the extent to which the members throughout this society work with information is less clear.

Nevertheless, by concentrating on an emerging knowledge elite, Bell drew attention to what appeared to be a significant departure from traditional industrial societies. His contribution was in signalling the debut of a post-industrial society, dominated by the service sector of the economy, and in pointing out society's dependence on information-related work.

Information workers: Porat

In his comprehensive assessment, *The Information Economy*, Marc Porat divided information occupations into three major groups, and further into five 'classes' of workers.¹⁶ First, there is the 'markets for information' group, which includes two classes of workers, 'knowledge producers' and 'knowledge distributors'. Second, there is the 'information in markets' group, which includes two additional classes, 'market search and coordination specialists' and 'information processors'. The third market is the 'information infrastructure' group, composed of 'information machine workers'. Porat estimated that 46.0 per cent of the United States GNP in 1967 originated in these three markets, in what he termed the primary and secondary information sector.¹⁷ The identification of information occupations along with their distribution in the labour force is treated very generally in *The Information Economy*. Perhaps this is not surprising, since Porat's purpose was to identify the contribution made by information activities to the gross national product. But, like his predecessors, Porat glossed over the actual performance of information work and allocated occupations according to their proximity to, and use of, 'new' information. Therefore, Porat's most important class creates new information, while the others manipulate it in some way. This classification approach is built upon, and further reinforces, the elite work biases of Machlup and Bell.

Porat also based his occupational categories on an ill-defined measure of creativity, especially in the first class of workers who 'create' information. The top half of this class (knowledge producers) is comprised exclusively of scientists and engineers (similar to Bell's 'knowledge workers'). The bottom half of this class 'repackages' information, and is not considered purely creative. This half includes lawyers, physicians, computer programmers, financial specialists, counsellors and many other professionals.

The second class 'distributes' knowledge without any further creative input. This class includes all educators, librarians and 'communication workers' (authors, entertainers, artists, photographers, etc). The third class contains workers who search for and gather or process information, or who plan and control activities. These workers are further

¹⁶Porat, *op cit*, Ref 4.

¹⁷*Ibid*, Vol 1, p 4.

Table 1. Porat's typology of information workers.

Markets for information
1: Knowledge producers
2: Knowledge distributors
Information in markets
3: Market search and coordination specialists
4: Information processors
Information infrastructure
5: Information machine workers

Source: Marc U. Porat, *The Information Economy*, OT Special Publication 77-12, US Department of Commerce, Washington, DC, May 1977.

divided according to whether they use electronic or non-electronic tools in their work. This class includes managers, buyers and sellers, postal personnel, administrators, appraisers, secretaries, registered nurses and bank tellers.

Finally, the fifth class includes any worker whose principal task is tending information machinery, ranging from computers and telecommunications systems to typewriters and postage meters. Porat identifies these individuals as members of the 'information infrastructure'.¹⁸

Porat's scenario is an interesting one. However, he isolated the workforce from its social context, and though he was clearly aware of workers' tasks, he tended to focus on the output of 'information industries'. Thus Porat contributed to the understanding of an economy based on information and documented the presence of information transactions in the GNP. But while this provided glimpses of the character and distribution of information work, it did so as a by-product of an economic analysis.

Ambiguities in classifying information work

Each of the approaches reviewed so far represents an attempt to explain an increasing social significance of information in society. They all provide classification systems for information-based work. However, they pose problems in that they focus either on a narrow range of professional information occupations (Machlup, Bell) or on categories that are hard to replicate (Porat).

One difficult aspect of the three major classification schemes is a sense of arbitrariness in the classifications themselves. Machlup acknowledged that his classifications were to some extent arbitrarily made. Charles Jonscher has expressed his misgivings over the arbitrariness of occupational classification, and explained how such poorly articulated classification decisions have hampered efforts at developing an economic measure of information-related work.¹⁹

While these are not the only analyses of information work that have been performed, Machlup, Bell and Porat formed the conceptual rationalization and guidelines which others have followed. Machlup, in particular, made advances in attempting to understand what he sensed to be a fundamental change in the nature of work. Despite their contributions, however, we are still faced with the task of developing a descriptive system that classifies and organizes the full range of occupations according to the presence or absence of information manipulation.

A behavioural taxonomy of information work

In this section, we propose a classification system that organizes occupations by information-related tasks, in order to focus directly on

¹⁸Ibid, p 106.

¹⁹Charles Jonscher, *Aggregate Measurement of Information Resources in the Economy*, MIT Sloan School of Management, Cambridge, MA, USA, July 1982; Charles Jonscher, 'The economic causes of information growth', *Intermedia*, Vol 10, No 6, Nov 1982, pp 34-37.

information (or information technology) manipulation as the principal working behaviour. Any occupation whose main task is the production, recycling or maintenance of information, or the production or maintenance of information technology, is therefore by its nature defined as an information occupation.

We have undertaken this classification system in order to define information work in a way which avoids the problems encountered by others. We sought sub-definitions that would embody a set of uniform, abstractly described activities, rather than definitions which start with existing occupations and then define information work based on a culturally-bound assessment of their social rank or value. Though every kind of classification scheme suffers from the preconceptions and cultural position of the classifier to some extent, we believe that an abstractly defined behavioural framework provides classification standards that progress beyond many of the intuitive judgements of the past.

To develop the categories of information work, we first reviewed the taxonomy of behavioural outcomes of instruction organized by Bloom, Krathwohl, Harrow *et al.*,²⁰ and which was summarized by Gronlund,²¹ as a model of possible work activities. The instructional outcomes (ie

²⁰Benjamin Bloom and others, *Taxonomy of Educational Objectives, Handbook 1: Cognitive Domain*, David McKay, New York, 1956; David Krathwohl and others, *Taxonomy of Educational Objectives, Handbook 2: Affective Domain*, David McKay, New York, 1964; A. J. Harrow, *Taxonomy of the Psychomotor Domain*, David McKay, New York, 1972.

²¹Norman E. Gronlund, *Stating Objectives for Classroom Instruction* (2nd ed), New York, MacMillan Publishing Co, New York, 1978.

Table 2. Bloom's taxonomy of educational objectives – behavioural terms.

Behavioural terms	Level
<i>Cognitive domain</i>	
Evaluation	Appraise, compare, conclude, contrast, criticize, describe, discriminate, explain, justify, interpret, relate, summarize, support, judge
Synthesis	Derive, plan, propose, produce, categorize, combine, compile, compose, create, devise, design, explain, generate, modify, organize, rearrange, reconstruct, relate, revise
Analysis	Break down, diagram, differentiate, distinguish, illustrate, infer, outline, point out, select, separate, subdivide
Application	Change, compute, demonstrate, discover, manipulate, operate, predict, prepare, show, solve, use
Comprehension	Convert, defend, estimate, extend, generalize, paraphrase, give examples
Knowledge	Define, describe, identify, label, list, match, name, reproduce, state
<i>Affective domain</i>	
Characterization by a value or value complex	Act, discriminate, display, influence, listen, modify, perform, practise, propose, qualify, question, revise, serve, solve, use, verify
Organization	Adhere, alter, arrange, combine, compare, complete, defend, explain, generalize, identify, integrate, order, organize, prepare, relate, synthesize
Valuing	Complete, describe, differentiate, explain, follow, form, initiate, invite, join, justify, propose, read, report, select, share, study, work
Responding	Answer, assist, comply, conform, discuss, greet, help, label, perform, practise, present, read, recite, report, select, tell, write
Receiving	Ask, choose, describe, follow, give, hold, identify, locate, name, point to, select, reply, use, attend
<i>Psychomotor domain</i>	
Origination	Arrange, combine, compose, construct, create, design, originate
Adaptation	Adapt, alter, change, rearrange, reorganize, revise, vary
Complex overt response	Assemble, build, calibrate, construct, dismantle, display, dissect, fasten, fix, grind, heat, manipulate, measure, mend, mix, organize, sketch, work
Mechanism	(same as complex overt response)
Guided response	(same as complex overt response)
Set	Begin, display, explain, move, proceed, react, respond, show, start, volunteer
Perception	Choose, describe, detect, differentiate, distinguish, identify, isolate, relate, select, separate

Source: Norman E. Gronlund, *Stating Objectives for Classroom Instruction* (2nd ed), Macmillan Publishing Co, New York, 1978.

Table 3. DOT work task codes

4th digit: data	5th digit: people	6th digit: things
0 synthesizing	0 mentoring	0 setting up
1 coordinating	1 negotiating	1 precision working
2 analysing	2 instructing	2 operating/controlling
3 compiling	3 supervising	3 driving/operating
4 computing	4 diverting	4 manipulating
5 copying	5 persuading	5 tending
6 comparing	6 speaking/signalling	6 feeding/offbearing
	7 serving	7 handling
	8 helping	

activities) in the Bloom taxonomy are divided into the cognitive, affective, and psychomotor domains. In turn, each of the domains is subdivided into increasingly complex levels of behaviour. For example, the cognitive domain has six levels, the most rudimentary of which is knowledge. The domain progresses up to the level of evaluation, which involves behaviour such as judgement, comparison, interpretation or criticism.

The heart, and descriptive power, of the Bloom taxonomy lies in the verbs used to describe the activities throughout the three domains. In Gronlund's summary of the taxonomy,²² he abstracted lists of example verbs for each level of each domain. (Table 2 contains his outline of the Bloom domains and levels, with corresponding example verbs.) Verbs like these formed the initial basis for devising the categories of information work. They (and their synonyms) were reorganized into five groups that would encompass both the intellectual and physical work pertaining to information and information technologies.

At the same time, the *DOT* was identified as the most comprehensive listing of occupational descriptions for the entire US workforce. Each occupation described in the *DOT* is labelled with a unique nine-digit code number. The fourth, fifth, and sixth digits of this code number correspond to a rating system that classified the occupation according to its relationship with data, people and things, respectively. While the *DOT* codes are not as comprehensive as the levels of the Bloom taxonomy, there are some interesting similarities between the two systems (cf Tables 2 and 3).

With these two classification systems in mind, the five-category information work behavioural taxonomy was designed to be as exhaustive as possible for all information-related occupations. The new taxonomy, and the verbs for each category, are summarized in Table 4.

In the following sections, each category of information work is described according to three aspects:

- the conceptual definition of the category
- the operational definition of the category, that is, the types of activities that would serve to place an occupation in it
- who is in the category, listing some generic examples of occupations included in the group

Information producers

This category of work (like Porat's first group) is based on the concept of creativity: workers are included in this category by merit of the creative nature of their work. However, unlike Porat and Bell, creativity is not restricted to the origination of 'new' knowledge. Our assumption is that all knowledge is derivative; and so synthesis and

²²Ibid.

Table 4. Taxonomy of information work: descriptive terms associated with each category.

Category 1: produce information		
create	illustrate	predict
synthesize	derive	distinguish
analyse	deduce/induce	detect
form patterns	diagnose	plan
compose	generalize	produce
design	interpret	modify
apply	combine	entertain
specify	estimate	hypothesize
integrate	propose	investigate
abstract	crystallize	clarify
develop	recognize trends	extrapolate
edit	employ	solve
paraphrase		
Category 2: recycle information		
transform	transmit	distribute
allocate	relay	route
move	rewrite	tell
correct	acquire	diffuse
broadcast	direct/redirect	record
manage	convert	extend
rearrange	collect	schedule
report		
Category 3: maintain information		
evaluate	categorize	organize
access	describe	discriminate
compare	recognize	label
judge	classify	catalogue
appraise	weigh alternatives	store
keep records	recognize patterns	maintain
restore	contrast	criticize
justify	summarize	differentiate
select	identify	search/find
Category 4: produce information technology		
assemble	fabricate	inspect
build	connect	construct
gather	solder	finishing
adjust	fit	attach
wire	insert	place
Category 5: maintain information technology		
install	monitor	observe
repair	diagnose	operate
load	service	clean
maintain	review	align
adjust	modify	analyse
quality control		tend

reorganization are accomplished by means of creative effort. Thus, this category is much broader than comparable categories proposed by other analysts. It includes any worker whose task is interpretation, creation, synthesis, composition, design, modification, combination or other related activities. This category, then, gathers together scientists and engineers, but it also includes artists, architects, lawyers, market analysts, computer programmers, teachers and most physicians. Because workers in this category are defined on the basis of cognitive behaviour, rather than on their status as part of a technocratic elite, many more kinds of occupations are legitimately considered information producers.

Information recyclers

Workers in this category move information from one place to another, or transform it from one form to another without altering the meaning. The principal activities include translation, transformation, transfer, routing and other similar tasks. Typical jobs in this category would include postal workers, secretaries, word processor operators, printers, translators and telephone operators.

Information maintainers

This category is roughly analogous to one that Porat considers part of the 'information distributor' class. It includes librarians, archivists, curators and other people who store and maintain information. The distinctive activity in this category is judgement, that is workers make decisions regarding the value of information. They decide what is worth keeping and what is not; what will be useful to specialists and what will not; what should be bought and what should not. Frequently, these workers must evaluate content in areas tht are diverse or obscure, and not necessarily within their own area of expertise. They make their judgements based on specialized sets of criteria that are devised and refined over time. Occupational tasks in this category encompass description, discrimination, comparison, organization, analysis, categorization and labelling; the ability to break down material into its component parts; and the recognition of organizational schemata within various content areas.

Information technology producers

All workers who produce information technology and all those who produce the first stage of components for that technology are included in this category. For example, workers assembling cathode ray tubes, computer chips, or telephone plugs would come under this category, but workers extracting or processing raw materials (silicon, copper, plastics) would not. This category includes the most traditional industrial assembly skills, applied in what we have broadly classified as information technology industries (see Table 5).²³

Information technology maintainers

This category includes workers who maintain, monitor, repair, operate or otherwise care for information technology after it is built. The main tasks involved here are operation, repair, monitoring, maintenance, installation, inspection and diagnosis. Examples of jobs in this category would be telephone line and repair personnel; computer operators; press operators; and television and radio engineers.²⁴

²³We use the term 'information technology' in the same way that Machlup, Ref 10, p 295, uses the term 'information machines': 'to stand for apparatuses, instruments, or gadgets of any size, simplicity or complexity, as long as they are "produced" and are devised to provide information.' Our list of information technology industries reflects this definition.

²⁴There are no information technology recyclers included as a group. The nature of information technology distribution is such that the dominant activity is physical movement, employing a worker whose primary task involves the physical distribution of materials, and other transportation occupations. This does not in itself involve information or information technology *per se*, and so information technology recycling cannot be justified as a separate work category.

Content analysis of the DOT

Once a suitable list of verbs and descriptions for the five information work categories was established, coding began on the DOT descriptions themselves. A content analysis of the entire DOT was performed by comparing the descriptions of principal job tasks in its listing with the information work taxonomy, and then assigning occupations to one of the groups. By using both the DOT and a standardized set of

Table 5. Information technology industries.

Audio equipment	Broadcasting
Computers	Electronics
Meters/gauges, other measurement devices	Office machines
Optics	Postal services
Photostatic, mimeo or other copiers	Printing
Satellite equipment	Radio
video/films	Scientific instrumentation
Telephone companies	Signalling or timekeeping devices
Television	Telegraph services
	Video equipment

classification criteria, all of the job descriptions were assigned to one of the five categories, or as 'not information work'.

History and purpose of the DOT

The *DOT* grew out of the needs of the Federal and states' employment systems to describe and classify occupations during the Depression. Government personnel needed a reference that would assist them in employment counselling and placement, and so in 1939 the first edition of the *DOT* was published. Updates were compiled periodically, and second and third complete editions were published in 1949 and 1965. The fourth edition, which was published in 1977, is used as the primary source for this study.²⁵

The occupations listed in the *DOT* were selected through the research efforts of both the US Employment Service and affiliated State Employment Service occupational Analysis Field Centers. These agencies conducted on-site occupational analyses from 1965 to the mid-1970s, and officials worked closely with professional and trade associations to identify approximately 20 000 job titles for the 1977 edition.

The compilers of the *DOT* attempted to make it reflect the US labour force of the mid-1970s as accurately as possible. For a variety of reasons, however, the *DOT* may lag behind the current reality of some occupations. This could have an effect on the depiction of information work in occupations that have undergone substantial changes since 1975. It can be argued that because the idea of information work has only recently come under close study, a 10-year-old document like the *DOT* may underrepresent information work in its descriptions. Therefore the estimates of the number of information work occupations can be considered conservative for 1984. However, the *DOT* remains the most comprehensive descriptive reference on occupations.

Structure of the DOT descriptions

The descriptions in the *DOT* are systematically written so that the primary work activity is cited in the first sentence of the description. Less important tasks of the occupation are mentioned in the description in descending order of importance. (For an example of a typical *DOT* listing, see Table 6).

To analyse the descriptions, the verbs in the first sentence were compared with those in the five information work categories. If the

²⁵The *DOT* undergoes a fairly constant system of revision, and updates are frequent. We chose to use the 1977 edition because: it was the current edition available when we began the analysis; it is relatively complete, and published in a single usable document; and the 1980 census figures on work were loosely classified according to the 1977 edition.

Table 6. Examples of occupational definitions as listed in the DOT.

072.061-010 ORAL PATHOLOGIST (medical ser.)

Examines and diagnoses tumors and lesions of mouth: Examines specimens from patients' mouths to determine pathological conditions, using microscope and other laboratory equipment and applying knowledge of dentistry. Sends results of diagnosis to referring dental practitioner.

100.367-022 MUSIC LIBRARIAN (radio & tv broad.) librarian.

Classifies and files musical recordings, sheet music, original arrangements, and scores for individual instruments. Selects music for subject matter of program or for specific visual or spoken action. Suggests musical selection to DIRECTOR, MUSIC (motion pic.; radio & tv broad.) Issues required music to CONDUCTOR, ORCHESTRA (profess. & kin.), or other studio personnel.

221.367-034 MACHINE-STOPPAGE-FREQUENCY CHECKER (textile) frequency checkers; survey hand.

Records number and cause of stops and ends down (yarn breaks) on textile machines, such as looms and spinning frames, for work assignment and quality control purposes: Observes machine and questions worker to determine reason for machine stoppage. Records information on special forms for analysis by management. When working in weave room may be known as LOOM-STOP CHECKER (textile). When observing spinning or roving frames may be known as ENDS-DOWN CHECKER (textile).

verbs in the first sentence clearly involved cognitive behaviour, the occupation was classified into either the information producer, recycler or maintainer groups. If the verbs in the first sentence indicated psychomotor behaviour, the occupation was first considered to see if it was in one of the information technology industries cited above. If so, the occupation was then classified into either the information technology producer or maintainer groups.

The three examples in Table 6 illustrate how occupational definitions are presented in the *DOT*. The definition for oral pathologist lists 'diagnoses' as a verb in the first sentence and stresses the same act later in the sentence, thus qualifying the definition for the information producer category. Similarly, a music librarian is defined by the verb 'classifies', one of the verbs in the category of information maintainer; in the second sentence, the verb 'selects' reinforces the verb 'classifies' to strengthen this choice. A machine-stoppage-frequency checker records information relating to the breakdown of mechanical textile looms. The *DOT* description of this occupation indicates that this industrial job should also be considered one in which information is recycled.

If the verbs in the first sentence of the description proved too vague or inadequate for classification, the coder was instructed to go on to the verbs in subsequent sentences, and to use them to classify the occupation according to the same criteria. Descriptions that were still unclear were classified under 'don't know' on coding sheets. Occupations that clearly did not fit any of the criteria for information work were classified as 'not information work'.

There were a few coding difficulties that presented themselves as the analysis progressed. As mentioned above, some of the descriptions were written imprecisely, so that coders had to infer the presence of information work from the description as a whole, rather than just from the verbs. We also accepted some degree of judgement by coders when classifications had to be based on synonyms of the verbs in the information work categories.²⁶ As a result of this process, the coders expanded the lists of information work terms as they became increasingly familiar with the information work categories.

Results of the DOT analysis

The results of the analysis are shown in Table 7. The classifications are aggregated into the two-digit divisions of the *DOT*. (The two digits being the first two of the nine-digit occupational codes.) The table shows the number of occupations in each *DOT* division classified as information producers, information recyclers, information maintainers, information technology producers, and information technology maintainers.

In the agricultural sector (*DOT* occupational divisions 40–46) 26.1 per cent of the occupations are information work (almost all of which were classified as information producers). In the service sector (*DOT* divisions 30–38) 49.6 per cent of the occupations were classified as information work. The industrial sector (*DOT* divisions 50–99) had 25.1 per cent classified into one of the five information work categories, while in the information sector (*DOT* divisions 00–29, including professional, technical, managerial, clerical and sales occupations) 96.9 per cent of the occupations were so classified.

Clearly, then, 'information work' is not a phenomenon that is the

²⁶For a complete listing of the *DOT* occupations and corresponding information work categorization of each occupation, please contact the authors.

Table 7. Distribution of information occupations by DOT two-digit occupational divisions.

	Producers	Recyclers	Maintainers	Technology producers	Technology maintainers	Total of information workers	Not inform- ation work	Don't knows	Total of occupations
Professional, technical and managerial occupations									
00-01 Architecture, engineering, services	237	12	—	1	1	251	—	—	251
02 Health & physical science	57	1	1	—	1	60	1	—	61
04 Life sciences	56	2	—	—	—	58	—	1	59
05 Social sciences	21	—	1	—	—	22	—	—	22
07 Medicine & health	122	18	1	—	—	141	10	—	151
09 Education	63	—	—	—	—	63	—	—	63
10 Museum, library, archival occupations	10	—	21	—	—	31	1	1	33
11 Law, jurisprudence	26	—	—	—	—	26	—	—	26
12 Religion & theology	5	—	—	—	—	5	1	—	6
13 Writing	37	—	—	—	—	37	—	3	40
14 Art	51	—	—	—	—	51	—	—	51
15 Entertainment & recreation	48	12	—	—	—	60	21	5	86
16 Administrative specialties	152	5	—	2	—	159	1	—	160
18 Managers & office nec*	326	2	—	—	—	328	—	—	328
19 Miscellaneous professional technical, managerial	91	12	—	—	17	120	8	4	132
Clerical and sales occupations									
20 Steno, typing, filing	20	97	18	—	17	152	—	—	152
21 Computing & accounting recording	33	128	19	—	11	191	—	—	191
22 Production & stock clerks	23	115	4	—	—	142	8	—	150
23 Information & message distribution	23	51	—	—	—	74	—	—	74
24 Miscellaneous clerical	30	69	2	—	—	101	—	—	101
25 Sales — services	1	40	—	—	—	41	—	—	41
26 Sales — consumable commodities	—	30	—	—	—	30	—	—	30
27 Sales — commodities nec*	—	101	—	—	—	101	—	—	101
29 Miscellaneous sales	12	61	—	—	—	73	8	—	81
Service occupations									
30 Domestic service	1	—	—	—	—	1	14	—	15
31 Food service	25	15	—	—	—	40	53	—	93
32 Lodging service	7	2	—	—	—	9	9	—	18
33 Barbers, cosmeticists	2	—	—	—	—	2	19	—	21
34 Amusement services	7	24	—	—	—	31	18	—	49
35 Miscellaneous personal services	17	21	—	—	—	38	33	—	71
36 Apparel/furnishings services	7	10	—	—	—	17	75	—	92
37 Protective services	85	34	—	—	—	119	26	—	145
38 Building services	3	1	—	—	—	4	18	—	22
Agricultural, fishery, forestry, and related occupations									
40 Plant farming	18	1	—	—	—	19	49	—	68
41 Animal farming	17	2	—	—	—	19	56	—	75
42 Miscellaneous agricultural	1	—	—	—	—	1	6	—	7
44 Fishery occupations	2	—	—	—	—	2	26	—	28
45 Forestry	11	5	—	—	—	16	22	—	38
46 Hunting & trapping	1	—	—	—	—	1	5	—	6
Processing occupations									
50 Metal processing	16	1	—	—	—	17	123	—	140
51 Ore refining-foundry	37	5	—	—	—	42	175	—	217
52 Food processing	122	2	—	—	—	124	697	—	821
53 Paper processing	25	—	—	—	—	25	78	—	103
54 Energy processing	22	—	—	—	—	22	73	—	95
55 Chemical, plastic processing	92	2	—	—	1	95	545	—	640
56 Wood processing	10	1	—	—	—	11	74	—	85
57 Stone & glass processing	47	—	—	1	—	48	187	—	235
58 Leather & textiles	30	—	—	—	—	30	314	3	347
59 Processing nec*	8	—	—	6	—	14	77	—	91
Machine trades occupations									
60 Metal machining	28	—	—	35	—	63	179	—	242
61 Metalworking nec*	43	3	—	—	—	46	250	—	296
62 Mechanics	37	—	—	—	6	43	126	—	169
63 Machinery repair	13	—	—	—	8	21	85	—	106

Table 7. Distribution of information occupations by DOT two-digit occupational divisions (cont'd).

	Producers	Recyclers	Maintainers	Technology producers	Technology maintainers	Total of information workers	Not information work	Don't know	Total of occupations
Machine trades occupations									
63 Machinery repair	13	—	—	—	8	21	85	—	106
64 Paperworking	6	—	—	3	—	9	119	—	128
65 Printing	14	62	—	—	27	103	55	2	160
66 Wood machining	17	5	—	—	—	22	192	—	214
67 Stone & glass machining	10	—	—	—	—	10	89	—	99
68 Textile occupations	37	3	—	—	—	40	301	—	341
69 Machine trades nec*	27	5	—	11	—	43	347	—	390
Benchwork occupations									
70 Fabrication, repair, assembly – metal prods.	36	14	—	7	4	61	195	—	256
71 Fabrication, repair scientific instruments, products	82	6	—	130	31	249	77	—	326
72 Repair, electrical equipment	49	1	—	21	19	90	107	—	197
73 Fabrication, repair assorted materials	67	9	—	54	26	156	311	—	467
74 Painting, decorating	7	—	—	—	—	7	59	—	66
75 Fabrication, repair plastics	16	—	—	—	—	16	96	—	112
76 Fabrication, repair wood	31	4	—	—	—	35	120	—	155
77 Fabrication, repair stone & glass	28	9	—	27	—	64	103	—	167
78 Fabrication, repair textile & leather	74	16	—	—	—	90	428	—	518
79 Benchwork nec*	1	3	—	—	—	4	39	—	43
Structural work occupations									
80 Metal fabrication nec*	71	3	—	—	—	74	148	—	222
81 Welders & cutters	5	—	—	—	—	5	47	—	52
82 Electrical assembly, installation, repair	53	—	—	—	53	106	74	—	180
84 Paint, plaster, cement	11	2	—	—	—	13	37	—	50
85 Excavation, grading, paving	15	1	—	—	—	16	46	—	62
86 Construction nec*	43	5	—	—	—	48	153	—	201
89 Structural nec*	14	1	—	—	—	15	31	—	46
Miscellaneous occupations									
90 Motor freight	4	1	—	—	—	5	20	—	25
91 Transport nec*	52	19	—	—	—	71	90	—	161
92 Packaging & materials handling	41	5	—	—	—	46	227	—	273
93 Mineral extraction	25	3	—	—	2	30	77	—	107
95 Utilities	28	8	—	—	4	40	63	—	103
96 Amusements – movies, radio, television	20	1	—	—	6	27	16	2	45
97 Graphic art work	36	100	1	11	4	152	26	—	178
Totals	3098	1074	70	307	238	4884	7164	21	12 069
	(26%)	(9%)	(.06%)	(3%)	(2%)	(40%)	(59%)	(.02%)	(100%)

*nec = not elsewhere classified

exclusive province of the so-called professional or white collar segments of the workforce. Information work is distributed across all of the traditional economic sectors. In fact, in the information sector, 3.1 per cent of the occupations were clearly not information workers. An interesting perspective on the historical development of information work could be obtained by doing similar analyses using the previous editions of the *DOT*, to see where and how occupational descriptions have been modified over time.

The principal finding of the analysis is that information occupations comprise 40.0 per cent of all the occupations classified. There is no way to directly compare this figure with those calculated by Machlup, Bell or Porat, since they exclusively focused on numbers of workers. Our attempt was to bring some systematic analysis to the problem of determining which occupations are informational. A next step would be to conduct an analysis of the labour force itself based on these

occupational definitions. Only then would we be able to make direct comparisons.

What is clear is that information work, as reflected in the ratio of informational to non-informational occupations, is a significant portion of the American labour picture. Moreover, it has a sizeable presence in all of the traditional labour sectors, comprising at least 25 per cent of the occupations in each sector. Information occupations are the second largest of the sectors, with industrial occupations comprising 55.0 per cent of all occupations. The dominance of industrial occupations can be attributed to the longer period of time available for these jobs to subdivide and specialize, as well as to a pro-industrial bias built into the *DOT* from its inception during the late Depression years.

Summary and research agenda

The classification system presented in this paper organizes information work into five categories representing the primary tasks of various jobs. Using this classification system, the standardized occupational descriptions that are currently catalogued by the Federal government were classified according to the presence of information work in them.

The value of studying information work is in the insight the analysis can provide about society at large. If work is the essential activity of sustenance in a given society, then understanding work behaviour is a prerequisite for understanding the nature of that society. In this case, the emergence of information as a significant and widespread work activity may represent a phenomenon which is redefining the meaning of work for a whole society.

The value of this new classification system is in the behavioural approach it takes, rather than one based on economic output. Our primary concern in this article has been to identify the behavioural characteristics of information work as it is performed by individual workers. Unlike the question, 'To what extent is the GNP composed of information activities?', asked by Machlup and Porat, we have asked, 'To what extent do Americans manipulate information as their principal work activity?' Clearly the two questions are related; yet the first focuses on economic exchange and on information as a tangible good, while the second focuses on work as fundamental and complex human social behaviour.

In this article, we have noted the diversity and extensiveness of information-related jobs. A great number of the known occupations in the US are jobs whose primary activity involves information producing or processing. Two immediate interpretations are suggested by these findings. First, from the large representation of information work in the range of occupational descriptions published by the Federal government it is reasonable to infer that there is a correspondingly large percentage of Americans who are by definition information workers. Second, the information occupations which are present in today's labour force may be redefinitions of traditional occupations which have existed in one form or another for thousands of years (as in the case of physicians), or they may be occupations which did not exist even a generation ago (such as microchip assemblers). This shift toward an emphasis on information manipulation in so many jobs may be the critical social change that has been sensed by social researchers, and which has prompted increased scholarly comment.

The data presented above have helped to resolve the problems of defining information work. Yet by attempting to solve these problems, new questions have been raised.

Research agenda

In future analyses, a deeper understanding of the nature of information work may be gained by conducting research along several lines. First, because the 1977 *DOT* was the basis for occupational data gathered in the 1980 census, it will be possible to calculate the actual number of information workers in the entire US labour force for that year.²⁷ Such a study would constitute the first occupationally-oriented analysis of information work. By using the five-category analysis framework, it is possible to measure the presence of information work within any industrial group, such as agriculture or aerospace.

Because US census and occupational data have been gathered regularly over the last two hundred years, it may also be possible to analyse information work at several points in the past, thus giving an historical view of the evolution of information work. Even when the immense difficulties of analysing data gathered at different times, under different assumptions and within different social settings are considered, the opportunity to gain a long-term view of the development of information work is worth taking.

The meaning and social context of information work can be discovered by linking the analytical framework used in this study (archival data analysis) with qualitative field work. The use of multiple methods is powerful. Just as the analysis of archival data addresses the external representation of information work in society, ethnographic methods would allow researchers to discover the internal, subjective experiences of people at work.

In another direction, it is possible that the social distance between work and home, or between public life and private life, may be diminishing, due to the presence of information activities in both places. The pervasiveness of these activities may change people's attitudes and expectations and alter social structures. Thus, the values and behaviour of those who spend the bulk of their work and leisure time in front of a video screen might be of special interest. Similarly, the introduction into the home of activities normally associated with the workplace (and vice versa) would be an interesting area of study. While the evolution of new social structures (dependent upon a decreased social distance between work and home) is uncertain, it cannot be easily dismissed. It is a notion which requires our attention as social scientists, especially as information researchers.

As a final point, the data presented in this study underscore the broad changes that seem to be in progress in American society. The main theoretical question remains before us: are we seeing the advent of a fundamentally new society (an 'information society') or is industrial society simply evolving into a more sophisticated phase?

The data presented here indicate that information plays a prominent role in the nature of work in America. This may indeed be the first step toward an 'information society'. If it can be demonstrated that the social context or organization of work has also changed, then perhaps a second step will have been taken. In any case, a comprehensive understanding of information work as a manifestation of contemporary American society is essential.

²⁷This task is not as simple as it might seem, due to various coding systems and the wide variety of occupational groupings imposed on census data by different Federal agencies and bureaus.